NEAR EARTH ASTEROIDS (NEAs)
A CHRONOLOGY OF MILESTONES 1800 - 2200

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(completeness not pretended)

Introduction

An asteroid is coined a **Near Earth Asteroid** (**NEA**) when its trajectory brings it within 1.3 AU from the Sun. A **NEA** is said to be a **Potentially Hazardous Asteroid** (**PHA**) when its orbit comes to within 0.05 AU (= 19.5 LD = 7.5 million km) of the Earth's orbit and has a measured absolute magnitude $H < 22$ mag (i.e., an estimated diameter $D > 140$ m).

As of 1 June 2021, 25946 **NEA**s are registered by *NASA JPL CNEOS*, including
891 **NEA**s with $D >$ 1 km (94.8 % of an estimated population of 940 ± 10);
8,782 **NEA**s with 1 km $> D >$ 140 m (35.1 % of an estimated population of 25,000);
7,974 **NEA**s with 140 m $> D >$ 40 m (1.59 % of an estimated population of 500,000);
4,572 **NEA**s with 40 m $> D >$ 20 m (0.18 % of an estimated population of 2,500,000);
3,728 **NEA**s with 20 m $> D$.
Among the km-size **NEA**s, 157 of those are **PHA**s.

Amor, **Apollo**, **Aten** and **Atira NEA**s

Definitions

Amor	Earth approaching asteroid with orbit exterior to Earth's orbit, but interior to the orbit of Mars. **Amor** was discovered 12 March 1932.
Apollo	Earth orbit crossing asteroid with semi-major axis larger than that of Earth. **Apollo** was discovered 24 April 1932.
Aten	Earth orbit crossing asteroid with semi-major axis smaller than that of Earth. **Aten** was discovered 7 January 1976.
Atira	Earth approaching asteroid with orbit interior to Earth's orbit. **Atira** was discovered 11 February 2003.

Occurrence

As of 30 May 2021, the 25945 registered **NEA**s include 14471 **Apollo**s (55.8 %), 9449 **Amor**s (36.4 %), 2002 **Aten**s (7.72 %), and 23 **Atira**s (0.09 %).

First *observed* **NEA** flyby at $d < 1$ LD : 18 Jan 1991, **1991 BA** ($D \approx 8$ m).
First *observed* **NEA** flyby at $d < 0.1$ LD : 31 Mar 2004, **2004 FU162** ($D \approx 8$ m).

Closest *observed* **NEA** flyby, at $d \approx 1.06\ R_{Earth}$ from the geocenter, on 13 Nov 2020: **2020 VT4** ($D \approx 6$ m).
One but closest *observed* **NEA** flyby, at $d \approx 1.46\ R_{Earth}$ from the geocenter, on 16 Aug 2020: **2020 QG** ($D \approx 4$ m).
See: https://www.jpl.nasa.gov/news/news.php?feature=7728

But see also: http://neo.ssa.esa.int/newsletters [4 September 2020]

The *NEA chronology* lists:

(*a*) data of known **NEA**s with past nominal Earth close approach distances $d \leq 1.00$ LD;
(*b*) data of known **NEA**s with future nominal Earth close approach distances $d \leq 10.00$ LD and minimum close approach distances $d \leq 1.00$ LD;
(*c*) data of known **PHA**'s with $H \leq 22$ mag and nominal Earth close approach distances $d \leq 5.00$ LD;
(*d*) scientific literature, conferences and other milestones of **NEO** research.
(e) interstellar minor planets
The *NEA Chronology* is updated monthly and can be downloaded as pdf file.

Information on categories (a) and (b) is quoted from both the ESA NEO Coordination Centre Close Approach Tables and the NASA JPL CNEOS Close Approach Tables for the period 1900 – 2200 A.D., as of 01 June 2021.
By listing in chronological order this broad selection of milestones of **NEO** research, a global impression is offered of what has been done and has happened, and what is being done and will happen in those fields, as far as presently known.

As 01 June 2021, the *NEA Chronology* lists 5702 entries of known *past* events registered since AD 1800, including 734 *observed* (the first one in 1991: **1991 BA**) *and calculated* close approaches of **NEA**s ranging in size from 1 to 325 m (including 7 **PHA**s, one in the km class (**2011 MD5)**) with nominal Earth close approach distances $d \leq 1.00$ LD (82 in 2019; 107 in 2020; to date 60 in 2021), 40 of which with $d \leq 0.10$ LD. Moreover, seven impacts have been recorded: on 30 June 1908 (Tunguska), 6 October 2008 (**2008 TC3**, Sudan), 15 February 2013 (Chelyabinsk), 2 January 2014 (**2014 AA**, off the coast of West Africa), 2 June 2018 (**2018 LA**, Botswana), 18 December 2018 (Bering Sea), and on 22 June 2019 (**2019 MO**, Caribbean Sea).

As of 01 June 2021, the *NEA Chronology* lists 668 entries of known *future* events announced and predicted up to AD 2200, of which 344 *predicted* close approaches of **NEA**s with nominal Earth close approach distances $d \leq 10.00$ LD and minimum close approach distances $d \leq 1.00$ LD (i.e., about one per year), including 55 *predicted* close approaches of **NEA**s with nominal Earth close approach distances $d \leq 1.00$ LD (10 of which are **PHA**s, one in the km class (**2001 WN5**) and one with $d \leq 0.10$ LD (**Apophis**)).

Colour coding

green bold	asteroid, meteorite, impact site
purple bold	Potentially Hazardous Asteroid
red bold italics	spacecraft
red bold	spacecraft subsystem
blue bold	NEA related institute, observatory, organization, program

blue bold italics NEA related conference, meeting, workshop, seminar

Sources

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https://www.nasa.gov/planetarydefense/overview
http://neo.ssa.esa.int/neo-home
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https://en.wikipedia.org/wiki/1862_Apollo
https://en.wikipedia.org/wiki/1221_Amor
https://en.wikipedia.org/wiki/2062_Aten
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See: http://adsabs.harvard.edu/abs/2015Icar..257..302H
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See: https://ui.adsabs.harvard.edu/abs/2021Icar..36514452H/abstract
- D.K. Yeomans, 2013, "Near-Earth Objects ---Finding them before they find us" (Princeton and Oxford : Princeton University Press)

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NEA CHRONOLOGY 1800 - 2200

1801, Jan 1	First and largest asteroid discovered, **1 Ceres** (*H* = 3.34 mag, *D* ≈ 975 km, main-belt asteroid), by Giuseppe Piazzi (1746 – 1826, Italy) at the Osservatorio Astronomico di Palermo. Asteroid **Cerere Ferdinandea** was named in honour of King Ferdinand IV of Sicily, and later became known simply as **Ceres**. Carl Gauss developed the math to determine an accurate orbit for **Ceres** and published his results in November 1801. Given the definition of planets and dwarfplanets accepted by the IAU XXVI General Assembly in 2006, **Ceres** is considered a dwarf planet rather than an asteroid. See: Ceres - JPL , 1 Ceres - SSA https://ssd.jpl.nasa.gov/sbdb.cgi?sstr=Ceres Ref: - G. Piazzi, 1802, *Della scoperta del nuovo planeta Cerere Ferdinandea* (Palermo: Nella Stamperia Reale).

	See: https://archive.org/details/DellaScopertaDelNuovoPianetaCerereFerdinandea See also: http://www.space.com/12969-giant-asteroid-ceres-telescopes-skywatching.html http://en.wikipedia.org/wiki/Ceres_(dwarf_planet) **More recently:** Since 6 March 2015, NASA spacecraft ***Dawn*** is in orbit around **Ceres**. See: http://www.jpl.nasa.gov/news/news.php?feature=4503 http://www.jpl.nasa.gov/news/news.php?feature=4540
1803, 26 Apr	**L'Aigle Meteorite Fall**. In the early afternoon of 26 April 1803 a meteorite shower of more than 3000 fragments fell upon the town of L'Aigle (Normandy, France). Ref: - M. Gounelle, 2003, in ***66th Annual Meteoritical Society Meeting*** (2003), *Meteoritics & Planetary Science*, 38, Supplement, abstract no.5251, "The **meteorite fall at l'Aigle** on April 26th 1803 and the Biot report." See: http://adsabs.harvard.edu/abs/2003M%26PSA..38.5251G See also: http://en.wikipedia.org/wiki/L'Aigle_(meteorite)
1807, Dec 14	**Weston Meteorite**. At 6:30 hr on the morning of 14 December 1807, a blazing fireball about two-thirds the size of the Moon was seen traveling southwards by early risers in Vermont and Massachusetts (USA). Three loud explosions were heard over the town of Weston in Fairfield County, Connecticut. Stone fragments fell in at least 6 places. See: http://peabody.yale.edu/collections/meteorites-and-planetary-science/weston-meteorite http://en.wikipedia.org/wiki/Weston_meteorite
1840, Jun 12	**Uden Meteorite** (Netherlands). A 0.6 kg meteorite was found. See: http://www.dwc.knaw.nl/DL/publications/PU00015500.pdf http://www.sterrenkunde.nl/index/encyclopedie/meteoren.html
1843, Jun 2	**Blauwkapel Meteorite** (Netherlands). Two pieces were found, of 2.7 and 7 kg. See: http://www.dwc.knaw.nl/DL/publications/PU00015500.pdf http://www.sterrenkunde.nl/index/encyclopedie/meteoren.html
1859, Nov 15	**New York City Fireball and Airburst** (USA). See:

	http://www.meteoritehistory.info/AJS/S2VIEWS/V30P186.HTM http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1860, Jul 20	The **Meteor Procession** of 20 July 1860, visible from the Great Lakes to New York State (USA), continuing out over the Atlantic Ocean. Ref: - Walt Whitman, 1859-1860, in *Leaves of Grass*, "Year of Meteors."; - A.G. Pope, 5-1-2010, *Astronomical dating of Edvard Munch's summer sky paintings*, University Honors Program, Texas State University; - R. Sinnott, 2010, *Sky & Telescope*, 7 June 2010, "Walt Whitman's "Meteor-Procession"." See: http://www.skyandtelescope.com/community/skyblog/newsblog/95765719.html - D.W. Olson, R.L Doescher, M.S. Olson, A.G. Pope, 2010, *Sky & Telescope*, 120, No.1, July 2010, p. 28, "Walt Whitman's "Year of Meteors"." See: http://www.skyandtelescope.com/community/skyblog/newsblog/95765719.html http://philosophyofscienceportal.blogspot.com/2010/06/walt-whitman-wrote-about-strange-huge.html http://www.txstate.edu/news/news_releases/news_archive/2010/06/YearOfMeteors060110.html http://www.newscientist.com/gallery/whitman-mystery-solved/3 http://www.newscientist.com/blogs/culturelab/2010/06/the-forensic-astronomer-donald-olson.html http://cosmiclog.msnbc.msn.com/_news/2010/06/02/4448882-150-year-old-meteor-mystery-solved http://apod.nasa.gov/apod/ap100722.html http://en.wikipedia.org/wiki/Earth-grazing_fireball
1864, May 14	**Orgueil Meteorite** rain over Orgueil (Southern France). Some 20 stones fell over an area of several square kilometers, with a total weight of 14 kg. Ref: - M. Gounelle, P. Spurný, P.A. Bland, 2006, *Meteoritics & Planetary Science*, 41, 135, "The orbit and atmospheric trajectory of the **Orgueil meteorite** from historical records." See: http://www.springerlink.com/content/m470723364612j6x/ See also: http://en.wikipedia.org/wiki/Orgueil_(meteorite)
1868, July 11	Main-belt asteroid **100 Hekate** (H = 7.66 mag, $D \approx$ 123 km) discovered by James C. Watson (1838 – 1880) at Ann Arbor (MI,

	USA). 100th numbered asteroid in the data base of the **IAU Minor Planet Center**, Cincinnati Observatory (Ohio, USA). See: 100 Hekate - JPL , 100 Hekate - SSA See also: http://en.wikipedia.org/wiki/100_Hekate
1873, Oct 27	**Diepenveen Meteorite Fall**, Diepenveen (the Netherlands). See: http://www.naturalis.nl/en/news/collectie-2/new-dutch-meteorite-fell-1873/
1890, May 2	**Forest City Meteorite Fall**, Forest City (Iowa, USA), 2 May 1890. Ref: - H.H. Nininger, 1942, *Popular Astronomy*, 50, 111, "A celestial bomb." See: http://en.wikipedia.org/wiki/Meteorite_falls
1891, Dec 22	First photographic discovery of an asteroid, **323 Brucia** (H = 9.53 mag, $D \approx$ 35.8 km), by Maximilian F.J.C. Wolf (1863 – 1932) at the Landessternwarte Heidelberg-Königstuhl (Heidelberg, Germany). See: Brucia - JPL , Brucia - SSA See also: http://en.wikipedia.org/wiki/323_Brucia
1893	G.K. Gilbert (1893) suggested impacts as most likely process for forming lunar craters. Ref: - G.K. Gilbert, 1893, *Bulletin of the Philosophical Society of Washington*, 12, 241, "The Moon's face: a study of the origin of its features." See: http://adsabs.harvard.edu/abs/1893QB591.G46......
1896, Feb 2	**Great Madrid Meteor Event**. See: http://adsabs.harvard.edu/full/1896PASP....8...86C http://en.wikipedia.org/wiki/Chelyabinsk_meteor
1898, Aug 13	First discovery of a NEA: asteroid **433 Eros** (**1898 DQ**, H = 10.3 mag, $D \approx 34.4 \times 11.2 \times 11.2$ km, orbital P = 1.76 yr, Amor asteroid), by Carl Gustav Witt (1866 – 1948) at the Urania Sternwarte Berlin (Germany), and independently by Auguste Charlois (1864 – 1910) at the Observatoire de Nice (France). **Second-largest NEA known**. Its perihelion distance of 1.133 AU brings it with 0.15 AU of the orbit of the Earth. See: 1898 DQ - JPL , 433 Eros - SSA See also: http://en.wikipedia.org/wiki/433_Eros

	Ref: - P. Michel, P. Farinella, Ch. Froeschlé, 1996, *Nature*, 380, 689, "The orbital evolution of the asteroid **Eros** and implications for collision with the Earth." See: http://adsabs.harvard.edu/abs/1996Natur.380..689M See also: http://www.oaa.gr.jp/~oaacs/mp/BriefHistoryofMPCbyConradBardwell.pdf See also: **23 Jan 1975**, **31 Jan 2012**.
1899, Mar 12	**Helsinki Fireball and Airburst (**Finland). See: http://www.somerikko.net/collection/meteorites.php?id=374 http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1900, Jan 1	**1 NEA** known. See: http://neo.jpl.nasa.gov/stats/
1900, Jan 4	Aten NEA **509352** (**2007 AG**, *H* = 20.2 mag, *D* ≈ 300 m, **PHA**), passed Earth at a nominal miss distance of 3.75 LD. Minimum miss distance 3.75 LD. See: 2007 AG - JPL , 2007 AG - SSA See also: **4 Jan 1919.**
1900, Jan 29	Apollo NEA **4660 Nereus** (**1982 DB**, *H* = 18.3 mag, *D* ≈ 510 x 330 240 m, **PHA**) passed Earth at a nominal distance of 8.09 LD. Minimum distance 8.08 LD. See: 1982 DB - JPL , 4660 Nereus - SSA https://ssd.jpl.nasa.gov/sbdb.cgi?sstr=4660 Nereus See also: http://en.wikipedia.org/wiki/4660_Nereus Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B - K. Kitazato, S. Abe, M. Ishiguro, et al., October 2012, *AAS DPS meeting* #44, #210.20, "Measuring the YORP effect of asteroid **4660 Nereus**." See: http://adsabs.harvard.edu/abs/2012DPS....4421020K See also: **22 Jan 2002, 11 Dec 2021**, **14 Feb 2060**, **4 Feb 2071**, **23 Dec 2112**, **4 Feb 2166**.
1900, May 10	Aten NEA **326290 Akhenaten** (**1998 HE3**, *H* = 22.0 mag, *D* ≈ 100 m, **PHA**), passed Earth at a nominal miss distance of 4.01 LD. Minimum miss distance 4.01 LD. See: 1998 HE3- JPL , 1998 HE3- SSA

1900, Jul 24	Apollo NEA **2007 HE15** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**), passed Earth at a nominal miss distance of 3.98 LD. Minimum miss distance 3.96 LD. See: 2007 HE15 - JPL , 2007 HE15 - SSA
1901, Jun 7	Aten NEA **2014 HQ124** (*H* = 19.0 mag, *D* ≈ 370 m, **PHA**), passed Earth at a nominal miss distance of 5.95 LD. Minimum miss distance 5.90 LD. See: 2014 HQ124 - JPL , 2014 HQ124 - SSA See also: https://www.google.nl/#q=asteroid+2014+hq124 https://en.wikipedia.org/wiki/2014_HQ124 See also: **7 Jun 1952, 8 Jun 2014, 8 Jun 2065**.
1901, Aug 14	Apollo NEA **2011 DS** (*H* = 26.8 mag, *D* ≈ 15 m), passed Earth at a nominal miss distance of 7.94 LD. Minimum miss distance 0.75 LD. See: 2011 DS - JPL , 2011 DS - SSA See also: **18 Feb 1966**, **18 Feb 2050**.
1902, May 22	Apollo NEA **2018 KS** (*H* = 28.0 mag, *D* ≈ 9 m), passed Earth at a nominal miss distance of 1.84 LD. Minimum miss distance 0.96 LD. See: 2018 KS - JPL , 2018 KS - SSA
1902**,** Nov 19	Aten NEA **2019 OR1** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**), passed Earth at a nominal miss distance of 3.80 LD. Minimum miss distance 2.40 LD. See: 2019 OR1 - JPL , 2019 OR1 - SSA See also: **20 Nov 2085 , 21 Nov 2100**, **21 Nov 2178**.
1903, Jan 13	Apollo NEA **2010 WZ8** (*H* = 20.9 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 3.51 LD. Minimum miss distance 3.51 LD. See: 2010 WZ8 - JPL , 2010 WZ8 - SSA See also: **13 Jan 2047**.
1903, Feb 18	Aten NEA **208023** (**1999 AQ10,** *H* = 20.6 mag, *D* ≈ 280 m, **PHA**), passed Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 4.28 LD. See: 1999 AQ10 - JPL , 1999 AQ10 - SSA See also: **18 Feb 2009**.
1903, Apr 24	Apollo NEA **2007 VG** (*H* = 21.4 mag, *D* ≈ 190 m, **PHA**) passed Earth at a nominal miss distance of 3.14 LD. Minimum miss distance 3.05 LD. See: 2007 VG - JPL , 2007 VG - SSA

	See also: **23 Apr 2062**.
1904, Oct 29	Apollo NEA **260141** (**2004 QT24** (*H* = 18.1 mag, *D* ≈ 900 m, **PHA**), passed Earth at a nominal miss distance of 2.30 LD. Minimum miss distance 2.29 LD. See: 2004 QT24 - JPL , 2004 QT24 - SSA
1905	C. Flammarion, 1905, *L'Astronomie*, 19, 309, "Si quelque jour la vertu disparaissait de la Terre, il serait convenable de la retrouver au ciel." See: http://gallica.bnf.fr/ark:/12148/bpt6k96408857
1905, Jun 3	Apollo NEA **2007 LU19** (*H* = 21.5 mag, *D* ≈ 180 m, **PHA**) passed Earth at a nominal miss distance of 2.97 LD. Minimum miss distance 2.97 LD. See: 2007 LU19 - JPL , 2007 LU19 - SSA
1905, Jun 27	Apollo NEA **25143 Itokawa** (**1998 SF36**, *H* = 19.1 mag, *D* = 520 × 270 × 230 m, *M* = 3.6 × 10^{10} kg, **PHA**) passed Earth at a nominal miss distance of 4.50 LD. Minimum miss distance 4.50 LD. See: 1998 SF36 - JPL , 25143 Itokawa - SSA See also: **26 Jun 2004, 9 Apr 2167.** See also: https://en.wikipedia.org/wiki/25143_Itokawa
1906, Jan 11	Apollo NEA **2018 YO2** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 36.68 LD. Minimum miss distance 0.38. LD. See: 2018 YO2 - SSA , 2018 YO2 - JPL See also: http://iawn.net/ See also: **28 Dec 2018**.
1906, Feb 26	Apollo NEA **2014 PW59** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 3.98 LD. Minimum miss distance 3.67 LD. See: 2014 PW59 - JPL , 2014 PW59 - SSA See also: **1 Mar 1947**.
1906, Apr 11	Apollo NEA **2011 UH20** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**) passed Earth at a nominal miss distance of 4.70 LD. Minimum miss distance 4.54 LD. See: 2011 UH20 - JPL , 2011 UH20 - SSA See also: **11 Apr 1977**.
1907, Apr 5	Apollo NEA **2005 TS15** (*H* = 21.3 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.44 LD. Minimum miss distance 4.43 LD.

	See: 2005 TS15 - JPL , 2005 TS15 - SSA
1907, Apr 13	Aten NEA **99942 Apophis** (**2004 MN4**, H = 19.7 mag, D = 310 ± 30 m, orbital P = 0.89 yr, **PHA**) passed Earth at a nominal miss distance of 11.27 LD. Minimum miss distance 8.12 LD. See: 2004 MN4 - JPL , 99942 Apophis - SSA See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://en.wikipedia.org/wiki/99942_Apophis See also: **14 Apr 1949**, **14 Apr 1998**, **13 Apr 2029**, **23 Mar 2036**, **7 Apr 2123.**
1907, May 20	Apollo NEA **2001 SG286** (H = 20.8 mag, D ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 2.84 LD. Minimum miss distance 2.84 LD. See: 2001 SG286 - JPL , 2001 SG286286 - SSA
1907, Dec 26	Aten NEA **2010 XC15** (H = 21.6 mag, D ≈ 170 m, **PHA**) passed Earth at a nominal miss distance of 4.61 LD. Minimum miss distance 2.74 LD. See: 2010 XC15 - JPL , 2010 XC15 - SSA See also: https://en.wikipedia.org/wiki/2010_XC15 See also: **27 Dec 1914**, **27 Dec 1976**, **27 Dec 2022**, **28 Dec 2059**, **26 Dec 2064**, **26 Dec 2096**.
1908, Jun 2	Apollo NEA **2020 KQ1** (H = 24.2 mag, D ≈ 50 m) passed Earth at a nominal miss distance of 4.32 LD. Minimum miss distance 0.26 LD. See: 2020 KQ1 – S2P , 2020 KQ1- JPL
1908, Jun 30	**Impact.** **Tunguska event**, Siberia (Russia). According to Boslough & Crawford (2008), possibly an asteroid with D ≈ 30 – 50 m, exploding in an airburst with E ≈ 4 megaton TNT at an altitude of ~8.5 km, flattening ~2000 km^2 of forest. Ref: - L.A. Kulik, 1938, *Astronomical Society of the Pacific Leaflets*, 3, 78, "The meteorite of June 30, 1908, in Central Siberia." See: http://adsabs.harvard.edu/abs/1938ASPL....3...78K - A. Ben-Menahem, September 1975, *Physics of the Earth and Planetary Interiors*, 11, 1, "Source parameters of the **Siberian explosion of June 30, 1908**, from analysis and synthesis of seismic signals at four stations." See: http://adsabs.harvard.edu/abs/1975PEPI...11....1B - L'. Kresak, 1978, *Bulletin Astronomical Institutes of Czechoslovakia*, 29, 129, "The **Tunguska** object – a fragment of

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See: http://adsabs.harvard.edu/abs/2007caih.book.....B
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	asteroid, nor a comet core." See: http://adsabs.harvard.edu/abs/2013arXiv1302.6273R See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=179 http://www.time.com/time/photogallery/0,29307,1818757,00.html http://apod.nasa.gov/apod/ap111002.html https://sputniknews.com/analysis/20080626112250936/ https://sputniknews.com/science/201701181049718416-tunguska-event-lake-cheko/ http://en.wikipedia.org/wiki/List_of_meteor_air_bursts http://en.wikipedia.org/wiki/Tunguska_event
1908, Oct 3	Apollo NEA **2020 JN3** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 6.46 LD. Minimum miss distance 0.89 LD. See: 2020 JN3 – S2P , 2020 JN3 - JPL
1908, Dec 16	Aten NEA **33342** (**1998 WT24**, *H* = 18.3 mag, *D* ≈ 415 m, **PHA**) passed Earth at a nominal miss distance of 3.54 LD. Minimum miss distance 3.54 LD. See: 1998 WT24 - JPL , 1998 WT24 - SSA See also: http://neo.jpl.nasa.gov/images/1998wt24.html http://science.nasa.gov/science-news/science-at-nasa/2001/ast14dec_1/ http://www.jpl.nasa.gov/news/news.php?feature=4800 https://en.wikipedia.org/wiki/(33342)_1998_WT24 See also: **16 Dec 1956, 16 Dec 2001, 11 Dec 2015, 18 Dec 2099**.
1909, Mar 6	Apollo NEA **474158** (**1999 FA**, *H* = 20.9 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal distance of 4.20 LD. Minimum distance 4.16 LD. See: 1999 FA - JPL , 1999 FA - SSA See also: **6 Mar 1999**, **6 Mar 2143**, **7 Mar 2194**.
1909, Aug 28	Aten NEA **2016 QA2** (*H* = 25.3 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 5.83 LD. Minimum miss distance 0.27 LD. See: 2016 QA2- JPL , 2016 QA2 - SSA
1910, Jan 1	**1 NEA** known. See: http://neo.jpl.nasa.gov/stats/
1910	Minor planet astronomy became organized in a formal way at the **Rechen-Institut** in Berlin-Dahlem (Germany), director Fritz Cohn (1878 – 1940). Ref: - G. Stracke, 1935, *Astronomische Nachrichten*, 255, 189, "25

	Jahre genäherte Bearbeitung der Bahnen der Kleinen Planeten im Astronomischen Rechen-Institut." Predecessor of the MPC. See: http://adsabs.harvard.edu/abs/1935AN....255..189S See also: **1947**.
1910, May 9	Aten NEA **2007 JB21** (*H* = 25.8 mag, *D* ≈ 25 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.16 LD. **[1910-01]** See: 2007 JB21 - JPL , 2007 JB21 - SSA See also: **8 May 2054**.
1911, Jun 28	The **Nakhla Meteorite** fell to Earth on 28 June 1911 in the Nakhla region of Abu Hommos (Alexandria, Egypt). Many people witnessed its explosion in the upper atmosphere before the meteorite fell to Earth in an area of 4.5 km in diameter. About forty pieces were recovered. Recovered fragments ranged in weight from 20 to 1813 g. See: http://en.wikipedia.org/wiki/Nakhla_meteorite
1911, Sep 8	Amor NEA **719 Albert** (**A911 TB** = **2000 JW8**, *H* = 15.8 mag, *D* ≈ 2400 m) passed Earth at 80 LD. Discovered by Johann Palisa (1848 – 1925), discoverer of 122 asteroids at the Vienna Observatory (Austria). Lost (the last missing), but rediscovered 1 May 2000 by Jeffrey A. Larsen with the **Spacewatch Telescope** in Arizona (USA). See: 2000 JW8 - JPL , 719 Albert - SSA See also: http://www.space.com/scienceastronomy/asteroid_found_000510.html http://en.wikipedia.org/wiki/719_Albert http://en.wikipedia.org/wiki/Johann_Palisa
1912, Sep 11	Apollo NEA **2001 FA58** (*H* = 21.5 mag, *D* ≈ 180 m, **PHA**) passed Earth at a nominal miss distance of 4.60 LD. Minimum miss distance 4.60 LD. See: 2001 FA58 - JPL , 2001 FA58 - SSA
1913, Feb 9	**Earth-grazing fireball**. A meteor procession observed from Canada to Bermuda and beyond. Ref: - J.A. O'Keefe, 1959, *Journal Royal Astronomical Society of Canada*, 53, 59, "A probable natural satellite: the meteor procession of February 9, 1913." As of 2008, four **Earth-grazing fireballs** have been scientifically observed: on 10 August 1972, 13 October 1990, 29 March 2006, and 7 August 2007. See: http://adsabs.harvard.edu/abs/1959JRASC..53...59O

	http://en.wikipedia.org/wiki/Earth-grazing_fireball
1913, Apr 2	Apollo NEA **2020 GY1** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 9.67 LD. Minimum miss distance 0.83 LD. See: 2020 GY1 – S2P , 2020 GY1 - JPL See also: **5 Apr 2020**, **5 Apr 2033**.
1913, Sep 30	Apollo NEA **2012 GV17** (*H* = 20.1 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 2.20 LD. Minimum miss distance 2.08 LD. See: 2012 GV17 - JPL , 2012 GV17 - SSA
1914, Mar 10	Apollo NEA **2016 CY135** (*H* = 24.5 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 2.28 LD. Minimum miss distance 0.80 LD. See: 2016 CY135 - JPL , 2016 CY135- SSA See also: **11 Mar 2068**.
1914, Oct 29	Apollo NEA **69230 Hermes** (**1937 UB**, *H* = 17.5 mag, *D* ≈ 1100 m, **PHA**) passed Earth at a nominal distance of 9.74 LD. Minimum distance 9.70 LD. Discovered by Karl W. Reinmuth (1892 – 1979) at the Landessternwarte Heidelberg-Königstuhl (Heidelberg, Germany); lost; recovered 15 October 2003. **Arecibo** radar observations on the same day revealed it to be a binary asteroid, with components of *D* ≈ 400 m, separated by 1200 m. See: 1937 UB - JPL , 69230 Hermes - SSA See also: http://science.nasa.gov/headlines/y2003/31oct_hermes.htm http://www.news.cornell.edu/releases/Oct03/Arecibo.asteroid.deb.html http://adsabs.harvard.edu/abs/2003IAUC.8227....2M http://en.wikipedia.org/wiki/69230_Hermes See also: **30 Oct 1937, 26 Apr 1942, 1 Nov 1954**, **31 Oct 2086, 30 Apr 2123**.
1914, Dec 18	Apollo NEA **2017 YE** (*H* = 28.7 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 5.57 LD. Minimum miss distance 0.34 LD. See: 2017 YE - JPL , 2017 YE - SSA
1914, Dec 27	Aten NEA **2010 XC15** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) passed Earth at a nominal miss distance of 2.00 LD. Minimum miss distance 1.94 LD. See: 2010 XC15 - JPL , 2010 XC15 - SSA See also: **26 Dec 1907**, **27 Dec 1976**, **27 Dec 2022**, **28 Dec 2059**, **26 Dec 2064**, **26 Dec 2096**.

	See also: https://en.wikipedia.org/wiki/2010_XC15
1914, Dec 31	Apollo NEA **152680 (1998 KJ9**, *H* = 19.4 mag, *D* ≈ 500 m, **PHA**) passed Earth at a nominal miss distance of 0.61 LD. Minimum miss distance 0.60 LD. **[1914-01]** See: 1998 KJ9 - JPL , 152680 1998 KJ9 - SSA See also: http://en.wikipedia.org/wiki/(152680)_1998_KJ9
1915, May 15	Apollo NEA **2000 SL10** (*H* = 22.5 mag, *D* ≈ 110 m, **PHA**) passed Earth at a nominal miss distance of 4.32 LD. Minimum miss distance 3.86 LD. See: 2000 SL10 - JPL , 2000 SL10 - SSA See also: **14 May 2029**.
1915, Aug 8	Aten NEA **2018 MD7** (*H* = 22.6 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.23 LD. **[1915-01]** See: 2018 MD7 - JPL , 2018 MD7 - SSA
1915, Sep 10	Apollo NEA **2010 RF12** (*H* = 28.1 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 1.22 LD. Minimum miss distance 1.10 LD. See: 2010 RF12 - JPL , 2010 RF12 - SSA See also: http://en.wikipedia.org/wiki/2010_RF12 See also: **8 Sept 2010, 5 Sep 2095**.
1916, Mar 12	Apollo NEA **216985** (**2000 QK130**, *H* = 21.3 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.67 LD. Minimum miss distance 4.59 LD. See: 2000 QK130 - JPL , 2000 QK130 - SSA See also: **14 Mar 1968**, **15 Mar 2036**, **15 Mar 2089**.
1917, Oct 4	Apollo NEA **2008 TC3** (*H* = 30.3 mag, *D* ≈ 4.1 m) passed Earth at a nominal miss distance of 6.80 LD. Minimum miss distance 1.06 LD. See: 2008 TC3 - JPL , 2008 TC3 - SSA See also: https://en.wikipedia.org/wiki/2008_TC3 See also: **11 Oct 1961**, **2 Oct 1971**, **27 Jan 1988, 6 Oct 2008**.
1918, Feb 17	Aten NEA **367943 Duende** (**2012 DA14**, *H* = 24.2 mag, *D* ≈ 40 × 20 m), discovered in 2012 by the Spanish **Observatorio Astronomico de la Sagra**, passed Earth at a nominal miss distance of 1.13 LD. Minimum miss distance 1.13 LD.

	See: 2012 DA14 - JPL , 367943 Duende - SSA See also: https://en.wikipedia.org/wiki/367943_Duende See also: **19 Aug 2004**, **16 Feb 2012**, **15 Feb 2013**, **15 Feb 2046, 15 Feb 2087**.
1918, Sep 17	Apollo NEA **458732** (**2011 MD5**, *H* = 17.8 mag, *D* ≈ 1000 m, **PHA**) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[1918-01]** See: 2011 MD5 - JPL , 2011 MD5 - SSA
1919, Jan 4	Aten NEA **509352** (**2007 AG**, *H* = 20.2 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 1.95 LD. Minimum miss distance 1.95 LD. See: 2007 AG - JPL , 2007 AG - SSA See also: **4 Jan 1900**.
1919, Nov 26	**Michigan - Indiana Fireball and Airburst** (USA). See: http://chroniclingamerica.loc.gov/lccn/sn84026749/1919-11-27/ed-1/seq-1/ http://neo.ssa.esa.int/newsletters (5 November 2019) http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1919, Dec 21	Amor NEA **2015 JQ1** (*H* = 20.5mag, *D* ≈ 280 m) passed Earth at a nominal miss distance of 9.94 LD. Minimum miss distance 0.28 LD. See: 2015 JQ1 - JPL , 2015 JQ1 - SSA
1920, Jan 1	**3 NEAs** known, of which **0 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1920, Feb 10	Apollo NEA **2019 CB2** (*H* = 26.1 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 2.90 LD. Minimum miss distance 0.80 LD. See: 2019 CB2 - SSA , 2019 CB2 - JPL
1920, Jun 20	Apollo NEA **2017 MF** (*H* = 26.4 mag, *D* ≈ 19 m) passed Earth at a nominal miss distance of 1.17 LD. Minimum miss distance 0.32 LD. See: 2017 MF - SSA , 2017 MF - JPL See also: **19 Jun 2017**.
1920, Dec 13	Apollo NEA **2016 WJ1** (*H* = 21.4 mag, *D* ≈ 180 m, **PHA**) passed Earth at a nominal miss distance of 4.49 LD. Minimum miss distance 4.36 LD. See: 2016 WJ1 - JPL , 2016 WJ1 - SSA

	See also: **14 Dec 2061**, **14 Dec 2097**.
1920, Dec 20	Apollo NEA **2015 YQ1** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 4.98 LD. Minimum miss distance 0.23 LD. See: 2015 YQ1- SSA , 2015 YQ1 - JPL
1921	Alfred Wegener (1880 – 1930, Germany), 1921, *Die Entstehung der Mondkrater* (Braunschweig: Friedrich Vieweg & Sohn). Translation: A. Wegener, 1975, *The Moon*, 4, 211, "The origin of lunar craters." See: http://adsabs.harvard.edu/abs/1975Moon...14..211W
1921, Oct 20	Apollo NEA **2340 Hathor** (**1976 UA**, *H* = 20.5 mag, *D* ≈ 210 m, **PHA**) passed Earth at a nominal miss distance of 3.82 LD. Minimum miss distance 3.82 LD. See: 1976 UA - JPL , 1976 UA - SSA See also: **20 Oct 1976**, **21 Oct.2069**, **21 Oct 2086**.
1922, Apr 30	Aten NEA **2020 JG** (*H* = 25.9 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 3.79 LD. Minimum miss distance 0.52 LD. See: 2020 JG – S2P , 2020 JG – JPL See also: **30 Apr 2020**.
1922, Jun 7	Apollo NEA **2017 LD** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance **0.025 LD (= 1.50 R_{Earth} from the geocenter)**. **[1922-01]** See: 2017 LD - SSA , 2017 LD - JPL
1923	Discovery of asteroid **1000 Piazzia (1923 NZ**, (*H* = 10.6 mag, *D* = 27 km, Main-belt asteroid), by Karl W. Reinmuth (1892 – 1979) at the Landessternwarte Heidelberg-Königstuhl in Heidelberg (Germany). Upon his proposal, the **IAU** named the asteroid **1000 Piazzia**, being the 1000th documented asteroid, in honour of Giuseppe Piazzi who discovered asteroid **Ceres** in 1801. See: 1923 NZ - JPL , 1000 Piazzia - SSA See also: http://en.wikipedia.org/wiki/1000_Piazzia Ref: - B. Asplind, 1926, *Astronomische Nachrichten*, 228, 89, "Benennung der Planeten 1000 – 1002." See: http://adsabs.harvard.edu/abs/1926AN....228...89A
1924, Jun 5	Aten NEA **163348** (**2002 NN4**, *H* = 20.3 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 4.49 LD. Minimum

	miss distance 4.48 LD. See: 2002 NN4- JPL , 2002 NN4 - SSA See also: **6 Jun 1965**, **6 Jun 2070**, **7 Jun 2130**.
1924, Aug 22	Apollo NEA **513126** (**1998 QP**, *H* = 21.6 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.25 LD. Minimum miss distance 4.25 LD. See: 1998 QP - JPL , 1998 QP - SSA See also: **23 Aug 1998**.
1924, Sep 27	Apollo NEA **2003 SR84** (*H* = 25.9 mag, *D* ≈ 29 m) passed Earth at a nominal miss distance of 1.68 LD. Minimum miss distance 0.10 LD. See: 2003 SR84 - JPL , 2003 SR84 - SSA
1924, Oct 23	Discovery of Amor NEA **1036 Ganymed** (**A924 UB**, *H* = 9.45, *D* = 36.5 km, orbital *P* = 4.34 yr), by W.H. Walter Baade at Hamburg-Bergedorf Observatory (Germany). **Largest known NEA**. In 1998, Arecibo radar images revealed a near spherical object. See: 1924 TD - JPL , 1036 Ganymed - SSA See also: http://en.wikipedia.org/wiki/1036_Ganymed Ref: - G. Hahn, P. Magnusson, A.W. Harris, et al., 1989, *Icarus*, 78, 363, "Physical studies of Apollo-Amor asteroids - *UBVRI* photometry of **1036 Ganymed** and **1627 Ivar**." See: http://adsabs.harvard.edu/abs/1989Icar...78..363H - P. Michel, R. Gonczi, P. Farinella, Ch. Froeschlé, 1999, *Astronomy & Astrophysics*, 347, 711, "Dynamical evolution of **1036 Ganymed**, the largest near-Earth asteroid." See: http://adsabs.harvard.edu/abs/1999A%26A...347..711M - S.K. Fieber-Beyer, M.J. Gaffey, P.A. Abell, 2011, *Icarus*, 212, 149, "Mineralogical characterization of Near Earth Asteroid **(1036) Ganymed**. See: http://adsabs.harvard.edu/abs/2011Icar..212..149F
1924, Dec 20	Aten NEA **2020 XY4** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 1.59 LD. Minimum miss distance 0.03 LD. See: 2020 XY4 – S2P , 2020 XY4 – JPL See also: **21 Dec 1958**.
1925, Aug 28	**Ellemeet Meteorite**. Whit aloud noise, so that horses and cows took fright, this meteorite fell down in a meadow near Ellemeet, on the island of Schouwen (the Netherlands) on 28 August 1925,

	about 11:30 hr a.m. See: http://www.sterrenkunde.nl/index/encyclopedie/meteoren.html Ref: - A.A. Nijland, 1927, *Hemel en Dampkring*, 1927, 187, "Een merkwaardige meteoorsteen." - W. Nieuwenkamp, 1927, *Proc. Koninklijke Nederlandse Academie van Wetenschappen*, 1927, 724, "The **Meteorite of Ellemeet** (after that of Uden in 1840, and that of Blauwkapel in 1843, the third known in the Netherlands)." See: http://www.dwc.knaw.nl/DL/publications/PU00015500.pdf
1925, Aug 30	Apollo NEA **163132 (2002 CU11**, H = 18.7 mag, $D \approx$ 460 m, **PHA**) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD. **[1925-01]** See: 2002 CU11 - JPL , 163132 2002 CU11 - SSA See also: https://en.wikipedia.org/wiki/(163132)_2002_CU11 See also **31 Aug 2080**.
1926, Nov 29	Apollo NEA **2015 XG55** (H = 27.9 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 7.61 LD. Minimum miss distance 0.92 LD. See: 2015 XG55 – SSA , 2015 XG55 – JPL
1927, Mar 14	Apollo NEA **275677 (2000 RS11**, H = 19.0 mag, $D \approx$ 600 m, **PHA**) passed Earth aat a nominal miss distance of 3.15 LD. Minimum miss distance 3.15 LD. See: 2000 RS11 - JPL , 2000 RS11 - SSA See also: **13 Mar 1940**.
1927, Apr 11	Apollo NEA **2002 JE9** (H = 21.2 mag, $D \approx$ 200 m, **PHA**) passed Earth at a nominal miss distance of 3.86 LD. Minimum miss distance 0.20 LD See: 2002 JE9 - JPL , 2002 JE9 - SSA See also: **11 Apr 1971**. See also: http://en.wikipedia.org/wiki/2002_JE9
1927, Dec 17	Apollo NEA **2016 XA2** (H = 21.8 mag, $D \approx$ 150 m, **PHA**) passed Earth at a nominal miss distance of 1.60 LD. Minimum miss distance 0.86 LD. See: 2016 XA2 - JPL , 2016 XA2 - SSA
1927, Dec 31	Apollo NEA **2018 WR1** (H = 20.3 mag, $D \approx$ 300 m, **PHA**) passed Earth at a nominal miss distance of 4.74 LD. Minimum miss distance 2.82 LD. See: 2018 WR1 – SSA , 2018 WR1 – JPL

1928, Jan 23	Apollo NEA **2010 XC25** (*H* = 21.1 mag, *D* ≈ 210 m, **PHA**) passed Earth at a nominal miss distance of 2.34 LD. Minimum miss distance 2.20 LD. See: 2010 XC25 - JPL , 2010 XC25 - SSA
1928, Apr 25	Aten NEA **2011 DV** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) passed Earth at a nominal miss distance of 1.53 LD. Minimum miss distance 1.11 LD. See: 2011 DV - JPL , 2011 DV - SSA See also: **25 Apr 2120**.
1928, Nov 20	Apollo NEA **2005 LW3** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) passed Earth at a nominal miss distance of 4.17 LD. Minimum miss distance 4.16 LD. See: 2005 LW3 - JPL , 2005 LW3 - SSA See also: **23 Nov 2022**, **22 Nov 2084**.
1929, Mar 3	Aten NEA **2019 VV** (*H* = 25.3 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 8.07 LD. Minimum miss distance 0.84 LD. See: 2019 VV – SSA , 2019 VV – JPL
1929, Mar 16	Aten NEA **2021 FC** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 6.30 LD. Minimum miss distance 0.50 LD. See: 2021 FC – S2P , 2021 FC – JPL
1929, Apr 4	Apollo NEA **2007 SQ6** (*H* = 22.0 mag, *D* ≈ 140 m, **PHA**) passed Earth at a nominal miss distance of 4.53 LD. Minimum miss distance 3.74 LD. See: 2007 SQ6 - JPL , 2007 SQ6 - SSA See also: **3 Apr 2072**.
1929, Nov 1	Apollo NEA **2016 VP1** (*H* = 27.3 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 7.07 LD. Minimum miss distance 0.62 LD. See: 2016 VP1 - JPL , 2016 VP1 - SSA See also: **2 Nov 2075**.
1930, Jan 1	**5 NEAs** known, of which **0 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1930, Jan 29	Apollo NEA **2018 BT6** (*H* = 21.4 mag, *D* ≈ 180 m, **PHA**) passed Earth at a nominal miss distance of 3.73 LD. Minimum miss distance 3.72 LD.

	See: 2018 BT6 - JPL , 2018 BT6 - SSA
1930, May 13	Aten NEA **2011 AX22** (*H* = 24.9 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 3.95 LD. Minimum miss distance 0.18 LD. See: 2011 AX22 - JPL , 2011 AX22 - SSA See also: **13 May 2055**.
1930, Jul 27	Apollo NEA **2014 SP142** (*H* = 21.8 mag, *D* ≈ 160 m, **PHA**) passed Earth at a nominal miss distance of 5.72 LD. Minimum miss distance 1.02 LD. See: 2014 SP142 - JPL , 2014 SP142 - SSA See also: **27 Jul 1984**.
1930**,** Aug 13	**Curuçá Fireball and Airburst** over Rio Curuçá (Amazonas, Brazil). Coinciding with the annual **Perseid meteor** shower. See: http://www.uh.edu/engines/epi1102.htm http://en.wikipedia.org/wiki/List_of_meteor_air_bursts Ref: - N. Vasilyev, G. Andreev, 1989, *WGN, the Journal of the International Meteor Organization*, 17, 245, "The Brazilian twin of the **Tunguska Meteorite**: myth or reality?" See: http://adsabs.harvard.edu/abs/1989JIMO...17..245V - M.E. Bailey, D.J. Markham, S. Massai, J.E. Scriven, 1995, *The Observatory*, 115, 250, "The 1930 August **'Brazilian Tunguska' Event**." See: http://adsabs.harvard.edu/abs/1995Obs...115..250B - D. Steel, 1995, *WGN, the Journal of the International Meteor Organization*, 23, 207, "Two '**Tunguskas**' in South America in the 1930's?" See: http://adsabs.harvard.edu/abs/1995JIMO...23..207S - W. Napier, D. Asher, 2009, *Astronomy & Geophysics*, 50, 1.18, "The **Tunguska** impact event and beyond." See: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-4004.2009.50118.x/abstract - G. Cordero, A. Poveda, 2011, *Planetary and Space Science*, 59(1), 10, "**Curuça 1930**: A probable **mini-Tunguska**?" See: http://adsabs.harvard.edu/abs/2011P%26SS...59...10C
1930, Oct 3	Apollo NEA **2016 TH** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 4.41 LD. Minimum miss distance 0.80 LD. See: 2016 TH - JPL , 2016 TH - SSA
1931, Feb 1	Apollo NEA **2020 BX12** (*H* = 20.7 mag, *D* ≈ 260 m, **PHA**) passed Earth at a nominal miss distance of 3.47 LD. Minimum miss

	distance 3.46 LD. See: 2020 BX12 – S2P , 2020 BX12 - JPL
1931, Feb 7	Apollo NEA **2008 PF1** (*H* = 21.2 mag, *D* ≈ 210 m, **PHA**) passed Earth at a nominal miss distance of 2.48 LD. Minimum miss distance 2.48 LD. See: 2008 PF1 – SSA , 2008 PF1 – JPL
1931, May 8	Apollo NEA **2008 JP24** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 0.30 LD. See: 2008 JP24 - JPL , 2008 JP24 - SSA
1931, Jun 7	Apollo NEA **2019 LZ4** (*H* = 24.6 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 4.20 LD. Minimum miss distance 0.12 LD. See: 2019 LZ4 - JPL , 2019LZ4 - SSA
1931, Sep 7	Aten NEA **2010 RX30** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 9.65 LD. Minimum miss distance 9.59 LD. See: 2010 RX30 - JPL , 2010 RX30 -SSA See also: http://en.wikipedia.org/wiki/2010_RX30 See also: **8 Sep 2010**.
1932, Jan 8	Aten NEA **2021 AD4** (*H* = 25.7 mag, *D* ≈ 26 m) passed Earth at a nominal miss distance of 1.21 LD. Minimum miss distance 0.14 LD. See: 2021 AD4 – S2P , 2021 AD4 – JPL
1932, Feb 3	Aten NEA **2014 BW32** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 6.47 LD. Minimum miss distance 0.86 LD. See: 2014 BW32 - JPL , 2014 BW32 - SSA
1932, Mar 12	Apollo NEA **2017 FD157** (*H* = 22.1 mag, *D* ≈ 130 m) passed Earth at a nominal miss distance of 2.07 LD. Minimum miss distance 0.43 LD. See: 2017 FD157 - JPL , 2017 FD157 - SSA See also: **13 Mrt 2094**.
1932, Mar 12	Discovery by Eugène Delporte (1882 – 1955) on 12 March 1932 at the Uccle Observatory (Brussels, Belgium) of asteroid **1221 Amor** (**1932 EA1**, *H* = 17.5 mag, *D* ≈ 1100 m) as an Earth-orbit approaching asteroid. Since then **Amor** is the namesake of the

	Amor asteroids. See: 1932 EA1 - JPL , 1221 Amor - SSA See also: http://en.wikipedia.org/wiki/1221_Amor
1932, Apr 24	Discovery by Karl W. Reinmuth (1892 – 1979), on 24 April 1932 at the Landessternwarte Heidelberg-Königstuhl (Heidelberg, Germany) of asteroid **1862 Apollo** (**1932 HA**, $H = 16.2$ mag, $D \approx$ 1400 m, **PHA**) as an Earth-orbit crossing asteroid. Since then **Apollo** is the namesake of the **Apollo** asteroids. See: 1932 HA - JPL , 1862 Apollo - SSA See also: http://en.wikipedia.org/wiki/1862_Apollo Ref: - M. Davidson, 1932, *Monthly Notices Roy. Astron. Soc.*, 92, 691, "The **Reinmuth object**." See: http://adsabs.harvard.edu/abs/1932MNRAS..92..691D - L.A. Lebofsky, G.J. Veeder, G.H. Rieke, et al., 1981, *Icarus*, 48, 335, "The albedo and diameter of **1862 Apollo**." See: http://adsabs.harvard.edu/abs/1981Icar...48..335L
1932, Oct 21	Apollo NEA **2012 CU** ($H = 26.3$ mag, $D \approx 20$ m) passed Earth at a nominal miss distance of 2.09 LD. Minimum miss distance 0.73 LD. See: 2012 CU - JPL , 2012 CU - SSA
1932, Dec	In December 1932, scientists surveying the southern Egyptian desert came upon pieces of a translucent, pale yellow-green, glassy substance, from tiny fragments to football-sized chunks, scattered over a huge area at the Libyan border. Known as **Libyan desert glass**, this almost pure silica contained isotopes showing it to be of extraterrestrial origin. **Further reading:** see 3 March 2006. See: http://www.sciencemag.org/cgi/content/summary/311/5765/1223c See also: http://www.wits.ac.za/newsroom/newsitems/201310/21649/news_item_21649.html http://en.wikipedia.org/wiki/Libyan_desert_glass
1932, Dec 8	**Arroyomolinos de León Fireball and Airburst** (Spain). See: http://www.lpi.usra.edu/meetings/lpsc2011/pdf/1368.pdf http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1932, Dec 22	Aten NEA **2020 YB** ($H = 28.9$ mag, $D \approx 6$ m) passed Earth at a

	nominal miss distance of 6.43 LD. Minimum miss distance 0.34 LD. See: 2020 YB – S2P , 2020 YB – JPL
1932, Dec 29	Aten NEA **2012 XE133** (*H* = 23.5 mag, *D* ≈ 70 m) passed Earth at a nominal miss distance of 5.51 LD. Minimum miss distance 0.9985 LD. See: 2012 XE133 - JPL , 2012 XE133 - SSA
1933, Jan 3	Apollo NEA **2017 XT61** (*H* = 23.1 mag, *D* ≈ 80 m) passed Earth at a nominal miss distance of 1.29 LD. Minimum miss distance 0.18 LD. See: 2017 XT61 - JPL , 2017 XT61 - SSA
1933, Jan 17	Apollo NEA **7482** (**1994 PC1**, *H* = 16.7 mag, ***D* ≈ 1300 m**, **PHA**) passed Earth at 2.93 LD. Minimum miss distance 2.93 LD. See: 1994 PC1 -JPL , 7482 1994 PC1 - SSA See also: **18 Jan 2022**. See also: https://en.wikipedia.org/wiki/(7482)_1994_PC1
1933, Jun 5	Apollo NEA **2018 LU2** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 3.00 LD. Minimum miss distance 0.84 LD. See: 2018 LU2 - JPL , 2018 LU2 - SSA
1933, Oct 22	Apollo NEA **2015 UM52** (*H* = 28.1 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.66 LD. Minimum miss distance 0.47 LD. **[1933-01]** See: 2015 UM52 - JPL , 2015 UM52 - SSA See also: **22 Oct 2015**.
1933, Dec 13	Apollo NEA **2010 MU112** (*H* = 20.9 mag, *D* ≈ 599 m, **PHA**) passed Earth at a nominal miss distance of 3.19 LD. Minimum miss distance 3.17 LD. See: 2010 MU112 - JPL , 2010 MU112 - SSA See also: **13 Dec 2082**.
1934, Feb 10	Discovery of Apollo NEA **1934 CT** and promptly lost. Re-discovered on 4 January 1989 and listed as **1989 AC** = **4179 Toutatis** (*H* = 15.3 mag, *D* ≈ 4750 x 1950 m) See: 1934 CT - JPL , 4179 Toutatis - SSA See also: http://en.wikipedia.org/wiki/4179_Toutatis See: **4 Jan 1989**.
1934, Apr 20	Apollo NEA **2014 SM143** (*H* = 20.4 mag, *D* ≈ 290 m, **PHA**)

	passed Earth at a nominal miss distance of 3.63 LD. Minimum miss distance 3.62 LD. See: 2014 SM143 - JPL , 2014 SM143 - SSA See also: **19 Apr 2093**, **23 Oct 2197**.
1934, May 3	Apollo NEA **2011 JV10** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 2.53 LD. Minimum miss distance 0.31 LD. See: 2011 JV10 - JPL , 2011 JV10 - SSA
1934, Sep 22	Aten NEA **2013 RG74** (*H* = 23.3 mag, *D* ≈ 80 m) passed Earth at a nominal miss distance of 7.58 LD. Minimum miss distance 0.84 LD. See: 2013 RG74 - JPL , 2013 RG74 - SSA
1935, Feb 8	Apollo NEA **2018 CN2** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 6.94 LD. Minimum miss distance 0.77 LD. See: 2018 CN2 - SSA , 2018 CN2 - JPL See also: **9 Feb 2018**, **9 Feb 2088**.
1935, Mar 8	Apollo NEA **2015 DD54** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 0.48 LD. Minimum miss distance 0.48 LD. **[1935-01]** See: 2015 DD54 - JPL , 2015 DD54 - SSA
1935, Apr	G. Stracke, 1935, *Astronomische Nachrichten*, 255, 189, "25 Jahre genäherte Bearbeitung der Bahnen der Kleinen Planeten im Astronomischen Rechen-Institut." Predecessor of the **Minor Planet Center**. At the time 1301 minor planets were numbered. See: http://adsabs.harvard.edu/abs/1935AN....255..189S
1935, Jul 20	Apollo NEA **2016 FG60** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) passed Earth at a nominal miss distance of 5.08 LD. Minimum miss distance 4.88 LD. See: 2016 FG60 - JPL , 2016 FG60 - SSA
1935, Dec 11	**Rupununi Fireball and Airburst** over Rupununi (British Guyana), near the date of the peak of the annual **Geminid** meteor shower. Ref: - D. Steel, 1995, *WGN, the Journal of the International Meteor Organization*, 23, 207, "Two '**Tunguskas**' in South America in the 1930's?" See: http://adsabs.harvard.edu/abs/1995JIMO...23..207S - W. Napier, D. Asher, 2009, *Astronomy & Geophysics*, 50, 1.18,

	"The **Tunguska** impact event and beyond." See: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-4004.2009.50118.x/abstract
1936	F. Watson, 1936, *Popular Astronomy*, 44, 2, "Meteor craters." See: http://adsabs.harvard.edu/abs/1936PA.....44....2W
1936	F. Watson, E.M. Cook, 1936, *Popular Astronomy*, 44, 131, "The detonating **Fireball of May 26, 1935**." See: http://adsabs.harvard.edu/abs/1936PA.....44..131W
1936, Jan 6	Apollo NEA **2010 VB1** (H = 23.5 mag, $D \approx$ 70 m) passed Earth at a nominal miss distance of 0.55 LD. Minimum miss distance 0.55 LD. **[1936-01]** See: 2010 VB1 - JPL , 2010 VB1 - SSA See also: **7 Jan 2086**.
1936, Feb 7	Second discovery of an Earth-orbit crossing Apollo NEA: asteroid **2101 Adonis** (**1936 CA**, H = 18.4 mag, $D \approx$ 880 m, **PHA**), by Eugene Delporte (1872 – 1955, Belgium). Nominal miss distance of 5.77 LD. Minimum miss distance 5.77 LD. Subsequently lost; recovered in 1977. See: 1936 CA - JPL , 2101 Adonis - SSA See also: http://en.wikipedia.org/wiki/2101_Adonis
1936, Feb 14	Apollo NEA **2021 CA6** (H = 28.6 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.20 LD. **[1936-02]** See: 2021 CA6 – S2P , 2021 CA6 – JPL See also: **13 Feb 2021**, **13 Feb 2054**.
1936, Mar 3	Apollo NEA **2014 EF** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 9.73 LD. Minimum miss distance 0.26 LD. See: 2014 EF - JPL , 2014 EF - SSA See also **6 Mar 2014**.
1936, Apr 15	Apollo NEA **2015 GA1** (H = 26.8 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 8.27 LD. Minimum miss distance 0.42 LD. See: 2015 GA1 - JPL , 2015 GA1 - SSA
1937	F.G. Watson, H. Shapley, 1937, *Annals of the Astronomical Observatory of Harvard College*, 105, no. 32, *The Observatory*, p. 623. See: http://adsabs.harvard.edu/abs/1937AnHar.105..623W

1937, Oct 30	Apollo NEA **69230 Hermes** (**1937 UB**, *H* = 17.5 mag, *D* ≈ 1100 m, **PHA**) passed Earth at 1.93 LD. Minimum miss distance 1.93 LD. Discovered by Karl W. Reinmuth (1892 – 1979) at the Landessternwarte Heidelberg-Königstuhl (Heidelberg, Germany); **lost; recovered 15 October 2003**. **Arecibo radar** observations on the same day revealed it to be a binary asteroid, with components of *D* ≈ 400 m, separated by 1200 m. See: 1937 UB - JPL , 69230 Hermes - SSA See also: http://science.nasa.gov/headlines/y2003/31oct_hermes.htm http://www.news.cornell.edu/releases/Oct03/Arecibo.asteroid.deb.html http://adsabs.harvard.edu/abs/2003IAUC.8227....2M http://en.wikipedia.org/wiki/69230_Hermes See also: **29 Oct 1914**, **26 Apr 1942**, **1 Nov 1954**, **31 Oct 2086, 30 Apr 2123**.
1937, Nov 17	Apollo NEA **2020 VT4** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 9.46 LD. Minimum miss distance 1.003 LD. See: 2020 VT4 – S2P , 2020 VT4 – JPL See also: **13 Nov 2020**. See also: https://en.wikipedia.org/wiki/2020_VT4
1938, Jan 09	Apollo NEA **332446** (**2008 AF4**, *H* = 19.7 mag, *D* ≈ 400 m, **PHA**) passed Earth at 2.19 LD. Minimum miss distance 2.18 LD. See: 2008 AF4 - JPL , 2008 AF4 - SSA See also: https://en.wikipedia.org/wiki/(332446)_2008_AF4
1938, Mar 11	Apollo NEA **2013 FA8** (*H* = 21.3 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.10 LD. Minimum miss distance 0.90 LD. See: 2013 FA8 - JPL , 2013 FA8 - SSA
1938, Jun 1	Apollo NEA **2017 KW31** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 8.54 LD. Minimum miss distance 0.52 LD. See: 2017 KW31 - JPL , 2017 KW31 - SSA
1938, Jun 2	Aten NEA **437844** (**1999 MN**, *H* = 20.8 mag, *D* ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 2.37 LD. Minimum miss distance 2.37 LD. See: 1999 MN - JPL , 1999 MN - SSA See also: **2 Jun 1943**, **4 Jun 2110**, **4 Jun 2137**, **3 Jun 2148**.

1938, Jun 21	Aten NEA **2018 RW** (*H* = 30.5 mag, *D* ≈ 2.8 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.05 LD. **[1938-01]** See: 2018 RW - SSA , 2018 RW - JPL See also: **8 Sep 2018**.
1938, Jun 24	**Chicora meteoroid.** A meteoroid exploded as it entered the atmosphere above Chicora (PA, USA) on June 24, 1938. Based on the size of the explosion, the rock's initial mass (before it broke up) may have been more than 450 tons. However, only scant pieces of the meteorite were ever found – located miles away from where the main mass, missing to this day, is thought to have landed. Several reports on the **Chicora meteorite** mention that an unsuspecting cow was struck and injured by one falling shard; other accounts say that the poor animal was killed. See: http://www.lifeslittlemysteries.com/1535-when-space-attacks-6-craziest-meteor-impacts-history.html http://en.wikipedia.org/wiki/Chicora,_Pennsylvania#Chicora_Meteor http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1938, Nov 2	Aten NEA **2016 VA** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.42 LD. **[1938-02]** See: 2016 VA - SSA , 2016 VA - JPL See also: **2 Nov 2016**, **1 Nov 2024**.
1938, Nov 18	Apollo NEA **496816** (**1989 UP,** *H* = 20.7 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 2.02 LD. Minimum miss distance 2.02 LD. See: 1989 UP - JPL , 1989 UP - SSA
1939, May 4	Apollo NEA **394130** (**2006 HY51,** *H* = 17.1 mag, *D* = 1218 ± 228 m) passed Earth at a nominal miss distance of 63.27 LD. Minimum miss distance 63.24 LD. See: 2006 HY 51 – SSA , 2006 HY51 – JPL See also : **15 May 1985**. See also : https://en.wikipedia.org/wiki/(394130)_2006_HY51 Eccentricity: 0.9695. **Mercury**, **Venus**, **Earth**, **Mars**, **Jupiter** crosser.
1939, May 30	Apollo NEA **2012 KP24** (*H* = 26.2 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 0.63 LD. See: 2012 KP24 - JPL , 2012 KP24 - SSA See also: https://en.wikipedia.org/wiki/2012_KP24

	See also: **28 May 2012**.
1940, Jan 1	**9 NEAs** known, of which **3 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1940	F. Watson, 1940, *Journal of the Royal Astronomical Society of Canada*, 34, 418, "The meteor of May 7, 1928." See: http://adsabs.harvard.edu/abs/1940JRASC..34..418W
1940**,** Feb 15	Aten NEA **2020 CL1** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 9.89 LD. Minimum miss distance 5.50 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1991, 15 Feb 2036, 14 Feb 2081, 16 Feb 2118, 16 Feb 2155**
1940**,** Mar 3	Apollo NEA **2021 DE1 (***H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 3.56 LD. Minimum miss distance 0.98 LD. See: 2021 DE1 – S2P , 2021 DE1 – JPL
1940, Mar 13	Apollo NEA **275677** (**2000 RS11**, *H* = 19.0 mag, *D* ≈ 600 m, **PHA**) passed Earth at 4.11 LD. Minimum miss distance 4.11 LD. See: 2000 RS11 - JPL , 2000 RS11 - SSA See also: **14 Mar 1927**.
1940**,** May 29	Apollo NEA **2018 LE1 (***H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 3.12 LD. Minimum miss distance 0.39 LD. See: 2018 LE1 - JPL , 2018 LE1 - SSA
1940, Jul 6	Apollo NEA **2014 HC199** (*H* = 22.6 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 5.45 LD. Minimum miss distance 0.30 LD. See: 2014 HC199 – SSA , 2014 HC199 – JPL
1940, Sep 16	Apollo NEA **2007 RJ1** (*H* = 25.3 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.60 LD. **[1940-01]** See: 2007 RJ1 – S2P , 2007 RJ1 – JPL
1941	F.G. Watson, 1941, *Between the planets* (Cambridge, MA: Harvard University Press).
1941, Jan 10	Apollo NEA **2014 AW32** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth

	at a nominal miss distance of 0.37 LD. Minimum miss distance 0.27 LD. **[1941-01]** See: 2014 AW32 - JPL , 2014 AW32 - SSA See also: **10 Jan 2014**.
1941, Apr 9	**Chelyabinsk Airburst and Fireball** (Russia). See: http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1941**,** Oct 9	Apollo NEA **2011 UK10** (*H* = 24.7 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 2.16 LD. Minimum miss distance 0.30 LD. See: 2011 UK10 - JPL , 2011 UK10 - SSA
1941**,** Oct 30	Aten NEA **2018 UC** (*H* = 26.0 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 5.14 LD. Minimum miss distance 0.93 LD. See: 2018 UC - JPL , 2018 UC - SSA See also: **10 Jun 2005**.
1942, Feb	H.H. Nininger, 1942, *Popular Astronomy*, 50, 111, "A celestial bomb." On the **Forest City** (Iowa, USA) **fall** of 2 May 1890. See: http://adsabs.harvard.edu/abs/1942PA.....50..111N
1942, Mar 22	Aten NEA **2006 GB** (*H* = 20.2 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 4.35 LD. Minimum miss distance 4.35 LD. See: 2006 GB - JPL , 2006 GB - SSA See also: **22 Mar 2037**, **22 Mar 2081**.
1942, Apr 2	Apollo NEA **2021 GE2** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 3.90 LD. Minimum miss distance 0.96 LD. See: 2021 GE2 – S2P , 2021 GE2 - JPL See also: **3 Apr 2021**, **2 Apr 2030**.
1942, Apr 26	Apollo NEA **69230 Hermes** (**1937 UB**, *H* = 17.5 mag, *D* ≈ 1100 m, **PHA**) passed Earth at a nominal miss distance of 1.65 LD. Minimum miss distance 1.65 LD. See: 1937 UB JPL , 69230 Hermes - SSA See also: http://en.wikipedia.org/wiki/69230_Hermes See also: **29 Oct 1914**, **30 Oct 1937, 1 Nov 1954**, **31 Oct 2086, 30 Apr 2123**.
1942, Jun 30	Aten NEA **2020 MK3** (*H* = 25.8 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 4.98 LD. Minimum miss distance 0.97 LD.

	See: 2020 MK3 – S2P , 2020 MK3 – JPL
1943	Antoine de Saint Exupéry, 1943, *Le Petit Prince* (Paris: Editions Gallimard). Featuring fictional asteroid B612. See: http://en.wikipedia.org/wiki/The_Little_Prince See also: http://www.universetoday.com/96509/chasing-the-little-prince-in-new-york-city/
1943, Feb 26	Apollo NEA **2017 DR34** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 5.92 LD. Minimum miss distance 0.24 LD. See: 2017 DR34 - JPL , 2017 DR34 - SSA See also: **25 Feb 2017**, **26 Feb 2105**.
1943, Mar 27	Apollo NEA **2018 EM4** (*H* = 25.3 mag, *D* ≈ 37 m) passed Earth at a nominal miss distance of 3.57 LD. Minimum miss distance 0.08 LD. See: 2018 EM4 - JPL , 2018 EM4 - SSA See also: **26 Mar 2063**.
1943**,** May 13	Apollo NEA **2015 KG158 (***H* = 28.1 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 6.19 LD. Minimum miss distance 0.72 LD. See: 2015 KG158 - JPL , 2015 KG158 - SSA See also: **15 May 2060.**
1943, Jun 2	Apollo NEA **437844** (**1999 MN,** *H* = 20.8 mag, *D* ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 4.86 LD. Minimum miss distance 4.86 LD. See: 1999 MN - JPL , 1999 MN - SSA See also: **2 Jun 1938**, **4 Jun 2110**, **4 Jun 2137**, **3 Jun 2148.**
1944, Feb 6	Apollo NEA **2013 VA10** (*H* = 22.4 mag, *D* ≈ 120 m) passed Earth at a nominal miss distance of 4.30 LD. Minimum miss distance 4.29 LD. See: 2013 VA10 – SSA , 2013 VA10 – JPL See also: **6 Feb 1944**, **8 Feb 2161**.
1944, Mar 9	Apollo NEA **2017 DA36 (***H* = 25.1 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 1.06 LD. Minimum miss distance 0.31 LD. See: 2017 DA36- JPL , 2017 DA36- SSA
1944, Jul 8	Aten NEA **2011 OB (***H* = 19.7 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 3.44 LD. Minimum miss distance 3.44 LD.

	See: 2011 OB - JPL , 2011 OB - SSA
1944**,** Nov 14	Apollo NEA **2007 VF189** **(***H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 6.28 LD. Minimum miss distance 0.92 LD. See: 2007 VF189 - JPL , 2007 VF189 - SSA See also: **14 Nov 2007**.
1944, Dec	**Daytime Fireball** over Bulannyo (Rhodesia). Norman Appleton witnessed a meteor so bright he remembered it his entire life. Right before his eyes a tremendous smoking fireball streaked across the daytime sky. Years later, as an accomplished member of the Guild of Aviation Artists, he recorded his memories in a painting. See: http://apod.nasa.gov/apod/ap010728.html http://www.gava.org.uk/index.cfm?page=searchresults&searchType=quickSearch
1945, Mar 15	Aten NEA **2020 FK1** **(***H* = 27.3 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 9.24 LD. Minimum miss distance 0.16 LD. See: 2020 FK1 – S2P , 2020 FK1 - JPL See also: **15 Mar 2070.**
1945**,** Jun 1	Aten NEA **2008 LH2** **(***H* = 23.6 mag, *D* ≈ 70 m) passed Earth at a nominal miss distance of 3.94 LD. Minimum miss distance 1.002 LD. See: 2008 LH2 - JPL , 2008 LH2 - SSA
1945**,** Jul 19	Apollo NEA **2016 BA15** **(***H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 9.99 LD. Minimum miss distance 0.09 LD. See: 2016 BA15 - JPL , 2016 BA15 - SSA See also: **21 Jul 2056**.
1945**,** Sep 4	Apollo NEA **2014 RC** **(***H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 6.67 LD. Minimum miss distance 0.42 LD. See: 2014 RC - JPL , 2014 RC - SSA See also: **7 Sep 2014**.
1945**,** Nov 2	Aten NEA **2016 VA** **(***H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 9.26 LD. Minimum miss distance 0.07 LD. See: 2016 VA - JPL , 2016 VA - SSA
1946, Apr 4	Apollo NEA **2020 TX2** **(***H* = 20.8 mag, *D* ≈ 240 m, **PHA**) passed

	Earth at a nominal miss distance of 6.96 LD. Minimum miss distance 0.31 LD. See: 2020 TX2 – S2P , 2020 TX2 – JPL
1946**,** Apr 29	Apollo NEA **2008 UC202** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 4.51 LD. Minimum miss distance 0.85 LD. See: 2008 UC202 - JPL , 2008 UC202 - SSA
1946, Aug 7	Asteroid **137108** (**1999 AN10**, *H* = 18.4 mag, *D* ≈ 700 m, **PHA**) passed Earth at 2.43 LD. Minimum miss distance 2.43 LD. See: 1999 AN10 - JPL , 137108 1999 AN10 - SSA See also: **7 Aug 2027**.
1946, Nov 15	Apollo NEA **2018 VJ10** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 5.48 LD. Minimum miss distance 0.98 LD. See: 2018 VJ10 - SSA , 2018 VJ10 - JPL See also: **14 Nov 2018**.
1947	**IAU Minor Planet Center (MPC),** established by the **International Astronomical Union, Commission 20**, and succeeding the work which was carried out since 1910 by the **Rechen-Institut** in Berlin-Dahlem (Germany), started operations at the Observatory of the University of Cincinnati (Ohio, USA), director Paul Herget (1908 – 1981, USA). At the time, 1564 minor planets were numbered. Upon Herget's retirement in 1978, the amount of numbered minor planets had reached 2060, and the **MPC** moved to the Harvard-Smithsonian Center for Astrophysics, Cambridge (MA, USA) with Brian G. Marsden (1937 – 2010) as director. For a history of the **MPC**, see: - C.M. Bardwell, 1989, "A brief history of the **Minor Planet Center**." - B.G. Marsden, 2009, *IAU Information Bulletin*, No. 104, p. 67, "History of the Minor Planet Center." See: http://www.cfa.harvard.edu/iau/mpc.html http://www.iau.org/static/publications/IB104.pdf , p. 67.
1947, Feb 12	**Sikhote-Alin Fireball and Airburst** passed over Sikhote-Alin mountains (Primorye, Russia), creating a 32 km long smoke trail in the sky at an altitude of 5.6 km. The bright flash and the deafening sound of the fall were observed at 300 km around the point of impact, not far from Luchegorsk and ~ 440 km northeast of Vladivostok. The pre-impact mass of the meteoroid may have been 100,000 kg. The strewn field of this meteorite covered an elliptical area of about 1.3 km. Some fragments made craters, the largest of which was about 26 m across and 6 m deep.

	Ref: - R.A. Gallant, 1997, *Sky & Telescope*, 93, no. 2, p.50, "**Sikhote-Alin**: 50 years later." See: http://adsabs.harvard.edu/abs/1997S%26T....93b..50G See also: http://www.lifeslittlemysteries.com/1535-when-space-attacks-6-craziest-meteor-impacts-history.html http://en.wikipedia.org/wiki/List_of_meteor_air_bursts http://en.wikipedia.org/wiki/Sikhote-Alin_meteorite
1947, Mar 1	Apollo NEA **2014 PW59** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 4.27 LD. Minimum miss distance 4.26 LD. See: 2014 PW59 - JPL , 2014 PW59 - SSA See also: **26 Feb 1906**.
1947, Apr 3	Apollo NEA **2008 GM2** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 9.99 LD. Minimum miss distance 0.51 LD. See: 2008 GM2 - JPL , 2008 GM2 - SSA See also: **3 Apr 2008**.
1947, Apr 21	Apollo NEA **2016 EK27** (*H* = 22.5 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 2.38 LD. Minimum miss distance 0.51 LD. See: 2016 EK27 - JPL , 2016 EK27 - SSA
1947, Dec 3	Apollo NEA **2008 WA14** (*H* = 22.9 mag, *D* ≈ 90 m) passed Earth at a nominal miss distance of 9.89 LD. Minimum miss distance 0.27 LD. See: 2008 WA14 -JPL , 2008 WA14 - SSA
1948	The international yearbook "**Ephemerides of minor planets**", published since 1948 for the **International Astronomical Union** by the **Institute of Applied Astronomy, St Petersburg** (Russian Federation), contains information on orbital elements of numbered minor planets and the circumstances of their observations during the best observation periods. See: http://www.ipa.nw.ru/PAGE/DEPFUND/LSBSS/engephem.htm
1948, Jan 24	Apollo NEA **2017 BX** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.17 LD. **[1948-01]** See: 2017 BX – S2P , 2017 BX - JPL
1948, Mar 31	Aten NEA **2015 FA285** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 2.23 LD. Minimum miss distance 0.44

	LD. See: 2015 FA285 - JPL , 2015 FA285 - SSA
1948**,** May 11	Aten NEA **2020 JQ1** (*H* = 26.0 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 6.98 LD. Minimum miss distance 0.27 LD. See: 2020 JQ1 – S2P , 2020 JQ1 – JPL See also: **12 May 1967**, **12 May 2039**.
1949	Ralph E. Baldwin (…. – 19.., USA), *The Face of the Moon* (Chicago: UCP), describing the damage that a NEO impact might cause on Earth. Reviews: http://adsabs.harvard.edu/abs/1949PA.....57..257B
1949, Jan 1	Apollo NEA **2003 YS70** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.63 LD. **[1949-01]** See: 2003 YS70 - JPL , 2003 YS70 - SSA
1949, Apr 14	Aten NEA **99942 Apophis** (**2004 MN4**, *H* = 19.7 mag, *D* = 310 ± 30 m, orbital *P* = 0.89 yr, **PHA**) passed Earth at a nominal miss distance of 10.89 LD. Minimum miss distance 10.87 LD. See: 2004 MN4 - JPL , 99942 Apophis - SSA See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://en.wikipedia.org/wiki/99942_Apophis See also: **13 Apr 1907, 14 Apr 1998**, **13 Apr 2029**, **23 Mar 2036**, **7 Apr 2123.**
1949, Jun 11	**Kunashak Meteor Shower**. A shower of about 20 meteorites fell near Kunashak (Chelyabinsk Province, Russia). Total recovered weight over 200 kg, the largest stones weighing 120 kg, 40 kg, and 36 kg. See: http://books.google.nl/books?id=mkdHJR35Q_8C&pg=PA285&redir_esc=y#v=onepage&q&f=false http://www.lpi.usra.edu/meteor/metbull.php?code=12377 http://en.wikipedia.org/wiki/Chelyabinsk_meteor
1949, Jun 27	Discovery of Earth-orbit crossing Apollo NEA **1566 Icarus** (**1949 MA**, *H* = 16.3 mag, *D* = 1300 m, also **Venus**- and **Mercury**-orbit crossing, **PHA**) by Walter Baade (1893 – 1960, Germany/USA). In 1968 **Icarus** became the first minor planet to be observed by radar. It is plausible that **Icarus** and asteroid **5786 Talos** (**1991 RC**, *H* = 16.0 mag, *D* ≈ 1.3 km) and asteroid **2007 MK6** (*H* = 19.9 mag, *D* ≈ 350 m) are related. See:

	1949 MA - JPL , 1566 Icarus - SSA See also: http://en.wikipedia.org/wiki/1566_Icarus Ref: - D.K. Yeomans, 1991, *Astronomical Journal*, 101, 1920, "A comet among the near-earth asteroids?" See: http://adsabs.harvard.edu/abs/1991AJ....101.1920Y Erratum: http://adsabs.harvard.edu/abs/1992AJ....104.1266Y - D. Steel, 1991, *Nature*, 354, 265, "Our asteroid-pelted planet." See: http://adsabs.harvard.edu/abs/1991Natur.354..265S - K. Ohtsuka, H. Arakida, T. Ito, et al., 2007, *Astrophysical Journal Letters*, 668, L71, "Apollo asteroids **1566 Icarus** and **2007 MK6**: **Icarus** family members?" See: http://adsabs.harvard.edu/abs/2007ApJ...668L..71O
1949, Aug 10	Apollo NEA **2018 PD20** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 3.77 LD. Minimum miss distance 0.57 LD. See: 2019 PD20 – SSA , 2019 PD20 – JPL
1949, Oct 14	Apollo NEA **2016 TZ55** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 6.98 LD. Minimum miss distance 0.06 LD. See: 2016 TZ55 - JPL , 2016 TZ55 - SSA
1949, Dec 11	Aten NEA **2010 XR69** (*H* = 26.1 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 4.42 LD. Minimum miss distance 0.90 LD. See: 2010 XR69 -JPL , 2010 XR69 - SSA
1950, Jan 1	**13 NEAs** known, of which **5 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1950	The **Yerkes-McDonald Survey of Asteroids** (1950 – 1952), down to *v* = 16.5, was performed by astronomers Gerard P. Kuiper (1905 – 1973, Netherlands/USA), George A. Van Biesbroeck (1880 – 1974, Belgium/USA), Cornelis J. van Houten (1920 – 2002, Netherlands), Ingrid M. van Houten-Groeneveld (Netherlands) and Tom Gehrels (Netherlands/USA). A number of 3247 objects were found. Ref: - G.P. Kuiper, Y. Fujita, T. Gehrels, I. M. Groeneveld, J. Kent, G.A. Van Biesbroeck, C.J. van Houten, 1958, *Astrophysical Journal Supplement*, 3, 289, "Survey of asteroids". See: http://adsabs.harvard.edu/abs/1958ApJS....3..289K
1950, Feb 10	Aten NEA **2009 BE58** (*H* = 21.8 mag, *D* ≈ 150 m, **PHA**) passed

	Earth at a nominal miss distance of 4.08 LD. Minimum miss distance 4.07 LD. See: 2009 BE58 - JPL , 2009 BE58 - SSA See also: **11 Feb 2058, 13 Feb 2194.**
1950**,** Sep 10	Apollo NEA **2018 RB1** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 4.17 LD. Minimum miss distance 0.28 LD. See: 2018 RB1 -JPL , 2018 RB1 - SSA
1950, Dec 12	Apollo NEA **523685** (**2014 DN112,** *H* = 19.9 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 4.68 LD. Minimum miss distance 4.67 LD. See: 2014 DN112 - JPL , 2014 DN112 - SSA
1951	Ernst Julius Öpik (1893-1985, Estonia – Ireland), 1951, *Proc. Royal Irish Academy*, 54A, 165, "Collision probabilities with the planets and the distribution of interplanetary matter." Discussing the possible importance of the Yarkovsky effect, discovered by Ivan Osipovich Yarkovsky (1844-1902, Russian-Polish civil engineer) for meteoroids moving about the Solar System. See: http://adsabs.harvard.edu/abs/1951PRIA...54..165O http://en.wikipedia.org/wiki/Yarkovsky_effect
1951, Apr 30	Asteroid **2013 JL22** (*H* = 21.3 mag, *D* ≈ 190 m, **PHA**) passed Earth at a nominal miss distance of 3.64 LD. Minimum miss distance 3.64 LD. See: 2013 JL22 - JPL , 2013 JL22 - SSA
1951, May 2	Aten NEA **2019 JX1** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 2.20 LD. Minimum miss distance 0.75 LD. See: 2019 JX1 - SSA , 2019 JX1 - JPL See also: **2 May 2019**
1951, Jun 22	Apollo NEA **496860** (**1999 XL136**, *H* = 19.4 mag, *D* ≈ 500 m, **PHA**) passed Earth at a nominal miss distance of 3.05 LD. Minimum miss distance 3.05 LD. See: 1999 XL136 - JPL , 1999 XL136 - SSA See also: **23 Jun 2012**.
1952	V.V. Radzievskii, 1952, *Astron. Zh.*, 29, 162, "A mechanism for the disintegration of asteroids and meteorites". See: http://adsabs.harvard.edu/abs/1952AZh....29..162R

1952, Jun 7	Aten NEA **2014 HQ124** (*H* = 19.0 mag, *D* ≈ 370 m, **PHA**) passed Earth at a nominal miss distance of 3.35 LD. Minimum miss distance 3.35 LD. See: 2014 HQ124 -JPL , 2014 HQ124 - SSA See also: https://en.wikipedia.org/wiki/2014_HQ124 See also: **7 Jun 1901**, **8 Jun 2014**, **8 Jun 2065**.
1952, Oct 23	Apollo NEA **2009 UU1** (*H* = 24.8 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 0.68 LD. Minimum miss distance 0.68 LD. **[1952-01]** See: 2009 UU1 – S2P , 2009 UU1 – JPL
1952, Dec	E.J. Öpik, 1952, *Irish Astronomical Journal*, 2, 95, "Collisions with heavenly bodies." See: http://adsabs.harvard.edu/abs/1952IrAJ....2...95O
1952, Dec 9	Apollo NEA **2014 QK434** (*H* = 19.5 mag, *D* ≈ 500 m, **PHA**) passed Earth at a nominal miss distance of 4.10 LD. Minimum miss distance 3.97 LD. See: 2014 QK434 - JPL , 2014 QK434 - SSA
1952, Dec 24	Asteroid **450293** (**2004 LV3**, *H* = 19.1 mag, *D* ≈ 500 m, **PHA**) passed Earth at 4.61 LD. Minimum miss distance 4.61 LD. See: 2004 LV3 - JPL , 2004 LV3 - SSA See also: **25 Dec 2049**.
1953, Nov 29	Aten NEA **153201** (**2000 WO107**, *H* = 19.4 mag, *D* ≈ 510 m, **PHA**) passed Earth at 2.53 LD. Minimum miss distance 2.53 LD. See: 2000 WO107 - JPL , 2000 WO107 - SSA See also: https://en.wikipedia.org/wiki/(153201)_2000_WO107 See also: **30 Nov 2093**, **1 Dec 2140**.
1954	A.C.B. Lovell, 1954, *Meteor Astronomy* (Oxford: Clarendon Press). See: http://adsabs.harvard.edu/abs/1954QB741.L6....... A critical review of this book, with comments on meteor velocities in particular, is given by E.J. Öpik, 1955, *Irish Astronomical Journal*, 3, 144, "Meteor astronomy." See: http://adsabs.harvard.edu/abs/1955IrAJ....3..144O
1954, Feb 28	Apollo NEA **462550** (**2009 CB3**, *H* = 19.7 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 3.47 LD. Minimum miss distance 3.47 LD. See: 2009 CB3 - JPL , 2009 CB3 - SSA

1954, Mar 13	Apollo NEA **2013 RZ53** (*H* = 31.4 mag, *D* ≈ 1.9 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[1954-01]** See: 2013 RZ53 - JPL , 2013 RZ53 - SSA See also: **18 Sep 2013**.
1954, Mar 18	Aten NEA **2005 FN** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 6.02 LD. Minimum miss distance 0.06 LD. See: 2005 FN - JPL , 2005 FN - SSA
1954, Aug 1	Apollo NEA **2011 CC22** (*H* = 21.3 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 11.87 LD. Minimum miss distance 11.86 LD. See: 2011 CC22 - SSA , 2011 CC22 - JPL See also: **4 Aug 2017**.
1954, Aug 1	Apollo NEA **2019 BV2** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 1.30 LD. Minimum miss distance 0.37 LD. See: 2019 BV2 - JPL , 2019 BV2 - SSA See also: **26 Jan 2016**, **2 Aug 2064**.
1954, Nov 30	**Hodges meteorite**. First known modern case of a human hit by a space rock occurred in Sylacauga (Alabama, USA). A 4 kg stone chondrite crashed through a roof and hit Mrs. Ann Hodges in her living room after it bounced off her radio. She was badly bruised. The **Hodges meteorite**, or **Sylacauga meteorite**, is on exhibit at the Alabama Museum of Natural History. See: http://www.lifeslittlemysteries.com/1535-when-space-attacks-6-craziest-meteor-impacts-history.html http://www.smithsonianmag.com/smart-news/only-person-ever-hit-meteorite-real-trouble-began-later-180961238/ http://en.wikipedia.org/wiki/Sylacauga_(meteorite)
1954, Dec	G.P. Kuiper, 1954, *Proceedings of the National Academy of Sciences of the United States of America*, 40(12), 1096, "On the origin of the lunar surface features." See: http://adsabs.harvard.edu/abs/1954PNAS...40.1096K
1954, Dec 4	Apollo NEA **2012 KT42** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 2.61 LD. Minimum miss distance 0.03 LD. See: 2012 KT42 - JPL , 2012 KT42 - SSA See also: https://en.wikipedia.org/wiki/2012_KT42

	See also: **3 Dec 1915**, **29 May 2012**.
1955, Feb 22	Aten NEA **2021 DA2** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.25 LD. Minimum miss distance 0.90 LD. See: 2021 DA2 – S2P , 2021 DA2 – JPL See also: **21 Feb 2021**, **21 Feb 2050**.
1955, Mar 13	Apollo NEA **2020 EQ** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.36 LD. Minimum miss distance 0.15 LD. See: 2020 EQ – S2P , 2020 EQ – JPL
1955, Apr 18	Apollo NEA **2021 HY2** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 7.62 LD. Minimum miss distance 0.32 LD. See: 2021 HY2 – S2P , 2021 HY2 – JPL
1955, Jun 19	Apollo NEA **2015 LR21** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.55 LD. **[1955-01]** See: 2015 LR21 - JPL , 2015 LR21 - SSA
1955, Sep 17	Aten NEA **2015 KE** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.61 LD. **Minimum miss distance 0.012 LD (= 0.72 R_{Earth} from the geocenter)**. **[1955-02]** See: 2015 KE - JPL , 2015 KE - SSA See also: **7 May 2107**.
1956, Jan	M.W. De Laubenfels, 1956, suggested that the dinosaurs demise is due to an impact event and the resulting super-hot winds that would result. He scaled up the effects of the **Tunguska** blast and made first suggestion of the death of the dinosaurs being impact related. Mammals first appeared in Cretaceous with the most outstanding type differing little from the modern opossum. The author argues for a brief period of extreme heat enough to kill exposed large animals. Birds, mammals, aquatic animals would have survived. He notes in October 1937 the close Earth approach of **Hermes** and the **Tunguska event**. He computes an amount of heat available from a 100 m sized impactor at 10 km/s and notes that if kinetic energy turned into heat, it would be enough to boil 10^{16} tons of water whereas entire oceans are 10^{18} tons. - Ref: M.W. De Laubenfels (Oregon State College), 1956, *Journal of Paleontology*, 30, 207, "Dinosaur extinction: one more hypothesis." See: http://www.norwebster.com/astrohit/

1956, May	C.S. Beals, G.M. Ferguson, A. Landau, 1956, *Sky & Telescope*, 15, 296, "The **Holleford Crater** in Ontario." See: http://adsabs.harvard.edu/abs/1956S%26T....15..296B
1956, Oct 13	Apollo NEA **496817** (**1989 VB**, *H* = 20.1 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 7.26 LD. Minimum miss distance 7.26 LD. See: 1989 VB - SSA , 1989 VB - JPL See also: **29 Sep 2017**, **20 Oct 2078**.
1956, Nov	Harold C. Urey (1893 – 1981, USA), 1956, *Astrophysical Journal*, 124, 623, "Diamonds, meteorites, and the origin of the Solar System." See: http://adsabs.harvard.edu/abs/1956ApJ...124..623U
1956, Nov 24	Apollo NEA **2013 NJ** (*H* = 22.1 mag, *D* ≈ 130 m) passed Earth at a nominal miss distance of 2.63 LD. Minimum miss distance 2.60 LD. See: 2013 NJ - SSA , 2013 NJ – JPL See also: **24 Nov 1997**, **26 Nov 2013, 26 Nov 2067**.
1956, Dec 16	Aten NEA **33342** (**1998 WT24**, *H* = 18.3 mag, *D* ≈ 415 m, **PHA**) passed Earth at a nominal miss distance of 3.52 LD. Minimum miss distance 3.52 LD. See: 1998 WT24 - JPL , 1998 WT24 - SSA See also: http://neo.jpl.nasa.gov/images/1998wt24.html http://science.nasa.gov/science-news/science-at-nasa/2001/ast14dec_1/ http://www.jpl.nasa.gov/news/news.php?feature=4800 https://en.wikipedia.org/wiki/(33342)_1998_WT24 See also: **16 Dec 1908, 16 Dec 2001, 11 Dec 2015, 18 Dec 2099**
1957, Jan 31	Apollo NEA **2019 CD2** (*H* = 19.9 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 2.95 LD. Minimum miss distance 0.13 LD. See: 2019 CD2 - JPL , 2019 CD2 - SSA
1957, Sep	C.S. Beals, 1957, *Sky & Telescope*, 16, 526, "A probable meteorite crater of great age." See: http://adsabs.harvard.edu/abs/1957S%26T....16..526B
1957, Oct 23	Aten NEA **2020 UO4** (*H* = 28.7 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 2.31 LD. Minimum miss distance 0.79 LD. See: 2020 UO4 – S2P , 2020 UO4 – JPL See also: **19 Oct 2068**.

1957, Oct 26	Apollo NEA **2019 UY7** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 2.00 LD. Minimum miss distance 0.05 LD. See: 2019 UY7 – SSA , 2019 UY – JPL
1957, Oct 10	Aten NEA **2020 TK5** (*H* = 23.7 mag, *D* ≈ 70 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.78 LD. **[1957-01]** See: 2020 TK5 – S2P , 2020 TK5 - JPL
1957, Dec 10	Apollo NEA **2010 XW58** (*H* = 25.0 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 0.16 LD. Minimum miss distance 0.16 LD. **[1957-02]** See: 2010 XW58 - JPL , 2010 XW58 - SSA
1958	E.J. Öpik, 1958, *Physics of meteor flight in the atmosphere* (New York: Interscience Publishers). See: http://adsabs.harvard.edu/abs/1958QB741.O38......
1958, Feb 22	C.S. Beals, 1958, *Nature*, 181, 559, "A survey of terrestrial craters." See: http://adsabs.harvard.edu/abs/1958Natur.181..559B
1958, Mar	E.J. Öpik, 1958, *Irish Astronomical Journal*, 5, 34, "On the catastrophic effect of collisions with celestial bodies." Öpik proposed that NEO impacts might have handicapped the development of land in the paleontological history. See: http://adsabs.harvard.edu/abs/1958QB741.O38......
1958, Jul	G.P. Kuiper, Y. Fujita, T. Gehrels, I.M. Groeneveld, J. Kent, G.A. Van Biesbroeck, C.J. van Houten, 1958, *Astrophysical Journal Supplement*, 3, 289, "Survey of asteroids". See: http://adsabs.harvard.edu/abs/1958ApJS....3..289K
1958, Oct 11	Aten NEA **2008 TZ** (*H* = 25.2 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 4.05 LD. Minimum miss distance 1.002 LD. See: 2008 TZ - JPL , 2008 TZ - SSA
1958, Oct 29	Apollo NEA **2020 TD8** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 2.11 LD. Minimum miss distance 0.62 LD. See: 2020 TD8 – S2P , 2020 TD8 – JPL
1958, Dec 21	Aten NEA **2020 XY4** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a

	nominal miss distance of 4.48 LD. Minimum miss distance 0.59 LD. See: 2020 XY4 – S2P , 2020 XY4 – JPL See also: **20 Dec 1924**.
1959, Jan 5	Apollo NEA **2020 JV** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) passed Earth at a nominal miss distance of 3.31 LD. Minimum miss distance 1.72 LD. See: 2020 JV – S2P , 2020 JV – JPL
1959**,** Jan 27	Aten NEA **2012 BX34** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.40 LD. **[1959-01]** See: 2012 BX34 - JPL , 2012 BX34 - SSA See also: https://en.wikipedia.org/wiki/2012_BX34 See also: **27 Jan 2012**
1959, Apr 7	**Příbram Meteorite Fall**, the first meteorite simultaneously observed by several stations in the Czech Republic. The network was initiated locally at Ondřejov Observatory. By 1963, the network consisted of 5 stations. In 1968 it had expanded by the installation of about 15 new stations in Germany, and was named the **European Fireball Network**. - Ref: P. Spurný, J. Borovička, L. Shrbený, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 121, "Automation of the Czech part of the **European Fireball Network**: equipment, methods and first results." See: http://adsabs.harvard.edu/abs/2007IAUS..236..121S http://www.dlr.de/pf/en/desktopdefault.aspx/tabid-623/1043_read-26813/ http://en.wikipedia.org/wiki/European_Fireball_Network
1959**,** May 29	Apollo NEA **2020 DY1** (*H* = 21.9 mag, *D* ≈ 150 m, **PHA**) passed Earth at a nominal miss distance of 5.22 LD. Minimum miss distance 4.79 LD. See: 2020 DY1 – S2P, 2020 DY1 - JPL
1959**,** Jul 12	Amor NEA **2017 NM6** (*H* = 19.0 mag, *D* ≈ 600 m, **PHA**) passed Earth at a nominal miss distance of 1.89 LD. Minimum miss distance 1.85 LD. See: 2017 NM6 - JPL , 2017 NM6 - SSA
1959, Aug 20	Apollo NEA **2020 QR5** (*H* = 27.3 mag, *D* ≈ 12 m) passed Earth at

	a nominal miss distance of 8.81 LD. Minimum miss distance 0.80 LD. See: 2020 QR5 – S2P , 2020 QR5 – JPL Discovery station: **Pan-STARS 1, Haleakala** See also: **23 Aug 2020**, **24 Aug 2105**.
1959, Nov 11	Apollo NEA **2018 VX1** (*H* = 27.7 mag, *D* ≈10 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.87 LD. **[1959-02]** See: 2018 VX1 - SSA , 2018 VX1 - JPL See also: **10 Nov 2018**.
1959**,** Nov 25	Apollo NEA **2018 WE1** (*H* = 26.2 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 8.60 LD. Minimum miss distance 0.77 LD. See: 2018 WE1 - JPL , 2018 WE1 - SSA See also: **25 Nov 2018.**
1959, Dec 15	Aten NEA **487577** (**2014 YQ15**, *H* = 20.9 mag, *D* ≈ 240 m, **PHA**) passed Earth at a nominal miss distance of 3.64 LD. Minimum miss distance 3.57 LD. See: 2014 YQ15 - JPL , 2014 YQ15- SSA See also: **15 Dec 2066**, **16 Dec 2122**.
1960, Jan 1	**20 NEAs** known, of wh ich **8 PHA6**. See: http://neo.jpl.nasa.gov/stats/
1960, Jan 17	Aten NEA **2001 BA16** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 1.88 LD. Minimum miss distance 0.20 LD. See: 2001 BA16 - JPL , 2001 BA16 - SSA See also: **15 Jan 2001**.
1960, Sep - Oct	Tom Gehrels took Palomar Schmidt (1.2-m) plates, on which C.J. van Houten et al. (1970) discovered over 2000 asteroids with *v* < 20 mag, including four NEAs. Ref: C.J. van Houten, I. van Houten-Groeneveld, P. Herget & T. Gehrels, 1970, *Astronomy & Astrophysics Suppl.*, 2, 339, "The **Palomar-Leiden survey of faint minor planets**." See: http://adsabs.harvard.edu/abs/1970A%26AS....2..339V C.J. van Houten, P. Herget, B.G. Marsden, 1984, *Icarus*, 59, 1, "The **Palomar-Leiden survey of faint minor planets** – Conclusion." See: http://adsabs.harvard.edu/abs/1984Icar...59....1V
1960, Oct 24	Aten NEA **2004 UH1** (*H* = 28.2 mag, *D* ≈ 10 m) passed Earth at a

	nominal miss distance of 0.48 LD. Minimum miss distance 0.41 LD. **[1960-01]** See: 2004 UH1 - JPL , 2004 UH1 - SSA See also: **24 Oct 2004**.
1960, Nov 22	Apollo NEA **2019 WG2** (*H* = 25.0 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 3.51 LD. Minimum miss distance 0.72 LD. See: 2019 WG2 – SSA , 2019 WG2 – JPL
1961, Mar 24	Aten NEA **234145** (**2000 EW70**, *H* = 21.9 mag, *D* ≈ 344 m, **PHA**) passed Earth at a nominal miss distance of 3.75 LD. Minimum miss distance 3.75 LD. See: 2000 EW70 - JPL , 2000 EW70 - SSA See also: **24 Mar 1971**.
1961, Apr 12	Aten NEA **163243** (**2002 FB3**, *H* = 16.6 mag, *D* ≈ **1620 m**, **PHA**) passed Earth at a nominal miss distance of 4.90 LD. Minimum miss distance 4.90 LD. See: 2002 FB3 - JPL , 2002 FB3 - SSA See also: https://en.wikipedia.org/wiki/(163243)_2002_FB3
1961, Sep 14	Aten NEA **2020 RF3** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 8.58 LD. Minimum miss distance 0.77 LD. See: 2020 RF3 – S2P , 2020 RF3 - JPL See also: **14 Sep 2020, 15 Sep 2070**.
1961, Oct	**Eugene M. Shoemaker** and **Edward C.T. Chao** proved that **Nördlingen Ries crater** (*d* = 24 km, Nördlingen, western Bavaria, Germany), formed ~14.4 My ago in the Miocene, was caused by meteorite impact. Another impact crater, the much smaller (3.8 km diameter) **Steinheim crater**, is located ~ 42 km WSW from the centre of Ries. The two craters are believed to have formed nearly simultaneously by the impact of a binary asteroid. The impactors probably had diameters of ~ 1.5 km (Ries) and 150 m (Steinheim), and a pre-impact separation of some tens of kilometers. Ref: - E.M. Shoemaker, E.C.T. Chao, 1961, *Journal of Geophysical Research*, 66, 3371, "New evidence for the impact origin of the Ries Basin, Bavaria, Germany." See: http://adsabs.harvard.edu/abs/1961JGR....66.3371S See also: http://en.wikipedia.org/wiki/N%C3%B6rdlinger_Ries http://www.unb.ca/passc/ImpactDatabase/images/ries.htm http://www.lpi.usra.edu/meetings/nordlingen2010/

	http://www.hq.nasa.gov/alsj/a14/a14ries.html The **Earth Impact Database** lists some 170 known impact craters on Earth. See: http://www.unb.ca/passc/ImpactDatabase/
1961, Oct 11	Apollo NEA **2008 TC3** (*H* = 30.3 mag, *D* ≈ 4.1 m, Apollo NEO) passed Earth at a nominal miss distance of 7.25 LD. Minimum miss distance 3.20 LD. See: 2008 TC3 - JPL , 2008 TC3 - SSA See also: **4 Oct 1917**, **2 Oct 1971**, **27 Jan 1988, 6 Oct 2008**.
1962, Mar 16	Aten NEA **2021 FA** (*H* = 25.1 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 5.38 LD. Minimum miss distance 0.78 LD. See: 2021 FA S2P , 2021 FA - JPL
1962, Mar 24	H.C. Urey, 1962, *Nature*, 193, 1119, " Life-forms in meteorites: origin of life-like forms in carbonaceous chondrites. Introduction." See: http://adsabs.harvard.edu/abs/1962Natur.193.1119U
1962, Mar 30	Aten NEA **2002 GQ** (*H* = 26.8 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 3.97 LD. Minimum miss distance 0.49 LD. See: 2002 GQ - JPL , 2002 GQ - SSA See also: **20 Mar 2035**.
1963	**Eugene M. Shoemaker** (1928 – 1997, USA) and colleagues firmly established the impact origin of the **Meteor Crater** in Arizona. **Meteor Crater** is located approximately 69 km east of Flagstaff, near Winslow in the northern Arizona desert of the United States. The site was formerly known as the Canyon Diablo Crater. Scientists generally refer to it as **Barringer Crater**, in honor of the geologist Daniel Barringer (1860 – 1929) who was first to suggest that it was produced by meteorite impact. **Barringer Meteor Crater** lies at an elevation of about 1,740 m above sea level. It is ~ 1,200 m in diameter, 170 m deep, and is surrounded by a rim that rises 45 m above the surrounding plains. The center of the crater is filled with 210 – 240 m of rubble lying above crater bedrock. The incoming asteroid had a diameter of ~ 25 m and a velocity of 15 km/s. The largest meteorite found is the so-called **Holsinger meteorite**, weighing 639 kg, on display in the **Meteor Crater** Visitor Center on the rim of the crater. See: http://en.wikipedia.org/wiki/Meteor_Crater http://en.wikipedia.org/wiki/Barringer_Crater http://en.wikipedia.org/wiki/Holsinger_Meteorite Ref:

	- E.M. Shoemaker, 1963, in: B.M. Middlehurst & G.P. Kuiper (eds.), The Moon, Meteorites, and Comets (Chicago: UCP), p. 301, "Impact mechanics at **Meteor Crater**, Arizona." See: http://adsabs.harvard.edu/abs/1963mmc..book..301S - D.J. Roddy, E.M. Shoemaker, 1995, *Meteoritics* 30(5), 567, "**Meteor Crater (Barringer Meteorite Crater)**, Arizona: summary of impact conditions." See: http://adsabs.harvard.edu/abs/1995Metic..30Q.567R - M. Boslough, 1996, *Skeptical Inquirer*, Vol. 20.2, March/April 1996, "Scientific knowledge is money in the bank." See: http://www.csicop.org/si/show/scientific_knowledge_is_money_in_the_bank - D.A. Kring, 1997, *Meteoritics& Planetary Science*, 32, 517, "Air blast produced by the **Meteor Crater** impact event and a reconstruction of the affected environment." See: http://adsabs.harvard.edu/abs/1997M%26PS...32..517K - D.A. Kring, 1999, *Sky & Telescope*, 98(5), 48, "Calamity at **Meteor Crater**." See: http://adsabs.harvard.edu/abs/1999S%26T....98e..48K - H.J. Melosh, G.S. Collins, 2005, *Nature*, 434, 157, "**Meteor Crater** formed by a low-velocity impact." See: http://adsabs.harvard.edu/abs/2005Natur.434..157M See also: http://www.unb.ca/passc/ImpactDatabase/images/barringer.htm http://antwrp.gsfc.nasa.gov/apod/ap070623.html
1963	Initiation of the **European Fireball Network**. Ref: J. Olberst, S. Molau, D. Heinlein, et al., 1998, *Meteoritics & Planetary Science*, 33, 49, "The '**European Fireball Network**': Current status and future prospects". See: http://adsabs.harvard.edu/abs/1998M&PS...33...49O See also: http://www.molau.de/meteore/imc97-2.html http://adsabs.harvard.edu/abs/2007IAUS..236..121S http://www.nature.com/nature/journal/v423/n6936/full/423123a.html http://www.dlr.de/pf/en/desktopdefault.aspx/tabid-623/1043_read-1425/
1963	M.R. Dence, M.J.S. Innes, C.S. Beals, 1963, *Astronomical Journal,* 68, 534, "On the probable meteorite origin of the Clearwater Lakes, Quebec." See: http://adsabs.harvard.edu/abs/1963AJ.....68..534D
1963, Mar	Initiation of the **Prairie Meteorite Network**, with a prototype station in Havanna (IL, USA). By May 1964, 16 stations were operational. Ref: - R.E. McCrosky, H. Boeschenstein, 1965, *SAO Special Report*,

	No. 173, "The **Prairie Meteorite Network**." See: http://adsabs.harvard.edu/abs/1965SAOSR.173.....M - Z. Ceplecha, R.E. McCrosky, 1997, *Meteoritics & Planetary Science*, 32, A157, "**Prairie Network fireballs**: data on height, distance and brightness for each measured time-mark." See: http://adsabs.harvard.edu/abs/1997M%26PSA..32..157C
1963, Aug 3	**Prince Edward Islands Fireball and Airburst** (South Africa). See: http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1963, Nov 2	R.L.C. Gallant, 1963, *Nature*, 200, 414, "Changes in the Earth's axis due to large meteorite collisions." See: http://adsabs.harvard.edu/abs/1963Natur.200..414G
1963, Nov 4	Apollo NEA **2010 JL88** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 7.80 LD. Minimum miss distance 0.56 LD. See: 2010 JL88 - JPL , 2010 JL88 - SSA See also: https://en.wikipedia.org/wiki/2010_JL88
1964	C.S. Beals, M.R. Dence, A.J. Cohen, 1964, *Astronomical Journal,* 69, 134, "Evidence suggesting a meteorite impact origin for Lac Couture, Quebec." See: http://adsabs.harvard.edu/abs/1964AJ.....69R.134B
1964	Dandridge M. Cole, Donald W. Cox, 1964, *Islands in space: the challenge of the planetoids* (Philadephia: Chilton). See: http://discoveryenterprise.blogspot.com/2007/08/islands-in-space-challenge-of.html
1964	René L.C. Gallant (1906 – 1985, Belgium), 1964, *Bombarded Earth* (London: John Baker Publishers Ltd). See: http://www.catastrophism.com/cdrom/pubs/books/gallant/index.htm http://www.velikovsky.info/Ren%C3%A9_Gallant#cite_note-palmer2003-0
1964, Oct 24	Apollo NEA **2020 FM6** (*H* = 21.9 mag, *D* ≈ 150 m, **PHA**) passed Earth at a nominal miss distance of 2.52 LD. Minimum miss distance 1.55 LD. See: 2020 FM6 – S2P, 2020 FM6 - JPL See also: **25 Oct 2101**.
1964, Nov 26	Apollo NEA **2014 EU** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 9.71 LD. Minimum miss distance 0.88 LD.

	See: 2014 EU - JPL , 2014 EU- SSA
1965, Jan 17	Apollo NEA **2007 BD** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 1.002 LD. Minimum miss distance 0.855 LD. See: 2007 BD - JPL , 2007 BD - SSA See also: **18 Jan 2007**.
1965, Mar 31	**Revelstoke Fireball and Airburst**, 64 km NW of the city of Revelstoke (BC, Canada): an extremely bright bolide giving off sparks was observed to travel for 100 km in 8 seconds. See: http://www.lpi.usra.edu/meteor/metbull.php?code=22592 http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1965, Jun 6	Aten NEA **163348** (**2002 NN4**, *H* = 20.3 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 3.01 LD. Minimum miss distance 3.01 LD. See: 2002 NN4 - JPL , 2002 NN4 - SSA See also: **5 Jun 1924**, **6 Jun 2070**, **7 Jun 2130**.
1965, Oct 21	Apollo NEA **171576** (**1999 VP11**, *H* = 18.7 mag, *D* ≈ 700 m, **PHA**) passed Earth at a nominal miss distance of 4.42 LD. Minimum miss distance 4.36 LD. See: 1999 VP11 - JPL , 1999 VP11 - SSA See also: **21 Oct 1982**, **22 Oct 2086**.
1965, Oct 27	Aten NEA **2005 VL1** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[1965-01]** See: 2005 VL1 - JPL , 2005 VL1 - SSA See also: **3 Nov 2087**.
1966, Jan 12	Apollo NEA **2016 AN165** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 3.21 LD. Minimum miss distance 0.31 LD. See: 2016 AN165- JPL , 2016 AN165- SSA See also: **13 Jan 2016**.
1966, Feb 18	Apollo NEA **2011 DS** (*H* = 26.8 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 9.44 LD. Minimum miss distance 0.55 LD. See: 2011 DS - JPL , 2011 DS - SSA See also: **14 Aug 1901**, **18 Feb 2050**.
1966, July	In an UPI report, Australian scientist S.T. Butler noted an upcoming close Earth approach by the asteroid **1566 Icarus** (**1949**

	MA, H = 16.0 mag, D = 1.3 km, **PHA**) in 1968. He suggested that the asteroid could possibly be destroyed by a nuclear warhead if it neared the Earth. Paul Sandorff (MIT, U.S.A.) then assigned a hypothetical problem to his system engineering class. This "**Icarus Project**" drew a good deal of attention, including a *Time Magazine* story in June 1967 and a book the following year. See: 1949 MA -JPL , 1566 Icarus - SSA , http://en.wikipedia.org/wiki/Project_Icarus Ref: - *Time Magazine*, 16 June 1967, "Systems engineering: avoiding an asteroid"; - Louis A. Kleinman (ed.), 1968, "**Project Icarus**: an MIT student project in systems engineering" (Cambridge: MIT Press); - MIT Students, 1979, "**Project Icarus** – revised edition" (Cambridge: MIT Press).
1966, Sep 17	**Lake Huron, Michigan-Ontario Fireball and Airburst** (USA, Canada). See: http://adsabs.harvard.edu/full/1966JRASC..60..257H http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1966, Nov 17	**Leonid Fireball** over Table Mountain Observatory (Angeles National Forest, Wrightwood, CA, USA). See: http://apod.nasa.gov/apod/ap981113.html
1967, Feb 5	**Vilna Fireball and Airburst** (Alberta, Canada). See: http://adsabs.harvard.edu/full/1969JRASC..63...61F http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1967, Mar 29	Aten NEA **2019 FB2** (H = 26.5 mag, $D \approx$ 21 m), passed Earth at a nominal miss distance of 1.52 LD. Minimum miss distance 0.08 LD. See: 2019 FB2 - JPL , 2019 FB2 - SSA
1967, May 12	Aten NEA **2020 JQ1** (H = 26.0 mag, $D \approx$ 22 m) passed Earth at a nominal miss distance of 7.30 LD. Minimum miss distance 0.10 LD. See: 2020 JQ1 – S2P , 2020 JQ1 – JPL See also: **11 May 1948**, **12 May 2039**.
1967, Jun	The largest know meteorite, the **Hoba meteorite**, lies on the farm "Hoba West", not far from Grootfontein, in the Otjozondjupa Region of Namibia. It has been uncovered in 1920, but, because of its large mass, has never been moved from where it fell. The main mass is estimated at 54,000 kg, and it is the largest known meteorite (as a single piece) and the most massive naturally-

	occurring piece of iron known at the Earth's surface. The **Hoba meteorite** is thought to have landed less than 80,000 years ago. It is inferred that the Earth's atmosphere slowed the object down to the point that it fell to the surface at terminal velocity, thereby remaining intact and causing little excavation. The **Hoba meteorite** is unusual in that it is flat on both major surfaces, possibly causing it to have skipped across the top of the atmosphere in the way a flat stone skips on water. Size: 2.7 × 2.7 × 0.9 m. Ref: - J.D. Fernie, 1967, *Journal of the Royal Astronomical Society of Canada*, 61, 127, "Journey via Otjiwarongo. A trip to the **Hoba Meteorite**." See: http://adsabs.harvard.edu/abs/1967JRASC..61..127F http://en.wikipedia.org/wiki/Hoba_meteorite
1967, Sep 29	Apollo NEA **440212** (**2004 OB**, *H* = 18.9 mag, *D* ≈ 600 m, **PHA**), passed Earth at a nominal miss distance of 4.35 LD. Minimum miss distance 4.35 LD. See: 2004 OB - JPL , 2004 OB - SSA
1967, Nov 3	Apollo NEA **2014 AA** (*H* = 30.9 mag, *D* ≈ 2.3 m), passed Earth at a nominal miss distance of 99.33 LD. Minimum miss distance 89.08 LD. **Impact on 2 January 2014.** See: 2014 AA - SSA , 2014 AA - JPL See also: http://www.minorplanetcenter.net/mpec/K14/K14A02.html http://www.jpl.nasa.gov/news/news.php?release=2014-001 https://en.wikipedia.org/wiki/2014_AA See also: **26 May 1994**, **21 Mar 1996**, **2 Jan 2014**.
1968	**European Fireball Network** established. Ref: - P. Spurný, J. Borovička, L. Shrbený, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 121, "Automation of the Czech part of the **European Fireball Network**: equipment, methods and first results." See: http://adsabs.harvard.edu/abs/2007IAUS..236..121S See also: http://www.dlr.de/pf/en/desktopdefault.aspx/tabid-623/1043_read-26813/ http://en.wikipedia.org/wiki/European_Fireball_Network
1968	C.S. Beals, 1968, *Contributions Dominion Observatory Ottawa*, 4(29), 1, "Theories of the origin of Hudson Bay. I. On the

	possibility of a catastrophic origin for the great arc of eastern Hudson Bay." See: http://adsabs.harvard.edu/abs/1968CoDAO...4....1B
1968, Jan	G.W. Wetherill, J.G. Williams, 1968, *Journal of Geophysical Research*, 73, 635, "Evaluation of the **Apollo** asteroids as sources of stone meteorites." See: http://adsabs.harvard.edu/abs/1968JGR....73..635W
1968, Mar 14	Apollo NEA **216985** (**2000 QK130**, *H* = 21.3 mag, *D* ≈ 200 m, **PHA**), passed Earth at a nominal miss distance of 2.53 LD. Minimum miss distance 2.53 LD. See: 2000 QK130 - JPL , 2000 QK130 - SSA See also: **12 Mar 1916**, **15 Mar 2036**, **15 Mar 2089**.
1968, Apr 23	Apollo NEA **2008 GD110** (*H* = 24.6 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 0.24 LD. Minimum miss distance 0.16 LD. **[1968-01]** See: 2008 GD110 - JPL , 2008 GD110 - SSA
1968, May 15	Aten NEA **2010 JR34** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.91 LD. **[1968-02]** See: 2010 JR34 -JPL , 2010 JR34 - SSA
1968, Jun 14	Apollo NEA **1566 Icarus** (**1949 MA**, *H* = 16.3 mag, *D* = 1300 m, **PHA**) passed Earth at 16.53 LD. Observed by radar by NASA's Goldstone Solar System Radar (CA, USA) and the MIT Haystack Observatory (Westfort, MA, USA). See: 1949 MA - JPL , 1566 Icarus - SSA See also: http://en.wikipedia.org/wiki/1566_Icarus Ref: - R.M. Goldstein, 1968, *Science*, 162, 903, "Radar observations of **Icarus**." See: http://adsabs.harvard.edu/abs/1968Sci...162..903G - B.G. Marsden, 1998, *Boston Sunday Globe*, 29 March 1989, "How the asteroid story hit: an astronomer reveals how a discovery spun out of control." See: http://www.minorplanetcenter.net/iau/pressinfo/1997XF11Globe.html See also: **16 Jun 2015, 14 Jun 2090**.
1968, Nov 30	Apollo NEA **2018 WE3** (*H* = 21.2 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 7.28 LD. Minimum miss distance 7.17 LD.

	See: 2018 WE3 - SSA , 2018 WE3 - JPL
1968, Dec 16	Apollo NEA **2015 XA378** (*H* = 25.9 mag, *D* ≈ 23 m) passed Earth at a nominal miss distance of 2.78 LD. Minimum miss distance 0.62 LD. See: 2015 XA378 - SSA , 2015 XA378 - JPL See also: **1 June 2053**.
1968, Dec 28	Aten NEA **2014 YW14** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.60 LD. **[1968-03]** See: 2014 YW14 - JPL , 2014 YW14 - SSA
1969, Jan 31	Aten NEA **2019 BE5** (*H* = 25.1 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 5.14 LD. Minimum miss distance 0.30 LD. See: 2019 BE5 – JPL , 2019 BE5 – SSA
1969, Feb 8	**Chihuahua Fireball**, witnessed falling over the Mexican State of Chihuahua. After breaking up in the atmosphere, an extensive search for pieces was conducted; it is often described as "the best-studied meteorite in history." Some 2000 kg of meteorite material has been collected. The largest piece found, the **Allende meteorite** of 0.520 kg, is notable for possessing abundant, large calcium-aluminum-rich inclusions, which are among the oldest objects formed in the Solar System. The $^{238}U/^{235}U$ isotope ratio found in the **Allende meteorite** by Brennecka et al. (2010) implies that the Solar System is some 5 million years younger than thought previously. See : http://en.wikipedia.org/wiki/Allende_meteorite Ref: - G.A. Brennecka, S. Weyer, M. Wadhwa, et al., 2010, *Science*, 327, 449, "$^{238}U/^{235}U$ variations in meteorites: extant ^{247}Cm and implications for Pb-Pb dating." See: http://www.sciencemag.org/content/327/5964/449 - Chi Ma, O. Tschauner, J.R. Beckett, et al., 2012, *American Mineralogist*, 97, 1219, "Panguite, $(Ti4^{+},Sc,Al,Mg,Zr,Ca)_{1.8}O_3$, a new ultra-refractory titania mineral from the **Allende meteorite**: synchrotron micro-diffraction and EBSD." See: http://www.its.caltech.edu/~chima/publications/2012_AM_buseckite.pdf http://media.caltech.edu/press_releases/13524
1969, Apr 12	Apollo NEA **2019 FV** (*H* = 24.0 mag, *D* ≈ 60 m) passed Earth at a nominal miss distance of 9.39 LD. Minimum miss distance 0.96 LD. See: 2019 FV – SSA , 2019 FV – JPL

1969, Jul 21	Apollo NEA **2018 BN6** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 9.47 LD. Minimum miss distance 0.96 LD. See: 2018 BN6 - SSA , 2018 BN6 - JPL See also: **24 Jan 2018**, **25 Jan 2045**
1969, Aug 4	Apollo NEA **2020 NK1** (*H* = 19.0 mag, *D* ≈ 600 m, **PHA**) passed Earth at a nominal miss distance of 7.83 LD. Minimum miss distance 6.66 LD. See: 2020 NK1 – S2P , 2020 NK1 - JPL See also: **4 Aug 2043**.
1969, Aug 27	Apollo NEA **192642** (**1999 RD32**, *H* = 16.7 mag, ***D* ≈ 1600 m**, **PHA**) passed Earth at a nominal miss distance of 3.63 LD. Minimum miss distance 3.62 LD. See: 1999 RD32 - JPL , 1999 RD32 - SSA See also: https://en.wikipedia.org/wiki/(192642)_1999_RD32
1969, Sep 28	**Murchison Fireball and Meteorite**. Near the town of Murchison (Victoria, Australia), a bright fireball was observed to separate into three fragments before disappearing, leaving a cloud of smoke. About 30 seconds later, a tremor was heard. Many specimens were found over an area larger than 13 km², with individual masses up to 7 kg; one piece, weighing 680 g, broke through a roof. The total collected mass exceeds 100 kg. Ref: - P. Schmitt-Kopplin, Z. Gabelica, R.D. Gougeon, et al., 2010, *Proc. Nat Acad. Sci. USA*, 107, 2763, "High molecular diversity of extraterrestrial organic matter in **Murchison meteorite** revealed 40 years after its fall." See: http://www.pnas.org/content/early/2010/02/12/0912157107.abstract - S. Pizzarello, August 2012, *Astrophysical Journal* (Letters), 754, L27, "Hydrogen cyanide in the **Murchison Meteorite**." See: http://adsabs.harvard.edu/abs/2012ApJ...754L..27P See also: http://tin.er.usgs.gov/meteor/metbull.php?code=16875 http://www.scientificamerican.com/article.cfm?id=murchison-meteorite http://en.wikipedia.org/wiki/Murchison_meteorite
1969, Dec	The **Japanese Antarctic Research Expedition** discovered nine meteorites on the blue ice field of the Yamato Mountains in Antarctica, December 1969. This was the first significant recovery of Antarctic meteorites and represented samples of several different types. In 2011, co-researchers from the USA, South Korea and Japan have found in meteorite **Yamato 691** a new mineral, dubbed

	"Wassonite", formed from sulfur and titanium, and possessing a unique crystal structure that has not been previously observed in nature. Ref: - T. Nagata, 30 June 1976, *Meteoritics*, 11, 181, "Yamato meteorites collected in Antarctica in 1969." See: http://adsabs.harvard.edu/abs/1976Metic..11..181N http://www.nasa.gov/centers/johnson/home/wassonite.html
1970, Jan 1	**27 NEAs** known, of which **10 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1970	First infrared diameter of an asteroid measured: **4 Vesta** (H = 3.40 mag, D = 530 km, Main-belt asteroid). See: Vesta - JPL , 4 Vesta - SSA See also: http://en.wikipedia.org/wiki/4_Vesta Ref: - D.A. Allen, 1970, *Nature*, 227, 158, "Infrared diameter of **Vesta**." See: http://nature.com/nature/journal/v227/n5254/abs/227158a0.html
1970, Jan 3	**Lost City Fireball**. Four stations (Hominy OK, Woodward OK, Pleasanton KS, and Garden City KS) of the **Prairie Meteorite Network** simultaneously photographed the track of a meteoroid fireball. Analysis of the photographs indicated that a meteorite might have landed within an area east of Lost City (OK, USA). This was the first time in the US that simultaneous photography of a fireball from multiple observation points was achieved, making it possible to calculate a trajectory and delimit a search area on the ground. Six days later, a 9.83 kg (21.6 pound) meteorite was spotted sitting in a snow-covered dirt road within one-half mile of Lost City. Three additional smaller meteorite fragments were recovered later (272 g, 640 g, 6.6 kg). Ref: - Z. Ceplecha, 1996, *Astronomy & Astrophysics*, 311, 329, "Luminous efficiency based on photographic observations of the **Lost City fireball** and implications for the influx of interplanetary bodies onto Earth." See: http://adsabs.harvard.edu/abs/1996A%26A...311..329C http://en.wikipedia.org/wiki/Lost_City,_Oklahoma
1970, Jan 24	C.S. Beals, 1970, *Nature*, 225, 368, "Impact craters and the relative ages of Earth and Moon." See: http://adsabs.harvard.edu/abs/1970Natur.225..368B

1970, Jan 31	Aten NEA **2006 AM4** (H = 21.7 mag, $D \approx$ 160 m, **PHA**) passed Earth at a nominal miss distance of 4.18 LD. Minimum miss distance 4.17 LD. See: 2006 AM4 - SSA , 2006 AM4 - JPL
1970, Feb 26	Apollo NEA **2019 DS1** (H = 25.6 mag, $D \approx$ 26 m) passed Earth at a nominal miss distance of 0.94 LD. Minimum miss distance 0.93 LD. **[1970-01]** See: 2019 DS1 - SSA , 2019 DS1 - JPL See also: **26 Feb 2082**.
1970, Mar 27	Apollo NEA **215588** (**2003 HF2**, H = 19.3 mag, $D \approx$ 490 m, **PHA**) passed Earth at a nominal miss distance of 4.02 LD. Minimum miss distance 4.02 LD. See: 2003 HF2 - JPL , 2003 HF2 - SSA
1970, May 7	Apollo NEA **2019 JJ3** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 3.96 LD. Minimum miss distance 0.43 LD. See: 2019 JJ3 – SSA , 2019 JJ3 – JPL See also: **13 May 2095**.
1970, Oct	C.J. van Houten, I. van Houten-Groeneveld, P. Herget & T. Gehrels, 1970, *Astronomy & Astrophysics Suppl.*, 2, 339, "The **Palomar-Leiden Survey of faint Minor Planets**." See: http://adsabs.harvard.edu/abs/1970A%26AS....2..339
1971, Jan 22	Aten NEA **2020 BP8** (H = 25.6 mag, $D \approx$ 28 m) passed Earth at a nominal miss distance of 7.14 LD. Minimum miss distance 0.88 LD. See: 2020 BP8 – S2P , 2020 BP8 – JPL
1971, Feb 4	Aten NEA **2016 CE** (H = 28.7 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.58 LD. **[1971-01]** See: 2016 CE - JPL , 2016 CE - SSA See also: **5 Feb 2056**.
1971, Mar 6-10	**IAU Colloquium No. 12 on *Physical Studies of Minor Planets***, Tucson (AZ, USA), 6-10 March 1971. Proceedings: T. Gehrels (ed.), 1971, *NASA SP*-267, "Physical studies of minor planets." See: http://adsabs.harvard.edu/abs/1971NASSP.267.....G
1971, Mar 24	Aten NEA **234145** (**2000 EW70**, H = 21.9 mag, $D \approx$ 344 m, **PHA**), passed Earth at a nominal miss distance of 4.61 LD. Minimum miss distance 4.61 LD.

	See: 2000 EW70 - JPL , 2000 EW70 - SSA See also: **24 Mar 1961**.
1971, Apr 2	Aten NEA **2015 FA285 (***H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 5.81 LD. Minimum miss distance 0.73 LD. See: 2015 FA285 - JPL , 2015 FA285 - SSA
1971, Apr 3	Aten NEA **2014 GC49** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 9.04 LD. Minimum miss distance 0.64 LD. See: 2014 GC49 - JPL , 2014 GC49 - SSA
1971, Apr 11	Apollo NEA **2002 JE9** (*H* = 21.2 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.65 LD. **[1971-02]** See: 2002 JE9 - JPL , 2002 JE9 - SSA See also: http://en.wikipedia.org/wiki/2002_JE9 See also: **10 Apr 1927**.
1971, May 11	Aten NEA **2021 JZ5** (*H* = 28.4 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 2.93 LD. Minimum miss distance 0.89 LD. See: 2021 JZ5 – S2P , 2021 JZ5 - JPL See also: **11 May 2034.**
1971, May 20	Aten NEA **2021 JY3** (*H* = 28.4 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.56 LD. Minimum miss distance 0.52 LD. **[1971-03]** See: 2021 JZ5 – S2P , 2021 JZ5 - JPL See also: **16 May 2052**, **8 May 2059**.
1971, May 22	Apollo NEA **2017 WL15** (*H* = 25.8 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 3.58 LD. Minimum miss distance 0.50 LD. See: 2017 WL15 - JPL , 2017 WL15 - SSA
1971, May 23	Apollo NEA **2020 KQ4** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 2.71 LD. Minimum miss distance 0.63 LD. See: 2020 KQ4 – S2P , 2020 KQ4 – JPL See also: **24 May 2031**.
1971, Jul 20	Apollo NEA **2002 BF25** (*H* = 22.2 mag, *D* ≈ 152 m) passed Earth at a nominal miss distance of 7.66 LD. Minimum miss distance

	7.66 LD. See: 2002 BF25 - SSA , 2002 BF25 - JPL See also: **20 Jul 2020**.
1971, Oct 2	Apollo NEA **2008 TC3** (*H* = 30.3 mag, *D* ≈ 4.1 m) passed Earth at a nominal miss distance of 15.26 LD. Minimum miss distance 14.01 LD. See: 2008 TC3 - JPL , 2008 TC3 - SSA See also: **4 Oct 1917**, **11 Oct 1961**, **27 Jan 1988, 6 Oct 2008**.
1971, Dec 7	Apollo NEA **2020 XC4** (*H* = 26.0 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 6.46 LD. Minimum miss distance 0.67 LD. See: 2020 XC4 – S2P , 2020 XC4 – JPL
1972	V.L. Masajtis, M.V. Mikhajlov, T.V. Selivanovskaya, 1972, *Meteoritics*, 7(1), 39, "The **Popigay meteorite crater**." See: http://adsabs.harvard.edu/abs/1972IGRv...14..327M
1972	V.L. Masaitis, M.V. Mikhailov, T.V. Selivanovskaya, 1972, *Int. Geol. Rev.*, 14, 327, "**Popigai Basin** -- an explosion **meteorite crater**." See: http://adsabs.harvard.edu/abs/1972Metic...7...39M
1972, Mar	D.J. Milton, B.C. Barlow, R. Brett, et al., 1972, *Science*, 175, 1199, "Gosses Bluff impact structure, Australia." See: http://adsabs.harvard.edu/abs/1972Sci...175.1199M http://en.wikipedia.org/wiki/Gosses_Bluff_crater
1972, Aug 6	Apollo NEA **2018 LB1** (*H* = 20.2 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 3.70 LD. Minimum miss distance 2.58 LD. See: 2018 LB1 - JPL , 2018 LB1 - SSA
1972, Aug 10	**Great Daylight 1972 Fireball** (**US19720810**), Earth-grazing asteroid, estimated *D* ≈ 3-14 m, 100-sec passage with 15 km/s through the Earth atmosphere, 57 km high over the Rocky Mountains from Utah (USA) to Alberta (Canada). Co-inciding with the annual **Perseid** meteor shower. Suggestions that this object is still in an Earth crossing orbit around the Sun and passed close to the Earth again in August 1997 have not been substantiated (Spahr, 2010, private communication). Ref: - R.D. Rawcliffe, C.D. Bartky, F. Li, et al., 1974, *Nature*, 247, 449, "Meteor of August 10, 1972." See: http://adsabs.harvard.edu/abs/1974Natur.247..449R

	- E.J. Öpik, 1974, *Irish Astronomical Journal*, 11, 165, "A meteorite that got away." See: http://adsabs.harvard.edu/abs/1974IrAJ...11..165O - A.C. Clarke, 1993, in preface of his novel *The Hammer of God* (New York: Bantam Books). See: http://en.wikipedia.org/wiki/The_Hammer_of_God - E. Tagliaferri, 1998, *Mercury*, Vol. 27, no. 6, p. 18, "Observation of meteoroid impacts by space-based sensors." See: http://adsabs.harvard.edu/abs/1998Mercu..27f..18T - Z. Ceplecha, 1994, *Astronomy & Astrophysics*, 283, 287, "Earth-grazing daylight fireball of August 10, 1972." See: http://adsabs.harvard.edu/abs/1994A%26A...283..287C See also: http://web.archive.org/web/20050120051405/www.maa.agleia.de/Comet/Other/1972.html http://apod.nasa.gov/apod/ap090302.html http://en.wikipedia.org/wiki/The_Great_Daylight_1972_Fireball http://en.wikipedia.org/wiki/Earth-grazing_fireball
1972, Oct 2	R.J. Ford, 1972, *Earth and Planetary Science Letters*, 16, 228, "A possible impact crater associated with Darwin glass." See: http://adsabs.harvard.edu/abs/1972E&PSL..16..228F See also: http://www.newscientist.com/article/dn24560-meteor-impact-trapped-ancient-swamp-plants-in-glass.html#.UpZU6rB3tdg
1973, Jan	Eleanor F. Helin and Eugene M. Shoemaker begin photographic NEO searches using Palomar 46 cm (18 inch) telescope: the **Planet-Crossing Asteroid Survey (PCAS)**, 1973 – 1978. They took photographic plates 3 nights each month till 1978 and found first Earth orbit crosser: Apollo NEA **5496** (**1973 NA**, $H = 15.9$ mag, $D \approx 2.73$ km) on 4 July 1973. See: 1973 NA - JPL , 5496 1973 NA - SSA See also: https://en.wikipedia.org/wiki/(5496)_1973_NA Ref: - E.F. Helin, E.M. Shoemaker, 1979, *Icarus*, 40, 321, "The **Palomar Planet-Crossing Asteroid Survey**, 1973 – 1978." See: http://adsabs.harvard.edu/abs/1979Icar...40..321H http://en.wikipedia.org/wiki/Planet-Crossing_Asteroid_Survey
1973, Jan 17	Aten NEA **2009 BH2** ($H = 22.3$ mag, $D \approx 130$ m) passed Earth at a nominal miss distance of 5.50 LD. Minimum miss distance 5.50 LD. See: 2009 BH2 - JPL , 2009 BH2 - SSA

1973, Feb	J.K. Bjorkman, 1973, *Meteoritics*, 8, 91, "Meteors and meteorites in the ancient Near East." See: http://adsbit.harvard.edu/cgi-bin/nph-iarticle_query?bibcode=1973Metic...8...91B&db_key=AST&page_ind=0&plate_select=NO&data_type=GIF&type=SCREEN_GIF&classic=YES .
1973, Mar 13	Discovery of Amor NEA **1943 Anteros** (**1973 EC**, *H* = 15.9 mag, *D* ≈ 2480 m). See: 1973 EC - JPL , 1973 EC - SSA See also: https://en.wikipedia.org/wiki/1943_Anteros See also: **6 February 2015**, **23 May 2038**, **20 May 2050**.
1973, Sep 18	Aten NEA **2017 RX2** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 3.81 LD. Minimum miss distance 0.50 LD. See: 2017 RX2 - JPL , 2017 RX2 - SSA
1973, Oct	P.D. Zimmerman, G.W. Wetherill, 1973, *Science*, 182, 51, "Asteroidal source of meteorites." See: http://adsabs.harvard.edu/abs/1973Sci...182...51Z
1973, Dec 19	Aten NEA **2017 YO3** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 2.43 LD. Minimum miss distance 0.63 LD. See: 2017 YO3 - JPL , 2017 YO3 - SSA See also: **20 Dec 2064**.
1974, Feb 12	Aten NEA **2017 CP32** (*H* = 23.8 mag, *D* ≈ 60 m) passed Earth at a nominal miss distance of 3.51 LD. Minimum miss distance 0.39 LD. See: 2017 CP32 - JPL , 2017 CP32 - SSA See also: **12 Feb 2061**.
1974, Mar 16	Apollo NEA **2012 EN5** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 2.10 LD. Minimum miss distance 0.31 LD. See: 2012 EN5 -JPL , 2012 EN5 - SSA
1974, May 6	Apollo NEA **2014 HB177** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.37 LD. **Minimum miss distance 0.075 LD (0.45 R_{Earth} from the geocenter).** See: 2014 HB177 - SSA , 2014 HB177 - JPL See also: **6 May 2034**.
1974, Oct 5	Apollo NEA **2018 CC1** (*H* = 23.5 mag, *D* ≈ 70 m) passed Earth at

	a nominal miss distance of 1.95 LD. Minimum miss distance 0.89 LD. See: 2018 CC1 - JPL , 2018 CC1 - SSA
1974, Dec 16	Apollo NEA **3200 Phaethon** (**1983 TB**, *H* = 14.4 mag, *D* ≈ 5100 ± 200 m, **PHA**, causing the annual **Geminids meteor shower**) passed Earth at a nominal miss distance of 21.30 LD (= 0.05 au). Minimum miss distance 21.30 LD. See: 3200 Phaethon - SSA , 1983 TB - JPL Ref: - T. Kasuga, J.-I. Watanabe, M. Sato, 2006, *Monthly Notices of the Royal Astronomical Society*, 373, 1107, "Benefits of an impact mission to **3200 Phaethon**: nature of the extinct comet and artificial meteor shower." See: http://adsabs.harvard.edu/abs/2006MNRAS.373.1107K See also: https://www.jpl.nasa.gov/news/news.php?feature=7030 https://phys.org/news/2017-12-arecibo-radar-asteroid-phaethon-images.html http://en.wikipedia.org/wiki/3200_Phaethon See also: https://www.space.com/42236-weird-blue-asteroid-phaethon.html See also: **16 Dec 2017, 14 Dec 2093**.
1975	G.W. Wetherill, 1975, in: Proc. 6*th* *Lunar Science Conference*, Houston (TX, USA), 17-21 March 1975, Vol. 2 (New York: Pergamon Press, Inc.), p. 1539, "Late heavy bombardment of the moon and terrestrial planets." See: http://adsabs.harvard.edu/abs/1975LPSC....6.1539W
1975, Jan 14	Aten NEA **2018 AS2** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 3.37 LD. Minimum miss distance 0.24 LD. See: 2018 AS2 - JPL , 2018 AS2 - SSA
1975, Jan 23	Amor NEA **433 Eros** (**A898 PA**, *H* = 10.3 mag, *D* = 34.4 × 11.2 × 11.2 km, orbital *P* = 1.76 yr), passed Earth at 59 LD (= 0.15 AU). See: 433 Eros - JPL , 433 Eros - SSA See also: http://en.wikipedia.org/wiki/433_Eros See also: **13 Aug 1898**, **31 Jan 2012**.
1975, Jan 31	Apollo NEA **27002** (**1998 DV9**, *H* = 18.2 mag, *D* ≈ 700 m, **PHA**) passed Earth at a nominal miss distance of 1.76 LD. Minimum miss distance 1.76 LD. See: 1998 DV9 - JPL , 1998 DV9 - SSA

1975, Mar 25	Aten NEA **2012 FT35** (*H* = 29.5 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 2.83 LD. Minimum miss distance 0.94 LD. See: 2012 FT35 - JPL , 2012 FT35 - SSA See also: **29 Mar 1925**.
1975, Apr 19	Apollo NEA **2018 HW1** (*H* = 25.8 mag, *D* ≈ 25 m) passed Earth at a nominal miss distance of 6.54 LD. Minimum miss distance 0.63 LD. See: 2018 HW1 – SSA , 2018 HW1 - JPL See also: **21 Apr 2018**, **24 Apr 2041**.
1975, Apr 26	Apollo NEA **2020 HF5** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 7.24 LD. Minimum miss distance 0.11 LD. See: 2020 HF5 – S2P , 2020 HF5 - JPL See also: **22 Apr 2020, 26 Apr 2079**.
1975, Sep	A. Ben-Menahem, 1975, *Physics of the Earth and Planetary Interiors*, 11, 1, "Source parameters of the **Siberian explosion of June 30, 1908**, from analysis and synthesis of seismic signals at four stations." See: http://adsabs.harvard.edu/abs/1975PEPI...11....1B
1975, Nov 11	Apollo NEA **2008 XA2** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) passed Earth at a nominal miss distance of 3.25 LD. Minimum miss distance 3.25 LD. See: 2008 XA2 - SSA , 2008 XA2 - JPL
1976	D. Morrison, 1976, *Astronomy*, 4, no. 6, p. 6, "Asteroids." See: http://adsabs.harvard.edu/abs/1976Ast.....4f...6M
1976, Jan 7	First discovery of an Earth orbit crossing **Aten NEA**: **2062 Aten** (**1976 AA**, *H* = 17.2 mag, *D* = 1300 m), by Eleanor F. Helin (1932 – 2009, USA). See: 1976 AA - JPL , 2062 Aten - SSA See also: http://en.wikipedia.org/wiki/2062_Aten Ref: - E.F. Helin, E.M. Shoemaker, 1977, *Icarus*, 31, 415, "Discovery of asteroid **1976 AA**". See: http://adsabs.harvard.edu/abs/1977Icar...31..415H
1976, Jan 16	Apollo NEA **2008 RM98** (*H* = 20.8 mag, *D* ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 2.18 LD. Minimum miss distance 2.17 LD.

	See: 2008 RM98 - JPL , 2008 RM98 - SSA
1976, Jan 28	**Gujarat Brilliant Fireball and Dhajala Meteorite Shower,** India. Ref: - N. Bhandari, D. Lal, J.R. Trivedi, 1976, *Meteoritics*, 11, 137, "The Dhajala meteorite shower." See: http://adsabs.harvard.edu/abs/1976Metic..11..137B
1976, Jan 28	Apollo NEA **2020 YB5** (*H* = 25.2 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 4.78 LD. Minimum miss distance 0.90 LD. See: 2020 YB5 – S2P , 2020 YB5 - JPL
1976, Mar 8	**Jilin Meteorite Shower**, near Jilin City (Jilin Province, China), had a dispersion ellipse of 72 × 8.5 km and landed over 100 fragments with a total mass > 2700 kg. The largest of these fragments weighs 1770 kg and presents the largest stony meteorite known. Ref: - K. Yau, P. Weissman, D. Yeomans, 1994, *Meteoritics*, 29, 864, "Meteorite falls in China and some related human casualty events." See: http://adsabs.harvard.edu/abs/1994Metic..29..864Y http://www.daviddarling.info/encyclopedia/J/Jilin.html http://en.wikipedia.org/wiki/Meteorite_fall
1976, Mar 29	Apollo NEA **2014 GY44** (*H* = 25.7 mag, *D* ≈ 26 m) passed Earth at a nominal miss distance of 1.19 LD. Minimum miss distance 0.17 LD. See: 2014 GY44 - JPL , 2014 GY44 - SSA
1976, Jun 7	Apollo NEA **2019 LW4** (*H* = 26.8 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 1.09 LD. Minimum miss distance 0.97 LD. See: 2019 LW4 - SSA , 2019 LW4 - JPL See also: **8 Jun 2019**, **9 Jun 2074**.
1976, Oct 17	Aten NEA **2013 UG1** (*H* = 22.5 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD. **[1976-01]** See: 2013 UG1 - JPL , 2013 UG1 - SSA See also: **17 Oct 2065**.
1976, Oct 20	Aten NEA **2340 Hathor** (**1976 UA**, *H* = 20.5 mag, *D* ≈ 210 m, **PHA**) passed Earth at a nominal miss distance of 3.02 LD. Minimum miss distance 3.02 LD.

	See: 1976 UA - JPL , 1976 UA - SSA See also: **20 Oct 1921**, **21 Oct 2069**, **21 Oct. 2086**.
1976, Dec	Z. Ceplecha, R.E. McCrosky, 1976, *Journal of Geophysical Research*, 81, 6257, "Fireball end h eights – a diagnostic for the structure of meteoric material." See: http://adsabs.harvard.edu/abs/1976JGR....81.6257C
1976, Dec 27	Aten NEA **2010 XC15** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) passed Earth at a nominal miss distance of 2.43 LD. Minimum miss distance 2.43 LD. See: 2010 XC15 - JPL , 2010 XC15 - SSA See also: **26 Dec 1907**, **27 Dec 1914**, **27 Dec 2022**, **28 Dec 2059**, **26 Dec 2064**, **26 Dec 2096**.
1977, Jan 29	Apollo NEA **292220** (**2006 SU49**, *H* = 19.7 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 3.87 LD. Minimum miss distance 3.86 LD. See: 2006 SU49 - JPL , 2006 SU49 - SSA See also: **30 Jan 1982**, **28 Jan 2029**. See also: https://en.wikipedia.org/wiki/(292220)_2006_SU49
1977, Apr 11	Apollo NEA **2011 UH20** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**) passed Earth at a nominal miss distance of 4.57 LD. Minimum miss distance 4.57 LD. See: 2011 UH20 - JPL , 2011 UH20 - SSA See also: **11 Apr 1906**.
1977, May 7	Apollo NEA **2018 VO6** (*H* = 24.3 mag, *D* ≈ 50 m) passed Earth at a nominal miss distance of 2.86 LD. Minimum miss distance 0.60 LD. See: 2007 VO6 - SSA , 2007 VO6 - JPL See also: **7 May 2058**, **8 May 2063**.
1977, Jun 8	Amor NEA **2020 KB3** (*H* = 24.9 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 4.10 LD. Minimum miss distance 0.87 LD. See: 2020 KB3 – S2P , 2020 KB3 – JPL
1977, Jul 21	Apollo NEA **2021 BN**, *H* = 28.3 mag, *D* ≈ 8 m passed Earth at a nominal miss distance of 8.83 LD. Minimum miss distance 0.95 LD. See: 2021 BN – S2P , 2021 BN – JPL See also: **28 Jul 2064**.
1977, Sep 13	Apollo NEA **2012 EP10** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at

	a nominal miss distance of 3.52 LD. Minimum miss distance 0.21 LD. See: 2012 EP10 - JPL , 2012 EP10 - SSA
1977, Oct 20	Apollo NEA **2020 FN3** (H = 24.5 mag, $D \approx$ 50 m) passed Earth at a nominal miss distance of 2.19 LD. Minimum miss distance 0.66 LD. See: 2020 FN3 – S2P , 2020 FN3 – JPL See also: **3 Apr 2075**.
1978	C.R. Chapman, J.G. Williams, W.K. Hartmann, 1978, *Annual Review of Astronomy & Astrophysics*, 16, 33, "The asteroids." See: http://adsabs.harvard.edu/abs/1978ARA%26A..16...33C
1978	L'. Kresák, 1978, *Bulletin Astronomical Institutes of Czechoslovakia*, 29, 103, "Passages of comets and asteroids near the earth." See: http://adsabs.harvard.edu/abs/1978BAICz..29..103K
1978	L'. Kresák, 1978, *Bulletin Astronomical Institutes of Czechoslovakia*, 29, 114, "The comet and asteroid population of the earth's environment." See: http://adsabs.harvard.edu/abs/1978BAICz..29..114K
1978	L'. Kresák, 1978, *Bulletin Astronomical Institutes of Czechoslovakia*, 29, 149, "The total number of the Apollo asteroids and their chance rediscoveries." See: http://adsabs.harvard.edu/abs/1978BAICz..29..149K
1978	B.L. Narendra, 1978, *Discovery* 13(1), 10, "The Peabody Museum meteorite collection: a historic account." See: http://peabody.yale.edu/collections/meteorites-and-planetary-science/weston-meteorite http://peabody.yale.edu/collections/meteorites-and-planetary-science/wethersfield-meteorite
1978	G.L. Verschuur, 1978, *Cosmic Catastrophes* (Reading, MA, USA: Addison-Wesley Publ. Co.). See: http://adsabs.harvard.edu/abs/1978coca.book.....V
1978, Apr 1	**IAU Minor Planet Center** moved to Smithsonian Astrophysical Observatory, Cambridge (MA, USA). Brian G. Marsden, director. Up to this time, the set of numbered minor planets had increased to 2060, with nearly 180,000 observations in the archive. See: http://www.oaa.gr.jp/~oaacs/mp/BriefHistoryofMPCbyConradBardwell.

	pdf http://www.iau.org/static/publications/IB104.pdf , p. 67.
1978, May 20 02:43	Apollo NEA **2017 KY4** (*H* = 24.5 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 7.50 LD. Minimum miss distance 0.77 LD. See: 2017 KY4 - JPL , 2017 KY4 - SSA
1978, May 20 12:48	Aten NEA **2011 UD21** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 1.75 LD. Minimum miss distance 0.24 LD. See: 2011 UD21 - JPL , 2011 UD21 - SSA
1978, Jul 1	Apollo NEA **436724** (**2011 UW158**, *H* = 20.0 mag, *D* ≈ 600 x 300 m, **PHA**) passed Earth at a nominal miss distance of 4.68 LD. Minimum miss distance 4.68 LD. See: 2011 UW158 - JPL , 2011 UW158 - SSA See also: https://en.wikipedia.org/wiki/(436724)_2011_UW158 See also: **2 Jul 2108**.
1978, Sep	E. Bowell, C.R. Chapman, J.C. Grady, D. Morrison, B. Zellner, 1978, *Icarus*, 35, 313, "Taxonomy of asteroids." See: http://adsabs.harvard.edu/abs/1978Icar...35..313B
1978, Oct 11	Aten NEA **2020 TK5** (*H* = 23.7 mag, *D* ≈ 70 m) passed Earth at a nominal miss distance of 9.82 LD. Minimum miss distance 0.62 LD. See: 2020 TK5 – S2P , 2020 TK5 – JPL See also: **12 Oct 2186**.
1978, Oct 20	Apollo NEA **2017 UJ2** (*H* = 31.0 mag, *D* ≈ 2.2 m) passed Earth at a nominal miss distance of 2.16 LD. Minimum miss distance 0.40 LD. See: 2017 UJ2 - SSA , 2017 UJ2 - JPL See also: **20 Oct 2017**, **30 Oct 2030**.
1979	T. Gehrels (ed.), 1979, *Asteroids I* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1979aste.book.....G
1979	E.J. Öpik, 1979, *Irish Astronomical Journal*, 14, 31, "Dinosaurs." See: http://adsabs.harvard.edu/abs/1979IrAJ...14Q..31O
1979, Jan 5	Apollo NEA **2018 BM3** (*H* = 22.0 mag, *D* ≈ 140 m, **PHA**) passed Earth at a nominal miss distance of 2.29 LD. Minimum miss distance 2.29 LD. See: 2018 BM3 - JPL , 2018 BM3 - SSA See also: **5 Jan 2051**.

1979, Feb	R.D. Rawcliffe, 1979, *Astrophysical Journal*, 228, 338, "Satellite observations of meteors." See: http://adsabs.harvard.edu/abs/1979ApJ...228..338
1979, Mar	G.W. Wetherill, 1979, *Scientific American*, 240, No. 3, 38, "Apollo objects." See: http://adsabs.harvard.edu/abs/1979SciAm.240...54W
1979, Aug 17	Apollo NEA **2017 RV** (*H* = 21.9 mag, *D* ≈ 150 m, **PHA**) passed Earth at a nominal miss distance of 4.20 LD. Minimum miss distance 4.19 LD. See: 2017 RV - JPL , 2017 RV - SSA See also: **19 Aug 2125**, **19 Aug 2175**.
1979, Sep 2	Apollo NEA **2014 WX202** (*H* = 29.8 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.86 LD. **[1979-01]** See: 2014 WX202 - JPL , 2014 WX202 - SSA See also: **7 Dec 2014**.
1979, Sep 22	**The Vela Incident.** Double flash explosion detected by an American ***Vela Hotel satellite*** over the South Atlantic caused by nuclear weapons test or meteoroid? See: http://en.wikipedia.org/wiki/Vela_Incident
1979, Nov	W.M. Napier, S.V.M. Clube, 1979, *Nature*, 282, 455, "A theory of terrestrial catastrophism." See: http://adsabs.harvard.edu/abs/1979Natur.282..455N
1979, Dec	E.F. Helin, E.M. Shoemaker, 1979, *Icarus*, 40, 321, "The **Palomar planet-crossing asteroid survey**, 1973-1978." See: http://adsabs.harvard.edu/abs/1979Icar...40..321H
1979, Dec	H.H. Nininger, 1979, *Meteoritics*, 14, 497, "Small asteroids frequently arrive on the Earth." See: http://adsabs.harvard.edu/abs/1979Metic..14..497N
1979, Dec 17	Apollo NEA **1979 XB** (*H* = 18.5 mag, *D* ≈ 700 m, **PHA**) passed Earth at a nominal miss distance of 14.24 LD. Minimum miss distance 11.30 LD. See: 1979 XB - JPL , 1979 XB - SSA This asteroid may make a close Earth flyby on **14 Dec 2113.**
1980, Jan 1	**51 NEAs** known, of which **17 PHAs**. See: http://neo.jpl.nasa.gov/stats/

1980	**Spacewatch** program started by Tom Gehrels and Robert S. McMillan, LPL, UA, Tucson (AZ, USA). Routine detections started in 1984, survey started in 1989. CCD-scanning observations are conducted 20 nights each lunation with the Steward Observatory 0.9-m **Spacewatch Telescope** (down to v = 21 mag) and the **Spacewatch** 1.8-m telescope (down to v = 23 mag), both on Kitt Peak (AZ, USA). From 1992 to 1995 **Spacewatch** automatically detected more than 60,000 asteroids down to v = 21 mag. See: http://spacewatch.lpl.arizona.edu/ Ref: - R.S. McMillan and The **Spacewatch** Team, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 329, "**Spacewatch** preparations for the era of deep all-sky surveys." See: http://adsabs.harvard.edu/abs/2007IAUS..236..329M - D.K. Yeomans, S.R. Chesley, P.W. Chodas, 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proc. Intern. Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against collisions with asteroids and comet nuclei*, St. Petersburg (Russian Federation), 21-25 September 2009 (Saint Petersburg: Nauka), p. 244, "NASA's Near-Earth Object Program Office." See: http://ftp://quasar.ipa.nw.ru/pub/ACHBOOK_2009/ach-2009_book.pdf http://www.skyandtelescope.com/news/125432648.html - R.S. McMillan, T.H. Bressi, J.V. Scotti, et al., 2012, American Astronomical Society, DPS meeting #44, #210.14, "**Spacewatch** observations of Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2012DPS....4421014M See also: http://spacewatch.lpl.arizona.edu/ http://en.wikipedia.org/wiki/Spacewatch
1980	E. Helin, D. Morrison, G. Wetherill, M. Hanner, 1980, *Sky & Telescope*, 60, 12, "***IRAS*** and the asteroids." See: http://adsabs.harvard.edu/abs/1980S%26T....60...12H
1980, Jan 12	L. Alvarez, W. Alvarez, S. Klint, 1980, *Science News*, 117(2), 22, 12 January 1980, "Asteroid-caused extinctions." Correction: *Science News*, 117(6), .., 9 February 1980. See: http://www.sciencenews.org/view/feature/id/188305/title/Now_--_Asteroid-Caused_Extinctions http://www.sciencenews.org/view/feature/id/177017/title/Correction_No

	w_--_Asteroid-Caused_Extinctions http://adsabs.harvard.edu/abs/1980SciN..117...22A
1980, Jan 20	Aten NEA **2018 BH3** (*H* = 25.2 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 1.14 LD. Minimum miss distance 0.92 LD. See: 2018 BH3 - JPL , 2018 BH3 - SSA See also: **20 Jan 2060**.
1980, Feb 18	Apollo NEA **2021 DG** (*H* = 30.1 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 6.01 LD. Minimum miss distance 0.72 LD. See: 2021 DG – S2P , 2021 DG – JPL See also: **18 Feb 2021**, **19 Feb 2031**.
1980, May 17	Apollo NEA **2009 WW7** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 6.71 LD. Minimum miss distance 0.12 LD. See: 2009 WW7 - JPL , 2009 WW7 - SSA
1980, May 22	J. Smit, J. Hertogen, 1980, *Nature*, 225, 198, "An extraterrestrial event in the Cretaceous-Tertiary boundary." See: http://adsabs.harvard.edu/abs/1980Natur.285..198S
1980, Jun	Nobel Prize winning physicist Luiz W. Alvarez (1911 – 1988, USA) and colleagues published their seminal paper (1980), associating the extinction of dinosaurs ~65.5 Myr ago with the direct impact of a large asteroid or comet. Ten years later after this initial proposal, evidence of a huge impact crater called **Chicxulub**, off the coast of Yucatán Peninsula (Mexico), strongly confirmed their theory. The crater center is located near the town Chicxulub. The crater diameter is over 180 km, maybe even 300 km, making the feature one of the largest confirmed impact craters on Earth. The crater was discovered by the geophysicist Glen Penfield, who had been looking for oil in Yucatán during the late-1970s. Returning later he found evidence for the impact theory (A.R. Hildebrand et al., 1991). The impacting NEO that formed the crater had a diameter *D* = 10 ± 4 km; the explosion released an energy of about 5 × 10^7 megaton TNT, substantially more powerful than the largest known volcanic eruption. W.F. Bottke et al. (2007) suggested that the impacting NEO was a member of the **Baptistina family of asteroids**, created by a collision of two main-belt asteroids (with *D* = 170 km and 60 km) 160 Myr ago, the largest surviving orbiting member of which is main-belt asteroid **298 Baptistina** (*D* = 13-30 km), discovered in 1890 by Auguste H. Charlois (1864 – 1910) at the Observatoire de Nice (France). But see Masiero et al. (2011). Schulte et al. (2010) summarized

	evidence that the **Chicxulub** impact triggered the mass extinction ~65.5 year ago. Ref: - L. Alvarez, W. Alvarez, S. Klint, 1980, *Science News*, 117(2), 22, 12 January 1980, "Asteroid-caused extinctions." Correction: *Science News*, 117(6), .., 9 February 1980. See: http://www.sciencenews.org/view/feature/id/188305/title/Now_--_Asteroid-Caused_Extinctions http://www.sciencenews.org/view/feature/id/177017/title/Correction_Now_--_Asteroid-Caused_Extinctions http://adsabs.harvard.edu/abs/1980SciN..117...22A - J. Smit, J. Hertogen, 1980, *Nature*, 225, 198, 22 May 1980, "An extraterrestrial event in the Cretaceous-Tertiary boundary." See: http://adsabs.harvard.edu/abs/1980Natur.285..198S - L.W. Alvarez, W. Alvarez, F. Asaro, H.V. Michel, 1980, *Science,* 208, 1095, 6 June 1980, "Extraterrestrial cause for the Cretaceous–Tertiary [K-T] extinction." See: http://adsabs.harvard.edu/abs/1980Sci...208.1095A - J. Smit, J. Hertogen, L.W. Alvarez, W. Alvarez, F. Asaro, H.V. Michel, E.M. Shoemaker, 1980, *Sky & Telescope*, 80, 188, "Fresh light on an ancient catastrophe – Cretaceous-Tertiary extinction event." See: http://adsabs.harvard.edu/abs/1980S%26T....60R.188S - D.V. Kent, G.C. Reid, R.E. Brown, L.W. Alvarez, et al. 1981, *Science*, 211, 648, 13 February 1981, "Asteroid extinction hypothesis." See: http://adsabs.harvard.edu/abs/1981Sci...211..648K - J. Smit, G. Klaver, 1981, *Nature*, 292, 47, 2 July 1981, "Sanadine spherules at the Cretaceous-Tertiary boundary indicate a large impact event." See: http://www.nature.com/nature/journal/v292/n5818/abs/292047a0.html http://adsabs.harvard.edu/abs/1981Natur.292...47S - R.P. Turco, O.B. Toon, C. Park, et al., 2 October 1981, *Science*, 214, 19, "**Tunguska meteor fall** of 1908 – effects on stratospheric ozone." See: http://adsabs.harvard.edu/abs/1981Sci...214...19T - R.A.F. Grieve, 2 August 1984, *Nature*, 310, 370, "Cretaceous-Tertiary extinctions: physical evidence of impact." See: http://adsabs.harvard.edu/abs/1984Natur.310..370G - A.R. Hildebrand, G.T. Penfield, D.A. Kring, et al., 1 September 1991, *Geology*, 19, 867, "**Chicxulub Crater**: A possible Cretaceous/Tertiary boundary impact crater on the Yucatán Peninsula, Mexico." See: https://pubs.geoscienceworld.org/gsa/geology/article-abstract/19/9/867/205322/chicxulub-crater-a-possible-cretaceous-tertiary?redirectedFrom=fulltext - K.O. Pope, K.H. Baines, A.C. Ocampo, B.A. Ivanov, December

	1994, *Earth and Planetary Science Letters*, 128, 719, "Impact winter and the Cretaceous/Tertiary extinctions: results of a **Chicxulub** asteroid impact model." See: http://adsabs.harvard.edu/abs/1994E%26PSL.128..719P - G.L. Verschuur, 1996, *Impact! The threat of comets and asteroids* (Oxford: OUP), Ch.2 "The saga of the **Chicxulub Crater**." See: http://adsabs.harvard.edu/abs/1996itca.book.....V - P. Claeys, S. Goderis, 6 September 2007, *Nature*, 449, 30, "Lethal billiards." See: http://adsabs.harvard.edu/abs/2007Natur.449...30C - W.F. Bottke, D. Vokrouhlický, D. Nesvorný, et al., 6 September 2007, *Nature*, 449, 48, "An asteroid breakup 160 Myr ago as the probable source of the K/T impactor." See: http://adsabs.harvard.edu/abs/2007Natur.449...48B - D.J. Majaess, D. Higgins, L.A. Molnar, et al., February 2009, *Journal of the Royal Astronomical Society of Canada*, 103, 7, "New constraints on the asteroid **298 Baptistina**, the alleged family member of the K/T impactor." See: http://adsabs.harvard.edu/abs/2009JRASC.103....7M - P. Schulte, L. Alegret, I. Arenillas, et al., 5 March 2010, *Science*, 327, 1214, "The **Chicxulub** asteroid impact and mass extinction at the Cretaceous-Paleogene boundary." See: http://www.sciencemag.org/content/327/5970/1214.abstract?sid=e1f5d964-44c1-471c-a76c-ee04a627676f - J.D. Archibald, W.A. Clemens, K. Padian, et al., 21 May 2010, *Science*, 328, 973, "Cretaceous-Extinctions: multiple causes." See: http://www.sciencemag.org/search?site_area=sci&y=9&x=32&fulltext=Cretaceous-Extinctions%3A%20multiple%20causes&submit=yes - P. Schulte, L. Alegret, I. Arenillas, et al., 21 May 2010, *Science*, 328, 975, "Cretaceous-Extinctions: multiple causes / responses." See: http://www.sciencemag.org/content/328/5981/975.full - J.R. Masiero, A.K. Mainzer, T. Grav, et al., 17 October 2011, *Astrophysical Journal*, 741, 68, "Main belt asteroids with ***WISE***/***NEOWISE***. I. Preliminary albedos and diameters." See: http://adsabs.harvard.edu/abs/2011ApJ...741...68M - H. Pälike, 8 February 2013, *Science*, 339, 655, "Impact and extinction." See: http://www.sciencemag.org/content/339/6120/655.summary - P.R. Renne, A.L. Deono, F.J. Hilgen, et al., 8 February 2013, *Science*, 339, 684, "Time scales of critical events around the Cretaceous-Paleogene boundary." See: http://www.sciencemag.org/content/339/6120/684.abstract - A.E. Zlobin, 29 April 2013, e-print *arXiv:*1304.8070, "Discovery of probably **Tunguska** meteorites at the bottom of Khushmo

	river's shoal." See: http://arxiv.org/abs/1304.8070 - J. Vellekoop, A. Sluijs, J. Smit, et al., 27 May 2014, *Proceedings of the National Academy of Sciences*, 111, 7537, "Rapid short-term cooling following the **Chicxulub impact** at the Cretaceous–Paleogene boundary." See: http://www.pnas.org/content/111/21/7537 - A.E. Zlobin, 7 Aug 2013, e-print *arXiv:* 1402.1408, "**Tunguska** similar impacts and origin of life." See: http://adsabs.harvard.edu/abs/2014arXiv1402.1408Z See also: http://www.unb.ca/passc/ImpactDatabase/images/chicxulub.htm http://www.colorado.edu/news/releases/2004/168.html http://en.wikipedia.org/wiki/Extinction_event http://www.jyi.org/volumes/volume5/issue6/features/weinreb.html http://www.jyi.org/volumes/volume5/issue7/features/weinreb.html http://www.scientificamerican.com/article.cfm?id=asteroid-killed-dinosaurs http://www.sciencedaily.com/releases/2007/01/070118094039.htm http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-296 http://www.space.com/19681-dinosaur-killing-asteroid-chicxulub-crater.html http://www.space.com/20354-dinosaur-extinction-caused-by-comet.html http://en.wikipedia.org/wiki/Chicxulub_crater
1980, Jun 6	L.W. Alvarez, W. Alvarez, F. Asaro, H.V. Michel, 1980, *Science,* 208, 1095, 6 June 1980, "Extraterrestrial cause for the Cretaceous–Tertiary [K-T] extinction." See: http://adsabs.harvard.edu/abs/1980Sci...208.1095A
1980, Aug 5	**Tajikistan Fireball**, 5 August 1980, observed by the meteor observing stations operated by the **Meteor Patrol** of the Hissar Astronomical Observatory (Tajikistan) and Kipchak station. Ref: - N.A. Konovalova, J.M. Madiedo, J.M. Trigo-Rodríguez, 2013, LPI Contribution No. 1719, p. 1479, "Analysis of a large meteorite-dropping fireball from the Apollo NEA family." See: http://adsabs.harvard.edu/abs/2013LPICo1719.1479K
1980, Sep 22	Apollo NEA **2016 FW3** (H = 25.5 mag, $D \approx 29$ m) passed Earth at a nominal miss distance of 1.01 LD. Minimum miss distance 1.003 LD. See: 2016 FW3 - JPL , 2016 FW3 - SSA
1980, Sep 28	Aten NEA **2011 TO** (H = 26.3 mag, $D \approx 23$ m) passed Earth at a nominal miss distance of 9.38 LD. Minimum miss distance 0.79 LD.

	See: 2011 TO - JPL , 2011 TO - SSA See also: **28 Sep 2011**, **27 Sep 2044**.
1980, Oct 15	Aten NEA **2018 RY1** (*H* = 24.4 mag, *D* ≈ 50 m) passed Earth at a nominal miss distance of 0.41 LD. Minimum miss distance 0.40 LD. **[1980-01]** See: 2018 RY1 - JPL , 2018 RY1 - SSA
1980, Nov 9	Aten NEA **2018 XQ2** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 44.31 LD. Minimum miss distance 0.48 LD. See: 2018 XQ2 - JPL , 2018 XQ2 - SSA See also: **11 Jan 1985**, **11 Nov 2048**.
1981, Feb 13	D.V. Kent, G.C. Reid, R.E. Brown, L.W. Alvarez, et al. 1981, *Science*, 211, 648, 13 February 1981, "Asteroid extinction hypothesis." See: http://adsabs.harvard.edu/abs/1981Sci...211..648K
1981, Apr 10	Apollo NEA **2012 HG2** (*H* = 27.2 mag, *D* ≈ 13m) passed Earth at a nominal miss distance of 4.74 LD. Minimum miss distance 0.49 LD. See: 2012 HG2 – SSA , 2012 HG2 - JPL See also: **12 Feb 2047**.
1981, May 7	R.A.F. Grieve, 1981, *Nature*, 291, 16, "Impact cratering." See: http://adsabs.harvard.edu/abs/1981Natur.291...16G
1981, May 18	Apollo NEA **143651** (**2003 QO104**, *H* = 16.2 mag, ***D* ≈ 2290 m**, **PHA**) passed Earth at a nominal miss distance of 2.76 LD. Minimum miss distance 2.76 LD. See: 2003 QO104 - JPL , 143651 2003 QO104 - SSA See also: https://en.wikipedia.org/wiki/(143651)_2003_QO104
1981, Jul 2	J. Smit, G. Klaver, 1981, *Nature*, 292, 47, 2 July 1981, "Sanadine spherules at the Cretaceous-Tertiary boundary indicate a large impact event." See: http://www.nature.com/nature/journal/v292/n5818/abs/292047a0.html http://adsabs.harvard.edu/abs/1981Natur.292...47S
1981, Jul 13-16	***First NASA NEO workshop on Collision of Asteroids and Comets with the Earth: Physical and Human Consequences***, Snowmass (CO, USA), chaired by Eugene M. Shoemaker. Report never published. Ref: - D. Chandler, 2008, *Nature,* 453, 1164, "The burger bar that saved

	the world." See: http://www.nature.com/news/2008/080625/full/4531164a.html
1981, Oct 2	R.P. Turco, O.B. Toon, C. Park, et al., 2 October 1981, *Science*, 214, 19, "**Tunguska meteor fall** of 1908 – effects on stratospheric ozone." See: http://adsabs.harvard.edu/abs/1981Sci...214...19T
1981, Oct 12-22	***First Snowbird Conference on Large Body Impacts and Terrestrial Evolution: Geological, Climatological, and Biological Implications***, Snowbird (Utah, USA). See: http://www.lpi.usra.edu/lpi_40th/1981.shtml
1981, Nov	C. Emiliani, E.B. Kraus, E.M. Shoemaker, 1981, *Earth and Planetary Science Letters*, 55, 317, "Sudden death at the end of Mesozoic." See: http://adsabs.harvard.edu/abs/1981E%26PSL..55..317E
1981, Nov	G.W. Wetherill, 1981, *Icarus*, 48, 308, "Which **fireballs** are **meteorites** – a study of the **Prairie Network** photographic meteor data." See: http://adsabs.harvard.edu/abs/1981Icar...48..308W
1982	L.T. Silver, P.H. Schulz (eds.), 1982, Proc., ***Geological implications of impacts of large asteroids and comets on the Earth***, *Geological Society of America Special Papers*, Vol. 190. See: http://specialpapers.gsapubs.org/content/190
1982, Jan 8	Aten NEA **2020 AD3** (H = 21.6 mag, $D \approx$ 170 m, **PHA**) passed Earth at a nominal miss distance of 8.33 LD. Minimum miss distance 7.27 LD. See: 2020 AD3 – S2P , 2020 AD3 - JPL See also: **12 Jan 2132**.
1982, Jan 9	Aten NEA **2018 AM12 (**H = 20.9 mag, $D \approx$ 230 m, **PHA**) passed Earth at a nominal miss distance of 2.57 LD. Minimum miss distance 2.56 LD. See: 2018 AM12 - JPL , 2018 AM12 - SSA See also: **11 Jan 2191**.
1982, Jan 30	Apollo NEA **292220** (**2006 SU49**, H = 19.7 mag, $D \approx$ 400 m, **PHA**) passed Earth at a nominal miss distance of 4.49 LD. Minimum miss distance 4.49 LD. See: 2006 SU49 - JPL , 2006 SU49 - SSA https://en.wikipedia.org/wiki/(292220)_2006_SU49 See also: **29 Jan 1977**, **28 Jan 2029**.

1982, Feb 8	Aten NEA **2021 CS9** (*H* = 24.3 mag, *D* ≈ 50 m) passed Earth at a nominal miss distance of 1.73 LD. Minimum miss distance 0.43 LD. See: 2021 CS9 – S2P , 2021 CS9 - JPL
1982, Oct 21	Apollo NEA **171576** (**1999 VP11**, *H* = 18.7 mag, *D* ≈ 700 m, **PHA**) passed Earth at a nominal miss distance of 2.77 LD. Minimum miss distance 2.77 LD. See: 1999 VP11 - JPL , 1999 VP11 - SSA See also: **21 Oct 1965**, **22 Oct 2086**.
1982, Nov 4	Apollo NEA **2012 TY52** (*H* = 21.3 mag, *D* ≈ 190 m, **PHA**) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.81 LD. **[1982-01]** See: 2012 TY52 - JPL , 2012 TY52 - SSA See also: **6 Nov 2158**.
1982, Nov 8	The **Wethersfield Fireball and Meteorite.** See: http://peabody.yale.edu/collections/meteorites-and-planetary-science/wethersfield-meteorite
1982, Nov 28	Apollo NEA **2018 WG2** (*H* = 30.2 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 2.905 LD. Minimum miss distance **0.011 LD (= 0.65 R_{Earth} from the geocenter)**. See: 2018 WG2 - SSA , 2018 WG2 - JPL See also: **30 Nov 2018**.
1983	E.M. Shoemaker, 1983, *Annual Review of Earth and Planetary Science*, 11, 461, "Asteroid and comet bombardment of the Earth." See: http://adsabs.harvard.edu/abs/1983AREPS..11..461S
1983	Discovery of the **Chesapeake Bay impact crater**, formed by a bolide that impacted the eastern shore of North America ~35 million years ago. It is the largest impact crater in the USA. Ref: - Wuchang Wei, C.W. Poag, L.J. Poppe, et al., 1993, *Geology*, 21, 478, "Deep sea drilling Project Site 612 bolide event: new evidence of a late Eocene impact-wave deposit and a possible impact site, U.S. east coast: comment and reply." See: http://geology.geoscienceworld.org/cgi/content/abstract/21/5/478> - C. Koeberl, W.U. Reimold, D. Brandt, C.W. Poag, 1995, *Meteoritics*, 30, 528, "**Chesapeake Bay crater**, Virginia: confirmation of impact origin." See: http://adsabs.harvard.edu/abs/1995Metic..30R.528K See also: http://woodshole.er.usgs.gov/epubs/bolide/ http://en.wikipedia.org/wiki/Chesapeake_Bay_impact_crater

1983, Jan 3	Apollo NEA **471240** (**2011 BT15**, *H* = 21.7 mag, *D* ≈ 160 m, **PHA**) passed Earth at a nominal miss distance of 4.04 LD. Minimum miss distance 4.04 LD. See: 2011 BT15 - JPL , 2011 BT15 - SSA See also: **7 Jan 2102**.
1983, Mar 19	Apollo NEA **2018 VG3** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 1.55 LD. Minimum miss distance 1.51 LD. See: 2018 VG3 - JPL , 2018 VG3 - SSA
1983, Mar 20	Apollo NEA **2021 FO1** (*H* = 29.5 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 6.88 LD. Minimum miss distance 0.25 LD. See: 2021 FO1 – S2P , 2021 FO1 – JPL See also: **23 Mar 2021**.
1983, Apr 17	Apollo NEA **2019 GC6** (*H* = 26.5 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 1.78 LD. Minimum miss distance 0.58 LD. See: 2019 GC6 - SSA , 2019 GC6 - JPL See also: **18 Apr 2019**, **17 Apr 2134**.
1983, Jun 20-22	***International conference on Asteroids, Comets, Meteors***, Uppsala (Sweden). Proceedings: C.-I. Lagerkvist & H. Rickman, 1983, *Asteroids, Comets, Meteors* (Uppsala: Astronomiska Observatoriet). See: http://adsabs.harvard.edu/abs/1983acmp.book.....L
1983, Jul 13	Apollo NEA **2018 NM** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 3.45 LD. Minimum miss distance 0.79 LD. See: 2018 NM - JPL , 2018 NM - SSA
1983, Oct 11	Apollo NEA **3200 Phaethon** (**1983 TB**, *H* = 13.9 mag, *D* ≈ 5100 ± 200 m, **PHA**) discovered by ***IRAS***. It approaches the Sun closer than any other numbered asteroid: its perihelion is 0.14 AU, i.e., less than half Mercury's perihelion distance. **Phaethon** is possibly an old comet core. Its closest approach to Earth within the next 190 yr will occur on 14 December 2093 at 7.7 LD. See: 1983 TB - JPL , 3200 Phaethon - SSA Ref: - J. Davies, S.F. Gree, C.M. Bardwell, et al., 1983, *IAU Circular* 3860, "Comet **IRAS (1983o)**."

	See: http://cepsar.open.ac.uk/pers/s.f.green/p4_6.shtml - J. Licandro, H. Campins, T. Mothé-Diniz, et al., 2007, *Astronomy & Astrophysics*, 461, 751, "The nature of comet-asteroid transition object **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2007A%26A...461..751L - J. de León, H. Campins, K. Tsiganis, et al., 2010, *Astronomy & Astrophysics*, 513, 26, "Origin of the near-Earth asteroid **Phaethon** and the **Geminids meteor shower**." See: http://adsabs.harvard.edu/abs/2010A%26A...513A..26D - D. Jewitt, J. Li, 2010, *Astronomical Journal*, 140, 1519, "Activity in Geminid parent (**3200**) **Phaethon**." See: http://adsabs.harvard.edu/abs/2010AJ....140.1519J - J. Li, D. Jewitt, June 2013, *Astronomical Journal*, 145, 9, "Recurrent perihelion activity in (**3200**) **Phaethon**." See: http://adsabs.harvard.edu/abs/2013AJ....145..154L See also: http://www.cfa.harvard.edu/iauc/03800/03878.html http://en.wikipedia.org/wiki/Geminids http://science.nasa.gov/science-news/science-at-nasa/2010/06dec_geminids/ http://en.wikipedia.org/wiki/3200_Phaethon
1984	The 0.9-m **Spacewatch Telescope** became the first telescope to detect and discover asteroids and comets with electronic detectors (CCDs, as opposed to photographic plates or films). See: http://spacewatch.lpl.arizona.edu/
1984, Jan	Z. Sekanina, D.K. Yeomans, 1984, *Astronomical Journal*, 89, 154, "Close encounters and collisions of comets with the **Earth**." See: http://adsabs.harvard.edu/abs/1984AJ.....89..154S
1984, Jan 10	Apollo NEA **2016 TB57** (H = 26.2 mag, $D \approx$ 20 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.76 LD. **[1984-01]** See: 2016 TB57 - JPL , 2016 TB57 - SSA
1984, May 24	J.K. Davies, S.F. Green, B.C. Stewart, et al., 1984, *Nature*, 309, 315, "The ***IRAS*** fast-moving object search." See: http://adsabs.harvard.edu/abs/1984Natur.309..315D
1984, Jul	C.J. van Houten, P. Herget, B.G. Marsden, 1984, *Icarus*, 59, 1, "**The Palomar-Leiden Survey of Faint Minor Planets** – conclusion." See: http://adsabs.harvard.edu/abs/1984Icar...59....1V
1984, Jul 27	Apollo NEA **2014 SP142** (H = 21.8 mag, $D \approx$ 160 m, **PHA**)

	passed Earth at a nominal miss distance of 2.53 LD. Minimum miss distance 2.48 LD. See: 2014 SP142 - JPL , 2014 SP142- SSA See also: **27 Jul 1930**,
1984, Aug 2	R.A.F. Grieve, 1984, *Nature*, 310, 370, "Cretaceous-Tertiary extinctions: physical evidence of impact." See: http://adsabs.harvard.edu/abs/1984Natur.310..370G
1984, Aug	H.J. Melosh, 1984, *Icarus*, 59, 234, "Impact ejection, spallation, and the origin of meteorites." See: http://adsabs.harvard.edu/abs/1984Icar...59..234M
1984, Oct 18	P. Hut, 1984, *Nature*, 311, 638, "How stable is an astronomical clock that can trigger mass extinctions on Earth?" See: http://adsabs.harvard.edu/abs/1984Natur.311..638H
1985	Fred L. Whipple (1906 – 2004, USA): *"Protection of the Earth from undesirable impacting bodies is not just a science fiction project for some improbable future. The cost might be comparable to, even smaller than, the world's current military expenditures. We could choose to do it now. We could choose to protect ourselves from asteroids and comets rather than from each other."* Ref: F.L. Whipple, 1985, *The Mystery of Comets* (Baltimore: Smithsonian Institution Press).
1985, Jan 11	Aten NEA **2018 XQ2** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 8.69 LD. Minimum miss distance **0.00081 LD (= 0.049 R_{Earth} from the geocenter)**. See: 2018 XQ2 - JPL , 2018 XQ2 - SSA See also: **9 Nov 1980**, **11 Nov 2048**.
1985, Jan 18	Apollo NEA **85640** (**1998 OX4**, *H* = 2.9 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 2.52 LD. Minimum miss distance 2.52 LD. See: 1998 OX4 - JPL , 1998 OX4 - SSA See also: **22 Jan 2148**.
1985, Feb	D.I. Steel, W.J. Baggaley, 1985, *Monthly Notices Royal Astronomical Society*, 212, 817, "Collisions in the Solar System. I. Impacts of the Apollo-Amor-Aten asteroids upon the terrestrial planets." See: http://adsabs.harvard.edu/abs/1985MNRAS.212..817S
1985, Feb 11	Apollo NEA **2012 PB20** (*H* = 25.0 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 1.23 LD. Minimum miss distance 0.86

	LD. See: 2012 PB20 - JPL , 2012 PB20 - SSA
1985, Mar	G. Hahn, H. Rickman, 1985, *Icarus*, 61, 417, "Asteroids in cometary orbits." See: http://adsabs.harvard.edu/abs/1985Icar...61..417H
1985, Mar	G.W. Wetherill, 1985, *Meteoritics*, vol. 20,1, "Asteroidal source of ordinary chondrites." See: http://adsabs.harvard.edu/abs/1985Metic..20....1W
1985, Apr 9	Apollo NEA **2017 UK1** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 1.34 LD. Minimum miss distance 0.51 LD. See: 2017 UK1 - JPL , 2017 UK1- SSA
1985, May 4	Apollo NEA **394130** (**2006 HY51**, *H* = 17.2 mag, *D* = 1218 ± 228 m) passed Earth at a nominal miss distance of 42.32 LD. Minimum miss distance 42.32 LD. See: 2006 HY 51 – SSA , 2006 HY51 – JPL See also : **4 May 1939**. See also : https://en.wikipedia.org/wiki/(394130)_2006_HY51 Eccentricity: 0.9695. Mercury, Venus, Earth, Mars, Jupiter crosser.
1985, May 17	G.W. Wetherill, 1985, *Science*, 228, 877, "Occurrence of giant impacts during the growth of the terrestrial planets." See: http://adsabs.harvard.edu/abs/1985Sci...228..877W
1985, Jun	P. Hut, P.R. Weissman, 1985, *Bulletin of the American Astronomical Society*, 17, 690, "Double craters on the Earth and planets: evidence for binary asteroids and comets." See: http://adsabs.harvard.edu/abs/1985BAAS...17R.690H
1985, Jun 3-6	***International conference on Asteroids, Comets, Meteors, II***, Uppsala (Sweden). Proceedings: C.-I. Lagerkvist, H. Rickman, B.A. Lindblad, H. Lundstedt, 1986, *Asteroids, Comets, Meteors II* (Uppsala: Astronomiska Observatoriet). See: http://adsabs.harvard.edu/abs/1986acm..proc.....L
1985, Jul 12	L.A. McFadden, M.J. Gaffey, Th.B. Mccord, 1985, *Science*, 229, 160, "Near-Earth Asteroids: possible sources from reflectance spectroscopy." See: http://adsabs.harvard.edu/abs/1985Sci...229..160M
1985, Sep 2	Apollo NEA **371660** (**2007 CN26**, *H* = 20.9 mag, *D* ≈ 240 m, **PHA**) passed Earth at at a nominal miss distance of 1.05 LD.

	Minimum miss distance 1.05 LD. See: 2007 CN26 - JPL , 371660 2007 CN26 - SSA
1985, Oct	P. Hut, 1985, *Zenit*, 12, 308, "Dreiging uit de kosmos." See: http://adsabs.harvard.edu/abs/1985Zenit..12..308H
1985, Nov 3	Apollo NEA **2018 GE2** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 2.53 LD. Minimum miss distance 1.004 LD. See: 2018 GE2 - SSA , 2018 GE2 - JPL See also: **29 Oct 2042**.
1985, Nov 28	I. Halliday, A.T. Blackwell, A.A. Griffin, 28 November 1985, *Nature*, 318, 317, "Meteorite impacts on humans and buildings." See: http://www.nature.com/nature/journal/v318/n6044/abs/318317a0.html
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1985, Dec	R.A.F. Grieve, V.L. Sharpton, A.K. Goodacre, 1985, *Earth and Planetary Science Letters*, 76, 1, "A perspective on the evidence for periodic cometary impacts on Earth." See: http://adsabs.harvard.edu/abs/1985E%26PSL..76....1G
1986	D.L. Matson, 1986, *The **IRAS** Asteroid and Comet Survey*, JPL D-3689 (Pasadena: JPL). See: http://irsa.ipac.caltech.edu/IRASdocs/surveys/comet.html
1986, Jan	D.I. Steel, W.G. Elford, 1986, *Monthly Notices Royal Astronomical Society*, 218, 185, "Collisions in the Solar System. III. Meteoroid survival times." See: http://adsabs.harvard.edu/abs/1986MNRAS.218..185S
1986, Jan 29	Apollo NEA **2020 OP3** (*H* = 20.8 mag, *D* ≈ 230 m, **PHA**) passed Earth at a nominal miss distance of 4.72 LD. Minimum miss distance 4.57 LD. See: 2020 OP3 – S2P , 2020 OP3 - JPL See also: **28 Jan 2027**, **29 Jan 2046**.
1986, Mar 13	ESA spacecraft ***Giotto*** flyby of **comet Halley**. Ref: - J. Kissel, D.E. Brownlee, K. Buchler, et al., 1986, *Nature*, 321, 336, "Composition of **comet Halley** dust particles from ***Giotto***

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1986, Apr 30	Apollo NEA **2019 JD6** (*H* = 25.0 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 5.85 LD. Minimum miss distance 0.78 LD. See: 2019 JD6 – SSA , 2019 JD6 - JPL
1986, Sep 22-25	R.N. Pugh, J.E. Allen, 1986, presented at the *49th Annual Meeting of the Meteoritical Society*, American Museum of Natural History, New York (NY, USA), LPI Contribution 600, p.208, "Origing of the **Willamette Meteorite**." See: http://adsabs.harvard.edu/abs/1986LPICo.600E.208P http://en.wikipedia.org/wiki/Willamette_Meteorite
1986, Oct 11	Apollo NEA **2012 TC4** (*H* = 26.7 mag, *D* ≈ 15 x 8 m) passed Earth at a nominal miss distance of 2.84 LD. Minimum miss distance **2.62×10^{-7} LD (= 1.58×10^{-5} R_{Earth} from the geocenter).** See: 2012 TC4 - JPL , 2012 TC4 - SSA See also: **12 Oct 2012, 12 Oct 2017**
1987	R.A.F. Grieve, 1987, *Annual Reviews of Earth and Planetary Sciences*, 15, 245, "Terrestrial impact structures." See: http://adsabs.harvard.edu/abs/1987AREPS..15..245G
1987, Apr 21	Apollo NEA **2017 HV2** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 8.76 LD. Minimum miss distance 0.19 LD. See: 2017 HV2 - JPL , 2017 HV2 - SSA
1987, Jun 1	Apollo NEA **2014 WG365** (*H* = 20.1 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 4.94 LD. Minimum miss distance 4.94 LD. See: 2014 WG365 - JPL , 2014 WG365 - SSA
1987, Jun 27	Apollo NEA **2019 MO** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 3.40 LD. Minimum miss distance

	1.0003 LD. See: 2019 MO - JPL , 2019 MO - SSA See also: **22 June 2019, object impacted Earth.**
1987, Jul	D.K. Yeomans, S.J. Ostro, P.W. Chodas, 1987, *Astronomical Journal*, 94, 189, "Radar astrometry of near-earth asteroids." See: http://adsabs.harvard.edu/abs/1987AJ.....94..189Y
1987, Jul	Z. Ceplecha, P. Spurný, J. Bocek, et al., 1987, *Bulletin Astronomical Institutes of Czechoslovakia*, 38, 211, "**European Network fireballs** photographed in 1978." See: http://adsabs.harvard.edu/abs/1987BAICz..38..211C
1987, Jul	Z. Ceplecha, 1987, *Bulletin of the Astronomical Institutes of Czechoslovakia*, 38, 222, "Geometric, dynamic, orbital and photometric data on meteoroids from **photographic fireball networks**." See: http://adsabs.harvard.edu/abs/1987BAICz..38..222C
1987, Sep	P. Hut, W. Alvarez, W.P. Elder, et al., 1987, *Nature*, 329, 118, "Comet showers as a cause of mass extinction." See: http://adsabs.harvard.edu/abs/1987Natur.329..118H
1987, Nov 3	Apollo NEA **2010 TU149** (H = 21.0 mag, $D \approx$ 603 m, **PHA**) passed Earth at a nominal miss distance of 4.75 LD. Minimum miss distance 4.74 LD. See: 2010 TU149 - JPL , 2010 TU149 - SSA
1988	T. Gehrels, 1988, *On the Glassy Sea. An Astronomer's Journey* (New York: American Institute of Physics), Ch. 16, p. 183, "Asteroid I mpacts and planet formation". Including the history of the 90 cm **Spacewatch Telescope** on Kitt Peak (AZ, USA). See: http://adsabs.harvard.edu/abs/1988gsaa.book.....G
1988, Jan 27	Apollo NEA **2008 TC3** (H = 30.3 mag, $D \approx$ 4.1 m) passed Earth at a nominal miss distance of 11.22 LD. Minimum miss distance 10.82 LD. See: 2008 TC3 - JPL , 2008 TC3 - SSA See also: **4 Oct 1917**, **11 Oct 1961**, **2 Oct 1971, 6 Oct 2008**.
1988, Feb 18	K.A. Maher, D.J. Stevenson, 1988, *Nature*, 331, 612, "Impact frustration of the origin of life." See: http://adsabs.harvard.edu/abs/1988Natur.331..612M
1988, Mar 8-11	***International conference on Asteroids II***, Tucson (AZ, USA). Proceedings: R.P. Binzel, T. Gehrels, & M.S. Matthews (eds.),

	1989, *Asteroids II* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1989aste.conf.....B
1988, Apr 21	H.J. Melosh, 1988, *Nature*, 332, 687, "The rocky road to panspermia." See: http://adsabs.harvard.edu/abs/1988Natur.332..687M
1988, Jul	Z. Ceplecha, 1988, *Bulletin Astronomical Institutes of Czechoslovakia*, 39, 221, "Earth's influx of different populations of sporadic meteoroids from photographic and television data." See: http://adsabs.harvard.edu/abs/1988BAICz..39..221C
1988, Aug	T. Gehrels, 1988, in: *Reports of Planetary Astronomy* (NASA: Washington), p. 45, "CCD scanning for comets and asteroids." See: http://adsabs.harvard.edu/abs/1988plas.rept...45G
1988, Sep 22	Apollo NEA **523654** (**2011 SR5**, $H = 20.5$ mag, $D \approx 280$ m, **PHA**) passed Earth at a nominal miss distance of 4.78 LD. Minimum miss distance 4.77 LD. See: 2011 SR5 - JPL , 2011 SR5 - SSA See also: **23 Sep 2066**.
1988, Sep 29	Apollo NEA **360191** (**1988 TA**, $H = 20.0$ mag, $D \approx 400$ m, **PHA**) passed Earth at a nominal miss distance of 3.83 LD. Minimum miss distance 3.83 LD. See: 1988 TA - JPL , 1988 TA - SSA See also: **20 Sep 2053**, **3 Oct 2189**.
1988, Oct	G.W. Wetherill, 1988, *Icarus*, 76, 1, "Where do the **Apollo** objects come from?" See: http://adsabs.harvard.edu/abs/1988Icar...76....1W
1988, Oct 15	Aten NEA **2010 UK** ($H = 27.1$ mag, $D \approx 13$ m) passed Earth at at a nominal miss distance of 0.96 LD. Minimum miss distance 0.82 LD. **[1988-01]** See: 2010 UK - JPL , 2010 UK - SSA
1988, Oct 20-22	***Second Snowbird Conference on Global Catastrophes in Earth History: Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality***, Snowbird (Utah, USA). Proc.: V.L. Sharpton & P.D. Ward (eds.), 1991, *Geol. Soc. of America Special Paper*, Vol. 247. See: http://www.lpi.usra.edu/lpi_40th/1988.shtml
1988, Oct 22	E.M. Shoemaker, C.S. Shoemaker, R.F. Wolfe, 1988, in: V.L. Sharpton & P.D. Ward (eds.), 1991, Proc. Second Snowbird

	Conference on *Global Catastrophes in Earth History: Interdisciplinary Conference on Impacts, Volcanism, and Mass Mortality,* Snowbird (Utah, USA), "Asteroid and comet flux in the neighbourhood of the Earth." See: http://www.lpi.usra.edu/lpi_40th/1988.shtml
1989	T. Gehrels begins full NEO search operation using CCD drift-scan mode at the **Spacewatch Telescope**, on Kitt Peak (AZ, USA). See: http://spacewatch.lpl.arizona.edu/
1989	C.R. Chapman, D. Morrison, 1989, *Cosmic Catastrophes* (New York: Plenum). See: http://adsabs.harvard.edu/abs/1989coca.book.....C
1989	H.J. Melosh, 1989, *Impact cratering: a geologic process* (New York: Oxford University Press). See: http://adsabs.harvard.edu/abs/1989icgp.book.....M http://adsabs.harvard.edu/abs/1989S%26T....78T.382M
1989	D.L. Matson, G.J. Veeder, E.F. Tedesco, L.A. Lebofsky, 1989, in: *Asteroids II*, R.P. Binzel, et al. (eds.), Proc. Conf. in Tucson (AZ, USA) 8-11 March 1988, (Univ. Arizona Press), p. 269, "The ***IRAS*** asteroid and comet survey". See: http://adsabs.harvard.edu/abs/1989aste.conf..269M A total of 1811 asteroids and 25 comets with known orbits were measured. Evidence was found in the ***IRAS*** data base for a large population of asteroids with unknown orbits. See also: D.L. Matson, IPAC, JPL D-3698, 1986, http://irsa.ipac.caltech.edu/IRASdocs/surveys/comet.html
1989	C.M. Bardwell (1926 – 2010), 1989, *Temmon Guide* Marsden, "A brief history of the **Minor Planet Center**." See: http://www.oaa.gr.jp/~oaacs/mp/BriefHistoryofMPCbyConradBardwell.pdf
1989, Jan 4	Re-discovery of the largest known **PHA**: **4179 Toutatis, 1989 AC** (H = 15.3 mag, D = 4.6×2.4×1.9 km, P = 4.03 yr). It was first sighted on February 10, 1934, as object **1934 CT**, and then promptly lost. Re-discovery on January 4, 1989, by Christian Pollas (France), and was named after the Celtic god Toutatis/Teutates, known to popular culture as the God the cartoon character Astérix's chief Vitalstatistix evokes so that the sky may never fall on his head. Radar imagery has shown that **Toutatis** is a irregular body consisting of two distinct "lobes",

	with maximum widths of about 4.6 km and 2.4 km respectively. It is hypothesized that **Toutatis** formed from two originally separate bodies which coalesced at some point, with the resultant asteroid being compared to a "rubble pile". See: 1989 AC - JPL , 4179 Toutatis - SSA Ref: - J.-L. Heudier, R. Chemin, A. Maury, C. Pollas, January 1989, *IAU Circ.*, 4701, 2, "**1989 AC**." See: http://adsabs.harvard.edu/abs/1989IAUC.4701....2H - S.J. Ostro, R.S. Hudson, R.F. Jurgens, et al., 1995, *Science*, 270, 80, "Radar images of asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/1995Sci...270...80O - R.S. Hudson, S.J. Ostro, 1995, *Science*, 270, 84, "Shape and non-principal axis spin state of asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/1995Sci...270...84H - D.J. Scheeres, S.J. Ostro, R.S. Hudson, et al., 1998, *Icarus*, 132, 53, "Dynamics of orbits close to asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/1998Icar..132...53S - S.J. Ostro, R.S. Hudson, K.D. Rosema, et al., 1999, *Icarus*, 137, 122, "Asteroid **4179 Toutatis**: 1996 radar observations." See: http://adsabs.harvard.edu/abs/1999Icar..137..122O - R.S. Hudson, S.J. Ostro, D.J. Scheeres, 2003, *Icarus*, 161, 346, "High-resolution model of asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/2003Icar..161..346H - A.M. MacRobert, 2004, *Sky & Telescope*, 108 (3), 82, "The Closest Whiz-by of **Toutatis**." See: http://adsabs.harvard.edu/abs/2004S%26T...108c..82M http://br.groups.yahoo.com/group/Astronomynews/message/5177 See also: http://science.nasa.gov/science-news/science-at-nasa/2000/ast31oct_1/ http://newton.dm.unipi.it/neodys/index.php?pc=1.1.8&n=Toutatis http://en.wikipedia.org/wiki/Toutatis-4179
1989, Mar	G.W. Wetherill, 1989, *Meteoritics*, 24, 15, "Cratering of the terrestrial planets by Apollo objects." See: http://adsabs.harvard.edu/abs/1989Metic..24...15W
1989, Mar 2	Apollo NEA **2016 DV1** (H = 24.3 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 6.55 LD. Minimum miss distance 0.05 LD. See: 2016 DV1 - JPL , 2016 DV1 - SSA See also: **3 Mar 2016**.
1989, Mar 22	Apollo NEA **4581 Asclepius** (**1989 FC**, H = 20.9 mag, $D \approx$ 230 m, **PHA**) passed Earth at at a nominal miss distance of 1.78 LD.

	Minimum miss distance 1.78 LD. The next pass to come within 3 LD will not take place until **2189**. See: 1989 FC - JPL , 4581 Asclepius - SSA Ref: - C.R. Chapman, D. Morrison, E. Bowell, 1989, in: *52nd Annual Meeting of the Meteoritical Society*, 31 July 31 – 4 August, Vienna (Austria), LPI Contr. 712, *Meteoritics*, 24, 258, "Hazards from Earth-approachers: implications of **1989 FC**'s 'Near Miss'." See also: http://adsabs.harvard.edu/abs/1989LPICo.712...33C http://adsabs.harvard.edu/abs/1989Metic..24S.258C http://en.wikipedia.org/wiki/4581_Asclepius See also: **16 Aug 2012, 24 Mar 2051**.
1989, Apr	G. Hahn, P. Magnusson, A.W. Harris, et al., 1989, *Icarus*, 78, 363, "Physical studies of Apollo-Amor asteroids - *UBVRI* photometry of **1036 Ganymed** and **1627 Ivar**." See: http://adsabs.harvard.edu/abs/1989Icar...78..363H
1989, Apr	A. Milani, M. Carpino, G. Hahn, A.M. Nobili, 1989, *Icarus*, 78, 212, "Dynamics of planet-crossing asteroids – classes of orbital behaviour. Project **SPACEGUARD**." See: http://adsabs.harvard.edu/abs/1989Icar...78..212M
1989, Apr	G.J. Veeder, M.S. Hanner, D.L. Matson, et al., 1989, *Astronomical Journal*, 97, 1211, "Radiometry of Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/1989AJ.....97.1211V
1989, May	S. van den Bergh, 1989, *Publ. Astron. Soc. Pacific*, 101, 500, "Life and death in the inner solar system." See: http://adsabs.harvard.edu/abs/1989PASP..101..500V http://www.astronomynotes.com/solfluf/s5.htm
1989, Jun 6	Apollo NEA **2018 LA** ($H = 30.5$ mag, $D \approx 2.8$ m) passed Earth at a nominal miss distance of 18.80 LD. Minimum miss distance 0.24 LD.. See: 2018 LA - SSA , 2018 LA - JPL See also: **2 June 2018**.
1989, Jun 12-16	***International conference on Asteroids, Comets, Meteors, III***, Uppsala (Sweden). Proceedings: C.-I. Lagerkvist, H. Rickman, B.A. Lindblad, & M. Lindgren, 1990, *Asteroids, Comets, Meteors III* (Uppsala: Astronomiska Observatoriet). See: http://adsabs.harvard.edu/abs/1990acmi.book.....L
1989, Jul 28	Apollo NEA **2020 OY4** ($H = 30.3$ mag, $D \approx 3$ m) passed Earth at a

	nominal miss distance of 5.14 LD. Minimum miss distance 0.36 LD. See: 2020 OY4 – S2P , 2020 OY4 - JPL See also: **28 Jul 2020**.
1989, Aug 19-22	First-ever radar images of an asteroid: **4769 Castalia** (**1989 PB**, Apollo NEA, *H* = 17.8 mag, *D* = 1.8 × 0.8 km, **PHA**) obtained with the **305 m Arecibo radio telescope** by Steven J. Ostro (1946 – 2008) of NASA JPL, Pasadena (CA, USA) and R. Scott Hudson of Caltech, Pasadena. At the time of observation the distance to **4769 Castalia** was *d* = 11 LD. See: 1989 PB - JPL , 4769 Castalia - SSA See also: http://en.wikipedia.org/wiki/4769_Castalia Ref: - S.J. Ostro, J.F. Chandler, A.A. Hine, et al., 1990, *Science*, 248, 1523, "Radar images of asteroid **1989 PB**." See: http://adsabs.harvard.edu/abs/1990Sci...248.1523O As of May 2008, Ostro and his collaborators had detected 222 NEAs (including 130 PHAs and 24 binaries) and 118 main-belt objects with radar. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=180
1989, Sep 15	Apollo NEA **408792** (**2000 GF2**, *H* = 20.6 mag, *D* ≈ 270 m, **PHA**) passed Earth at a nominal miss distance of 4.90 LD. Minimum miss distance 4.90 LD. See: 2000 GF2- JPL , 2000 GF2- SSA
1989, Oct 20	Aten NEA **2015 UH52** (*H* = 26.2 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 4.15 LD. **Minimum miss distance 0.0055 LD (= 0.33 R_{Earth} from the geocenter)**. See : 2015 UH52 - JPL , 2015 UH52 - SSA See also: **19 Oct 2000**, **20 Oct 2052**.
1989, Nov	J. Luu, D. Jewitt, 1989, *Astronomical Journal*, 98, 1905, "On the relative numbers of C types and S types among near-earth asteroids." See: http://adsabs.harvard.edu/abs/1989AJ.....98.1905L
1989, Nov 4	Apollo NEA **2015 JJ** (*H* = 22.3 mag, *D* ≈ 130 m) passed Earth at a nominal miss distance of 9.12 LD. Minimum miss distance 9.12 LD. See : 2015 JJ - JPL , 2015 JJ - SSA See also: **5 Nov 2050**, **5 Nov 2094**, **6 Nov 2110**,
1989, Nov 6	D.M. Raup, P.A. Sabine, P. Ashmole, et al., 1989, *Philosophical*

	Transactions of the Royal Society of London, series B, Biological Sciences, vol. 325, No. 1228, Evolution and Extinction, p. 421, "The case for extraterrestrial causes of extinction." See: http://adsabs.harvard.edu/abs/1989RSPTB.325..421R http://www.jstor.org/stable/pdfplus/2396933.pdf?acceptTC=true
1989, Nov 9	N.H. Sleep, K.J. Zahnle, J.F. Kasting, H.J. Morowitz, 1989, *Nature*, 342, 139, "Annihilation of ecosystems by large asteroid impacts on the early Earth." See: http://adsabs.harvard.edu/abs/1989Natur.342..139S
1989, Dec	C.R. Chapman, D. Morrison, 1989, *Mercury*, 18, 185, "Cosmic impacts, cosmic catastrophes." See: http://adsabs.harvard.edu/abs/1989Mercu..18..185C
1990, Jan 1	**134 NEAs** known, of which **42 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1990	V.L. Sharpton, P.D. Ward (eds.), 1990, Proc. ***Global catastrophes in earth history; an interdisciplinary conference on impacts, volcanism, and mass mortality***, …, …., 20-23 October 1988, *Geological Society of America Special Papers*, Vol. 247. See: http://specialpapers.gsapubs.org/content/247 **Among the articles:** - K.W. Flessa, 1990, *GSA SP*, 247, 1, "The “facts” of mass extinctions." See: http://specialpapers.gsapubs.org/content/247/1.abstract - R.B. Stothers, M.R. Rampino, 1990, *GSA SP*, 247, 9, "Periodicity in flood basalts, mass extinctions, and impacts; A statistical view and a model." See: http://specialpapers.gsapubs.org/content/247/9.abstract - D.E. Loper, K.McCartney, 1990, *GSA SP*, 247, 19, "On impacts as a cause of geomagnetic field reversals or flood basalts." See: http://specialpapers.gsapubs.org/content/247/19.abstract - D.M. Raup, 1990, *GSA SP*, 247, 27, "Impact as a general cause of extinction; A feasibility test " See: http://specialpapers.gsapubs.org/content/247/27.abstract - C.J. Orth, M. Attrep, L.R. Quintana, 1990, *GSA SP*, 247, 45, "Iridium abundance patterns across bio-event horizons in the fossil record." See: http://specialpapers.gsapubs.org/content/247/45.abstract - KJ. Hsü, J.A. McKenzie, 1990, *GSA SP*, 247, 61, "Carbon-isotope anomalies at era boundaries; Global catastrophes and their ultimate cause." See: http://specialpapers.gsapubs.org/content/247/61.abstract - S.A. Davenport, T.J. Wdowiak, D.D. Jones, P.Wdowiak, 1990, *GSA*

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1990	S.V.M. Clube, W.M. Napier, 1990, *The Cosmic Winter* (Oxford: Blackwell). See: http://adsabs.harvard.edu/abs/1990cowi.book.....C
1990	From 1990 until its termination in 1996, Duncan Steel, director of **Spaceguard Australia** and Vice-President of **The Spaceguard Foundation** (see 26 March 1996), directed the southern hemisphere program **Anglo-Australian Near Earth Asteroid Survey (AANEAS)** for the discovery and tracking of near-Earth asteroids, based at the Anglo-Australian Observatory, using the UK 1.2m Schmidt Telescope. Ref: - D.I. Steel, R.H. McNaught, G.J. Garradd, D.J. Asher, K.S. Russell, 1997, *Australian J. Astron.*, 7, 67, "AANEAS: a valedictory report."

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1990	R.A.F. Grieve, 1990, *Scientific American*, 262(4), 66, "Impact cratering on the Earth." See: http://adsabs.harvard.edu/abs/1990SciAm.262...44G
1990	E.F. Helin, R.S. Dunbar, 1990, *Vistas in Astronomy*, 33, 21, "Search techniques for near-earth asteroids." See: http://adsabs.harvard.edu/abs/1990VA.....33...21H
1990, Feb	Chapman, C.R., Morrison, D., 1990, *Mercury*, 19, 21; 19, 30, "Cosmic impacts, cosmic catastrophes. II." See: http://adsabs.harvard.edu/abs/1990Mercu..19...21C
1990, Mar	D. Morrison, C.R. Chapman, 1990, *Sky & Telescope*, 79, 261, "Target Earth – it will happen." See: http://adsabs.harvard.edu/abs/1990S%26T....79..261M
1990, Apr	American Institute of Aeronautics and Astronautics (AIAA), recommendations concerning NEOs to US Congress in a Position Paper *Dealing with the Threat of an Asteroid Striking the Earth*. See: http://pdf.aiaa.org//downloads/publicpolicypositionpapers//Asteroid-1990.pdf
1990, Apr 7	**Glanerbrug meteorite**. A **fireball** seen by hundreds of people in the Netherlands, Germany and Denmark resulted in an impact of an 885 g meteorite, riddling the roof of a home in Glanerbrug (the Netherlands). See: http://www.sterrenkunde.nl/index/encyclopedie/meteoren.html http://nl.wikipedia.org/wiki/Glanerbrug_meteoriet http://en.wikipedia.org/wiki/Meteorite_fall
1990, Apr 26	C.R. Chapman, 1990, *Nature*, 344, 813, "Meteorite parent bodies." See: http://adsabs.harvard.edu/abs/1990Natur.344..813C
1990, Jul 7	Aten NEA **2018 NX** (H = 27.9 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 7.62 LD. Minimum miss distance 0.61 LD. See: 2018 NX - SSA , 2018 NX - JPL See also: **7 July 2018**, **5 July 2086**.

1990, Jul 25	Apollo NEA **2013 PG10** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 7.05 LD. Minimum miss distance 0.63 LD. See: 2013 PG10 - SSA , 2013 PG10 - JPL See also: **24 Jul 2041**.
1990, Sep	US Congress House in NASA Multiyear Authorization Act of 1990: "… imperative that detection rate of Earth-orbit-crossing asteroids must be increased substantially, and that means to destroy or alter orbits … should be defined and agreed internationally. …"
1990, Sep 19	Aten NEA **2003 SW130** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at at a nominal miss distance of 0.54 LD. Minimum miss distance 0.46 LD. **[1990-01]** See: 2003 SW130 - JPL , 2003 SW130 - SSA See also: **19 Sept 2003**.
1990, Oct 13	**Earth-grazing fireball**, a 40 kg asteroid passing 98 km above Czechoslovakia and Poland with 41.5 km/s. Ref: - P. Spurný, Z. Ceplecha, J. Borovička, 1991, *WGN, the Journal of the IMO*, 19, 13, "Earth-grazing fireball: Czechoslovakia, Poland, October 13, 1990, 03h27m16sUT." See: http://adsabs.harvard.edu/abs/1991JIMO...19...13S - J. Borovička, Z. Ceplecha, 1992, *Astronomy & Astrophysics*, 257, 323, "Earth-grazing fireball of October 13, 1990." See: http://adsabs.harvard.edu/abs/1992A%26A...257..323B See also: http://en.wikipedia.org/wiki/Earth-grazing_fireball
1990, Nov 10	Apollo NEA **2019 VF5** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 6.72 LD. Minimum miss distance 0.38 LD. See: 2019 VF5 – SSA , 2019 VF5 - JPL See also: **9 Nov 2019**.
1990, Dec	A. Milani, M. Carpino, F. Marzari, 1990, *Icarus*, 88, 292, "Statistics of close approaches between asteroids and planets: project **SPACEGUARD**." See: http://adsabs.harvard.edu/abs/1990Icar...88..292M
1991	US Congresssional Statement 1991: "The House Committee on Science and Technology believes that it is imperative that the detection rate of Earth-orbit-crossing asteroids must be increased substantially, and that the means to destroy or alter the orbits of asteroids when they do threaten collisions should be defined and

	agreed upon internationally. The chances of the Earth being struck by a large asteroid are extremely small, but because the consequences of such a collision are extremely large, the Committee believes it is only prudent to assess the nature of the threat and prepare to deal with it." NASA Authorization Bill, 1991. The US Congress House Committee on Science and Technology used NASA Authorization Bill to direct NASA to study (1) a programme to increase detection rate of Earth-orbit-crossing asteroids addressing costs, schedule, technology and equipment (**Spaceguard Survey** Report); (2) systems and technologies to destroy or alter orbits of such asteroids if they should pose a danger to life on Earth (***NEO Interception Workshop***). See: http://impact.arc.nasa.gov/gov_cong_hearings_1.cfm
1991	The 5000th minor planet was numbered at the **IAU Minor Planet Center**, Main-belt asteroid **5000 IAU** (**1987 QN7**, $H = 14.3$ mag, $D \approx 5000$ m), discovered on 23 August 1987 by Eleanor F. Helin (1932 – 2009) at Palomar Observatory (CA, USA). See: 1987 QN7 - JPL , 5000 IAU - SSA , http://en.wikipedia.org/wiki/5000_IAU
1991, Jan 18	Apollo NEA **1991 BA** ($H = 28.7$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.36 LD. **[1991-01]** See: 1991 BA - JPL , 1991 BA - SSA See also: http://en.wikipedia.org/wiki/1991_BA Ref: - D. Steel, 1991, *Nature*, 354, 265, "Our asteroid-pelted planet". See: http://adsabs.harvard.edu/abs/1991Natur.354..265S - J.V. Scotti, D.L. Rabinowitz, B.G. Marsden, 1991, *Nature*, 354, 287, "Near miss of the Earth by a small asteroid." See: http://adsabs.harvard.edu/abs/1991Natur.354..287S
1991, Feb 15	Aten NEA **2020 CL1** ($H = 20.0$ mag, $D \approx 400$ m, **PHA**) passed Earth at a nominal miss distance of 8.08 LD. Minimum miss distance 6.41 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1940, 15 Feb 2036, 14 Feb 2081, 16 Feb 2118, 16 Feb 2155**
1991, Mar	P. Hut, E.M. Shoemaker, W. Alvarez, A. Montanari,1991, *Abstracts of the Lunar and Planetary Science Conference*, 22, 603, "Astronomical mechanisms and geologic evidence for multiple impacts on **Earth**." See: http://adsabs.harvard.edu/abs/1991LPI....22..603H

1991, Apr	D.L. Rabinowitz, 1991, *Astronomical Journal*, 101, 1518, "Detection of earth-approaching asteroids in near real time." See: http://adsabs.harvard.edu/abs/1991AJ....101.1518R
1991, Apr 8	Apollo NEA **2012 UE34** (*H* = 23.1 mag, *D* ≈ 90 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[1991-02]** See: 2012 UE34 - JPL , 2012 UE34 - SSA See also: https://en.wikipedia.org/wiki/2012_UE34 See also: **8 Apr 2041**.
1991, Apr/May	**Workshop on *Hazards Due to Comets and Asteroids (1)***, San Juan Capistrano (CA, USA). Proceedings: T. Gehrels, M.S. Matthews & A.M. Schumann (eds.), 1994, *Hazards Due to Comets and Asteroids* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1994hdtc.conf.....G http://www.ips.gov.au/IPSHosted/neo/info/refers/Bk_Hazards_Gehrels.htm
1991, May 7	**Benešov Bolide** detected and observed at the Czech stations of the **European Fireball Network** on 7 May 1991, one of the brightest and best-documented bolides. Ref: - J. Borovicka, O.P. Popova, I.V. Nemtchinov, et al., 1998, *Astronomy & Astrophysics*, 334, 713, "Bolides produced by impacts of large meteoroids into the Earth's atmosphere: comparison of theory with observations. I. **Benešov Bolide** dynamics and fragmentation." See: http://adsabs.harvard.edu/abs/1998A%26A...337..591B - N.G. Barri, V.P. Stulov, 2003, *Solar System Research*, 37, 302, "Peculiarities of the fragmentation of **Benešov's Bolide**." See: http://adsabs.harvard.edu/abs/2003SoSyR..37..302B
1991, Jun 24-28	***International conference on Asteroids, Comets, Meteors, IV***, Flagstaff, (AZ, USA). Proceedings: A.W. Harris & E.L.G. Bowell (eds.), 1992, *Asteroids, Comets, Meteors 1991* (Houston: Lunar & Planetary Institute). See: http://adsabs.harvard.edu/abs/1992acm..proc.....H
1991, June 30 – Jul Sep 24-25 Nov 5	NASA ***International NEO Detection Workshops***, (*1st*) San Juan Capistrino Research Institute; (*2nd*) NASA Ames Research Center; (*3rd*) Palo Alto (CA, USA).
1991, Aug	**IAU XXI General Assembly**, Buenos Aires (Argentina). Resolution by IAU Commission 20 on *Positions and Motions of*

	Asteroids, Comets and Satellites, under the presidency of Richard West, calling for an **IAU Inter-Commission *Working Group on Near Earth Objects* (*WG-NEO*)**. See: http://web.mit.edu/rpb/wgneo/ http://spaceguard.iasf-roma.inaf.it/SGF/history.html
1991, Sep	R.A.F. Grieve, 1991, *Meteoritics*, 26, 175, "Terrestrial impact – the record in the rocks." See: http://adsabs.harvard.edu/abs/1991Metic..26..175G
1991, Sep	G.L. Verschuur, 1991, *Astronomy*, 19, No. 9, p. 50, "The end of civilization." See: http://adsabs.harvard.edu/abs/1991Ast....19...50V
1991, Sep 1	A.R. Hildebrand, G.T. Penfield, D.A. Kring, et al., 1 September 1991, *Geology*, 19, 867, "**Chicxulub Crater**: A possible Cretaceous/Tertiary boundary impact crater on the Yucatán Peninsula, Mexico." See: https://pubs.geoscienceworld.org/gsa/geology/article-abstract/19/9/867/205322/chicxulub-crater-a-possible-cretaceous-tertiary?redirectedFrom=fulltext
1991, Oct	S.J. Ostro, R.F. Jurgens, K.D. Rosema, R. Winkler, D.K. Yeomans, D.B. Campbell, J.F. Chandler, I.I. Shapiro, A.A. Hine, R. Velez, 1991, *Astronomical Journal*, 102, 1490, "Asteroid radar astrometry." See: http://adsabs.harvard.edu/abs/1991AJ....102.1490O
1991, Oct 10-11	***All-Union conference The Asteroid Hazard***, St. Petersburg (Russian Federation). Proceedings in Russian.
1991, Oct 29	NASA spacecraft ***Galileo*** flew by asteroid **951 Gaspra** (**1916 S45**, $H = 11.6$ mag, $D = 18.2 \times 10.5 \times 8.9$ km, Main-belt asteroid) at a distance of 1600 km. See: 1916 S45 - JPL , 951 Gaspra - SSA See also: http://en.wikipedia.org/wiki/951_Gaspra Ref: - J. Veverka, M. Belton, K. Klaasen, C. Chapman, 1994, *Icarus*, 107, 2, "Galileo's encounter with **951 Gaspra**: overview." See: http://adsabs.harvard.edu/abs/1994Icar..107....2V
1991, Nov	G.L. Verschuur, 1991, *Air and Space,* vol. 6, Oct.-Nov. 1991, p. 88, "This target earth." See: http://adsabs.harvard.edu/abs/1991AirSp...6...88V

1991, Nov 28	J.V. Scotti, D.L. Rabinowitz, B.G. Marsden, 1991, *Nature*, 354, 287, "Near miss of the earth by a small asteroid." See: http://adsabs.harvard.edu/abs/1991Natur.354..287S
1991, Dec	S.J. Ostro, 1991, *Meteoritics*, 26, 381, "Radar constraints on asteroid metal abundances and meteorite associations." See: http://adsabs.harvard.edu/abs/1991Metic..26R.381O
1991, Dec	A. Cellino, V. Zappalà, P. Farinella, 1991, *Monthly Notices Royal Astronomical Society*, 253, 561, "The size distribution of main-belt asteroids from ***IRAS*** data." See: http://adsabs.harvard.edu/abs/1991MNRAS.253..561C The ***IRAS*** data base on asteroid albedos and diameters has been used to derive size distributions for a set of ~ 4000 numbered main-belt asteroids.
1991, Dec	T. Gehrels, 1991, *Space Science Reviews*, 58, 347, "Scanning with charge-coupled devices." See: http://adsabs.harvard.edu/abs/1991SSRv...58..347G
1992	E. Tollmann, A. Tollmann, 1992, *Mitt. Österr. Geol. Ges.*, 84, 1, "The Flood Impact." On Tollmann's hypothetical bolide. See: http://en.wikipedia.org/wiki/Tollmann's_hypothetical_bolide
1992	C. Sagan, 1992, *Bulletin of the Atomic Scientists*, 48, 24, "Between enemies." See: http://en.wikiquote.org/wiki/Carl_Sagan
1992, Jan	**Workshop on *Hazards Due to Comets and Asteroids (2)***, Los Alamos (NM, USA). Proceedings: T. Gehrels, M.S. Matthews & A.M. Schumann (eds.), 1994, *Hazards Due to Comets and Asteroids* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1994hdtc.conf.....G http://www.ips.gov.au/IPSHosted/neo/info/refers/Bk_Hazards_Gehrels.htm
1992, Jan 10	Apollo NEA **2016 AH164** (H = 30.0 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 1.77 LD. Minimum miss distance 0.0089 LD **(= 0.53 R_{Earth} from the geocenter)**. See: 2016 AH164- JPL , 2016 AH164- SSA See also: **12 Jan 2016**.
1992, Jan 14-16	**NASA *NEO Interception Workshop***, Los Alamos (NM, USA). Full investigation of counter-measures concluded that nuclear explosives in stand-off mode most likely to succeed. Proceedings: G. Canavan, J. Solem, D.G.Rather (eds.), 1993,

	LANL 12476-C. See: http://impact.arc.nasa.gov/downloads/spacesurvey.pdf http://adsabs.harvard.edu/abs/1994hdtc.conf...93C
1992, Jan 25	*The **Spaceguard Survey**: **Report of the NASA International NEO Detection Workshop***, D. Morrison (ed.), 1992 (Washington DC: NASA). Delivered to US Congress. Recommends a search programme and international collaboration to find objects with *D* > 1 km; and the provision of six ground based telescopes, northern and southern hemisphere sites, southern hemisphere radar; half costs to come from international partners. See: http://impact.arc.nasa.gov/downloads/spacesurvey.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=59 http://impact.arc.nasa.gov/news_detail.cfm?ID=4 http://impact.arc.nasa.gov/news_detail.cfm?ID=24 http://impact.arc.nasa.gov/news_detail.cfm?ID=99 http://impact.arc.nasa.gov/news_detail.cfm?ID=109 http://impact.arc.nasa.gov/news_detail.cfm?ID=133 http://impact.arc.nasa.gov/news_detail.cfm?ID=143 http://impact.arc.nasa.gov/news_detail.cfm?ID=162 The term **Spaceguard** loosely refers to a number of efforts to discover and study NEOs. The British author Arthur C. Clarke (1917 – 2008) coined the name in his novel *Rendezvous with Rama* (London: Victor Gollancz, 1973) where ***Spaceguard*** was the name of an early warning system. The name was later adopted by a number of real life efforts to discover and study NEOs. The **IAU Working Group on Near-Earth Objects (WG-NEO)** presented a paper in September 1995 entitled ***Beginning the Spaceguard Survey***, which led on 26 March 1996 to the international organization called the **Spaceguard Foundation** (**SGF**). See: http://spaceguard.iasf-roma.inaf.it/SGF/history.html http://en.wikipedia.org/wiki/Spaceguard Ref: - A.W. Harris, 2008, *Nature,* 453, 1178, "What **Spaceguard** did." See: http://adsabs.harvard.edu/abs/2008Natur.453.1178H
1992, Apr	G.L. Verschuur, 1992, *Astronomy*, 20(4), 46, "Mysterious sungrazers." See: http://adsabs.harvard.edu/abs/1992Ast....20...46V
1992, May	M. Pilkington, R.A.F. Grieve, 1992, *Reviews of Geophysics*, 30, 161, "The geophysical signature of terrestrial impact craters." See: http://adsabs.harvard.edu/abs/1992RvGeo..30..161P
1992, Jun	G.H. Canavan, J. Solem, May-June 1992, *Mercury*, 21(3), 107,

	"Interception of near-earth objects." See: http://adsabs.harvard.edu/abs/1992Mercu..21..107C
1992, Jun	D. Morrison, 1992, *Mercury*, 21, 103, "The **Spaceguard Survey** – protecting the earth from cosmic impacts." See: http://adsabs.harvard.edu/abs/1992Mercu..21..103M
1992, Jun 5	Apollo NEA **2017 CH1** (H = 17.7 mag, $D \approx$ 1000 m, **PHA**) passed Earth at a nominal miss distance of 4.49 LD. Minimum miss distance 4.42 LD. See: 2017 CH1 - JPL , 2017 CH1 - SSA
1992, Jul	H.A. Thronson, J.K. Davies, J. Hackwell, et al., 1992, *Space Science Reviews*, 61, 145, "***EDISON*** - the next generation infrared space observatory." See: http://adsabs.harvard.edu/abs/1992SSRv...61..145T
1992, Jul 6-12	***International Conference on Meteoroids and their parent bodies***, Smolenice (Slovakia). Proceedings: J. Stohl & I.P. Williams (eds.), 1993 (Bratislava: Astronomical Institute, Slovak Academy of Sciences). See: http://adsabs.harvard.edu/abs/1993mtpb.conf.....S
1992, Jul 10	ESA spacecraft ***Giotto*** flyby of **comet Grigg-Skjellerup**. Ref: - J.A.M. McDonnell, N. McBride, R. Beard, et al., 1993, *Nature*, 362, 732, "Dust particle impacts during the ***Giotto*** encounter with **comet Grigg-Skjellerup**." See: http://adsabs.harvard.edu/abs/1993Natur.362..732M - S.M.P. McKenna-Lawlor, P.W. Daly, E. Kirsch, et al., 1993, *Nature*, "Energetic ions at **comet Grigg-Skjellerup** measured from the ***Giotto*** spacecraft." See: http://adsabs.harvard.edu/abs/1993Natur.363..326M See also: http://hubble.esa.int/science-e/www/area/index.cfm?fareaid=15 http://www.esa.int/SPECIALS/Rosetta/SEMMA0YTVKG_0.html
1992, Aug 7	R.P. Binzel, S. Xu, S.J. Bus, E. Bowell, 1992, *Science*, 257, 779, "Origins for the Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/1992Sci...257..779B
1992, Aug 7	Apollo NEA **2021 AY5** (H = 24.9 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 5.18 LD. **Minimum miss distance 0.0026 LD (= 0.16 R_{Earth} from the geocenter)**. See: 2021 AY5 – S2P , 2021 AY 5 – JPL
1992, Sep	Z. Ceplecha, 1992, *Astronomy & Astrophysics*, 263, 361, "Influx of

	interplanetary bodies onto earth." See: http://adsabs.harvard.edu/abs/1992A%26A...263..361C
1992, Oct 9	**Peekskill Fireball and Meteorite**. A fireball was seen streaking across the sky from Kentucky to New York. At least 14 people captured part of the fireball on videotape. A 12-kilogram stony meteorite (chondrite) from the fireball fell in Peekskill (NY, USA), smashed the trunk of a parked automobile and came to rest beneath it. Ref: - Z. Ceplecha, P. Brown, R.L. Hawkes, 1994, *Meteoritics*, 29, 455, "Video observations of the **Peekskill meteorite fireball**: atmospheric trajectory and orbit." See: http://adsabs.harvard.edu/abs/1994Metic..29Q.455C - P. Brown, Z. Ceplecha, R.L. Hawkes, et al., 1994, *Nature*, 367, 624, "The orbit and atmospheric trajectory of the **Peekskill meteorite** from video records." See: http://adsabs.harvard.edu/abs/1994Natur.367..624B See also: http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/peekskill.html http://csep10.phys.utk.edu/astr161/lect/meteors/impacts.html http://uregina.ca/~astro/mb_5.html http://www.lifeslittlemysteries.com/1535-when-space-attacks-6-craziest-meteor-impacts-history.html http://apod.nasa.gov/apod/ap021118.html http://apod.nasa.gov/apod/ap061119.html http://apod.nasa.gov/apod/ap110123.html
1992, Oct 21	Apollo NEA **2020 HN3** (H = 29.7 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.85 LD. **[1992-01]** See: 2020 HN3 – S2P , 2020 HN3 - JPL
1992, Nov 23	J. Impocco, J.F. Podevin, 1992, *Newsweek*, 23 November 1992, Vol. 120, No. 21, "Doomsday science - New theories about comets, asteroids and how the world might end." See: http://www.amazon.com/Newsweek-November-DOOMSDAY-THEORIES-ASTEROIDS/dp/B0054K8T0E
1992, Dec 3	T.J. Ahrens, A.W. Harris, 1992, *Nature*, 360, 429, "Deflection and fragmentation of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/1992Natur.360..429A
1992, Dec 8	Apollo NEA **4179 Toutatis** (**1989 AC**, H = 15.2 mag, $D \approx$ 4.6×2.4×1.9 km, orbital P = 4.03 yr, **PHA**) passed Earth at 9.40 LD. Minimum miss distance 9.40 LD. It is the largest known

	PHA. See: 1989 AC - JPL , 4179 Toutatis - SSA Ref: - R.S. Hudson, S.J. Ostro, D.J. Scheeres, 2003, *Icarus*, 161, 346, "High-resolution model of asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/2003Icar..161..346H See also: http://science.nasa.gov/science-news/science-at-nasa/2000/ast31oct_1/ http://newton.dm.unipi.it/neodys/index.php?pc=1.1.8&n=Toutatis http://en.wikipedia.org/wiki/4179_Toutatis See also: **30 Nov 1996**, **31 Oct 2000**, **29 Sep 2004, 9 Nov 2008, 12 Dec 2012**, **5 Nov 2069**.
1993	**NASA Planetary Astronomy Program Office** begins ramp up of funding for NEO observations.
1993	Major L.N. Johnson, 1993, White Paper, presented to ***SPACECAST 2020***, "Preparing for **Planetary Defense**: detection and interception of asteroids on collision course with Earth." In this paper the term **Planetary Defense** was coined. See: http://csat.au.af.mil/2020/index.htm http://www.fas.org/spp/military/docops/usaf/2020/app-r.htm
1993	Photographic asteroid and comet search project started by Timothy B. Spahr and C. Hergenrother (LPL, Univ. of Arizona). This project eventually evolved into the **Catalina Sky Survey** in 1998. Ref: - T.B. Spahr, C. Hergenrother, S.M. Larson, 1993, *Bulletin of the American Astronomical Society*, 25, 1059, "High ecliptic latitude asteroid and comet search." See: http://adsabs.harvard.edu/abs/1993DPS....25.1013S
1993	Arthur C. Clarke (1917-2008, UK/Sri Lanka), 1993, *The Hammer of God* (London: Victor Gollancz Ltd). See: http://en.wikipedia.org/wiki/The_Hammer_of_God
1993	R.A.F. Grieve, 1993, *Vistas in Astronomy*, 36, 203, "Impact craters: lessons from and for the Earth." See: http://adsabs.harvard.edu/abs/1993VA.....36..203G
1993	F.E. Wickman, 1993, *Swedish Geol. Journal*, 115, 29, "Eight pound ball fell on the ship and killed two boatsmen." An eight-pound meteorite hit the Dutch VOC ship *Malacca*, sailing from Holland to Batavia (Java, Netherlands-Indies) in 1648, allegedly killing two sailors. Story based on book *Reesa till Ostindien jempte een kort berättelse om konungerijket Japan* (1674) by 17th century

	Swedish historian-turned sailor Olof Eriksson Willman, who travelled the Netherlands-Indies in 1647 – 1653. See also: http://sv.wikipedia.org/wiki/Olof_Eriksson_Willman
1993, Jan 7	C.F. Chyba, P.J. Thomas, K.J. Zahnle, 1993, *Nature*, 361, 40, "The 1908 **Tunguska** explosion: atmospheric disruption of a stony asteroid." See: http://adsabs.harvard.edu/abs/1993Natur.361...40C
1993, Jan 7-12	**Workshop on *Hazards Due to Comets and Asteroids (3)***, Tucson (AZ, USA). Proceedings: T. Gehrels, M.S. Matthews & A.M. Schumann (eds.), 1994, *Hazards Due to Comets and Asteroids* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1994hdtc.conf.....G http://www.ips.gov.au/IPSHosted/neo/info/refers/Bk_Hazards_Gehrels.htm
1993, Jan 19	**Lugo Fireball and Airburst** (Northern, Italy). See: http://www.ta3.sk/caosp/Eedition/FullTexts/vol24/pp117-124.pdf http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1993, Feb	P. Farinella, R. Gonczi, Ch. Froeschlé, C. Froeschlé, 1993, *Icarus*, 101, 174, "The injection of asteroid fragments into resonances." See: http://adsabs.harvard.edu/abs/1993Icar..101..174F
1993, Mar	J.G. Hills, M.P. Goda, 1993, *Astronomical Journal*, 105, 1114, "The fragmentation of small asteroids in the atmosphere." See: http://adsabs.harvard.edu/abs/1993AJ....105.1114H
1993, Mar	European Science Foundation (ESF) initiates new scientific network "**Impact Cratering and Evolution of Planet Earth**." This led to the submission of a Research Networking Programme proposal in 1998, "Response of the Earth System to Impact Processes (IMPACT)", approved for five years, 1998 to 2002. Four workshops were held in 2002 – 2003." See: http://www.esf.org/impact
1993, Mar 24	U.S. Congressional Hearing on NEOs and Planetary Defense: "The Threat of Large Earth-Orbit Crossing Asteroids." See: http://impact.arc.nasa.gov/gov_earthasteroids_1.cfm
1993, Apr	D.L. Rabinowitz, 1993, *Astrophysical Journal*, 407, 412, "The size distribution of the Earth-approaching asteroids." See: http://adsabs.harvard.edu/abs/1993ApJ...407..412R

1993, Apr	J.C. Solem, 1993, *Journal of Spacecraft and Rockets*, 30 (2), 222, "Interception of comets and asteroids on collision course with Earth." See: http://adsabs.harvard.edu/abs/1993JSpRo..30..222S
1993, May	***Workshop on Hazards Due to Comets and Asteroids (4),*** Erice (Italy). Proceedings: T. Gehrels, M.S. Matthews & A.M. Schumann (eds.), 1994, *Hazards due to Comets and Asteroids* (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/1994hdtc.conf.....G http://www.ips.gov.au/IPSHosted/neo/info/refers/Bk_Hazards_Gehrels.htm
1993, May 20	Apollo NEA **1993 KA2** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[1993-01]** See: 1993 KA2 - JPL , 1993 KA2 - SSA
1993, Jun 14-18	***IAU Symposium No. 160 on Asteroids, Comets, Meteors, V***, Belgirate (Italy). Proceedings: A. Milani, M. Di Martino & A. Cellino (eds.), 1994, *Asteroids, Comets, Meteors 1993* (Dordrecht: Kluwer). See: http://adsabs.harvard.edu/abs/1994IAUS..160.....M
1993, Jun 24	C.F. Chyba, 1993, *Nature*, 363, 701, "Explosions of small **Spacewatch** objects in the Earth's atmosphere." See: http://adsabs.harvard.edu/abs/1993Natur.363..701C
1993, Jun 24	D.L. Rabinowitz, T. Gehrels, J.V. Scotti, et al., 1993, *Nature*, 363, 704, "Evidence for a near-Earth asteroid belt." See: http://adsabs.harvard.edu/abs/1993Natur.363..704R
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1993, Aug 17	Tom Gehrels' *Vainu Bappu Lecture*, presented to the ***6th Asian-Pacific Regional IAU Meeting***, 16-20 August, Pune (India). Ref.: T. Gehrels, 1995, *J. Astrophys. Astr. Suppl.*, 16, 1, "The beauty and danger of comets and asteroids." See: http://adsabs.harvard.edu/abs/1995JApAS..16....1G

1993, Aug 28	NASA spacecraft ***Galileo*** flew by asteroid **243 Ida** (H = 9.94 mag, D = 59.8 × 25.4 × 18.6 km, Main-belt asteroid) at a distance of 10,300 km, and discovered binary component **Dactyl** (D = 1.4 km), orbiting **Ida** at a distance of 56 km. See: 243 Ida - JPL , 243 Ida - SSA Ref: - E. Asphaug, 2004, in: M.J.S. Belton, et al. (eds.), *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 66, "Interior structures for asteroids and cometary nuclei". See: http://adsabs.harvard.edu/abs/2004mhca.conf...66A See also: http://www2.jpl.nasa.gov/galileo/sepo/cruise/ida/ida.html http://en.wikipedia.org/wiki/243_Ida
1993, Sep	S. Larson, J. Brownlee, C. Hergenrother, T. Spahr, 1993, *AAS-DPS meeting* #30, id.12.P14; *Bulletin of the American Astronomical Society*, 30, 1037, "The **Catalina Sky Survey** for NEOs." See: http://adsabs.harvard.edu/abs/1998BAAS...30.1037L
1993, Nov	P. Farinella, B. Chauvineau, 1993, *Astronomy & Astrophysics*, 279, 251, "On the evolution of binary Earth-approaching asteriods." See: http://adsabs.harvard.edu/abs/1993A%26A...279..251F
1993, Nov	Z. Ceplecha, P. Spurný, J. Borovićka, J. Keclíková, 1993, *Astronomy & Astrophysics*, 279, 615, "Atmospheric fragmentation of meteoroids." See: http://adsabs.harvard.edu/abs/1993A%26A...279..615C
1993, Nov 4	H.J. Melosh, I.V. Nemchinov, 1993, *Nature*, 366, 21, "Solar asteroid diversion." See: http://adsabs.harvard.edu/abs/1993Natur.366...21M
1993, Dec	D.J. Asher, S.V.M. Clube, 1993, *Quarterly Journal Royal Astronomical Society*, 34, 481, "An extraterrestrial influence during the current Glacial-Interglacial." See: http://adsabs.harvard.edu/abs/1993QJRAS..34..481A
1994	T. Gehrels, M.S. Matthews & A.M. Schumann (eds.), 1994, *Hazards Due to Comets and Asteroids* (Tucson: Univ. of Arizona Press). Proceedings of four Workshops in April/May 1991, January 1992, January 1993, and May 1993. See: http://adsabs.harvard.edu/abs/1994hdtc.conf.....G http://ips.gov.au/IPSHosted/neo/info/refers/Bk_Hazards_Gehrels.htm
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	Astronomicheskij Vestnik, 28, 13, "An analysis of the possibility of asteroid hazard mitigation for the Earth by the impact of a spacecraft." See: http://adsabs.harvard.edu/abs/1994AVest..28...13A
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1994, Jan	A.W. Harris, 1994, *Icarus*, 107, 209, "Tumbling asteroids." See: http://adsabs.harvard.edu/abs/1994Icar..107..209H
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1994, Jan 18	**Cando Fireball and Airburst** (Spain). See: http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1994, Feb	P. Spurný, 1994, *Planetary and Space Science*, 42, 157, "Recent **fireballs** photographed in central Europe." See: http://adsabs.harvard.edu/abs/1994P%26SS...42..157S
1994, Feb	US Congress House Committee on Science and Technology passed an amendment to NASA Authorization Bill directing NASA to report within a year with a programme to identify and catalogue, with help from the Department of Defense and space agencies of other countries, within 10 year, orbital characteristics of all comets and asteroids with $D > 1$ km and in an orbit that crosses Earth's. See: http://impact.arc.nasa.gov/gov_cong_hearings_1.cfm
1994, Feb 1	**Marshall Islands Fireball and Airbursts**. A large **meteoroid** impacted over the Pacific Ocean at 2.6° N, 164.1° E, 300 km south of Kosrae (Micronesia). The impact was observed by space-based infrared sensors operated by the U.S. Department of Defense and by visible wavelength sensors operated by the U.S. Department of

	Energy. The object produced a 11 kT explosion. During entry the object broke into several pieces, one of which detonated at 34 km and another at 21 km altitude. $M \approx 1.6\times10^5$ kg - 4.4×10^6 kg; $D \approx$ 4.4 - 13.5 m. Ref: - E. Tagliaferri, R. Spalding, C. Jacobs, Z. Ceplecha, 1995, *Earth, Moon, and Planets*, 68, 563, "Analysis of the **Marshall Island Fireball** of February 1, 1994." See: http://adsabs.harvard.edu/abs/1995EM%26P...68..563T - T.B. McCord, J. Morris, D. Persong, et al., 1995, *Journal of Geophysical Research*, 100, E2, 3245, "Detection of a meteoroid entry into the Earth's atmosphere on February 1, 1994." See: http://adsabs.harvard.edu/abs/1995JGR...100.3245M - E. Tagliaferri, 1998, *Mercury*, 27, no.6, p.18, "Observation of meteoroid impacts by space-based sensors." See: http://adsabs.harvard.edu/abs/1998Mercu..27f..18T See also: http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
1994, Mar 15	Apollo NEA **1994 ES1** (H = 28.6 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[1994-01]** See: 1994 ES1 - JPL , 1994 ES1 - SSA
1994, Apr 5	Apollo NEA **2019 SQ1** (H = 27.4 mag, $D \approx 12$ m) passed Earth at a nominal miss distance of 4.08 LD. Minimum miss distance 0.28 LD. See: 2019 SQ1 – SSA , 2019 SQ1 – JPL
1994, Apr 7	C. Sagan, S.J. Ostro, 1994, *Nature*, 368, 501, "Dangers of asteroid deflection." See: http://adsabs.harvard.edu/abs/1994Natur.368..501S
1994, Apr 16	Apollo NEA **2019 UU1** (H = 30.5 mag, $D \approx 2.9$ m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.32 LD. **[1994-02]** See: 2019 UU1 – SSA , 2019 UU1 - JPL See also: **18 Oct 2019**.
1994, May 18	Aten NEA **2017 KJ32** (H = 28.9 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 7.10 LD. Minimum miss distance 0.27 LD. See: 2017 KJ32 - JPL , 2017 KJ32 - SSA See also: **21 May 2042**.
1994, May 26	Apollo NEA **2014 AA** (H = 30.9 mag, $D \approx 2.3$ m) passed Earth at a nominal miss distance of 184.47 LD. Minimum miss distance

	164.67 LD. **Impact on 2 January 2014.** See: 2014 AA - SSA , 2014 AA - JPL See also: http://www.minorplanetcenter.net/mpec/K14/K14A02.html http://www.jpl.nasa.gov/news/news.php?release=2014-001 https://en.wikipedia.org/wiki/2014_AA See also: **3 Nov 1967**, **21 Mar 1996**, **2 Jan 2014**.
1994, Jun	Z. Ceplecha, 1994, *Astronomy & Astrophysics*, 286, 967, "Impacts of meteoroids larger than 1 M into the Earth's atmosphere." See: http://adsabs.harvard.edu/abs/1994A%26A...286..967C
1994, Jun 14	**St-Robert Daylight Fireball and Meteorite Fall** over the Canada-US border, travelling at a velocity of ~13 km/s, widely seen from the provinces of Quebec and Ontario and the states of New Hampshire, Vermont and New York at distances up to ~500 km. The rock fragmented spectacularly ~50 km NE of Montreal at an altitude of ~36 km; hundreds of fragments have been found with pieces of up to 6.5 kg. See: http://en.wikipedia.org/wiki/St-Robert_meteorite Ref: - P. Brown, A.R. Hildebrand, D.W. Green, et al., 1996, *Meteoritics*, 31, 502, "The fall of the **St-Robert meteorite**." See: http://adsabs.harvard.edu/abs/1996M%26PS...31..502B - A.R. Hildebrand, P.G. Brown, J.F. Wacker, et al., 1997, *Journal of the Royal Astronomical Society of Canada*, 91, 261, "The **St-Robert Bolide** of June 14, 1994." See: http://adsabs.harvard.edu/abs/1997JRASC..91..261H
1994, Jun 30	H.J. Melosh, E.A. Whitaker, 1994, *Nature*, 369, 713, "Lunar crater chains." See: http://adsabs.harvard.edu/abs/1994Natur.369..713M
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1994, Jul	W.F. Bottke, M.C. Nolan, R. Greenberg, 1994, *Meteoritics*, 29, 446, "Provenance of the spacewatch small Earth-approaching asteroids." See: http://adsabs.harvard.edu/abs/1994Metic..29S.446B
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	Ref: - H.A. Weaver, P.D. Feldman, M.F. A'Hearn, et al., 1994, *Science*, 263, 787, "***Hubble Space Telescope*** observations of **comet Shoemaker-Levy 9 (1993e)**." See: http://adsabs.harvard.edu/abs/1994Sci...263..787W - K. Zahnle, M.-M. Mac Low, 1994, *Icarus*, 108,1, "The collision of Jupiter and comet **Shoemaker-Levy 9**." See: http://adsabs.harvard.edu/abs/1994Icar..108....1Z - M.-M. Mac Low, K. Zahnle, 1994, *Astrophysical Journal*, 434, 33, "Explosion of comet **Shoemaker-Levy 9** on entry into the Jovian atmosphere." See: http://adsabs.harvard.edu/abs/1994ApJ...434L..33M - G. Orton, M. A'Hearn, K. Baines, et al., 1995, *Science*, 267, 1277, "Collision of comet **Shoemaker-Levy 9** with Jupiter observed by the NASA Infrared Telescope Facility." See: http://adsabs.harvard.edu/abs/1995Sci...267.1277O - H.A. Weaver, M.F. A'Hearn, C. Arpigny, et al., 1995, *Science*, 267, 1282, "The ***Hubble Space Telescope*** (***HST***) observing campaign on comet **Shoemaker- Levy 9**." See: http://adsabs.harvard.edu/abs/1995Sci...267.1282W - D.H. Levy, E.M. Shoemaker, C.S. Shoemaker, 1995, *Scientific American*, 273, 68, "Comet **Shoemaker-Levy 9** meets Jupiter." See: http://adsabs.harvard.edu/abs/1995SciAm.273...68L - D.H. Levy, 1995, *Impact Jupiter: the crash of comet **Shoemaker-Levy 9*** (New York: Plenum Press). See: http://adsabs.harvard.edu/abs/1995ijcc.book.....L - J.K. Beatty, D.H. Levy, 1995, *Sky & Telescope*, 90, 18, "Crashes to ashes: a comet's demise." See: http://adsabs.harvard.edu/abs/1995S%26T....90...18B - K.S. Noll, H.A. Weaver & P.D. Feldman (eds.), 2006, *The impact of comet **Shoemaker-Levy 9** on Jupiter*, Proc. IAU Coll. No. 156, Baltimore (MD, USA) 9-12 May 1995, *STScI Symposium Series* No. 9 (Cambridge: CUP, ISBN-0521-03162-1). See: http://www.iau.org/science/publications/iau/ See also: http://www.stsci.edu/institute/conference/jupiter-impact http://www2.jpl.nasa.gov/sl9/ http://www.huffingtonpost.com/mark-boslough/unforgettable-shoemakerle_b_2946407.html http://en.wikipedia.org/wiki/Comet_Shoemaker-Levy_9
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1994, Aug 20	**IAU XXII General Assembly**, Den Haag (the Netherlands). The **IAU Working Group on Near Earth Objects**, chaired by Andrea Carusi, had a science meeting, and presented a report recommending that an international authority should take responsibility for NEO investigations and initiatives. Ref: - I. Appenzeller (ed.), 1996, *Transactions IAU XXIIB*, (Dordrecht: Kluwer Acad. Publ.), IAU Commission 20 Report, p. 164, "Working Group Meeting 2 on Near-Earth Object Detection." See: http://adsabs.harvard.edu/abs/1996IAUTB..22.....A - J. Tate, 2000, *Space Policy*, 16, 261, "Avoiding collisions: the **Spaceguard Foundation**." See: http://www.sciencedirect.com/science/article/pii/S0265964600000369 See also: http://spaceguard.iasf-roma.inaf.it/SGF/history.html
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1994, Oct	D.L. Rabinowitz, 1994, *Icarus*, 111, 364, "The size and shape of the near-Earth asteroid belt." See: http://adsabs.harvard.edu/abs/1994Icar..111..364R
1994, Nov	K. Yau, P. Weissman, D. Yeomans, 1994, *Meteoritics*, 29, 864, "Meteorite falls in China and some related human casualty events." In February-March of the year 1490 a barrage of stones of 1 – 1.5 kg fell like rain in the Chíng-yang district of Shansi Province (China), killing more than 10,000 people. See: http://adsabs.harvard.edu/abs/1994Metic..29..864Y See also: http://www.mail-archive.com/meteorite-list@meteoritecentral.com/msg80757.html http://en.wikipedia.org/wiki/Impact_event
1994, Nov 24	Aten NEA **1994 WR12** (H = 22.7 mag, $D \approx$ 100 m) passed Earth

	at a nominal miss distance of 1.85 LD. Minimum miss distance 1.85 LD. See: 1994 WR12 - JPL , 1994 WR12 - SSA See also: http://en.wikipedia.org/wiki/1994_WR12 See also: **25 Nov 2046**.
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1994, Dec 9	Apollo NEA **1994 XM1** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[1994-03]** See: 1994 XM1 - JPL , 1994 XM1 SSA See also: http://spacewatch.lpl.arizona.edu/pics.html http://impact.arc.nasa.gov/news_detail.cfm?ID=96 http://www.rssd.esa.int/index.php?project=GAIA&page=picture_of_the_week&pow=5
1994, Dec 17	S. Rozendaal, 1994, *Elsevier*, 17 december 1994, "De catastrophe. Waarom de dino's uitstierven en de mens ontstond."
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1995	The (1.0/1.2m) **Schmidt CCD Asteroid Program (SCAP)** of the Beijing Astronomical Observatory put in practice, a NEO search telescope in operation at the Xuyu Station of the Purple Mountain Observatory, 120 km north of Nanjing (China).

	Ref: - Y. Ma, H. Zhao, D. Yao, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 381, "NEO search telescope in China." See: http://adsabs.harvard.edu/abs/1997IAUJD...6E..24Z
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1995	D.I. Steel, R.H. McNaught, C.J. Garradd, et al., 1995, in: J. Chapman, R. Cannon & B. Hidayat (eds.), Proc. IAU Colloquium No. 148 on *The Future Utilisation of Schmidt Telescopes*, Bandung (Indonesia), 7-11 March 1994, *ASP Conf. Series*, 84, 159, "Searching for Near-Earth Asteroids with the UK Schmidt telescope at the AAO." See: http://adsabs.harvard.edu/abs/1995ASPC...84..159S
1995, Jan	J.G. Hills, P.J.T. Leonard, 1995, *Astronomical Journal*, 109, 401, "Earth-crossing asteroids: the last days before earth impact." See: http://adsabs.harvard.edu/abs/1995AJ....109..401H
1995, Jan	K. Muionen, E. Bowell, K. Lumme, 1995, *Astronomy & Astrophysics*, 293, 948, "Interrelating asteroid size, albedo, and magnitude distributions." See: http://adsabs.harvard.edu/abs/1995A%26A...293..948M
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1995, Jun 24	Apollo NEA **170086** (**2002 XR14**, $H = 18.5$ mag, $D \approx 700$ m,

	PHA) passed Earth at a nominal miss distance of 4.26 LD. Minimum miss distance 4.26 LD. See: 2002 XR14 - JPL , 2002 XR14 - SSA
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1995, Sep 18-22	***IAU Working Group on Near Earth Objects Workshop***, Vulcano (Italy), ***Beginning the Spaceguard Survey*****.** The Workshop participants agreed to set up a **Spaceguard Foundation**, which materialized on 26 September 1996, in Rome. The **Spaceguard Central Node (SCN)**, hosted by ESA at ESRIN (Frascati, Italy) is a web site of **The Spaceguard Foundation**. Since 2002, the SCN is supporting ESA's Science Programme in all issues related to NEOs. Ref: - J. Tate, 2000, *Space Policy*, 16, 261, "Avoiding collisions: the **Spaceguard Foundation**." See: http://www.sciencedirect.com/science/article/pii/S0265964600000369 See also: http://cfa-www.harvard.edu/~marsden/SGF/Vulcano/programme.ps http://spaceguard.iasf-roma.inaf.it/SGF/history.html http://www.esa.int/esaMI/NEO/SEMS58OVGJE_0.html
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1996**,** Mar 20	Parliamentary Assembly of the Council of Europe (Strasbourg, France), Resolution 1080: "On the detection of asteroids and comets potentially dangerous to mankind", invited governments of member states and the European Space Agency (ESA) to give the necessary support to an international program to detect NEOs that are potentially dangerous to mankind and to develop a strategy for remedies against possible impacts. See: http://www.cfa.harvard.edu/~marsden/SGF/resol.html http://impact.arc.nasa.gov/news_detail.cfm?ID=82
1996, Mar 21	Apollo NEA **2014 AA** (H = 30.9 mag, $D \approx$ 2.3 m, Apollo NEO) passed **Mars** at a nominal miss distance of 11.86 LD. Minimum miss distance 2.07 LD. **Impact on 2 January 2014.** See: 2014 AA - SSA , 2014 AA - JPL See also: http://www.minorplanetcenter.net/mpec/K14/K14A02.html http://www.jpl.nasa.gov/news/news.php?release=2014-001 https://en.wikipedia.org/wiki/2014_AA See also: **3 Nov 1967**, **26 May 1994**, **2 Jan 2014**.
1996, Mar 26	Inauguration of the **Spaceguard Foundation (SGF)**, Rome (Italy), founded by E. Shoemaker, D. Steel, A. Carusi and the **IAU WG-NEO**. The **SGF** is located at the ESA Centre for Earth Observations (ESRIN) in Frascati (Italy). See: http://spaceguard.iasf-roma.inaf.it/SGF/history.html http://www.cfa.harvard.edu/~marsden/SGF/ http://spaceguard.esa.int

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1996, May 14	Massive asteroid **1996 JA1** (*H* = 20.8 mag, *D* ≈ 200 m, **PHA**) discovered by Timothy B. Spahr on photographic plates at the University of Arizona. Ref: - T. Spahr, D.J. Tholen, M. Hicks, J. Collins, 1996, *IAU Circ.* 6402, "**1996 JA1**." See: http://adsabs.harvard.edu/abs/1996IAUC.6402....1S - T.B. Spahr, C.W. Hergenrother, S.M. Larson, et al., 1997, *Icarus*, 129, 415, "The discovery and physical characteristics of **1996 JA1**." See: http://adsabs.harvard.edu/abs/1997Icar..129..415S See also: http://findarticles.com/p/articles/mi_m1200/is_n23_v149/ai_18385352/ http://en.wikipedia.org/wiki/Timothy_B._Spahr
1996, May 19	Apollo NEA **1996 JA1** (*H* = 20.8 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 1.18 LD. Minimum miss distance 1.18 LD. See: 1996 JA1- JPL , 1996 JA1 - SSA
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1996, Jul 8-12	***International conference on Asteroids, Comets, Meteors, VI***, Versailles (France). Proc.: A.V. Levasseur-Regourd & M. Fulchignoni (eds.), *Asteroids, Comets, Meteors 1996*, I: 1996, *Planetary and Space Science*, 45, No. 5; II: 1997, *Planetary and Space Science*, 45 No.7; III: 1997, *Planetary and Space Science*, 45, No.12; *Planetary and Space Science*, 46, No.8. See: http://adsabs.harvard.edu/abs/1997P%26SS...45.....L http://adsabs.harvard.edu/abs/1998P%26SS...46..835L
1996, Jul 15-17	***International conference Tunguska '96***, Bologna (Italy). See: http://impact.arc.nasa.gov/news_detail.cfm?ID=88
1996, Jul 28	T. Mallon, 8 July 1996, *New York Times Magazine*, "The asteroids

	are coming! The asteroids are coming! See: http://www.nytimes.com/1996/07/28/magazine/the-asteroids-are-coming-the-asteroids-are-coming.html?pagewanted=all&src=pm
1996, Aug	W.F. Bottke, M.C. Nolan, H.J. Melosh, 1996, *Icarus*, 122, 406, "Origin of the **Spacewatch** small Earth-approaching asteroids." See: http://adsabs.harvard.edu/abs/1996Icar..122..406B
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1996, Sep	P. Michel, C. Froeschle, P. Farinella, 1996, *Astronomy & Astrophysics*, 313, 993, "Dynamical evolution of two near-Earth asteroids to be explored by spacecraft: **(433) Eros** and **(4660) Nereus**." See: http://adsabs.harvard.edu/abs/1996A%26A...313..993M
1996, Sep 23-27	***2nd International Conference on Space Protection of the Earth (SPE-96)***, Snezhinsk/Chelyabinsk (Russian Federation). See: http://impact.arc.nasa.gov/news_detail.cfm?ID=87
1996, Oct	P.M. Sforza, J.L. Remo, 1996, *Acta Astronautica*, 39, 517, "Propulsion options for missions to near-Earth objects." See: http://adsabs.harvard.edu/abs/1996AcAau..39..517S
1996, Oct	J.M. Urias, I.M. DeAngelis, D.A. Ahern, et al., 1996, paper presented to *Air Force 2025*, "Planetary Defense: catastrophic health insurance for planet Earth." See: http://csat.au.af.mil/2025/volume3/vol3ch16.pdf
1996, Oct	Start of the **OCA-DLR Asteroid Survey (O.D.A.S.)**, to search for

	asteroids and comets with emphasis on NEO's, operated from October 1996 to April 1999 by the Observatoire de Côte d'Azur (OCA, Nice, France) and the DLR – Institute of Planetary Research (Berlin-Adlershof, Germany), in the framework of the **EUNEASO** project. Five NEAs were discovered. See: http://earn.dlr.de/odas/ http://earn.dlr.de/euneaso.htm
1996, Oct 20	The **Japanese Spaceguard Association (JSGA)** officially founded. Plans for the future involved two 1-m class ground-based NEO telescopes in Japan and a 30-cm NEO telescope on the Moon. A 1-m wide-field telescope for NEO detection became operational in 2002, and observes NEOs down to $v = 20.5$ since 2006. Ref: *SGF Information Bulletin* No. 1997/01, May 22, 1997, Item 7. See also: http://www.unoosa.org/pdf/reports/ac105/AC105_976E.pdf http://www.oosa.unvienna.org/pdf/reports/ac105/C1/AC105_C1_100E.pdf
1996, Oct 21	**Space Shield Foundation** established in Russia. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=91
1996, Nov	A.W. Harris, 1996, *Mercury*, 25, no.6, p.12, "Can we defend Earth against impacts by comets and small asteroids?" See: http://adsabs.harvard.edu/abs/1996Mercu..25f..12H
1996, Nov 12	Founding of **Spaceguard UK**, set up to promote UK NEO activities. The **UK Spaceguard Centre** is located at Knighton (Powys, Wales, UK). See: http://www.spaceguarduk.com/ http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_863Add1E.pdf
1996, Nov 22	**Honduras bolide**. Fireball over San Luis (Honduras). Estimated initial diameter $D \approx 2$ m. No meteorites were recovered. Ref: - NN, 1997, *Sky & Telescope*, 93, 12, "A hit in Honduras?"; - J. Borovička, C.M. Pineda de Carías, A. Ocampo, et al., 1999, in: W.J. Baggaley & V. Porubcan (eds.), *Meteoroids 1998*, Proc. Int. Conf., Tatranska Lomnica (Slovakia), 17-21 August 1998 (Slovak Academy of Sciences: Astronomical Institute), "About a big **fireball** seen in Honduras." See: http://adsabs.harvard.edu/abs/1999md98.conf..139B http://impact.arc.nasa.gov/news_detail.cfm?ID=69

1996, Nov 30	Apollo NEA **4179 Toutatis** (**1989 AC**, *H* = 15.2 mag, *D* = 4.6×2.4×1.9 km, orbital *P* = 4.03 yr, **PHA**) passed Earth at 13.79 LD. It is the largest known **PHA**. See: 1989 AC - JPL , 4179 Toutatis - SSA See also: http://en.wikipedia.org/wiki/4179_Toutatis **8 Dec 1992, 31 Oct 2000, 29 Sep 2004, 9 Nov 2008, 12 Dec 2012, 5 Nov 2069**.
1996, Dec	P.A. Bland, T.B. Smith, A.J.T. Jull, et al., 1996, *Monthly Notices Royal Astronomical Society*, 283, 551, "The flux of meteorites to the Earth over the last 50 000 years." See: http://adsabs.harvard.edu/abs/1996MNRAS.283..551B
1996, Dec	A. Tollman, 1996, *Astronomie + Raumfahrt in Unterricht*, 33 (6), 12, "Ein Komet – Ursache der Sintflut." See: http://www.fachportal-paedagogik.de/fis_bildung/suche/fis_set.html?FId=405749
1997	The survey project **Lincoln NEA Research (LINEAR),** a MIT Lincoln Laboratory program funded by the US Air Force and NASA, began operations with robotic telescopes and fast read-out CCD. Two **LINEAR** 1-m telescopes (White Sands Missile Range, Socorro, NM, USA) observe the sky five times per night. A third telescope is used for confirmation of NEO orbits, down to *v* = 20 mag. As of 31 December 2007, LINEAR had detected 2019 NEAs and 236 comets. Ref: - G.H. Stokes, J.B. Evans, H.E.M. Viggh, et al., 2000, *Icarus*, 148, 21, "**Lincoln Near-Earth Asteroid Research (LINEAR)**." See: http://adsabs.harvard.edu/abs/2000Icar..148...21S - D.K. Yeomans, S.R. Chesley, P.W. Chodas, 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proc. Intern. Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against collisions with asteroids and comet nuclei*, St. Petersburg (Russian Federation), 21-25 September 2009 (Saint Petersburg: Nauka), p. 244, "**NASA's Near-Earth Object Program Office**." See also: http://www.ll.mit.edu/mission/space/linear/ http://ftp://quasar.ipa.nw.ru/pub/ACHBOOK_2009/ach-2009_book.pdf
1997	**Spanish Meteor and Fireball Network**. Operations started in 2004 using high-resolution all-sky CCD camera's and video systems at stations (25 by 2010) located around the Mediterranean coast. Ref: - J.M. Trigo-Rodríguez, A.J. Castro-Tirado, J. Llorca, et al., 2004, *Earth, Moon, and Planets*, 95, 553, "The development of the

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	based cameras. Estimated initial NEA mass $M \approx 36{,}000$ kg. No meteorites were recovered. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=80 http://goes.gsfc.nasa.gov/text/9712.greenland/9712.greenland.html http://en.wikipedia.org/wiki/List_of_meteor_air_bursts Ref: - H. Pedersen, R.E. Spalding, E. Tagliaferri, et al., 2001, *Meteoritics & Planetary Science*, 36, 549, "**Greenland superbolide event** of 1997 December 9." See: http://adsabs.harvard.edu/abs/2001M%26PS...36..549P
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1998, Mar 11	B.G. Marsden, 1998, IAU *Circular* 6837, "**1997 XF11**." See: http://www.cbat.eps.harvard.edu/iauc/06800/06837.html#Item2 http://www.minorplanetcenter.net/iau/pressinfo/1997XF11.html IAU *Circular* 6837 contained the (later corrected) assertion of a possible impact on Earth by Apollo NEA **35396** (**1997 XF11**, *H* = 17.3 mag, *D* ≈ 1600 m, **PHA**) on 26 Oct 2028. The ensuing debate on orbit determination, evaluation of impact risks and the dissemination of such results led to considerable activity. Improved analyses predicted an approach distance of 2.42 LD on **26 October 2028**. See: 1997 XF11 - JPL , 35396 1997 XF11 - SSA See also: http://www.ibtimes.co.in/would-asteroid-discovered-1997-hit-earth-search-answers-led-much-more-732947 https://en.wikipedia.org/wiki/(35396)_1997_XF1 Ref: - B.G. Marsden, 1998, *Boston Sunday Globe*, 29 March 1989, "How the asteroid story hit: an astronomer reveals how a discovery spun out of control." See: http://www.minorplanetcenter.net/iau/pressinfo/1997XF11Globe.html - I. Semeniuk, 1998, *Mercury*, 27, No. 6, p. 12, "Armageddon? … Sorry, just Armakiddin!" See: http://adsabs.harvard.edu/abs/1998Mercu..27f..12S - B.G. Marsden, 1999, *AAS-DAA meeting* #31, #07.02, "Asteroid **1997 XF11** could collide with earth." See: http://adsabs.harvard.edu/abs/1999DDA....31.0702M - B.G. Marsden, 1999, *Journal of the British Astronomical Association*, 109, 39, "**1997 XF11** - the true story." See: http://adsabs.harvard.edu/abs/1999JBAA..109...39M - B.G. Marsden, 1999, *Journal British Interplanetary Society*, 52 (5 - 6), 195, "A discourse on **1997 XF11**." See: http://adsabs.harvard.edu/abs/1999JBIS...52..195M - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard."

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1998, Mar 29	B.G. Marsden, 1998, *Boston Sunday Globe*, 29 March 1989, "How the asteroid story hit: an astronomer reveals how a discovery spun out of control." See: http://www.minorplanetcenter.net/iau/pressinfo/1997XF11Globe.html
1998, Apr	The **Catalina Sky Survey** came into operation, starting from the ashes of an old photographic project started by Spahr & Hergenrother (1993). The **CSS** consists of a consortium of three cooperating surveys, all funded by NASA: the original Catalina Sky Survey (**CSS**, 0.7-m telescope) in Arizona, the Siding Spring Survey (**SSS**, 0.5-m telescope) in Australia, and the Mt. Lemmon Survey (**MLSS**, 1.5-m telescope) in Arizona. As of 2009, **CSS** had discovered more than 2,142 NEOs down to $v = 22$ mag. Ref: - T.B. Spahr, C. Hergenrother, S.M. Larson, 1993, *Bulletin American Astronomical Society*, 25, 1059, "High ecliptic latitude asteroid and comet search." See: http://adsabs.harvard.edu/abs/1993DPS....25.1013S - D.K. Yeomans, S.R. Chesley, P.W. Chodas, 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proc. Intern. Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against*

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1998, Apr	P. Farinella, D. Vokroughlický, W.K. Hartmann, 1998, *Icarus*, 132, 378, "Meteorite delivery via Yarkovsky orbital drift." See: http://adsabs.harvard.edu/abs/1998Icar..132..378F
1998, Apr 10	Apollo NEA **138175** (**2000 EE104**, $H = 20.7$ mag, $D \approx 260$ m, **PHA**) passed Earth at a nominal miss distance of 4.46 LD. Minimum miss distance 4.46 LD. See: 2000 EE104- JPL , 2000 EE104- SSA See also: **11 Apr 1999**.
1998, Apr 14	Aten NEA **99942 Apophis** (**2004 MN4**, $H = 19.0$ mag, $D = 310 \pm 30$ m, orbital $P = 0.89$ yr, **PHA**) passed Earth at a nominal miss distance of 9.491 LD. Minimum miss distance 9.490 LD. See: 2004 MN4 - JPL , 99942 Apophis - SSA See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://en.wikipedia.org/wiki/99942_Apophis See also: **13 Apr 1907**, **14 Apr 1949**, **13 Apr 2029**, **23 Mar 2036**, **7 Apr 2123.**
1998, May	D.I. Steel, 1998, *Planetary and Space Science*, 46, 473, "Distributions and moments of asteroid and comet impact speeds upon the Earth and Mars." See: http://adsabs.harvard.edu/abs/1998P%26SS...46..473S

1998, May 21	***U.S. Congressional Hearing on NEOs and Planetary Defense.*** Statement by Carl Pilcher, Science Director, Solar System Exploration, Office of Space Science, NASA, announcing the **Spaceguard Goal** to the U.S. House Subcommittee on Space & Aeronautics, i.e., find and track 90% of NEOs with $D > 1$ km. See: http://impact.arc.nasa.gov/gov_asteroidperils_1.cfm http://impact.arc.nasa.gov/gov_asteroidperils_3.cfm
1998, Jun	**NASA Near Earth Orbit Program Office** established at NASA Jet Propulsion Laboratory (Pasadena, CA, USA), to coordinate and provide a focal point for US studies of NEOs. See: http://neo.jpl.nasa.gov/ http://impact.arc.nasa.gov/programs_office.cfm
1998, Jun	J. Borovička, O.P. Popova, I.V. Nemtchinov, P. Spurný, Z. Ceplecha, 1998, *Astronomy & Astrophysics*, 334, 713, "Bolides produced by impacts of large meteoroids into the Earth's atmosphere: comparison of theory with observations. I. **Benešov bolide** dynamics and fragmentation." See: http://adsabs.harvard.edu/abs/1998A%26A...334..713B **Benešov bolide** was detected and observed at the Czech stations of the **European Fireball Network** on 7 May 1991, one of the brightest and best-documented bolides.
1998, Jun	G.L. Verschuur, 1998, *Sky & Telescope,* 95(6), 26, "Impact hazards: truth and consequences." See: http://adsabs.harvard.edu/abs/1998S%26T....95f..26V
1998, Jun	P.A. Wiegert, K.A. Innanen, S. Mikkola, 1998, *Astronomical Journal*, 115, 2604, "The orbital evolution of Near-Earth Asteroid **3753**." See: http://iopscience.iop.org/1538-3881/115/6/2604/fulltext/
1998, Jun 4	A.W. Harris, 1998, *Nature*, 393, 418, "Planetary science: making and braking asteroids." See: http://adsabs.harvard.edu/abs/1998Natur.393..418H
1998, Jun 4	E. Asphaug, S.J. Ostro, R.S. Hudson, D.J. Scheeres, W. Benz, 1998, *Nature*, 393, 437, "Disruption of kilometre-sized asteroids by energetic collisions." See: http://adsabs.harvard.edu/abs/1998Natur.393..437A
1998, Jun 8	Apollo NEA **1998 KY26** ($H = 25.5$ mag, $D \approx 30$ m) passed Earth at a nominal miss distance of 2.10 LD. Minimum miss distance 2.10 LD.

	See: 1998 KY26 - JPL , 1998 KY26 - SSA See also: http://en.wikipedia.org/wiki/1998_KY26 Ref: - S.J. Ostro, P. Pravec, L.A.M. Benner, et al. 1999, *Science*, 285, 557, "Radar and optical observations of asteroid **1998 KY26**." See: http://adsabs.harvard.edu/abs/1999Sci...285..557O See also: http://antwrp.gsfc.nasa.gov/apod/ap020919.html
1998, Jul	F. Langenhorst, G. Shafranovsky, V.L. Masaitis, 1998, *Meteoritics & Planetary Science*, 33, A90, "A comparative study of impact diamonds from the **Popigai**, **Ries**, **Sudbury**, and **Lappajarvi Craters**." See: http://adsabs.harvard.edu/abs/1998M%26PSA..33R..90L
1998, Jul	V. Zappalà, A. Cellino, B.J. Gladman, et al., 1998, *Icarus*, 134, 176, "Asteroid showers on Earth after family breakup events." See: http://adsabs.harvard.edu/abs/1998M%26PSA..33R..90L
1998, Jul 4	The **International Astronomical Union** Executive Committee, at its 71st meeting in Paris, on the initiative of General Secretary Johannes Andersen, issued a policy statement, which made clear that the detection and observations of NEOs to determine their orbits "is an international responsibility that requires the efforts of and support for astronomers around the world." It also stated that the IAU "coordinates this activity through the **IAU Working Group on Near Earth Objects (WG-NEO)** and offers the services of the **Minor Planet Center**, the international clearing house and data disseminator for NEO observations and research." It was emphasized that this was not a scientific policy judgment, but a policy issue related to public safety. **See:** https://www.iau.org/static/publications/IB83.pdf ***IAU Information Bulletin No.83, January 1999:*** ***8. Policy Statement On Near Earth Object Research,*** ***Issued by the IAU Executive Committee on July 4, 1998.*** *The Solar system contains a large number of bodies ranging in size from the major planets to tiny meteorites. Research over the last several decades has revealed that all major bodies of the Solar system have suffered larger or smaller impacts of bodies ranging in size from millimetres to kilometres, the best-known example of which is the abundance of craters on the Moon. Geological features on Earth show that impacts of significant size have occurred also on our own planet. The realization that such impacts occur at long, but presently poorly-known intervals has recently*

	caused growing concern in the public, and in the press. *Research on the minor constituents of the Solar system - the minor planets or asteroids - has formed part of astronomical research for the last two centuries* ***. The International Astronomical Union (IAU)*** *has acted as the international focal point for this research since the foundation of the Union in 1919, in particular through its* ***Commission on the Positions and Motions of Minor Planets, Planets, and Satellites****. As part of this function, the IAU has for over 50 years operated a* ***Minor Planet Center (MPC)****, currently at the Smithsonian Astrophysical Observatory (SAO; Cambridge, Mass., USA), for the collection of data and the dissemination of information concerning minor planets and, lately, comets. When continued research showed that the orbits of several minor planets crossed that of the Earth, the IAU in 1991 appointed a* ***Working Group on Near Earth Objects (NEO)*** *to coordinate international studies of NEOs and develop suitable strategies for detection, follow-up, and orbit prediction. As one result of this work, the international* ***Spaceguard Foundation*** *was formed, and a number of observational programs for the detection of NEO's have been started. The* ***WGNEO*** *is also active in the development of proven algorithms for long-term NEO orbit prediction and thus for assessing the distance to which NEOs may approach Earth within the next few centuries.* *Currently, the number, size distribution, and orbits of individual NEOs are incompletely known from observation. Thus, the most urgent task is the detection and observation of NEO's to determine their orbits. This is an international responsibility that requires the efforts of and support for astronomers around the world. As the international organization of professional astronomers, the IAU coordinates this activity through the* ***NEO Working Group*** *and offers the services of the* ***MPC*** *for the collection and collation of new observations and computation of predictions from which follow-up observations can be made to improve our knowledge of the orbits and sizes of these objects.* *It is possible that, sometime in the future, these studies may lead to the prediction of an actual impact on Earth. In such a case, this information must be promptly conveyed to the governments of the world, who may be in a position to organise countermeasures (a subject outside the mandate of the IAU). On the other hand, public announcements of potential impacts without proper verification are clearly undesirable. The IAU has therefore charged the* ***WGNEO****, in consultation with astronomers worldwide, to draft a set of recommended procedures to be followed in case minor planets and comets are discovered that lead to predictions by the*

	MPC *of potential impacts. These procedures will conform to the following general principles:* *1: All information will be openly shared with astronomers and the general public world-wide.* *2: The content of public statements that might alarm the public will be subject to prior scientific peer review by the IAU.* *3: The IAU Officers and appropriate authorities will be consulted before such information is released to the press.* *The IAU reaffirms and increases its support of the* ***Minor Planet Center****, as the international clearing-house for this research, and acknowledges the support of SAO and NASA for its operation. The IAU encourages all countries of the world to contribute to the effort of charting the NEO population and will continue to ensure that this global issue is addressed in a properly international forum.*
1998, Jul 14	Anon., 1998, *JPL News*, 14 July 1998, "JPL selected for **Near-Earth Object Program Office**." See: https://www.jpl.nasa.gov/news/news.php?feature=5134
1998, Jul 28	Apollo NEA **2019 BZ** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 4.87 LD. Minimum miss distance 0.13 LD. See: 2019 BZ - JPL , 2019 BZ - SSA See also: **24 Jan 2000**.
1998, Aug	S.J. Ostro, C. Sagan, 1998, *Astronomy & Geophysics*, 39, 22, "Cosmic collisions and galactic civilizations." See: http://adsabs.harvard.edu/abs/1998A%26G....39d..22O
1998, Aug	A.W. Harris, 1998, in: J. Andersen (ed.), Proc. IAU XXIII GA Joint Discussion *Interactions between Planets and Small Bodies*, in: *Highlights in Astronomy*, 11A, 257, "Searching for NEAs from Earth or space." See: http://adsabs.harvard.edu/abs/1998HiA....11..257H
1998, Aug	A.D. Taylor, W.G. Elford, 1998, in: J. Andersen (ed.), Proc. IAU XXIII GA Joint Discussion *Interactions between Planets and Small Bodies*, in: *Highlights in Astronomy*, 11A, 239, "Aspects of the terrestrial influx of small meteoroids." See: http://adsabs.harvard.edu/abs/1998HiA....11..239T

1998, Aug 23	Apollo NEA **513126** (**1998 QP**, *H* = 21.6 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.62 LD. Minimum miss distance 4.62 LD. See: 1998 QP - JPL , 1998 QP- SSA See also: **22 Aug 1924**.
1998, Aug 30	Apollo NEA **2009 DM45** (*H* = 21.2 mag, *D* ≈ 200 m, **PHA**) passed Earth at a nominal miss distance of 4.43 LD. Minimum miss distance 4.42 LD. See: 2009 DM45 - JPL , 2009 DM45 - SSA
1998, Sep	Z. Ceplecha, J. Borovička, W.G. Elford, et al., 1998, *Space Science Reviews*, 84, 327, "Meteor phenomena and bodies." See: http://adsabs.harvard.edu/abs/1998SSRv...84..327C
1998, Sep	A. Morbidelli, B. Gladman, 1998, *Meteoritics & Planetary Science*, 33, 999, "Orbital and temporal distributions of meteorites originating in the asteroid belt." See: http://adsabs.harvard.edu/abs/1998M%26PS...33..999M
1998, Sep 25	R. Greenberg, 1998, *Science*, 281, 1971, "How asteroids come to Earth." See: http://adsabs.harvard.edu/abs/1998Sci...281.1971G
1998, Sep 25	F. Migliorini, P. Michel, A. Morbidelli, et al., 1998, *Science*, 281, 2022, "Origin of multi-kilometer Earth- and Mars-crossing asteroids: a quantitative simulation." See: http://adsabs.harvard.edu/abs/1998Sci...281.2022M
1998, Oct 7	C.R. Chapman, 1998, "History of the asteroid/comet impact hazard." See: http://www.boulder.swri.edu/clark/ncarhist.html
1998, Nov	R.B. Stothers, 1998, *Monthly Notices Royal Astronomical Society*, 300, 1098, "Galactic disc dark matter, terrestrial impact cratering and the law of large numbers." See: http://adsabs.harvard.edu/abs/1998MNRAS.300.1098S
1998, Nov	R.J. Whiteley, D.J. Tholen, 1998, *Icarus*, 136, 154, "A CCD search for Lagrangian asteroids of the Earth–Sun system." See: http://adsabs.harvard.edu/abs/1998Icar..136..154W
1998, Nov	J.C. Wynn, E.M. Shoemaker, 1998, *Scientific American*, 279 (5), 36, "The day the sands caught fire." See: http://adsabs.harvard.edu/abs/1998SciAm.279e..36W http://volcanoes.usgs.gov/jwynn/1998SciAm-Wabar.pdf

1998, Nov	**Leonid meteor shower "Glowworm"**, seen over Kirtland Air Force Base, Albuquerque (NM, USA). See: http://apod.nasa.gov/apod/ap000428.html
1998, Nov 1	P. Pravec, M. Wolf, L. Šarounová, 1998, *Icarus*, 136, 124, "Lightcurves of 26 Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/1998Icar..136..124P
1998, Nov 17	**Leonid Fireball** over Monteromano (Italy). See: http://apod.nasa.gov/apod/ap991112.html
1998, Nov 17	**Leonid Fireball** over Cape Canaveral (FL, USA). See: http://apod.nasa.gov/apod/ap981120.html
1998, Nov 17	**Large Leonid meteor fireballs over northern New Mexico**. Ref: - J. Zinn, J. Wren, R. Whitaker, et al., 1999, *Meteoritics & Planetary Science*, 34, 1007, "Coordinated observations of two large **Leonid meteor fireballs** over northern New Mexico, and computer model comparisons." See: http://adsabs.harvard.edu/abs/1999M%26PS...34.1007Z
1998, Nov 25	E. Pierazzo, D.A. Kring, H.J. Melosh, 1998, *Journal of Geophysical Research, Planets*, 103, 28607, "Hydrocode simulation of the **Chicxulub impact** event and the production of climatically active gases." See: http://onlinelibrary.wiley.com/doi/10.1029/98JE02496/abstract
1998, Dec	E.M. Shoemaker, 1998, *Journal of the Royal Astronomical Society of Canada*, 92, 297, "Impact cratering through geologic time." See: http://adsabs.harvard.edu/abs/1998JRASC..92..297S
1998, Dec 23	NASA spacecraft ***Near Earth Asteroid Rendezvous – Shoemaker*** (***NEAR – Shoemaker***) arrives at Amor NEA **433 Eros** (**1898 DQ**, H = 11.16 mag, D = 34.4 × 11.2× 11.2 km, orbital period P = 1.76 yr, Amor asteroid). See: 1898 DQ- JPL , 433 Eros - SSA See also: http://near.jhuapl.edu/media/NEAR_fact_sheet.pdf http://www.scientificamerican.com/article.cfm?id=come-closer-my-near http://en.wikipedia.org/wiki/433_Eros
1999, Jan 1	**650 NEAs** known, of which **166 PHAs**. See: http://neo.jpl.nasa.gov/stats/
1999	The 10,000th minor planet was numbered at the **IAU Minor Planet**

	Center: Main-belt asteroid **10000 Myriostos** (**1951 SY**, $H = 15.1$ mag, $D \approx 3000$ m), discovered by Albert G. Wilson at Palomar Observatory (CA, USA). See: 1951 SY - JPL , 10000 Myriostos - SSA See also: http://www.iau.org/static/publications/IB104.pdf p. 67, http://www.physics.uc.edu/~sitko/AdvancedAstro/25-SmallBodies/SmallBodies.htm http://en.wikipedia.org/wiki/10000_Myriostos
1999	**NASA NEO Program Office** at the Jet Propulsion Laboratory (Caltech, Pasadena, CA, USA) begins partial funding of the IAU **Minor Planet Center**. See: http://www.minorplanetcenter.net/iau/mpc.html
1999	**LINEAR** adds second co-located 1m search telescope with fast read-out CCD. See: http://www.ll.mit.edu/mission/space/linear/
1999	Australian National Observatory 0.5 m telescope in Siding Spring begins follow up observations as part of the **Catalina Sky Survey**. See: http://www.lpl.arizona.edu/css/index.html
1999	B.O. Dressler, V.L. Sharpton (eds.), 1999, Proc., ***Large meteorite impacts and planetary evolution; II***, *Geological Society of America Special Papers*, Vol. 339. See: http://specialpapers.gsapubs.org/content/339
1999	J.S. Lewis, 1999, *Comet and asteroid impact hazards on a populated Earth* (New York: Academic Press). See: http://en.wikipedia.org/wiki/John_S._Lewis http://adsabs.harvard.edu/abs/2000caih.book.....L
1999	H.Y. McSween, 1999, *Meteorites and their Parent Planets* (Cambridge: CUP). See: http://www.cambridge.org/us/academic/subjects/earth-and-environmental-science/planetary-science-and-astrobiology/meteorites-and-their-parent-planets-2nd-edition
1999	C.W. Poag, 1999, ***Chesapeake invader****: discovering America's giant meteorite crater* (Princeton: Princeton University Press, ISBN 0-691-00919-8). See: http://press.princeton.edu/titles/6765.html
1999, Jan	A. Morbidelli, 1999, *Celestial Mechanics and Dynamical Astronomy*, 73(1/4), 39, "Origin and evolution of Near Earth

	Asteroids." See: http://adsabs.harvard.edu/abs/1999CeMDA..73...39M
1999, Jan 21	**Fireball** over Czech Republic, recorded by the **European Fireball Network**. The luminous trail is measured to begin at an altitude of 81.9 kilometers and covered 71.1 kilometers in 6.7 seconds. See: http://apod.nasa.gov/apod/ap990219.html
1999, Mar	The threat from NEOs is debated in the UK House of Commons. Minister for Energy & Industry, John Battle, said that the government will consult British astronomers and other experts on ways the UK can support NEO research.
1999, Mar 5-6	**Near Earth Objects Dynamic Site (NEODyS)** created, as an Italian/Spanish service that provides information on NEOs, operated at the University of Pisa (Italy), with a mirror site in Valladolid (Spain). Operational since November 1999. Both the University of Pisa and JPL post their web sites for information on NEOs (close approaches, ephemerides, orbital data). The close approach monitoring efforts, **CLOMON** at Pisa and **SENTRY** at NASA-JPL were initiated later. Since early 2002 the two automated NEO close approach monitoring services, **CLOMON2** (Pisa) and **SENTRY** (JPL), are cross-checking their monitoring results. Starting from 1 September 2011 **NEODyS** is sponsored by ESA, which pays a portion of the operating costs, both for the background orbit and risk computations and for the database and web interface; the rest of the cost is covered, as before, by the Department of Mathematics, University of Pisa, with the running research grants of the Celestial Mechanics Group, and by IASF-INAF (Rome), with a PRIN-INAF grant. Ref: - A. Milani, S.R. Chesley, M.E. Sansaturio, G. Tommei, G.B. Valsecchi, 2005, *Icarus*, 173, 362, "Nonlinear impact monitoring: line of variation searches for impactors." See: http://adsabs.harvard.edu/abs/2005Icar..173..362M See also: http://newton.dm.unipi.it/neodys/ http://neo.jpl.nasa.gov/risk/ http://adsabs.harvard.edu/abs/2001DPS....33.4108C http://aas.org/archives/BAAS/v31n4/dps99/28.htm http://en.wikipedia.org/wiki/NEODyS
1999, Mar 6	Apollo NEA **474158** (**1999 FA**, $H = 20.9$ mag, $D \approx 300$ m, **PHA**) passed Earth at a nominal miss distance of 4.17 LD. Minimum miss distance 4.17 LD. See: 1999 FA - JPL , 1999 FA - SSA See also: **6 Mar 1909**, **6 Mar 2143**, **7 Mar 2194**.

1999, Mar 12	Apollo NEA **2013 EC20** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.27 LD. **[1999-01]** See: 2013 EC20 -JPL , 2013 EC20 - SSA See also: **9 March 2013**.
1999, Apr	D. Vokrouhlický, 1999, *Astronomy & Astrophysics*, 344, 362, "A complete linear model for the Yarkovsky thermal force on spherical asteroid fragments." See: http://adsabs.harvard.edu/abs/1999A%26A...344..362V
1999, Apr 11	Apollo NEA **138175** (**2000 EE104**, *H* = 20.7 mag, *D* ≈ 260 m, **PHA**) passed Earth at a nominal miss distance of 4.72 LD. Minimum miss distance 4.72 LD. See: 2000 EE104 - JPL , 2000 EE104 - SSA See also: **10 Apr 1998**.
1999, May	**NASA/USAF NEO Search Program**. NASA, in collaboration with the USA Air Force, is moving to implement a search program to meet the objectives of the **Spaceguard Survey**, as set down in the NASA **Spaceguard** reports of 1992 and 1995. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=22
1999, May	In a report to the ESA Council at ministerial level, the ESA Long-Term Space Policy Committee recommended (Action 13, Threat of Cosmic Collision) that ESA be involved in NEO activities, including the study of counter measures. Ref: LSPC Report "Investing in space – the challenge for Europe", 1999, *ESA SP-2000*. See: http://www.esa.int/esapub/sp/sp2000/sp2000.pdf
1999, May	A. Poveda, M.A. Herrera, J.L. García, K. Curioka, 1999, *Planetary and Space Science*, 47, 679, "The diameter distribution of Earth-crossing asteroids." See: http://adsabs.harvard.edu/abs/1999P%26SS...47..679P
1999, May	A. Poveda, M.A. Herrera, J.L. García, A. Hernandéz-Alcántara, K. Curioka, 1999, *Planetary and Space Science*, 47, 715, "The expected frequency of collisions of small meteorites with cars and aircraft." See: http://adsabs.harvard.edu/abs/1999P%26SS...47..715P
1999, May 6	Aten NEA **2000 SG344** (*H* = 25.1 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 1.48 LD. Minimum miss distance 1.48 LD.

	See: 2000 SG344 - JPL , 2000 SG344 - SSA See also: http://en.wikipedia.org/wiki/2000_SG344 Ref: - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998 – 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B See also: **7 May 2028, 13 Sep 2072**.
1999, May 10	R.P. Binzel, M. A'Hearn, C.R. Chapman, C. Chyba, A.L. Cochran, A.W. Harris, D.K. Yeomans, B.G. Marsden, R.L. Millis & D. Morrison, 1999, *"From the pragmatic to the fundamental: the scientific case for near-Earth object surveys."* Report prepared for the Astronomy and Astrophysics Survey Committee (AASC) of the National Academy of Sciences. Quoted in: http://www.boulder.swri.edu/clark/ncar799.html
1999, May 18	P.W. Chodas, 18 May 1999, "The continuing story of asteroid **1999 AN10**." See: http://neo.jpl.nasa.gov/news/news017.html
1999, May 27	Aten NEA **2010KV39** (H = 27.0 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 5.80 LD. Minimum miss distance 0.98 LD. See: 2010 KV39 -JPL , 2010 KV39 - SSA
1999, Jun	S. Isobe and **Japan Spaceguard Association**, 1999, *Advances in Space Research*, 23(1), 33, "Japanese 0.5 m and 1.0 m telescopes to detect space debris and near-earth asteroids." See: http://adsabs.harvard.edu/abs/1999AdSpR..23...33I
1999, Jun	A. Milani, S.R. Chesley, G.B. Valsecchi, 1999, *Astronomy & Astrophysics* (Letters), 346, L65, "Close approaches of asteroid **1999 AN10**: resonant and non-resonant returns." See: http://adsabs.harvard.edu/abs/1999A%26A...346L..65M See also: **7 August 2027**.
1999, Jun	A. Morbidelli, D. Nesvorný, 1999, *Icarus*, 139, 295, "Numerous weak resonances drive asteroids toward terrestrial planets orbits." See: http://adsabs.harvard.edu/abs/1999A%26A...346L..65M

1999, Jun	Threat from NEOs discussed in UK House of Lords. Science Minister, Lord Sainsbury, says that Britain must cooperate internationally on this topic. See: http://www.greatdreams.com/near.htm
1999, Jun 1-4	Torino **Workshop on *International Monitoring Programs for Asteroid and Comet Threat* (IMPACT)**, Torino (Italy), organized by IAU Commission 15, the **Spaceguard Foundation** and others, and co-sponsored by NASA, ESA, IAU, ASI, IACG, Planetary Society, Alenia. The outcome includes the **"Torino Scale"** (describing risk and severity of possible impact for newly discovered hazardous objects), a call for national **Spaceguard** centres, and a plea to finance these centers in order to facilitate international collaboration in the international **Spaceguard** programme. Ref: - R.P. Binzel, 2000, *Planetary and Space Science*, 48, 297, "The Torino Impact Hazard Scale." See: http://adsabs.harvard.edu/abs/2000P%26SS...48..297B See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=35 http://impact.arc.nasa.gov/news_detail.cfm?ID=49 http://impact.arc.nasa.gov/news_detail.cfm?ID=55 http://neo.jpl.nasa.gov/news/news024.html
1999, Jul	The **Torino Impact Hazard Scale** announced simultaneously by the IAU and by NASA. Ref: - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M http://neo.jpl.nasa.gov/torino_scale.html
1999, Jul	The **Third United Nations Conference on the *Exploration and Peaceful Uses of Outer Space* (*UNISPACE III*,** Vienna, Austria), held a workshop on NEOs and made recommendations to the UN General Assembly. Resolution 1 adopted by the Conference, the *Vienna Declaration on Space and Human Development*, declares a strategy including actions that should be taken to: improve knowledge of NEOs; improve international coordination of activities related to NEOs; harmonize worldwide effort directed to identification, follow-up observations and orbit prediction; and research safety measures on the use of nuclear power sources in

	outer space. The Vienna Declaration stated that: – That the United Nations take the initiative of inviting all Member States to support near-Earth object research in their own countries, through the establishment of national or regional "spaceguard" centres to be coordinated by the international **Spaceguard Foundation**; – That every effort be made to provide financial support for near-Earth object research, both theoretical and observational (from ground and space), … – The United Nations support and promote greater involvement of scientists and observatories from nations in the southern hemisphere, ... This *Vienna Declaration* was endorsed by the UN General Assembly in December 1999. In 2001, in response to recommendation 14 of ***UNISPACE III*, Action Team 14** on NEOs was established by **UN-COPUOS** with terms of reference: (a) review the content, structure and organization of on-going efforts in the field of NEOs; (b) identify any gaps in the on-going work where additional cooperation is required and/or where other countries or organizations could make contributions; and (c) propose steps for the improvement of international coordination in collaboration with specialized bodies. See: http://www.oosa.unvienna.org/oosa/unisp-3/index.html http://www.un.org/events/unispace3/bginfo/events.htm
1999, Jul	Start of the **Arcetri NEO Precovery Program (ANEOPP)**. See: http://www.arcetri.astro.it/science/aneopp/ Ref: - A. Boattini, G. D'Abramo, G. Forti, R. Gal, 2001, *Astronomy & Astrophysics*, 375, 293, **"The Arcetri NEO Precovery Program."** See: http://adsabs.harvard.edu/abs/2001A%26A...375..293B - A. Boattini, G. D'Abramo, G. Forti, 2003, *Memorie della Società Astronomica Italiana*, 74, 864, "The importance of Near Earth Object detections on archival images: recent results and future potential." See: http://adsabs.harvard.edu/abs/2003MmSAI..74..864B
1999, Jul	W.K. Hartmann, P. Farinella, D. Vokrouhlický, 1999, *Meteoritics & Planetary Science*, 34, A161, "Reviewing the Yarkovsky effect: new light on the delivery of stone and iron meteorites from the asteroid belt." See: http://adsabs.harvard.edu/abs/1999A%26A...347..711M
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1999, Jul 29	NASA spacecraft ***Deep Space 1*** (1998 – 2001) flew by **9969 Braille** (**1992 KD**, $H = 15.9$ mag, $D \approx 2200$ m, Mars-crossing asteroid) at a distance of 26 km. See: 1992 KD - JPL , 9969 Braille - SSA Ref: - B.J. Buratti, D.T. Britt, L.A. Soderblom, et al., 2004, *Icarus*, 167, 129, "**9969 Braille**: ***Deep Space 1*** infrared spectroscopy, geometric albedo and classification." See: http://adsabs.harvard.edu/abs/2004Icar..167..129B See also: http://nmp.nasa.gov/ds1/gen/gen3.html http://impact.arc.nasa.gov/news_detail.cfm?ID=53 http://antwrp.gsfc.nasa.gov/apod/ap990805.html http://en.wikipedia.org/wiki/9969_Braille
1999, Aug 15-19	***1999 AAS/AIAA Astrodynamics Specialist Conference,*** Girdwood, Alaska (USA). See: http://www.space-flight.org/AAS_meetings/1999_astro/1999_astro.html
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1999, Nov	T. Gehrels, 1999, *Earth, Planets and Space*, 51, 1155, "A review of comet and asteroid statistics." See: http://adsabs.harvard.edu/abs/1999EP%26S...51.1155G
1999, Nov 7-20	First-ever radar images of a Main-belt asteroid: **216 Kleopatra** (H = 7.20 mag, D = 270 × 94 × 81 km) obtained with the 305 m Arecibo radio telescope by Steven J. Ostro (1946 – 2008) of NASA JPL, Pasadena (CA, USA). Shape: dog bone. At the time of observation the distance to **216 Kleopatra** was $d = 171 \times 10^6$ km. As of May 2008, Ostro and his collaborators had detected 222 NEAs (including 130 PHAs and 24 binaries) and 118 main belt objects with radar. See: 216 Kleopatra - JPL , 216 Kleopatra - SSA Ref: - S.J. Ostro, R.S. Hudson, M.C. Nolan, et al., 5 May 2000, *Science*, 288, 836, "Radar observations of asteroid **216 Kleopatra**." See: http://adsabs.harvard.edu/abs/2000Sci...288..836O - P. Descamps, F. Marchis, J. Berthier, et al., 2011, *Icarus*, 211, 1022, "Triplicity and physical characteristics of asteroid (**216**) **Kleopatra**." See: http://adsabs.harvard.edu/abs/2011Icar..211.1022D - T. Chanut, O.C. Winter, October 2012, American Astronomical Society, DPS meeting #44, #210.15, "Evaluation of the gravity field and the dynamic environment of asteroid **216 Kleopatra**." See: http://adsabs.harvard.edu/abs/2012DPS....4421015C See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=38 http://newscenter.berkeley.edu/2011/02/22/how-kleopatra-got-its-moons/ http://www.planetary.org/blog/article/00002926/ http://www.space.com/11836-asteroid-kleopatra-moons-rubble-pile.html http://en.wikipedia.org/wiki/216_Kleopatra
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1999, Nov 18	**Leonid Fireball** over Dagali (Norway). See: http://apod.nasa.gov/apod/ap991202.html
1999, Dec	A.W. Harris, J.K. Davies, 1999, *Icarus*, 142, 464, "Physical characteristics of Near-Earth Asteroids from thermal infrared spectrophotometry." See: http://adsabs.harvard.edu/abs/1999Icar..142..464H
2000, Jan 1	**879 NEAs** known, of which **215 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2000	The 100,000th minor planet was numbered at the **Minor Planet Center**: inner Main-belt asteroid **100000 Astronautica (1982 SH1**, $H = 16.8$ mag, $D \approx 1500$ m), discovered on 28 September 1982 by J. Gibson at Palomar Observatory (CA, USA). This minor planet has been named **Astronautica** to recognize the 50th anniversary of the beginning of the Space Age, inaugurated by the launch of the first artificial earth satellite on 4 October 1957, ***Sputnik***. The name **Astronautica** is associated with this significant number, as space is defined to begin at an altitude of 100,000 meters above the Earth's surface. See: 1982 SH1 - JPL , 100000 Astronautica - SSA http://en.wikipedia.org/wiki/100000_Astronautica
2000	**Bisei Spaceguard Center** established in Bisei (Okayama, Japan). See: http://en.wikipedia.org/wiki/Bisei_Spaceguard_Center http://www.spaceguard.or.jp/ja/index.html
2000	A. Deutsch, V.L. Masaitis, F. Langenhorst, R.A.F. Grieve, 2000, *Episodes* 23(1), 3, "**Popigai**, Siberia - well preserved giant impact structure, national treasury, and world's geological heritage." See: http://en.wikipedia.org/wiki/Popigai_crater
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	"Spurious periods in the terrestrial impact crater record." See: http://adsabs.harvard.edu/abs/2000A%26A...353..409J
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2000, Jan	D.A. Kring, 2000, *GSA Today*, 10(8), 1, "Impact events and their effects on the origin, evolution and distribution of life." See: http://www.geosociety.org/pubs/gsatoday/archive/sci0008.htm http://www.lpi.usra.edu/science/kring/cataclysm_concept.pdf
2000, Jan 1	The University of Pisa puts its **NEO Close Approach Monitoring system (CLOMON)** on-line. See: http://newton.dm.unipi.it/neodys/
2000, Jan 13	D.C. Jewitt, 2000, *Nature*, 403, 145, "Eyes wide shut." See: http://adsabs.harvard.edu/abs/2000Natur.403..145J http://www.nature.com/nature/journal/v403/n6766/full/403145a0.html http://impact.arc.nasa.gov/news_detail.cfm?ID=44 http://www.bibliotecapleyades.net/ciencia/ciencia_nemesis09.htm
2000, Jan 13	D. Rabinowitz, E. Helin, K. Lawrence, S. Pravdo, 2000, *Nature*, 403, 165, "A reduced estimate of the number of kilometre-sized near-Earth asteroids". See: http://adsabs.harvard.edu/abs/2000Natur.403..165R
2000, Jan 18	The **Tagish Lake Meteorite** exploded in the upper atmosphere at an estimated altitude of ~ 40 km with an energy of 1.7 kT TNT over Tagish Lake (Yukon Territory and northern British Columbia, Canada). A fireball was observed and over 500 fragments of meteorite collected. The **Tagish Lake meteoroid** is estimated to have been of $D \approx 4.5$ m in diameter and $M \approx 75$ tons in weight before it entered the Earth's atmosphere. It is estimated that only 1.3 tons remained after ablation in the upper atmosphere and several fragmentation events, meaning that around 97% of the meteorite had vaporized. Of these 1.3 tons of fragmented rock, only 0.1% was found and collected. Studies of the reflectance spectrum of the meteorite indicate that it likely originated from **773 Irmintraud**, a D-type main-belt asteroid. Ref: - T. Hiroi, M.E. Zolensky, C.E. Pieters, 2001, *Science*, 293, 2234, "The **Tagish Lake Meteorite**: a possible sample from a D-type asteroid." See: http://adsabs.harvard.edu/abs/2001Sci...293.2234H

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2000, Jan 23	NASA/ESA spacecraft ***Cassini/Huygens*** took pictures of Main-belt asteroid **2685 Masursky (1981 JN**, H = 12.1, D = 13 km**)**. See: 1981 JN - JPL , 2685 Masursky - SSA See also: http://ciclops.org/view/76/Masursky_Flyby?js=1 http://uanews.org/node/2841 http://www.nasa.gov/pdf/474203main_Coradini_ExploreNOW.pdf https://en.wikipedia.org/wiki/2685_Masursky
2000, Jan 24	Apollo NEA **2019 BZ** (H = 27.7 mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 4.73 LD. Minimum miss distance 0.53 LD**.** See: 2019 BZ - JPL , 2019 BZ - SSA See also: **28 Jul 1998**.
2000, Feb	The **Japanese Spaceguard Association (JSGA)** starts operations at **Bisei Spaceguard Center** (0.5 m and 1.0 m telescopes), Bisei (Japan). Ref: - M. Yoshikawa, A. Asami, D. Asher, et al., 2002, *Memorie della Società Astronomica Italiana*, 73, 772, "Current status of asteroid observations in **Bisei Spaceguard Center**." See: http://adsabs.harvard.edu/abs/2002MmSAI..73..772Y
2000, Feb	P. Michel, V. Zappalà, A. Cellino, P. Tanga, 2000, *Icarus*, 143, 42, "Estimated abundance of Atens and asteroids evolving on orbits between Earth and Sun." This paper defines the Inner-Earth Objects (IEOs). See: http://adsabs.harvard.edu/abs/2000Icar..143..421M
2000, Feb	C.R. Chapman, 2000, in: D. Sarewitz, R.A. Pielke, R. Byerly (eds.), *Prediction: Science, Decision Making, and the Future of*

	Nature (Washington DC: Island Press), p. 107, "The asteroid/comet impact hazard: homo sapiens as dinosaur?" See: http://www.boulder.swri.edu/clark/ncar799.html http://impact.arc.nasa.gov/news_detail.cfm?ID=57
2000, Mar	Between August 1972 and March 2000, the US Air Force ***Early Warning Satellites*** sensors detected 518 impact events (~30 events per year) in the > 1kT TNT class, i.e. impacts of objects with $D \approx$ few meters. Most of these events were primarily bursts in the upper atmosphere and were not detected at ground level. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=43
2000, Mar	D.W. Dunham, B. Cudnik, D.M. Palmer, et al., 2000, in: *31st Annual Lunar and Planetary Science Conference*, March 13-17, 2000, Houston (Texas, USA), abstract no. 1547, "The first confirmed video recordings of lunar meteor impacts." See: http://adsabs.harvard.edu/abs/2000LPI....31.1547D
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2000, Apr 20	D.K. Yeomans, 2000, *Nature*, 404, 829, "Small bodies of the Solar System." See: http://adsabs.harvard.edu/abs/2000Natur.404..829Y
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2000, May	S.N. Ward, E. Asphaug, 2000, *Icarus*, 145, 64, "Asteroid impact tsunami: a probabilistic hazard assessment." See: http://adsabs.harvard.edu/abs/2000Icar..145...64W
2000, May 6	**Morávka (Czech Republic) Meteorite Fall**. Occurred on May 6, 2000, 11:52 UT, during the daytime. Six H56 ordinary chondrites with a total mass of 1.4 kg were recovered. The corresponding fireball was witnessed by thousands of people and video-taped by three casual witnesses. Sonic booms were recorded by 16 seismic stations in the Czech Republic and Poland and by one infrasonic station in Germany. See: https://www.lpi.usra.edu/meteor/metbull.php?code=16742 Ref: - J. Borovička, P. Spurný, P. Kalenda, E. Tagliaferri, 2003, *Meteoritics & Planetary Science*, 38, 975, "The **Morávka meteorite fall**. 1. Description of the events and determination of the fireball trajectory and orbit from video records." See: http://adsabs.harvard.edu/abs/2003M%26PS...38..975B
2000, May 16	"Near-Earth Object meeting has quite an impact." Representatives of ESA and other European organizations gathered in Paris to discuss the threat from Near-Earth Objects (NEOs). Non-ESA participants included the General Secretary of the International Astronomical Union (IAU), delegates from several ESA member states, experts from a number of astronomical observatories

	including the European Southern Observatory (ESO), and a representative from the European Community. The purpose of the meeting was to define a European strategy for the protection of the planet from Near-Earth Objects – asteroids and comets which pass close to the Earth's orbit. See: http://astronomy 2009.esa.int/science-e/www/object/index.cfm?fobjectid=19110
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2000, Jul 9-12	***International conference on Catastrophic Events & Mass Extinctions: Impacts and Beyond***, 9-12 Jul 2000, Vienna (Austria). Proceedings: C. Koeberl & K.G. MacLeod (eds.), 2002, *Geological Society of America Special Papers*, Vol. 356, "Catastrophic events and mass extinctions: impacts and beyond." See: http://specialpapers.gsapubs.org/content/356 See: http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=2001ceme.conf.3142O&db_key=AST See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=46
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2000, Aug 14	**IAU XXIV General Assembly**, Manchester (UK). Division III ***Working Group on Near-Earth Objects (WG-NEO) meeting***. Report by David Morrison, chair of the WG. Ref: - H. Rickman (ed.), 2001, IAU WG-NEO Report, *Transactions*

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2000, Sep 22	R.P. Binzel, 2000, *Science*, 289, 2065, "Asteroids come of age." See: http://www.sciencemag.org/content/289/5487/2065.summary?sid=07315ef2-c90b-4465-839a-dc2946cc0fbc
2000, Oct	D. Vokrouhlický, A. Milani, 2000, *Astronomy & Astrophysics*, 362, 746, "Direct solar radiation pressure on the orbits of small near-Earth asteroids: observable effects?" See: http://adsabs.harvard.edu/abs/2000A%26A...362..746V
2000, Oct 5	D. Vokrouhlický, P. Farinella, 2000, *Nature*, 407, 606, "Efficient

	delivery of meteorites to the Earth from a wide range of asteroid parent bodies." See: http://adsabs.harvard.edu/abs/2000Natur.407..606V
2000, Oct 10	Apollo NEA **2020 GB1** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 2.79 LD. Minimum miss distance 0.02 LD. See: 2020 GB1 – S2P , 2020 GB1 – JPL See also: **7 Apr 2035**.
2000, Oct 19	Aten NEA **2015 UH52** (*H* = 26.2 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 3.49 LD. Minimum miss distance 0.34 LD**.** See: 2015 UH52 - JPL , 2015 UH52 - SSA See also: **20 Oct 1989**, **20 Oct 2052**.
2000, Oct 31	Apollo NEA **4179 Toutatis** (**1989 AC**, *H* = 15.2 mag, *D* = 4.6×2.4×1.9 km, orbital *P* = 4.03 yr, **PHA**) passed Earth at 28.7 LD. It is the largest known **PHA**. See: 1989 AC - JPL , 4179 Toutatis - SSA http://en.wikipedia.org/wiki/4179_Toutatis Ref: - R.S. Hudson, S.J. Ostro, D.J. Scheeres, 2003, *Icarus*, 161, 346, "High-resolution model of asteroid **4179 Toutatis**." See: http://adsabs.harvard.edu/abs/2003Icar..161..346H See also: http://science.nasa.gov/science-news/science-at-nasa/2000/ast31oct_1/ http://newton.dm.unipi.it/neodys/index.php?pc=1.1.8&n=Toutatis See also: **8 Dec 1992**, **30 Nov 1996**, **29 Sep 2004**, **9 Nov 2008**, **12 Dec 2012**, **5 Nov 2069**.
2000, Nov	R.S. Hudson, S.J. Ostro, R.F. Jurgens, et al., 2000, *Icarus*, 148, 37, "Radar observations and physical model of asteroid **6489 Golevka.**" See: http://adsabs.harvard.edu/abs/2000Icar..148...37H **6489 Golevka**, **1991 JX**, *H* = 18.9 mag, *D* ≈ 350 x 250 x 250 m, Apollo NEA, **PHA**. See: 1991 JX - JPL , 6489 Golevka - SSA
2000, Nov	P. Pravec, A.W. Harris, 2000, *Icarus*, 148, 12, "Fast and slow rotating asteroids." See: http://adsabs.harvard.edu/abs/2000Icar..148...12P
2000, Nov	D.P. Rubincam, 2000, *Icarus*, 148, 2, "Radiative spin-up and spin-down of small asteroids." See: http://adsabs.harvard.edu/abs/2000Icar..148....2R

2000, Nov	J. Tate, 2000, *Space Policy*, 16(4), 261, "Avoiding collisions: the **Spaceguard Foundation**." See: http://www.sciencedirect.com/science/article/pii/S0265964600000369
2000, Nov	D. Vokrouhlický, A. Milani, S.R. Chesley, 2000, *Icarus*, 148, 118, "Yarkovsky effect on small Near-Earth Asteroids: mathematical formulation and examples." See: http://adsabs.harvard.edu/abs/2000Icar..148..118V
2000, Dec 17	Apollo NEA **2020 XF4** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 6.52 LD. Minimum miss distance 0.44 LD. See: 2020 XF4 – S2P , 2020 XF4 – JPL See also: **16 Dec 2020**.
2001, Jan 1	**1241 NEAs** known, of which **291 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2001	The **CINEOS** program (**Campo Imperatore Near Earth Object Survey)**, which started in 2001, is dedicated to the discovery and follow-up of Near Earth Objects with a 90-cm Schmidt telescope. Between October 2001 and November 2004 **CINEOS** measured more than 6,1000 asteroid positions and discovered almost 2,200 new objects, including six NEOs and one Centaur (planetoid). Ref: - F. Bernardi, A. Boattini, G. D'Abramo, 2002, in B. Warmbein (ed.), 2002, Proc. *Asteroids, Comets, Meteors - ACM 2002*, 29 July - 2 August 2002, Berlin (Germany), ESA SP-500, p. 801, **"The Campo Imperatore Near Earth Objects Survey (CINEOS)."** See: http://adsabs.harvard.edu/abs/2002ESASP.500.....W - A. Boattini, G. D'Abramo, G.B. Valsecchi, et al., 2007, *Earth, Moon and Planet*, 100, 259, **"The Campo Imperatore Near Earth Objects Survey (CINEOS)."** See: http://adsabs.harvard.edu/abs/2007EM%26P..100..259B See also: http://en.wikipedia.org/wiki/Campo_Imperatore_Near-Earth_Object_Survey
2001	Steps towards a NEO survey program in the southern hemisphere: **Búsqueda Uruguaya de Supernovas, Cometas y Asteroides (BUSCA)**, in cooperation with the **South American Spaceguard Association**, with telescopes in Argentina, Brazil, Paraguay and Uruguay. A new 46-cm telescope of the Observatorio Astronómico Los Molinos (Uruguay) is expected to be operational in early 2002. Ref: - G. Tancredi, A. Sosa, E. Acosta, et al. 2004, in: W. Wamsteker, R.

	Albrecht, H. Haubold (eds.), *Developing Basic Space Science World-Wide. A Decade of UN/ESA Workshops* (Dordrecht: Kluwer), p. 137, "The Uruguayan automated and robotic telescope **BUSCA**." See: http://adsabs.harvard.edu/abs/2004dbss.book..137T See also: http://oalm.astronomia.edu.uy/proyectos/busca/NEOSurvey.htm
2001	A.W. Harris, 2001, in: M. Marov, H. Rickman (eds.), *Collisional processes in the Solar System* (Dordrecht: Kluwer), p. 323, "Near-Earth Asteroid surveys." See: http://adsabs.harvard.edu/abs/2001ASSL..261..323H
2001	S. Isobe, 2001, *Advances in Space Research*, 28, 1139, "Short warning time for an NEA collision." See: http://adsabs.harvard.edu/abs/2001AdSpR..28.1139I
2001	C. Koeberl, 2001, *Earth, Moon and Planets*, 85-86, 209, "Craters on the Moon from Galileo to Wegener: a short history of the impact hypothesis, and implications for the study of terrestrial impact craters." See: http://adsabs.harvard.edu/abs/2001EM%26P...85..209K
2001	M. Marov, H. Rickman (eds.), 2001, *Collisional processes in the Solar System* (Dordrecht: Kluwer). See: http://adsabs.harvard.edu/abs/2001ASSL..261.....M
2001	S.D. Price, M.P. Egan, 2001, *Advances in Space Research*, 28, 1117, "Spaced based infrared detection and characterization of Near Earth Objects." See: http://adsabs.harvard.edu/abs/2001AdSpR..28.1117P
2001	A. Morbidelli, 2001, in: M. Marov, H. Rickman (eds.), *Collisional processes in the Solar System* (Dordrecht: Kluwer), p. 289, "Origin and evolution of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2001ASSL..261..289M
2001, Jan	A. Cellino, 2001, *Advances in Space Research*, 28, 1103, "Physical properties of near-earth objects: open problems." See: http://adsabs.harvard.edu/abs/2001AdSpR..28.1103C
2001, Jan 1	**Spaceguard Survey** update, ~50% of asteroids with $D > 1$ km discovered. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=31
2001, Jan 15	Aten NEA **2001 BA16** ($H = 26.5$ mag, $D \approx 18$ m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.79

	LD. **[2001-01]** See: 2001 BA16 - JPL , 2001 BA16 - SSA See also: **17 Jan 1960**.
2001, Jan 18	**Perseid Meteor Shower** recorded at Wise Observatory (Israel). See: http://apod.nasa.gov/apod/ap050812.html
2001, Jan 19	**NEO - MIPA *Near-Earth Object hazard mitigation publication analysis***, performed for ESA-ESOC. See: http://www.tu-dresden.de/mwilr/space/rfs/Dokumente/Publikationen/NEO-MIPA-report.pdf
2001, Feb	**Asiago DLR Asteroid Survey (ADAS)** began observations at Asiago-CimaEkar, a joint venture between the Department of Astronomy of the University of Asiago (Italy), the Astronomical Observatory of Padua (Italy), and the DLR Institute of Space Sensor Technology and Planetary Exploration, Berlin-Adlershof (Germany). The system uses a 2K x 2K CCD detector and a 0.6 m aperture Schmidt telescope. 108 asteroids discovered in 2001 – 2002. See: http://dipastro.pd.astro.it/planets/adas/ http://neo.jpl.nasa.gov/programs/adas.html
2001, Feb 12	Touch down of NASA spacecraft ***Near Earth Asteroid Rendezvous – Shoemaker*** (***NEAR – Shoemaker***), launched 17 February 1996, on Amor NEA **433 Eros** (**A898 PA**, $H = 11.16$ mag, $D = 34.4 \times 11.2 \times 11.2$ km, orbital $P = 1.76$ yr) in the "saddle region." Radio contact with ***NEAR– Shoemaker*** was lost on 28 February 2001. See: 1898 DQ - JPL , 433 Eros - SSA Ref: - D.K. Yeomans, P.G. Antreasian, J.-P. Barriot, et al., 2000, *Science*, 289, 2085, "Radio science results during the ***NEAR-Shoemaker*** spacecraft rendezvous with **Eros**." See: http://adsabs.harvard.edu/abs/2000Sci...289.2085Y - E. Asphaug, September 2001, *Nature*, 413, 369, "Once upon an asteroid." See: http://adsabs.harvard.edu/abs/2001Natur.413..369A - J. Veverka, B. Farquhar, M. Robinson, et al., 2001, *Nature*, 413, 390, "The landing of the ***NEAR-Shoemaker*** spacecraft on asteroid **433 Eros**." See: http://adsabs.harvard.edu/abs/2001Natur.413..390V - J. Veverka (ed.), 2002, *Icarus*, 155, 1, "***Near*** at **Eros**." See: http://adsabs.harvard.edu/abs/2002Icar..155....1V - D.W. Dunham, R.W. Farquhar, J.V. McAdams, et al., *Icarus*,

	159, 433, "Implementation of the first asteroid landing." See: http://adsabs.harvard.edu/abs/2002Icar..159..433D - C.R. Chapman, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 104, "What we know and don't know about surfaces of potentially hazardous small bodies." See: http://adsabs.harvard.edu/abs/2004mhca.conf..104C See also: http://near.jhuapl.edu/ http://near.jhuapl.edu/media/NEAR_fact_sheet.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=40 http://impact.arc.nasa.gov/news_detail.cfm?ID=101 http://nssdc.gsfc.nasa.gov/planetary/news/near_descent_pr_20010131.html http://www.scientificamerican.com/article.cfm?id=come-closer-my-near http://www.scientificamerican.com/article.cfm?id=nearing-a-crash-landing http://www.scientificamerican.com/article.cfm?id=close-encounter http://antwrp.gsfc.nasa.gov/apod/ap070217.html http://antwrp.gsfc.nasa.gov/apod/ap090607.html http://www.wired.com/wiredscience/2012/05/manned-asteroid-flyby-mission-1966/ http://en.wikipedia.org/wiki/433_Eros
2001, Feb 12	Number 1 issue of ***Tumbling Stone***, on-line scientific magazine about NEOs, published by the **Spaceguard Foundation** and **NEODyS**. Discontinued after Number 25, 20 May 2004. See: http://spaceguard.iasf-roma.inaf.it/tumblingstone/index.html
2001, Feb 23	New asteroid survey telescope proposed: the **LSST**. See: **2021**. See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=30 http://www.lsst.org/lsst
2001, Feb 24	C.R. Chapman, D.D. Durda, R.E. Gold, 2001, "The comet/asteroid impact hazard: a systems approach." See: http://www.internationalspace.com/pdf/NEOwp_Chapman-Durda-Gold.pdf
2001, Feb 26	Apollo NEA **2001 EC**, $H = 18.9$ mag, $D \approx 600$ m, **PHA**) passed Earth at a nominal miss distance of 3.83 LD. Minimum miss distance 3.83 LD. See: 2001 EC - JPL , 2001 EC - SSA
2001, Mar	A.R. Hildebrand, K.A. Carroll, D.D. Balam, et al., 2001, presented at *32nd Annual Lunar and Planetary Science Conference*, 12-16 March 2001, Houston (TX, USA), abstract no.1790, "The ***Near-Earth Space Surveillance*** (***NESS***) mission: discovery, tracking,

	and characterization of asteroids, comets, and artificial satellites with a microsatellite." See: http://adsabs.harvard.edu/abs/2001LPI....32.1790H
2001, Mar	A. Morbidelli, J.-M. Petit, B. Gladman, J. Chambers, 2001, *Meteoritics & Planetary Science*, 36, 371, "A plausible cause of the Late Heavy Bombardment." See: http://adsabs.harvard.edu/abs/2001M%26PS...36..371M
2001, Mar 5	Apollo NEA **29075** (**1950 DA**, *H* = 17.5 mag, *D* ≈ 2000 m, **PHA**) passed Earth at 0.05 AU (= 20.3 LD). It will pass Earth closely on **16 March 2880**. See: 1950 DA - JPL , 29075 1950 DA - SSA Ref: - J.D. Giorgini, S.J. Ostro, L.A.M. Benner, et al., 2002, *Science*, 296, 132, "Asteroid **1950 DA's** encounter with Earth in **2880**: physical limits of collision probability prediction." See: http://adsabs.harvard.edu/abs/2002Sci...296..132G - D. Farnocchia, S.R. Chesley, 2014, *Icarus*, 229, 321, "Assessment of the 2880 impact threat from asteroid **(29075) 1950 DA**." See: http://adsabs.harvard.edu/abs/2014Icar..229..321F See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=111 https://cneos.jpl.nasa.gov/doc/1950da/ http://en.wikipedia.org/wiki/(29075)_1950_DA See also: **16 Mar 2880.**
2001, Mar 27	Apollo NEA **2012 FP35** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 9.43 LD. Minimum miss distance 0.15 LD. See: 2012 FP35 - JPL , 2012 FP35 - SSA See also: https://en.wikipedia.org/wiki/2012_FP35
2001, Apr	G. Neukum, B.A. Ivanov, W.K. Hartmann, 2001, *Space Science Reviews*, 96, 55, "Cratering records in the inner solar system in relation to the Lunar Reference System." See: http://link.springer.com/article/10.1023%2FA%3A1011989004263
2001, May	D.F. Lupishko, T.A. Lupishko, 2001, *Solar System Research*, 35, 227, "On the origins of Earth-approaching asteroids." See: http://adsabs.harvard.edu/abs/2001SoSyR..35..227L
2001, May 12	New evidence indicates that the Triassic-Jurassic mass extinction 200 Myr ago was sudden, consistent with possible impact

	mechanism. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=23 http://en.wikipedia.org/wiki/Triassic%E2%80%93Jurassic_extinction_event
2001, May 25	Binary Aten NEA **66391** (**1999 KW4**, *H* = 16.9 mag, *D* ≈ 1600 m, **PHA**) passed Earth at 12.58 LD. Minimum miss distance 12.58 LD. See: 1999 KW4 - JPL , 66391 1999 KW4 - SSA A team of astronomers studied images that show the trail of a smaller component orbiting a larger component, images made with the **70-m Goldstone radar antenna** in California's Mojave Desert. The system is the third binary near-Earth asteroid pair revealed by radar, but the first system imaged over a complete orbit of one component around the other. Steven J. Ostro of NASA's Jet Propulsion Laboratory in Pasadena (CA, USA), leader of the team that made the discovery: *"**Goldstone** was able to track the asteroid for up to eight hours daily for a week. Then we made close-up images of each component using the **Arecibo telescope** in Puerto Rico, which is not as fully steerable but is much more powerful."* Ref: - S.J. Ostro, J.-L. Margot, L.A.M. Benner, et al., 2006, *Science*, 314, 1276, "Radar imaging of binary Near-Earth Asteroid (**66391**) **1999 KW4**." See: http://adsabs.harvard.edu/abs/2006Sci...314.1276O - A.W. Harris, E.G. Fahnestock, P. Pravec, 2009, *Icarus*, 199, 310, "On the shapes and spins of "rubble pile" asteroids." See: http://adsabs.harvard.edu/abs/2009Icar..199..310H See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=2 http://impact.arc.nasa.gov/news_detail.cfm?ID=169 http://www.planetary.org/radio/show/00000216/ http://en.wikipedia.org/wiki/(66391)_1999_KW4 See also: **25 May 2019, 27 May 2071**.
2001, Jun	R.P. Binzel, A.W. Harris, S.J. Bus, T.H. Burbine, 2001, *Icarus*, 151, 139, "Spectral properties of Near-Earth Objects: Palomar and IRTF results for 48 objects including spacecraft targets (**9969**) **Braille** and (**10302**) **1989 ML**." NEOs show a greater spectral diversity than main-belt asteroids. See: http://adsabs.harvard.edu/abs/2001Icar..151..139B
2001, Jun 11-16	**International meeting *Asteroids 2001: From Piazzi to the 3rd Millennium* (*Asteroids III*),** Palermo (Sicily, Italy). Proceedings: W.F. Bottke, A. Cellino, P. Paolicchi & R.P. Binzel (eds.), 2002, *Asteroids III* (Tucson: Univ. Arizona Press).

	See: http://adsabs.harvard.edu/abs/2002aste.conf.....B
2001, Jun 17-25	**Workshop on *Physical Properties Of Potential Earth Impactors: Know Your Enemy***, Erice (Sicily, Italy). Proceedings: W.F. Huebner, J.M. Greenberg (eds.), 2002, *Meteoritics & Planetary Science*, 37, "Erice Workshop Summary on Physical and Chemical Properties of Potential Earth Impactors." See: http://adsabs.harvard.edu/abs/2002M%26PS...37.1642H http://www.ccsem.infn.it/ccsem01/Greenberg01.html
2001, Jul	G.F. Gronchi, 2001, *Icarus*, 152, 58, "Proper elements for Earth-crossing asteroids." See: http://adsabs.harvard.edu/abs/2001Icar..152...58G
2001, Jul 23	**Bright meteor fireball over central Pennsylvania** (USA) seen from the ground and space (by DoD satellites), tracked from an altitude of 82 km down to 32 km. Evaporated object had initial mass $M \approx 30 - 90$ ton. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=1 http://www.space.com/scienceastronomy/solarsystem/meteor_eastcoast_010725.html
2001, Aug	A. Boattini, G. D'Abramo, G. Forti, R. Gal, 2001, *Astronomy & Astrophysics*, 375, 293, ***"The Arcetri NEO precovery program."*** See: http://adsabs.harvard.edu/abs/2001A%26A...375..293B
2001, Aug	J.L. Remo, H.J. Haubold, 2001, *Space Policy*, 17, 213, "NEO scientific and policy developments, 1995–2000." See: http://adsabs.harvard.edu/abs/2001SpPol..17..213R
2001, Sep	M.C. Nolan, E. Asphaug, R. Greenberg, H.J. Melosh, 2001, *Icarus*, 153, 1, "Impacts on asteroids: fragmentation, regolith transport, and disruption." See: http://adsabs.harvard.edu/abs/2001Icar..153....1N
2001, Sep	G. D'Abramo, A.W. Harris, A. Boatini, S.C. Werner, A.W. Harris, G.B. Valsecchi, 2001, *Icarus*, 153, 214, "A simple probabilistic model to estimate the population of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2001Icar..153..214D
2001, Sep 11-15	**4th International Conference on *Space Protection of the Earth* (SPE-2001)**, Evpatoriya (Ukraine).
2001, Oct	S.V. Jeffers, S.P. Manley, M.E. Bailey, D.J. Asher, 2001, *Monthly Notices of the Royal Astronomical Society*, 327, 126, "Near-Earth

	object velocity distributions and consequences for the **Chicxulub impactor**." See: http://adsabs.harvard.edu/abs/2001MNRAS.327..126J
2001, Oct 20	**B612 Foundation founding workshop on *Deflecting Asteroids***, NASA Johnson Space Center, Houston (TX, USA), organized by Ed Lu and Piet Hut. Named after the asteroid featuring in the novel *Le Petit Prince* (Antoine de Saint Exupéry, 1943, Paris: Editions Gallimard), **B612** is a think-tank and lobby group set up by Apollo 9 astronaut Russell L. Schweickart to further the Earth's protection against asteroid strikes. See: http://www.b612foundatiom.org/b612 Ref: - D. Chandler, 2008, *Nature,* 453, 1164, "The burger bar that saved the world." See: http://www.nature.com/news/2008/080625/full/4531164a.html See also: http://www.b612foundation.org/about/history.html http://www.sns.ias.edu/~piet/act/geo/deflection/index.html
2001, Oct 23 – 26	**International Workshop on *Collaboration and Coordination among NEO Observers and Orbital Computers***, Kurashiki (Okayama, Japan), organized by the **Japan Spaceguard Association**. Proceedings: S. Isobe & Y. Asakura (eds.), 2001. See: http://www.spaceguard.or.jp/SGFJ/ws2001/kurashiki.pdf
2001, Oct 24	Aten NEA **2010 FN** (H = 26.4 mag, $D \approx$ 18 m) passed Earth at a nominal miss distance of 9.54 LD. Minimum miss distance 0.64 LD. See: 2010 FN - JPL , 2010 FN - SSA See also: **24 Mar 2074**.
2001, Nov	J.S. Stuart, 2001, *Science*, 294, 1691, "A Near-Earth Asteroid population estimate from the **LINEAR Survey**." See: http://adsabs.harvard.edu/abs/2001Sci...294.1691S The NEA population is more highly inclined than previously estimated, and the total number of kilometer-sized NEAs is estimated at 1227_{-90}^{+170} (1σ).
2001, Nov 8	Apollo NEA **2017 VW13** (H = 20.6 mag, $D \approx$ 270 m, **PHA**) passed Earth at a nominal miss distance of 0.37 LD. Minimum miss distance 0.32 LD. **[2001-02]** See: 2017 VW13 - JPL , 2017 VW13 - SSA
2001, Nov 17	**Trans-Carpathians Fireball**. The bolide, **EN171101**, which entered the atmosphere near the village Turýi Remety in the Trans-Carpathians (Ukraine) was photographed by the Czech and

	Slovakia chambers of the **European Bolide Network**. The length of the luminous track reached 107 km, starting at an altitude of 81 km. The initial mass was estimated at 4500 kg. Ref: - K.I. Churyumov, R.A. Belevtsev, E.V. Sobotovich, et al., 2010, in: J.A. Fernández, et al. (eds.), *Icy Bodies of the Solar System*, Proc. IAU Symp. No. 263, Rio de Janeiro (Brazil) 3-7 August 2009 (Cambridge: CUP), p. 244, "Magnetic microspheric particles from bright bolide of **EN171101**, exploded above the Trans-Carpathians mountains on November 17, 2001." See: http://adsabs.harvard.edu/abs/2010IAUS..263..244C
2001, Nov 18	**Fireball, Smoke Trail, Meteor Storm**, over Spruce Knob (WV, USA). See: http://apod.nasa.gov/apod/ap011122.html
2001, Nov 18	**Leonids Meteor Shower Fireball**, over Hawaii (USA). See: http://apod.nasa.gov/apod/ap011119.html
2001, Nov 23	J.S. Stuart, 2001, *Science*, 294, 1691, "A Near-Earth Asteroid population estimate from the **LINEAR survey**." See: http://adsabs.harvard.edu/abs/2001Sci...294.1691S See also: http://www.sciencemag.org/content/294/5547/1691.full.pdf http://www.scientificamerican.com/article.cfm?id=new-studies-sharpen-pictu
2001, Nov 23	W.F. Bottke, D. Vokrouhlický, M. Brož, D. Nesvorný, A. Morbidelli, 2001, *Science*, 294, 1693, "Dynamical spreading of asteroid families by the Yarkovsky Effect." See: http://adsabs.harvard.edu/abs/2001Sci...294.1693B See also: http://www.scientificamerican.com/article.cfm?id=new-studies-sharpen-pictu
2001, Nov 23	P. Michel, W. Benz, P. Tanga, D.C. Richardson, 2001, *Science*, 294, 1696, "Collisions and gravitational re-accumulation: forming asteroid families and satellites." See: http://adsabs.harvard.edu/abs/2001Sci...294.1696M See also: http://www.scientificamerican.com/article.cfm?id=new-studies-sharpen-pictu
2001, Dec 16	Aten NEA **33342** (**1998 WT24**, $H = 18.3$ mag, $D \approx 415$ m, **PHA**) passed Earth at a nominal miss distance of 4.86 LD. Minimum miss distance 4.86 LD. See: 1998 WT24 - JPL , 1998 WT24 - SSA

	See also: http://neo.jpl.nasa.gov/images/1998wt24.html http://science.nasa.gov/science-news/science-at-nasa/2001/ast14dec_1/ http://www.jpl.nasa.gov/news/news.php?feature=4800 https://en.wikipedia.org/wiki/(33342)_1998_WT24 See also: **16 Dec 1908, 16 Dec 1956, 11 Dec 2015, 18 Dec 2099**
2002, Jan 1	**1683 NEAs** known, of which **373 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2002	Russian and Ukrainian organizations founded the **Planetary Defence Centre** (Khimki-2, Moscow, Russian Federation) as a nonprofit-making partnership, with a view to combining the efforts of organizations and experts working in various fields towards the establishment of a planetary defence system. The activities of the **Planetary Defence Centre** are based on the conceptual design for the **'Citadel Planetary Defence System'**, which has been approved by the Centre's member organizations. See: http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_863Add1E.pdf http://www.unoosa.org/pdf/pres/stsc2010/tech-43.pdf
2002	W.F. Bottke, A. Cellino, P. Paolicchi & R.P. Binzel (eds.), 2002, *Asteroids III*, Proceedings International meeting *Asteroids 2001: From Piazzi to the 3rd Millennium*, Palermo (Sicily, Italy), 11-16 June 2001 (Tucson: Univ. Arizona Press). See: http://adsabs.harvard.edu/abs/2002aste.conf.....B **Among the papers:** - A. Milani, S.R. Chesley, P.W. Chodas, G.B. Valsecchi, 2002, p. 55, "Asteroid close approaches: analysis and potential impact detection." See: http://adsabs.harvard.edu/abs/2002aste.book...55M https://cneos.jpl.nasa.gov/doc/milani_impact_paper.html - G.H. Stokes, J.B. Evans, S.M. Larson, 2002, p. 45, "Near-Earth Asteroid search programs." See: http://adsabs.harvard.edu/abs/2002aste.conf...45S http://www.lpi.usra.edu/books/AsteroidsIII/pdf/3037.pdf
2002	C. Koeberl, K.G. MacLeod (eds.), 2002, Proceedings ***International conference on Catastrophic Events & Mass Extinctions: Impacts and Beyond***, 9-12 Jul 2000, Vienna (Austria), *Geological Society of America Special Papers*, Vol. 356, "Catastrophic events and mass extinctions: impacts and beyond." See: http://specialpapers.gsapubs.org/content/356 See: http://adsabs.harvard.edu/abs/2002caev.book.....K See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=46

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2002, Jan 7	Apollo NEA **2001 YB5** (*H* = 20.4 mag, *D* ≈ 290 m, **PHA**) passed Earth at a nominal miss distance of 2.16 LD. Minimum miss distance 2.16 LD. See: 2001 YB5 - JPL , 2001 YB5 - SSA

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2002, Jan 22	Apollo NEA **4660 Nereus** (**1982 DB**, H = 18.5 mag, D = 510 x 330 x 240 m, **PHA**) passed Earth at 11.30 LD. Minimum miss distance 11.30 LD. See: 1982 DB - JPL , 4660 Nereus - SSA Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B - K. Kitazato, S. Abe, M. Ishiguro, et al., October 2012, American Astronomical Society, DPS meeting #44, #210.20, "Measuring the YORP effect of asteroid **4660 Nereus**." See: http://adsabs.harvard.edu/abs/2012DPS....4421020K See also: http://en.wikipedia.org/wiki/4660_Nereus See also: **29 Jan 1900**, **11 Dec 2021**, **14 Feb 2060, 4 Feb 2071**, **23 Dec 2112**, **4 Feb 2166**.
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2002, Mar 8	Aten NEA **2002 EM7** (H = 25.0 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 1.21 LD (and the Moon at 0.4 LD). Minimum miss distance 1.21 LD. See: 2002 EM7 - JPL , 2002 EM7 - SSA See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=114
2002, Mar 12	**NASA's Near-Earth Object Program Office** at JPL puts its **SENTRY** automatic approach monitoring system on-line, complementary to the **NEODyS CLOMON2** (Pisa, Italy) close approach monitoring system. Ref: - A.B. Chamberlin, S.R. Chesley, P.W. Chodas, J.D. Giorgini, M.S. Keesey, R.N. Wimberly, D.K. Yeomans, 2001, *Bull. Am. Astron. Soc.*, "SENTRY: an automated close approach monitoring

	system for Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2001DPS....33.4108C See also: http://neo.jpl.nasa.gov/news/news126.html http://impact.arc.nasa.gov/news_detail.cfm?ID=110
2002, Mar 24	Apollo NEA **2021 FP2** (H = 30.1 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 1.62 LD. Minimum miss distance 0.32 LD. See: 2021 FP2 – S2P , 2021 FP2 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **2021 Mar 23**.
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2002, Apr	**UK Near Earth Object Information Centre (NEOIC)** operational, based at the British National Space Center in Leicester (UK). See: http://www.bnsc.gov.uk/ http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_863Add1E.pdf
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2002, Apr 6	**Neuschwanstein meteorite** detected by the **European Fireball Network**. Fell to Earth near Neuschwanstein Castle, Bavaria, at the Germany-Austria border. The original meteorite burst into several fragments at a height of about 22 kilometers above the ground. The fragments descended on an area of several square kilometers. Three fragments were recovered with a total mass of about six kilograms.

	Ref: - P. Spurný, J. Oberst, D. Heinlein, 2003, *Nature*, 423, 151, "Photographic observations of **Neuschwanstein**, a second **meteorite** from the orbit of the Příbram chondrite." See: http://adsabs.harvard.edu/abs/2003Natur.423..151S - J. Oberst, D. Heinlein, U. Köhler, P. Spurný, 2004, *Meteoritics & Planetary Science*, 39, 1627, "The multiple **meteorite fall of Neuschwanstein**: Circumstances of the event and meteorite search campaigns". See: http://adsabs.harvard.edu/abs/2004M%26PS...39.1627O See also: http://en.wikipedia.org/wiki/Neuschwanstein_(meteorite)
2002, Apr 24	Atira NEA **434326** (**2004 JG6**, H = 18.7 mag, $D \approx$ 700 m, **PHA**) passed Earth at 16.79 LD. Minimum miss distance 16.79 LD. See: 2004 JG6 - JPL , 2004 JG6 - SSA , This NEA has the smallest orbit known around the Sun (P = 184.9 days). See also: http://www.spacedaily.com/news/asteroid-04g.html http://adsabs.harvard.edu/abs/2004S%26T...108c..18M http://en.wikipedia.org/wiki/2004_JG6
2002, May 4-11	European Science Foundation Research Networking Programme **Response of the Earth System to Impact Processes (IMPACT),** Short Course on *Impact Stratigraphy*, Osservatorio Geologico do Coldigioco (Italy). See: http://www.esf.org/activities/research-networking-programmes/life-earth-and-environmental-sciences-lesc/completed-esf-research-networking-programmes-in-life-earth-and-environmental-sciences/response-of-the-earth-system-to-impact-processes-impact/science-meetings.html
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2002, Jun	J.L. Remo, 2002, *Acta Astronautica*, 50, 737, "Characterizing the Near-Earth Object hazard and its mitigation." See: http://adsabs.harvard.edu/abs/2002AcAau..50..737R
2002, Jun	V. Zappalà, A. Cellino, A., Dell'Oro, 2002, *Icarus*, 157, 280, "A search for the collisional parent bodies of large NEAs." See: http://adsabs.harvard.edu/abs/2002Icar..157..280Z
2002, Jun 6	**Eastern Mediterranean Fireball and Airburst**. Estimated ~ 10 m object exploded in mid-air between Libya and Crete. See: http://abob.libs.uga.edu/bobk/ccc/cc071502.html http://www.spaceref.com/news/viewpr.html?pid=8834 http://en.wikipedia.org/wiki/Eastern_Mediterranean_event http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
2002, Jun 14	Apollo NEA **2002 MN** (H = 23.9 mag, $D \approx$ 60 m) passed Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.31 LD. **[2002-01]** See: 2002 MN - JPL , 2002 MN - SSA Ref: - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M - B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998

	– 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=114 http://impact.arc.nasa.gov/news_detail.cfm?ID=116 http://www.planetary.org/news/2002/0624_The_Close_Call_that_was_A steroid_2002.html http://antwrp.gsfc.nasa.gov/apod/ap050417.html http://www.scientificamerican.com/article.cfm?id=avoiding-the-impact http://en.wikipedia.org/wiki/2002_MN
2002, Jul	E.F. Tedesco, M.P. Egan, S.D. Price, 2002, *Astronomical Journal*, 124, 583, "The ***Midcourse Space Experiment*** infrared minor planet survey." See: http://adsabs.harvard.edu/abs/2002AJ....124..583T
2002, Jul 15	USAF General Simon P. Worden, 10 July 2002, speech: "Military perspectives on the Near-Earth Object (NEO) threat." " Introduction: A few weeks ago the world almost saw a nuclear war. Pakistan and India were at full alert and poised for a large-scale war - which both sides appeared ready to escalate into nuclear war. The situation was defused - for now! Most of the world knew about this situation and watched and worried. But few know of an event over the Mediterranean in early June of this year that could have had a serious bearing on that outcome. U.S. early warning satellites detected a flash that indicated an energy release comparable to the Hiroshima burst. We see about 30 such bursts per year, but this one was one of the largest we've ever seen. The event was caused by the impact of a small asteroid - probably about 5-10 meters in diameter on the earth's atmosphere. Had you been situated on a vessel directly underneath the intensely bright flash would have been followed by a shock wave that would have rattled the entire ship and possibly caused minor damage. The event of this June caused little or no notice as far as we can tell. But had it occurred at the same latitude, but a few hours earlier, the result on human affairs might have been much worse. Imagine that the bright flash accompanied by a damaging shock wave had occurred over Delhi, India or Islamabad, Pakistan? Neither of those nations have the sophisticated sensors we do that can determine the difference between a natural NEO impact and a nuclear detonation. The resulting panic in the nuclear-armed and hair-trigger militaries there could have been the spark that would have ignited the nuclear horror we'd avoided for over a half-century. This situation alone should be sufficient to get the world to take notice of the threat of asteroid impact." . . . See: http://www.spaceref.com/news/viewpr.html?pid=8834

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2002, Jul 25	R. Schoenberg, B.S. Kamber, K.D. Collerson, S. Moorbath, 2002, *Nature*, 418, 403, "Tungsten isotope evidence from 3.8 Gyr metamorphosed sediments for early meteorite bombardment of the Earth". See: http://adsabs.harvard.edu/abs/2002Natur.418..403S
2002, Jul 29 – Aug	***International conference on Asteroids, Comets, Meteors, VIII***, 29 July - 2 August 2002, Berlin (Germany). **Proceedings:** B. Warmbein (ed.), 2002, *Asteroids, Comets, Meteors 2002*, ESA-SP 500 (Noordwijk: ESA). See: http://adsabs.harvard.edu/abs/2002ESASP.500.....W See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=118 **Among the papers:** - F. Bernardi, A. Boattini, G. D'Abramo, 2002, ESA SP-500, p. 801, **"The Campo Imperatore Near Earth Objects Survey (CINEOS)."** See: http://adsabs.harvard.edu/abs/2002ESASP.500..801B - R.P. Binzel, 2002, ESA SP-500 (Noordwijk: ESA), p. 5, "Asteroids, comets, Kuiper Belt objects, meteors: the ACM (AKM) 2002 perspective." See: http://adsabs.harvard.edu/abs/2002ESASP.500....5B - M. Delbò, A.W. Harris, R. Binzel, et al., 2002, ESA SP-500 (Noordwijk: ESA), p. 891, "Surveying near-Earth asteroids in the thermal infrared." See: http://adsabs.harvard.edu/abs/2002ESASP.500..891D - M. Leipold, A. von Richter, G. Hahn, et al., 2002, ESA SP-500 (Noordwijk: ESA), p. 107, "Earthguard-I: a NEO detection space mission." See: http://adsabs.harvard.edu/abs/2002ESASP.500..107L - J. de Léon, M. Serra-Ricart, J. Licandro, L., Dominiguez, 2002, ESA SP-500 (Noordwijk: ESA), p. 911, "Monitoring and physical characterization of Near Earth Objects." See: http://adsabs.harvard.edu/abs/2002ESASP.500..911D
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	http://sbn.psi.edu/pds/resource/s3os2.html
2002, Aug	S.P. Kelley, E. Gurov, 2002, *Meteoritics & Planetary Science*, 37, 1031, "The **Boltysh**, another end-Cretaceous impact." See: http://adsabs.harvard.edu/abs/2002M%26PS...37.1031K http://www.skyandtelescope.com/news/3306656.html?page=1&c=y
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2002, Aug	T.D. Jones, D.R. Davis, D.D. Durda, et al., 2002, in: M.V. Sykes (ed.), *The Future of Solar System Exploration 2003 – 2013*, Community Contributions to the NRC Solar System Exploration Decadal Survey, *ASP-CS*, 272, 141, "The next giant leap: human exploration and utilization of Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2002ASPC..272..141J
2002, Aug 3	Apollo NEA **2013 YP139** ($H = 21.2$ mag, $D \approx 968$ m, **PHA**) passed Earth at a nominal miss distance of 4.12 LD. Minimum miss distance 4.12 LD. See: 2013 YP139 - JPL , 2013 YP139 - SSA See also: **12 Dec 2069**.
2002, Aug 18	Apollo NEA **2002 NY40** ($H = 19.3$ mag, $D \approx 280$ m, **PHA**) passed Earth at 1.37 LD. Minimum miss distance 1.37 LD. See: 2002 NY40 - JPL , 2002 NY40 - SSA Ref: - R.W. Sinnott, 23 July 2003, *Sky & Telescope*, "Hefty asteroid to sweep near Earth." See: http://www.skyandtelescope.com/news/3306351.html

	- L.C. Roberts, D.T. Hall, J.V. Lambert, et al., 2007, *Icarus*, 192, 469, "Characterization of the near-Earth asteroid **2002 NY40**." See: http://adsabs.harvard.edu/abs/2007Icar..192..469R - J.M. Trigo-Rodríguez, E. Lyytinen, D.C. Jones, et al., 2007, *Monthly Notices of the Royal Astronomical Society*, 382, 1933, "Asteroid **2002 NY40** as a source of meteorite-dropping bolides." See: http://adsabs.harvard.edu/abs/2007MNRAS.382.1933T See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=115 http://antwrp.gsfc.nasa.gov/apod/ap020817.html http://www.planetary.org/news/2002/0802_Your_Chance_to_See_a_NEO.html See also: **11 Feb 2038**.
2002, Sep	A.L. Cione, E.P. Tonni, J. San Cristobál, et al., 2002, *Earth, Moon, and Planets*, 91(1), 9, "Putative **meteoritic craters in Río Cuarto** (Central Argentina) interpreted as Eolian structures." See: http://adsabs.harvard.edu/abs/2002EM%26P...91....9C
2002, Sep 3-6	**NASA *Workshop on Scientific Requirements for Mitigation of Hazardous Comets and Asteroids***, Arlington (VA, USA). Proceedings: M.J.S. Belton, T.H. Morgan, N. Samarasinha & D.K. Yeomans (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2004mhca.conf.....B **Final report:** http://www.noao.edu/meetings/mitigation/report.html **Summary:** http://impact.arc.nasa.gov/news_detail.cfm?ID=121 See also: http://www.noao.edu/meetings/mitigation/format.html http://www.noao.edu./meetings/mitigation/media/arlington.extended.pdf
2002, Sep 15	Aten NEA **2020 RD4** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 7.06 LD. Minimum miss distance 0.03 LD. See: 2020 RD4 – S2P , 2020 RD4 - JPL See also: **14 Sep 2020**, **15 Sep 2079**.
2002, Sep 25	**Vitim Fireball and Airburst** event. Believed to be an impact by a bolide or comet nucleus in the Vitim River basin, near Bodaybo (Mamsko-chuisky district, Irkutsk Oblast, Siberia, Russia). Explosion energy estimates range from 0.2 to 5 kT. See: http://www.absoluteastronomy.com/topics/Meteorite http://en.wikipedia.org/wiki/Vitim_event http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
2002, Oct	A. Carusi, G.B. Valsecchi, G. D'Abramo, et al., 2002, *Icarus*, 159,

	417, "Deflecting NEOs in route of collision with Earth." See: http://adsabs.harvard.edu/abs/2002Icar..159..417C
2002, Oct	S.R. Chesley, P.W. Chodas, A. Milani, G.B. Valsecchi, D.K. Yeomans, D.K., 2002, *Icarus*, 159, 423, "Quantifying the risk posed by potential Earth impacts." Defining the **Palermo Technical Impact Hazard Scale**. See: http://adsabs.harvard.edu/abs/2002Icar..159..423C https://cneos.jpl.nasa.gov/doc/chesley_impact_paper.html See also: http://neo.jpl.nasa.gov/risk/doc/palermo.html
2002, Oct 3	Brig. Gen. Simon P. Worden, United States Strategic Command, U.S. Congressional Hearing Statement, before the House Science Committee, Space and Aeronautics Subcommittee, on Near-Earth Object Threat: "The Threat of Near-Earth Asteroids." See: http://www.spaceref.com/news/viewsr.html?pid=6723 See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=119 See also: **15 Jul 2002**.
2002, Oct 7	**B612 Foundation** officially established by Clark R. Chapman, Piet Hut, Ed T. Lu, and Russell L. Schweickart. Goal: to significantly alter the orbit of an asteroid, in a controlled manner, by 2015. A private California non-profit foundation. See: http://www.b612foundation.org/
2002, Oct 12-16	**European Science Foundation Research Networking Programme *Response of the Earth System to Impact Processes (IMPACT)*, Workshop on *Impacts: a Geological and Astronomical Perspective***, Prague (Czech Republic). See: http://www.esf.org/activities/research-networking-programmes/life-earth-and-environmental-sciences-lesc/completed-esf-research-networking-programmes-in-life-earth-and-environmental-sciences/response-of-the-earth-system-to-impact-processes-impact/science-meetings.html
2002, Oct 29	C.A. Glatz, D.H. Abbott, A.A. Nunes, 2002, in: *2002 Denver Annual Meeting* of the Geological Society of America, Denver, (CO, USA), 27-30 October 2002, paper no. 178-7, "A possible source crater for the **Eltanin impact** layer." See: http://gsa.confex.com/gsa/2002AM/finalprogram/abstract_45134.htm
2002, Nov	M.H.M. Morais, A. Morbidelli, 2002, *Icarus*, 160, 1, "The

	population of Near-Earth Asteroids in coorbital motion with the Earth." See: http://adsabs.harvard.edu/abs/2002Icar..160....1M
2002, Nov 2	NASA spacecraft ***Stardust*** flew within 3300 km of inner Main-belt asteroid **5535 Annefrank** (**1942 EM**, *H* = 13.7 mag, *D* = 6.6 × 5.0 × 3.4 km). See: 1942 EM - JPL , 5535 Annefrank - SSA , Ref: - J.K. Hillier, J.M. Bauer, B.J. Buratti, 2011, *Icarus*, 211, 546, "Photometric modelling of asteroid **5535 Annefrank** from ***Stardust***." See: http://adsabs.harvard.edu/abs/2011Icar..211..546H See also: http://en.wikipedia.org/wiki/5535_Annefrank
2002, Nov 21	P. Brown, R.E. Spalding, D.O. ReVelle, E. Tagliaferri, S.P. Worden, 2002, *Nature*, 420, 294, "The flux of small near-Earth objects colliding with the Earth." See: http://adsabs.harvard.edu/abs/2002Natur.420..294B Ref: - M. Dimartino, A. Cellino, 2004, in: M.J.S. Belton, et al. (eds.), *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 153, "Physical properties of comets and asteroids inferred from **fireball** observations." See: http://adsabs.harvard.edu/abs/2004mhca.conf..153D See also: http://www.scientificamerican.com/article.cfm?id=satellites-track-near-ear http://neo.jpl.nasa.gov/fireballs/ http://neo.jpl.nasa.gov/news/fireball_130301.html
2002, Nov 29	J.N. Head, H.J. Melosh, B.A. Ivanov, 2002, *Science*, 298, 1752, "Martian meteorite launch: high-speed ejecta from small craters." See: http://adsabs.harvard.edu/abs/2002Sci...298.1752H
2002, Dec	A. Cellino, V. Zappala, E.F. Tedesco, 2002, *Meteoritics & Planetary Science*, 37, 1965, "Near-Earth objects: origins and need of physical characterization." See: http://adsabs.harvard.edu/abs/2002M%26PS...37.1965C
2002, Dec	A.W. Harris, E.L.G. Bowell, 2002, *Bulletin of the American Astronomical Society*, 34, 1174, "NEO observations with **LSST**: populations and survey completeness." See: http://adsabs.harvard.edu/abs/2002AAS...201.4518H
2002, Dec	E.L.G. Bowell, A.W. Harris, 2002, *Bulletin of the American*

	Astronomical Society, 34, 1318, "Hunting for Near-Earth Asteroids using **LSST**: detection methods and observational strategies." See: http://adsabs.harvard.edu/abs/2002AAS...20113404B
2002, Dec 11	Apollo NEA **2002 XV90** (*H* = 25.9 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.30 LD. **[2002-02]** See: 2002 XV90 - JPL , 2002 XV90 - SSA
2003, Jan 1	**2171 NEAs** known, of which **468 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2003	E. Asphaug, D. Korycansky, S. Ward, 2003, *EOS, Transactions American Geophysical Union*, 84, 339, "Exploring ocean waves from asteroid impacts." See: http://adsabs.harvard.edu/abs/2003EOSTr..84..339A
2003	A. Boattini, G. D'Abramo, G. Forti, 2003, *Memorie della Società Astronomica Italiana*, 74, 864, "The importance of Near Earth Object detections on archival images: recent results and future potential." See: http://adsabs.harvard.edu/abs/2003MmSAI..74..864B
2003	T. Palmer, 2003, *Perilous planet Earth: catastrophes and catastrophism through the ages* (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2003ppe..book.....P
2003	Sir Martin Rees, 2003, *Our Final Hour: A Scientist's Warning: How Terror, Error, and Environmental Disaster Threaten Humankind's Future In This Century – On Earth and Beyond* (New York: Basic Books), p. 89, "Chapter 7. Baseline natural hazards. Asteroid impacts." See: http://adsabs.harvard.edu/abs/2003ofhs.book.....R
2003, Jan	R. Jedicke, A. Morbidelli, T. Spahr, et al., 2003, *Icarus*, 161, 17, "Earth- and space-based NEO survey simulations: prospects for achieving the **Spaceguard Goal**." See: http://adsabs.harvard.edu/abs/2003Icar..161...17J
2003, Jan	D. Morrison, 2003, *Astrobiology*, 3, 193, "Impacts and evolution: future prospects." See: http://adsabs.harvard.edu/abs/2003AsBio...3..193M
2003, Jan	In the context of ESA NEO space mission preparations, ESA presented the mission study report for ***Smallsat Intercept Missions to Objects Near Earth*** (***SIMONE***).

	See: http://www.esa.int/gsp/completed/neo/simone.html http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_863Add1E.pdf
2003, Jan 4	A.P.J. Abdul Kalam, President of India, 4 January 2003, Space Summit Address to the 90th Indian Science Congress, "Vision for the global space community: prosperous, happy and secure planet earth." See: http://neo.jpl.nasa.gov/1950da/1950DA_Kalam_90th_Indian_Congress.pdf
2003, Jan 8	Aten NEA **2002 AA29** ($H = 24.5$ mag, $D \approx 25$ m) passed Earth at 15.22 LD. Minimum miss distance 15.22 LD. See: 2002 AA29 - JPL , 2002 AA29 - SSA See also: http://neo.jpl.nasa.gov/news/news137.html http://www.spaceref.com/news/viewpr.html?pid=8834 https://cneos.jpl.nasa.gov/doc/2002aa29/ http://en.wikipedia.org/wiki/2002_AA29
2003, Jan 8	R.L. Schweickart, 2003, "The need for a United Nations asteroid deflection treaty to establish a system for trustworthy mission design and execution." See: http://www.b612foundation.org/papers/OECD_trustworthy.pdf
2003, Jan 9	C.R. Chapman, 2003, in: OECD Global Science Forum Workshop *Near Earth Objects: Risk, Policies and Actions*, Frascati (Italy) 20-22 January 2003, "How a Near-Earth Object impact might affect society." See: http://www.oecd.org/dataoecd/18/40/2493218.pdf
2003, Jan 20-22	Organization for Economic Cooperation and Development (OECD, Paris, France) **Global Science Forum *Workshop on Near Earth Objects: Risk, Policies and Actions***, hosted by ESRIN, Frascati (Italy). Final report of 11 August 2004. See: http://www.iau.org/static/publications/IB93.pdf , p. 13, "NEO-related activities". **The Workshop stated:** • ".. assess the NEO hazard as it relates to public safety, determine the commensurate level of response, and undertake appropriate actions at national and international levels." • ".. each government that has not already done so consider designating a responsible official (office, administration, etc.) within the government, tasked with following the ever-growing body of knowledge about NEO impacts, and, where appropriate, advising the government regarding the implications for public safety of the NEO risk.

	• "explore strategies for mitigating the impact of a range of characteristic NEOs, identifying the scientific, technical, legal and policy implications of mounting a NEO negation mission.." Ref: - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M See also: http://www.oecd.org/document/17/0,3343,en_2649_34319_2767633_1_1_1_1,00.html http://www.oecd.org/dataoecd/39/40/2503992.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=124
2003, Feb	Lowell Observatory (Flagstaff, AZ, USA) and Discovery Communications formed a partnership to build the 4.2m **Discovery Channel Telescope**. First light expected by the end of 2010. Ref: - E. Bowell, R.L. Millis, E.W. Dunham, et al., 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 363, "Searching for NEOs using the Lowell Observatory's **Discovery Channel Telescope (DCT)**." See: http://adsabs.harvard.edu/abs/2007IAUS..236..363B
2003, Feb	D.W. Hughes, 2003, *Monthly Notice of the Royal Astronomical Society*, 338, 999, "The approximate ratios between the diameters of terrestrial impact craters and the causative incident asteroids." See: http://adsabs.harvard.edu/abs/2003MNRAS.338..999H
2003, Feb 6	P. Michel, W. Benz, D.C. Richardson, 2003, *Nature*, 421, 608, "Disruption of fragmented parent bodies as the origin of asteroid families." See: http://adsabs.harvard.edu/abs/2003Natur.421..608M
2003, Feb 10	Great Impact Debates, *Astrobiology Magazine*, 10 February 2003, "The benefits of hard bodies." See: http://www.astrobio.net/debate/373/the-benefits-of-hard-bodies
2003, Feb 11	First discovery of an IEO asteroid: **163693 Atira** (**2003 CP20**, $H = 16.5$, $D \approx 1800$ m), by the **LINEAR** team of the **Lincoln Near-Earth Asteroid Research** at Lincoln Laboratory's Experimental Test Site near Socorro (NM, New Mexico, USA). **Atira** is the Pawnee goddess of Earth and the evening star. This is the first numbered minor planet to have an orbit completely interior to that

	of the Earth. See: 2003 CP20 - JPL , 163693 Atira - SSA See also: http://en.wikipedia.org/wiki/163693_Atira
2003, Feb 14	**Symposium on *The Asteroid/Comet Impact Hazard: A Decade of Growing Awareness***, American Association for the Advancement of Science (AAAS), Denver (CO, USA), marking the 10th anniversary of the **Spaceguard Report**. See: http://www.aaas.org/news/releases/2003/0122am.shtml http://impact.arc.nasa.gov/news_detail.cfm?ID=122
2003, Feb 17	Great Impact Debates, *Astrobiology Magazine*, 17 February 2003, "Much ado about nothing?" See: http://www.astrobio.net/debate/378/much-ado-about-nothing
2003, Feb 24	Great Impact Debates, *Astrobiology Magazine*, 24 February 2003, "The large and the small." See: http://www.astrobio.net/debate/382/the-large-and-the-small
2003, Mar 3	Great Impact Debates, *Astrobiology Magazine*, 3 March 2003, "Collision course for Earth." See: http://www.astrobio.net/debate/389/collision-course-for-earth
2003, Mar 14	M. Belló, J.A. González, A. Milani, G. Valsecchi, P. Paolicchi, et al., 2003, *NEO-DMS-EXS*, "Near Earth Objects space mission preparation: ***Don Quijote*** mission executive summary." ESA study contract. See: http://www.esa.int/gsp/completed/neo/donquijote_execsum.pdf See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=144 http://www.space.com/12781-space-missions-deflect-dangerous-asteroids-apophis.html
2003, Mar 16	**Technical workshop *Tsunami Hazard Workshop***, Houston (TX, USA). See: http://impact.arc.nasa.gov/news_detail.cfm?ID=123
2003, Mar 27	**Park Forest Fireball and Meteorite**. Bolide entering the Earth atmosphere over Park Forest (Il, USA) south of Chicago, detected by U.S. Department of Energy and Department of Defense satellites. Estimated initial NEA diameter $D \approx 1.8$ m, estimated initial mass $M \approx 11{,}000$ kg. Ref: - P. Brown, D. Pack, W.N. Edwards, et al., 2004, *Meteoritics & Planetary Science*, 39, 1781, "The orbit, atmospheric dynamics,

	and initial mass of the **Park Forest Meteorite**." See: http://adsabs.harvard.edu/abs/2004M%26PS...39.1781B See also: http://apod.nasa.gov/apod/ap030506.html http://apod.nasa.gov/apod/ap050724.html
2003, Apr 3	Apollo NEA **2003 GG21** (*H* = 22.1 mag, *D* ≈ 140 m, **PHA**) passed Earth at a nominal miss distance of 3.39 LD. Minimum miss distance 3.39 LD. See: 2003 GG21 - JPL , 2003 GG21 - SSA
2003, Apr 13-16	**European Science Foundation Research Networking Programme *Response of the Earth System to Impact Processes (IMPACT)*, Workshop on *Biological Processes in Impact Craters*,** Cambridge (UK). See: http://www.esf.org/activities/research-networking-programmes/life-earth-and-environmental-sciences-lesc/completed-esf-research-networking-programmes-in-life-earth-and-environmental-sciences/response-of-the-earth-system-to-impact-processes-impact/science-meetings.html
2003, Apr 19	E. Asphaug, 2003, *New Scientist*, "Taming the heavens." See: http://www.newscientist.com/article/mg17823914.400-taming-the-heavens.html
2003, Apr 22-23	***ICSU workshop on NEOs***, Paris (France), with IAU, IUGG, IUGS, COSPAR, SCOR, SCOPE, and the USA, as well as the OECD GSF. See: http://www.iau.org/static/publications/IB93.pdf , p. 13, "NEO-related activities."
2003, Apr 29	Apollo NEA **2003 HW10** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2003-01]** See: 2003 HW10 - JPL , 2003 HW10 - SSA
2003, May	A. Morbidelli, D. Vokrouhlický, 2003, *Icarus*, 163, 120, "The Yarkovsky-driven origin of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2003Icar..163..120M
2003, May 1-4	**Meeting on *Asteroids and Comets in Europe***, Costitx (Mallorca, Spain). See: http://www.minorplanets.org/MACE2003/
2003, Jun	G. Masi, 2003, *Icarus*, 163, 389, "Searching for inner-Earth objects: a possible ground-based approach." See: http://adsabs.harvard.edu/abs/2003Icar..163..389M

2003, Jun 20	A. Milani, 2003, *Science*, 300, 1882, "Extraterrestrial material – virtual or real hazards?" See: http://www.sciencemag.org/content/300/5627/1882.summary?sid=e377c0b3-994a-4614-bc70-5ee36edb563c
2003, Jul 14	In a letter to Congress, a group of space-savvy Americans urged the U.S. government to begin immediate preparations to deal with the threat of NEOs. See: http://usgovinfo.about.com/cs/technology/a/aaneoletter.htm
2003, Jul 14	S. Nadis, 2003, *Scientific American*, 14 July 2003, "Keeper of the objects." … With a shoestring budget, asteroid and comet watcher Brian Marsden looks out for Armageddon from the skies – and not without controversy … . See: http://www.scientificamerican.com/article.cfm?id=keeper-of-the-objects
2003, Jul 22	***IAU XXV General Assembly***, Sydney (Australia). ***Division III Working Group on Near-Earth Objects (WG-NEO) meeting***. Report by David Morrison, chair WG-NEO. Ref: - D. Morrision, 2007, in: O. Engvold (ed.), 2007, *Transactions IAU XXVB* (San Francisco: ASP), p. 131, "Working Group on Near-Earth Objects." See: http://www.astrosociety.org/astroshop/index.php?p=product&id=119&parent=8
2003, Jul 23	***IAU XXV General Assembly***, Sydney (Australia). ***Joint Discussion 10 on Physical Properties and Morphology of Small Solar System Bodies.*** In: O. Engvold (ed.), 2005, *Highlights of Astronomy*, Vol. 13 (San Francisco: ASP), p. 721. See: http://adsabs.harvard.edu/abs/2005HiA....13.....E http://www.iau.org/science/publications/iau/highlights/
2003, Aug	J.M. Trigo-Rodriguez, J. Llorca, J. Borovicka, J. Fabregat, 2003, *Meteoritics & Planetary Science*, 38, 1283, "Chemical abundances determined from meteor spectra. I. Ratios of the main chemical elements." See: http://adsabs.harvard.edu/abs/2003M%26PS...38.1283T
2003, Aug 22	G.H. Stokes, D.K. Yeomans, W.F. Bottke, et al. (eds.), 2003, **NASA NEO Science Definition Team (SDT)** report *Study to Determine the Feasibility of Extending the Search for Near-Earth*

	Objects to Smaller Limiting Diameters, NASA Office of Space Science, Solar System Exploration Division, Washington DC, USA (2003). See: http://neo.jpl.nasa.gov/neo/report.html http://neo.jpl.nasa.gov/neo/neoreport030825.pdf https://cneos.jpl.nasa.gov/doc/neoreport030825.pdf **Summary:** http://impact.arc.nasa.gov/news_detail.cfm?ID=131
2003, Aug 25	F.A. Macdonald, J.A. Bunting, S.E. Cina, 2003, *Earth and Planetary Science Letters*, 213, 235, "**Yarrabubba** - a large, deeply eroded impact structure in the Yilgarn Craton, Western Australia." See: https://www.sciencedirect.com/science/article/pii/S0012821X03003224
2003, Sep	E. Asphaug, 2003, *Scientific American*, 13, 44, "The small planets." See: http://81.70.242.211/.../Scientific%20American/.../ ...
2003, Sep 19	Aten NEA **2003 SW130** (H = 29.4 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2003-02]** See: 2003 SW130 - JPL , 2003 SW130 - SSA See also: **19 Sep 1990**.
2003, Sep 27	Apollo NEA **2003 SQ222** (H = 30.0 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.22 LD. **[2003-03]** See: 2003 SQ222 - JPL , 2003 SQ222 - SSA See also: http://antwrp.gsfc.nasa.gov/apod/ap031015.html http://www.newscientist.com/article/dn4228-closest-asteroid-yet-flies-past-earth.html http://www.skyandtelescope.com/news/3308176.html
2003, Sep late	**Fireball** over South Wales (UK). See: http://apod.nasa.gov/apod/ap031001.html
2003, Oct 12	Apollo NEA **2003 UM3** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.59 LD. **[2003-04]** See: 2003 UM3 - JPL , 2003 UM3 - SSA
2003, Oct 15	Apollo NEA **69230 Hermes** (**1937 UB**, H = 17.5 mag, $D \approx$ 1100, **PHA**) re-discovered. Binary asteroid, each $D \approx$ 300 m, *separation* $\approx$ 1200 m, P = 778 d.

	See: 1937 UB - JPL , 69230 Hermes - SSA See also: http://www.news.cornell.edu/releases/Oct03/Arecibo.asteroid.deb.html http://science.nasa.gov/headlines/y2003/31oct_hermes.htm http://en.wikipedia.org/wiki/69230_Hermes See also: **29 Oct 1914**, **30 Oct 1937**, **26 Apr 1942**, **1 Nov 1954**, **31 Oct 2086**, **30 Apr 2123**.
2003, Oct 16	W.T. Huntress, 2003, statement before the Committee on Science, U.S. House of Representatives, "The future of human space flight". Advocating *inter alia* a one-year human mission to a Near Earth Object. See: http://www.access.gpo.gov/congress/house/pdf/108hrg/89892.pdf http://www.planetary.org/programs/projects/aim_for_mars/testimony_huntress_2003.html
2003, Nov	D. Morrison, 2003, *Mercury*, 32, no. 6, p. 15, "Commentary: are astronomers crying wolf?" See: http://adsabs.harvard.edu/abs/2003Mercu..32f..15M
2003, Nov	R.L. Schweickart, E.T. Lu, P. Hut, C.R. Chapman, 2003, *Scientific American*, 13 October 2003, "The ***Asteroid Tugboat***." See: http://scientificamerican.com/article.cfm?id=the-asteroid-tugboat See also: http://www.secureworldfoundation.org/siteadmin/images/files/file_97.pdf http://www.b612foundation.org/press/press.html #3 http://www.b612foundation.org/papers/AT-GT.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=130 http://www.nature.com/scientificamerican/journal/v305/n6/full/scientificamerican1211-16.html
2003, Nov	M. Delbò, A.W. Harris, R.P. Binzel, et al., 2003, *Icarus*, 166, 166, "Keck observations of near-Earth asteroids in the thermal infrared." See: http://adsabs.harvard.edu/abs/2003Icar..166..116D
2003, Nov 12	Apollo NEA **65803 Didymos** (**1996 GT**, $H = 18.1$ mag, $D \approx 800 + 160$ m, **PHA**) passed Earth at 18.69 LD (= 0.05 AU). Minimum miss distance 18.69 LD. Flyby target for ***AIDA*** mission. See: 65803 Didymos - SSA , 1996 GT - JPL See also: https://en.wikipedia.org/wiki/65803_Didymos See also: **29 May 2012**, **4 Oct 2022**, **20 Oct 2062**, **4 Nov 2123**
2003, Dec	A. Boattini, G. D'Abramo, H. Scholl, O.R. Hainaut, R. West, G. Hahn, R. Michelsen, G. Forti, P. Pravec, G.B. Valsecchi, 2003, *Earth, Moon, and Planets*, 93, 239, "Eliminating virtual impactors

	with the Very Large Telescope: an ESO program with the FORS2 camera." See: http://adsabs.harvard.edu/abs/2003EM%26P...93..239B
2003, Dec	S.R. Chesley, A.W. Harris, D.K. Yeomans, S.N. Ward, 2003, *American Geophysical Union, Fall Meeting 2003*, abstract #P51E-01, "An updated assessment of the hazard due to Earth impacts." See: http://adsabs.harvard.edu/abs/2003AGUFM.P51E..01C
2003, Dec 5	S.R. Chesley, S.J. Ostro, D. Vokrouhlický, et al., 2003, *Science*, 302, 1739, "Direct detection of the Yarkovsky Effect by radar ranging to Apollo NEA **6489 Golevka**." See: http://adsabs.harvard.edu/abs/2003Sci...302.1739C See also: **6489 Golevka**, **1991 JX**, *H* = 18.9 mag, *D* = 350 x 250 x 250 m, **PHA**. 1991 JX -JPL , 6489 Golevka - SSA See also: http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf https://en.wikipedia.org/wiki/6489_Golevka
2003, Dec 6	Apollo NEA **2003 XJ7** (*H* = 26.1 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2003-05]** See: 2003 XJ7 - JPL , 2003 XJ7 - SSA
2003, Dec 9	B.R. Blair, 2003, Research Paper, EB560 – Decision Analysis, Division of Economics and Business, Colorado School of Mines, "Decision model for potential asteroid impacts." See: http://www.digitalspace.com/projects/neo-mission/docs/Blair_ADM03.pdf
2003, Dec 22	Aten/Apollo NEA **2020 XC** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 4.13 LD. Minimum miss distance 0.94 LD. See: 2020 XC – S2P , 2020 XC – JPL See also: **30 May 2013**, **30 Nov 2020**.
2004, Jan 1	**2608 NEAs** known, of which **551 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2004	A. Cellino, K. Muinonen, E.F. Tedesco, 2004, *Advances in Space Research*, 33, 1576, "Rationale and orbital options for a dedicated space-based observatory for NEOs."

	See: http://adsabs.harvard.edu/abs/2004AdSpR..33.1576C
2004	R.A. Posner, 2004, *Catastrophe: risk and response* (Oxford: Oxford University Press). See: http://ukcatalogue.oup.com/product/9780195306477.do See also: http://www.hsaj.org/?article=4.1.5
2004	D. Sears, C. Allen, D. Britt, et al., 2004, *Advances in Space Research*, 34, 2270, "The ***Hera*** mission: multiple near-earth asteroid sample return." See: http://adsabs.harvard.edu/abs/2004AdSpR..34.2270S http://www.uark.edu/misc/hera/
2004	The international yearbook *Ephemerides of minor planets* (EMP), published since 1948 for the International Astronomical Union by the Institute of Applied Astronomy (IAA) in St. Petersburg (Russian Federation), contains information on orbital elements of numbered minor planets and the circumstances of their observations during the best observation periods. Starting in 2004 the IAA publishes the EMP in a reduced volume with information on a limited number of minor planets, together with a CD with data for all numbered planets. See: http://www.ipa.nw.ru/PAGE/DEPFUND/LSBSS/engephem.htm
2004, Jan	ESA international **Near-Earth Object Mission Advisory Panel (NEOMAP)** established. **NEOMAP** was charged with the task of advising ESA on cost-effective options for ESA participation in a space mission to contribute to our understanding of the physical nature of near-Earth asteroids and their terrestrial impact hazard. See: http://www.esa.int/SPECIALS/NEO/SEM4Q7OVGJE_0.html http://ebooks.worldscinet.com/ISBN/9789812701787/9789812701787_0021.html
2004	H. Dypvik, A. Mørk, M. Smelror, et al., 2004, *Norwegian Journal of Geology*, 84(3), 143, "Impact breccia and ejecta from the **Mjølnir crater** in the Barents Sea - The Ragnarok Formation and Sindre Bed." See: http://www.geologi.no/cgi-bin/geologi/imaker?id=4333&visdybde=2&aktiv=4333 http://www.geologi.no/data/f/0/05/01/9_22301_0/Dypvik http://folk.uio.no/ftsikala/mjolnir/
2004, Jan 4	**Villabeto de la Peña superbolide** (Villabeto, Spain). Chondrite

	meteorites found. Ref: - J. Llorca, J.M. Trigo-Rodríguez, J.L. Ortiz, et al., 2005, *Meteoritics & Planetary Science*, 40, 795, "The **Villalbeto de la Peña meteorite fall**: I. Fireball energy, meteorite recovery, strewn field, and petrography." See: http://adsabs.harvard.edu/abs/2005M%26PS...40..795L - J.M. Trigo-Rodríguez, J. Borovička, P. Spurný, et al., 2006, *Meteoritics & Planetary Science*, 41, 505, "The **Villalbeto de la Peña meteorite fall**: II. Determination of atmospheric trajectory and orbit." See: http://adsabs.harvard.edu/abs/2005M%26PS...41..505T See also: http://www.spmn.uji.es/ENG/presentation.html
2004, Jan 13	Apollo NEA **444004** (**2004 AS1**, $H = 20.8$, $D \approx 250$ m, **PHA**) discovered and initially thought to be heading for potential (10-25%) Earth impact within 24 hours. Questions were raised re who should be notified and whether or not such notice should be raised to [US] Presidential level. Fortunate late telescopic view by amateur astronomer in the UK found that NEO not on impact trajectory. Czech observation following night demonstrated that the asteroid passed Earth on 16 February 2004 at 33.2 LD. See: 2004 AS1 - JPL , 2004 AS1 - SSA Ref: - B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998 – 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B See also: http://www.planetarydefense.info/resources/pdf/chapman.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=135 http://b612foundation.org/papers/Chapman_AIAA.pdf http://en.wikipedia.org/wiki/2004_AS1
2004, Feb 8	Apollo NEA **2008 CE22** ($H = 26.6$ mag, $D \approx 17$ m) passed Earth at a nominal miss distance of 6.74 LD. Minimum miss distance 0.95 LD. See: 2008 CE22 - JPL , 2008 CE22 - SSA
2004, Feb 23-26	***2004 Planetary Defense Conference, Protecting Earth from Asteroids***, Garden Grove (CA, USA), sponsored by the American Institute of Aeronautics and Astronautics (AIAA) and The Aerospace Corporation. Summary in **White Paper**. See: http://www.planetarydefense.info/ http://www.planetarydefense.info/resources/pdf/conference_white_paper

	.pdf http://www.aero.org/conferences/planetdef http://impact.arc.nasa.gov/news_detail.cfm?ID=136 http://impact.arc.nasa.gov/news_detail.cfm?ID=139 http://www.usatoday.com/tech/news/2004-03-11-asteroid-menace_x.htm
2004, Feb 23	C.R. Chapman, 2004, presented at AIAA 2004 Planetary Defense Conference *Protecting Earth from Asteroids*, Garden Grove (CA, USA), "NEO impact scenarios." See: http://www.b612foundation.org/papers/Chapman_AIAA.pdf
2004, Feb 23	D.K. Lynch, G.E. Peterson, 2004, presented at AIAA 2004 Planetary Defense Conference *Protecting Earth from Asteroids*, Garden Grove (CA, USA), "Athos, Porthos, Aramis, & D'Artagnon: four planning scenarios for planetary protection." See: http://www.planetarydefense.info/resources/pdf/lynch.pdf
2004, Mar	R.P. Binzel, E. Perozzi, A.S. Rivkin, A. Rossi, A.W. Harris, S.J. Bus, G.B. Valsecchi, S.M. Slivan, 2004, *Meteoritics & Planetary Science*, 39, 351, "Dynamical and compositional assessment of near-Earth object mission targets." See: http://adsabs.harvard.edu/abs/2004M%26PS...39..351B
2004, Mar	P. Jenniskens, 2004, *WGN, Journal of the International Meteor Organization*, 32, 7, "**2003 EH1** and the **Quadrantid shower**." See: https://ui.adsabs.harvard.edu/abs/2004JIMO...32....7J/abstract See also: https://www.space.com/quadrantid-meteor-shower-2020-peaks-what-to-expect.html
2004, Mar	S.J. Ostro, L.A.M. Benner, M.C. Nolan, et al., 2004, *Meteoritics & Planetary Science*, 39, 407, "Radar observations of asteroid **25143 Itokawa** (**1998 SF36**)." See: http://adsabs.harvard.edu/abs/2004M%26PS...39..407O
2004, Mar	K. Petreshock, D. Abbott, C. Glatz, 2004, in: *35th Lunar and Planetary Science Conference*, 15-19 March 2004, League City (TX, USA), abstract no.1364, "Continental impact debris in the **Eltanin impact** layer." See: http://adsabs.harvard.edu/abs/2004LPI....35.1364P
2004, Mar 1	Apollo NEA **2017 EA** (H = 31.0 mag, $D \approx 2.3$ m) passed Earth at a nominal miss distance of 1.25 LD. Minimum miss distance 0.66 LD. See: 2017 EA – SSA , 2017 EA – JPL
2004, Mar 18	Aten NEA **2004 FH** (H = 26.3 mag, $D \approx 19$ m) passed Earth at a

	nominal miss distance of 0.128 LD. Minimum miss distance 0.128 LD. **[2004-01]** See: 2004 FH - JPL , 2004 FH - SSA See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=137 http://neo.jpl.nasa.gov/news/news142.html http://antwrp.gsfc.nasa.gov/apod/ap040322.html http://en.wikipedia.org/wiki/2004_FH
2004, Mar 25	A. La Spina, P. Paolicchi, A. Kryszczyńska, P. Pravec, 2004, *Nature*, 428, 400, "Retrograde spins of near-Earth asteroids from the Yarkovsky effect." See: http://adsabs.harvard.edu/abs/2004Natur.428..400L
2004, Mar 27	Apollo NEA **2004 FY15** ($H = 26.2$ mag, $D \approx 20$ m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2004-02]** See: 2004 FY15 -JPL , 2004 FY15 - SSA
2004, Mar 31	Aten NEA **2004 FU162** ($H = 28.7$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.034 LD **(= 2.03 R_{Earth} from the geocenter)**. Minimum miss distance 0.0090 LD **(= 0.54 R_{Earth} from the geocenter).** **[2004-03]** See: 2004 FU162 - JPL , 2004 FU162 - SSA See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=145 See also: http://neo.ssa.esa.int/newsletters [June 2020] https://en.wikipedia.org/wiki/2004_FU162
2004, Apr	The **Catalina Sky Survey** brings a 0.5 m Schmidt telescope on-line at Siding Spring (Australia) for a southern hemisphere NEO search effort. See: http://uanews.org/node/23277
2004, Apr 7	NASA astronauts Russell L. Schweickart and Ed T. Lu on deflecting NEAs, testimony before the U.S. Senate Subcommittee on Science, Technology and Space, dealing with defense against asteroid impacts. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=140 http://www.globalsecurity.org/space/library/congress/2004_h/040407-schweickart.htm
2004, Apr 7	Apollo NEA **2008 GF1** ($H = 28.5$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 2.57 LD. Minimum miss distance 0.25 LD.

	See: 2008 GF1 - JPL , 2008 GF1 - SSA See also: **7 Apr 2008**.
2004, Apr 18	Apollo NEA **2004 HE** (H = 26.8 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2004-04]** See: 2004 HE - JPL , 2004 HE - SSA
2004, May	A. Boattini, G. D'Abramo, H. Scholl, et al., 2004, *Astronomy & Astrophysics*, 418, 743, "Near Earth Asteroid search and follow-up beyond 22nd magnitude. A pilot program with ESO telescopes." See: http://adsabs.harvard.edu/abs/2004A%26A...418..743B
2004, May	J.L. Remo, 2004, *Acta Astronautica*, 54, 755, "A quantitative NEO hazard mitigation scale." See: http://adsabs.harvard.edu/abs/2004AcAau..54..755R
2004, May	Stokes, G., 2004, American Geophysical Union, Spring Meeting 2004, abstract #P11A-03, "A study to determine the feasibility of extending the search for NEOs to smaller limiting diameters: report of a NASA Science Definition Team." See: http://adsabs.harvard.edu/abs/2004AGUSM.P11A..03S
2004, May 15	C.R. Chapman, 2004, *Earth and Planetary Science Letters*, 222, 1, "The hazard of Near-Earth Asteroid impacts on Earth." See: http://adsabs.harvard.edu/abs/2004E%26PSL.222....1C See also: http://www.b612foundation.org/press/press.html , #5, http://www.sciencemag.org/content/304/5674/1081.1.full?sid=7557ae29-dd09-49f2-8140-b0fc461e288d
2004, May 25	A. Cheng, 2004, *Space Daily*, 25 May 2004, "One giant leap on an asteroid." See: http://www.spacedaily.com/news/asteroid-04f.html
2004, May 27-30	**Meeting on *Asteroids and Comets in Europe***, Fraso Sabino (Italy). See: http://www.ara.roma.it/eng/div/specials.htm
2004, Jun	**Nordic Near-Earth Object Network (NEON)** started operations with the Nordic Optical Telescope on La Palma (Canary Islands, Spain), running till September 2006. Ref: - K. Muinonen, J. Torpa, J Virtanen, et al., 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symp. No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006

	(Cambridge: CUP), p. 309, "Spins, shapes and orbits for near-Earth objects by Nordic NEON." See: http://adsabs.harvard.edu/abs/2007IAUS..236..309M
2004, Jun 4	L. Becker, R.J. Poreda, A.R. Basu, et al., 2004, *Science*, 304, 1469, "**Bedout**, a possible end-Permian **impact crater** offshore of Northwestern Australia." See: http://www.sciencemag.org/content/304/5676/1469.abstract?sid=78e2e4f7-3397-4d09-b789-98f4799cf917
2004, Jun 19	Aten NEA **99942 Apophis** (**2004 MN4**, $H = 19.0$ mag, $D = 310 \pm 30$ m, $M \approx 4.7 \times 10^{10}$ kg, orbital $P = 0.89$ yr, **PHA**) discovered, initially considered a serious impact probability. See: 2004 MN4 - JPL , 99942 Apophis - SSA Ref: - A.M. MacRobert, 15 February 2005, *Sky & Telescope*, "Asteroid **2004 MN4**: a really near miss!" See: http://adsabs.harvard.edu/abs/2005S%26T...109e..16M - D. Chandler, 2005, *New Scientist*, 25 June 2005, issue 2505, "Killer asteroid: too close for comfort." See: http://www.newscientist.com/article/mg18625051.200-killer-asteroid-too-close-for-comfort.html - B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998 – 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B - J.D. Giorgini, L. Benner, S.J. Ostro, et al., 2008, *Icarus*, 193, 1, "Predicting the Earth encounters of (**99942**) **Apophis**." See: http://adsabs.harvard.edu/abs/2008Icar..193....1G - S.R. Chesley, A. Milani, D. Tholen, et al., 2009, *AAS-DPS*, 41.4306, "An updated assessment of the impact threat from **99942 Apophis**." See: http://adsabs.harvard.edu/abs/2009DPS....41.4306C - J. Žižka, D. Vokrouhlický, 2011, *Icarus*, 211, 511, "Solar radiation pressure on (**99942**) **Apophis**." See: http://adsabs.harvard.edu/abs/2011Icar..211..511Z - M. Brozovic, L. Benner, J. McMichael, et al., 2015, AAS DPS meeting #47, #402.06, "Size estimate of **(99942) Apophis** based on radar imaging." See: http://adsabs.harvard.edu/abs/2015DPS....4740206B See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=154 http://impact.arc.nasa.gov/news_detail.cfm?ID=157 http://impact.arc.nasa.gov/news_detail.cfm?ID=161 http://impact.arc.nasa.gov/news_detail.cfm?ID=165

	http://neo.jpl.nasa.gov/news/news164.html http://neo.jpl.nasa.gov/apophis/ http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2332 http://www.newscientist.com/article/mg18625051.200-killer-asteroid-too-close-for-comfort.html http://www.unoosa.org/pdf/pres/stsc2010/tech-45.pdf http://content.usatoday.com/communities/sciencefair/post/2010/11/apophis-asteroid-2013/1 See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://en.wikipedia.org/wiki/99942_Apophis See also: **13 Apr 1907**, **14 Apr 1949**, **14 Apr 1998**, **9 Jan 2013**, **13 Apr 2029, 23 Mar 1936, 11 Sep 2059**.
2004, Jun 25	J.K. Beatty, 2004, *Sky & Telescope*, "Killer asteroids: the count rises." See: http://www.skyandtelescope.com/news/3304491.html?page=1&c=y
2004, Jun 26	Apollo NEA **25143 Itokawa** (**1998 SF36**, $H = 19.1$ mag, $D = 0.520 \times 0.270 \times 0.230$ km, $M = 3.6 \times 10^{10}$ kg, **PHA**) passed Earth at a nominal miss distance of 5.02 LD. Minimum miss distance 5.02 LD. See: 1998 SF36 - JPL , 25143 Itokawa - SSA See also: http://en.wikipedia.org/wiki/25143_Itokawa See also: **27 Jun 1905, 9 Apr 2167**.
2004, Jul 9	ESA report *The Near-Earth Object Impact Hazard: Space Mission Priorities for Risk Assessment and Reduction*, recommendations to ESA by the **Near-Earth Object Mission Advisory Panel (NEOMAP)**, by A.W. Harris, W. Benz, A. Fitzsimmons, A. Galvez, S.F. Green, P. Michel, and G.B. Valsecchi. See : http://www.esa.int/gsp/NEO/doc/NEOMAP_report_June23_wCover.pdf
2004, Jul 9	A Cosmic Study by the International Academy of Astronautics, final report "The next steps in exploring deep space", advocating *inter alia* the exploration of Near Earth Asteroids by human spaceflight. See: http://www.lpi.usra.edu/lunar/strategies/AdvisoryGroupReports/iaa_report.pdf
2004, Jul 15	P.R. Heck, B. Schmitz, H. Baur, A.N. Halliday, R. Wieler, 2004, *Nature*, 430, 323, "Fast delivery of meteorites to Earth after a major asteroid collision." See: http://adsabs.harvard.edu/abs/2004Natur.430..323H

2004, Jul 16	Apollo NEA **2004 OD4** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2004-05]** See: 2004 OD4 - JPL , 2004 OD4 - SSA
2004, Aug	R.P. Binzel, A.S. Rivkin, J.S. Stuart, et al., 2004, *Icarus*, 170, 259, "Observed spectral properties of near-Earth objects: results for population distribution, source regions, and space weathering processes." See: http://adsabs.harvard.edu/abs/2004Icar..170..259B
2004, Aug	J.S. Stuart, R.P. Binzel, 2004, *Icarus*, 170, 295, "Bias-corrected population, size distribution, and impact hazard for the near-Earth objects." See: http://adsabs.harvard.edu/abs/2004Icar..170..259B
2004, Aug	D.J. Scheeres, F. Marzari, A. Rossi, 2004, *Icarus*, 170, 312, "Evolution of NEO rotation rates due to close encounters with Earth and Venus." See: http://adsabs.harvard.edu/abs/2004Icar..170..312S
2004, Aug 6	Apollo NEA **2004 QB**, *H* = 19.8 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 4.29 LD. See: 2004 QB - JPL , 2004 QB - SSA
2004, Aug-Nov	N. Peter, A. Barton, D. Robinson, J.M. Salotti, 2004, *Acta Astronautica*, 55, 325, "Charting response options for threatening Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2004AcAau..55..325P 559
2004, Aug 12	**Perseid Fireball** over Japan. See: http://apod.nasa.gov/apod/ap040813.html
2004, Aug 19	Aten NEA **367943 Duende** (**2012 DA14**, *H* = 24.2 mag, *D* ≈ 40 × 20 m) passed Earth at a nominal miss distance of 3.16 LD. Minimum miss distance 3.16 LD. See: 2012 DA14 - JPL , 367943 Duende - SSA See also: http://en.wikipedia.org/wiki/2012_DA14 See also: **17 Feb 1918**, **16 Feb 2012**, **15 Feb 2013**, **15 Feb 2046, 15 Feb 2087**.
2004, Aug 24	Aten NEA **2004 QA22** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 2.47 LD. Minimum miss distance 2.46 LD.

	See: 2004 QA22 - JPL , 2004 QA22 - SSA See also: http://www.hohmanntransfer.com/mn/0408/29.htm http://www.hohmanntransfer.com/mn/0409/05.htm
2004, Aug 31 - Sep	**IAU Colloquium No. 197 on *Dynamics of Populations of Planetary Systems***, Belgrado (Serbia & Montenegro). Proceedings: Z. Knežević & A. Milani (eds.), 2005, *Dynamics of Populations of Planetary Systems* (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2005dpps.conf.....K
2004, Sep 4	**Antarctica Fireball and Airburst**. United States Department of Defense (DoD) space-based infrared sensors detected a large meteor in flight at an altitude of approximately 75 km at on 3 September 2004 at latitude 67.72° S, longitude 16.89° E. Space-based Department of Energy (DoE) visible light sensors also detected the fireball. The emissive debris trail from the fireball extended from 56 – 18 km altitude and remained detectable at infrared wavelengths owing to solar scattering for over an hour. Two distinct disintegration features were visible along the path, at 32 km and 25 km altitude. Initial mass estimate $M \approx 0.6 \times 10^6$ kg, energy release $E \approx 13$ kT of exploding TNT). The original solar orbit of the body is similar to near-Earth asteroids of the Aten group. See: http://www.antarctica.gov.au/__data/assets/pdf_file/0010/22213/0520cosmic20hole20in20one.pdf http://en.wikipedia.org/wiki/List_of_meteor_air_bursts Ref: - A.R. Klekociuk, P.G. Brown, D.W. Pack, et al., 2005, *Nature*, 436, 1132, "Meteoritic dust from the atmospheric disintegration of a large meteoroid". See: http://adsabs.harvard.edu/abs/2005Natur.436.1132K
2004, Sep 13	Apollo NEA **2004 RU109** ($H = 26.4$ mag, $D \approx 18$ m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.96 LD. **[2004-06]** See: 2004 RU109 - JPL , 2004 RU109 - SSA
2004, Sep 21	Apollo NEA **2004 ST26** ($H = 26.1$ mag, $D \approx 21$ m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.95 LD. **[2004-07]** See: 2004 ST26 - JPL , 2004 ST26 - SSA
2004, Sep 26	Apollo NEA **2016 TT** ($H = 26.1$ mag, $D \approx 22$ m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.64 LD. **[2004-08]**

	See: 2016 TT - JPL , 2016 TT - SSA
2004, Sep 29	Apollo NEA **4179 Toutatis** (**1989 AC**, *H* = 15.2 mag, ***D* = 4.6 × 2.4 × 1.9 km**, orbital *P* = 4.03 yr, the largest known **PHA**) passed Earth at a nominal miss distance of 4.03 LD. Minimum miss distance 4.03 LD. See: 1989 AC - JPL , 4179 Toutatis - SSA See also: http://echo.jpl.nasa.gov/asteroids/4179_Toutatis/toutatis.html http://www.space.com/scienceastronomy/toutatis_video_040929.html#video http://impact.arc.nasa.gov/news_detail.cfm?ID=95 http://impact.arc.nasa.gov/news_detail.cfm?ID=144 http://impact.arc.nasa.gov/news_detail.cfm?ID=151 http://antwrp.gsfc.nasa.gov/apod/ap041001.html http://antwrp.gsfc.nasa.gov/apod/ap041002.html http://www.planetary.org/news/2004/0927_Very_Close_Approach_by_Asteroid_4179.html http://www.planetary.org/news/2004/0929_Simultaneous_Observations_of_Asteroid.html http://en.wikipedia.org/wiki/4179_Toutatis See also: **8 Dec 1992**, **30 Nov 1996**, **31 Oct 2000**, **9 Nov 2008**, **12 Dec 2012**, **5 Nov 2069**.
2004, Oct	NASA **Meteoroid Environment Office**, established in October 2004, at NASA Marshall Space Flight Center, Huntsville (AL, USA). The office set up the NASA **All-sky Fireball Network**. See: http://www.nasa.gov/offices/meo/home/aboutMEO-rd.html http://fireballs.ndc.nasa.gov/
2004, Oct	American Institute of Aeronautics and Astronautics (AIAA), Position Paper *Protecting Earth from Asteroids and Comets*. See: http://pdf.aiaa.org//downloads/publicpolicypositionpapers//Asteroids-Final. pdf http://www.planetarydefense.info/resources/pdf/Asteroids-Final.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=153
2004, Oct 2	Aten NEA **2016 TQ54** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 1.84 LD. Minimum miss distance 0.13 LD. See: 2016 TQ54 - JPL , 2016 TQ54 - SSA
2004, Oct 16	Apollo NEA **2017 UR2** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 3.93 LD. Minimum miss distance **0.016 LD (= 0.99 R_{Earth} from the geocenter)**. See: 2017 UR2 - SSA , 2017 UR2 - JPL See also: **17 Oct 2017, 21 Oct 2119**.

2004, Oct 24	Aten NEA **2004 UH1** (H = 28.4 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2004-09]** See: 2004 UH1 - JPL , 2004 UH1 - SSA See also: **24 Oct 1960**.
2004, Nov	D. Lazzaro, C.A. Angeli, J.M. Carvano, et al., 2004, *Icarus*, 172, 179, "**S³OS²**: the visible spectroscopic survey of 820 asteroids." See: http://adsabs.harvard.edu/abs/2004Icar..172..179L **S³OS²: Small Solar System Objects Spectroscopic Survey** – carried out at the ESO (La Silla, Chile). See also: http://sbn.psi.edu/pds/resource/s3os2.html
2004, Nov 27 – Dec 2	***ICSU Workshop on NEOs*** in La Laguna (Tenerife, Spain), "Tenerife Retreat", supported by the 2004 ICSU/UNESCO Grant Programme, and co-sponsored by the IAU. Proceedings: P. Bobrowsky & H. Rickman (eds.), 2007, ***Comet/Asteroid Impacts and Human Society*** (Berlin: Springer). See: http://adsabs.harvard.edu/abs/2007caih.book.....B http://thelightofdayradioshow.com/.../Comet-Asteroid-Impacts-and-Human-Socie... See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=155 http://www.icsu.org/what-we-do/projects-activities/icsu-grants-programme/grant-summary-reports/?icsudocid=summary-2004 http://www-th.bo.infn.it/tunguska/ICSU_PARTICIPANTS_LIST.pdf
2004, Nov 26	E. Asphaug, 2004, *Science*, 306, 1489, "Nothing simple about asteroids." See: http://www.sciencemag.org/content/306/5701/1489.summary
2004, Dec	M.J.S. Belton, T.H. Morgan, N. Samarasinha & D.K. Yeomans (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2004mhca.conf.....B http://cambridge.org/us/catalogue/catalogue.asp?isbn=9780521827645&ss=ind http://www.cambridge.org/gb/knowledge/isbn/item1170928/?site_locale=en_GB Abstracts: http://www.noao.edu/meetings/mitigation/eav.html **Full report and recommendations:** http://www.beltonspace.com/bsei_web_page_0000d.htm

2004, Dec	M.D. Campbell-Brown, A. Hildebrand, 2004, *Earth, Moon, and Planets*, 95, 489, "A new analysis of **fireball data** from the **Meteorite Observation and Recovery Project (MORP)**." See: http://adsabs.harvard.edu/abs/2004EM%26P...95..489C
2004, Dec	D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 38, "The role of radar in predicting and preventing asteroid and comet collisions with Earth." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M
2004, Dec	S.J. Ostro, J.D. Giorgini, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf...38O
2004, Dec	A.S. Rivkin, R.P. Binzel, J. Sunshine, et al., 2004, *Icarus*, 172, 408, "Infrared spectroscopic observations of **69230 Hermes (1937 UB)**: possible unweathered endmember among ordinary chondrite analogs." See: http://adsabs.harvard.edu/abs/2004Icar..172..408R
2004, Dec 9	Aten NEA **2015 XT378** (H = 28.3 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 2.65 LD. Minimum miss distance 0.20 LD. See: 2015 XT378 - JPL , 2015 XT378 - SSA
2004, Dec 16	Apollo NEA **2004 XB45** (H = 26.2 mag, $D \approx$ 21 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.84 LD. **[2004-10]** See: 2004 XB45 - JPL , 2004 XB45 - SSA
2004, Dec 19	Apollo NEA **2004 YD5** (H = 29.2 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.088 LD **(= 5.32 R_{Earth} from the geocenter)**. Minimum miss distance 0.088 LD. **[2004-11]** See: 2004 YD5 - JPL , 2004 YD5 - SSA See also: http://www.space.com/scienceastronomy/asteroid_close_041222.html
2004, Dec 24	Apollo NEA **184266** (**2004 VW14**, H = 19.3 mag, $D \approx$ 500 m, **PHA**) passed Earth at a nominal miss distance of 4.93 LD. Minimum miss distance 4.93 LD. See: 2004 VW14 - JPL , 2004 VW14 - SSA

2005, Jan 1	**3146 NEAs** known, of which **646 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2005	T. Kenkmann, F. Hörz, A. Deutsch (eds.), 2005, Proceedings ***Large meteorite impacts III***, *Geological Society of America Special Papers*, Vol. 384. See: http://specialpapers.gsapubs.org/content/384
2005	D. Morrison, 2005, *Science and Global Security*, 13, 87, "Defending the Earth against asteroids: the case for a global response." See: http://www.informaworld.com/smpp/content~content=a714010227~db=all~jumptype=rss http://www.princeton.edu/sgs/publications/sgs/pdf/13%201-2%20Morrision.pdf
2005, Jan	M.C. Nolan, L.A. Benner, G. Black, et al., 2005, in: O. Engvold (ed.), *Highlights of Astronomy*, 13, 759, as presented at the ***XXVth General Assembly of the IAU***, Sydney (Australia), 13 - 26 July 2003 (San Francisco: ASP), "Radar observations of Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2005HiA....13..759N
2005, Jan	P. Pravec, A.W. Harris, P. Scheirich, et al., 2005, *Icarus*, 173, 108, "Tumbling asteroids." See: http://adsabs.harvard.edu/abs/2005Icar..173..108P
2005, Jan 7	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS),** *Information on research in the field of NEOs carried out by Member States, international organizations and other entities.* See: http://www.unoosa.org/pdf/reports/ac105/AC105_839E.pdf
2005, Jan 13	Apollo NEA **2005 BS1** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.68 LD. Minimum miss distance 0.68 LD. **[2005-01]** See: 2005 BS1 - JPL , 2005 BS1 - SSA
2005, Feb 21- Mar	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and Technical Subcommittee*, 42nd Session, Action Team 14** on NEOs meets in Vienna (Austria), during the 42nd session of the Scientific & Technical Subcommittee of **UN-COPUOS**. Report 25 February 2005. Hans Rickman, former IAU General Secretary, presents paper "Comet/Asteroid Impacts and Human Society". The Planetary Defense Center of Lavochkin

	Association, Moscow (Russia) presents a proposal "Creation of the 'Citadel' International Planetary Defense System." **Report:** http://www.unoosa.org/pdf/reports/ac105/AC105_848E.pdf See also: http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_863Add1E.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=47
2005, Feb	A. Milani, S.R. Chesley, M.E. Sansaturio, 2005, *Icarus*, 173, 362, "Nonlinear impact monitoring: line of variation searches for impactors." See: http://adsabs.harvard.edu/abs/2005Icar..173..362M
2005, Feb 15	A.M. MacRobert, 15 February 2005, *Sky & Telescope*, "Asteroid **2004 MN4**: a really near miss!" See: http://www.skyandtelescope.com/news/3310036.html?page=1&c=y
2005, Mar 5	H. Rickman, former IAU General Secretary, 2005, in: A. Heck (ed.), 2006, *Organizations and Strategies in Astronomy*, Vol. 6 (Dordrecht: Springer), p. 225, "IAU initiatives relating to the Near Earth Object impact hazard." See: http://adsabs.harvard.edu/abs/2006ASSL..335..225R
2005, Mar 10	H.J. Melosh, G.S. Collins, 2005, *Nature*, 434, 157, "**Meteor Crater** formed by a low-velocity impact." See: http://adsabs.harvard.edu/abs/2005Natur.434..157M See also: http://articles.cnn.com/2005-03-09/tech/arizona.meteor.crater_1_meteor-crater-jay-melosh-space-rock?_s=PM:TECH
2005, Mar 18	Aten NEA **2005 FN** (H = 26.6 mag, $D \approx$ 17 m) passed Earth at a nominal miss distance of 0.37 LD. Minimum miss distance 0.37 LD. **[2005-02]** See: 2005 FN - JPL , 2005 FN - SSA
2005, Apr	P. Michel, A. Morbidelli, W.F. Bottke, 2005, *Comptes Rendus – Physique*, 6, 291, "Origin and dynamics of Near Earth Objects." See: http://adsabs.harvard.edu/abs/2005CRPhy...6..291M
2005, Apr	W. Thuillot, J. Vaubaillon, H. Scholl, 2005, *Comptes Rendus - Physique*, 6, 327, "Relevance of the NEO dedicated observing programs." See: http://adsabs.harvard.edu/abs/2005CRPhy...6..327T
2005, Apr 13	Apollo NEA **2018 GD2** (H = 29.5 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 9.77 LD. Minimum miss distance 0.78 LD. 2018 GD2 - SSA , 2018 GD2 - JPL

	See also: **12 Apr 2018**, **15 Oct 2065**.
2005, May 20	R.L. Schweickart, 2005, presented at the National Space Society *International Space Development Conference*, Washington (DC, USA), "A call to (considered) action". See: http://www.b612foundation.org/papers/Call_for_Action.pdf See also: http://www.thespacereview.com/article/384/1
2005, May 26	R. Gomes, H.F. Levison, K. Tsiganis, A. Morbidelli, 2005, *Nature*, 435, 466, "Origin of the cataclysmic **Late Heavy Bombardment** period of the terrestrial planets." See: http://adsabs.harvard.edu/abs/2005Natur.435..466G
2005, May 31	J. Foust, *The Space Review*, 31 May 2005, "Sounding an alarm, cautiously." See: http://www.thespacereview.com/article/384/1
2005, Jun	G.S. Collins, H.J. Melosh, R.A. Marcus, 2005, *Meteoritics & Planetary Science*, 40, 817, "Earth impact effects program: a web-based computer program for calculating the regional environmental consequences of a meteoroid impact on Earth." See: http://adsabs.harvard.edu/abs/2005M%26PS...40..817C http://www.lpl.arizona.edu/impacteffects/ http://www.lpl.arizona.edu/impacteffects/CollinsEtAl2005.pdf
2005, Jun 6 – Oct 1	Exchange of letters between **B612 Foundation** and NASA Administrator re the potential need for a near-term launch of a mission to **Apophis (2004 MN4)** to precisely determine its orbit in order to permit an orderly deflection mission should it, in fact, be on an impact trajectory. See: http://www.b612foundation.org/press/press.html #11.
2005, Jun 10	Aten NEA **2018 UC** ($H = 26.0$ mag, $D \approx 22$ m) passed Earth at a nominal miss distance of 8.55 LD. Minimum miss distance 0.92 LD. 2018 UC - SSA , 2018 UC - JPL See also: **30 Oct 1941**.
2005, Jul	**Vredefort crater**, located in the Free State Province of South Africa, and named after the town of Vredefort situated near its centre, is the largest verified impact crater on Earth. The site is also referred to as **Vredefort** dome or **Vredefort** impact structure. In 2005, the **Vredefort** Dome was added to the list of UNESCO World Heritage Sites for its geologic interest. The asteroid that hit the **Vredefort** area in pre-historic times is one of the largest to ever impact Earth (at least since the Hadean), with an estimated

	diameter of $D > 10$ km. The crater has a diameter $d \approx 250 - 300$ km, larger than the 200 km wide **Sudbury Basin crater** and the 170 km wide **Chicxulub crater**. This makes **Vredefort** the largest known impact structure on Earth. The age is estimated to be 2,023 ± 4 million years, impacting during the Paleoproterozoic era. Ref: - E.P. Turtle, E. Pierazzo, D.P. O'Brien, 2003, *Meteoritics & Planetary Science*, 38, 293, "Numerical modeling of impact heating and cooling of the **Vredefort impact** structure." See: http://adsabs.harvard.edu/abs/2003M%26PS...38..293T - W.U. Reimold, R.L. Gibson, 2005, "Meteorite Impact! The danger from space and South Africa's mega-impact the **Vredefort** structure" (Johannesburg: Chris van Rensburg Publications). Review by D.T. King. See: http://onlinelibrary.wiley.com/doi/10.1111/j.1945-5100.2005.tb00154.x/abstract - R.A.F. Grieve, W.U. Reimold, J. Morgan, et al., 2008, *Meteoritics & Planetary Science*, 43, 855, "Observations and interpretations at **Vredefort**, **Sudbury**, and **Chicxulub**: towards an empirical model of terrestrial impact basin formation." See: http://adsabs.harvard.edu/abs/2008M%26PS...43..855G See also: http://en.wikipedia.org/wiki/Vredefort_crater http://www.hartrao.ac.za/other/vredefort/vredefort.html http://en.wikipedia.org/wiki/Earth_Impact_Database
2005, Jul 4	NASA spacecraft ***Deep Impact*** collided with comet **9P/Tempel**. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=159 http://impact.arc.nasa.gov/news_detail.cfm?ID=160 http://www.nasa.gov/pdf/474723main_Johnson-DI_Lessons_Learned_for_NOW.ppt.pdf http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-367 http://en.wikipedia.org/wiki/Deep_Impact_(space_mission)
2005, Jul 20	E. Asphaug, 2005, *Nature*, 436, 335, "Asteroids: shaken on impact." See: http://adsabs.harvard.edu/abs/2005Natur.436..335A
2005, Aug	M. Ćuk, J.A. Burns, 2005, *Icarus*, 176, 418, "Effects of thermal radiation on the dynamics of binary NEAs." See: http://adsabs.harvard.edu/abs/2005Icar..176..418C
2005, Aug 7-12	**IAU Symposium No. 229 on *Asteroids, Comets, Meteors, IX*,** Búzios (Rio de Janeiro, Brazil). Proceedings: D. Lazzaro, S. Ferraz-Mello & J.A. Fernández (eds.), 2006, *Asteroids, Comets, Meteors 2005* (Cambridge: CUP).

	See: http://journals.cambridge.org/action/displayIssue?jid=IAU&volumeId=1&issueId=S229
2005, Aug 7	R.P. Binzel, D.F. Lupishko, 2006, in: D. Lazzaro, S. Ferraz-Mello & J.A. Fernández (eds.), Proc. IAU Symposium No. 229 on *Asteroids, Comets, Meteors, IX*, Búzios (Rio de Janeiro, Brazil), 7-12 Aug 2005 (Cambridge: CUP), p. 207, "Properties of the Near-Earth object population: the ACM 2005 view." See: http://adsabs.harvard.edu/abs/2006IAUS..229..207B
2005, Aug 7	S.R. Chesley, 2006, in: D. Lazzaro, S. Ferraz-Mello & J.A. Fernández (eds.), Proc. IAU Symposium No. 229 on *Asteroids, Comets, Meteors, IX*, Búzios (Rio de Janeiro, Brazil), 7-12 Aug 2005 (Cambridge: CUP), p. 215, "Potential impact detection for Near-Earth asteroids: the case of **99942 Apophis (2004 MN4)**." See: http://adsabs.harvard.edu/abs/2006IAUS..229..215C http://www.b612foundation.org/papers/Chesley_paper.pdf
2005, Aug 13	**Spaceguard Survey** progress: **3496 NEAs** known, of which 793 with $D > 1$ km. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=162
2005, Aug 25	A.R. Klekociuk, P.G. Brown, D.W. Pack, et al., 2005, *Nature*, 436, 1132, "Meteoritic dust from the atmospheric disintegration of a large meteoroid." See: http://adsabs.harvard.edu/abs/2005Natur.436.1132K
2005, Sep	M.J. Gaffey, P.A. Abell, P.S. Hardersen, et al., 2005, in: Proc. *68th Annual Meeting of the Meteoritical Society*, 12-16 September 2005, Gatlinburg (TN, USA), *Meteoritics & Planetary Science*, 40, Supplement, p.5127, "Compositions of binary Near-Earth Objects: implications for the meteorite flux." See: http://adsabs.harvard.edu/abs/2005M%26PSA..40.5127G
2005, Sep	D.T. King, L.W. Petruny, 2005, in: Proc. *68th Annual Meeting of the Meteoritical Society*, 12-16 September 2005, Gatlinburg (TN, USA), *Meteoritics & Planetary Science*, 40, Supplement, p.5317, "The stratigraphic and historic record of meteoritic impact events in Alabama." See: http://adsabs.harvard.edu/abs/2005M%26PSA..40.5317K
2005, Sep 25	ESA selected two target asteroids for its NEO deflection mission concept ***Don Quijote***, under study by ESA's Advanced Concepts Team (ACT). In February 2005 ESA's **NEO Mission Advisory Panel (NEOMAP)** submitted a target selection report for Europe's

	future asteroid mitigation missions, identifying the relevant criteria for selecting a target and picking two objects that meet most of those criteria: asteroid **10302** (**1989 ML**, *H* = 19.5 mag, *D* = 500 m, Amor asteroid) and asteroid **2002 AT4** (*H* = 20.9 mag, *D* = 160 × 370 m, Amor asteroid). Three industrial phase-A studies were completed in September 2007. See: http://www.esa.int/esaCP/SEML9B8X9DE_index_0.html http://www.esa.int/SPECIALS/NEO/SEMZRZNVGJE_0.html http://www.esa.int/SPECIALS/NEO/SEM3P4OVGJE_0.html http://www.esa.int/SPECIALS/NEO/SEMVXVB1S6F_0.html http://en.wikipedia.org/wiki/Don_Quijote_(space_probe) http://www.nasa.gov/pdf/474203main_Coradini_ExploreNOW.pdf http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf
2005, Sep - Oct	R.L. Schweickart, C.R. Chapman, 2005, *American Scientist*, 93, 392, "Better collision insurance - asteroids smaller than those now being actively catalogued constitute a largely neglected natural hazard." See: http://www.americanscientist.org/issues/pub/better-collision-insurance http://impact.arc.nasa.gov/news_detail.cfm?ID=163
2005, Oct	D.J. Asher, M. Bailey, V. Emel'yanenko, W. Napier, 2005, *The Observatory*, 125, 319, "Earth in the cosmic shooting gallery." See: http://adsabs.harvard.edu/abs/2005Obs...125..319A
2005, Oct 10	Apollo NEA **2005 TK50** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.23 LD. **[2005-03]** See: 2005 TK50 - JPL , 2005 TK50 - SSA
2005, Oct 10-14	The Association of Space Explorers (ASE), at its XIX Congress in Salt Lake City (Utah, USA), formed the **ASE Committee on Near-Earth Objects** (chair Russell L. Schweickart), and charged it with bringing to the attention of world leaders and key international institutions the threat of asteroid impacts to life on Earth. An Open Letter elaborates on the issue. See: http://www.space-explorers.org/committees/NEO/docs/ASE_intro_AT-14.pdf http://www.space-explorers.org/committees/NEO/docs/Open_Letter.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=164
2005, Oct 16	Apollo NEA **2017 BG92** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at

	a nominal miss distance of 3.49 LD. Minimum miss distance 0.62 LD. See: 2017 BG92 – SSA , 2017 BG92 – JPL
2005, Oct 30	Apollo NEA **2005 UW5** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2005-04]** See: 2005 UW5 - JPL , 2005 UW5 - SSA
2005, Nov	H. Fu, R. Jedicke, D.D. Durda, et al., 2005, *Icarus*, 178, 434, "Identifying near-Earth object families." See: http://adsabs.harvard.edu/abs/2005Icar..178..434F
2005, Nov	D.P. O'Brien, R. Greenberg, 2005, *Icarus*, 178, 179, "The collisional and dynamical evolution of the main-belt and NEA size distributions." See: http://adsabs.harvard.edu/abs/2005Icar..178..179O
2005, Nov	V.V. Svetsov, 2005, *Planetary and Space Science*, 53, 1205, "Numerical simulations of very large impacts on the Earth." See: http://adsabs.harvard.edu/abs/2005P%26SS...53.1205S
2005, Nov 1	**Taurid Meteor shower** over Cerro Pachon (Chile). See: http://apod.nasa.gov/apod/ap051115.html
2005, Nov 10	E.T. Lu, S.G. Love, 2005, *Nature*, 438, 177: "***Gravitational tractor*** for towing asteroids", an article describing how a spacecraft could deflect an Earth-bound asteroid without having to dock to its surface. See: http://adsabs.harvard.edu/abs/2005Natur.438..177L http://www.b612foundation.org/press/press.html #12.
2005, Nov 19, 25	Japan Aerospace Exploration Agency (JAXA) spacecraft ***Hayabusa*** (formerly MUSES-C), launched 9 May 2003, lands on Apollo NEA **25143 Itokawa** (**1998 SF36**, *H* = 19.1 mag, *D* = 535 × 290 × 209 m, $M = 3.6 \times 10^{10}$ kg, **PHA**). The first rendezvous mission to a PHA. Sample return to Earth in June 2010. JAXA is considering a ***Hayabusa2*** sample return mission to Apollo NEA **162173 Ryugu** (**1999 JU3**, *H* = 19.5 mag, *D* ≈ 870 m, **PHA**). See: http://www.isas.ac.jp/e/enterp/missions/hayabusa/index.shtml http://www.jspec.jaxa.jp/e/activity/hayabusa2.html http://en.wikipedia.org/wiki/Hayabusa https://en.wikipedia.org/wiki/25143_Itokawa Ref: - I. Fuyuno, 2005, *Nature*, 438, 542, "***Hayabusa*** ready to head

	home with asteroid sample." See: http://adsabs.harvard.edu/abs/2005Natur.438..542F - E. Asphaug, 2006, *Science*, 312, 1328, "Adventures in Near-Earth Object exploration." See: http://adsabs.harvard.edu/abs/2006Sci...312.1328A http://www.ipsubc.org/paper/1328.pdf - A. Fujiwara, et al., 2006, *Science*, 312, 1327, "***Hayabusa*** at asteroid **Itokawa.**" See: http://www.sciencemag.org/content/312/5778.toc - A. Fujiwara, J. Kawaguchi, D.K. Yeomans, et al., *Science*, 312, 1330, "The rubble-pile asteroid **Itokawa** as observed by ***Hayabusa***." See: http://adsabs.harvard.edu/abs/2006Sci...312.1330F - J. Saito, H. Miyamoto, R. Nakamura, et al., 2006, *Science*, 312, 1341, "Detailed images of asteroid **25143 Itokawa** from ***Hayabusa***." See: http://adsabs.harvard.edu/abs/2006Sci...312.1341S - H. Yano, T. Kubota, H. Miyamoto, et al., 2006, *Science*, 312, 1350, "Touchdown of the ***Hayabusa*** spacecraft at the Muses Sea on **Itokawa**." See: http://adsabs.harvard.edu/abs/2006Sci...312.1350Y - M. Yoshikawa, A. Fujiwara, J. Kawaguchi, 2007, in: K.A. van der Hucht (ed.), *Highlights of Astronomy*, Vol. 14, presented at the ***IAU XXVI General Assembly,*** Prague, 2006 (Cambridge: CUP), p. 323, "***Hayabusa*** and its adventure around the tiny asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2007HiA....14..323Y - M. Yoshikawa, A. Fujiwara, J. Kawaguchi, et al., 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), *Near Earth Objects, our Celestial Neighbors: Opportunities and Risk*, Proc. IAU Symposium No. 236, Prague, 2006 (Cambridge: CUP), p. 401, "The nature of asteroid **Itokawa** revealed by ***Hayabusa***." See: http://adsabs.harvard.edu/abs/2007IAUS..236..401Y Read further the items of 13 June 2010 and 17 November 2010. See also: http://www.unoosa.org/pdf/pres/stsc2010/tech-44.pdf http://www.nasa.gov/pdf/474205main_Kuninaka_HayabusaLL_ExploreNOW.pdf http://blogs.nature.com/news/thegreatbeyond/2010/06/japan_celebrates_asteroid_roun.html http://www.youtube.com/watch?v=bbI78CZWP7g http://www.youtube.com/watch?v=jEyQDwAUfRQ&NR=1 http://www.youtube.com/watch?v=qtwTD8cBhKc&NR=1 http://www.nature.com/news/2010/290610/full/466016a.html http://www.space.com/news/japan-approves-asteroid-probe-new-rocket-100820.html http://antwrp.gsfc.nasa.gov/apod/ap070422.html http://www.nature.com/news/2011/110825/full/news.2011.506.html

	http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10080/150_read-5773/year-all/
2005, Nov 23	**Workshop *Near Earth Objects, a Natural Hazard of Global Proportions***, London (UK), hosted by the Royal Aeronautical Society. See: http://www.raes.org.uk/conference/PDFs/520.pdf http://www.spaceref.com/news/viewpr.html?pid=18431
2005, Nov 26	Apollo NEA **2005 WN3** (H = 30.2 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.22 LD. **[2005-05]** See: 2005 WN3 - JPL , 2005 WN3 - SSA
2005, Dec	C.S. Cockell, P. Lee, P. Broady, 2005, *Meteoritics & Planetary Science*, 40, 1901, "Effects of asteroid and comet impacts on habitats for lithophytic organisms – a synthesis." See: http://adsabs.harvard.edu/abs/2005M%26PS...40.1901C
2005, Dec 5	Apollo NEA **2005 XA8** (H = 25.8 mag, $D \approx$ 24 m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.56 LD. **[2005-06]** See: 2005 XA8 - JPL , 2005 XA8 - SSA
2005, Dec 22	US Congress passed Section 321 of the NASA Authorization Act of 2005 (Public Law No. 109-155), a.k.a. the "George E. Brown Jr NEO Survey Act" (in honour of US Congressman G. E. Brown, 1920 – 1999), charging NASA to detect, track and characterize 90% of NEOs with D > 140 m that could potentially strike Earth, by the end of 2020. Aim probably not reached before 2028. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=54 http://www.govtrack.us/congress/billtext.xpd?bill=s109-1281 http://en.wikipedia.org/wiki/Planetary_defense#cite_note-morrison_1992-1
2006, Jan 1	**3775 NEAs** known, of which **741 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2006	A. Cellino, R. Somma, L. Tommasi, et al., 2006, *Advances in Space Research*, 37, 153, "NERO: general concept of a Near-Earth Object radiometric observatory." See: http://adsabs.harvard.edu/abs/2006AdSpR..37..153C
2006	J. de Léon, J. Licandro, R. Duffard, M. Serra-Ricart, 2006, *Advances in Space Research*, 37, 178, "Spectral analysis and

	mineralogical characterization of 11 olivine pyroxene rich NEAs." See: http://adsabs.harvard.edu/abs/2006AdSpR..37..178D
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2006	O. Văduvescu, M. Birlan, 2006, *Romanian Astronomical Journal*, 16 (2), 201, "Planning Near-Earth Asteroid observations on a 1-meter class telescope." See: http://adsabs.harvard.edu/abs/2006RoAJ...16..201V
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2006, Jan	K.J. Walsh, D.C. Richardson, 2006, *Icarus*, 180, 201, "Binary near-Earth asteroid formation: rubble pile model of tidal disruptions." See: http://adsabs.harvard.edu/abs/2006Icar..180..201W
2006, Jan 12	E. Asphaug, C.B. Agnor, Q. Williams, 2006, *Nature*, 439, 155, "Hit-and-run planetary collisions." See: http://adsabs.harvard.edu/abs/2006Natur.439..155A
2006, Jan 27, 29, 3(	**Arecibo** radar observations of Aten NEA **99942 Apophis** (**2004 MN4**, $H = 19.1$ mag, $D = 310 \pm 30$ m, $M \approx 4.7 \times 10^{10}$ kg, orbital $P = 0.89$ yr, **PHA**) by Steven J. Ostro. See: 2004 MN4 - JPL , 99942 Apophis - SSA See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=1253 http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://en.wikipedia.org/wiki/99942_Apophis
2006, Jan 28	Apollo NEA **2006 BV39** ($H = 29.1$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88 LD. **[2006-01]** See: 2006 BV39 - JPL , 2006 BV39 - SSA

2006, Jan 29	Apollo NEA **2006 BF56** (*H* = 29.7 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.53 LD. **[2006-02]** See: 2006 BF56 - JPL , 2006 BF56 - SSA
2006, Feb	G. Beekman, 2006, *Journal for the History of Astronomy*, 37, 71, "I.O. Yarkovsky and the discovery of 'his' effect." See: http://adsabs.harvard.edu/abs/2006JHA....37...71B
2006, Feb 16	Apollo NEA **2020 QN4** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 4.92 LD. Minimum miss distance 0.58 LD. See: 2020 QN4 – S2P , 2020 QN4 - JPL See also: **21 Aug 2020**, **21 Feb 2050**.
2006, Feb 18	Apollo NEA **2020 DA1** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 4.41 LD. Minimum miss distance 0.14 LD. See: 2020 DA1 – S2P , 2020 DA1 - JPL See also: **18 Feb 2020**.
2006, Feb 20	**The Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**. Pursuant to paragraph 16 of UN General Assembly resolution 61/111 of 14 December 2006, the **UN-COPUOS Scientific and Technical Subcommittee**, at its 670th meeting, on 20 February, established a **Working Group on Near-Earth Objects** for one year under the chairmanship of Richard Tremayne-Smith (UK). See: http://www.unoosa.org/pdf/reports/ac105/AC105_890E.pdf Annex III http://www.space-explorers.org/committees/NEO/docs/ASE_Intervention.pdf
2006, Feb 20	R.L. Schweickart, 2006, presentation to the Royal Aeronautical Society & CCLRC, Rutherford Appleton Laboratory (U.K.), 20 February 2006, "Near-Earth Asteroids: deciding to deflect." See: http://www.space-explorers.org/committees/NEO/neo.html
2006, Feb 23	Apollo NEA **2006 DD1** (*H* = 26.4 mag, *D* ≈ 19 m) passed Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.31 LD. **[2006-03]** See: 2006 DD1 - JPL , 2006 DD1 - SSA
2006, Feb 24	Aten NEA **2006 DM63** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.59 LD. **[2006-04]** See: 2006 DM63 - JPL , 2006 DM63 - SSA

2006, Mar	P. Pravec, P. Scheirich, P. Kušnirák, et al., 2006, *Icarus*, 181, 63, "Photometric survey of binary near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2006Icar..181...63P
2006, Mar	S.P. Wright, M.A. Vesconi, A. Gustin, 2006, presented at *37th Annual Lunar and Planetary Science Conference*, 13-17 March 2006, League City (TX, USA), abstract no.1102, "Revisiting the **Campo Del Cielo Crater Field** (Argentina): a new data point from a natural laboratory of multiple low velocity, oblique impacts." See: http://adsabs.harvard.edu/abs/2006LPI....37.1102W Read also: - M.C.L. Rocca, September 2006, presented at Proc. *69th Annual Meeting of the Meteoritical Society*, 6-11 August 2006, Zürich (Switzerland), *Meteoritics & Planetary Science*, 41, Supplement, p. 5001, "A catalogue of large meteorite specimens from **Campo Del Cielo Meteorite** shower, Cahco Province (Argentina)." See: http://adsabs.harvard.edu/abs/2006M%26PSA..41.5001R - P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/asteroid impacts and human society* (Berlin: Springer), p. 30, "Campo del Cielo, Argentina)." See: http://adsabs.harvard.edu/abs/2007caih.book.....B The **Campo del Cielo Meteorites** refers to a group of iron meteorites or to the area where they were found situated on the border between the provinces of Chaco and Santiago del Estero, 1,000 kilometers NW of Buenos Aires (Argentina). The crater field covers an area of 3×20 km and contains at least 26 craters, the largest being 115×91 m. The craters' age is estimated as 4,000 – 5,000 years. The craters, containing iron masses, were reported in 1576, but were already well known to the aboriginal inhabitants of the area. The craters and the area around contain numerous fragments of an iron meteorite. The total weight of the pieces so far recovered exceeds 100 tonnes, making the meteorite the heaviest one ever recovered on Earth. The largest fragment, consisting of 37 tonnes, is the second heaviest single-piece meteorite recovered on Earth, after the **Hoba Meteorite** (see: June 1967). See also: http://www.lpi.usra.edu/meetings/lpsc2006/pdf/1102.pdf http://www.lpi.usra.edu/meetings/metsoc2006/pdf/5001.pdf http://en.wikipedia.org/wiki/Campo_del_Cielo
2006, Mar 1-2	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and Technical Subcommittee*, 43rd Session, Action Team 14 on NEOs** meets in Vienna (Austria). **Report 16 March 2006:** http://www.unoosa.org/pdf/reports/ac105/AC105_869E.pdf

2006, Mar 3	In December 1932, scientists surveying the southern Egyptian desert came upon pieces of a translucent, pale yellow-green, glassy substance, from tiny fragments to football-sized chunks, scattered over a huge area at the Libyan border. Known as **Libyan Desert Glass**, this almost pure silica contained isotopes showing it to be of extraterrestrial origin. But scientists had not been able to figure out where it came from. Now Farouk El-Baz, director of the Boston University Center for Remote Sensing, believes the mystery has been solved. On satellite images of the Sahara Desert, he found a gigantic impact crater in the area. At a diameter of 30 km, it's "the largest crater yet found in the Sahara," El-Baz says, and big enough to be the source of the glass, which covers a 60- by 100-km area. He believes the crater hadn't been recognized before because it is so big; also, parts of its rims were eroded by two ancient river systems. El-Baz has named the crater, located on the Gilf Kebir plateau, the Kebira. Ref: - N.N., 2006, *Science*, 311, 1223, "Glass with an impact." See: http://www.sciencemag.org/content/311/5765/1223.2.full.pdf - K. Floor, E. Echternach, 2006, *Zenit*, September 2006, p. 404, "Het is rond en het... . Inslagkraters op satellietbeelden." See: http://www.dekoepel.nl/zenit/september2006.html http://keesfloor.nl/artikelen/zenit/2006pdf/kraters.pdf - L. Orti, M. di Martino, M. Morelli, et al., 2008, *Meteoritics & Planetary Science,* 43, 1629, "Non-impact origin of the crater-like structures in the Gilf Kebir area (Egypt): implications for the geology of eastern Sahara." See: http://adsabs.harvard.edu/abs/2008M%26PS...43.1629O - G.R. Osinski, J. Kieniewics, J.R. Smith, M.B.E. Boslough, et al., 2008, *Meteoritics & Planetary Science*, 43, 2089, "The **Dakhleh Glass**: product of an impact airburst or cratering event in the Western Desert of Egypt?" See: http://adsabs.harvard.edu/abs/2008M%26PS...43.2089O See also: http://www.sciencemag.org/cgi/content/summary/311/5765/1223c http://www.planetary.org/news/2006/0303_Egyptian_Impact_Site_Possible_Source.html http://www.wits.ac.za/newsroom/newsitems/201310/21649/news_item_21649.html http://en.wikipedia.org/wiki/Kebira_crater http://en.wikipedia.org/wiki/Libyan_desert_glass
2006, Mar 8	Apollo NEA **2006 EC** (H = 26.5 mag, $D \approx$ 18 m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2006-05]** See: 2006 EC - JPL , 2006 EC - SSA See also: **11 March 2063**.

2006, Mar 20	B. Peiser, 2006, *The Space Review*, 20 March 2006, "Asteroid turns hot potato: when NEO risk communication becomes uncommunicative." See: http://www.thespacereview.com/article/581/1
2006, Mar 20	B.G. Marsden, 2006, *The Space Review*, 20 March 2006, "**2004 VD17**, impact assessment scales, and a natural impact warning clearinghousee." See: http://www.thespacereview.com/article/581/2 See also: **7 November 2041**.
2006, Mar 29	**Earth-grazing fireball**, travelling in 30 seconds about 1000 km, 71 km above Japan. Estimated mass $M \approx 100$ kg. Ref: - S. Abe, J. Borovička, P. Spurný, et al., 2006, Proc. *European Planetary Science Congress* 2006, Berlin (Germany), 18-22 September 2006, "**Earth-grazing fireball** on March 29, 2006." See: http://adsabs.harvard.edu/abs/2006epsc.conf..486A http://en.wikipedia.org/wiki/Earth-grazing_fireball
2006, Mar 31	Aten NEA **2021 FW2** ($H = 25.4$ mag, $D \approx 30$ m) passed Earth at a nominal miss distance of 3.10 LD. Minimum miss distance 0.16 LD. See: 2021 FW2 - S2P , 2021 FW2 – JPL See also: **31 March 2064**.
2006, Apr	P.A. Bland, N.A. Artemieva, 2006, *Meteoritics*, 41, 607, "The rate of small impacts on Earth." See: http://adsabs.harvard.edu/abs/2006M%26PS...41..607B
2006, Apr 24	Apollo NEA **2020 HX3** ($H = 27.2$ mag, $D \approx 13$ m) passed Earth at a nominal miss distance of 4.35 LD. Minimum miss distance 0.34 LD. See: 2020 HX3 – S2P , 2020 HX3 - JPL See also: **24 Apr 2020**. See: also: https://www.space.com/house-size-asteroid-2020-gh2-earth-flyby-april-2020.html
2006, Apr 26-28	**International Conference on *Near-Earth Objects Hazard: Knowledge and Action***, Belgirate (Italy).
2006, May	W.F. Bottke, A. Morbidelli, 2006, in: *Workshop on Surface Ages and Histories: Issues in Planetary Chronology*, Houston (TX, USA), 23 May 2006, *LPI Contribution* No. 1320, "The asteroid

	and comet impact flux in the terrestrial planet region: a brief history of the last 4.6 Gy." See: http://adsabs.harvard.edu/abs/2006LPICo1320...18B
2006, May	W.F. Bottke, D. Vokrouhlický, D.P. Rubincam, D. Nesvorný, 2006, *Annual Review of Earth and Planetary Sciences*, 34, 157, "The Yarkovsky and YORP effects: implications for asteroid dynamics." See: http://adsabs.harvard.edu/abs/2006AREPS..34..157B
2006, May 8-12	**40th ESLAB *Symposium, 1st International Conference on Impact Cratering in the Solar System***, Noordwijk (the Netherlands), 8-12 May 2006. See: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=37662
2006, May 10	Apollo NEA **2006 JY26** (H = 28.3 mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 1.13 LD (and the Moon at 0.38 LD). Minimum miss distance 1.13 LD (and the Moon at 0.38 LD). See: 2006 JY26 - JPL , 2006 JY26 - SSA Ref: - R. Brasser, P. Wiegert, 2008, *Monthly Notices Royal Astronomical Society*, 386, 2931, "Asteroids on Earth-like orbits and their origin." See: http://adsabs.harvard.edu/abs/2008MNRAS.386.2031B See also: http://fromthegonzo.wordpress.com/2006/05/12/asteroid-impact-effects/ https://en.wikipedia.org/wiki/2006_JY26 See also: **3 May 2074**.
2006, May 11	W.D. Maier, M.A.G. Andreoli, I. McDonald, et al., 2006, *Nature*, 441, 203, "Discovery of a 25-cm asteroid clast in the giant **Morokweng impact crater**, South Africa." See: http://adsabs.harvard.edu/abs/2006Natur.441..203M
2006, May 12	R. Irion, 12 May 2006, *Science*, 312, 840, "A Hawaiian upstart prepares to monitor the starry heavens." See: http://www.sciencemag.org/content/312/5775/840.summary/
2006, May 12-14	Meeting on ***Asteroids and Comets in Europe***, Vienna (Austria). See: http://forum.sci.hr/viewtopic.php?t=186 http://www.astrometrica.at/MACE/abstracts.html
2006, May 28	Aten NEA **2020 KJ4** (H = 29.9 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 2.12 LD. Minimum miss distance 0.17 LD. See: 2020 KJ4 – S2P , 2020 KJ4 – JPL

	See also: **28 May 2020**.
2006, Jun	W.N. Edwards, P.G. Brown, D.O. Revelle, 2006, *Journal of Atmospheric and Solar-Terrestrial Physics*, 68, 1136, "Estimates of meteoroid kinetic energies from observations of infrasonic airwaves." See: http://adsabs.harvard.edu/abs/2006JASTP..68.1136E
2006, Jun	R. Kahle, G. Hahn, E. Kührt, 2006, *Icarus*, 182, 482, "Optimal deflection of NEOs en route of collision with the Earth." See: http://adsabs.harvard.edu/abs/2006Icar..182..482K
2006, Jun	A. Morbidelli, M. Gounelle, H.F. Levison, W.F. Bottke, 2006, *Meteoritics & Planetary Science*, 41, 874, "Formation of the binary near-Earth object **1996 FG3**: can binary NEOs be the source of short-CRE meteorites?" See: http://adsabs.harvard.edu/abs/2006M%26PS...41..874M
2006, Jun 2	E. Asphaug, 2006, *Science*, 312, 1328, "Adventures in Near-Earth Object exploration." See: http://adsabs.harvard.edu/abs/2006Sci...312.1328A http://www.ipsubc.org/paper/1328.pdf
2006, Jun 9	Establishment of **EUROpean Near Earth Asteroid Research (EURONEAR)**, a network for follow-up of NEAs/PHAs using 1-2 m class telescopes in Europe by professionals, students and amateurs. Ref: - F. Colas, M. Birlan, O. Vaduvescu, et al., 2006, presented at the *American Astronomical Society, DPS meeting #38, #58.05; Bulletin of the American Astronomical Society*, 38, 592, "**EURONEAR** - First Results at Pic du Midi." See: http://adsabs.harvard.edu/abs/2006DPS....38.5805C - O. Vaduvescu, M. Birlan, F. Colas, et al., 2008, *Planetary and Space Science*, 56, 1913, "**EURONEAR**: first results." See: http://adsabs.harvard.edu/abs/2008P%26SS...56.1913V - A. Tudorica, R. Toma, A.B. Sonka, et al., 2009, *American Astronomical Society, DPS meeting* #40, #27.09; *Bulletin of the American Astronomical Society*, 41, 557, "**EURONEAR** - the first 100 NEA's observed." See: http://adsabs.harvard.edu/abs/2009DPS....40.2709T - O. Vaduvescu, L. Curelaru, M. Birlan, 2009, *Astronomische Nachrichten*, 330, 698, "**EURONEAR**: data mining of asteroids and Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2009AN....330..698V - M. Birlan, O. Văduvescu, D.A. Nedelcu, **EURONEAR** Team,

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2006, Jun 26-29	**NASA *Workshop on Near-Earth Object Detection, Characterization, and Threat Mitigation***, Vail (CO, USA). **Proceedings:** *NEO Survey and Deflection Analysis of Alternatives: Report to Congress*, issued March 2007. See: http://neo.jpl.nasa.gov/neo/report2007.html http://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf http://www.hq.nasa.gov/office/pao/FOIA/NEO_Analysis_Doc.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=168 **Among the papers:** - R. Schweickart, C.Chapman, D. Durda, B. Bottke, D. Nesvorny, P. Hut 2006, e-print *arXiv*:physics/0608155, "Threat characterization: trajectory dynamics." See: http://www.b612foundation.org/papers/wpdynamics.pdf http://www.b612foundation.org/papers/dynamics.pdf http://adsabs.harvard.edu/abs/2006physics...8155S - R. Schweickart (B612 Foundation), C. Chapman, D. Durda, P. Hut, 2006, e-print *arXiv*:physics/0608156, "Threat mitigation: the ***Asteroid Tugboat***." See: http://adsabs.harvard.edu/abs/2006physics...8156S - R. Schweickart (B612 Foundation), C. Chapman, D. Durda, P. Hut, 2006, e-print *arXiv*:physics/0608157, "Threat mitigation: the ***Gravity Tractor***." See: http://adsabs.harvard.edu/abs/2006physics...8157S
2006, Jul	S.R. Chesley, S.N. Ward, 2006, *Natural Hazards*, 38, 355, "A quantitative assessment of the human and economic hazard from impact-generated tsunami." See: http://www.es.ucsc.edu/~ward/papers/tsunami_(v43).pdf See also:

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2006, Jul	D.P. O'Brien, R. Greenberg, J.A. Richardson, 2006, *Icarus*, 183, 79, "Craters on asteroids: reconciling diverse impact records with a common impacting population." See: http://adsabs.harvard.edu/abs/2006Icar..183...79O
2006, Jul 3	Apollo NEA **2004 XP14** (*H* = 19.8 mag, *D* ≈ 260 m, **PHA**) passed Earth at a nominal miss distance of 1.12 LD. Minimum miss distance 1.12 LD. See: 2004 XP14 - JPL , 2004 XP14 - SSA Ref: - M.W. Busch, S.R. Kulkarni, A.R. Conrad, P.B. Cameron, 2007, *Icarus*, 189, 589, "Keck adaptive optics imaging of near-Earth asteroid **2004 XP14**." See: http://adsabs.harvard.edu/abs/2007Icar..189..589B See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=168 http://en.wikipedia.org/wiki/2004_XP14
2006, Jul 16	J. Davis, P. Singla, J. Junkins, 2006, presented at the *7th International Conference on Dynamics and Control of Systems and Structures in Space* (DCSSS), London (England), 16-20 July 2006, "Identifying near-term missions and impact keyholes for asteroid **99942 Apophis**." See: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.188.4573 http://lairs.eng.buffalo.edu/pdffiles/pconf/RC1.pdf
2006, Jul 23	Apollo NEA **2006 OK3** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2006-06]** See: 2006 OK3 - JPL , 2006 OK3 - SSA
2006, Aug	R. Schweickart, C. Chapman, D. Durda, B. Bottke, D. Nesvorny, P. Hut, 2006, presented at NASA Workshop on *Near-Earth Object Detection, Characterization, and Threat Mitigation*, Vail (CO, USA), 26-29 Jun 2006, **White Paper 040**, "Threat characterization: trajectory dynamics." See: http://adsabs.harvard.edu/abs/2006physics...8155S http://www.b612foundation.org/papers/wpAT.pdf http://www.b612foundation.org/papers/AT-GT.pdf
2006, Aug	R. Schweickart, C. Chapman, D. Durda, P. Hut, 2006, presented at NASA Workshop on *Near-Earth Object Detection,*

	Characterization, and Threat Mitigation, Vail (CO, USA), 26-29 Jun 2006, **White Paper 041**, "Threat mitigation: the ***Asteroid Tugboat***." See: http://adsabs.harvard.edu/abs/2006physics...8156S http://www.b612foundation.org/papers/wpAT.pdf http://www.b612foundation.org/papers/AT-GT.pdf
2006, Aug	R. Schweickart, C. Chapman, D. Durda, P. Hut, 2006, presented at NASA Workshop on *Near-Earth Object Detection, Characterization, and Threat Mitigation*, Vail (CO, USA), 26-29 Jun 2006, **White Paper 042**, "Threat mitigation: the ***Gravity Tractor***." See: http://adsabs.harvard.edu/abs/2006physics...8157S http://www.b612foundation.org/papers/wpGT.pdf http://www.b612foundation.org/papers/AT-GT.pdf
2006, Aug	D. Morrison, 2006, *Philosophical Transactions Royal Society A*, 364, 2041, "Asteroid and comet impacts: the ultimate environmental catastrophe." See: http://adsabs.harvard.edu/abs/2006RSPTA.364.2041M http://rsta.royalsocietypublishing.org/content/364/1845/2041.full.pdf+html
2006, Aug	First asteroid discovered by the **La Sagra Sky Survey (LSSS)**, of the Observatorio Astronomico de La Sagra (OLS), Puebla de Don Fadrique (Andalusia, Spain), operated by the Observatorio Astronomico de Mallorca (OAM). The **LSSS** employs three 45cm f/2.8 telescopes. Since 2009, **LSSS** is the most prolific European NEO survey. As of Spring 2012, the **LSSS** has submitted more than 1,000,000 observations of asteroids and comets to the **Minor Planet Center (MPC)** and the **LSSS** has been credited with over 6,000 asteroid discoveries, including 52 NEOs. See: http://www.minorplanets.org/OLS/ http://lasagraskysurvey.org/index.html http://lasagraskysurvey.org/neoslist.html
2006, Aug 14	As a follow-up of the **IAU Working Group on Near Earth Objects (WG-NEO)**, the IAU EC appointed an **IAU Advisory Committee on Hazards of Near Planetary Objects**. Membership: six IAU Division III asteroid scientists. See: http://www.iau.org/science/scientific_bodies/working_groups/125/
2006, Aug 14-18	**IAU Symposium No. 236 on *Near Earth Objects, our Celestial***

	***Neighbours: Opportunity and Risk*, Prague** (Czech Republic). Proceedings: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), 2007 (Cambridge: CUP). See: http://journals.cambridge.org/action/displayIssue?jid=IAU&volumeId=2&issueId=S236 http://adsabs.harvard.edu/abs/2007IAUS..236.....V
2006, Aug 18	B.G. Marsden, 2006, *Dissertatio cum Nuncio Siderio III* (***IAU XXVI General Assembly*** journal), No. 5, p. 1, "Defenestrace." See: http://astro.cas.cz/nuncius/nsiii_05.pdf
2006, Aug 23	Aten NEA **2019 AU6** ($H = 26.6$ mag, $D \approx 17$ m) passed Earth at a nominal miss distance of 1.87 LD. Minimum miss distance 0.98 LD. See: 2019 AU6 - JPL , 2019 AU6 - SSA
2006, Aug 24	Brian G. Marsden retired as director of the **IAU Minor Planet Center** (Cambridge, MA, USA), to be succeeded by Timothy B. Spahr. See: http://www.cfa.harvard.edu/iau/mpc.html
2006, Aug 31	Apollo NEA **2006 QM111** ($H = 27.6$ mag, $D \approx 11$ m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.41 LD. **[2006-07]** See: 2006 QM111 - JPL , 2006 QM111 - SSA
2006, Sep	P.A. Bland, P. Spurný, A.W.R. Bevan, et al., 2006, in: Proceedings *69th Annual Meeting of the Meteoritical Society*, 6-6-11 August 2006, Zürich (Switzerland), *Meteoritics & Planetary Science*, 41, Supplement, p.5197, "First Light for the **Desert Fireball Network**." See: http://adsabs.harvard.edu/abs/2006M%26PSA..41.5197B
2006, Sep	F. Colas, M. Birlan, O. Vaduvescu, et al., 2006, presented at the *American Astronomical Society, DPS meeting #38, #58.05; Bulletin of the American Astronomical Society*, 38, 592, "**EURONEAR** - First Results at Pic du Midi." See: http://adsabs.harvard.edu/abs/2006DPS....38.5805C
2006, Sep	J. de Léon, R. Duffard, J. Licandro, et al., 2006, *Bulletin of the American Astronomical Society*, 38, 627, "**Near-Earth Objects Spectroscopic Survey (NEOSS)**: first results from mineralogical analysis." See: http://adsabs.harvard.edu/abs/2006DPS....38.7107D
2006, Sep	R. Duffard, J. de León, J. Licandro, D. Lazzaro, M. Serra-Ricart,

	2006, *Astronomy & Astrophysics*, 456, 775, "Basaltic asteroids in the Near-Earth Objects population: a mineralogical analysis." See: http://adsabs.harvard.edu/abs/2006A%26A...456..775D
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2006, Sep 18-22	***European Planetary Science Congress 2006*** **(EPSC #1)**, Berlin (Germany), 18-22 September 2006. See: http://meetings.copernicus.org/epsc2006/
2006, Oct	J.L. Ortiz, F.J. Aceituno, J.A. Quesada, 2006, *Icarus*, 184, 319, "Detection of sporadic impact flashes on the Moon: implications for the luminous efficiency of hypervelocity impacts and derived terrestrial impact rates." See: http://adsabs.harvard.edu/abs/2006Icar..184..319O
2006, Oct 2	First light of the China **NEO Survey Telescope (NEOST)**, located at Xuyi Station of Purple Mountain Observatory (Nanjing, China). **NEOST**, is the the best performing telescope in fields of Near

	Earth Object survey and optical imaging in China. **NEOST** is a f/1.8 Schmidt type telescope with a 1.20 m primary mirror and a 1.04 m corrector. Its 4K by 4K CCD camera provides a FoV of 3.8 sq.d. Up to August 2012, the **China NEO Survey (CNEOS)** program has observed 149971 asteroids with more than 530 thousands observations, found 1279 new provisional designation asteroids, and catalogued 251 numbered asteroids (including 5 Jupiter trojans, 2 Hildas, 1 Phocaea). The **CNEOS** program has obtained 824 NEO position observations and found 4 new NEOs, including one Apollo type NEO, 2007 JW2, and three Amor type NEOs, **2009 MZ6**, **2007 RT147**, **2007 QX14**. (priv.comm., August 2012) See also: http://english.pmo.cas.cn/rh/dcm/nsb/200908/t20090831_35079.html Ref: - R. Stone, 2008, *Science*, 319, 1326, "Preparing for doomsday." See: http://www.sciencemag.org/content/319/5868/1326.summary/
2006, Oct	P. Vereš, L. Kornoš, J. Tóth, 2006, *Contributions Astronomical Observatory Skalnaté Pleso*, 36 (3), 171, "Search for very close approaching NEAs." See: http://adsabs.harvard.edu/abs/2006CoSka..36..171V
2006, Oct 5-6	***Workshop on Spacecraft Reconnaissance of Asteroid and Comet Interiors***, Santa Cruz (CA, USA), 5-6 October 2006. See: http://www.lpi.usra.edu/meetings/recon2006/
2006, Oct 7	Apollo NEA **2006 RZ**, H = 20.6 mag, $D \approx$ 270 m, **PHA**) passed Earth at a nominal miss distance of 4.99 LD. Minimum miss distance 4.99 LD. See: 2006 RZ- JPL , 2006 RZ - SSA
2006, Oct 8 15.57	Apollo NEA **2019 TM3** (H = 27.3 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 2.47 LD. Minimum miss distance 0.99. LD. See: 2019 TM3 – SSA , 2019 TM3 - JPL
2006, Oct 21	Apollo NEA **2006 UE64** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2006-08]** See: 2006 UE64 - JPL , 2006 UE64 - SSA
2006, Oct 30	Apollo NEA **2006 UJ185** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.695 LD. Minimum miss distance 0.694 LD. **[2006-09]** See: 2006 UJ185 - JPL , 2006 UJ185 - SSA

2006, Oct-Dec	A. Debus, 2006, *Acta Astronautica*, 59, 1093, "Planetary protection: elements for cost minimization." See: http://adsabs.harvard.edu/abs/2006AcAau..59.1093D
2006, Nov	D.D. Durda, 2006, *Sky & Telescope*, November 2006, p. 29, "The most dangerous asteroid ever found." See: http://adsabs.harvard.edu/abs/2006S%26T...112e..28D
2006, Nov 16	Apollo NEA **2006 WP1** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.81 LD. Minimum miss distance 0.80 LD. **[2006-10]** See: 2006 WP1 - JPL , 2006 WP1 - SSA
2006, Nov 20	Apollo NEA **2006 WX29** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.85 LD. **[2006-11]** See: 2006 WX29 - JPL , 2006 WX29 - SSA
2006, Nov 21 10:07	Apollo NEA **2006 WV** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2006-12]** See: 2006 WV - JPL , 2006 WV - SSA
2006, Nov 21 22:44	Asteroid **2017 KB3** (*H* = 25.1 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 5.59 LD. Minimum miss distance 0.78 LD. See: 2017 KB3 - JPL , 2017 KB3 - SSA
2006, Nov 24	D.J. Scheeres, E.G. Fahnestock, S.J. Ostro, J.-L. Margot, et al., 2006, *Science*, 314, 1280, "Dynamical configuration of binary Near-Earth Asteroid (**66391**) **1999 KW4**." See: http://adsabs.harvard.edu/abs/2006Sci...314.1280S
2006, Nov 24	S.J. Ostro, J.-L. Margot, L.A.M. Benner, J.D. Giorgini, et al., 2006, *Science*, 314, 1276, "Radar imaging of binary Near-Earth Asteroid (**66391**) **1999 KW4**." See: http://adsabs.harvard.edu/abs/2006Sci...314.1276O
2006, Dec 12	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) Action Team 14**: *Interim Report*. See: http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L290E.pdf http://www.unoosa.org/pdf/pres/stsc2007/tech-35.pdf
2006, Dec 28	NASA *Near-Earth Object Survey and Deflection Study*, Final

	report. See: http://www.hq.nasa.gov/office/pao/FOIA/NEO_Analysis_Doc.pdf http://neo.jpl.nasa.gov./neo/report2007.html
2007, Jan 1	**4412 NEAs** known, of which **825 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2007	The 200,000th minor planet was numbered at the **IAU Minor Planet Center**: asteroid **200000** (**2007 JT40**, $H = 15.7$ mag, $D \approx 2.5$ km, main-belt asteroid), discovered on 12 May 2007 by the **Mount Lemon Survey** at Mount Lemmon (AZ, USA), as part of the **Catalina Sky Survey.**
2007	The Association of Space Explorers (ASE) formed an **ASE Panel on Asteroid Threat Mitigation**. See: http://www.space-explorers.org/committees/NEO/neo.html
2007	P. Bobrowsky & H. Rickman (eds.), 2007, ***Comet/Asteroid Impacts and Human Society*** (Berlin: Springer). Report of the "Tenerife Retreat" of December 2004. See: http://adsabs.harvard.edu/abs/2007caih.book.....B http://thelightofdayradioshow.com/PlanetX_Files/Comet-Asteroid-Impacts-and-Human-Society.pdf See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=155 **Among the papers:** - J. Andersen, 2007, p. 521, "Towards rational international policies on the NEO hazard." See: http://adsabs.harvard.edu/abs/2007caih.book.....B **-** B.G. Marsden, 2007, p. 505, "Impact risk communication management (1998 – 2004): has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B - D. Morrison, 2007, p. 163, "The impact hazard: advanced NEO surveys and societal responses." See: http://adsabs.harvard.edu/abs/2007caih.book.....B
2007	K.R. Evans, J.W. Horton, D.T. King, J.R. Morrow (eds.), 2007, Proc., ***The Sedimentary Record of Meteorite Impacts***, *Geological Society of America Special Papers*, Vol. 437. See: http://specialpapers.gsapubs.org/content/437
2007	J.D. Koenig, C.F. Chyba, 2007, *Science & Global Security*, 15 (1), 57, "Impact deflection of potentially hazardous asteroids using current launch vehicles." See:

	http://scienceandglobalsecurity.org/archive/2007/05/impact_deflection_of_potential.html http://scienceandglobalsecurity.org/archive/sgs15koenig.pdf
2007	D.A. Kring, 2007, *LPI Contribution* No. 1355, "Guidebook to the Geology of Barringer Meteorite Crater, Arizona (a.k.a. Meteor Crater)." See: http://www.lpi.usra.edu/publications/books/barringer_crater_guidebook/
2007	A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on ***Near Earth Objects, our Celestial Neighbours: Opportunity and Risk***, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2007neoo.book.....M **Among the papers:** - G.B. Valsecchi, 2007, *IAUS 236*, xvii, "236 years ago … ." See: http://adsabs.harvard.edu/abs/2007IAUS..236.....V - S.J. Ostro, J.D. Giorgini, L.A.M. Benner, 2007, p *IAUS 236*, 143, "Radar reconnaissance of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2007IAUS..236..143O - P. Pravec, A.W. Harris, B.D. Warner, 2007, *IAUS 236*, 167, NEA rotations and binaries." See: http://adsabs.harvard.edu/abs/2007IAUS..236..167P - D.F. Lupishko, M. Di Martino, R.P. Binzel, 2007, *IAUS 236*, 251, "Near-Earth objects as principal impactors of the Earth: physical properties and sources of origin." See: http://adsabs.harvard.edu/abs/2007IAUS..236..251L - A. Boattini, A. Milani, G.F. Gronchi, T. Spahr, G.B. Valsecchi, 2007, *IAUS 236*, p. 291, "Low solar elongation searches for NEO: a deep sky test and its implications for survey strategies." See: http://adsabs.harvard.edu/abs/2007IAUS..236..291B - S. Larson, 2007, *IAUS 236*, p. 323, "Current NEO surveys." See: http://adsabs.harvard.edu/abs/2007IAUS..236..323L - R.S. Mc Millan, *IAUS 236*, p. 329, "**Spacewatch** preparations for the era of deep all-sky surveys." See: http://adsabs.harvard.edu/abs/2007IAUS..236..329M - O. Engvold, IAU General Secretary, 2007, *IAUS 236*, p. 467, "The IAU role." See: http://adsabs.harvard.edu/abs/2007IAUS..236..467E
2007	L.D. Schmadel, 2007, *Dictionary of minor planet names* (Berlin: Springer). See: http://adsabs.harvard.edu/abs/2007dmpn.book.....S
2007, Jan	J. Licandro, H. Campins, T. Mothé-Diniz, et al., 2007, *Astronomy and Astrophysics*, 461, 751, "The nature of comet-asteroid transition

	object (**3200**) **Phaethon**." See: http://adsabs.harvard.edu/abs/2007A%26A...461..751L
2007, Jan 18	Aten NEA **2007 BD** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84 LD. **[2007-01]** See: 2007 BD - JPL , 2007 BD - SSA See also: **17 Jan 1965.**
2007, Jan 19	Aten NEA **2007 BB** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 1.01 LD. Minimum miss distance 0.99 LD. See: 2007 BB - JPL , 2007 BB - SSA
2007, Feb 7	J.P. Sanchez Cuartielles, C. Colombo, M. Vasile, G. Radice, 2007, in: *New trends in astrodynamics and applications. III.*, AIP Conference Proceedings, 886, 317, "A multi-criteria assessment of deflection methods for dangerous NEOs." See: http://adsabs.harvard.edu/abs/2007AIPC..886..317S
2007, Feb 11	Apollo NEA **2007 CC27** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2007-02]** See: 2007 CC27 - JPL , 2007 CC27 - SSA
2007, Feb 11	D. Vergano, 2007, *USA Today*, "Near-Earth asteroids could be 'steppingstones to **Mars**'." See: http://www.usatoday.com/tech/science/space/2007-02-12-asteroid_x.htm
2007, Feb 21	Apollo NEA **2007 DN41** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.79 LD. Minimum miss distance 0.78 LD. **[2007-03]** See: 2007 DN41 - JPL , 2007 DN41 - SSA
2007, Feb 21-22	**UN Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and Technical Subcommittee*, 44th Session, Action Team 14** on NEOs meets in Vienna (Austria). **Action Team** 14 recommends addressing the threat from smaller NEAs, augmentation of the **Minor Planet Center**, preparation of a draft NEA deflection protocol and international procedures. **Report 6 March 2007:** http://www.unoosa.org/pdf/reports/ac105/AC105_890E.pdf
2007, Feb 21	R.L. Schweickart, 2007, presented at the 44th Session of the **UN-COPUOS *Scientific and Technical Subcommittee* Meeting**, Vienna (Austria), "Deflecting NEOs: a pending international

	challenge." See: http://www.space-explorers.org/committees/NEO/docs/STSC07paper.pdf
2007, Mar	D. Morrison, A. Milani, R. Binzel, et al., 2007, in: O. Engvold (ed.), *Reports on Astronomy*, IAU Transactions XXVIA (Cambridge: CUP), p. 187, "Division I & III WG on Near Earth Objects". See: http://adsabs.harvard.edu/abs/2007IAUTA..26..187M
2007, Mar	NASA, 2007, "Near-Earth Object survey and deflection analysis of alternatives. Report to Congress." See: https://www.nasa.gov/pdf/171331main_NEO_report_march07.pdf https://www.hq.nasa.gov/office/pao/FOIA/NEO_Analysis_Doc.pdf https://cneos.jpl.nasa.gov/doc/neo_report2007.html
2007, Mar	G.B. Valsecchi, J.A. Fernández, et al., 2007, in: O. Engvold (ed.), *Reports on Astronomy*, IAU Transactions XXVIA (Cambridge: CUP), p. 153, "Commission 20: Positions and motions of minor planets, comets and satellites". See: http://adsabs.harvard.edu/abs/2007IAUTA..26..153V
2007, Mar 5-8	**International Academy of Astronautics (IAA) *2007 Planetary Defense Conference, Protecting Earth from Asteroids***, Washington, D.C. (USA). Summary and recommendations in **White Paper**. See: http://www.aero.org/conferences/planetarydefense/ http://www.aero.org/conferences/planetarydefense/2007papers/WhitePaperFinal.pdf http://www.space-explorers.org/committees/NEO/docs/Intnl_Policy_Issues.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=170 http://impact.arc.nasa.gov/news_detail.cfm?ID=172 http://impact.arc.nasa.gov/news_detail.cfm?ID=173
2007, Mar 5	R.L. Schweicart, 2007, presented at the International Academy of Astronautics (IAA) *2007 Planetary Defense Conference, Protecting Earth from Asteroids,* Washington D.C. (USA), 5-8 March 2007, "The NEO threat: international policy issues". See: http://www.planetarydefense.info http://www.space-explorers.org/committees/NEO/docs/Intnl_Policy_Issues.pdf
2007, Mar 7	NASA report to Congress *NEO Survey and Deflection Analysis of Alternatives – Report to Congress*, in response to the George E.

	Brown Jr NEO Survey Act of 28 December 2005. See: http://neo.jpl.nasa.gov/neo/report2007.html http://impact.arc.nasa.gov/news_detail.cfm?ID=171 http://impact.arc.nasa.gov/news_detail.cfm?ID=174 Critique: http://www.b612foundation.org/press/press.html #15, #16
2007, Mar 11	Apollo NEA **2007 EH** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.46 LD. Minimum miss distance 0.46 LD. **[2007-04]** See: 2007 EH - JPL , 2007 EH - SSA
2007, Mar 13	Apollo NEA **2007 EK** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2007-05]** See: 2007 EK - JPL , 2007 EK - SSA
2007, Mar 25	Apollo NEA **2006 RH120** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2007-06]** See: 2006 RH120 - JPL , 2006 RH120 - SSA See also: http://www.space.com/14037-earth-2-moons-asteroids-theories.html http://en.wikipedia.org/wiki/2006_RH120 See also: **14 Jun 2007**. Ref: - T. Kwiatkowski, A. Kryszczyńska, M. Polińska, et al., 2009, *Astronomy & Astrophysics*, 495, 967, "Photometry of **2006 RH120**: an asteroid temporary captured into a geocentric orbit." See: http://adsabs.harvard.edu/abs/2009A%26A...495..967K
2007, Mar 31	Apollo NEA **374851** (**2006 VV2**, *H* = 16.9 mag, *D* ≈ 1800 m, **PHA**) passed Earth at a nominal miss distance of 8.81 LD. Minimum miss distance 8.81 LD. See: 2006 VV2 - JPL , 374851 2006 VV2 Ref: - R. Huziak, 2007, *Journal of the Royal Astronomical Society of Canada*, 101, 165, "Ramblings of a variable-star addict: precise measurements for Earth-crossing asteroid **2006 VV2**". See: http://adsabs.harvard.edu/abs/2007JRASC.101..165H See also: http://www.rasc.ca/news/2006VV2.shtml http://antwrp.gsfc.nasa.gov/apod/ap070405.html See also: **29 Mar 2177**.
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	"Formation and destruction of small binary asteroids." See: http://adsabs.harvard.edu/abs/2007ApJ...659L..57C
2007, Apr 2	NASA Report to Congress on Advanced NEO Survey. See: http://impact.arc.nasa.gov/news_detail.cfm?ID=171
2007, Apr 13	S.C. Lowry, A. Fitzsimmons, P. Pravec, et al., 2007, *Science*, 316, 272, "Direct detection of the asteroidal YORP effect." See: http://star.pst.qub.ac.uk/comast/papers/YORP1.pdf
2007, Apr 24	Apollo NEA **2007 HB15** (*H* = 27.7 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2007-07]** See: 2007 HB15 - JPL , 2007 HB15 - SSA
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2007, May	M. Delbò, A. Cellino, E.F. Tedesco, 2007, *Icarus*, 188, 266, "Albedo and size determination of potentially hazardous asteroids: (**99942**) **Apophis**." See: http://adsabs.harvard.edu/abs/2007Icar..188..266D
2007, May	R.A. Fevig, U. Fink, 2007, *Icarus*, 188, 175, "Spectral observations of 19 weathered and 23 fresh NEAs and their correlations with orbital parameters." See: http://adsabs.harvard.edu/abs/2007Icar..188..175F
2007, May	R.B. Firestone, A. West, Z. Revay, et al., 2007, in: *American Geophysical Union, Spring Meeting 2007*, abstract #PP41A-01, "Evidence for a massive extraterrestrial airburst over North America 12.9 ka ago." See: http://adsabs.harvard.edu/abs/2007AGUSMPP41A..01F
2007, May	R.B. Firestone, A. West, J.P. Kenneth, et al., 2007, in: *American Geophysical Union, Spring Meeting 2007*, abstract #PP43A-01, "Evidence for an extraterrestrial impact event 12,900 years ago that contributed to megafaunal extinctions and the Younger Dryas cooling." See: http://adsabs.harvard.edu/abs/2007AGUSMPP43A..01F
2007, May	M. Moidel, *Space Viz*, 2007, DVD, *Planetary Defense*. Interviews with M. A'Hearn, M. Belton, R. Binzel, C. Chapman, A.C. Clarke, F.J. Dyson, A.W. Harris (Germany), A.W. Harris (USA), D.H.

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2007, May 9-12	**1st International Workshop on *NEO Deflection Policy***, International Space University, Strasbourg (France), organized by the Association of Space Explorers (ASE). See: http://www.space-explorers.org/committees/NEO/docs/ASE_NEO_Aug06.pdf http://www.space-explorers.org/committees/NEO/workshop1.html http://www.isunet.edu/index.php?option=com_docman&task=doc_view&gid=131&Itemid=26 http://www.spaceref.com/news/viewpr.html?pid=20596
2007, May 10	**Puerto Lápice Fireball and Meteorite**. A brilliant fireball of absolute magnitude – 14 ± 4 was widely seen all over Spain. The fireball travelled from south to north and experienced various explosions along its trajectory. The **Spanish Fireball Network (SPMN)** and numerous images taken by observers documented the fall. Some 500 g of meteorite material was collected at Puerto Lápice (Ciudad Real, Castilla-La Mancha, Spain), notably achondrite (eucrite, brecciated). Ref: - J.M. Trigo-Rodríguez, J. Borovička, P. Spurný, et al., 2006, *Meteoritics & Planetary Science*, 44, 175, "**Puerto Lápice eucrite fall**: strewn field, physical description, probable fireball trajectory, and orbit." See: http://onlinelibrary.wiley.com/doi/10.1111/j.1945-5100.2009.tb00726.x/abstract See also: http://tin.er.usgs.gov/meteor/metbull.php?code=45984
2007, May 31	In 2006, 14 space agencies (ASI, Italy; CNES, France; CNSA China; CSA, Canada; CSIRO, Australia; DLR, Germany; ESA, Europe; ISRO, India; JAXA, Japan; KARI, Republic of Korea; NASA, USA; NSAU, Ukraine; Roscosmos, Russia; BNSC/UKSA, UK) began a series of discussions on global interests in space exploration. Together they took the step of elaborating a vision for peaceful robotic and human space exploration, focusing on destinations within the Solar System, and developed a common set of key space exploration themes. This vision was articulated in ‘The Global Exploration Strategy: The Framework for Coordination,' hereinafter referred to as the 'Framework Document'. A key finding of the Framework Document is the need to establish a voluntary, non-

	binding international coordination mechanism through which individual agencies may exchange information regarding interests, objectives and plans in space exploration, with the goal of strengthening both individual exploration programs as well as the collective effort. The coordination mechanism is named the **International Space Exploration Coordination Group (ISECG)**. See: http://www.globalspaceexploration.org/
2007, Jun	A. Boattini, G. D'Abramo, G.B. Valsecchi, et al., 2007, *Earth, Moon and Planet*, 100, 259, **"The Campo Imperatore Near Earth Objects Survey (CINEOS)."** See: http://adsabs.harvard.edu/abs/2007EM%26P..100..259B
2007, Jun	J.K. Paty, W.U. Reimold, 2007, *Journal of Earth System Science*, 116, 81, "Impact cratering — fundamental process in geoscience and planetary science." See: http://adsabs.harvard.edu/abs/2007JESS..116...81P
2007, Jun	D.J. Scheeres, M. Abe, M. Yoshikawa, et al., 2007, *Icarus*, 188, 425, "The effect of YORP on **Itokawa**." See: http://adsabs.harvard.edu/abs/2007Icar..188..425S
2007, Jun	D.J. Scheeres, 2007, *Icarus*, 188, 430, "The dynamical evolution of uniformly rotating asteroids subject to YORP." See: http://adsabs.harvard.edu/abs/2007Icar..188..430S
2007, Jun 11-15	**International meeting on minor bodies *Meteoroids 2007***, Barcelona (Spain), 11-15 June 2007. See: http://www.spmn.uji.es/meteoroids-2007/
2007, Jun 14	Apollo NEA **2006 RH120** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2007-08]** See: 2006 RH120 - JPL , 2006 RH120 - SSA See also: http://www.space.com/14037-earth-2-moons-asteroids-theories.html http://en.wikipedia.org/wiki/2006_RH120 See also: **25 Mar 2007**. Ref: - T. Kwiatkowski, A. Kryszczyńska, M. Polińska, et al., 2009, *Astronomy & Astrophysics*, 495, 967, "Photometry of **2006 RH120**: an asteroid temporary captured into a geocentric orbit." See: http://adsabs.harvard.edu/abs/2009A%26A...495..967K
2007, Jun 26-29	**VIIth Workshop on *Catastrophic Disruption in the Solar System***, Alicante (Spain). See: http://irtfweb.ifa.hawaii.edu/~sjb/CD07/CD07.htm

2007, Jul 6	C.R. Chapman, 2007, *New Scientist*, Issue 2611, 6 July 2007, "How not to save the planet." See: http://www.newscientist.com/article/mg19526115.800-comment-how-not-to-save-the-planet.html
2007, Jul 20	"Potentially hazardous Near Earth Objects coming to your neighborhood soon". See: http://www.greatdreams.com/near.htm
2007, Jul 23	Green.view, 2007, *The Economist*, 23 July 2007, The threat from outer space." See: http://www.economist.com/node/9533468
2007, Jul 26	Apollo NEA **2020 HL6** (H = 27.9 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 1.14 LD. Minimum miss distance 0.50 LD. See: 2020 HL6 – S2P , 2020 HL6 - JPL
2007, Jul-Aug	B. Dachwald, B. Wie, 2007, *Journal of Spacecraft and Rockets*, 44, 755, "Solar sail kinetic energy impactor trajectory optimization for an asteroid-deflection mission." See: http://adsabs.harvard.edu/abs/2007JSpRo..44..755D See also: http://arc.aiaa.org/doi/abs/10.2514/1.22586
2007, Aug	L. Gasperini, F. Alvisi, F., G. Biasini, et al., 2007, *Terra Nova*, 19, 245, "A possible impact crater for the **1908 Tunguska Event**." See: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3121.2007.00742.x/abstract?
2007, Aug	F. Mellor, 2007, *Social Studies of Science*, 37, 499, "Colliding worlds: asteroid research and the legitimisation of war in space." See: http://sss.sagepub.com/content/37/4/499
2007, Aug 7	**Earth-grazing fireball EN070807** passed through the upper Earth atmosphere with an orbit belonging to the rare Aten asteroid type. See: http://adsabs.harvard.edu/abs/2008LPICo1405.8217S http://www.lpi.usra.edu/meetings/acm2008/pdf/8217.pdf http://en.wikipedia.org/wiki/Earth-grazing_fireball http://en.wikipedia.org/wiki/ The_Great_Daylight_1972_Fireball#All_known_Earth-grazing_fireballs
2007, Aug 13-17	***70th Annual Meeting Meteoritical Society***, Tucson (AZ, USA), 13-17 August 2007. See: http://www.lpi.usra.edu/meetings/metsoc2007/

2007, Aug 19-24	***2nd European Planetary Science Congress* (EPSC 2007)**, Potsdam (Germany). See: http://www.europlanet-eu.org/outreach/index.php?option=com_content&task=view&id=61&Itemid=41 http://meetings.copernicus.org/epsc2007/
2007, Sep	M. Delbò, A. Dell'Oro, A.W. Harris, et al., 2007, *Icarus*, 190, 236, "Thermal inertia of near-Earth asteroids and implications for the magnitude of the Yarkovsky effect." See: http://adsabs.harvard.edu/abs/2007Icar..190..236D
2007, Sep	W.U. Reimold, 2007, *Meteoritics & Planetary Science*, 42, 1467, "The impact crater bandwagon. (Some problems with the terrestrial impact cratering record)" See: http://adsabs.harvard.edu/abs/2007M%26PS...42.1467R
2007, Sep 5	Apollo NEA **2007 RS1** (H = 31.1 mag, $D \approx$ 2.1 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2007-09]** See: 2007 RS1 - JPL , 2007 RS1 - SSA See also: **2 Sep 1964**.
2007, Sep 6	W.F. Bottke, D. Vokrouhlický, D. Nesvorný, et al., 2007, *Nature*, 449, 48, "An asteroid breakup 160 Myr ago as the probable source of the K/T impactor." See: http://adsabs.harvard.edu/abs/2007Natur.449...48B See also: http://www.planetary.org/news/2007/0921_Ancient_Collision_between_Asteroids.html
2007, Sep 6	P. Claeys, S. Goderis, 6 September 2007, *Nature*, 449, 30, "Lethal billiards." See: http://adsabs.harvard.edu/abs/2007Natur.449...30C
2007, Sep 12-15	***2nd International Workshop on NEO Deflection Policy***, Sibiu (Romania), organized by the Association of Space Explorers (ASE). See: http://www.oosa.unvienna.org/pdf/pres/stsc2008/tech-12.pdf
2007, Sep 15	**Carancas Chondritic Fireball and Meteorite Fall** on the Altiplano at the Peru-Bolivia border, near the village of Carancas (Peru), forming a 13.5-m wide crater, with a depth of 4.5 m. The stony meteorite may have had original mass of 1-2 ton. Ref:

	- J. Borovička, P. Spurný, 2008, *Astronomy & Astrophysics*, 485, 1, "The **Carancas meteorite** impact – encounter with a monolithic meteoroid." See: http://adsabs.harvard.edu/abs/2008A%26A...485L...1B - P. Brown, D.O. ReVelle, E.A. Silber, et al., September 2008, *Journal of Geophysical Research*, 113, 9007, "Analysis of a crater-forming **meteorite impact in Peru**." See: http://adsabs.harvard.edu/abs/2008JGRE..113.9007B - G. Tancredi, J. Ishitsuka, P. Schultz, et al., 2009, *Meteoritics & Planetary Science*, 44, 1967, "A meteorite crater on Earth formed on September 15, 2007: the **Carancas** hypervelocity impact." See: http://adsabs.harvard.edu/abs/2009M%26PS...44.1967T See also: http://news.nationalgeographic.com/news/2007/09/070921-meteor-peru.html http://www.lifeslittlemysteries.com/1535-when-space-attacks-6-craziest-meteor-impacts-history.html http://en.wikipedia.org/wiki/Carancas_impact_event
2007, Sep 27	NASA spacecraft ***Dawn*** launched. Asteroid **4 Vesta** (H = 3.20 mag, D = 530 km, Main-belt asteroid) rendezvous in July 2011, leaving May 2012. Dwarf planet **1 Ceres** (H = 3.34 mag, D = 952 km) rendezvous March 6, 2015. End of primary mission July 2015. See: http://dawn.jpl.nasa.gov/ http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2014-313 http://www.jpl.nasa.gov/news/news.php?release=2014-443
2007, Sep 28	**Northern Ostrobothania Fireball and Airburst** (Finland). See: http://yle.fi/uutiset/super-meteor_lights_up_northern_sky/5803349 http://en.wikipedia.org/wiki/List_of_meteor_air_bursts
2007, Oct	A.W. Harris, 2007, ***American Astronomical Society DPS meeting*** *#39*, #50.01, *Bulletin of the American Astronomical Society*, 39, 511, "An update of the population of NEAs and impact risk." See: http://adsabs.harvard.edu/abs/2007DPS....39.5001H
2007, Oct 8	IAU General Secretary Karel A. van der Hucht informs the director of the Harvard-Smithsonian Center for Astrophysics, host of the **Minor Planet Center**, of the full support of the IAU Executive Committee for the MPC and its new director, Timothy B. Spahr. The IAU GS expresses its gratitude to **MPC** director-emeritus Brian G. Marsden for directing the **MPC** during more than three decades in an outstanding way.

2007, Oct 9	Tom Gehrels, founder of the **Spacewatch** project, named winner of the 2007 Harold Masursky Award by the the American Astronomical Society Division of Planetary Sciences at the DPS 39th annual meeting in Orlando (FL, USA). See: http://uanews.org/node/16265
2007, Oct 9	R.B. Firestone, A. West, J.P. Kennett, et al., 2007, *Proc. National Academy of Sciences*, 104, 16016, "Evidence for an extraterrestrial impact 12,900 years ago that contributed to the megafaunal extinctions and the Younger Dryas cooling." See: https://www.pnas.org/content/104/41/16016 See also: D.J. Kennett, J.P. Kennett, A. West, et al., 2009, *Science*, 323, 94, "Nanodiamonds in the Younger Dryas boundary sediment layer." See: http://adsabs.harvard.edu/abs/2009Sci...323...94K But see also: http://adsabs.harvard.edu/abs/2010DDA....41.0601H
2007, Oct 11	Testimony of Russell L. Schweickart, chairman, **B612 Foundation**, before the Space and Aeronautics Subcommittee of the U.S. House Committee on Science and Technology. See: http://www.science.house.gov/publications/Testimony.aspx?TID=9743 http://democrats.science.house.gov/media/File/Commdocs/hearings/2007/space/08nov/Schweickart_testimony.pdf
2007, Oct 12	Apollo NEA **2007 TX22** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.37 LD. **[2007-10]** See: 2007 TX22 - JPL , 2007 TX22 - SSA
2007, Oct 17, 14:52	Apollo NEA **2007 UO6** (H = 27.6 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.93 LD. **[2007-11]** See: 2007 UO6 - JPL , 2007 UO6 - SSA
2007, Oct 17, 15:25	Apollo NEA **2007 UN12** (H = 28.7 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2007-12]** See: 2007 UN12 - JPL , 2007 UN12 - SSA
2007, Oct 18	Apollo NEA **2007 UD6** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2007-13]** See: 2007 UD6 - JPL , 2007 UD6 - SSA See also: **18 Oct 2048**.

2007, Oct 19	ESA announced the results of its *Cosmic Visions 2015 – 2025* call for proposals: seven space science missions selected for further study, including ***Marco Polo***, a NEO rendez-vous and sample-return mission. See: http://www.esa.int/esaSC/SEM1IQAMS7F_index_0.html
2007, Oct 20-21	**NASA *Workshop on Low-Cost Missions to NEOs***. NASA Ames Research Center, Mountain View (CA, USA). See: http://impact.arc.nasa.gov/news_detail.cfm?ID=177
2007, Oct 30	Apollo NEA **2007 US51** (H = 27.2 mag, $D \approx$ 13 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.58 LD. **[2007-14]** See: 2007 US51 - JPL , 2007 US51 - SSA
2007, Nov	A.A. Christou, J. Oberst, D. Koschny, et al., 2007, *Planetary and Space Science*, 55, 2049, "Comparative studies of meteoroid-planet interaction in the inner solar system." See: http://adsabs.harvard.edu/abs/2007P%26SS...55.2049C
2007, Nov 5	R.R. Landis, D.J. Korsmeyer, P.A. Abell, et al., 2007, in: Proc. *First International Conference on the Exploration of Phobos and Deimos*, 5-8 November 2007, Moffett Field (CA, USA). LPI Contribution No. 1377, p.24, "Prelude to human exploration of Phobos and Deimos: the NEO factor." See: http://adsabs.harvard.edu/abs/2007epd..conf...24L
2007, Nov 6	Apollo NEA **2007 VK184** (H = 22.2 mag, $D \approx$ 130 m) passed Earth at a nominal miss distance of 23.9 LD. Minimum miss distance 23.9 LD. See: 2007 VK184 - JPL , 2007 VK184 - SSA See also: http://neo.jpl.nasa.gov/news/news183.html https://en.wikipedia.org/wiki/2007_VK184 See also: **2 Jun 2048, 6 Jun 2118**.
2007, Nov 8	***Congressional hearings on Near-Earth Objects (NEOs) – Status of the Survey Program and Review of NASA's Report to Congress***, for the US House of representatives, Committee on Science and Technology, Subcommittee on Space and Aeronautics. Speakers included chairman Mark Udall, Rep. Luis G. Fortuno, Donald Campbell (Cornell University), Jim Green (NASA Hq), Scott Pace (NASA Hq), Russell L. Schweickart (**B612 Foundation**), Anthony Tyson (University of California at Davis), and Donald Yeomans (JPL). See: http://democrats.science.house.gov/media/File/Commdocs/

	hearings/2007/space/08nov/Tyson_testimony.pdf http://www.plutotoday.com/news/viewsr.html?pid=25962 http://impact.arc.nasa.gov/news_detail.cfm?ID=178 http://www.b612foundation.org/press/press.html #17, http://www.b612foundation.org/papers/Hearing_Charter.pdf
2007, Nov 14	Apollo NEA **2007 VF189** (H = 28.7 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.61 LD. Minimum miss distance 0.61 LD. **[2007-15]** See: 2007 VF189 - JPL , 2007 VF189 - SSA See also: **14 Nov 1944**.
2007, Dec	D.P. Rubincam, 2007, *Icarus*, 192, 460, "Orbital YORP and asteroid orbit evolution, with application to **Apophis**." See: http://adsabs.harvard.edu/abs/2007Icar..192..460R
2007, Dec	Wording inserted into the Departments of Commerce, Justice, Science, and Related Agencies Appropriations Act, 2008 (H.R. 3093): NASA is directed to provide additional funding for the **Arecibo Observatory**; NASA shall contract with the National Research Council (NRC) to study the **Arecibo** issue and make recommendations; As part of its deliberations, the NRC shall review NASA's report 2006 *Near-Earth Object Survey and Deflection Study* as well as any other relevant literature; An interim report with recommendations focusing primarily on the optimum approach to the survey program shall be submitted within 15 months of enactment of this Act; The NRC study shall include an assessment of the costs of various alternatives, including options that may blend the use of different facilities (whether ground- or space-based), or involve international cooperation. See: http://www7.nationalacademies.org/ocga/laws/PL110-161.asp
2007, Dec 3	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) Action Team 14**, *Interim Report (2007 – 2008)*. See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L295E.pdf
2007, Dec 4	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS).** *Information on research in the field of NEOs carried out by Member States, international organizations and other entities.* See: http://www.unoosa.org/pdf/reports/ac105/AC105_896E.pdf
2007, Dec 13	Apollo NEA **2007 XB23** (H = 27.1 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.25 LD. **[2007-16]** See: 2007 XB23 - JPL , 2007 XB23 - SSA See also: **11 Dec 2024**.

2007, Dec 15	Apollo NEA **2007 YN1** (H = 25.0 mag, $D \approx$ 42 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.02 LD. See: 2007 YN1 - JPL , 2007 YN1 - SSA
2007, Dec 27	Apollo NEA **2007 YP56** (H = 25.8 mag, $D \approx$ 24 m) passed Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.54 LD. **[2007-17]** See: 2007 YP56 - JPL , 2007 YP56 - SSA
2008, Jan 1	**5061 NEAs** known, of which **910 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2008	The International Astronautical Federation creates an **IAF Technical Committee on NEOs**. See: http://www.iafastro.net/?id=993 http://www.unoosa.org/pdf/pres.stsc2009/tech-31.pdf
2008	The Space Generation Advisory Council (SGAC) documentary about issues surrounding defending the Earth from asteroid and comet impacts, "Near Earth Objects and Planetary Defence." See: http://spacegeneration.org/index.php/activities/papers-a-reports/124-neodocumentary
2008	***Asteroid Finder***, a space project of the German Aerospace Center (DLR) approved, planned for launch in 2013 with an one-year baseline mission duration, with a 25-cm telescope mirror and a 2° × 2° FoV camera, to operate in a Sun-synchronous low-Earth orbit. The primary goals are to detect and track the population of NEOs interior to Earth's orbit, and to determine their size distribution and orbital properties, along with impact hazard assessment. Ref: - M. Drentschew, G.J. Hahn, E. Kührt, et al., 2008, Proc. *Asteroids, Comets, Meteors 2008*, 14-18 July 2008, Baltimore (MD, USA), LPI Contribution No. 1405, paper id. 8125, "Modeling of the expected performance for the German ***AsteroidFinder***." See: http://adsabs.harvard.edu/abs/2008LPICo1405.8125D - S. Mottola, A. Börner, J.T. Grundmann, G.J. Hahn, et al., 2008, Proc. *Asteroids, Comets, Meteors 2008*, 14-18 July 2008, Baltimore (MD, USA), LPI Contribution No. 1405, paper id. 8140, "***AsteroidFinder***: a space-based search for IEOs." See: http://adsabs.harvard.edu/abs/2008LPICo1405.8140M See also: http://www.dlr.de/pf/Portaldata/6/Resources/asteroiden_und_kometen/D

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2008	R.P. Binzel, C.A. Thomas, A. Tokunaga, 2008, in: Proc. *Asteroids, Comets, Meteors 2008*, 14-18 July 2008, Baltimore (MD, USA), LPI Contribution No. 1405, paper id. 8228, "Spectral properties of Near-Earth Object mission targets." See: http://adsabs.harvard.edu/abs/2008LPICo1405.8228B
2008	R.-M. Bonnet, L. Woltjer, 2008, *Surviving 1000 Centuries* (Berlin: Springer Praxis Books), p. 62, chapter 3.3, "Solar System hazards." See: http://adsabs.harvard.edu/abs/2008stc..book.....B
2008	P.C. Plait, *Death from the skies: these are the ways the world will end* (Pinguin Books: London). See: http://en.wikipedia.org/wiki/Death_from_the_Skies#Reviews See also: http://www.wired.com/geekdad/2008/11/death-from-the/ http://skepchick.org/2008/10/book-review-death-from-the-skies-by-phil-plait/
2008	P. Spurný, J. Borovicka, Z. Ceplecha, L. Shrbený, 2008, in: Proc. *Asteroids, Comets, Meteors 2008*, 14-18 July 2008, Baltimore (MD, USA), LPI Contribution No. 1405, paper id. 8217, "Precise multi-instrument data on 45 fireballs recorded over central Europe in the period 2006-2008." See: http://adsabs.harvard.edu/abs/2008LPICo1405.8217S
2008, Jan	J.D. Giorgini, L. Benner, S.J. Ostro, et al., 2008, *Icarus*, 193, 1, "Predicting the Earth encounters of (**99942**) **Apophis**." See: http://adsabs.harvard.edu/abs/2008Icar..193....1G http://neo.jpl.nasa.gov/apophis/
2008 Jan	N. Pinter, S.E. Ishman, 2008, *GSA Today*, 18 (1), 38, "Impacts, mega-tsunami and other extraordinary claims." See: http://www.geosociety.org/gsatoday/archive/18/1/pdf/i1052-5173-18-1-37.pdf
2008, Jan	B. Schmitz, D.A.T. Harper, B. Peucker-Ehrenbrink, et al., 2008, *Nature Geoscience*, 1, 49, "Asteroid breakup linked to the Great Ordovician Bio-diversification Event." See: http://www.nature.com/ngeo/journal/v1/n1/full/ngeo.2007.37.html

2008, Jan 1	H.-K. Moon, Y.-I., Byon, S.N. Raymaond, T. Spahr, 2008, *Icarus*, 19, 53, "Realistic survey simulations for kilometer class near Earth objects." See: http://adsabs.harvard.edu/abs/2008Icar..193...53M
2008, Jan 13	Apollo NEA **2008 AF3** (*H* = 26.4 mag, *D* ≈ 19 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.98 LD. **[2008-01]** See: 2008 AF3 - JPL , 2008 AF3 - SSA
2008, Jan 14	**First meeting *International Primitive Body Exploration Working Group (IPEWG)***, Okinawa (Japan). JAXA will maintain website. See: http://www.jspec.jaxa.jp/okinawa_index.html http://www.jspec.jaxa.jp/IPEWG_circular_final-2.pdf http://www.lpi.usra.edu/sbag/meetings/jan2009/presentations/Sykes_ipewg_SBAG.pdf
2008, Jan 16	Apollo NEA **2008 BW2** (*H* = 29.7 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.92 LD. **[2008-02]** See: 2008 BW2 - JPL , 2008 BW2 - SSA
2008, Jan 29	Apollo NEA **2007 TU24** (*H* = 20.5 mag, *D* = 250 m, **PHA**) passed Earth at a nominal miss distance of 1.44 LD. Minimum miss distance 1.44 LD. See: 2007 TU24 - JPL , 2007 TU24 - SSA Closest approach by a known asteroid of this size or larger until **2027**. Radar detection was acquired on 23 January using the NASA Goldstone 70 m antenna, part of NASA's Deep Space network station in the Southern California Mojave Desert. See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=1586 http://antwrp.gsfc.nasa.gov/apod/ap080130.html See also: http://en.wikipedia.org/wiki/2007_TU24 See also: **30 Jan 2168.**
2008, Jan 30	Apollo NEA **2007 WD5** (*H* = 24.5 mag, *D* ≈ 50 m, discovered by the **Catalina Sky Survey**) passed **Mars** by 26,100 km. See: 2007 WD5 - JPL , 2007 WD5 - SSA See also: http://neo.jpl.nasa.gov/news/news151.html http://uanews.org/node/17415 http://www.jpl.nasa.gov/news/news.cfm?release=2007-152 http://neo.jpl.nasa.gov/news/news153.html

	http://impact.arc.nasa.gov/news_detail.cfm?ID=179 http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2007%20WD5;orb=1;cov=0;log=0;cad=1#cad http://en.wikipedia.org/wiki/2007_WD5
2008, Jan 31	Apollo NEA **2008 BC15** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2008-03]** See: 2008 BC15 - JPL , 2008 BC15 - SSA
2008, Feb	R.W. Sinnott, 2008, *Sky & Telescope*, 115, no.2, p. 86, "Wouldn't a 300-meter asteroid be able to eclipse the Moon, if it should pass in front of it?" See: http://adsabs.harvard.edu/abs/2008S%26T...115R..86S
2008, Feb 5	Aten NEA **2008 CT1** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.34 LD. **[2008-04]** See: 2008 CT1 - JPL , 2008 CT1 - SSA
2008, Feb 6	Apollo NEA **2008 CE22** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 1.001 LD. Minimum miss distance 0.999 LD. See: 2008 CE22 - JPL , 2008 CE22 - SSA See also: **5 Feb 2066.**
2008, Feb 15	Apollo NEA **2008 CK70** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 0.97 LD. Minimum miss distance 0.97 LD. **[2008-05]** See: 2008 CK70 - JPL , 2008 CK70 - SSA See also: https://en.wikipedia.org/wiki/2008_CK70
2008, Feb 18	T. Graham, R.L. Schweickart, 2008, *Scientific American*, 18 February 2008, "NASA's flimsy argument for nuclear weapons." See: http://www.scientificamerican.com/article.cfm?id=nasas-flimsy-argument-for-nuclear-weapons
2008, Feb 18-19	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and technical Subcommittee*, 45th Session, Action Team 14** on NEOs meets in Vienna (Austria). **Report** (11 March 2008)**:** http://www.unoosa.org/pdf/reports/ac105/AC105_911E.pdf
2008, Feb 26	**The Planetary Society *Apophis Mission Design Competition*** results released. See:

	http://planetary.org/programs/projects/near_earth_objects/apophis_competition/rules.html http://www.planetary.org/programs/projects/apophis_competition/update_20080226.html http://www.esa.int/SPECIALS/NEO/SEMJCNM5NDF_0.html
2008, Mar	***Small Bodies Assessment Group***, chartered by NASA's Planetary Science Division to identify scientific priorities and opportunities for the exploration of asteroids, comets, interplanetary dust, small satellites, and Trans-Neptunian Objects. The group also provides scientific input on the utility of asteroids and comets in support of human space activities. See: http://www.lpi.usra.edu/sbag/
2008, Mar	R. Linfield, J. Vancleve, H.J. Reitsema, R. Arentz, 2008, in: Proc. *39th Lunar and Planetary Science Conference*, League City (TX, USA), 10-14 March 2008, *Lunar and Planetary Science XXXIX*, LPI Contribution No. 1391, p. 1412, "Searching for Near Earth Objects from a Venus-like orbit." See: http://adsabs.harvard.edu/abs/2008LPI....39.1412L Read also: - R. Linfield, J. Vancleve, H.J. Reitsema, R. Arentz, 2008, in: Proc. *Asteroids, Comets, Meteors 2008*, 14-18 July 2008, Baltimore (MD, USA). LPI Contribution No. 1405, paper id. 8270, "Searching for Near Earth Objects: an IR telescope in a Venus-like orbit." See: http://adsabs.harvard.edu/abs/2008LPICo1405.8270L - B. Corbin, 2010, presented at the *61st International Astronautical Congress*, Prague (Czech Republic), 27 September - 1 October 2010, "Implementing advanced technologies and models to reduce uncertainty in a global, cost-effective asteroid mitigation system." See: http://spacegeneration.org/index.php/activities/current-projects/neo-working-group/move-an-asteroid http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf
2008, Mar 3	Apollo NEA **2008 EK68** ($H = 29.6$ mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 1.51 LD. **Minimum miss distance 0 LD**. See: 2008 EK68 - JPL , 2008 EK68 - SSA
2008, Mar 7	R. Stone, 2008, *Science*, 319, 1326, "Preparing for doomsday." See: http://www.sciencemag.org/content/319/5868/1326.summary/

2008, Mar 7	R. Stone, 2008, *Science*, 319, 1329, "The state of our planet's defenses." See: http://www.sciencemag.org/content/319/5868/1329.summary
2008, Mar 9	Apollo NEA **2008 EZ7** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2008-06]** See: 2008 EZ7 - JPL , 2008 EZ7 - SSA
2008, Mar 10, 05:24	Apollo NEA **2008 EF32** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.13 LD. **[2008-07]** See: 2008 EF32 - JPL , 2008 EF32 - SSA
2008, Mar 10, 19:39	Apollo NEA **2008 EM68** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.15 LD. **[2008-08]** See: 2008 EM68 - JPL , 2008 EM68 - SSA
2008, Mar 23	Apollo NEA **2008 FK** (*H* = 27.3 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84 LD. **[2008-09]** See: 2008 FK - JPL , 2008 FK - SSA
2008, Mar 29	Apollo NEA **2008 FP** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2008-10]** See: 2008 FP - JPL , 2008 FP - SSA
2008, Apr	A. Carusi, G. D'Abramo, G.B. Valsecchi, 2008, *Icarus*, 194, 450, "Orbital and mission planning constraints for the deflection of NEOs impacting on Earth." See: http://adsabs.harvard.edu/abs/2008Icar..194..450C
2008, Apr	G.S. Collins, N. Artemieva, K. Wünnemann, et al., 2008, *Terra Nova*, 20, 165, "Evidence that Lake Cheko is not an impact crater." See: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3121.2008.00791.x/full .
2008, Apr	J. Davis, 2008, *Astronomy*, 36, No. 4, p. 34, "185 million years before the dinosaurs' demise, did an asteroid nearly end life on Earth?" See: http://adsabs.harvard.edu/abs/2008Ast....36d..34D
2008, Apr	M.A. McDonald, H.J. Melosh, S.P.S. Gulick, 2008, *Geophysical Research Letters*, 35(7), L07203, "Oblique impacts and peak ring

	position: **Venus** and **Chicxulub**." See: http://adsabs.harvard.edu/abs/2008GeoRL..3507203M
2008, Apr 3	Apollo NEA **2008 GM2** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.54 LD. **[2008-11]** See: 2008 GM2 - JPL , 2008 GM2 - SSA See also: **4 Apr 1947**.
2008, Apr 7	Apollo NEA **2008 GF1** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.76 LD. Minimum miss distance 0.76 LD. **[2008-12]** See: 2008 GF1 - JPL , 2008 GF1 - SSA See also: **7 Apr 2004**.
2008, Apr 7	Fall of the **Berduc L6 Chondrite Meteorite**. A daylight **fireball** was witnessed by hundreds of people from Argentina and Uruguay, and recorded by an infrasound array in Paraguay. Ref: - J.M. Trigo-Rodriguez, J. Llorca, J.M. Madiedo, et al., 2010, *Meteoritics and Planetary Science*, 45, 383, "The **Berduc L6 chondrite fall**: meteorite characterization, trajectory, and orbital elements." See: http://adsabs.harvard.edu/abs/2010M%26PS...45..383T
2008, Apr 9	Apollo NEA **2018 GY3** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 1.57 LD. Minimum miss distance 1.57 LD. It passed the Moon at a nominal miss distance of 0.80 LD. Minimum miss distance 0.80 LD. See: 2018 GY3 - JPL , 2018 GY3 - SSA
2008, Apr 23-26	***3rd International Workshop on NEO Deflection Policy***, Guácimo (Costa Rica), organized by the Association of Space Explorers (ASE). See: http://www.space-explorers.org/committees/NEO/workshop3.html http://www.oosa.unvienna.org/pdf/pres/stsc2008/tech-12.pdf
2008, May 10	Apollo NEA **2008 JL24** (*H* = 29.8 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2008-13]** See: 2008 JL24 - JPL , 2008 JL24 - SSA
2008, May 19	Apollo NEA **2015 XR169** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 5.78 LD. Minimum miss distance 0.12 LD. See: 2015 XR169 - JPL , 2015 XR169 - SSA

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2008, Jun	G. Drolshagen, V. Dikarev, M. Landgraf, 2008, *Earth, Moon, and Planets*, 102, 191, "Comparison of meteoroid flux models for near Earth space." See: http://adsabs.harvard.edu/abs/2008EM%26P..102..191D
2008, Jun	M.A. Sansaturio, O. Arratia, 2008, *Earth, Moon, and Planets*, 102, 425, "**Apophis**: the story behind the scenes." See: http://adsabs.harvard.edu/abs/2008EM%26P..102..425S
2008, Jun	R.M. Suggs, W.J. Cooke, R.J. Suggs, et al., 2008, *Earth, Moon, and Planets*, 102, 293, "The **NASA Lunar Impact Monitoring Program**." See: http://adsabs.harvard.edu/abs/2008EM%26P..102..293S
2008, Jun 5-6	First open ***Workshop on the ESA Marco Polo mission study***, a NEO sample return mission within the ESA Cosmic Vision Program, La Croisette (Cannes, France). See: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=42479
2008, Jun 26	Editorial, *Nature*, 453, 1143, 2008, "The unlikely matters. The study of cosmic impacts and the effects they have offers two lessons for students of science." See: http://www.nature.com/nature/journal/v453/n7199/full/4531143a.html
2008, Jun 26	D.I. Steel, 2008, *Nature,* 453, 1157, "**Tunguska** at 100." See: http://www.nature.com/news/2008/080625/full/4531157a.html
2008, Jun 26	E. Hand, 2008, *Nature,* 453, 1160, "The hole at the bottom of the moon." See: http://www.nature.com/news/2008/080625/full/4531160a.html
2008, Jun 26	D. Chandler, 2008, *Nature,* 453, 1164, "Planetary science: *the burger bar that saved the world*." Interviews with pioneers in the NEO field Clark Chapman, Tom Gehrels, Brian Marsden, Andrea Milani, David Morrison, Steve Ostro, Rusty Schweickart, and

	Carolyn Shoemaker. See: http://www.nature.com/news/2008/080625/full/4531164a.html
2008, Jun 26	Anon., 2008, *Nature,* 453, 1170, "All craters great and small." See: http://www.nature.com/news/2008/080625/full/4531170a.html
2008, Jun 26	A.W. Harris, 2008, *Nature,* 453, 1178, "What **Spaceguard** did." See: http://adsabs.harvard.edu/abs/2008Natur.453.1178H http://www.nature.com/nature/journal/v453/n7199/full/4531178a.html
2008, Jun 26-28	**International Conference *100 Years Since Tunguska Phenomenon: Past, Present and Future***, Moscow (Russia), hosted by the Russian Academy of Sciences. Proceedings in: *Solar System Research*, 43, Nos. 4, 5, 6 (2009). See: http://runners.ritsumei.ac.jp/cgi-bin/swets/volume-query-e?mode=0&key=S122060696421602&issn=&tr=Solar+System+Research http://springerlink.com/content/106293/ See also: http://tunguska.sai.msu.ru/content/abstract_all.pdf http://smerdyachee.ucoz.ru/_ld/0/8_abstract_all.pdf http://tunguska.sai.msu.ru/index.php?q=index_e
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2008, Jul 9	W.F. Bottke, 2008, *Nature*, 454, 173, "Asteroids: how to make a flying saucer." See: http://adsabs.harvard.edu/abs/2008Natur.454..173B
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	"Rotational breakup as the origin of small binary asteroids." See: http://adsabs.harvard.edu/abs/2008Natur.454..188W
2008, Jul 13	R.L. Schweickart, 2008, presented at the *37th COSPAR Scientific Assembly*, Montreal (Canada), 13-20 July 2008, "The asteroid impact threat: decisions upcoming." See: http://adsabs.harvard.edu/abs/2008cosp...37.2792S http://www.space-explorers.org/committees/NEO/docs/COSPAR-paper.pdf
2008, Jul 13-18	***International conference on Asteroids, Comets, Meteors, X***, Baltimore (MD, USA). Proceedings: … (eds.), *Asteroids, Comets, Meteors 2008.* See: http://acm2008.jhuapl.edu/ http://www.lpi.usra.edu/meetings/acm2008/pdf/program.pdf http://www.lpi.usra.edu/meetings/acm2008/acm2008.authorindex.shtml
2008, Jul 23	**Tajikistan superbolide**. See: http://www.bolides09.com/docs/bolides09_program.pdf See also: http://adsabs.harvard.edu/doi/10.1111/maps.12217
2008, Jul 29	Apollo NEA **2008 OT7** ($H = 27.1$ mag, $D \approx 14$ m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2008-14]** See: 2008 OT7 - JPL , 2008 OT7 - SSA
2008, Jul 30	N.A. Artemieva, V.V. Shuvalov, 2008, *Solar System Research*, 42, 329, "Numerical simulation of high-velocity impact ejecta following falls of comets and asteroids onto the Moon." See: http://adsabs.harvard.edu/abs/2008SoSyR..42..329A
2008, Aug 12	**Perseid Fireball** seen over Vancouver (Canada). See: http://apod.nasa.gov/apod/ap080816.html
2008, Aug 14	P. Vernazza, R.P. Binzel, C.A. Thomas, et al., 2008, *Nature*, 454, 858, "Compositional differences between meteorites and near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2008Natur.454..858V
2008, Aug 17-21	***International Conference on Large Meteorite Impacts and Planetary Evolution, IV***, Vredefort Dome (South Africa). See: http://www.lpi.usra.edu/meetings/lmi2008/ http://www.agu.org/pubs/crossref/2009/2009EO010006.shtml

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2008, Sep 5	ESA spacecraft ***Rosetta*** flew at 803 km by Main-belt asteroid **2867 Šteins** (**1969 VC**, $H = 12.7$ mag, $D = 6.7 \times 5.8 \times 4.5$ km). See: 1969 VC - JPL , 2867 Steins - SSA Ref: - K.-H. Glassmeier, H. Boehnhardt, D. Koschny, et al., 2007, *Space Science Reviews*, 128, 1, "The ***Rosetta*** mission: flying towards the origin of the Solar System." See: http://adsabs.harvard.edu/abs/2007SSRv..128....1G - P.R. Weissman, M.D. Hicks, P.A. Abell, et al., 2008, *Meteoritics & Planetary Science*, 43, 905, "***Rosetta*** target asteroid **2867 Šteins**: an unusual E-type asteroid." See: http://adsabs.harvard.edu/abs/2008M%26PS...43..905W - H.U. Keller, C. Barbieri, D. Koschny, et al., 2010, *Science*, 327, 190, "E-type asteroid (**2867**) **Šteins** as imaged by **OSIRIS** on board ***Rosetta***". See: http://adsabs.harvard.edu/abs/2010Sci...327..190K - S. Besse, P. Lamy, L. Jorda, et al., November 2012, *Icarus*, 221, 1119, "Identification and physical properties of craters on asteroid (**2867**) **Steins**." See: http://adsabs.harvard.edu/abs/2012Icar..221.1119B

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2008, Sep 21-26	***European Planetary Science Congress 2008 (EPSC 2008)***, Münster (Germany), 21-26 September 2008. See: http://meetings.copernicus.org/epsc2008/
2008, Sep 22	D.K. Yeomans, S. Bhaskaran, S. Broschart, et al., 2008, "Near-Earth Object (NEO) analysis of transponder tracking and **gravity tractor** performance". A study, requested and funded by the **B612 Foundation**, carried out by JPL scientists to detemine the feasibility of using a ***gravity tractor*** concept for use in NEO impact mitigation and to build credibility for the concept. See: http://neo.jpl.nasa.gov/neo/b612_report.html http://www.b612foundation.org/papers/t-GT_summary.pdf https://cneos.jpl.nasa.gov/doc/b612_report.html
2008, Sep 22-25	***4th International Workshop on NEO Deflection Policy***, San Francisco (CA, USA), organized by the Association of Space Explorers (ASE). See: http://www.oosa.unvienna.org/pdf/pres/stsc2008/tech-12.pdf
2008, Sep 25	**The Association of Space Explorers (ASE)** ***Committee on Near-Earth Objects Panel on Asteroid Threat Mitigation (PATM)*** (chairman Russell Schweickart) presented its report ***Asteroid Threats: a Call for Global Response***, to UN-COPUOS, Vienna (Austria). See: http://www.space-explorers.org/committees/NEO/docs/ATACGR.pdf http://www.unoosa.org/pdf/pres/stsc2009/tech-31.pdf

2008, Sep 29	R.L. Schweickart, 2008, presentation to the International Astronautical Congress, Glasgow (Scotland, UK), 29 September - 3 October 2008, "Decision program on asteroid threat mitigation." See: http://www.space-explorers.org/committees/NEO/docs/IAC08_paper.pdf
2008, Sep 30	**Black Mesa Bolide**, seen over the Oklahoma panhandle's Black Mesa State Park in the Midwestern US. See: http://farlimas.com/skyeye/skydatatext/space349text.html http://antwrp.gsfc.nasa.gov/apod/ap081011.html
2008, Oct	**Lowell Observatory Near-Earth Object Search (LONEOS)** discontinued the search for NEOs in favor of an asteroid photometric survey.
2008, Oct 3	Apollo NEA **2008 TN9** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.63 LD. **[2008-15]** See: 2008 TN9 - JPL , 2008 TN9 - SSA
2008, Oct 6	**Impact.** Apollo NEA **2008 TC3** (H = 30.3 mag, $D \approx$ 4.1 m) was discovered by the **Catalina Sky Survey (CSS)** Mt Lemmon Survey 1.5 telescope, 19 hr before disintegrating over the Nubian desert (northern Sudan), in a **Fireball and Airburst**. Before impact, the international observer community responded with 570 observations from 27 observers. A systematic search in the desert located 280 fragments with a total mass of 3.9 kg. See: 2008 TC3 - JPL , 2008 TC3 - SSA Ref: - P. Jenniskens, M.H. Shaddad, D. Numan, et al., 2009, *Nature*, 458, 485, "The impact and recovery of asteroid **2008 TC_3**". See: http://adsabs.harvard.edu/abs/2009Natur.458..485J - Special Issue of *Meteoritics & Planetary Science*, 2010, 45, Issue 10-11, pp. 1553-1845, "**2008 TC3** and Almahata Sitta." Dedicated to NEA **2008 TC3**, impact on 6 October 2008. Editorial: P. Jenniskens, M.H. Shaddad, 2010, *Meteoritics & Planetary Science*, 45, 1553, "**2008 TC3**: the small asteroid with an impact." See: http://adsabs.harvard.edu/abs/2010M%26PS...45.1553J - P. Jenniskens, J. Vaubaillon, R.P. Binzel, et al., 2010, *Meteoritics & Planetary Science*, 45, 1590, "**Almahata Sitta** (= asteroid **2008 TC3**) and the search for the ureilite parent body." See: http://adsabs.harvard.edu/abs/2010M%26PS...45.1590J - P. Scheirich, J. Durech, P. Pravec, 2010, *Meteoritics & Planetary Science*, 45, 1804, "The shape and rotation of asteroid **2008 TC3**." See: http://adsabs.harvard.edu/abs/2009Natur.458..485J

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2008, Oct 9	Apollo NEA **2008 TS26** (H = 33.2 mag, $D \approx$ 0.8 m) passed Earth at a **nominal miss distance of 0.033 LD (= 1.98 R_{Earth} from the geocenter)**. Minimum miss distance 0.030 LD. **[2008-16]** See: 2008 TS26 - JPL , 2008 TS26 - SSA See also: http://www.newscientist.com/blogs/shortsharpscience/2008/10/trio-of-asteroids-buzz-earth.html See also: http://neo.ssa.esa.int/newsletters [June 2020]
2008, Oct 16	US President Bush signs NASA Authorization bill (H.R. 6063), which among other topics requests information on: (1) a low-cost space mission with the purpose of rendezvous-ing with, attaching a tracking device, and characterizing the **Apophis** asteroid; and (2) a medium-sized space mission with the purpose of detecting NEOs with D > 140 m. Congress also requests that within two years after the date of enactment of this Act, the Director of the OSTP shall (1) develop a policy for notifying Federal agencies and relevant emergency response institutions of an impending NEO threat, if near-term public safety is at risk; and (2) recommend a federal agency or agencies to be responsible for: (a) protecting the United States from a NEO that is expected to collide with Earth; and (b) implementing a deflection campaign, in consultation with international bodies, should one be necessary. See: http://legislative.nasa.gov/PL%20110-422.pdf
2008, Oct 18	Apollo NEA **2008 UA202** (H = 29.3 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.86 LD. **[2008-17]** See: 2008 UA202 - JPL , 2008 UA202 - SSA See also: **21 Oct 2029**.
2008, Oct 20	Apollo NEA **2008 US** (H = 31.4 mag, $D \approx$ 1.9 m) passed Earth at a nominal miss distance of 0.086 **LD (= 5.16 R_{Earth} from the geocenter)**. Minimum miss distance 0.079 LD. **[2008-18]** See: 2008 US - JPL , 2008 US - SSA
2008, Oct 21	Apollo NEA **2019 UE4** (H = 27.9 mag, $D \approx$ 9 m) will pass Earth at a nominal miss distance of 2.00. Minimum miss distance 0.34 LD. See: 2019 UE4 – SSA , 2019 UE4 – JPL See also: **10 Oct 2064**.
2008, Oct 22	Apollo NEA **2008 UM1** (H = 31.7 mag, $D \approx$ 1.6 m) passed Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.09 LD. **[2008-19]**

	See: 2008 UM1 - JPL , 2008 UM1 - SSA
2008, Oct 29	Apollo NEA **2008 VL** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 2.52 LD. Minimum miss distance 0.73 LD. See: 2008 VL - JPL , 2008 VL - SSA
2008, Nov	*Beyond the Moon. A New Roadmap for Human Space Exploration in the 21st Century*. Study report of The Planetary Society, advocating *inter alia* the exploration of Near Earth Asteroids by human spaceflight. See: http://www.planetary.org/special/roadmap/beyond_the_moon.pdf
2008, Nov	M. Delbò, P. Tanga, F. Mignard, 2008, *Planetary and Space Science*, 56, 1823, "On the detection of the Yarkovsky effect on near-Earth asteroids by means of ***Gaia***." See: http://adsabs.harvard.edu/abs/2008P%26SS...56.1823D
2008, Nov	O. Vaduvescu, M. Birlan, F. Colas, et al., 2008, *Planetary and Space Science*, 56, 1913, "**EURONEAR**: first results." See: http://adsabs.harvard.edu/abs/2008P%26SS...56.1913V
2008, Nov	**ESA Space Situational Awareness (SSA) Preparatory Programme**, a new ESA initiative, accepted at the November 2008 Ministerial Conference in Den Haag (Netherlands) as a new optional programme of ESA, covering the time frame 2009 – 2011. **SSA** includes activities in three main domains: space surveillance, space weather, and Near Earth Objects (NEOs). As part of the **SSA** programme, the 1-m ESA Optical Ground Station has been made available for NEO observations for four nights every month starting in 2010. Full operational services are to be implemented in 2012-2019. Ref: - Z. Sodnik, B. Furch, H.Lutz, Nov 2007, *ESA Bulletin*, No. 132, p. 34, "The ESA Optical Groundstation, ten years since First Light." See: http://www.esa.int/esapub/bulletin/bulletin132/bul132d_sodnik.pdf On 28/29 September 2011, a NEA was detected in this program for the first time: **2011 SF108**, by the **Teide Observatory Tenerife Asteroid Survey (TOTAS)**. See: http://www.esa.int/SPECIALS/SSA/SEMURW6UXSG_0.html http://www.esa.int/SPECIALS/SSA/SEMDQGCKP6G_2.html See also: http://www.esa.int/esaMI/Operations/SEMDPU3Z2OF_0.html http://www.esa.int/esaMI/SSA/SEMDQGCKP6G_0.html http://www.unoosa.org/pdf/pres/stsc2009/tech-13.pdf http://www.unoosa.org/pdf/pres/stsc2010/tech-36.pdf http://www.space.com/news/asteroid-threat-global-action-plan-

	101109.html
2008, Nov 2	Aten NEA **2015 VL64** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.29 LD. Minimum miss distance 1.03 LD. See: 2015 VL64 - SSA , 2015 VL64 - JPL See also: **2 Nov 2028**.
2008, Nov 3	Apollo NEA **2008 VM** (*H* = 30.2 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.120 LD (and the **Moon** at 0.985 LD). Minimum miss distance 0.112 LD. **[2008-20]** See: 2008 VM - SSA , 2008 VM - JPL
2008, Nov 9	Apollo NEA **4179 Toutatis** (**1989 AC**, *H* = 15.2 mag, *D* = 4.6 × 2.4 × 1.9 km, orbital *P* = 4.03 yr, **PHA**) passed Earth at 19.6 LD. See: 4179 Toutatis - SSA , 1989 AC - JPL See also: http://en.wikipedia.org/wiki/4179_Toutatis See also: **8 Dec 1992**, **30 Nov 1996**, **31 Oct 2000**, **29 Sep 2004, 12 Dec 2012**, **5 Nov 2069**.
2008, Nov 16	Apollo NEA **2008 WO2** (*H* = 29.8 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.05 LD. Minimum miss distance 1.04 LD. See: 2008 WO2 - SSA , 2008 WO2 - JPL
2008, Nov 19-20	***Workshop on the Early Solar System Impact Bombardment***, Houston (TX, USA), 19-20 November 2008. See: http://www.lpi.usra.edu/meetings/bombardment2008/
2008, Nov 20	**Buzzard Coulee Fireball and Meteorite Fall** (Saskatchewan, Canada). Estimated NEA entry mass *M* ≈ 15,000 kg. Ref: - A.R. Hildebrand, E.P. Miley, P.G. Brown, et al., 2009, 40th Lunar and Planetary Science Conference, *Lunar and Planetary Science XL*, 23-27 March 2009, The Woodlands (TX, USA), id. 2505, "Characteristics of a bright fireball and meteorite fall at **Buzzard Coulee**, Saskatchewan (Canada), 20 November 2008." See: http://adsabs.harvard.edu/abs/2009LPI....40.2505H See also: http://antwrp.gsfc.nasa.gov/apod/ap081125.html
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2008, Dec	M.B.E. Boslough, D.A. Crawford, 2008, *International Journal of Impact Engineering*, 35, 1441, "Low-altitude airbursts and the impact threat." See: http://www.sciencedirect.com/science/article/pii/S0734743X08001784 http://www.sandia.gov/ldrd/images/Posters/Boslough_Poster.pdf http://share.sandia.gov/news/resources/releases/2007/asteroid.html
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2008, Dec	M. Zavodny, R. Jedicke, E.C. Beshore, et al., 2008, *Icarus*, 198, 284, "The orbit and size distribution of small Solar System objects orbiting the Sun interior to the Earth's orbit." See: http://adsabs.harvard.edu/abs/2008Icar..198..284Z
2008, Dec 5	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**, *Information on research in the field of NEOs carried out by Member States, international organizations and other entities*. See: http://www.unoosa.org/pdf/reports/ac105/AC105_926E.pdf
2008, Dec 6	Apollo NEA **2008 XK** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 1.60 LD. Minimum miss distance 0.08 LD. See: 2008 XK - SSA , 2008 XK - JPL
2008, Dec 6	**Colorado Fireball**. See: http://www.universetoday.com/21959/exploding-colorado-fireball-100-

	times-brighter-than-the-moon-video/
2008, Dec 6	**Panoramic Survey Telescope And Rapid Response System (Pan-STARRS)**, first telescope **PS1** (Haleakala, Maui, HI, USA) operational, of four 1.8m telescopes, each with 3° FoV and 1.4 gigapixel camera. The **PS2** telescope is under construction. The **PS3** and **PS4** telecopes are as yet uncertain. With **PS1** the available sky is being observed three times per month down to *v* = 24 mag. Regular observations started in March 2009, were suspended in September 2009, but resumed in May 2010. The favored location for **PS4** is the site of the University of Hawaii 2.2-meter telescope on Mauna Kea. Funding for the development of the observing system has been provided by the U.S. Air Force. Ref: - R. Irion, 12 May 2006, *Science*, 312, 840, "A Hawaiian upstart prepares to monitor the starry heavens." See: http://www.sciencemag.org/content/312/5775/840.summary/ - R. Jedicke, E.A. Magnier, N. Kaiser, et al., 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symp. No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 341, "The next decade of Solar System discovery with **Pan-STARRS**." See: http://adsabs.harvard.edu/abs/2007IAUS..236..341J - W. Burgett, N. Kaiser, 2009, in: S. Ryan (ed.), Proc. *Advanced Maui Optical and Space Surveillance Technologies Conference*, Wailea (Maui, HI, USA), 1-4 September 2009 (The Maui Economic Development Board), p. E39, "The **Pan-STARRS** Project: the next generation of survey astronomy has arrived." See: http://www.amostech.com/TechnicalPapers/2009/Astronomy/Burgett.pdf - R.J. Wainscoat, L. Denneau, P. Veres, et al., October 2012, American Astronomical Society, DPS meeting #44, #305.07, "The **Pan-STARRS 1** search for Near Earth Objects: recent progress and future plans." See: http://adsabs.harvard.edu/abs/2012DPS....4430507W http://adsabs.harvard.edu/abs/2009amos.confE..39B See also: http://pan-starrs.ifa.hawaii.edu/public http://www.newscientist.com/article/dn9403 http://www.ifa.hawaii.edu/info/press-releases/Pan-STARRS_Donation/
2008, Dec 10	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) Action Team 14**, *Interim Report (2008 – 2009)*. See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L298E.pdf

2008, Dec 15	Steven J. Ostro (1946-2008) passed away. Ref: - C. Anderson, 2008, *Planetary News:* Space People (2008), 16 December 2008, "Steven J. Ostro, 1946 - 2008." See: http://www.planetary.org/news/2008/1216_Steven_J_Ostro_1946__2008. html - K. Beatty, 2008, *Sky & Telescope*, 18 December 2008, "Remembering Steven Ostro", See: http://www.skyandtelescope.com/community/skyblog/newsblog/36421054.html - D. Morrison, 2008, *Asteroid and Comet Impact Hazards*, 30 December 2008, "Death of Steve Ostro (1946-2008)." See: http://impact.arc.nasa.gov/news_detail.cfm?ID=180 - A.W. Harris, 2009, American Astronomical Society, DPS meeting #41, #29.01, "Steven J. Ostro: Pioneer in asteroid lightcurve inversion." See: http://adsabs.harvard.edu/abs/2009DPS....41.2901H See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=180 http://www.planetary.org/blog/article/00001774 http://www.planetary.org/blog/article/00001976/ http://echo.jpl.nasa.gov/ostro_symposium/ostro_symposium.html http://en.wikipedia.org/wiki/Steven_J._Ostro
2008, Dec 23	Aten NEA **341843** (**2008 EV5**, *H* = 19.9 mag, *D* = 370 m, **PHA**) passed Earth at a nominal miss distance of 8.41 LD. Minimum miss distance 8.41 LD. See: 341843 2008 EV5 - SSA , 2008 EV5 - JPL Ref: - M.W. Busch, S.J. Ostro, L.A.M. Benner, et al., 2011, *Icarus*, 212, 649, "Radar observations and the shape of Near-Earth Asteroid **2008 EV5**." See: http://adsabs.harvard.edu/abs/2011Icar..212..649B - V. Reddy, L. LeCorre, M. Hicks, et al., 2012, *Icarus*, 221, 678, "Composition of Near-Earth Asteroid **2008 EV5**: potential target for robotic and human exploration." See: http://adsabs.harvard.edu/abs/2012Icar..221..678R See also: http://www.activeboard.com/forum.spark?forumID=58381&p=3&topicID=23138860 https://en.wikipedia.org/wiki/(341843)_2008_EV5
2009, Jan 1	**5864 NEAs** known, of which **1008 PHAs**. See: http://neo.jpl.nasa.gov/stats/
2009	The **Space Generation Advisory Council (SGAC)**, Vienna,

	(Austria), in the context of the *International Year of Astronomy 2009*, launched its initiative *Move an Asteroid 2009*. The Winner of the competition, announced on 26 August 2009, is Sini Merikallio of the Finnish Meteorological Institute, Helsinki (Finland) with the paper: "Moving an asteroid with electric solar wind sail". See: http://www.spacegeneration.org/asteroid
2009	The **IAU Minor Planet Center** is funded over 90% through a grant from NASA's Planetary Science Division. This grant enabled the **MPC** to hire two additional staff members, and will support funding at this level for the next 2.5 years. The **MPC** is operated at the Harvard-Smithsonian Astrophysical Observatory, Cambridge (MA, USA) and supported by the **IAU** and sponsors, including the Tamkin Foundation. The **MPC** is responsible for the collection, validation and distribution of all positional measurements made worldwide of minor planets, comets and other irregular natural satellites. While the **MPC** handles data on all classes of object, it focuses on the rapid collection and distribution of observations and information on the orbits of NEOs. The **MPC** is now fully upgraded to LINUX-based processors; it processes all observations received world-wide each night within the next day; its database contains over 68,000,000 observations and over 475,000 orbits for minor planets. NEO observations are identified and processed on receipt in near-real-time. Suspected discoveries are automatically posted to the NEO Confirmation Page. Since June 2018 the **IAU Minor Planet Center** is operating under the NASA **Planetary Data System's Small Bodies Node**. See: http://www.cfa.harvard.edu/iau/mpc.html http://www.unoosa.org/pdf/pres/stsc2010/tech-39.pdf http://targetneo.jhuapl.edu/pdfs/sessions/TargetNEO-Session2-Spahr.pdf https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/fast.pdf
2009	A.W. Harris, P. Abell, L.A.M. Benner, et al. 2009, in: *Astro2010: The Astronomy and Astrophysics Decadal Survey*, Science White Papers, no. 113, "Surveying the inner Solar System." See: http://adsabs.harvard.edu/abs/2009astro2010S.113H
2009	L.D. Schmadel, 2009, *Dictionary of minor planet names: Addendum to the fifth edition* (Berlin: Springer). See: http://adsabs.harvard.edu/abs/2009dmpn.book.....S
2009	A. Tudorica, R. Toma, A.B. Sonka, et al., 2009, *American Astronomical Society, DPS meeting* #40, #27.09; *Bulletin of the American Astronomical Society*, 41, 557, "**EURONEAR** - the first 100 NEA's observed."

	See: http://adsabs.harvard.edu/abs/2009DPS....40.2709T
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2009, Jan	D. Koschny, J. McAuliffe, 2009, *Meteoritics & Planetary Science*, 44, 1871, "Estimating the number of impact flashes visible on the Moon from an orbiting camera." See: http://adsabs.harvard.edu/abs/2009M%26PS...44.1871K
2009, Jan	J. Morrow, R. Gibson, W.U. Reimold, 2009, *Eos, Transactions American Geophysical Union*, 90, 4, "Impact cratering and its planetary and environmental effects." See: http://adsabs.harvard.edu/abs/2009EOSTr..90....4M
2009, Jan	International Academy of Astronautics (IAA) report *Dealing with the threat to Earth from Asteroids and Comets*, Ivan Bekey (ed.). See: http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg35/sg35finalreport.pdf
2009, Jan 2	R.A. Kerr, 2009, *Science*, 323, 26, "Did the mammoth slayer leave a diamond calling card?" See: http://www.sciencemag.org/content/323/5910/26.summary
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2009, Jan 12-13	**Inaugural Meeting NASA *Small Bodies Assessment Group* (SBAG)**, Adelphi (MD, USA). See: http://www.lpi.usra.edu/sbag/meetings/ http://www.lpi.usra.edu/sbag/meetings/jan2009/minutes.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/
2009, Jan 14-15	**ESA Workshop on *Guidance, Navigation, Control (GNC) for Small Body Missions***, Noordwijk (Netherlands). See: http://www.congrex.nl/09m01/
2009, Feb	A.W. Harris, E.G. Fahnestock, P. Pravec, 2009, *Icarus*, 199, 310, "On the shapes and spins of "rubble pile" asteroids." See: http://adsabs.harvard.edu/abs/2009Icar..199..310H

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2009, Feb 2	Apollo NEA **2009 CC2** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.46 LD. **[2009-01]** See: 2009 CC2 - SSA , 2009 CC2 - JPL
2009, Feb 12	J. Matson, 2009, *Scientific American*, 12 February 2009, "Close encounters of the worst kind: how safe are we from killer asteroids?" See: http://www.scientificamerican.com/article.cfm?id=killer-asteroids-how-safe-are-we
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2009, Feb 16-17	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and Technical Subcommittee*, 46th Session, Action Team 14** on NEOs under the Chairmanship of Richard Crowther (UK) met in Vienna (Austria) during the 46th session of its Scientific and Technical Subcommittee, to review the Association of Space Explorers **(ASE) Committee on Near-Earth Objects Panel on Asteroid Threat Mitigation** (chair Russell L. Schweickart) report *Asteroid Threats: a Call for Global Response* (see 25 September 2008), and as a result developed UN document A/AC.105/C.1/2009/CRP.13 dated 17 February 2009, outlining draft international procedures to respond to NEO threat for consideration by **UN-COPUOS** Member States. **Report, 6 March 2009:** http://www.unoosa.org/pdf/reports/ac105/AC105_933E.pdf http://www.unoosa.org/pdf/limited/c1/AC105_C1_2009_CRP13E.pdf **Technical presentations:** **-** Boris Shustov, 2009, "Asteroid-comet impact hazard problem. Current state of art in Russia."

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2009, Feb 18	Aten NEA **208023** (**1999 AQ10**, $H = 20.6$ mag, $D \approx 300$ m, **PHA**) passed Earth at a nominal miss distance of 4.39 LD. Minimum miss distance 4.39 LD. See: 1999 AQ10 - JPL , 1999 AQ10 - SSA See also **18 Feb 1903**.
2009, Feb 26	Apollo NEA **2009 DT43** ($H = 27.0$ mag, $D \approx 14$ m) passed Earth at a nominal miss distance of 1.03 LD. Minimum miss distance 1.03 LD. See: 2009 DT43 - SSA , 2009 DT43 - JPL
2009, Feb 27	Apollo NEA **2009 EJ1** ($H = 28.6$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.16 LD. Minimum miss distance 0.15 LD. **[2009-02]** See: 2009 EJ1 - SSA , 2009 EJ1 - JPL
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2009, Mar 2	Apollo NEA **2009 DD45** (*H* = 25.9 mag, *D* ≈ 19 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2009-03]** See: 2009 DD45 - SSA , 2009 DD45 - JPL See also: http://www.newscientist.com/article/dn 16697-tunguskasized-space-rock-buzzes-earth.html http://news.sky.com/skynews/Home/UK-News/Earth-Has-Near-Miss-As-Asteroid-Passes-50000-Miles-Away/Article/200903115234146?lpos=UK_News_First_Home_Article_Teaser_Region_0&lid=ARTICLE_15234146_Earth_Has_Near_Miss_As_Asteroid_Passes_50%2C000_Miles_Away http://en.wikipedia.org/wiki/2009_DD45 See also: **3 March 2067**.
2009, Mar 6	Apollo NEA **2009 EW** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88 LD. **[2009-04]** See: 2009 EW - SSA , 2009 EW - JPL
2009, Mar 16	Apollo NEA **2009 FJ** (*H* = 24.7 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 4.92 LD. Minimum miss distance 4.91 LD. See: 2009 FJ - SSA , 2009 FJ - JPL Ref: - I. Wlodarczyk, 2012, *Solar System Research*, 46, 301, "Impact orbits of the asteroid **2009 FJ** with the Earth." See: http://adsabs.harvard.edu/abs/2012SoSyR..46..301W
2009, Mar 18	Apollo NEA **2009 FH** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.22 LD. **[2009-05]** See: 2009 FH - SSA , 2009 FH - JPL

2009, Mar 19	Apollo NEA **2009 FK** (H = 28.4 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.97 LD. **[2009-06]** See: 2009 FK - SSA , 2009 FK - JPL
2009, Mar 27	Brian G. Marsden (**Minor Planet Center** emeritus-director), June 2009, *IAU Information Bulletin* No. 104, p. 67, "History of the **Minor Planet Center**." At the time of writing, the **MPC** files counted 210,454 numbered minor planets. The total number of observations of minor planets in the **MPC** files in mid-2008 was 55.4 million. See: http://www.iau.org/static/publications/IB104.pdf
2009, Mar 27	Apollo NEA **410777** (**2009 FD**, H = 22.3 mag, $D \approx$ 472 m) passed Earth at a nominal miss distance of 1.62 LD. Minimum miss distance 1.62 LD. See: 410777 2009 FD - SSA, 2009 FD - JPL See also: http://www.space.com/12645-asteroid-deflection-doomsday-earth-capability.html http://www.eso.org/public/announcements/ann14004/ http://neo.ssa.esa.int/ http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/European_cooperation_reduces_asteroid_risk http://en.wikipedia.org/wiki/2009_FD See also: **29 Mar 2185**.
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	"Averting asteroid danger with a nuclear nudge." See: http://newsline.llnl.gov/_rev02/articles/2009/apr/04.24.09-dearborn.php http://www.scientificamerican.com/blog/post.cfm?id=back-off-asteroids--weve-got-nukes-2010-05-26 http://www.space.com/8666-nuclear-bombs-save-earth-asteroids.html
2009, Apr 24	Apollo NEA **2009 HW67** (H = 26.0 mag, $D \approx$ 22 m) passed Earth at a nominal miss distance of 1.05 LD. Minimum miss distance 1.04 LD. See: 2009 HW67 - SSA , 2009 HW67 - JPL
2009, Apr 27-30	**1st International Academy of Astronautics (IAA) *Planetary Defense Conference: Protecting the Earth from Asteroids,*** Granada (Spain), co-sponsored by ESA and The Aerospace Corporation. See: http://pdc.iaaweb.org/?q=content/2009-granada **Papers:** http://www.congrex.nl/09c04/IAA_Papers.zip **Key points and recommendations:** http://www.nss.org/resources/library/planetary defense/WhitePaper-2009PlanetaryDefenseConference.pdf **Summary:** http://impact.arc.nasa.gov/news_detail.cfm?ID=181 **Among the papers:** - D.K. Yeomans, S. Bhaskaran, S.B. Broschart, S.R. Chesley, P.W. Chodas, T. H. Sweetser, R. Schweickart, 2009, "Deflecting a Hazardous Near-Earth Object." See: https://cneos.jpl.nasa.gov/doc/PDC_proceedings_062009.pdf https://cneos.jpl.nasa.gov/doc/PDC2015_paper.html
2009, Apr 27	D.K. Yeomans, S. Bhaskaran, S.R. Broschart, S.R. Chesley, P.W. Chodas, T.H., Sweetser, R.L. Schweickart, 2009, presented at 1st International Academy of Astronautics (IAA) Planetary Defense Conference: *Protecting Earth from Asteroids*, Granada (Spain), 27-30 April 2009, "Deflecting a hazardous Near-Earth Object." See: http://neo.jpl.nasa.gov/neo/PDC_proceedings_062009.doc http://neo.jpl.nasa.gov/neo/pdc_paper.html
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2009, May 5	Apollo NEA **2009 JF1** (*H* = 27.1 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.76 LD. Minimum miss distance 0.76 LD. **[2009-07]** See: 2009 JF1 - SSA , 2009 JF1 - JPL
2009, May 9	Apollo NEA **2009 JE1** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 5.98 LD. **Minimum miss distance 0 LD**. See: 2009 JE1 - SSA , 2009 JE1 - JPL
2009, May 10-15	***International Conference on Bolides and Meteorite Falls***, Prague, Czech Republic. See: http://www.bolides09.com/docs/bolides09_program.pdf
2009, May 13	A. Nayar, 2009, *Nature News*, 13 May 2009, "Did **dinosaur-killing space rock** create enough carbon monoxide to trigger extreme global warming?" See: http://www.nature.com/news/2009/090513/full/news.2009.477.html
2009, May 13	Apollo NEA **2009 JL2** (*H* = 25.8 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2009-08]** See: 2009 JL2 - SSA , 2009 JL2 - JPL See also: http://www.scientificamerican.com/blog/post.cfm?id=newfound-asteroid-will-pass-by-eart-2010-04-08
2009, May 18-20	**ESA International Symposium *Marco Polo and Other Small Body Return Missions***, Paris, France. See: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=43784
2009, May 21	O. Abramov, S.J. Mojzsis, 2009, *Nature*, 459, 419, "Microbial habitability of the Hadean Earth during the **Late Heavy Bombardment**." Ancient asteroid storm may have aided the emergency of life. See: http://adsabs.harvard.edu/abs/2009Natur.459..419A See also: http://planetary.org/news/2009/0529_Ancient_Asteroid_Storm_May_

	have_Aided.html
2009, May 30	K. Kawaragi, Y. Sekine, T. Kadono, et al., 2009, *Earth and Planetary Science Letters*, 282, 56, "Direct measurements of chemical composition of shock-induced gases from calcite: an intense global warming after the **Chicxulub impact** due to the indirect greenhouse effect of carbon monoxide." See: http://adsabs.harvard.edu/abs/2009E%26PSL.282...56K See also: http://www.nature.com/news/2009/090513/full/news.2009.477.html
2009, Jun	B.G. Marsden, 2009, *IAU Information Bulletin*, No.104, p. 67, "History of the **Minor Planet Center**." See: http://www.iau.org/static/publications/IB104.pdf
2009, Jun 1	Apollo NEA **2009 KR21** (H = 27.0 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.72 LD. **[2009-09]** See: 2009 KR21 - SSA , 2009 KR21 - JPL
2009, Jun 3-12	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS, 52nd session) and Action Team 14 on NEOs**, chaired by Richard Crowther (UK), meets in Vienna (Austria). See: http://www.oosa.unvienna.org/pdf/gadocs/A_64_20E.pdf
2009, Jun 4	**Steven J. Ostro Memorial Symposium on *Planetary Radar and Near-Earth Objects***, JPL, Pasadena (CA, USA). Ref: - S.J. Ostro, J.D. Giorgini, L.A.M. Benner, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symp. No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 143, "Radar reconnaissance of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2007IAUS..236..143O See also: http://echo.jpl.nasa.gov/ostro_symposium/ostro_symposium.html http://www.planetary.org/blog/article/00001976/
2009, Jun 5	ESA *Space Science*, 5 June 2009, ESA ***Mars Express***, "Craters and channels in Hephaestus Fossae." See: http://www.esa.int/esaSC/SEMSKCVTGVF_index_0.html
2009, Jun 10	L. David, 2009, *Space.com*, "Military hush-up: incoming space rocks now classified." See: http://www.space.com/news/090610-military-fireballs.html

2009, Jun 10	Apollo NEA **136617** (**1994 CC**, $H = 18.1$ mag, $D \approx 600$ m, **PHA**) passed Earth at a nominal miss distance of 6.55 LD. Minimum miss distance 6.55 LD. Observed with **NASA Goldstone Solar System Radar** (CA, USA). The asteroid appeared to be **a triple system**, each of the two moons having $D \approx 50$ m. See: 136617 1994 CC - SSA , 1994 CC - JPL Ref: - J. Fang, J.-L. Margot, M. Brozovic, et al., 2011, *Astronomical Journal*, 141, 154, "Orbits of Near-Earth Asteroid triples **2001 SN263** and **1994 CC**: properties, origin, and evolution." See: http://adsabs.harvard.edu/abs/2011AJ....141..154F - M. Brozović, L.A.M. Benner, P.A. Taylor, et al., 2011, *Icarus*, 216, 241, "Radar and optical observations and physical modeling of triple near-Earth Asteroid (**136617**) **1994 CC**." See: http://adsabs.harvard.edu/abs/2011Icar..216..241B See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2259 https://cneos.jpl.nasa.gov/news/news199.html http://en.wikipedia.org/wiki/(136617)_1994_CC
2009, Jul	O. Vaduvescu, L. Curelaru, M. Birlan, 2009, *Astronomische Nachrichten*, 330, 698, "**EURONEAR**: data mining of asteroids and Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2009AN....330..698V
2009, Jul	B.D. Warner, A.W. Harris, P. Pravec, 2009, *Icarus*, 202, 134, "The asteroid lightcurve database." See: http://adsabs.harvard.edu/abs/2009Icar..202..134W
2009, Jul 3	L. David, 2009, *Space.com*, "Military seeks common ground with scientists on **Fireball** data flap." See: http://www.space.com/news/090610-military-fireballs.html
2009, Jul 13	Review of report *Defending Planet Earth*: *Near-Earth Object Surveys and Hazard Mitigation Strategies, Survey/Detection Panel*, Santa Fe (NM, USA). See: http://www8.nationalacademies.org/cp/meetingview.aspx?MeetingID=3445&MeetingNo=4 http://www.nap.edu/catalog.php?record_id=12842
2009, Jul 16	C.R. Chapman, A.W. Harris, 2009, in: ***72nd Annual Meeting of the Meteoritical Society***, Nice (France), "Near-Earth asteroid/meteoroid impacts: prospects for linking telescopic observations with recovered meteorites." See:

	http://www.lpi.usra.edu/meetings/metsoc2009/pdf/5041.pdf http://www.boulder.swri.edu/clark/metsoc09.ppt
2009, Jul 19	**Impact on Jupiter of an asteroid**, $D \approx 0.2 - 0.5$ km. Ref: - A. Sánchez-Lavega, A. Wesley, G.S. Orton, et al., 2010, *Astrophysical Journal Letters*, 715, L155, "The impact of a large object on Jupiter in 2009 July." See: http://adsabs.harvard.edu/abs/2010ApJ...715L.155S - G.S. Orton, L.N. Fletcher, P.W. Chodas, et al., 2011, *Icarus*, 211, 587, "The atmospheric influence, size and possible asteroidal nature of the **July 2009 Jupiter impactor**." See: http://adsabs.harvard.edu/abs/2011Icar..211..587O See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=182 http://www.jpl.nasa.gov/news/news.cfm?release=2011-028&cid=release_2011-028&msource=11028&tr=y&auid=7679941
2009, Jul 24	ESA *Space Science*, 24 July 2009, ESA ***Mars Express***, "Craters, lava flows and tectonic features near Ma'adim Vallis." See: http://www.esa.int/esaSC/SEMQU2E3GXF_index_0.html
2009, Jul 25-26	***First Asian Asteroid Observation Network Meeting***, Purple Mountain Observatory, Nanjing (China), with participants from China, Finland, Japan, Taiwan, and Uzbekistan. Establishment of the **Asian Asteroid Observation Network**. See: http://english.pmo.cas.cn/ic/ic/200908/t20090826_34050.html http://english.pmo.cas.cn/rh/dcm/nsb/200908/t20090831_35079.html
2009, Jul 29	NASA Jet Propulsion Laboratory provides news updates on objects approaching **Earth** on its web site *Asteroid Watch*. See: http://www.jpl.nasa.gov/asteroidwatch
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	measurements." See: http://adsabs.harvard.edu/abs/2009JGRE..114.8006S
2009, Aug 3-7	**IAU Symposium No. 263 on *Icy Bodies of the Solar System***, Rio de Janeiro (Brazil). Proceedings: J.A. Fernández, D. Lazzaro, D. Prilanik, R. Schulz (eds.), 2010, *Icy Bodies of the Solar System* (Cambridge: CUP). See: http://adsabs.harvard.edu/abs/2010IAUS..263.....F
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2009, Aug 22-26	**International Conference *Near-Earth Astronomy 2009***, Kazan (Russian Republic). See: http://www.ksu.ru/astrcongr/index.php?id=1&num=2
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2009, Sep	S.R. Chesley, A. Milani, D. Tholen, et al., 2009, *AAS-DPS*, 41.4306, "An updated assessment of the impact threat from **99942 Apophis**." See: http://adsabs.harvard.edu/abs/2009DPS....41.4306C
2009, Sep	C.R. Chapman, A.W. Harris, 2009, in: Proc. *72nd Annual Meeting of the Meteoritical Society*, 13-18 July, Nancy (France), *Meteoritics and Planetary Science Supplement*, p.5041, "Near-Earth asteroid/meteoroid impacts: prospects for linking telescopic observations with recovered meteorites." See: http://adsabs.harvard.edu/abs/2009M%26PSA..72.5041C http://www.boulder.swri.edu/clark/metsoc09.ppt#373,1
2009, Sep	R.L. Jones, S.R. Chesley, A.J. Connolly, A.W. Harris, et al., 2009, *Earth, Moon, and Planets*, 105, 101, "Solar System science with **LSST**." See: http://adsabs.harvard.edu/abs/2009EM%26P..105..101J
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	See: http://meetings.copernicus.org/epsc2009/
2009, Sep 18	P.A. Bland, P. Spurný, M.C. Towner, et al., 2009, *Science*, "An anomalous basaltic meteorite from the innermost Main Belt." See: http://www.sciencemag.org/content/325/5947/1525.abstract?sid=940580e5-583a-4fa6-a92e-6a2ca87d4e2a
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2009, Sep 25	**Grimsby Fall and Fireball** event. Meteorites fell in the area of Grimsby (Ontario, Canada) on the early evening of 25 September 2009. As of mid-2010, 13 fragments totaling 215 g of a fresh H5 chondrite have been recovered. Records of the accompanying fireball from the Southern Ontario Meteor Network, including six all-sky video cameras, a large format CCD, infrasound and radar records, have been used to characterize the trajectory, speed, orbit, and initial mass of the meteoroid: 20-50 kg. Ref: - P.J.A. McCausland, P.G. Brown, A.R. Hildebrand, et al., 2010, presented at *41st Lunar and Planetary Science Conference*, 1-5 March 2010, The Woodlands (Texas, USA), *LPI Contribution* No. 1533, p. 2716, "Fall of the **Grimsby H5 chondrite**." See: http://adsabs.harvard.edu/abs/2010LPI....41.2716M - P. Brown, P.J.A. McCausland, M. Fries, et al., 2011, *Meteoritics & Planetary Science*, 46, 339, "The fall of the **Grimsby meteorite**—I: Fireball dynamics and orbit from radar, video, and infrasound records." See: http://adsabs.harvard.edu/abs/2011M%26PS...46..339B See also: http://meteor.uwo.ca/research/fireball/events/grimsby/overview.html http://www.lpi.usra.edu/meetings/lpsc2010/pdf/2716.pdf http://www.youtube.com/watch?v=2IyPvX7ELDE
2009, Oct	A. Milani, S.R. Chesley, M.E. Sansaturio, et al., 2009, *Icarus*, 203, 460, "Long term impact risk for **(101955) 1999 RQ**."

	See: http://adsabs.harvard.edu/abs/2009Icar..203..460M
2009, Oct	P. Vereš, R. Jedicke, R. Wainscoat, et al., 2009, *Icarus*, 203, 472, "Detection of Earth-impacting asteroids with the next generation all-sky surveys." See: http://adsabs.harvard.edu/abs/2009Icar..203..472V
2009, Oct 1	Apollo NEA **2009 TB** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.14 LD. **[2009-10]** See: 2009 TB - SSA , 2009 TB - JPL
2009, Oct 5	Apollo NEA **2009 TD17** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.67 LD. **[2009-11]** See: 2009 TD17 - SSA , 2009 TD17 - JPL See also: **23 Apr 1992, 7 May 2039**
2009, Oct 7	NASA scientists refine asteroid **Apophis**' path toward **Earth**. Updated computational techniques and newly available data indicate the probability of an **Earth** encounter on April 13, 2036, for **Apophis** has dropped from one-in-45,000 to about four-in-a million. See: http://neo.jpl.nasa.gov/news/news164.html
2009, Oct 8	G. Musser, 2009, *Scientific American*, p. 109, "Planetary bombardments, past and future: third dispatch from the annual planets meeting." See: http://blogs.scientificamerican.com/observations/2009/10/08/planetary-bombardments-past-and-future-third-dispatch-from-the-annual-planets-meeting/
2009, Oct 8, 02:56	Apollo NEA **2016 QE45**, *H* = 21.8 mag, *D* ≈ 160 m, **PHA**) passed Earth at a nominal miss distance of 2.58 LD. Minimum miss distance 2.51 LD. See: 2016 QE45 - JPL , 2016 QE45 - SSA
2009, Oct 8, 23:50	Apollo NEA **2009 TU** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.79 LD. Minimum miss distance 0.79 LD. **[2009-12]** See: 2009 TU - SSA , 2009 TU - JPL
2009, Oct 8	**Bone Fireball** (South Sulawesi, Indonesia), a bolide exploding with an energy of 40-50 kT TNT. Incoming object probably with *D* ≈ 5 – 10 m. See:

	http://neo.jpl.nasa.gov/news/news165.html#report http://www.youtube.com/watch?v=yeQBzTkJNhs&videos=jkRJgbXY-90 http://www.skyandtelescope.com/news/65960457.html http://lunarmeteoritehunters.blogspot.com/2009/10/indonesia-meteormeteorite-news.html http://scienceblips.dailyradar.com/video/benda-mirip-meteor-jatuh-di-bone-sulawesi-utara/ http://www.technologyreview.com/blog/arxiv/25991/?p1=A3 Ref: - E.A. Silber, A. Le Pichon, P.G. Brown, June 2011, *Geophysical Research Letters*, 38, L12201, "Infrasonic detection of a near-Earth object **impact over Indonesia** on 8 October 2009." See: http://adsabs.harvard.edu/abs/2011GeoRL..3812201S
2009, Oct 12-16	***International Symposium on Hazardous Near Earth Asteroids***, Valletta (Malta). Organized by the Russian Academy of Sciences, with the support and participation of ESA. See: http://nea2009.cosmos.ru/ http://iya2009malta.page.tl/International-Symposium-on-Near_Earth-Hazardous-Asteroids.htm
2009, Oct 13	**Netherlands fireball**. Hundred of people in the Netherlands and Germany reported seeing a **fireball** streak across the twilight sky around 7 p.m. See: http://www.planetary.org/blog/article/00002166/ http://news.nationalgeographic.com/news/2009/10/091015-fireball-explodes-netherlands-germany-picture.html http://apod.nasa.gov/apod/ap091015.html
2009, Oct 17	Apollo NEA **2009 TM8** (H = 28.7 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD. **[2009-13]** See: 2009 TM8 - SSA , 2009 TM8 - JPL See also: **17 Oct 2011**.
2009, Oct 22	Presentation of the Review of the U.S. Human Spaceflight Plans Committee, chair Norman R. Augustine: *Seeking a Human Spaceflight Program Worthy of a Great Nation*. The Review suggests manned spaceflight to an NEA, among other future destinations for exploration. See: http://www.nasa.gov./offices/hsf/meetings/10_22_pressconference.html http://www.nasa.gov./pdf/396093main_HSF_Cmte_FinalReport.pdf
2009, Oct 24	M. di Martino, 2009, in: Ecole Internationale Daniel Chalonge,

	Torino Cosmology Colloquium *Latest news from the Universe*, Turin, 21-24 October 2009, p. 17, "Discovery of a recent impact crater." See: http://adsabs.harvard.edu/abs/2009lnu..confE..17D http://ecolechalongetorino.oato.inaf.it/lectures/DIMARTINO.pdf
2009, Nov	R. Firestone, 2009, *Journal of Cosmology*, 2, 256, "The case for the Younger Dryas extraterrestrial impact event: mammoth, megafauna and Clovis extinction." See: http://adsabs.harvard.edu/abs/2009JCos....2..256F
2009, Nov	R. Crowther, 2009, *Journal of Cosmology*, 2, 411, "Near Earth Object (NEO) impact threat: an international policy response." See: http://adsabs.harvard.edu/abs/2009JCos....2..411C
2009, Nov 6	Apollo NEA **2009 VA** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.053 LD **(= 3.21 R_{Earth} from the geocenter)**. Minimum miss distance 0.042 LD. **[2009-14]** Discovered 15 hours before closest approach. Third closest (non-impacting) Earth approach on record for catalogued asteroids. See: 2009 VA - SSA , 2009 VA - JPL See also: http://neo.jpl.nasa.gov/news/news166.html http://en.wikipedia.org/wiki/2009_VA
2009, Nov 9-11	***First Arab Impact Cratering and Astrogeology Conference***, Amman (Jordan), 9-11 November 2009. See: http://www.aaru.edu.jo/index.php?option=com_content&task=view&id=229&Itemid=38 http://adsabs.harvard.edu/abs/2010M%26PS...45..157R
2009, Nov 12	Apollo NEA **2009 VZ39** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.68 LD. Minimum miss distance 0.02 LD. **[2009-15]** See: 2009 VZ39 - SSA , 2009 VZ39 - JPL
2009, Nov 15	Apollo NEA **2009 WP6** (*H* = 27.0 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.68 LD. **[2009-16]** See: 2009 WP6 - SSA , 2009 WP6 - JPL
2009, Nov 16	Aten NEA **2009 WQ6** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2009-17]** See: 2009 WQ6 - SSA , 2009 WQ6 - JPL See also: **18 Nov 2189**.

2009, Nov 18	**Utah Fireball**. A remarkable midnight fireball was seen over parts of the western USA: Utah, Wyoming and Idaho, that "turned night into day". Infrasound measurements suggest a sporadic asteroid not associated with the Leonid debris stream of 17 November. The space rock exploded in the atmosphere with an energy equivalent to 0.5 - 1 kT TNT. See: http://www.spaceweather.com/archive.php?view=1&day=18&month=11&year=2009 http://video.google.com/videosearch?q=Fireball+Utah,+November+18+2009&rls=com.microsoft:en-us&oe=UTF-8&rlz=1I7ADBF_nl&um=1&ie=UTF-8&ei=3t2MS5b_BMzc-Qa13NDjDQ&sa=X&oi=video_result_group&ct=title&resnum=4&ved=0CBMQqwQwAw#
2009, Nov 18-19	**Second NASA *Small Bodies Assessment Group Meeting***, Boulder (CO, USA). See: http://www.lpi.usra.edu/sbag/meetings/ http://www.lpi.usra.edu/sbag/meetings/sbag2/agenda.shtml http://www.lpi.usra.edu/sbag/meetings/sbag2/meeting_notes_091119.pdf **Findings:** https://www.lpi.usra.edu/sbag/findings/
2009, Nov 20	Apollo NEA **2009 WJ6** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.46 LD. Minimum miss distance 0.46 LD. **[2009-18]** See: 2009 WJ6 - SSA , 2009 WJ6 - JPL See also: **21 Nov 2063**.
2009, Nov 24	Apollo NEA **2009 WV51** (H = 27.3 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2009-19]** See: 2009 WV51 - SSA , 2009 WV51 - JPL
2009, Nov 27	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), Action Team 14 on Near-Earth Objects**, *Interim Report (2009 – 2010)*. See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L301E.pdf
2009, Nov-Dec	R.L. Schweickart, 2009, *Acta Astronautica*, 65, 1402, "Decision program on asteroid threat mitigation", See: http://adsabs.harvard.edu/abs/2009AcAau..65.1402S
2009, Dec	C.R. Chapman, 2009, *American Geophysical Union, Fall Meeting 2009*, abstract #SA12B-03, "Asteroids shedding meteoroids...or

	becoming bolides." See: http://adsabs.harvard.edu/abs/2009AGUFMSA12B..03C
2009, Dec	A.W. Harris, 2009, *American Geophysical Union, Fall Meeting 2009*, abstract #PP33B-05, "Cosmic impact: what are the odds?" See: http://adsabs.harvard.edu/abs/2009AGUFMPP33B..05H
2009, Dec	U.G. Jørgenson, P.W.U. Appel, Y. Hatsukawa, R. Frei, M. Oshima, Y. Toh, A. Kimura, 2009, *Icarus*, 204, 368, "The Earth-Moon system during the late heavy bombardment period - Geochemical support for impacts dominated by comets." See: http://adsabs.harvard.edu/abs/2009Icar..204..368G
2009, Dec	R.R. Landis, P.A. Abell, D.J. Korsmeyer, et al., 2009, *Acta Astronautica*, 65, 1689, "Piloted operations at a near-Earth object (NEO)." See: http://adsabs.harvard.edu/abs/2009AcAau..65.1689L
2009, Dec	D.K. Yeomans, A. Chamberlin, S. Chesley, P.W. Chodas, 2009, *American Geophysical Union, Fall Meeting 2009*, abstract #NH32A-02, "Issues that drive Near-Earth Object mitigation responses." See: http://adsabs.harvard.edu/abs/2009AGUFMNH32A..02Y
2009, Dec 1	ESA ***Marco Polo*** assessment study report (SRE-2009-3), a NEA sample return mission, presented. Six year mission, 17 months at the asteroid. Junior partners: JAXA (from ***Hayabusa*** heritage: guidance, navigation and control) and NASA (SALMON: hardware and software components). Mission profile: launch Nov/Dec 2018; rendezvous with NEA **162173** (**1999 JU3**, H = 19.18 mag, $D \approx$ 920m, **PHA**) in February 2022; return to Earth in December 2024. Ref: - H. Campins, J.P. Emery, M. Kelley, et al., 2009, *Astronomy & Astrophysics* (Letters), 503, L17, "***Spitzer*** observations of spacecraft target **162173** (**1999 JU3**)"; See: http://adsabs.harvard.edu/abs/2009A%26A...503L..17C - T.G. Müller, J. Ďurech, S. Az, et al., 2011, *Astronomy & Astrophysics*, 525, id.A145, "Thermo-physical properties of **162173** (**1999 JU3**), a potential flyby and rendezvous target for interplanetary missions." See: http://adsabs.harvard.edu/abs/2011A%26A...525A.145M See also: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=46019# http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=44880 On 26 January 2010, the project has been shelved by ESA.

2009, Dec 5-15	***Workshop on asteroid* 2008 TC3**, University of Khartoum (Khartoum, Sudan). See: http://asima.seti.org/2008TC3/workshop2008TC3.html
2009, Dec 13/14	**Geminids meteor shower**, having its origin from Apollo NEA **3200 Phaethon** (**1983 TB**, *H* = 14.4 mag, *D* ≈ 5.1 ± 0.2 km, **PHA**). The asteroid has a trail of pebble- and dust-sized debris, causing a meteor shower when Earth crosses the trail. Asteroid **3200 Phaethon** was detected by ***IRAS*** on 11 October 1983. It approaches the **Sun** closer than any other numbered asteroid: its perihelion is 0.14 AU, less than half **Mercury**'s perihelion distance. **3200 Phaethon** is possibly an old comet core. Its closest to **Earth** within the next 190 yr will occur on 14 December **2093** at 7.7 LD. Ref: - G.O. Ryabova, May 2012, *Monthly Notices Royal Astronomical Society*, 423, 2254, "On the possible ejection of meteoroids from asteroid **(3200) Phaethon** in 2009." See: http://adsabs.harvard.edu/abs/2012MNRAS.423.2254R See also: http://www.space.com/10467-geminids-shower-meteor-gems-skywatchers-week.html http://apod.nasa.gov/apod/ap091217.html http://apod.nasa.gov/apod/ap091219.html http://en.wikipedia.org/wiki/Geminids http://en.wikipedia.org/wiki/3200_Phaethon
2009, Dec 14	Launch of NASA ***Wide-field Infrared Survey Explorer*** (***WISE***). The ***WISE*** instrument is a four-channel imager which operates in a single mode, taking overlapping snapshots of the sky. It includes a 40-cm telescope; a 47' FoV; 1024^2 HgCdTe and Si:As detector arrays at 3.4, 4.6, 12, and 22 μm; a resolution of 6" (12" at 22 μm); a two-stage solid-hydrogen cryostat with an expected 10-month lifetime. ***WISE*** will detect hundreds of thousands of asteroids. Some 100,000 previously unknown main-belt asteroids with *D* > 3 km in diameter and some 200 new NEAs, with diameters *D* > ~100 m, are expected to be discovered during the six-month prime mission of ***WISE***. **NEO-WISE** is a program to identify previously unknown moving object candidates and report them promptly to the **Minor Planet Center** so that they can be recovered with ground-based telescopes during their discovery apparitions. Ref: - E.L. Wright, P.R.M. Eisenhardt, A.K. Mainzer, et al., 2010, *Astronomical Journal*, 140, 1868, "The ***Wide-field Infrared Survey Explorer*** (***WISE***): mission description and initial on-orbit performance." See: http://adsabs.harvard.edu/abs/2010AJ....140.1868W

	See also: http://adsabs.harvard.edu/abs/2009AAS...21345906M http://wise.ssl.berkeley.edu http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2460 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2612 http://neo.jpl.nasa.gov/stats/wise/ http://wise.ssl.berkeley.edu/documents/WISESPIE_2008.pdf?product_id=790087 http://www.lpi.usra.edu/sbag/meetings/sbag2/presentations/Mainzer_WISE.pdf
2009, Dec 18	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**, *Information on research in the field of NEOs carried out by Member States, international organizations and other entities*. Document: A/AC.105/949. See: http://www.unoosa.org/pdf/reports/ac105/AC105_949E.pdf
2009, Dec 29	NASA selects three proposals as candidates for the agency's next space venture to another celestial body. After selection in mid-2011, the selected mission must be ready for launch no later than 30 December 2018. One of the three candidates is the ***Origins Spectral Interpretation Resource Identification Security Regolith Explorer*** **(*Osiris-REx*)**, which would rendezvous and orbit an asteroid in 2020, possibly asteroid **101955** (**1999 RQ36**, *H* = 20.8 mag, *D* = 575 m, **NEO**, **PHA**). After extensive measurements, instruments would collect more than two ounces of material from the asteroid's surface for return to **Earth**. P.I.: Michael Drake, University of Arizona (Tucson, USA). See: http://osiris-rex.lpl.arizona.edu/ Ref: - A. Milani, S.R. Chesley, M.E. Sansaturio, et al., 2009, *Icarus*, 203, 460, "Long term impact risk for (**101955**) **1999 RQ**." See: http://adsabs.harvard.edu/abs/2009Icar..203..460M - D.S. Lauretta, M.J. Drake, R.P. Binzel, et al., 2010, in: *73rd Annual Meeting of the Meteoritical Society*, 26-30 July 2010, New York (NY, USA), *Meteoritics and Planetary Science Supplement*, id.5153, "Asteroid (**101955**) **1999 RQ36**: optimum target for an asteroid sample return mission." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5153L - M. Delbò, P. Michel, 2011, *Astrophysical Journal* (*Letters*), 728, L42, "Temperature history and dynamical evolution of (**101955**) **1999 RQ36**: a potential target for sample return from a primitive asteroid." See: http://adsabs.harvard.edu/abs/2011ApJ...728L..42D - B.E. Clark, R.P. Binzel, E.S. Howell, et al., 2011, *Icarus*, 216, 462, "Asteroid (**101955**) **1999 RQ36**: spectroscopy from 0.4 to 2.4 μm and meteorite analogs."

	See: http://adsabs.harvard.edu/abs/2011Icar..216..462C - J.P. Emery, M.S. Kelly, Y.R. Fernandez, et al., 2012, American Astronomical Society, DPS meeting #44, #102.05, "Thermal and physical characterization of the ***OSIRIS-REx*** target asteroid (**101955**) **1999 RQ36**." See: http://adsabs.harvard.edu/abs/2012DPS....4410205E - M.C. Nolan, C. Magri, L.A.M. Benner, et al., October 2012, American Astronomical Society, DPS meeting #44, #110.02, "The shape of ***OSIRIS-REx*** mission target **1999 RQ36** from RADAR and lightcurve data." See: http://adsabs.harvard.edu/abs/2012DPS....4411002N - T.G. Müller, L. O'Rourke, A.M. Barucci, et al., December 2012, *Astronomy & Astrophysics*, 548, 36, "Physical properties of ***OSIRIS-REx*** target asteroid (**101955**) **1999 RQ36**. Derived from ***Herschel***, **VLT/ VISIR**, and ***Spitzer*** observations." See: http://adsabs.harvard.edu/abs/2012A%26A...548A..36M See also: http://www.jpl.nasa.gov/news/news.cfm?release=2009-205 http://uanews.org/node/29231 http://www.nasa.gov/topics/solarsystem/features/osiris-rex.html http://adsabs.harvard.edu/abs/2012LPI....43.2219H http://adsabs.harvard.edu/abs/2012LPI....43.2491L
2010, Jan 1	**6644 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed**, **A924 UB**, $H = 9.45$ mag, $D = 36.5$ km, Amor NEA), of which **1086 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis**, **1989 AC**, $H = 15.3$ mag, $D = 4.6 \times 2.4 \times 1.9$ km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2010	M. Birlan, O. Văduvescu, D.A. Nedelcu, **EURONEAR** Team, 2010, *Romanian Astronomical Journal*, 20, Supplement "Recent insights into our Universe", 119, "High-precision astrometry of NEAs via **EURONEAR** observations." See: http://adsabs.harvard.edu/abs/2010RoAJ...20S.119B
2010	A.W. Harris, 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proceedings Intern. Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against collisions with asteroids and comet nuclei*, St. Petersburg (Russian Federation), 21-25 September 2009 (Saint Petersburg: Nauka), p. 312, "Estimating the NEO population and impact risk: past present and future." See: http://ftp://quasar.ipa.nw.ru/pub/ACHBOOK_2009/ach-2009_book.pdf
2010	W.F. Huebner, D.C. Boice. P. Bradley, et al., 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proceedings Intern.

	Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against collisions with asteroids and comet nuclei*, St. Petersburg (Russian Federation), 21-25 September 2009 (Saint Petersburg: Nauka), p. 337, "The engagement space for countermeasures against Potentially Hazardous Objects (PHOs)." See: http://ftp://quasar.ipa.nw.ru/pub/ACHBOOK_2009/ach-2009_book.pdf
2010	T. Kwiatkowski, D.A.H. Buckley, D. O'Donoghue, et al., 2010, *Astronomy and Astrophysics*, 509, 94, "Photometric survey of the very small Near-Earth Asteroids with the SALT telescope. I. Lightcurves and periods for 14 objects." See: http://adsabs.harvard.edu/abs/2010A%26A...509A..94K
2010	T. Kwiatkowski, 2010, *Astronomy and Astrophysics*, 509, 95, "Photometric survey of the very small Near-Earth Asteroids with the SALT telescope. II. Discussion of YORP." See: http://adsabs.harvard.edu/abs/2010A%26A...509A..95K
2010	T. Kwiatkowski, M. Polinska, N. Loaring, et al., 2010, *Astronomy and Astrophysics*, 511, 49, "Photometric survey of the very small Near-Earth Asteroids with the SALT telescope. III. Lightcurves and periods for 12 objects and negative detections." See: http://adsabs.harvard.edu/abs/2010A%26A...511A..49K
2010	D. Lazzaro, 2010, *Boletín de la Asociación Argentina de Astronomía*, 53, 315, "Photometric and spectroscopic studies of small Solar System bodies and the **IMPACTON** project." See: http://adsabs.harvard.edu/abs/2010BAAA...53..315D The Brazilian **IMPACTON** project - Iniciativa de Mapeamento e Pesquisa de Aster´oides nas Cercanias da Terra no Observat´orio Nacional - formally started in 2005 aiming to install and operate a robotic telescope dedicated to the follow-up and physical characterization of NEOs. See also: http://www.on.br/impacton/
2010	D.K. Yeomans, S.R. Chesley, P.W. Chodas, 2010, in: A.M. Finkelstein, W.F. Huebner & V.A. Shor (eds.), Proceedings Intern. Conf. *Asteroid-Comet Hazard 2009, Protecting the Earth against collisions with asteroids and comet nuclei*, St. Petersburg (Russian Federation), 21-25 September 2009 (Saint Petersburg: Nauka), p. 244, "NASA's Near-Earth Object Program Office." See: http://ftp://quasar.ipa.nw.ru/pub/ACHBOOK_2009/ach-2009_book.pdf
2010, Jan	T. Kwiatkowski, D.A.H. Buckley, D. O'Donoghue, et al., 2010, *Astronomy & Astrophysics*, 509, A94, "Photometric survey of the

	very small near-Earth asteroids with the SALT telescope . I. Lightcurves and periods for 14 objects." See: http://adsabs.harvard.edu/abs/2010A%26A...509A..94K
2010, Jan	T. Kwiatkowski, 2010, *Astronomy & Astrophysics*, 509, A95, "Photometric survey of the very small near-Earth asteroids with the SALT telescope. II. Discussion of YORP." See: http://adsabs.harvard.edu/abs/2010A%26A...509A..95K
2010, Jan 4	A. Nathues, H. Boehnhardt, A.W. Harris, et al., 2010, *Advances in Space Research*, 45, 169, "***ASTEX***: an in situ exploration mission to two near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2010AdSpR..45..169N
2010, Jan 6	Object **P/2010 A2**, discovered by **LINEAR**, is an unusual object that superficially looks like a (Encke-type) comet but lives among the asteroids. ***HST*** and ***Rosetta*** observations show a bizarre X-pattern of filamentary structures near the point-like nucleus of the object and trailing streamers of dust. This complex structure suggests the object is not a comet but instead the product of a head-on collision between two asteroids. See: http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=P%2F2010+A2&orb=1 http://en.wikipedia.org/wiki/P/2010_A2 Ref: - C. Snodgrass, C. Tubania, J.-B. Vincent, et al., 14 October 2010, *Nature*, 467, 814, "A collision in 2009 as the origin of the debris tail of asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2010Natur.467..814S - D. Jewitt, H. Weaver, J. Agarwal, et al., 14 October 2010, *Nature*, 467, 817, "A recent disruption of the main-belt asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2010Natur.467..817J - D. Jewitt, J.S. Stuart, J. Li, 2011, *Astronomical Journal*, 142, Issue 1, article id. 28, "Pre-discovery observations of disrupting asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2011AJ....142...28J - O.R. Hainaut, J. Kleyna, G. Sarid, et al., 2012, *Astronomy & Astrophysics*, 537, 69, "**P/2010 A2** LINEAR. I. An impact in the asteroid main belt." See: http://adsabs.harvard.edu/abs/2012A%26A...537A..69H - D. Jewitt, M. Ishiguro, J. Agarwal, February 2013, *Astrophysical Journal* (Letters), 764, L5, "Large particles in active asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2013ApJ...764L...5J - J. Agarwal, D. Jewitt, H. Weaver, 20 May 2013, *Astrophysical Journal*, 769, 46, "Dynamics of large fragments in the tail of active

	asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2013ApJ...769...46A See also: http://hubblesite.org/newscenter/archive/releases/2010/34 http://hubblesite.org/newscenter/archive/releases/2010/07/full/ http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=47830 http://www.spacetelescope.org/news/heic1016/ http://hubblesite.org/pubinfo/pdf/2010/34/pdf.pdf http://www.scientificamerican.com/article.cfm?id=comet-may-be-colliding-asteroids-2010-01 http://www.scientificamerican.com/article.cfm?id=comet-tail-asteroid
2010, Jan 10	**NASA's Flexible Path** evaluation of human mission in **2025** to visit an asteroid. See: http://www.nasaspaceflight.com/2010/01/nasas-flexible-path-2025-human-mission-visit-asteroid/
2010, Jan 12	NASA's ***Wide-field Infrared Survey Explorer (WISE)***, spotted its first never-before-seen near-Earth asteroid, **2010 AB78** (H = 18.6 mag, $D \approx$ 0.6 km), at a distance of ~ 160 x 10^6 km. See: http://www.nasa.gov/mission_pages/WISE/news/wise20100122.html http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2460 http://www.astro.ucla.edu/~wright/WISE/
2010, Jan 13	Apollo NEA **2010 AL30** (H = 27.3 mag, $D \approx$ 13 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2010-01]** Discovered by the **LINEAR** survey of MIT's Lincoln Laboratories on 10 January 2010. Radar observations with the **Goldstone planetary radar** had been planned. One would expect a NEA of this size, one of ~ 2,000,000 such objects in near-Earth space, to pass **Earth** within 1 LD about once every week on average. See: 2010 AL30 - SSA , 2010 AL30 - JPL See also: http://neo.jpl.nasa.gov/news/news167.html http://www.wired.com/wiredscience/2010/01/wednesdays-near-earth-asteroid-caught-on-film/ http://en.wikipedia.org/wiki/2010_AL30
2010, Jan 14	Apollo NEA **2015 AQ43** (H = 28.4 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 3.46 LD. Minimum miss distance 0.05 LD. See: 2015 AQ43 - SSA , 2015 AQ43 - JPL See also: **14 Jan 2015**.
2010, Jan 18-20	**Workshop on *NEO Information, Analysis and Warning***, Mexico

	City (Mexico). Sponsored by the **Association of Space Explorers (ASE)**, the **Secure World Foundation (SWF)**, and the Centro Regional de Enseñanza de Ciencia y Tecnología del Espacio para America Latina y el Caribe (CRECTEALC). Summary: Functions and Characteristics of **NEO Information, Analysis and Warning Network (IWAN)**. See: http://www.space-explorers.org/ http://www.space-explorers.org/committees/NEO/NEO%20IAWN%20Workshop%20Executive%20Summary%202-12-10.pdf http://www.unoosa.org/pdf/pres/stsc2010/tech-24.pdf http://swfound.org/events/2010/neo-information-analysis-and-warning-network-workshop
2010, Jan 20	C.R. Chapman, 2010, *Nature* (News & Views), 463, 305, "Asteroids: stripped on passing by Earth." See: http://adsabs.harvard.edu/abs/2010Natur.463..305C
2010, Jan 21	R.P. Binzel, A. Morbidelli, S. Merouana, et al., 2010, *Nature* (Letters), 463, 331, "Earth encounters as the origin of fresh surfaces on near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2010Natur.463..331B http://www.scientificamerican.com/article.cfm?id=asteroid-quakes
2010, Jan 22	US National Research Council Space Studies Board Committee (chair Irwin Shapiro) on ***Defending Planet Earth: Near Earth Object Surveys and Hazard Mitigation Strategies***. Final Report. The report calls for an international body that would be prepared to take action and defend the planet whenever an asteroid is discovered on a likely collision course. The body would be composed of *"representatives of nations concerned with this problem and willing to invest in preparedness for damaging collisions."* If a hazardous asteroid were discovered far enough in advance, that body could arrange for a space mission to deflect it. *"It's the only natural disaster we know about where we could actually prevent it."* US Congress has set a goal of mapping 90% of NEOs with $D > 140$ m by 2020. The report states that at the current rate of funding the effort will take decades. It also notes that possibly even NEOs as small as 30 – 50 m may pose a serious threat. The most promising search tool being built – the **Large Synoptic Survey Telescope** – may lose out on funding in current project prioritization. The report gives two options for detection of the $D > 140$ m NEOs – completion by 2020 would require space missions, one in Sun-Earth Lagrangian point L1 and one in a Venus-trailing orbit. While use of a large ground based telescope

	would be cheaper but reach the goal only by 2030. See: http://www.nap.edu/catalog/12842.html http://impact.arc.nasa.gov/news_detail.cfm?ID=183 http://www.scientificamerican.com/blog/post.cfm?id=new-report-warns-against-smaller-ne-2010-01-22 http://www.scientificamerican.com/article.cfm?id=asteroid-impact-climate-change http://www.universetoday.com/2010/01/22/asteroid-detection-deflection-needs-more-money-report-says/ http://www.space.com/scienceastronomy/asteroid-hunt-space-telescopes-100204.html
2010, Jan 23	R. Arentz, H. Reitsema, J. Van Cleve, R. Linfield, 2010, in: Proc. *Space, Propulsion & Enery Sciences International Forum SPESIF-2010*, Baltimore, 23-26 February 2010, AIP Conf. Proc., 1208, 418, "***NEO Survey***, an efficient search for Near-Earth Objects by an IR observatory in a Venus-like orbit." See: http://adsabs.harvard.edu/abs/2010AIPC.1208..418A Submitted to the Primitive Bodies Subcommittee of the Decadal Survey. A 50 cm telescope with a 2 × 5 degree FoV, and a camera working at 40 K in the 6 – 10.5 µm range, capable of detecting 85% of all NEOs with $D > 100$ m, 70% of those with $D > 60$ m, and about 50% of those with $D > 50$ m, in a period of 7.5 years. Also presented at ***1st IAA Planetary Defense Conference***, see 27-30 April 2009. See: http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=APCPCS001208000001000418000001&idtype=cvips&gifs=yes&ref=no http://www.lpi.usra.edu/decadal/sbag/topical_wp/RobertFArentz.pdf http://www.space.com/news/nasa-neo-asteroid-spacecraft-101221.html
2010, Jan 23	I. Semeniuk, 2010, *Sky & Telescope*, 23 January 2010, "Asteroids pale after close encounters." See: http://www.skyandtelescope.com/news/82499022.html
2010, Feb	M. Birlan, O. Vaduvescu, A. Tudorica, et al., 2010, *Astronomy & Astrophysics*, 511, 40, "More than 160 near Earth asteroids observed in the **EURONEAR** network." See: http://adsabs.harvard.edu/abs/2010A%26A...511A..40B
2010, Feb	T. Kwiatkowski, M. Polinska, N. Loaring, et al., 2010, *Astronomy & Astrophysics*, 511, A49, "Photometric survey of the very small near-Earth asteroids with the SALT telescope. III. Lightcurves and periods for 12 objects and negative detections." See: http://adsabs.harvard.edu/abs/2010A%26A...511A..49K
2010, Feb	C.A. Thomas, R.P. Binzel, 2010, *Icarus*, 205, 419, "Identifying

	meteorite source regions through near-Earth object spectroscopy." See: http://adsabs.harvard.edu/abs/2010Icar..205..419T
2010, Feb 3	ESA *Space News*, 3 February 2010, ESA ***Mars Express***, "Craters young and old in Sirenum Fossae." See: http://www.esa.int/esaSC/SEMJLFSJR4G_index_0.html
2010, Feb 8	Aten NEA **2015 CL** (H = 25.6 mag, $D \approx$ 27 m) passed Earth at a nominal miss distance of 1.04 LD. Minimum miss distance 1.04 LD. See: 2015 CL - SSA , 2015 CL - JPL
2010, Feb 9	Final Report of the Research Project ***Legal Aspects of NEO Threat Response and Related Institutional Issues***, undertaken by the University of Nebraska-Lincoln's Programme on Space and Telecommunications Law, sponsored by the Secure World Foundation and with the support of an International Advisory Board of eminent international space law experts from various states around the world, members of the International institute of Space Law (IISL) and the International Academy of Astronautics (IAA). Rapporteur: Frans G. von der Dunk. See: http://spaceandtelecomlaw.unl.edu/home/neoresearchproject
2010, Feb 15-16	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Scientific and Technical Subcommittee*, 47th Session, Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico), meets in Vienna (Austria). **Report:** http://www.unoosa.org/pdf/reports/ac105/AC105_958E.pdf http://www.unoosa.org/pdf/limited/c1/AC105_C1_L300E.pdf http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_NEO_2010_L01E.pdf **Among the Technical presentations:** - ASE, SWF, CRECTEAL, 2010, "***NEO IAWN Workshop*** summary." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-24.pdf - S. Freeland, 2010, "Legal aspects of NEO threat response and related institutional issues." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-25.pdf - B. Shustov, 2010, "The NEO problem: activities in Russia." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-35.pdf - D. Koschny, 2010, "Current status of ESA's **Space Situational Awareness** Near-Earth Object programme." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-36.pdf - L. Johnson, 2010, "**Near Earth Object Observations Program**." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-39.pdf

	- O. Ventskovsky, 2010, "Global project on the anti-asteroid protection of the **Earth**." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-41.pdf - A.S. Koroteev, B.A. Liaschuk, S.A. Popov, et al., 2010, "On the possible approach to formation of echelon of short-term reaction of the international planetary defense system." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-43.pdf - T. Okada, 2010, "The Hayabusa mission: challenge to Near-Earth Asteroid sample-return and new insights into solar system origin." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-44.pdf - J.-Y. Prado, 2010, "**Apophis** 2029, a unique mission opportunity." See: http://www.unoosa.org/pdf/pres/stsc2010/tech-45.pdf
2010, Feb 17	Aten NEA **2010 CK19** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2010-02]** See: 2010 CK19 - SSA , 2010 CK19 - JPL
2010, Feb 21	Apollo NEA **2010 DJ1** (H = 27.1 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 1.002 LD. Minimum miss distance 1.002 LD. It passed the **Moon** at anominal miss distance of 0.48 LD. Minimum miss distance 0.48 LD See: 2010 DJ1 - SSA , 2010 DJ1 - JPL
2010, Feb 23	C.A. Maddock, 2010, *On the dynamics, navigation and control of a spacecraft formation of solar concentrators in the proximity of an asteroid*, PhD thesis, University of Glasgow (UK). See: http://theses.gla.ac.uk/1572/01/2010maddockphd.pdf http://planetarydefense.blogspot.com/2010/03/dr-christie-maddocks-thesis-now.html
2010, Feb 28	**Košice meteorite fall.** Occurred in eastern Slovakia on February 28, 2010, 22:25 UT. The very bright bolide was imaged by three security video cameras from Hungary. Ref: - J. Borovička, J. Tóth, A. Igaz, 2013, *Meteorics & Planetary Science*, 48, 1757, "The **Košice meteorite fall**: atmospheric trajectory, fragmentation, and orbit." See: http://onlinelibrary.wiley.com/doi/10.1111/maps.12078/
2010, Mar	P.R. Renne, H.P. Schwarcz, M.R. Kleindienst, et al., 2010, *Earth and Planetary Science Letters*, 291, 201, "Age of the **Dakhleh impact** event and implications for Middle Stone Age archeology in the western desert of Egypt." See: http://adsabs.harvard.edu/abs/2010E%26PSL.291..201R

2010, Mar 5	P. Schulte, L. Alegret, I. Arenillas, et al., 5 March 2010, *Science*, 327, 1214, "The **Chicxulub** asteroid impact and mass extinction at the Cretaceous-Paleogene boundary." See: http://adsabs.harvard.edu/abs/2010Sci...327.1214S See also: http://www.sciencedaily.com/releases/2010/03/100304142242.htm
2010, Mar 11-12	**Second *Asian Asteroid Observation Network Workshop***, Lijiang (Yunnan, China). See: http://www.ynao.ac.cn/announcement/announcement/2009/091228.pdf
2010, Mar 31	R. Lloyd, *Scientific American*, 31 March 2010, "Competing catastrophes: what's the bigger menace, an asteroid impact or climate change?" See: http://www.scientificamerican.com/article.cfm?id=asteroid-impact-climate-change
2010, Apr	C.R. Chapman, D. Morrison, 2010, in: Proceedings Astrobiology Science Conference 2010: *Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond*, 26-30 April, 2010, League City (TX, USA), LPI Contribution No. 1538, p. 5164, "Planetary defense and near-Earth objects." See: http://adsabs.harvard.edu/abs/2010LPICo1538.5164C http://www.lpi.usra.edu/meetings/abscicon2010/pdf/5164.pdf
2010, Apr	J. de Léon, H. Campis, K. Tsiganis, et al., 2010, *Astronomy and Astrophysics*, 513, id.A26, "Origin of the near-Earth asteroid **Phaethon** and the **Geminids meteor shower**." See: http://adsabs.harvard.edu/abs/2010A%26A...513A..26D
2010, Apr	G.R. Osinski, C.S. Cockell, P. Lindgren, J. Parnell, 2010, in: Proceedings Astrobiology Science Conference 2010, *Evolution and Life: Surviving Catastrophes and Extremes on Earth and Beyond*, 26-30 April, 2010, League City (TX, USA), LPI Contribution No. 1538, p. 5252, "The effect of meteorite impacts on the elements essential for life." See: http://adsabs.harvard.edu/abs/2010LPICo1538.5252O http://www.lpi.usra.edu/meetings/abscicon2010/pdf/5252.pdf
2010, Apr 1	E. Asphaug, 2010, *Chemie der Erde - Geochemistry*, 70, 199, "Similar-sized collisions and the diversity of planets." See: http://adsabs.harvard.edu/abs/2010ChEG...70..199A

2010, Apr 9	Apollo NEA **2010 GA6** (*H* = 26.2 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 1.13 LD. Minimum miss distance 1.13 LD. See: 2010 GA6 - SSA , 2010 GA6 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2549 http://www.scientificamerican.com/blog/post.cfm?id=newfound-asteroid-will-pass-by-eart-2010-04-08 http://en.wikipedia.org/wiki/2010_GA6
2010, Apr 14	**Wisconsin Fireball**, seen in at least six US states. The parent body was ~1 m in diameter and while disintegrating released energy equivalent to the detonation of ~20 tons of TNT. See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2565 See also: http://articles.cnn.com/2010-04-15/tech/midwest.fireball_1_fireball-nws-northern-sky?_s=PM:TECH http://articles.cnn.com/2010-04-26/us/wisconsin.meteorite.boomtown_1_meteorite-space-rock-livingston?_s=PM:US
2010, Apr 15	US President Barack Obama on Space Exploration in the 21st Century, speaking at John F. Kennedy Space Center, Merritt Island (FL, USA): "*... And by 2025, we expect new spacecraft designed for long journeys to allow us to begin the first-ever crewed missions beyond the Moon into deep space. So we'll start – we'll start by sending astronauts to an asteroid for the first time in history. By the mid-2030s, I believe we can send humans to orbit Mars and return them safely to Earth. And a landing on Mars will follow. And I expect to be around to see it ... .*" This follows recommendations of the Augustine Review of 22 Oct 2009. See: http://www.whitehouse.gov/the-press-office/remarks-president-space-exploration-21st-century http://www.nasa.gov/about/obamaspeechfeature.html http://www.nasa.gov/news/media/trans/obama_ksc_trans.html http://www.nasa.gov./pdf/396093main_HSF_Cmte_FinalReport.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=184 This is formalized in the document *National Space Policy of the United States of America* of 28 June 2010. See also: http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf http://www.nytimes.com/2010/04/16/science/space/16nasa.html http://www.usatoday.com/cleanprint/?1289391814765 http://www.space.com/18373-presidential-election-obama-nasa-future.html

	http://www.space.com/18380-nasa-moon-missions-obama-election.html
2010, Apr 15	Establishment of the **NASA Advisory Council *Ad Hoc Task Force on Planetary Defense***. See: http://www.nasa.gov/pdf/490945main_10-10_TFPD.pdf http://www.nasa.gov/exploration/about/planetarydefense_taskforce_prt.htm http://www.planetary.org/programs/projects/space_information/20101027.html
2010, Apr 18	Apollo NEA **2010 HP20** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.08 LD. **[2010-03]** See: 2010 HP20 - SSA , 2010 HP20 - JPL
2010, Apr 19	H. Campins, K. Hargrove, N. Pinilla-Alonso, et al., 2010, *Nature*, 464, 1320, "Water ice and organics on the surface of the asteroid **24 Themis**." Main-belt asteroid. See: http://adsabs.harvard.edu/abs/2010Natur.464.1320C http://news.nationalgeographic.com/news/2010/04/100428-asteroid-water-first-ice-frost-themis/
2010, Apr 25	Apollo NEA **2019 VB5** (*H* = 31.7 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 1.66 LD. Minimum miss distance 0.91 LD. See: 2019 VB5 – SSA , 2019 VB5 - JPL See also: **9 Nov 2019**.
2010, Apr 26	Lori B. Garver, NASA Deputy Administrator, 2010, Address at the Center for Strategic and International Studies, Washington DC (USA). Comments on President Obama's speech of 15 April 2010 at the JFK Space Center, Florida (USA), referring to NEAs as the next target for US human spaceflight. One potential target could be asteroid **1999 AO10** (*H* = 23.9 mag, *D* ≈ 60 m), which will pass Earth at 10.4 LD on 12 February 2026. It could be reached with a launch in 2025 on a 150 day round trip mission, spending ~2 weeks at the asteroid. See: http://www.nasa.gov/pdf/448579main_CSIS_Garver_20100426a.pdf http://impact.arc.nasa.gov/news_detail.cfm?ID=184 http://www.nasaspaceflight.com/2010/01/nasas-flexible-path-2025-human-mission-visit-asteroid/ http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf

2010, May	A. Glikson, 2010, *Icarus*, 207, 39, "Archaean asteroid impacts, banded iron formations and MIF-S anomalies: a discussion." See: http://adsabs.harvard.edu/abs/2010Icar..207...39G
2010, May	A.W. Harris, 2010, *Bull. American Astron. Soc.*, 41, 930, "Cosmic disasters, real and imagined." See: http://adsabs.harvard.edu/abs/2010DDA....41.0601H http://nightsky.jpl.nasa.gov/docs/AlanHarris.ppt
2010, May	O.B. Toon, T. Segura, K. Zahnle, 2010, *Annual Review of Earth and Planetary Sciences*, 38, 303, "The formation of Martian river valleys by impacts." See: http://httadsabs.harvard.edu/abs/2010AREPS..38..303T
2010, May 13	**Panoramic Survey Telescope And Rapid Response System (Pan-STARRS**, Maui, HI, USA). The 1.8 m telescope **PS1** on Haleakala goes operational and begins its science mission. The 1.4 giga-pixel digital camera will take over 500 exposures each night and send about 4 terabytes of data to the Maui High Performance Computing Center for analysis. In the next three years, **PS1** is expected to discover ~100,000 asteroids**. PS1** is the experimental proptotype for the larger **PS4** telescope, which will have four times the power of **PS1** and is planned for Mauna Kea. See item 6 December 2008. See: http://pan-starrs.ifa.hawaii.edu/public/ http://www.ifa.hawaii.edu/info/press-releases/PS1/ http://www.scientificamerican.com/article.cfm?id=pan-starrs-neo http://www.spacedaily.com/reports/PS1_Telescope_Establishes_Near_Earth_Asteroid_Discovery_Record_999.html
2010, May 17	Asteroid **2010 JL88** ($H = 26.5$ mag, $D \approx 18$ m) passed Earth at a nominal miss distance of 1.002 LD. Minimum miss distance 1.001 LD. It passed the **Moon** at a nominal miss distance of 0.495 LD. Minimum miss distance 0.494 LD. See: 2010 JL88 - SSA , 2010 JL88 - JPL See: also: https://en.wikipedia.org/wiki/2010_JL88 See also: **5 Nov 1963, 15 May 2005, 5 Nov 2020**
2010, May 20	Australian National University scientists identified a dome at least 50 km in diameter, buried under the Timor Sea, that was created by a giant asteroid that collided with Earth ~35 million yr ago – a period of heavy extraterrestrial bombardment. Ref:

	- A.Y. Glikson, D. Jablonski, S. Westlake, 2010, *Australian Journal of Earth Sciences*, 57, 411, "Origin of the **Mt Ashmore structural done**, west Bonaparte Basin, Timor Sea." See: http://www.tandfonline.com/doi/abs/10.1080/08120099.2010.481327?scroll=top&needAccess=true&journalCode=taje20 See also: http://news.anu.edu.au/?p=2159
2010, May 21	J.D. Archibald, W.A. Clemens, K. Padian, et al., *Science*, 328, 973, "Cretaceous-Extinctions: multiple causes." See: http://www.sciencemag.org/search?site_area=sci&y=9&x=32&fulltext=Cretaceous-Extinctions%3A%20multiple%20causes&submit=yes
2010, May 21	P. Schulte, L. Alegret, I. Arenillas, et al., 2010, *Science*, 328, 975, "Cretaceous-Extinctions: multiple causes / responses." See: http://www.sciencemag.org/content/328/5981/975.full
2010, May 21	Object **2010 KQ** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.9 LD. Its orbit around the Sun is so similar to the Earth's orbit, that it is suspected to be a rocket stage which escaped years ago from the Earth-Moon system. See: http://www.jpl.nasa.gov/news/news.cfm?release=2010-183 http://neo.jpl.nasa.gov/news/news168.html Ref: - R. Miles, 2011, *Journal of the British Astronomical Association*, 121, 350, "The unusual case of 'asteroid' **2010 KQ**: a newly discovered artificial object orbiting the Sun." See: http://adsabs.harvard.edu/abs/2011JBAA..121..350M See also: http://en.wikipedia.org/wiki/2010_KQ See also: **3 Jan 2036**.
2010, May 21-23	**Meeting on *Asteroids and Comets in Europe***, Višnjan/Tićan (Croatia). See: http://www.minorplanets.org/MACE2010/
2010, May 23	Apollo NEA **2010 KO10** (H = 27.0 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2010-04]** See: 2010 KO10 - SSA , 2010 KO10 - JPL
2010, May 24-28	***Meteoroids 2010. International Conference on Minor Bodies in the Solar System*,** Breckenridge (CO, USA).

	See: http://www.cora.nwra.com/Meteoroids2010/ http://www.space.com/8517-asteroid-probe-return-earth-scientists-edge.html http://www.space.com/8604-nasa-prepares-potentially-damaging-2011-meteor-shower.html http://www.space.com/8986-asteroid-threat-early-warning-system-proposed.html
2010, May 26	Aten NEA **2010 KV39** (H = 27.0 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2010-05]** See: 2010 KV39 - SSA , 2010 KV39 - JPL
2010, May/Jun	D. Morrison, 2010, *Skeptical Inquirer*, 34.3, "Did a cosmic impact kill the mammoths?" See: http://www.csicop.org/si/show/did_a_cosmic_impact_kill_the_mammoths/
2010, Jun	M. Ćuk, B.J. Gladman, S.T. Stewart, 2010, *Icarus*, 207, 590, "Constraints on the source of **lunar** cataclysm impactors." See: http://adsabs.harvard.edu/abs/2010Icar..207..590C Read also: - R. Malhotra, R.G. Strom, 2011, *Icarus*, 216, 359, "Comment on "Constraints on the source of **lunar** cataclysm impactors" (Cuk et al., 2010, *Icarus*, 207, 590-594)." See: http://adsabs.harvard.edu/abs/2011Icar..216..359M - M. Ćuk, B.J. Gladman, S.T. Stewart, 2011, *Icarus*, 216, 363, "Rebuttal to the comment by Malhotra and Strom on 'Constraints on the source of **lunar** cataclysm impactors'." See: http://adsabs.harvard.edu/abs/2011Icar..216..363C
2010, Jun	G. de Villiers, D.T. King, L.J. Marzen, 2010, *Meteoritics and Planetary Science*, 45, 947, "A study of candidate marine target impact craters in Arabia Terra, **Mars**." See: http://adsabs.harvard.edu/abs/2010M%26PS...45..947D
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2010, Jun	R. Lloyd, 2010, *Scientific American*, 302, 25, "Asteroid collision. An extinction-level event is unlikely, but 'airbursts' could flatten a

	city." See: http://www.scientificamerican.com/article.cfm?id=interactive-12-events
2010, Jun	R. Lloyd, 2010, *Scientific American*, 302, 48, "What the future holds. Asteroid collision." See: http://www.nature.com/scientificamerican/journal/v302/n6/full/scientificamerican0610-48a.html
2010, Jun	M. Vasile, C.A. Maddock, 2010, *Celestial Mechanics and Dynamical Astronomy*, 107, 265, "On the deflection of asteroids with mirrors." See: http://adsabs.harvard.edu/abs/2010CeMDA.107..265V See also: http://planetarydefense.blogspot.com/2010/11/paper-on-deflection-of-asteroids-with.html http://www.planetary.org/programs/projects/mirrorbees/ http://www.bbc.com/future/story/20120622-a-laser-fix-for-asteroid-threats
2010, Jun 3	**Fireball lights up Jupiter**. Impacting asteroid or comet with $D \approx$ 8-13 m. Ref: - R. Hueso, A. Wesley, C. Go, et al., 2010, *Astrophysical Journal Letters*, 721, L129, "First Earth-based detection of a **superbolide on Jupiter**." See: http://adsabs.harvard.edu/abs/2010ApJ...721L.129H See also: http://www.jpl.nasa.gov/news/news.cfm?release=2010-293&cid=release_2010-293&msource=2010293B&tr=y&auid=6964089
2010, Jun 7-11	**International Conference *Gaia: at the frontiers of astrometry***, 7-11 June 2010, Sèvre (France). Proc: C. Turon, F. Meynadier, F. Arenou (eds.), 2011, ***Gaia**: at the frontiers of astrometry*, *ESA Publication Series*, 45. See: http://adsabs.harvard.edu/abs/2011EAS....45D...3T http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=45565 http://wwwhip.obspm.fr/gaia2010/IMG/pdf/Abstract_booklet.pdf
2010, Jun 9-18	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS, 53rd session) and Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico), meets in Vienna (Austria). See: http://www.oosa.unvienna.org/pdf/gadocs/A_65_20E.pdf
2010, Jun 11	K. Rowan, 2010, *Space.com,* "5 reasons to care about asteroids".

	See: http://www.space.com/8590-5-reasons-care-asteroids.html
2010, Jun 13	Return of JAXA spacecraft ***Hayabusa***, landing in Woomera (Australia), after a seven-year journey to bring a sample of Apollo NEA **25143 Itokawa** (**1998 SF36**, *H* = 19.2 mag, *D* = 0.535 × 0.29 × 0.209 km, **PHA**) back to Earth. See also: **19 Nov 2005**, **17 Nov 2010**. See: http://hayabusa.jaxa.jp/e/index.html http://www.isas.jaxa.jp/e/topics/2010/0705.shtml http://www.isas.jaxa.jp/e/enterp/missions/hayabusa/index.shtml http://impact.arc.nasa.gov/news_detail.cfm?ID=185 http://www.jpl.nasa.gov/news/news.cfm?release=2010-194&cid=release_2010-194&msource=2010194&tr=y&auid=6468044 http://airborne.seti.org/hayabusa/ http://blogs.nature.com/news/thegreatbeyond/2010/06/japan_celebrates_asteroid_roun.html http://www.nature.com/news/2010/290610/full/466016a.html http://www.spacedaily.com/reports/The_Hayabusa_Adventure_999.html http://news.nationalgeographic.com/news/2010/06/100614-science-space-asteroids-hayabusa-return-fiery/ http://www.youtube.com/watch?v=ljd989jfuis&feature=player_embedded http://www.youtube.com/watch?v=bbI78CZWP7g http://www.youtube.com/watch?v=jEyQDwAUfRQ&NR=1 http://www.youtube.com/watch?v=qtwTD8cBhKc&NR=1 http://www.space.com/news/japan-hayabusa-asteroid-graphic-100611.html http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day3/d3_1330_Zolensky_Hayabusa.pdf http://www.oosa.unvienna.org/pdf/reports/ac105/C1/AC105_C1_100E.pdf http://www.space.com/14691-asteroid-impacts-hayabusa-meteorite-samples.html http://www.space.com/14767-lego-asteroid-spacecraft-hayabusa.html http://www.nature.com/news/2011/110825/full/news.2011.506.html http://en.wikipedia.org/wiki/Hayabusa
2010, Jun 23	Asteroid-aware lawmaker U.S. Representative Dana Rohrabacher (R - CA) introduced a bill that would create a special government commission to study the threat of major collisions of asteroids – Near Earth Objects – with the Earth. Rep. Rohrabacher's bill "To establish a United States Commission on Planetary Defense" (H.R. 5587), would create within the legislative branch a United States **Commission on Planetary Defense**. See: http://thomas.loc.gov/cgi-bin/query/z?c111:H.R.5587: http://usgovinfo.about.com/b/2010/07/26/bill-would-create-asteroid-threat-commission.htm

2010, Jun 25-27	**International Workshop *Nördlingen 2010: the Ries Crater, the Moon, and the future of human space exploration***, Nördlingen (Germany), 25-27 June 2010. See: http://www.lpi.usra.edu/meetings/nordlingen2010/
2010, Jun 25	D. Stöffler, W.U. Reimold, 2010, in: International Workshop *Nördlingen 2010: the* ***Ries Crater****, the Moon, and the future of human space exploration*, Nördlingen (Germany), 25-27 June 2010, LPI Contribution No. 1559, p.37, "The impact of **Ries Crater** research on the recognition and classification of impact-metamorphosed planetary rocks." See: http://adsabs.harvard.edu/abs/2010LPICo1559...37S
2010, Jul	M. Brozovic, L.A.M. Benner, C. Magri, S.J. Ostro, et al., 2010, *Icarus*, 208, 207, "Radar observations and a physical model of contact binary asteroid **4486 Mithra**." Apollo NEA, **4486 Mithra**, **1987 SB**, $H = 15.8$ mag, $D \approx 2.35 \times 1.65 \times 1.44$ km, **PHA**. See: http://adsabs.harvard.edu/abs/2010Icar..208..207B
2010, Jul	J. de León, J. Licandro, M. Serra-Ricard, et al., 2010, *Astronomy & Astrophysics*, 517, 23, "Observations, compositional, and physical characterization of near-**Earth** and **Mars**-crosser asteroids from a spectroscopic survey." See: http://adsabs.harvard.edu/abs/2010A%26A...517A..23D
2010, Jul	B.D. Warner, P. Pravec, A. Harris, et al. 2010, *Minor Planet Bulletin*, 37, 86, "Analysis of the lightcurve of (**217807**) **2000 XK44**: a tumbling [Amor] NEA." See: http://adsabs.harvard.edu/abs/2010MPBu...37...86W
2010, Jul 2	A. Steele, F.M. McCubbin, M. Fries, et al., 2010, *Science*, 329, 51, "Graphite in an ***Apollo 17*** impact melt breccia." See: http://www.sciencemag.org/content/329/5987/51.short See also: http://www.jpl.nasa.gov/news/news.cfm?release=2010-220&cid=release_2010-220&msource=m20100701&tr=y&auid=6573935
2010, Jul 5-9	***2nd International Symposium Space & Global Security of Humanity***, Riga (Latvia), 5-9 July 2010. See: http://www.tsi.lv/?id=5108&lang=en&top=336&top=136 http://www.tsi.lv/Research/Conference/SGS-2010/SGS_2010_abstracts.pdf
2010, Jul 5	V.V. Adushkin, A.V. Vityazev, D.V. Gorobets, et al., 2010,

	presented at the 2nd International Symposium *Space & Global Security of Humanity*, Riga (Latvia), 5-9 July 2010, "Conceptual, technological and legal bases of creation of the International Planetary Defense System (PDS 'Citadel')." See: http://www.tsi.lv/space/SGS1020_221%20-%2005.07.10/Adushkin/IAA-RACT%20C2%20S3-03.pdf
2010, Jul 8-9	NASA Advisory Council's ad-hoc **Task Force on Planetary Defense**, co-chaired by former astronauts Russell Schweickart and Tom Jones, meeting in Boulder (CO, USA), asked for a **Planetary Defense Coordination Office**. See: http://www.nasa.gov/directorates/heo/library/nac/planetary-defense.html **Presentations:** - L. Johnson, 2010, "NASA Near Earth Object (NEO) program status; NASA FY11 budget for NEO Research." See: http://www.nasa.gov/pdf/467238main_20100415_NEOObservationsProgram_Johnson.pdf - E. Crawley, 2010, "NEOs in the context of the Augustine Committee report (Oct 09)." See: http://www.nasa.gov/pdf/466631main_20100416Synopsis_ReviewOfHumanSpaceflightCommittee_Crawley.pdf See also: http://www.nature.com/news/2010/100908/full/467140a.html http://www.space.com/news/nasa-asteroid-impact-near-earth-objects-planetary-defense-100726.html
2010, Jul 10	ESA spacecraft ***Rosetta*** fly-by of Main-belt asteroid **21 Lutetia** (*H* = 7.5 mag, *D* = 132 × 101 × 76 km), at a distance of 3162 km. See: 21 Lutetia - SSA , 21 Lutetia - JPL Ref: - S.A. Stern, J.Wm. Parker, P.D. Feldman, et al., 2011, *Astronomical Journal*, 141(6), article id. 199, "Ultraviolet discoveries at asteroid (**21**) **Lutetia** by the ***Rosetta*** Alice Ultraviolet Spectrograph." See: http://adsabs.harvard.edu/abs/2011AJ....141..199S - H. Sierks, P. Lamy, C. Barbieri, et al., 2011, *Science*, 334, 487, "Images of asteroid **21 Lutetia**: a remnant planetesimal from the early Solar System." See: http://adsabs.harvard.edu/abs/2011Sci...334..487S - P. Vemazza, P. Lamy, O. Groussin, et al., 2011, *Icarus*, 216, 650, "Asteroid (**21**) **Lutetia** as a remnant of Earth's precursor planetesimals." See: http://adsabs.harvard.edu/abs/2011Icar..216..650V - R. Schulz, H. Sierks, M. Küppers, A. Accomazzo, 2012,

	Planetary and Space Science, 66, 2, "***Rosetta*** fly-by at asteroid (**21**) **Lutetia**: an overview." See: http://adsabs.harvard.edu/abs/2012P%26SS...66....2S See also: http://www.esa.int/SPECIALS/Rosetta/index.html http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2666 http://esamultimedia.esa.int/docs/rosetta/Rosetta_fact_sheetv3.pdf http://www.nasa.gov/pdf/474203main_Coradini_ExploreNOW.pdf http://www.esa.int/esaSC/SEMSTK58BOG_index_0.html http://www.esa.int/esaSC/SEMUAYJ4LOG_index_0.html http://www.esa.int/esaSC/SEMG93HURTG_index_0.html http://www.space.com/13594-earth-ancestor-banished-asteroid-belt.html http://www.eso.org/public/news/eso1144/ http://www.eso.org/public/videos/eso1144a/ http://www.eso.org/public/images/eso1144b/ https://en.wikipedia.org/wiki/21_Lutetia
2010, Jul 16	NASA spacecraft ***WISE*** completed its first half-year of observations, its program **NEO-WISE** detecting at infrared wavelengths 97 new near-Earth asteroids, including 14 **PHAs**. A 10 August report said that the spacecraft is running out of the frozen coolant needed to keep its heat-sensitive instrument chilled. See: http://wise.ssl.berkeley.edu/ http://neo.jpl.nasa.gov/stats/wise/ http://www.jpl.nasa.gov/news/news.cfm?release=2010-238
2010, Jul 18-25	**38th COSPAR Scientific Assembly**, Bremen (Germany), session B04, ***Small body exploration: past, present and future space missions***. See: http://www.cospar-assembly.org/
2010, Jul 19	EU Call for Proposals Work Programme 2011, Cooperation Theme 9 *Space* (European Commission C(2010)4900 of 19 July 2010), Activity 9.2: Strengthening the foundations of space science and technology, Area 9.2.3: Research into reducing the vulnerability of space assets, SPA.2011.2.3-01: Prevention of impacts from Near Earth Objects (NEOs) on our Planet. Deadline: 25 November 2010. See: http://ftp://ftp.cordis.europa.eu/pub/fp7/docs/wp/cooperation/space/j-wp-201101_en.pdf http://www.eurosfaire.prd.fr/7pc/documents/1279796061_paris__infoday30june10_ce.ppt#258,1,Slide 1 http://www.euresearch.ch/fileadmin/documents/events2010/2010_InfoDay-Space_MaT.pdf
2010, Jul 26-30	***73rd Annual Meeting of the Meteoritical Society***, New York (NY,

	USA) 26-30 July 2011. See: http://www.lpi.usra.edu/meetings/metsoc2010/
2010, Jul 28	N. Kaiser, W. Burgett, K.C. Chambers, et al., 2010, in: L.M. Stepp, R. Gilmozzi & H.J. Hall (eds.), Ground-based and airborne telescopes. III, *Proceedings of the SPIE*, 7733, 77330E, "The **Pan-STARRS** wide-field optical/NIR imaging survey." See: http://adsabs.harvard.edu/abs/2010SPIE.7733E..12K See also: http://www.scientificamerican.com/article.cfm?id=pan-starrs-neo
2010, July-August	G. Meishan Goh, 2010, *Acta Astronautica*, 67, 230, "Pella vilya: Near Earth Objects—Planetary defence through the regulation of resource utilisation." See: http://adsabs.harvard.edu/abs/2010AcAau..67..230M
2010, Aug 3-4	**Third NASA *Small Bodies Assessment Group Meeting***, Pasadena (CA, USA). See: http://www.lpi.usra.edu/sbag/meetings/ http://www.lpi.usra.edu/sbag/meetings/aug2010/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the papers:** - P. Abell, R. Landis, 2010, "New NASA initiatives for the exploration of Near-Earth Objects." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/Abell_Human_NEO_Mission_3rd%20SBAG2010.pdf - P. Abell, 2010, "Human exploration." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/Human_Exploration_Outline.pdf - M. Zolensky, 2010, "***Hayabusa*** mission update." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/HayabusaRecoveryMZolensky.pdf - B. Geldzahler, J. Crusan, P. Martin, et al., 2010, "NEO tracking and characterization facility." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/Geldzahler_NEO_Tracking_and_Characterization_Facility_v5.pdf - J. Nuth, 2010, "Small body science issues." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/NuthSmallBodyScienceIssues.pdf - Y. Fernandez, 2010, "Outline: population identification and characterization."

	See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/fernandez_outline-ident.pdf - D. Britt, 2010, "Small Bodies roadmap outline: in-situ study." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/britt_outline_insitu.pdf - P. Weissman, 2010, "SBAG roadmap: sample return." See: http://www.lpi.usra.edu/sbag/meetings/aug2010/presentations/weissman_Sample_return_outline_new.pdf
2010, Aug 10-11	**NASA Interactive Workshop *Exploration of Near Earth Object objectives***, to identify objectives for exploration missions to near-Earth objects. Washington DC (USA). See: http://www.nasa.gov/home/hqnews/2010/aug/HQ_M10-105_NEO_Workshop.html http://www.nasa.gov/exploration/new_space_enterprise/home/neoworkshop.html
2010, Aug 13	L. Folco, M. di Martino, A. El Barkooky, 2010, *Science*, 329, 804, "The **Kamil Crater** in Egypt." A newly discovered impact crater. See: http://www.sciencemag.org/content/329/5993/804.abstract
2010, Aug 20	**Fireball lights up Jupiter**. Impacting asteroid or comet. See: http://www.jpl.nasa.gov/news/news.cfm?release=2010-293&cid=release_2010-293&msource=2010293B&tr=y&auid=6964089
2010, Aug 26	Announcement of the winner of the **Space Generation Advisory Council** International Student and Young Professional Technical Paper Competition *Asteroid Warning System 2010*: Ben Corbin (MIT, USA), 2010, presented at the *61st International Astronautical Congress*, Prague (Czech Republic), 27 September - 1 October 2010, "Implementing advanced technologies and models to reduce uncertainty in a global, cost-effective asteroid mitigation system". See: http://spacegeneration.org/index.php/eventstopics/news/169-win-a-trip-to-sgc-and-iac-with-the-2010-move-an-asteroid-competition http://today.ucf.edu/ucf-alum-writes-asteroid-warning-strategy/ http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf http://www.gbv.de/dms/tib-ub-hannover/66102427x.pdf
2010, Aug 30	***Plymouth Rock*** deep space asteroid mission presented. See: http://www.space.com/news/asteroid-mission-plans-orion-

	spacecraft-100830.html
2010, Aug 31	K. Beatty, *Sky & Telescope*, 31 August 2010, "The dinosaurs got a warning shot." See: http://www.skyandtelescope.com/community/skyblog/newsblog/101880488.html
2010, Sep	P.A. Bland, P. Spurný, L. Shrbený, et al., 2010, *73rd Annual Meeting of the Meteoritical Society,* New York (NY, USA), 26-30 July 2010, *Meteoritics and Planetary Science Supplement*, id. id.5209, "**Meteorite falls** observed by the **Desert Fireball Network**: an update." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5209B
2010, Sep	H. Campins, A. Morbidelli, K. Tsiganis, et al., 2010, *Astrophysical Journal* (Letters), 721, L53, "The origin of asteroid **101955** (**1999 RQ36**)." See: http://adsabs.harvard.edu/abs/2010ApJ...721L..53C
2010, Sep	T.J. Goldin, C. Koeberl, H.J. Melosh, 2010, *73rd Annual Meeting of the Meteoritical Society*, New York (NY, USA), 26-30 July 2010, *Meteoritics and Planetary Science Supplement*, id. id.5261, "The fate of ejecta rays in the Earth's atmosphere: from Popigai to **Chicxulub**." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5261G
2010, Sep	T. Ito, R. Malhotra, 2010, *Astronomy & Astrophysics*, 519, A63, "Asymmetric impacts of near-Earth asteroids on the Moon." See: http://adsabs.harvard.edu/abs/2010A%26A...519A..63I
2010, Sep	G.L. Matloff, L. Leng, T. Le, 2010, in: *73rd Annual Meeting of the Meteoritical Society*, New York (NY, USA), July 26-30 2010, *Meteoritics and Planetary Science Supplement*, id.5004, "Optical transmission of an **Allende Meteorite** thin section and simulated regolith." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5004M See also: http://www.sify.com/news/study-sheds-light-on-asteroid-deflection-strategy-to-avert-collision-news-scitech-lb3u4cgjbej.html
2010, Sep	E.R.D. Scott, J.I. Goldstein, J. Yang, et al., 2010, in: *73rd Annual Meeting of the Meteoritical Society*, New York (NY, USA), July 26-30 2010, *Meteoritics and Planetary Science Supplement*, id.5015, "Iron and stony-iron meteorites and the missing mantle meteorites and asteroids." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5015S

2010, Sep	R.P. Binzel, A. Morbidelli, S. Merouane, et al., 2010, in: *73rd Annual Meeting of the Meteoritical Society*, New York (NY, USA), July 26-30 2010, *Meteoritics and Planetary Science Supplement*, id.5263, "Asteroid analogs to ordinary chondrite meteorites: Earth encounters as the key to resolving the paradox." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5263B
2010, Sep	D. Jolley, I. Gilmour, E. Gurov, 2010, *Geology*, 38, 835, "Two large meteorite impacts at the Cretaceous-Paleogene boundary." See: http://geology.geoscienceworld.org/cgi/content/abstract/38/9/835 http://www.bbc.co.uk/news/science-environment-11112417?print=true http://www.skyandtelescope.com/news/3306656.html?page=1&c=y http://en.wikipedia.org/wiki/Boltysh_crater
2010, Sep	D.E. Trilling, M. Mueller, J.L. Hora, et al., 2010, *Astronomical Journal*, 140, 770, "ExploreNEOs. I. Description and first results from the ***Warm-Spitzer*** **Near-Earth Object survey**." **The *Warm Spitzer* NEO Survey**, exploring the history of the inner Solar System and near Earth space in the two ***Warm Spitzer*** wavelength channels at 3.5 µm and 4.5 µm. See: http://adsabs.harvard.edu/abs/2010AJ....140..770T See also: http://www.jpl.nasa.gov/news/news.cfm?release=2010-283 http://www.scientificamerican.com/blog/post.cfm?id=nearby-asteroids-are-a-diverse-bunc-2010-09-03 https://www.jpl.nasa.gov/news/news.php?feature=7575
2010, Sep 3	As a sequel of ***NEAR***, a joint mission study by Johns Hopkins University Applied Physics Laboratory and NASA's Goddard and Johnson Space Flight Centers focuses on ***Next Gen NEAR***, a concept of a robotic precursor for a human visit to a near-Earth asteroid. The mission could launch as soon as 2014 and begin to return data from a target asteroid the following year. See: http://www.jhuapl.edu/newscenter/pressreleases/2010/100903.asp
2010, Sep 8, 09:51	Aten NEA **2010 RX30** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of a nominal miss distance of 0.64 LD. Minimum miss distance 0.64 LD. **[2010-06]** See: 2010 RX30 - SSA , 2010 RX30 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2725 http://neo.jpl.nasa.gov/news/news169.html http://www.astronomynow.com/news/n1009/07asteroids/ http://www.space.com/spacewatch/asteroids-passing-near-earth-telescopes-100908.html http://en.wikipedia.org/wiki/2010_RX30

	See also: **8 Sep 1931.**
2010, Sep 8, 21:13	Asteroid **2010 RF12** (H = 28.1 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.207 LD. Minimum miss distance 0.206 LD. **[2010-07]** See: 2010 RF12 - SSA , 2010 RF12 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2725 http://neo.jpl.nasa.gov/news/news169.html http://www.astronomynow.com/news/n1009/07asteroids/ http://www.space.com/spacewatch/asteroids-passing-near-earth-telescopes-100908.html http://en.wikipedia.org/wiki/2010_RF12 See also: **10 Sep 1915**, **6 Sep 2095**.
2010, Sep 8, 23:58	Apollo NEA **2010 RK53** (H = 27.9 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2010-08]** See: 2010 RK53 - SSA , 2010 RK53 - JPL
2010, Sep 16-19	***International Meteor Conference 2010***, Armagh (Northern Ireland, UK). See: http://www.imo.net/imc2010 http://www.imo.net/imc2010/schedule.php
2010, Sep 17	J.W. Head III, C.I. Fassett, S.J. Kadish, et al., 2010, *Science*, 329, 1504, "Global distribution of large lunar craters: implications for resurfacing and impactor populations." See: http://adsabs.harvard.edu/abs/2010Sci...329.1504H http://news.brown.edu/pressreleases/2010/09/moon
2010, Sep 19-24	***European Planetary Science Conference (EPSC 2010)***, Rome (Italy). See: http://meetings.copernicus.org/epsc2010/ **Among the papers:** - D.V. Koschny, G. Drolshagen, N. Bobrinsy, M. Gritsevich, 2010, "The **European Space Situational Awareness programme.**" See: http://adsabs.harvard.edu/abs/2010epsc.conf..686K http://meetings.copernicus.org/epsc2010 p.686. - E. Perozzi, R.P. Binzel, A. Rossi, G.B. Valsecchi, 2010, "Asteroids more accessible than the **Moon**." See: http://adsabs.harvard.edu/abs/2010epsc.conf..750P http://meetings.copernicus.org/epsc2010 p.750. - T.J. Jopek, G.B. Valsecchi, 2010, "From meteor observations to

	meteoroid orbits: propagation of uncertainties." See: http://adsabs.harvard.edu/abs/2010epsc.conf..888J http://meetings.copernicus.org/epsc2010 p.888
2010, Sep 27 – Oct	***61st International Astronautical Congress***, Prague (Czech Republic). See: http://www.iac2010.cz/en/welcome
2010, Sep 27	R. Williamson, B. Weeden, S. Camacho, T. Jones, R. Schweickart, 2010, IAC-E.3.1.B4, paper presented at *23rd Symposium on Space policy, Regulations and Economics*, International Astronautical Congress, Prague, 27 September - 1 October 2010, "Responding to the threat of potentially-hazardous Near Earth Objects". See: http://swfound.org/media/16114/iac-10.e3.1b.4.pdf
2010, Sep 30	Apollo NEA **2010 SK13** (H = 27.6 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2010-09]** See: 2010 SK13 - SSA , 2010 SK13 - JPL
2010, Oct	G. Drolshagen, D. Koschny, N. Bobrinsky, 2010, *Cosmic Research*, 48(5), 399, "The near-Earth objects segment of the **European Space Situational Awareness** program." See: http://adsabs.harvard.edu/abs/2010CosRe..48..399D
2010, Oct	D.P. Glavin, A.D. Aubrey, M.P. Callahan, et al., 2010, *Meteoritics & Planetary Science*, 45, 1695, "Extraterrestrial amino acids in the **Almahata Sitta meteorite**." See: http://adsabs.harvard.edu/abs/2010M%26PS...45.1695G
2010, Oct	R. Hueso, A. Wesley, C. Go, 2010, *Astrophysical Journal* (Letters), 721, L129, "First Earth-based detection of a superbolide on Jupiter." See: http://adsabs.harvard.edu/abs/2010ApJ...721L.129H
2010, Oct	D.C. Hyland, H.A. Altwaijry, S. Ge, et al., 2010, *Cosmic Research*, 48, 430, "A permanently-acting NEA damage mitigation technique via the Yarkovsky effect." See: http://adsabs.harvard.edu/abs/2010CosRe..48..430H
2010, Oct	D.C. Hyland, H.A. Altwaijry, R. Margulieux, et al., 2010, *Cosmic Research*, 48, 437, "A mission template for exploration and damage mitigation of potential hazard of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2010CosRe..48..437H

2010, Oct	J. McMahon, D. Scheeres, 2010, *Icarus*, 209, 494, "Detailed prediction for the BYORP effect on binary near-Earth Asteroid (**66391**) **1999 KW4** and implications for the binary population." See: http://adsabs.harvard.edu/abs/2010Icar..209..494M
2010, Oct	P. Michel, M. Delbò, 2010, *Icarus*, 209, 520, "Orbital and thermal evolutions of four potential targets for a sample return space mission to a primitive near-Earth asteroid." See: http://adsabs.harvard.edu/abs/2010Icar..209..520M
2010, Oct	S.A. Naroenkov, 2010, *Cosmic Research*, 48, 455, "Storing and processing astrometric and photometric data on NEA: current state and future in Russia." See: http://adsabs.harvard.edu/abs/2010CosRe..48..455N
2010, Oct	D. Nesvorný, W.F. Bottke, D. Vokrouhlický, et al., 2010, *Icarus*, 209, 510, "Do planetary encounters reset surfaces of near Earth asteroids?" See: http://adsabs.harvard.edu/abs/2010Icar..209..510N
2010, Oct	B.M. Shustov, 2010, *Cosmic Research*, 48(5), 378, "On coordinated approach to the problem of asteroid-comet impact hazard." See: http://adsabs.harvard.edu/abs/2010CosRe..48..378S http://www.springerlink.com/content/4ru4763wl0873563/
2010, Oct	G.B. Valsecchi, A. Rossi, A. Milani, S.R. Chesley, 2010, in: *Mathematics and Astronomy: A Joint Long Journey*, AIP Conf. Proc., 1283, 231, "Collision probability: a new analytical derivation." See: http://adsabs.harvard.edu/abs/2010AIPC.1283..231V
2010, Oct 4	NASA spacecraft ***WISE*** has reached the expected end of its on-board supply of frozen coolant. Although ***WISE*** has 'warmed up,' NASA has decided the mission will still continue. ***WISE*** will now focus on asteroids and comets. To date, ***WISE*** has discovered 19 comets and more than 33,500 asteroids, including 120 NEOs. The continuation mission, dubbed the **NEO-WISE Post-Cryogenic Mission**, observes at about –203 C, using only its two shortest-wavelength detectors. See: http://wise.ssl.berkeley.edu/ http://wise.ssl.berkeley.edu/gallery_AsteroidCensus.html http://www.jpl.nasa.gov/news/news.cfm?release=2010-320&cid=release_2010-320&msource=2010320&tr=y&auid=7105499 http://www.space.com/10735-asteroid-survey-space-rocks-comets.html

2010, Oct 5	The **Asteroid Terrestrial-impact Last Alert System (ATLAS)** project. Update of web site describing proposal 10-NEOO10-0009 to the NASA Near-Earth Object Observation (NEOO) program. **ATLAS** is meant as a survey complementary to **Pan-STARRS**, focussing on 140 m – 50 m objects, observing down to $v = 20$ mag with an array of 10-inch telescopes and CCD cameras. This will probably not provide enough warning time to deflect the asteroid – it is intended to provide warning of impending asteroid. Proposers: John Tonry (Univ. of Hawaii, HI, USA), Robert Jedicke (Univ. of Hawaii, HI, USA) and Armin Rest (Space Telescope Science Institute (Baltimore, MD, USA). As of January 2013, the **ATLAS** program is funded by NASA. See: https://fallingstar.com/home.php http://www.fallingstar.com/index.php http://www.fallingstar.com/ua20111230.php http://www.fallingstar.com/ua20120330.php http://www.fallingstar.com/ua20120630.php http://www.fallingstar.com/ua20120930.php Ref: - J.L. Tonry, 2011, *Publ. Astron. Soc. Pacific*, 123, 58, "An early warning system for asteroid impact." See: http://adsabs.harvard.edu/abs/2011PASP..123...58T - R. Jedicke, J. Tonry, P. Veres, et al., October 2012, American Astronomical Society, DPS meeting #44, #210.12, "**ATLAS: Asteroid Terrestrial-impact Last Alert System**." See: http://adsabs.harvard.edu/abs/2012DPS....4421012J See also: http://fallingstar.com/index.html http://www.space.com/news/nasa-asteroid-impact-near-earth-objects-planetary-defense-100726.html http://www.msnbc.msn.com/id/38791514/ http://www.ifa.hawaii.edu/info/press-releases/ATLAS/
2010, Oct 6	Report of the NASA Advisory Council ***Ad Hoc Task Force on Planetary Defense***, established 15 April 2010. Members: R.P. Binzel, MIT; C.R. Chapman, SRI, L.N. Johnson, NASA NEOOP; T.D. Jones, IHMC; R.L. Schweickart, **B612**; B. Wilcox, JPL; D.K. Yeomans, JPL; B. Siegel, NASA ESMD. Recommendations: (1) Organize for effective action on planetary defense; (2) Acquire essential search, track and warning capabilities; (3) Investigate the nature of the impact threat; (4) Prepare to respond to impact threats; (5) Lead U.S. planetary defense efforts in national and international forums. The **Task Force** called for the creation of a **Planetary Defense Coordination Office**. See:

	http://www.nasa.gov/pdf/490945main_10-10_TFPD.pdf http://www.nasa.gov/exploration/about/planetarydefense_taskforce_prt.htm http://www.nasa.gov/pdf/493115main_10-10_TFPD_BRIEFING.pdf See also: http://www.nature.com/news/2010/100908/full/467140a.html http://www.scientificamerican.com/article.cfm?id=nasa-panel-weighs-asteroid-danger http://www.planetary.org/programs/projects/space_information/20101027.html http://www.space.com/news/nasa-planetary-defense-fights-asteroids-101019.html http://gaiashield.com/NACTaskForceFR/NACTaskForceFR.pdf
2010, Oct 9	Apollo NEA **2010 TW54** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2010-10]** See: 2010 TW54 - SSA , 2010 TW54 - JPL See also: **10 Oct 2103**.
2010, Oct 11	Apollo NEA **2010 TN55** (H = 26.8 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD **[2010-11]** See: 2010 TN55 - SSA , 2010 TN55 - JPL
2010, Oct 12	Apollo NEA **2010 TD54** (H = 28.6 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2010-12]** A ~5-m sized NEA from the undiscovered population of ~30 million would be expected to pass daily within a lunar distance, and one might strike Earth's atmosphere about every 2 years on average. If an asteroid of the size of **2010 TD54** were to enter Earth's atmosphere, it would be expected to burn up high in the atmosphere and cause no damage to Earth's surface. See: 2010 TD54 - SSA , 2010 TD54 - JPL See also: http://www.jpl.nasa.gov/news/news.cfm?release=2010-332 http://www.space.com/scienceastronomy/small-asteroid-passing-earth-tuesday-101011.html http://www.space.com/spacewatch/small-asteroid--passing-earth-101116.html http://en.wikipedia.org/wiki/2010_TD54
2010, Oct 14	C. Snodgrass, C. Tubiana, J.-B. Vincent, et al., 2010, *Nature*, 467, 814, "A collision in 2009 as the origin of the debris trail of asteroid **P/2010 A2**." See: http://adsabs.harvard.edu/abs/2010Natur.467..814S

2010, Oct 15	Memo from John P. Holdren, Director of the White House Office of Science and Technology Policy of the Executive Office of the U.S. President, to U.S. House of Representatives Committee on Science and Technology, and to U.S. Senate Committee on Commerce, Science and Transportation, Washington DC (USA), describing (1) U.S. current and prospective NEO detection activities; (2) notification procedures for a potential NEO threat; (3) emergency response procedures for a potential NEO threat; and (4) U.S. Government roles and responsibilities for potential future NEO mitigation/deflection activities. See: http://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp-letter-neos-house.pdf http://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp-letter-neo-senate.pdf http://www.nature.com/news/2010/101021/full/news.2010.554.html http://www.scientificamerican.com/article.cfm?id=nasa-to-lead-global-asteroid-r http://www.planetary.org/programs/projects/space_information/20101027.html http://www.space.com/news/white-house-plans-asteroid-impact-101021.html http://www.space.com/9370-ready-meet-asteroid-threat-white-house-science-adviser.html http://newsfeed.time.com/2010/10/26/white-house-nasa-needs-to-figure-out-how-to-save-us-from-an-asteroid/ http://www.aolnews.com/2010/10/25/hold-for-buck-us-must-be-ready-for-asteroid-strike-top-scien/ http://gaiashield.com/OSTPNEO/WWOSTPPOTUS.pdf http://gaiashield.com/OSTPNEO/WWOSTPCongress.pdf
2010, Oct 16	Asteroid **2010 UE** (H = 29.5 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.30 LD. Minimum miss distance 0.29 LD. **[2010-13]** See: 2010 UE - SSA , 2010 UE - JPL
2010, Oct 17	Aten NEA **2010 TE55** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.95 LD. Minimum miss distance 0.95 LD. **[2010-14]** See: 2010 TE55 - SSA , 2010 TE55 - JPL
2010, Oct 25	R. Schweickart, 2010, *The New York Times*, October 25, "Humans to Asteroids: Watch Out!" See: http://www.nytimes.com/2010/10/26/opinion/26schweickart.html?_r=1&scp=1&sq=humans%20to%20asteroids:%20watch%20out!&st=cse
2010, Oct 26	Aten NEA **2010 UY7** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.63

	LD. **[2010-15]** See: 2010 UY7 - SSA , 2010 UY7 - JPL
2010, Oct 27-29	**ESA Mission Planning and Operations Group (MPOG) Workshop *Plausible asteroid impact and timing scenarios***, 27-29 October 2010, Darmstadt (Germany), co-sponsored by the **Association of Space Explorers** and the **Secure World Foundation**. In a post-workshop hand-out, the attendees concluded that: (*a*) a **Mission Planning and Operations Group** should be established; (*b*) the **MPOG** should identify to space agencies the technical issues involved in planetary defense, to take advantage of synergies between human exploration, science, and study of the NEO hazard; (*c*) the **MPOG** should propose research themes in NEO deflection for use by space agencies, addressing those areas most critical for effective deflection strategies; and (*d*) there is great value in finding hazardous NEOs early, to reduce the costs of deflection missions. Early detection would require upgraded NEO search and tracking capabilities. See: http://www.space-explorers.org/committees/NEO/MPOG.pdf http://swfound.org/events/2010/neo-mission-planning-and-operations-group-workshop http://swfound.org/media/16096/mpog%20exec%20summary%2011-18-10a.pdf http://www.esa.int/SPECIALS/ESOC/SEMECCHMI8G_0.html http://www.livestream.com/eurospaceagency/video?clipId=pla_853975ca-049b-4a49-bece-460fbf456d05 http://www.space-explorers.org/committees/NEO/MPOG.pdf http://www.mail-archive.com/meteorite-list@meteoritecentral.com/msg91343.html http://www.newswise.com/articles/view/570456/?sc=dwtr&xy=5028369 http://www.spaceguarduk.com/news/312-global-action http://www.bbc.co.uk/blogs/thereporters/jonathanamos/2010/10/when-the-time-comes-to-duck.shtml http://www.space.com/news/asteroid-threat-global-action-plan-101109.html
2010, Oct 27	R. Schweickart, 2010, presented at ESA **Mission Planning and Operations Group (MPOG) workshop *Plausible asteroid impact and timing scenarios***, 27-29 October 2010, Darmstadt (Germany), "Implementation of the **MPOG (Mission Planning and Operations Group)**". See: http://swfound.org/media/30999/Schweickart%20-%20Intro%20to%20the%20MPOG.pdf
2010, Oct/Nov	Special Issue *Meteoritics & Planetary Science*, 2010, 45, Issue 10-11, pp. 1553-1845, "**2008 TC3** and **Almahata Sitta**." Dedicated to NEA **2008 TC3**, impact on 6 October 2008. Editorial: P. Jenniskens, M.H. Shaddad, 2010, *Meteoritics & Planetary Science*, 45, 1553, "**2008**

	TC3: the small asteroid with an impact." See: http://adsabs.harvard.edu/abs/2010M%26PS...45.1553J See also: http://onlinelibrary.wiley.com/doi/10.1111/maps.2010.45.issue-10-11/issuetoc http://www.nasa.gov/home/hqnews/2010/dec/HQ_10-340_Asteroid_Meteorite.html
2010, Nov	S.R. Chesley, J. Baer, D.G. Monet, 2010, *Icarus*, 210, 158, "Treatment of star catalog biases in asteroid astrometric observations." See: http://adsabs.harvard.edu/abs/2010Icar..210..158C The authors illustrate the benefits of debiasing to high-precision astrometric applications such as asteroid mass determination and collision analysis, including a refined prediction of the impact probability of **99942 Apophis**. Specifically, they find the IP of **Apophis** to be lowered by nearly an order of magnitude to 4.5×10^{-6} for the **2036** close approach.
2010, Nov	D. Jewitt, J. Li, 2010, *Astronomical Journal*, 140, 1519, "Activity in Geminid parent (**3200**) **Phaethon**." See: http://adsabs.harvard.edu/abs/2010AJ....140.1519J http://science.nasa.gov/science-news/science-at-nasa/2010/06dec_geminids/
2010, Nov	E. Pierazzo, R.R. Carcia, D.E. Kinnison, D.R. Marsh, J. Lee-Taylor, P.J. Crutzen, 2010, *Earth and Planetary Science Letters*, 299, 263, "Ozone perturbation from medium-size asteroid impacts in the ocean." See: http://adsabs.harvard.edu/abs/2010E%26PSL.299..263P http://www.newscientist.com/article/dn19579-ocean-asteroid-hits-will-create-huge-ozone-holes.html
2010, Nov	D.P. Rubincam, S.J. Paddock, 2010, *Icarus*, 209, 863, "Zero secular torque on asteroids from impinging solar photons in the YORP effect: a simple proof." See: http://adsabs.harvard.edu/abs/2010Icar..209..863R
2010, Nov 2, 02:37	Aten NEA **2010 UJ7** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.74 LD. **[2010-16]** See: 2010 UJ7 - SSA , 2010 UJ7 - JPL
2010, Nov 2, 18:05	Apollo NEA **2010 VN1** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34

	LD. **[2010-17]** See: 2010 VN1 - SSA , 2010 VN1 - JPL
2010, Nov 4	D. Lupishko, Z. Pozhalova, 2010, in: C. Barbieri, M. Coradini, S. Chakrabarti (eds.), Proc. IAU Symposium No. 269 on *Galileo's Medicean Moons: their impact on 400 years of discovery* (Cambridge: CUP), p. 234, "Near-Earth Objects 400 years after Galileo: physical properties and internal structure." See: http://adsabs.harvard.edu/abs/2010IAUS..269..234L
2010, Nov 4	NASA spacecraft ***EPOXI*** successfully flew by comet **Hartley 2** at about 7 a.m. PDT. **Hartley 2** is the fifth comet nucleus visited by a spacecraft. See: http://epoxi.umd.edu/ http://www.lpi.usra.edu/sbag/meetings/jan2009/presentations/AHearn_SBAG-EPOXI.pdf http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2727 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2754 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2010-346 http://www.jpl.nasa.gov/news/news.cfm?release=2010-371&cid=release_2010-371&msource=e20101104&tr=y&auid=7308484 http://www.jpl.nasa.gov/news/news.cfm?release=2010-373&cid=release_2010-373&msource=10373&tr=y&auid=7313419 http://www.jpl.nasa.gov/news/news.cfm?release=2010-375&cid=release_2010-375&msource=2010375&tr=y&auid=7321315 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2010-387 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-185
2010, Nov 7	Apollo NEA **2010 VR21** ($H = 29.2$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2010-18]** See: 2010 VR21 - SSA , 2010 VR21 - JPL See also: http://www.space.com/spacewatch/small-asteroid--passing-earth-101116.html
2010, Nov 11	**Cameras for Allsky Meteor Surveillance (CAMS)**. First light. **CAMS** is an automated video surveillance of the night sky in search of meteors to validate minor showers in the **IAU Working List of Meteor Showers**. Stations are located in California. See: http://cams.seti.org/ http://www.astro.amu.edu.pl/~jopek/MDC2007/Roje/roje_lista.php?corobic_roje=0&sort_roje=0
2010, Nov 12	Apollo NEA **2010 VP139** ($H = 27.4$ mag, $D \approx 12$ m) passed Earth at a nominal miss distance of 0.21 LD. Minimum miss distance

	0.02 LD. **[2010-19]** See: 2010 VP139 - SSA , 2010 VP139 - JPL
2010, Nov 13	Apollo NEA **2010 VC140** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2010-20]** See: 2010 VC140 - SSA , 2010 VC140 - JPL
2010, Nov 14	Apollo NEA **2010 RF181**, *H* = 20.6 mag, *D* ≈ 280 m, **PHA**) passed Earth at a nominal miss distance of 4.30 LD. Minimum miss distance 4.30 LD. See: 2010 RF181- JPL , 2010 RF181- SSA
2010, Nov 16	Successful **NEA** sample return. Particles returned by the JAXA spacecraft ***Hayabusa*** on 13 June 2010 have been identified to originate from asteroid **25143 Itokawa** (**1998 SF36**, *H* = 19.5 mag, *D* = 520 × 270 × 230 m, *M* = 3.6 × 1010 kg, **PHA**). Some 1500 grains with sizes < 10 µm were identified as rocky particles, most of them judged to be of extraterrestrial origin. In August 2010 JAXA received governmental go-ahead for preliminary design work on follow-up asteroid sample return mission ***Hayabusa 2***, aimed for launch in 2014 to reach a carbon-rich asteroid in 2018 for a touch-and-go approach to collect samples, and return to Earth in 2020. See: http://hayabusa.jaxa.jp/e/index.html http://www.jaxa.jp/projects/sat/muses_c/index_e.html http://www.jaxa.jp/press/2010/11/20101116_hayabusa_e.html http://blogs.nature.com/news/thegreatbeyond/2010/11/hayabusa_claims_first_dust_fro_1.html http://www.scientificamerican.com/blog/post.cfm?id=hayabusa-probe-succeeded-in-returni-2010-11-16 http://www.space.com/news/japan-approves-asteroid-probe-new-rocket-100820.html http://science.nasa.gov/science-news/science-at-nasa/2010/30dec_samplereturn/ http://en.wikipedia.org/wiki/25143_Itokawa
2010, Nov 17	Apollo NEA **2010 WA** (*H* = 30.3 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.101 LD **(= 6.1 R_{Earth} from the geocenter)**. Minimum miss distance 0.101 LD. **[2010-21]** See: 2010 WA - SSA , 2010 WA - JPL See also: http://www.space.com/spacewatch/small-asteroid--passing-earth-101116.html http://www.space.com/scienceastronomy/tiny-asteroid-passing-earth-spins-fast-101120.html

2010, Nov 18	Emeritus-Director of the **IAU Minor Planet Center** Dr. Brian G. Marsden (1937 - 2010) passed away. Ref: - G.V. Williams, 2010, *Minor Planet Electronic Circulars*, No. 2010-W10, "Brian Marsden (1937 Aug. 5 - 2010 Nov. 18)". See: http://www.minorplanetcenter.org/mpec/K10/K10W10.html#form See also: http://www.iau.org/science/news/115/ http://www.cfa.harvard.edu/news/2010/pr201025.html http://planetary.org/news/2010/1118_Brian_Marsden_1937__2010.html http://www.scientificamerican.com/blog/post.cfm?id=brian-marsden-longtime-director-of-2010-11-18 http://www.scientificamerican.com/article.cfm?id=keeper-of-the-objects http://blogs.nature.com/news/thegreatbeyond/2010/11/and_loses_a_giant_among_minor.html http://www.newscientist.com/blogs/shortsharpscience/2010/11/brian-marsden-the-man-who-made.html http://www.skyandtelescope.com/news/109107254.html http://www.space.com/news/astronomers-brian-marsden-allan-sandage-obits-101119.html http://www.universetoday.com/79392/astronomer-brian-marsden-has-died/ http://www.economist.com/node/17627004 http://en.wikipedia.org/wiki/Brian_G._Marsden
2010, Nov 29	Apollo NEA **2010 XR** (H = 26.8 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.45 LD. **[2010-22]** See: 2010 XR - SSA , 2010 XR - JPL
2010, Nov 29 - Dec	***Gaia Follow-Up Network*** (***Gaia-FUN***) ***Workshop***, hosted by the Institut de Mécanique Céleste et de Calcul des Éphémérides (IMCCE), Paris (France), to discuss and start up a network for follow-up asteroid observations to be made with ESA's ***Gaia*** mission, scheduled for launch in Spring 2012. See: http://www.imcce.fr/langues/en/publications/colloques/gaiafun/
2010, Nov 30	Apollo NEA **2010 XB** (H = 29.6 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.14 LD. Minimum miss distance 0.14 LD. **[2010-23]** See: 2010 XB - SSA , 2010 XB - JPL
2010, Nov-Dec	D.R. Adamo, J.D. Giorgini, P.A. Abell, R.R. Landis, 2010, *Journal of Spacecraft and Rockets*, 47, 994, "Asteroid destinations accessible for human exploration: a preliminary survey in mid-2009." See: http://www.aiaa.org/content.cfm?pageid=318&volume=47&issue=6&pu

	bid=25&paperid=48681
2010, Dec	I. de Pater, L.N. Fletcher, S. Pérez-Hoyos, et al., 2010, *Icarus*, 210, 722, "A multi-wavelength study of the 2009 impact on **Jupiter**: comparison of high resolution images from Gemini, Keck and ***HST***." See: http://adsabs.harvard.edu/abs/2010Icar..210..722D
2010, Dec	D. Morrison, 2010, *Proceedings American Philosophical Society*, 154 (4), 439, "Impacts and evolution: protecting **Earth** from asteroids." (Read also 13 November 2008.) See: http://www.amphilsoc.org/sites/default/files/1540404.pdf
2010, Dec	E.L. Wright, P.R.M. Eisenhardt, A.K. Mainzer, et al., 2010, *Astronomical Journal*, 140, No.6, "The ***Wide-Field Infrared Survey Explorer (Wise)***: mission description and initial on-orbit performance." See: http://iopscience.iop.org/article/10.1088/0004-6256/140/6/1868
2010, Dec 2	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**, *Information on research in the field of NEOs carried out by Member States, international organizations and other entities.* See: http://www.unoosa.org/pdf/reports/ac105/AC105_976E.pdf http://www.unoosa.org/pdf/limited/AC105_C1_2011_CRP12E.pdf
2010, Dec 5	Apollo NEA **2010 XC** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 4.47 LD. **Minimum miss distance 0 LD.** See: 2010 XC - SSA , 2010 XC - JPL
2010, Dec 7	S. Merikallio, P. Janhunen, 2010, *Astrophys. Space Sci. Trans.*, 6, 41, "Moving an asteroid with electric solar wind sail." Winning paper of the 2009 Space Generation Advisory Council *Move An Asteroid Competition*. See: http://www.astrophys-space-sci-trans.net/6/41/2010/astra-6-41-2010.pdf
2010, Dec 7	IAU announced the formation of a new **IAU Working Group on Near Earth Objects** under IAU Division III, created 1 October 2010. See: http://www.iau.org/science/news/119/ http://www.iau.org/science/scientific_bodies/working_groups/171/
2010, Dec 9	Apollo NEA **529668** (**2010 JL33**, *H* = 17.7 mag, *D* = 1000 m, **PHA**) passed Earth at a nominal miss distance of 16.6 LD. Minimum miss distance 16.6 LD.

	This asteroid, discovered on 6 May 2010 by the **Catalina Sky Survey**, is one of 14 new NEAs with $D > 1$ km discovered in this decade. Its rotation period $P = 9$ hr. Radar imaging at NASA's Goldstone Solar System Radar in the California desert was obtained on 11 and 12 December 2010. A video of the radar images was released by NASA on 11 January 2011. See: 2010 JL33 - SSA , 2010 JL33 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-011 http://www.nasa.gov/multimedia/videogallery/index.html?media_id=51265981 See also: http://adsabs.harvard.edu/abs/2018arXiv180208904Y
2010, Dec 10	W.F. Bottke, R.J. Walker, J.M.D. Day, et al., 2010, *Science*, 330, 1527, "Stochastic late accretion to Earth, the Moon, and Mars." See: http://adsabs.harvard.edu/abs/2010Sci...330.1527B
2010, Dec 10	L. David, 2010, *Space.com*, "U.S. military in talks to share **Fireball** data from secret satellites." See: http://www.space.com/news/military-satellites-fireball-data-talks-101210.html
2010, Dec 11	**Iran Fireball**. Intensely bright **fireball** meteor flashed on 11 December 2010 through the cold, clear, early morning skies over the Karkas Mountains in central Iran, near the peak of the annual **Geminid Meteor Shower**. See: http://apod.nasa.gov/apod/ap101217.html
2010, Dec 16	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS),** *Near-Earth objects, 2010-2011, Interim report of* ***Action Team 14 on Near-Earth Objects***. See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L308E.pdf
2010, Dec 21	L. David, 2010, *Space.com*, "Experts push for a NASA asteroid-hunting spacecraft." See: http://www.space.com/news/nasa-neo-asteroid-spacecraft-101221.html
2011, Jan 1	**7566 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, $H = 9.45$ mag, $D = 36.5$ km, Amor NEA), of which **1177 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis**, **1989 AC**, $H = 15.3$ mag, $D = 4.6 \times 2.4 \times 1.9$ km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2011	On NATO and Space Situational Awareness, related to space

	weather, space debris and Near Earth Objects. See: http://www.rta.nato.int/ACTIVITY_META.asp?ACT=SCI-229
2011, Jan	G. Cordero, A. Poveda, 2011, *Planetary and Space Science*, 59, 10, "**Curuça 1930**: A probable mini-**Tunguska**?" See also item of 13 August 1930. See: http://adsabs.harvard.edu/abs/2011P%26SS...59...10C
2011, Jan	J.L. Tonry, 2011, *Publ. Astron. Soc. Pacific*, 123, 58, "An early warning system for asteroid impact." See: http://adsabs.harvard.edu/abs/2011PASP..123...58T See also: http://fallingstar.com/ http://www.space.com/8986-asteroid-threat-early-warning-system-proposed.html http://www.space.com/9629-week-warning-asteroid-strike-simple-scientist.html
2011, Jan	J. Žižka, D. Vokrouhlický, 2011, *Icarus*, 211, 511, "Solar radiation pressure on (**99942**) **Apophis**." See: http://adsabs.harvard.edu/abs/2011Icar..211..511Z See also: http://content.usatoday.com/communities/sciencefair/post/2010/11/apophis-asteroid-2013/1
2011, Jan	G.S. Orton, L.N. Fletcher, P.W. Chodas, et al., 2011, *Icarus*, 211, 587, "The atmospheric influence, size and possible asteroidal nature of the **July 2009 Jupiter impactor**." See: http://adsabs.harvard.edu/abs/2011Icar..211..587O
2011, Jan 3	Aten NEA **2011 AE3 (**H = 26.9 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 2.22 LD. **Minimum miss distance 0 LD.** See: 2011 AE3 - SSA , 2011 AE3 - JPL
2011, Jan 11	Apollo NEA **2011 AM37** (H = 30.0 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2011-01]** See: 2011 AM37 - SSA , 2011 AM37 - JPL
2011, Jan 17	Apollo NEA **2011 AN52** (H = 28.4 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.83 LD. Minimum miss distance 0.83 LD. **[2011-02]** See: 2011 AN52 - SSA , 2011 AN52 - JPL
2011, Jan 20	Apollo NEA **2011 BY10** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.92 LD. **[2011-03]**

	See: 2011 BY10 - SSA , 2011 BY10 - JPL
2011, Jan 24-26	**Fourth NASA *Small Bodies Assessment Group* Meeting**, Washington (DC, USA). See: http://www.lpi.usra.edu/sbag/meetings/ http://www.lpi.usra.edu/sbag/meetings/jan2011/poster.pdf http://www.lpi.usra.edu/sbag/meetings/jan2011/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - M.V. Sykes, 2011, "Science and exploration of small bodies in the solar system." See: http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day1/d1_1030_panel_charge.pdf - J.A. Nuth, 2011, "Small body science issues." See: http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day2/d2_1345_Nuth.pdf - Y. Fernandez, 2011, "Roadmap: population identification and characterization." See: http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day2/d2_1430_Fernandez.pdf - T. Farnham, 2011, "***EPOXI*** results and future proposals for the spacecraft." See: http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day3/d3_1300_Farnham.pdf - M. Zolensky, 2011, "***Hayabusa*** update." See: http://www.lpi.usra.edu/sbag/meetings/jan2011/presentations/day3/d3_1330_Zolensky_Hayabusa.pdf
2011, Jan 25	Apollo NEA **2011 BW11** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.33 LD. **[2011-04]** See: 2011 BW11 - SSA , 2011 BW11 - JPL
2011, Jan 31	Apollo NEA **2011 CA4** (H = 27.0 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.64 LD. **[2011-05]** See: 2011 CA4 - SSA , 2011 CA4 - JPL
2011, Jan 31	Press release, Institute for Astronomy, University of Hawaii (HI, USA), 9 March 2011, "Hawaii astronomers keep tabs on asteroid **Apophis**." On January 31 University of Hawaii at Manoa astronomers used the UH 2.2-meter telescope on Mauna Kea to take the first new images in over three years of the potentially dangerous near-Earth asteroid **Apophis** as it emerged from behind the Sun. See: http://www.ifa.hawaii.edu/info/press-releases/Apophis2011Jan/

	http://www.space.com/11094-watching-asteroid-apophis-photo.html http://www.space.com/10047-collision-watch.html
2011, Feb	First light of the **DARPA Space Surveillance Telescope (SST)**. See: http://www.darpa.mil/program/space-surveillance-telescope http://www.defensenews.com/articles/bulgaria-amends-aircraft-tender-criteria-with-f-16-in-mind https://en.wikipedia.org/wiki/Space_Surveillance_Telescope
2011, Feb	S.G. Djorgovski, A.J. Drake, A.A. Mahabal, in: T. Mihara & N. Kawai (eds.), 2011, *The first year of MAXI: Monitoring Variable X-ray Sources*, Proc. International Conference, Aoyama (Tokyo, Japan) 30 November - 2 December 2010 (Tokyo: JAXA Special Publication), "The **Catalina Real-Time Transient Survey**". See: http://maxi.riken.jp/FirstYear/proceedings/procindex.html The **Catalina Sky Survey** for NEO detection and tracking has as by-product the **Catalina Real-time Transient Survey**: watching for transient events among the background stars and galaxies. The **CRTS** has collected 20 billion brightness measurements of 198 million stars and other objects, i.e. an average of 100 brightness measurements for each one. The objects range from 12.5 to 20 mag and span an area of just over half the celestial sphere. Ref.: - A.J. Drake, S.G. Djorgovski, A. Mahabal, et al., 2012, in: R.E.M. Griffin, R.J. Hanisch, R. Seaman (eds.), *New horizons in time-domain astronomy*, Proc. IAU Symposium No. 285 (Cambridge: CUP), p. 306, "The **Catalina Real-time Transient Survey**." See: http://adsabs.harvard.edu/abs/2012IAUS..285..306D See also: http://www.skyandtelescope.com/news/137519153.html http://crts.caltech.edu/ http://nesssi.cacr.caltech.edu/DataRelease/
2011, Feb	S.-P. Gong, J.-F. Li, Y.-F. Gao, 2011, *Research in Astronomy and Astrophysics*, 11, 205, "Dynamics and control of a solar collector system for near Earth object deflection." See: http://adsabs.harvard.edu/abs/2011RAA....11..205G
2011, Feb	T.V. Gudkova, Ph. Lognonné, J. Gagnepain-Beyneix, 2011, *Icarus*, 211, 1049, "Large impacts detected by the ***Apollo*** seismometers: impactor mass and source cutoff frequency estimations." See: http://adsabs.harvard.edu/abs/2011Icar..211.1049G
2011, Feb	M.M. Marinova, O. Aharonson, E. Asphaug, 2011, *Icarus*, 211, 960, "Geophysical consequences of planetary-scale impacts into a

	Mars-like planet." See: http://adsabs.harvard.edu/abs/2011Icar..211..960M
2011, Feb 1	NASA's ***NEOWISE*** (see 14 Dec 2009) mission completed its survey of asteroids and comets. The mission's discoveries of previously unknown objects include 20 comets, more than 33,000 main belt asteroids and 134 Near-Earth Asteroids. See: http://wise.ssl.berkeley.edu/ http://www.jpl.nasa.gov/news/news.php?release=2013-257 http://www.jpl.nasa.gov/news/news.php?release=2013-373 Ref: - A. Mainzer, J. Bauer, T. Grav, et al., 2011, *Astrophysical Journal*, 731, 53, "Preliminary results from ***NEOWISE***: an enhancement to the ***Wide-field Infrared Survey Explorer*** for Solar System science." See: http://adsabs.harvard.edu/abs/2011ApJ...731...53M - A. Mainzer, T. Grav, J. Masiero, et al., 2012, *Astrophysical Journal*, 752, 110, "Characterizing subpopulations within the Near Earth Objects with ***NEOWISE***: preliminary results." See: http://adsabs.harvard.edu/abs/2012ApJ...752..110M See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-031 http://www.space.com/10735-asteroid-survey-space-rocks-comets.html http://www.jpl.nasa.gov/news/news.cfm?release=2011-117&cid=release_2011-117&msource=11117&tr=y&auid=8164024 http://www.jpl.nasa.gov/video/index.cfm?id=935
2011, Feb 4, 19:39	Aten NEA **2011 CQ1** (H = 31.9 mag, $D \approx$ 1.5 m) passed Earth at a nominal miss distance of 0.031 LD **(= 1.86 R_{Earth} from the geocenter)** over the mid-Pacific. Minimum miss distance 0.031 LD. **[2011-06]** This object is the closest non-impacting object in the **Minor Planet Center** asteroid catalog to date. Prior to the Earth close approach, this object was in a so-called Apollo-class orbit that was mostly outside the Earth's orbit. Following the close approach, the Earth's gravitational attraction modified the object's orbit to an Aten-class orbit where the asteroid spends almost all of its time inside the Earth's orbit. See: 2011 CQ1 - SSA , 2011 CQ1 - JPL See also: http://neo.jpl.nasa.gov/news/news170.html http://www.space.com/10927-asteroid-2011cq1-record-close-pass-earth.html See also: http://neo.ssa.esa.int/newsletters [June 2020] http://en.wikipedia.org/wiki/2011_CQ1

2011, Feb 4, 23:08	Aten NEA **2011 CH22** (*H* = 27.1 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 3.29 LD. **Minimum miss distance 0 LD**. See: 2011 CH22 – SSA , 2011 CH22 – JPL
2011, Feb 4	**February Eta Draconids**. A meteor outburst was detected in **Cameras for Allsky Meteor Surveillance (CAMS)** February 4 data, obtained at the Fremont Peak (Rick Morales, Loren Dynneson, et al.) and Mountain View (Peter Jenniskens) stations. This is the first new shower discovered by **CAMS**. It is also a very unusual shower, of a type that only occurs once or twice every sixty years and is caused by the dust trail of a (still to be discovered) **Potentially Hazardous long-period Comet**. The new shower was named the **February Eta Draconids** and is now listed as shower 427 in the **IAU Working List of Meteor Showers**. Ref: - P. Jenniskens, P.S. Gural, 2011, *WGN, Journal of the International Meteor Organization*, 39, 93, "Discovery of the **February Eta Draconids** (**FED, IAU#427**): the dust trail of a potentially hazardous long-period comet." See: http://www.imo.net/imo/wgn See also: http://cams.seti.org/FED.pdf http://cams.seti.org/ http://cams.seti.org/CBET2763.txt http://www.astro.amu.edu.pl/~jopek/MDC2007/Roje/roje_lista.php?corobic_roje=0&sort_roje=0 http://www.space.com/12450-unknown-comet-earth-threat-meteor-shower-evidence.html
2011, Feb 6	Apollo NEA **2011 CF22** (*H* = 30.9 mag, *D* ≈ 2.4 m) passed Earth at a nominal miss distance of 0.105 LD **(= 6.31 R_{Earth} from the geocenter)**. Minimum miss distance 0.092 LD. **[2011-07]** See: 2011 CF22 - SSA , 2011 CF22 - JPL
2011, Feb 7	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**, *Information on research in the field of NEOs carried out by Member States, international organizations and other entities*. See: http://www.unoosa.org/pdf/limited/AC105_C1_2011_CRP12E.pdf
2011, Feb 8	C. Kazan, 2011, *Daily Galaxy*, 8 February 2011, "Tracking the realtime threat of near-Earth asteroids & comets – could it save the planet?" See: http://www.dailygalaxy.com/my_weblog/2011/02/tracking-the-realtime-threat-of-near-earth-asteroids-will-it-save-the-planet.html

2011, Feb 9	Apollo NEA **2011 CA7** (*H* = 30.3 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[2011-08]** See: 2011 CA7 - SSA , 2011 CA7 - JPL See also: http://www.scientificamerican.com/blog/post.cfm?id=record-setting-near-miss-of-earth-d-2011-02-10 http://www.space.com/10800-car-size-asteroid-passing-earth.html
2011, Feb 14	NASA's ***Stardust-NExT*** spacecraft flew by comet **Temple 1**. See: http://stardustnext.jpl.nasa.gov/ http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-053 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-054 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-056 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-094 http://stardustnext.jpl.nasa.gov/mission/lastdrop/html
2011, Feb 14	NASA announces Fiscal Year 2012 Budget. Funds for NEO observations would quadruple to US $20.4 million. See: http://www.nasa.gov/news/budget/index.html http://news.sciencemag.org/scienceinsider/2011/02/climate-science-asteroid-detection.html?ref=ra
2011, Feb 14-16	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 48th Session, WG NEO and Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico), meets in Vienna (Austria). **Report:** http://www.unoosa.org/oosa/en/COPUOS/stsc/2011/index.html http://www.unoosa.org/pdf/reports/ac105/AC105_987E.pdf **Statements:** Thomas D. Jones, chair, ASE Committee on Near-Earth Objects, Statement by the Association of Space Explorers, <http://…>. **Technical presentations:** - A. Grovas (Mexico), "First scientific light of the GMT, millimetric telescope". See: http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-32.pdf - W. Ailor (**IAA**), "Planetary Defense Conferences: sharing information on NEO threats and mitigation". See: http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-36.pdf - T. Jones (**ASE**), "Results from the Near-Earth Objects Mission Planning and Operations Group workshop". See: http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-38.pdf

	- D. Yeomans (USA), "**Spaceguard program**". See: http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-42.pdf - T. Yamada (Japan), "Dawn of the age of solar system exploration – ***Hayabusa***, ***Ikaros***, and future ". See http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-45.pdf - B. Shustov (Russian Federation), "Towards national near-Earth objects program". See: http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-47.pdf
2011, Feb 15	P. Tanga, 2011, in: C. Turon, F. Meynadier & F. Arenou (eds.), Proc. International Conference ***Gaia****: at the frontiers of astrometry*, 7-11 June 2010, Sèvre (France), *ESA Publication Series*, 45, 225, "Solar System science: ***Gaia*** and other forthcoming surveys." See: http://adsabs.harvard.edu/abs/2011EAS....45..225T See also: http://wwwhip.obspm.fr/gaia2010/IMG/pdf/Abstract_booklet.pdf http://www.eas-journal.org/index.php?option=com_article&access=doi&doi=10.1051/eas/1045038&Itemid=129
2011, Feb 18	R.A. Kerr, 2011a, *Science*, 331, 841, "NASA weighs asteroids: cheaper than Moon, but still not easy." See: http://adsabs.harvard.edu/abs/2011Sci...331..841K
2011, Feb 18	R.A. Kerr, 2011b, *Science*, 331, 843, "A windfall for defenders of the planet." See: http://adsabs.harvard.edu/abs/2011Sci...331..843K
2011, Feb 22	**Open Global Community NEO Workshop *Target NEO: Providing a resilient NEO accessibility program for human exploration beyond low Earth orbit***, 22 February 2011, George Washington University, School of Media and Public Affairs, Washington, DC (USA). See: http://targetneo.jhuapl.edu/ http://targetneo.jhuapl.edu/sessions.html http://www.space.com/11189-nasa-asteroid-choice-astronauts-deep-space.html **Final report:** http://targetneo.jhuapl.edu/pdfs/2013_Presentations/TargetNEO2WorkshopReport.pdf **Some of the presentations:** - T. Jones, 2011, "NEO search reduces risk". - T.B. Spahr, 2011, "**Minor Planet Center**, operations and update." - D.K. Yeomans, 2011, "Precision NEO orbit prediction at JPL." - J.S. Stuart, 2011, "Searching for asteroids." - A. Mainzer, 2011, "Space-based NEO detection and tracking: ***NEOWISE*** and beyond."

	- A.W. Harris, 2011, "NEO population." - P. Michel, 2011, "Physical properties of NEOs from observations, and their influence for the design of a human mission." - L. Benner, 2011, "**Arecibo** and **Goldstone** radar characterization of NEO mission targets." - J.A. Nuth, 2011, "Do we really understand the rocks that astronauts might be visiting." - D.J. Scheeres, P. Sánchez, 2011, "Can small, fast spinning asteroids be rubble piles?" - A. Cheng, 2011, "NEO orbit simulation approach." - L. Jones, 2011, "NEO detection capabilities of **LSST**." - K. Hibbard, 2011, "***Near-Earth Survey Telescope*** (***NEST***). Human robotic precursor mission concept." - A. Mainzer, 2011, "Next-generation space-based IR NEO surveys." - R. R. Arentz, 2011, "A candidate NEO survey mission for affordable human spaceflight target assurance."
2011, Feb 23	Apollo NEA **2011 DU9** (H = 26.5 mag, $D \approx$ 18 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2011-09]** See: 2011 DU9 - SSA , 2011 DU9 - JPL
2011, Feb 25	ESA selected four candidates for a medium-class mission within the Cosmic Vision programme that will launch in the period 2020-22 for an initial Assessment Phase study. Among these candidates is ***Marco Polo-R***, a sample return mission to a Near Earth Asteroid. See: http://www.oca.eu/MarcoPolo-R/ Ref: - M.A. Barucci, M. Yoshikawa, P. Michel, et al., 2009, *Experimental Astronomy*, 23, 785, "***Marco Polo***: near earth object sample return mission." See: http://adsabs.harvard.edu/abs/2009ExA....23..785B - P. Michel, A. Barucci, D. Koschny, et al., 2009, in: Proc. *72nd Annual Meeting of the Meteoritical Society*, 13-18 July 2009, Nancy (France), *Meteoritics and Planetary Science Supplement,* p.5261, "***Marco Polo***: a sample return mission to a primitive Near-Earth Object in assessment study in the ESA program Cosmic Vision 2015-2025." See: http://adsabs.harvard.edu/abs/2009M%26PSA..72.5261M - J. de León, T. Mothé-Diniz, J. Licandro, et al., 2011, *Astronomy & Astrophysics*, 530, id.L12, "New observations of asteroid (**175706**) **1996 FG3**, primary target of the ESA ***Marco Polo-R mission***." See: http://adsabs.harvard.edu/abs/2011A%26A...530L..12D - M.A. Barucci, A.F. Cheng, P. Michel, et al., 2012, *Experimental Astronomy,* 33, 645, "***MarcoPolo-R*** near earth asteroid sample

	return mission." See: http://adsabs.harvard.edu/abs/2012ExA....33..645B - M.A. Barucci, P. Michel, A. Cheng, et al., 2012, LPI Contribution No. 1659, p.1457, "***MarcoPolo-R***: Near Earth Asteroid sample return mission selected for ESA assessment study phase." See: http://adsabs.harvard.edu/abs/2012LPI....43.1457B - R.P. Binzel, D. Polishook, F.E. DeMeo, et al., 2012, LPI Contribution No. 1659, p.2222, "***Marco Polo-R*** target asteroid (**175706**) **1996 FG3**: possible evidence for an annual thermal wave." See: http://adsabs.harvard.edu/abs/2012LPI....43.2222B - A.S. Rivkin, E.S. Howell, F.E. DeMeo, et al., 2012, LPI Contribution No. 1659, p.1537, "New observations and proposed meteorite analogs of the ***MarcoPolo-R*** target asteroid (**175706**) **1996 FG3**." See: http://adsabs.harvard.edu/abs/2012LPI....43.1537R - K.J. Walsh, M. Delbo, M. Mueller, R.P. Binzel, F.E. DeMeo, 2012, *Astrophysical Journal*, 748, 104, "Physical characterization and origin of binary Near-Earth Asteroid (**175706**) **1996 FG3**." See: http://adsabs.harvard.edu/abs/2012ApJ...748..104W - L.A.M. Benner, M. Brozovic, J.D. Giorgini, et al., 2012, American Astronomical Society, DPS meeting #44, #102.06, "**Arecibo** and **Goldstone** Radar Observations of binary Near-Earth Asteroid and ***Marco Polo-R*** mission target (**175706**) **1996 FG3**." See: http://adsabs.harvard.edu/abs/2012DPS....4410206B - C. Lantz, E. Dotto, M.A. Barucci, et al., 2012, American Astronomical Society, DPS meeting #44, #215.02, "The European sample return mission ***MarcoPolo-R***: understanding the nature of extraterrestrial primitive materials and tracing the origins." See: http://adsabs.harvard.edu/abs/2012DPS....4421502L See also: http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=48467 http://smass.mit.edu/MarcoPolo/home.html http://www.oca.eu/MarcoPolo-R/Workshops/WorkshopsMarcoPolo-R.html
2011, Feb 26	Apollo NEA **367789** (**2011 AG5**, *H* = 22.0 mag, *D* ≈ 140 m, **PHA**) passed Earth at a nominal miss distance of 37.2 LD. Minimum miss distance 37.2 LD. See: 367789 2011 AG5 - SSA , 2011 AG5 - JPL See also: http://en.wikipedia.org/wiki/2011_AG5 See also: **3 Feb 2023**, **4 Feb 2040**.
2011, Feb 27	C.Y. Johnson, 2011, *The Boston Globe*, 27 February 2011, "Just another asteroid hurtling toward Earth ... ." See:

	http://www.boston.com/news/science/articles/2011/02/27/local_scientists_study_asteroids_for_clues_potential_threats/
2011, Feb 28	T. Friend, 2011, *The New Yorker*, 28 February 2011, p. 22, "Vermin of the sky." See: http://www.newyorker.com/reporting/2011/02/28/110228fa_fact_friend
2011, Mar	M. Delbò, K. Walsh, M. Mueller, A.W. Harris, E.S. Howell, 2011, *Icarus*, 212, 138, "The cool surfaces of binary near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2011Icar..212..138D
2011, Mar	S.K. Fieber-Beyer, M.J. Gaffey, P.A. Abell, 2011, *Icarus*, 212, 149, "Mineralogical characterization of near-Earth Asteroid (**1036**) **Ganymed**." See: http://adsabs.harvard.edu/abs/2011Icar..212..149F
2011, Mar	M. Fischetti, 2011, *Scientific American*, 304, 80, "Death by asteroid." See: http://www.nature.com/scientificamerican/journal/v304/n3/full/scientificamerican0311-80.html
2011, Mar	A.W. Harris, M. Mommert, J.L. Hora, et al., 2011, *Astronomical Journal*, 141, 75, "ExploreNEOs. II. The accuracy of the ***Warm Spitzer*** **Near-Earth Object Survey**." See: http://adsabs.harvard.edu/abs/2011AJ....141...75H See also: https://www.jpl.nasa.gov/news/news.php?feature=7575
2011, Mar	V. Reddy, A. Nathues, M.J. Gaffey, 2011, *Icarus*, 212, 175, "First fragment of **asteroid 4 Vesta**'s mantle detected." The fragment is NEA (**237442**) **1999 TA10** (H = 17.9 mag, $D \approx$ 900 m). See: http://adsabs.harvard.edu/abs/2011Icar..212..175R See also: http://www.mpg.de/877913/Pressrelease20110106 http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=1999+TA10+&orb=1 http://en.wikipedia.org/wiki/(237442)_1999_TA10
2011, Mar 1	NASA's ***Mars Exploration Rover Opportunity*** has nearly completed its three-month examination of an impact crater on Mars informally named "**Santa Maria**", but before the rover resumes its overland trek, an orbiting camera has provided a color image of ***Opportunity*** beside **Santa Maria**. The High Resolution Imaging Science Experiment (HiRISE) camera on NASA's ***Mars Reconnaissance Orbiter*** acquired the image on March 1. **Santa Maria** crater is ~ 90 m in diameter.

	See: http://www.jpl.nasa.gov/news/news.cfm?release=2011-072&cid=release_2011-072&msource=11072&tr=y&auid=7906048
2011, Mar 2	NASA established a network of smart cameras to keep a robotic vigil on the roughly 100 tons of meteoroids that slam into Earth every day. The cameras are operated by the NASA **All-sky Fireball Network** of the NASA **Meteoroid Environment Office**, established in October 2004. See: http://fireballs.ndc.nasa.gov/ http://www.nasa.gov/offices/meo/home/aboutMEO-rd.html http://www.space.com/11010-nasa-tracks-meteor-fireballs-robot-cameras.html
2011, Mar 3	Apollo NEA **2011 EN11** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.64 LD. **[2011-10]** See: 2011 EN11 - SSA , 2011 EN11 - JPL
2011, Mar 4	ESA *Space Science News*, 4 March 2011, "The scars of impacts on **Mars**." See: www.esa.int/esaSC/SEMTK5VTLKG_index_0.html
2011, Mar 7	Apollo NEA **2011 EY11** (H = 28.6 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2011-11]** See: 2011 EY11 - SSA , 2011 EY11 - JPL
2011, Mar 7-11	***42nd Lunar and Planetary Science Conference***, 7-11 March 2011, The Woodlands (TX, USA). See: http://www.lpi.usra.edu/meetings/lpsc2011/ **Among the presentations:** - R.P. Binzel, F.E. DeMeo, M. Lockhart, et al., 2011, LPI Contribution No. 1608, p.2226, "Spectral reconnaissance for 200 Near-Earth Object mission targets." See: http://adsabs.harvard.edu/abs/2011LPI....42.2226B - F.E. DeMeo, R.P. Binzel, 2011, LPI Contribution No. 1608, p.2055, "SMASS-Next: A next generation asteroid spectroscopic survey." See: http://adsabs.harvard.edu/abs/2011LPI....42.2055D
2011, Mar 8	Apollo NEA **2011 EM40** (H = 27.9 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.63 LD. **[2011-12]** See: 2011 EM40 - SSA , 2011 EM40 - JPL
2011, Mar 16	Aten NEA **2011 EB74** (H = 26.9 mag, $D \approx$ 15 m) passed Earth at a

	nominal miss distance of 0.85 LD. Minimum miss distance 0.58 LD. **[2011-13]** See: 2011 EB74 - SSA , 2011 EB74 - JPL See also: http://www.space.com/11145-small-asteroid-2011eb74-passing-earth.html
2011, Mar 30	J. Matson, 2011, *Scientific American*, 30 March 2011, "Which near-Earth asteroids are ripe for a visit?" See: http://blogs.scientificamerican.com/observations/2011/03/30/which-near-earth-asteroids-are-ripe-for-a-visit/
2011, Mar-Apr	G.L. Matloff, M. Wilga, 2011, *Acta Astronautica*, 68, 599, "NEOs as stepping stones to Mars and main-belt asteroids." See: http://adsabs.harvard.edu/abs/2011AcAau..68..599M
2011, Apr	M.W. Busch, S.J. Ostro, L.A.M. Benner, et al., 2011, *Icarus*, 212, 649, "Radar observations and the shape of Near-Earth Asteroid **2008 EV5**." See: http://adsabs.harvard.edu/abs/2011Icar..212..649B Corrigendum: https://ui.adsabs.harvard.edu/abs/2019Icar..333..548B/abstract
2011, Apr	S.R. Chesley, 2011, *Bulletin of the American Astronomical Society*, 43, 2011, "Asteroid impact hazard assessment over Long time intervals." See: http://adsabs.harvard.edu/abs/2011DDA....42.0601C
2011, Apr	M. Mueller, M. Delbò, J.L. Hora, et al., 2011, *Astronomical Journal*, 141, 109, "ExploreNEOs. III. Physical characterization of 65 potential spacecraft target asteroids." See: http://adsabs.harvard.edu/abs/2011AJ....141..109M See also: http://www.scientificamerican.com/blog/post.cfm?id=which-near-earth-asteroids-are-ripe-2011-03-30
2011, Apr 5	A. Mann, 2011, *Nature*, 472, 16. "NASA human space-flight programme lost in transition." See: http://www.nature.com/news/2011/110405/full/472016a.html
2011, Apr 6, 04:54	Apollo NEA **2011 GW9** (H = 28.4 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2011-14]** See: 2011 GW9 - JPL , 2011GW9 - SSA
2011, Apr 6, 19:38	Apollo NEA **2011 GP28** (H = 29.7 mag, $D \approx$ 4 m) passed Earth at

	a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2011-15]** See: 2011 GP28 - SSA , 2011 GP28 - JPL
2011, Apr 7	E. Lu, 2011, *Nature*, 472, 28, "Deflect risky asteroids." Embedded in article "NASA: what now?" *Nature*, 472, 27-29. See: http://adsabs.harvard.edu/abs/2011Natur.472R..28L
2011, Apr 10	A. Mainzer, J. Bauer, T. Grav, et al., 2011, *Astrophysical Journal*, 731, 53, "Preliminary results from ***NEOWISE***: an enhancement to the ***Wide-field Infrared Survey Explorer*** for Solar System science." See: http://adsabs.harvard.edu/abs/2011ApJ...731...53M See also: http://apod.nasa.gov/apod/ap111001.html
2011, Apr 15	R.E. Kerr, 2011, *Science*, 332, 302, "Asteroid model shows early life suffered a billion-year battering." Report on presentation at *Lunar and Planetary Science Conference*, 7-11 March 2011, The Woodlands (TX, USA). See: http://www.sciencemag.org/content/332/6027/302.1.summary
2011, Apr 15	R.E. Kerr, 2011, *Science*, 332, 302, "Prime science achieved at asteroid." Report on **Itokawa** particles returned by ***Hayabusa***, presented at *Lunar and Planetary Science Conference*, 7-11 March 2011, The Woodlands (TX, USA). See: http://www.sciencemag.org/content/332/6027/302.2.summary
2011, Apr 15	Aten NEA **2011 GP59** (H = 24.5 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 1.39 LD. Minimum miss distance 1.39 LD. $P_{rot} \approx$ 7.5 min and blinking. See: 2011 GP59 - SSA , 2011 GP59 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-118 http://www.youtube.com/watch?v=O7wsAZNr56E
2011, Apr 19	Asteroid **2006 HF6** (H = 24.6 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 3.58 LD. Minimum miss distance 0.94 LD. See: 2006 HF6 - SSA , 2006 HF6 - JPL
2011, Apr 25	Apollo NEA **2011 JA**, H = 21.2 mag, $D \approx$ 210 m, **PHA**) passed Earth at a nominal miss distance of 1.62 LD. Minimum miss distance 1.62 LD. See: 2011 JA- JPL , 2011 JA- SSA

2011, May	O. Abramov, S.J. Mojzsis, 2011, *Icarus*, 213, 273, "Abodes for life in carbonaceous asteroids?" See: http://adsabs.harvard.edu/abs/2011Icar..213..273A
2011, May	J. Fang, J.-L. Margot, M. Brozovic, et al., 2011, *Astronomical Journal*, 141, 154, "Orbits of Near-Earth Asteroid triples **2001 SN263** and **1994 CC**: properties, origin, and evolution." See: http://adsabs.harvard.edu/abs/2011AJ....141..154F See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2259 http://en.wikipedia.org/wiki/(136617)_1994_CC
2011, May	C.I. Fassett, S.J. Kadish, J.W. Head, et al., 2011, *Geophysical Research Letters*, 38(10), L10202, "The global population of large craters on Mercury and comparison with the Moon." See: http://adsabs.harvard.edu/abs/2011GeoRL..3810202F
2011, May	S. Mouret, F. Mignard, 2011, *Monthly Notices Royal Astronomical Society*, 413, 741, "Detecting the Yarkovsky effect with the ***Gaia*** mission: list of the most promising candidates." See: http://adsabs.harvard.edu/abs/2011MNRAS.413..741M
2011, May 5	NASA announces the selection of proposals for technology development, including ***NEOCam***, an infrared telescope operating at the L1 Lagrange point to study the origin and evolution of NEOs and study the present risk of Earth-impact. It would generate a catalog of objects and accurate infrared measurements to provide a better understanding of small bodies that cross our planet's orbit. Amy Mainzer of JPL is principal investigator. ***NEOCam***, a 50 cm diameter telescope operating at two heat-sensing infrared wavelengths will carry out a four year baseline survey to find 2/3 of the near-Earth objects larger than 140 m (large enough to cause major regional damage in the event of an Earth impact). By using two heat-sensitive infrared imaging channels, ***NEOCam*** can make accurate measurements of NEO sizes and can gain valuable information about their composition, shapes, rotational states, and orbits. See: http://discovery.nasa.gov/news/index.cfml?ID=1034 http://neocam.ipac.caltech.edu/ See also: http://blogs.discovermagazine.com/badastronomy/2012/06/28/privately-and-publicly-looking-for-earth-threatening-asteroids/ http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-135 http://neocam.ipac.caltech.edu/news/tracking-sensor-passes-test https://www.lpi.usra.edu/sbag/findings/index.shtml#jan2018

2011, May 5	Apollo NEA **2011 JV10** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD. **[2011-16]** See: 2011 JV10 - SSA , 2011 JV10 - JPL
2011, May 9-12	***2011 IAA Planetary Defense Conference, From Threat to Action***, Bucharest (Romania), 9-12 May 2011, sponsored by ESA, NASA and, *inter alia,* the IAU. See: http://pdc.iaaweb.org/?q=content/2011-bucharest http://www.congrex.nl/11C03/pages/standaard/PDC_2011_White_Paper.pdf http://www.nss.org/resources/library/planetarydefense/WhitePaper-2009PlanetaryDefenseConference.pdf http://iaaweb.org/content/view/426/589/ http://alcohol.44cent.com/en/planetary-defense-conference-to-consider-response-to-earth-impacting-threat/ http://www.planetary.org/blog/article/00003026/ http://www.planetary.org/blog/article/00003028/ http://ieet.org/index.php/IEET/more/sandberg20110513 **Conference report:** http://iaaweb.org/iaa/Scientific%20Activity/pdc2011.pdf **Presentations:** http://www.congrex.nl/11C03/papers.zip **Session 1** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session1.htm): - D. Morrison, "Historical overview of the cosmic impact hazard." - R. Crowther, R. Tremayne-Smith, "Responding to the Near Earth Object (NEO) impact threat through appropriate policy initiatives." - A.W. Harris, and the **NEOShield** Consortium, "A global approach to near-Earth object impact threat mitigation." See also: http://elib.dlr.de/70019/ Report on the international **NEOShield** project to address impact hazard mitigation issues, contained in a proposal to the European Commission FP7 Space Programme Call 2011, entitled *Prevention of impacts from near-Earth objects on our planet*. **Session 2** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session2.htm): - A.W. Harris, 2011, "Update of estimated NEO population and current survey completion." - D.K. Yeomans, A.B. Chamberlin, 2011, "Comparing the Earth impact flux from comets and near-Earth asteroids." - R. Wainscoat, R. Jedicke, L. Denneau, et al., 2011, "The **Pan-STARRS** search for Near Earth Asteroids: present status and future plans." - D. Hestroffer, D. Bancelin, W. Thuillot, P. Tanga, 2011, "***Gaia***

	Astrometry of Near-Earth Objects." - A. Hildebrand, B. Gladman, E.F. Tedesco, et al., 2011, "***The Near Earth Object Surveillance Satellite*** (***NEOSSat***) will search near-Sun along the ecliptic plane to efficiently discover objects of the Aten and Atira orbital classes." - P.A. Abell, R.G. Mink, J.B. Garvin, et al., 2011, "A space-based ***Near-Earth Object Survey Telescope*** in support of human exploration, solar system science, and planetary defense." **Session 3** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session3.htm): - P. Michel, 2011, "Physical properties of Near-Earth Objects that inform mitigation." - A. Mainzer, J. Bauer, T. Grav, et al., 2011, "***NEOWISE*** – an infrared view of NEOs and the solar system." - L. Benner, L.A.M. Benner, 2011, "Radar tracking and Near-Earth Object characteristics." - A. Milani, F. Bernardi, D. Farnocchia, G.B. Valsecchi, 2011, "**1999 RQ36** impact risk and modeling the long-term Yarkovsky effect." - S. Chesley, 2011, "Asteroid impact hazard assessment over long time intervals." **Session 4** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session4.htm): - G. Longo, L. Gasperini, E. Bonatti, et al., 2011, "Consequences of the **Tunguska** impact and their interpretation." - M.O. Mueller, 2011, "Creating awareness – the impact hazard in public education. Curricula content, students' interests and concepts and educational implementation." - M. Boslough, 2011, "Airburst warning and response." - G.R. Gisler, 2011, "Calculation of the impact of a small asteroid on a continental shelf." - D. Isvoranu, S. Danaila, V. Badescu, 2011, "Dynamics of tsunamis generated by asteroid impact in the Black Sea." - L. Ferrier, J.-L. Vérant, J.-M. Moschetta, et al., 2011, "The protective role of the Earth's atmosphere against the threat of asteroids." **Session 5** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session5.htm): - J.T. Grundmann, S. Mottola, M. Drentschew, et al., 2011, "**AsteroidSquads/*i*SSB** – a synergetic NEO deflection campaign and mitigation effects test mission scenario." - A. Zimmer, E. Messerschmid, 2011, "Target selection and mission analysis of human exploration missions to near-earth asteroids." - Y. Sugimoto, G. Radice, J.P. Sanchez, 2011, "Effects of NEO

	composition on deflection methodologies." - C. Foster, J. Bellerose, D. Mauro, J. Belgacem, 2011, "Mission concepts and operations for asteroid mitigation involving multiple ***Gravity Tractors***." - N. Melamed, 2011, "Development of a handbook and an on-line tool on defending Earth against potentially hazardous objects." - A. Galvez, I. Carnelli, 2011, "ESA asteroid mission studies: what have we learnt?" - S. Wagner, B. Wie, 2011, "Robotic and human exploration/deflection mission design for asteroid **99942 Apophis**." - X. Zhang, C. Granier, E. Ball, L. Kochmanski, S.D. Howe, 2011, "Near Earth Object interception using nuclear thermal rocket propulsion." **Session 6** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session6.htm): - K. Housen, K.A. Holsapple, 2011, "Measuring the momentum transfer for asteroid deflections." - O. Golubov, Y.N. Krugly, 2011, "Influence of intermediate-scale structures on Yarkovsky and YORP effect." - A. Klesh, T. Yoshimitsu, T. Kubota, 2011, "Improved navigation techniques for asteroid landers and impactors." - J. Gil-Fernandez, R. Cadenas, T. Prieto, D. Escorial, 2011, "Design options for NEO missions." - C.S. Plesko, R.P. Weaver, W.F. Huebner, 2011, "Numerical models of hazard mitigation by nuclear stand-off burst." - M. Bruck, D.S.P. Dearborn, 2011, "Limits on the use of nuclear explosives for asteroid deflection." - B. Wie, 2011, "Hypervelocity nuclear interceptors for asteroid deflection or disruption." - J. Bellerose, C. Foster, D. Mauro, B. Jaroux, 2011, "***Gravity tractor*** strategies for deflecting a binary asteroid system." - V.P. Friedensen, P. Abell, B. Drake, 2011, "Meeting objectives for human exploration of Near-Earth Asteroids: first steps in understanding how to explore." - C. Bombardelli, J. Peláez, E. Ahedo, et al., 2011, "The ion beam shepherd: a new concept for asteroid deflection." **Session 7** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session7.htm): - A. Gibbings, J.-M. Hopkins, D. Burns, M. Vasile, 2011, "On testing laser ablation processes for asteroid deflection." - M. Micheli, D.J. Tholen, G.T. Elliott, 2011, "Detecting radiation pressure on NEOs: the case of **2009 BD**." - C. Norlund, H.G. Lewis, P.M. Atkinson, J.Y. Guo, 2011, "**NEOMiSS**: A Near Earth Object decision support tool."

	- D. Farnocchia, F. Bernardi, A. Milani, 2011, "The performances of a wide survey on a population of impactors." - D. Bancelin, W. Thuillot, D. Hestroffer, 2011, "Near Earth Asteroids orbits from ***Gaia*** and ground-based observations." - B. Kaplinger, B. Wie, D. Dearborn, 2011, "Nuclear fragmentation/dispersion modeling and simulation of hazardous Near-Earth Objects." - N.K. Mishra, G. Patel, 2011, "Development of mission design process for collision avoidance of Near Earth Objects." **Session 8** (see also http://www.congrex.nl/11C03/docs/11C03_Planetary_Defense/session8.htm): - B.Shustov, Yu.Makarov, 2011, "Towards national NEO program."
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2011, Jun	J. de Léon, T. Mothé-Diniz, T. Licandro, et al., 2011, *Astronomy & Astrophysics*, 530, L12, "New observations of asteroid (**175706**) **1996 FG3**, primary target of the ESA ***Marco Polo-R*** mission." See: http://adsabs.harvard.edu/abs/2011A%26A...530L..12D
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2011, Jun	F. Usui, D. Kuroda, T.G. Mueller, 2011, *Publications Astronomical Society of Japan*, 63, 1117, "Asteroid catalog using ***AKARI***: the ***AKARI*/IRC Mid-infrared Asteroid Survey**." 58 NEAs detected in survey of 5120 objects. See: http://adsabs.harvard.edu/abs/2011PASJ...63.1117U
2011, Jun 1-10	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS, 54th session) and Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico), did meet in Vienna (Austria). See: http://www.oosa.unvienna.org/oosa/en/COPUOS/index.html **Technical presentation:** - W. Ailor, 2011, Summary of the ***2011 IAA Planetary Defense Conference***. See: http://www.oosa.unvienna.org/pdf/pres/copuos2011/tech-27.pdf
2011, Jun 2	Apollo NEA **2009 BD** (H = 28.6 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD **[2011-17]** See: 2009 BD - SSA , 2009 BD - JPL Ref: - M. Micheli, D.J. Tholen, G.T. Elliott, 2012, *New Astronomy*, 17, 446, "Detection of radiation pressure acting on **2009 BD**." See: http://adsabs.harvard.edu/abs/2012NewA...17..446M - J. Foust, 2013, *thespacereview.com*, 22 April 2013, "To catch a planetoid." See: http://www.thespacereview.com/article/2283/1 - M. Mommert, J.L. Hora, D. Farnocchia, et al., May 2014, *Astrophysical Journal*, 786, 148, "Constraining the physical properties of Near-Earth Object **2009 BD**." See: http://adsabs.harvard.edu/abs/2014ApJ...786..148M See also: https://en.wikipedia.org/wiki/2009_BD

2011, Jun 8	First images from the ESO **VLT Survey Telescope (VST)**. See: http://www.eso.org/public/news/eso1119/ http://www.eso.org/public/teles-instr/surveytelescopes.html
2011, Jun 9-10	**ESA Workshop *Scientific and technological aspects of a sample return mission to a Near Earth Asteroid: the ESA Cosmic Vision M3 mission MarcoPolo-R***, ESA-ESRIN, Frascati (Italy). ***MarcoPolo-R*** is a sample return mission to a NEA, selected by ESA as part of its Cosmic Vision M3 programme for an assessment study with launch in 2020-2022. See: http://www.oa-roma.inaf.it/MarcoPolo-R/MarcoPolo-R/Home.html
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2011, Jun 11	Apollo NEA **2016 LY10** (H = 28.5 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 1.84 LD. Minimum miss distance 0.82 LD. See: 2016LY10 - SSA , 2016 LY10 - JPL
2011, Jun 13-16	**Workshop on *Very Wide Field Surveys in the Light of Astro2010***, Baltimore (MD, USA). See: http://widefield2011.pha.jhu.edu/ http://www.stsci.edu/institute/conference/verywidefield
2011, Jun 15	B. Schmitz, P.R. Heck, C. Alwmark, et al., 2011, *Earth and Planetary Science Letters*, 306 (3-4), 149, "Determining the impactor of the **Ordovician Lockne crater**: oxygen and neon isotopes in chromite versus sedimentary PGE signatures." See: http://adsabs.harvard.edu/abs/2011E%26PSL.306..149S
2011, Jun 15	Apollo NEA **530520** (**2011 LT17**, H = 21.6 mag, $D \approx$ 170 m, **PHA**) passed Earth at a nominal miss distance of 4.64 LD. Minimum miss distance 4.64 LD. See: 2011 LT17 - JPL , 2011 LT17 - SSA See also: **16 Jun 2155**, **16 Dec 2156**.
2011, Jun 27	C.A.L. Bailer-Jones, 2011, *Monthly Notices Royal Astronomical Society*, 416, 1163, "Bayesian time series analysis of terrestrial impact cratering." See: http://adsabs.harvard.edu/abs/2011MNRAS.416.1163B

	See also: http://www.spacedaily.com/reports/Earth_Impacts_More_Likely_in_the_Past_or_Present_999.html
2011, Jun 27, 17:00	Apollo NEA **2011 MD** (*H* = 28.3 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.0485 LD **(= 2.93 R_{Earth} from the geocenter)**. Minimum miss distance 0.0485 LD. **[2011-18]** See: 2011 MD - SSA , 2011 MD - JPL See also: http://neo.jpl.nasa.gov/news/news172.html http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-197 http://www.space.com/12067-asteroid-2011-md-close-earth-flyby-june-27.html http://www.space.com/12086-asteroid-2011-md-buzzes-earth-pictures.html http://web.mit.edu/newsoffice/2011/3q-2011md-binzel-0626.html http://www.jpl.nasa.gov/news/news.php?release=2014-193&3&utm_source=iContact&utm_medium=email&utm_campaign=NASAJPL&utm_content=Daily20140619 http://neo.ssa.esa.int/newsletters [June 2020] http://en.wikipedia.org/wiki/2011_MD Ref: - M. Mommert, D. Farnocchia, J. L. Hora, et al., 19 June 2014, *Astrophysical Journal* (Letters), 789, L22, "Physical properties of Near-Earth Asteroid **2011 MD**." See: http://adsabs.harvard.edu/abs/2014ApJ...789L..22M
2011, Jul	A. Christou, D.J. Asher, 2011, *Monthly Notices Royal Astronomical Society*, 414, 2965, "A long-lived horseshoe companion to the Earth." On asteroid **2010 SO16** (*H* = 20.6 mag, *D* ≈ 250 m, PHA) and its horseshoe orbit. See: http://adsabs.harvard.edu/abs/2011MNRAS.414.2965C See also: http://www.arm.ac.uk/press/2011/aac_horseshoe_orbit.html http://star.arm.ac.uk/highlights/2011/574.html http://www.technologyreview.com/blog/arxiv/26608/ http://www.jpl.nasa.gov/news/news.cfm?release=2011-112&cid=release_2011-112&msource=2011112&tr=y&auid=8128132 http://www.nasa.gov/mission_pages/WISE/news/wise20110408.html http://en.wikipedia.org/wiki/2010_SO16
2011, Jul	R. Duffard, K. Kumar, S. Pirrotta, et al., 2011, *Advances in Space Research*, 48, 120, "A multiple-rendezvous, sample-return mission to two near-Earth asteroids." Proposal of a dual-rendezvous mission, targeting NEAs, including sample-return. The proposed mission, ***Asteroid Sampling Mission*** (*ASM*), comprises flyby and remote sensing of a Q-type asteroid, and sampling of a V-type

	asteroid. See: http://adsabs.harvard.edu/abs/2011AdSpR..48..120D
2011, Jul	C.W. Hergenrother, R.J. Whiteley, 2011, *Icarus*, 214, 194, "A survey of small fast rotating asteroids among the near-Earth asteroid population." See: http://adsabs.harvard.edu/abs/2011Icar..214..194H
2011, Jul	M. Le Feuvre, M.A. Wieczorek, M.A., 2011, *Icarus*, 214, 1, "Non-uniform cratering of the Moon and a revised crater chronology of the inner Solar System." See: http://adsabs.harvard.edu/abs/2011Icar..214....1L
2011 Jul	C. Magri, E.S. Howell, M.C. Nolan, et al, 2011, *Icarus*, 214, 210, "Radar and photometric observations and shape modeling of contact binary near-Earth asteroid (**8567**) **1996 HW1**." See: http://adsabs.harvard.edu/abs/2011Icar..214..210M
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2011, Jul	X.-Y. Zeng, H. Baoyin, J.-F. Li, et al., 2011, *Research in Astronomy and Astrophysics*, 11(7), 863, "New applications of the H-reversal trajectory using solar sails." See: http://adsabs.harvard.edu/abs/2011RAA....11..863Z
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2011, Jul 11	Anton M.J. (Tom) Gehrels (1925 - 2011, Netherlands/USA), founder of the **Spacewatch** project, passed away. See:

	http://uanews.org/node/40649 http://www.skyandtelescope.com/news/125432648.html http://azstarnet.com/news/local/govt-and-politics/article_1702e3a9-fc0c-50f0-adf1-f84c5b0abf3b.html http://www.lpl.arizona.edu/people/faculty/gehrels2.html http://www.nature.com/news/2008/080625/full/4531164a.html http://adsabs.harvard.edu/abs/1988gsaa.book.....G http://uanews.org/node/16265 http://www.lpl.arizona.edu/calendar/calendar.php?ID=457 http://en.wikipedia.org/wiki/Tom_Gehrels See also: 1980, **Spacewatch** program.
2011, Jul 14	R. Cowen, 2011, *Nature*, 475, 147, "***Dawn*** nears **Vesta**." See: http://adsabs.harvard.edu/abs/2011Natur.475..147C
2011, Jul 16	NASA spacecraft ***Dawn***, launched 27 September 2007, with German (DLR, MPS) and Italian (ASI-INAF) instrumentation, reached main-belt asteroid **4 Vesta** (*H* = 3.20 mag, *D* = 530 km) and will orbit it at an altitude of 650 - 200 km for one year, to map 80 % of the asteroid's surface. Departure from **Vesta** on 5 September 2012 with destination dwarf planet (former main-belt asteroid) **1 Ceres** (*H* = 3.34 mag, *D* = 952 km), arriving on **6 March 2015**. See: http://www.nasa.gov/mission_pages/dawn/main/index.html Ref: - C.T. Russell, C.A. Raymond, A. Coradini, et al., 11 May 2012, *Science,* 336, 684, "***Dawn*** at **Vesta**: testing the protoplanetary paradigm." See: http://adsabs.harvard.edu/abs/2012Sci...336..684R - R. Jaumann, D.A. Williams, D.L. Buczkowski, et al., 11 May 2012, *Science*, 336, 687, "**Vesta**’s shape and morphology." See: http://adsabs.harvard.edu/abs/2012Sci...336..687J - S. Marchi, H.Y. McSween, D.P. O'Brien, et al., 11 May 2012, *Science*, 336, 690, "The violent collisional history of asteroid **4 Vesta**." See: http://adsabs.harvard.edu/abs/2012Sci...336..690M - P. Schenk, D.P. O'Brien, S. Marchi, et al., 2012, *Science*, 336, 694, "The geologically recent giant impact basins at Vesta’s South Pole." See: http://www.sciencemag.org/content/336/6082/694.full - M.C. De Sanctis, E. Ammannito, M.T. Capria, et al., 11 May 2012, *Science*, 336, 697, "Spectroscopic characterization of mineralogy and its diversity across **Vesta**." See: http://adsabs.harvard.edu/abs/2012Sci...336..697D - V. Reddy, A. Nathues, L. Le Corre, et al., 11 May 2012, *Science*, 336, 700, "Color and albedo heterogeneity of **Vesta** from ***Dawn***." See: http://adsabs.harvard.edu/abs/2012Sci...336..700R

	- C.T. Russell, C.A. Raymond, R. Jaumann, et al., November 2013, *Meteoritics & Planetary Science*, 48, 2076, "***Dawn*** completes its mission at **4 Vesta**." See: http://adsabs.harvard.edu/doi/10.1111/maps.12091 See also: https://en.wikipedia.org/wiki/Dawn_(spacecraft)
2011, Jul 18	**Morocco Fireball** seen 18 July 2011 over Tata (Morocco). The fireball yields rare **Mars** meteorites. See: http://blogs.nature.com/news/2012/01/morocco-fireball-yields-rare-mars-meteorite.html http://www.space.com/14268-rare-mars-meteorite-rocks-tissint.html http://www.space.com/20426-mercury-meteorite-discovery-messenger.html http://www.space.com/20547-mercury-meteorite-mystery-age.html
2011, Jul 22	K. Beatty, 2011, *Sky & Telescope*, 22 July 2011, "Massive meteorite found in China." A massive space rock – one that could rank as one of the largest meteorites ever recovered – has been found in the Altai Mountains of Xinjiang Uygur province in northwest China, at an altitude of 2900 m. The large brown iron-nickel meteorite juts out from beneath a larger granite slab and the portion above ground measures about 2.3 m long and half as wide. The meteorite's mass could range between 25 to 30 tons, which would make it one of the largest meteorites known. If so, this space rock would surpass the current largest one in China, a 28-ton meteorite that was discovered in 1898 in the same region. See: http://www.skyandtelescope.com/news/126009563.html See also: http://www.space.com/12416-giant-meteorite-china-discovery.html
2011, Jul 24	Apollo NEA **2011 PU1** (H = 25.5 mag, $D \approx$ 28 m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.87 LD. **[2011-19]** See: 2011 PU1 - SSA, 2011 PU1 - JPL
2011, Jul 28	M. Connors, P. Wiegert, C. Veillet, 28 July 2011, *Nature*, 475, 481, "Earth's Trojan asteroid". See: http://adsabs.harvard.edu/abs/2011Natur.475..481C During NASA's ***WISE*** mission the first "Trojan" asteroid sharing Earth's orbit: **2010 TK7** (**NEA**, H = 20.6 mag, $D \approx$ 300 m) was discovered, liberating around the leading Lagrange triangular point, L4. Its orbit is stable over at least ten thousand years. See also: http://blogs.nature.com/news/2011/07/astronomers_spot_earths_first.html

	http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-230 http://www.nasa.gov/multimedia/videogallery/index.html?media_id=103550791 http://neo.jpl.nasa.gov/news/news173.html http://www.space.com/12443-earth-asteroid-companion-discovered-2010-tk7.html http://www.time.com/time/health/article/0,8599,2085982,00.html http://www.floridatoday.com/article/20121130/COLUMNISTS0404/311300013/Stargazing-Asteroid-s-near-Earth-encounter-just-days-away https://astronomynow.com/2017/02/01/nasas-osiris-rex-probe-moonlights-as-asteroid-sleuth/ Ref.: - M.G. Connors, P. Wiegert, C. Veillet, 2011, in: American Geophysical Union, Fall Meeting 2011, abstract #P23C-1727, "Discovery of an Earth Trojan Asteroid." See: http://adsabs.harvard.edu/abs/2011AGUFM.P23C1727C - R. Dvorak, C. Lhotka, L. Zhou, May 2012, *Astronomy & Astrophysics*, 541, 127, "The orbit of **2010 TK7**. Possible regions of stability for other Earth Trojan asteroids." See: http://adsabs.harvard.edu/abs/2012A%26A...541A.127D
2011, Jul 28	Apollo NEA **2011 OD18** (H = 26.4 mag, $D \approx$ 19 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2011-20]** See: 2011 OD18 - SSA , 2011 OD18 - JPL
2011, Aug	J.M. Houtkooper, 2011, *Planetary and Space Science*, 59, 1107, "Glaciopanspermia: Seeding the terrestrial planets with life?" See: http://adsabs.harvard.edu/abs/2011P%26SS...59.1107H
2011, Aug	L.B.S. Pham, Ö. Karatekin, V. Dehant, 2011, *Planetary and Space Science*, 59, 1087, "Effects of impacts on the atmospheric evolution: comparison between Mars, Earth, and Venus." See: http://adsabs.harvard.edu/abs/2011P%26SS...59.1087P
2011, Aug	J. Tóth, P. Vereš, L. Kosnoš, 2011, *Monthly Notices Royal Astronomical Society*, 415, 1527, "Tidal disruption of NEAs – a case of **Příbram meteorite**." See: http://adsabs.harvard.edu/abs/2011MNRAS.415.1527T
2011, Aug 8-12	*74th Annual Meeting of the Meteoritical Society*, London (UK), 8-12 August 2011. See: http://www.lpi.usra.edu/meetings/metsoc2011/
2011, Aug 22-24	***International Primitive Body Exploration Working Group 2011* Workshop**, California Institute of Technology, Pasadena (CA, USA).

	See: http://ipewg.caltech.edu/ **Among the presentations:** - L. Johnson, 2011, "Planetary defense activities at NASA Science Mission Directorate." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/NEO%20Update%20for%20IPEWG%20%208-23-2011.pptx - T. Jones, 2011, "A synergistic strategy for robotic and human NEO exploration." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/Jones%20IPEWG%20NEO%20Strategy%208-11.pptx - D. Koschny, G. Drolshagen, 2011, "The Near-Earth Object segment of ESA's **Space Situational Awareness** programme (**SSA-NEO**)." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/ESA_SSA-NEO_overview_IPEWG_2011-08-19.ppt - E. Kürt, J. Biele, 2011, "Present and future exploration of primitive bodies at the German Aerospace Center." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/DLR%20ipewg2011.ppt - T.M. Randolph, 2011, "***NEO Surveyor***." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/NEO%20Surveyor.pptx - JHU/APL, a joint study with GSFC and JSC, 2011, "***Near Earth Survey Telescope***." See: http://ipewg.caltech.edu/IPEWG_Released_Presentations/NEST_IPEWG_2011.pptx
2011, Aug 23	N. Atkinson, 2011, *Universe Today*, 23 August 2011, "Human mission to an asteroid: why should NASA go?" See: http://www.universetoday.com/88384/human-mission-to-an-asteroid-why-should-nasa-go/
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2011, Aug 24	H.-X. Baoyin, Y. Chen, J.-F. Li, 2011, *Research in Astronomy and Astrophysics* (Chinese Journal of Astronomy and Astrophysics), 10, 587, "Capturing Near Earth Objects." See: http://adsabs.harvard.edu/abs/2010RAA....10..587B See also:

	http://www.technologyreview.com/blog/arxiv/27112/
2011, Aug 25	**Cusco Fireball Meteor** sighted over Cusco (Peru), 25 August 2011. See: http://www.youtube.com/watch?v=rdQLQmoHuJk
2011, Aug 25-26	**Mission Planning and Operations Group (MPOG)** preparation ***Workshop on international recommendations of Near-Earth Object threat mitigation***, organized by **COPUOS STsC Action Team 14**, jointly with the **Association of Space Exploreres (ASE)**, the **Secure World Foundation (SWF)**, and hosted by NASA in Pasadena (CA, USA), 25-26 August 2011. Follow-up of workshop held at ESA/ESOC, Darmstadt (Germany), 27-29 October 2010. The **MPOG** will be part of the decision structure for an imminent impact threat, as proposed by the **ASE** and adopted by **UN COPUOS's Action Team 14**. See: http://swfound.org/events/2011/workshop-on-international-recommendations-for-neo-threat-mitigation http://www.newswise.com/articles/view/580097/?sc=dwtr&xy=5028369
2011, Aug 25-26	**Fifth NASA *Small Bodies Assessment Group* meeting**, 25-26 August 2011. Pasadena (CA, USA). See: http://www.lpi.usra.edu/sbag/meetings/ http://www.cvent.com/events/5th-meeting-of-the-nasa-small-bodies-assessment-group/event-summary-47d7c1cecd5841878eb6ca7b07554dfc.aspx http://www.lpi.usra.edu/sbag/meetings/aug2011/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Presentations:** - J. Nuth, 2011, "SBAG roadmap. Science issues." See: http://www.lpi.usra.edu/sbag/meetings/aug2011/presentations/1030_Nuth_SBAG5.pdf - M. Zolensky, P. Weissman, 2011, "Sample return roadmap." See: http://www.lpi.usra.edu/sbag/meetings/aug2011/presentations/1100_Sykes_SBAG5.pdf - Y. Fernandez, 2011, "Roadmap: population identification characterization." See: http://www.lpi.usra.edu/sbag/meetings/aug2011/presentations/1430_Fernandez_SBAG5.pdf - J. Green, L. Johnson, 2011, "Planetary Science Division activities with small bodies." See: http://www.lpi.usra.edu/sbag/meetings/aug2011/presentations/Green_LNJ.pdf - P. Abell, 2011, "Roadmap for human exploration of small bodies." See:

	http://www.lpi.usra.edu/sbag/meetings/aug2011/presentations/1450_Abell_SBAG5.pdf
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2011, Aug 26	A.N. Krot, 2011, *Science*, 333, 1098, "Bringing part of an asteroid back home." See: http://adsabs.harvard.edu/abs/2011Sci...333.1098K See also: http://www.nature.com/news/2011/110825/full/news.2011.506.html http://physicsworld.com/cws/article/news/46981
2011, Aug 26	T. Nakamura, T. Noguchi, M. Tanaka, et al., 2011, *Science*, 333, 1113, "**Itokawa** dust particles: a direct link between S-type asteroids and ordinary chondrites." See: http://adsabs.harvard.edu/abs/2011Sci...333.1113N
2011, Aug 26	H. Yurimoto, K, Abe, M. Abe, et al., 2011, *Science*, 333, 1116, "Oxygen isotopic compositions of asteroidal materials returned from **Itokawa** by the ***Hayabusa*** mission." See: http://adsabs.harvard.edu/abs/2011Sci...333.1116Y
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2011, Aug 26	A. Tsuchiyama, M. Uesugi, T. Matsushima, et al., 2011, *Science*, 333, 1125, "Three-dimensional structure of ***Hayabusa*** samples: origin and evolution of **Itokawa** regolith." See: http://adsabs.harvard.edu/abs/2011Sci...333.1121N
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2011, Sep	C.A. Thomas, D.E. Trilling, J.P. Emery, et al., 2011, *Astronomical Journal*, 142, 85, "ExploreNEOs. V. Average albedo by taxonomic complex in the Near-Earth Asteroid population." See: http://adsabs.harvard.edu/abs/2011AJ....142...85T
2011, Sep	J. Yang, J.I. Goldstein, E.R.D. Scott, et al., 2011, *Meteoritics & Planetary Science*, 46, 1227, "Thermal and impact histories of reheated group IVA, IVB, and ungrouped iron meteorites and their parent asteroids." See: http://adsabs.harvard.edu/abs/2011M%26PS...46.1227Y
2011, Sep 1	Starting from 1 September 2011 **NEODyS** (see item 1999, March 5-6) is sponsored by ESA, which pays a portion of the operating costs, both for the background orbit and risk computations and for the database and web interface; the rest of the cost is covered, as before, by the Department of Mathematics, University of Pisa, with the running research grants of the Celestial Mechanics Group, and by IASF-INAF (Rome), with a PRIN-INAF grant. See: http://newton.dm.unipi.it/neodys/
2011, Sep 6	The **Space Generation Advisory Council (SGAC)** announced the winner of the 2011 *Move an Asteroid Competition*, Alison Gibbings (UK). See: http://spacegeneration.org/index.php/eventstopics/news/454-sgac-announces-the-winner-of-the-2011-move-an-asteroid-competition http://spacegeneration.org/images/stories/Projects/NEO/MAA/a_smart_cloud_approach_to_asteroid_deflection.pdf
2011, Sep 8	M. Willbold, T. Elliott, S. Moorbath, 2011, *Nature*, 477,195, "The tungsten isotopic composition of the Earth's mantle before the

	terminal bombardment." See: http://adsabs.harvard.edu/abs/2011Natur.477..195W http://www.nature.com/nature/journal/v477/n7363/full/nature10399.html
2011, Sep 15	**Meteor fireball** over Southern California, Arizona and Nevada (USA). See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-291 http://www.amsmeteors.org/2011/09/major-fireball-event-seen-from-southern-california-arizona-and-nevada-september-14th-2011-945-pdt/ http://latimesblogs.latimes.com/lanow/2011/09/meteor-reports-across-sky.html http://www.irishweatheronline.com/news/space/meteorite/meteorite-hunt-begins-after-thousands-witness-southwestern-us-fireball/37884.html
2011, Sep 15-18	***International Meteor Conference 2011***, 30th edition, 15-18 September, Sibiu (Romania), See: http://www.imo.net/imc2011/index.php
2011, Sep 16	**Memorial seminar *Tom Gehrels 1925-2011: A Celebration of Life***, Lunar and Planetary Laboratory, Kuiper Space Sciences, Rm 308, Tucson (AZ, USA), 16 September 2011, 3:00 - 5:00 p.m.. See: http://www.lpl.arizona.edu/calendar/calendar.php?ID=457
2011, Sep 27	Apollo NEA **2011 SE58** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2011-21]** See: 2011 SE58 - SSA , 2011 SE58 - JPL See also: http://www.space.com/13145-2-small-asteroids-pass-earth-moon.html
2011, Sep 27-30	***Keck Institute for Space Studies (KISS) Workshop - Asteroid Retrieval Mission Study***, California Institute of Technology, Pasadena (CA, USA), 27-30 September 2011. See: http://kiss.caltech.edu/workshops/asteroid2011/index.html http://www.wired.com/wiredscience/2011/10/asteroid-moving/ http://www.space.com/13164-killer-asteroids-deflection-humanity-cooperation.html http://billionyearplan.blogspot.com/2011/10/to-deflect-killer-asteroids-humanity.html http://www.newscientist.com/article/dn23039-nasa-mulls-plan-to-drag-asteroid-into-moons-orbit.html http://www.space.com/19151-asteroid-moon-orbit-nasa-study.html **Study final report** (2 April 2012)**:**

	http://kiss.caltech.edu/study/asteroid/asteroid_final_report.pdf **Other presentations:** - J. Brophy, F. Culick, L. Friedman, et al., March 14, 2012, "Asteroid retrieval feasibility." See: http://kiss.caltech.edu/study/asteroid/20120314_ESA_ESTEC.pdf - J.R. Brophy, L. Friedman, F. Culick, et al., March 7, 2012, "Asteroid retrieval mission feasibility study." See: http://kiss.caltech.edu/study/asteroid/20120307_IEEE_Presentation.pdf - J.R. Brophy, L. Friedman, F. Culick, July 9, 2012, "Asteroid retrieval mission feasibility study." See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1645_Brophy_Asteroid_Return.pdf See also: http://www.space.com/19151-asteroid-moon-orbit-nasa-study.html http://www.space.com/20538-nasa-asteroid-capture-funding.html http://www.space.com/20552-nasa-considers-plan-to-lasso-an-asteroid-for-study-video.html http://www.space.com/20591-nasa-asteroid-capture-mission-feasibility.html http://www.nasa.gov/news/budget/index.html http://www.space.com/20599-nasa-2014-budget-highlights.html http://www.space.com/20601-animation-of-proposed-asteroid-retrieval-mission-video.html http://www.thespacereview.com/article/2283/1 http://targetneo.jhuapl.edu http://www.nasa.gov/content/new-imagery-of-asteroid-mission/#.UkNbdX-TLpe http://www.nasa.gov/content/asteroid-initiative-idea-synthesis-workshop/#.UkPgqn-TLpc
2011, Sep 28	Aten NEA **2011 TO** (*H* = 26.8 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2011-22]** See: 2011 TO - SSA , 2011 TO - JPL See also: **28 Sep 1980**, **27 Sep 2044**.
2011, Sep 28-29	First NEA detected by the **Teide Observatory Tenerife Asteroid Survey (TOTAS)** during an observation slot sponsored by the **ESA Space Situational Awareness (SSA)** programme : **2011 SF108** (*H* = 20.0 mag, *D* = 350 m). See: http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2011+SF108&orb=1 http://www.esa.int/SPECIALS/SSA/SEMURW6UXSG_0.html See also: http://www.space.com/13272-asteroid-discovery-amateur-astronomers-2011-sf108.html http://news.discovery.com/space/near-earth-asteroid-discovered-via-crowd-sourcing-111012.html http://www.dailymail.co.uk/sciencetech/article-2048797/Amateur-

	skywatchers-Tenerife-impact-threat-asteroid.html http://tech.groups.yahoo.com/group/mpml/message/26123
2011, Sep 29	Observations by NASA's ***Wide-field Infrared Survey Explorer (WISE)***, in a survey program called ***NEOWISE***, show that there are significantly fewer near-Earth asteroids in the mid-size range than previously thought. The findings also indicate that the **Spaceguard** program has found 911 NEAs, 93% of the estimated 981±19 NEAs larger than 1000 m, meeting the 90% goal agreed to with U.S. Congress in 1998. For smaller objects the ***NEOWISE*** detection census reads: ~1,200 (80%) of the estimated ~1,500 NEAs in the 500-1000 m range; ~1,100 (46%) of the estimated ~2,400 NEAs in the 300-500 m range; ~2,000 (13%) of the estimated ~15,700 NEAs in the 100-300 m range. The estimated number of NEAs with $D > 140$ m is 13,200 ± 1,900. The estimated number of NEAs with $D > 100$ m is 20,500 ± 3,000. Ref: - A. Mainzer, T. Grav, J. Bauer, et al., 2011, *Astrophysical Journal*, 743, 156, "***NEOWISE*** observations of Near-Earth Objects: preliminary results." See: http://adsabs.harvard.edu/abs/2011ApJ...743..156M - A. Mainzer, T. Grav, J. Masiero, et al., June 2012, *Astrophysical Journal*, 752, 110, "Characterizing subpopulations within the Near Earth Objects with ***NEOWISE***: preliminary results." See: http://adsabs.harvard.edu/abs/2012ApJ...752..110M See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-304 http://www.jpl.nasa.gov/video/index.cfm?id=1023 http://apod.nasa.gov/apod/ap111001.html http://www.space.com/13132-potentially-killer-asteroids-earth-nasa.html http://www.space.com/13129-killer-asteroids-wise.html
2011, Sep 30	Apollo NEA **2011 SM173** ($H = 28.1$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.76 LD. Minimum miss distance 0.75 LD. **[2011-23]** See: 2011 SM173 - SSA , 2011 SM173 - JPL See also: http://www.space.com/13145-2-small-asteroids-pass-earth-moon.html
2011, Oct	G. Beekman, 2011, *Zenit*, oktober 2011, "Vier trouwe begeleiders van de aarde." See: http://www.dekoepel.nl/zenit/
2011, Oct	G.C. de Elía, R.P. Di Sisto, 2011, *Astronomy & Astrophysics*, 534,

	A129, "Impactor flux and cratering on **Ceres** and **Vesta**: implications for the early Solar System." See: http://adsabs.harvard.edu/abs/2011A%26A...534A.129D
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2011, Oct	G. Pratesi, V.M. Cecchi, 2011, *Atlas of Meteorites* (Cambridge: CUP). See: http://www.cambridge.org/aus/catalogue/catalogue.asp?isbn=9780521840354
2011, Oct	V.V. Shuvalov, I.A. Trubetskaya, 2011, *Solar System Research*, 45, 392, "Numerical simulation of high-velocity ejecta following comet and asteroid impacts: preliminary results." See: http://adsabs.harvard.edu/abs/2011SoSyR..45..392S

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2011, Oct	S.D. Wolters, A.J. Ball, N. Wells, et al., 2011, *Earth and Planetary Astrophysics*, 59, 1506, "Measurement requirements for a near-Earth asteroid impact mitigation demonstration mission." See: http://adsabs.harvard.edu/abs/2011P%26SS...59.1506W See also: http://www.technologyreview.com/blog/arxiv/27028/
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2011, Oct 8	**Draconid meteor shower**, left-overs from the tail of comet Giacobini-Zinner, observed from ESA Falcon-20 research airplanes. See: http://www.esa.int/esaSC/SEM8DPGURTG_index_0.html
2011, Oct 11	I. Halevy, W.W. Fischer, J.M. Eiler, 2011, *Proc. National Academy of Sciences,* 108, 16895, "Carbonates in the Martian meteorite **Allan Hills 84001** formed at 18 ± 4 °C in a near-surface aqueous environment." See: http://www.pnas.org/content/108/41/16895.abstract
2011, Oct 12	Apollo NEA **2011 UT** (H = 26.0 mag, $D \approx$ 22 m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59

	LD. **[2011-24]** See: 2011 UT - SSA , 2011 UT - JPL
2011, Oct 13	Closest approach of Amor NEA **1036 Ganymed** (**A924 UB**, *H* = 9.6 mag, *D* ≈ 36.49 km), largest NEA known, in the period 1900-2100 yr, at a distance of 0.36 AU ≈ 140 LD. See: 1036 Ganymed - SSA, 1924 TD - JPL Ref: J. Meeus, M. Drummen, September 2011, *Zenit*, "**Ganymed** in aantocht." See: http://www.dekoepel.nl/zenit/september2011.html See also: http://en.wikipedia.org/wiki/1036_Ganymed See also: **13 Oct 2024**.
2011, Oct 15	G.R. Osinski, L.L. Tornabene, R.A.F. Grieve, 2011, *Earth and Planetary Science Letters*, 310, 167, "Impact ejecta emplacement on terrestrial planets." See: http://adsabs.harvard.edu/abs/2011E%26PSL.310..167O
2011, Oct 17	Apollo NEA **2009 TM8** (*H* = 28.7 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.46 LD. **[2011-25]** See: 2009 TM8 - SSA , 2009 TM8 - JPL See also: **17 Oct 2009**.
2011, Oct 26	Apollo NEA **2011 UL169** (*H* = 28.3 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2011-26]** See: 2011 UL169 - SSA , 2011 UL169 - JPL
2011, Oct 28	Apollo NEA **2011 UX255** (*H* = 27.4 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.36 LD. **[2011-27]** See: 2011 UX255 - SSA , 2011 UX255 - JPL
2011, Oct 28	H. Sierks, P. Lamy, C. Barbieri, et al., 2011, *Science*, 334, 487, "Images of asteroid **21 Lutetia**: a remnant planetesimal from the early Solar System." See: http://adsabs.harvard.edu/abs/2011Sci...334..487S
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2011, Nov	M. Brozović, L.A.M. Benner, P.A. Taylor, et al., 2011, *Icarus*, 216, 241, "Radar and optical observations and physical modeling of triple near-Earth Asteroid (**136617**) **1994 CC**." See: http://adsabs.harvard.edu/abs/2011Icar..216..241B
2011, Nov	M. Hicks, J. Somers, T. Truong, et al., 2011, *The Astronomer's Telegram*, #3763, "Broadband photometry of **2005 YU55**: Solar phase behavior and absolute magnitude." See: http://adsabs.harvard.edu/abs/2011ATel.3763....1H
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2011, Nov	J.R. Masiero, A.K. Mainzer, T. Grav, et al., 2011, *Astrophysical Journal*, 741, 68, "Main belt asteroids with ***WISE***/**NEOWISE**. I. Preliminary albedos and diameters." See: http://adsabs.harvard.edu/abs/2011ApJ...741...68M See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-296
2011, Nov	M. Popescu, M. Birlan, R. Binzel, et al., 2011, *Astronomy & Astrophysics*, 535, A15, "Spectral properties of eight near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2011A%26A...535A..15P
2011, Nov 8, 23:29	Apollo NEA **308635** (**2005 YU55**, H = 21.6 mag, D = 360 m, P_o = 1.22 yr, **PHA**) passed Earth at a **nominal miss distance of 0.845 LD (= 51.0 R_{Earth} from the geocenter)** and the Moon at a nominal miss distance of 0.624 LD. Minimum miss distance 0.845 LD. **Arecibo Observatory** radar imaging on 19 April 2010 reduced uncertainties about its orbit by 50%, eliminating any possibility of an impact with the Earth for the next 100 years. New **Arecibo Observatory** and **Goldstone** radar observations on 7 and 8 November 2011 confirmed a spherical shape. On 19 January **2029**, asteroid **2005 YU55** will pass **Venus** at a nominal distance of 0.74 LD; minimum miss distance 0.66 LD. See: 308635 2005 YU55 - SSA , 2005 YU55 - JPL **[2011-28]** Ref: - M. Hicks, K. Lawrence, L. Benner, 2010, *The Astronomer's Telegram*, #2571, "Palomar spectroscopy of **2001 FM129**, **2004 FG11**, and **2005 YU55**." See: http://adsabs.harvard.edu/abs/2010ATel.2571....1H - M. Hicks, J. Somers, T. Truong, et al., 2011, *The Astronomer's Telegram*, #3763, "Broadband photometry of **2005 YU55**: Solar

	phase behavior and absolute magnitude." See: http://adsabs.harvard.edu/abs/2011ATel.3763....1H - P.A. Taylor, M.C. Nolan, E.S. Howell, et al., 2011, *Bulletin American Astronomical Society*, AAS Meeting #219, #432.11, "Radar observations of **2005 YU55**'s flyby of Earth." See: http://adsabs.harvard.edu/abs/2012AAS...21943211T - N.A. Moskovitz, B. Yang, L.F. Lim, et al., 2012, in: *43rd Lunar and Planetary Science Conference*, 19-23 March 2012, The Woodlands (TX, USA), *LPI Contribution* No. 1659, p.2080, "The near-Earth encounter of asteroid **2005 YU55**: visible and near-infrared spectroscopy." See: http://adsabs.harvard.edu/abs/2012LPI....43.2080M - L.F. Lim, J.P. Emery, N.A. Moskovitz, M. Granvik, 2012, in: *43rd Lunar and Planetary Science Conference*, 19-23 March 2012, The Woodlands (TX, USA), *LPI Contribution* No.1659, id.2202, "The near-Earth encounter of **2005 YU55**: thermal infrared observations from Gemini North." See: http://adsabs.harvard.edu/abs/2012LPI....43.2202L - B.D. Warner, R.D. Stephens, J.W. Brinsfield, et al., 2012, *Minor Planet Bulletin*, 39, 84,"Lightcurve analysis of NEA **2005 YU55**." See: http://adsabs.harvard.edu/abs/2012MPBu...39...84W - L.F. Lim, J.P. Emery, N.A. Moskovitz, et al., October 2012, American Astronomical Society, DPS meeting #44, #305.01, "The Near-Earth encounter of asteroid **308635** (**2005 YU55**): thermal IR observations." See: http://adsabs.harvard.edu/abs/2012DPS....4430501L - T. G. Mueller, T. Miyata, C. Kiss, M. A. Gurwell, et al., Oct 2013, *Astronomy & Astrophysics*, 558, 97, "Physical properties of asteroid **(308635) 2005 YU55** derived from multi-instrument infrared observations during a very close Earth-approach." See: http://www.aanda.org/articles/aa/abs/2013/10/aa21664-13/aa21664-13.html See also: http://www.jpl.nasa.gov/news/news.cfm?release=2010-144 http://www.nasa.gov/topics/solarsystem/features/asteroid20100429.html http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2005%20YU55%20;orb=1;cov=0;log=0;cad=1#cad http://www.news.cornell.edu/stories/April10/AreciboAsteroid.html http://www.space.com/8312-potentially-dangerous-asteroid-spotted-passing-earth.html http://www.space.com/11310-huge-asteroid-2005-yu55-passing-earth-november.html http://www.sciencedaily.com/releases/2010/05/100503010702.htm http://www.planetary.org/blog/article/00002463/ http://neo.jpl.nasa.gov/news/news171.html http://www.nature.com/news/2011/111102/full/news.2011.625.html http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-129 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2011-332

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2011, Nov 13-20	***The Second Arab Impact Cratering and Astrogeological Conference (AICAC II)***, 13-20 November 2011, Casablanca (Morocco). See: http://www.fsac.ac.ma/aicaii/index.html
2011, Nov 14-15	***Near Earth Objects (NEOs) Working Group on Media Communications and Risk Management***, 14-15 November 2011, Laboratory for Atmospheric and Space Physics (LASP), University of Colorado, Boulder (CO, USA). Co-sponsored by Secure World Foundation and the Association of Space Explorers. See: http://swfound.org/events/2011/near-earth-objects-mediarisk-communications-working-group http://www.unoosa.org/pdf/pres/stsc2012/tech-46E.pdf **Report:** http://swfound.org/media/82686/SWF%20NEO_Media_Risk_Communications_Working_Group_Final_%20Report_June_%202012.pdf See also: http://www.skyandtelescope.com/community/skyblog/newsblog/If-An-Impact-Looms-Then-What-134136683.html http://bigthink.com/ideas/41151?page=all http://cosmiclog.msnbc.msn.com/_news/2011/11/16/8845471-asteroid-debate-rises-to-next-level http://www.aviationweek.com/Article.aspx?id=/article-xml/AW_11_28_2011_p51-395551.xml# http://www.space.com/16033-asteroid-strike-global-warning-system.html
2011, Nov 14-16	**NASA** ***Human Space Exploration Community Workshop on the Global Exploration Roadmap***, 14-16 November 2011, San Diego (CA, USA). The workshop did frame the Global Exploration Roadmap, with overviews of NASA's plans for human spaceflight,

	including exploration missions to an asteroid and Mars. See: http://www.nasa.gov/exploration/about/isecg/ger-workshop.html
2011, Nov 17	Charles F. Bolden Jr., 2011, NASA Administrator, Statement before the Subcommittee on Science and Space Committee on Commerce, Science and Transportation, U. S. Senate. See: http://www.spaceref.com/news/viewsr.html?pid=39082
2011, Nov 17	EU FP7 **NEOShield** proposal approved and grant agreement signed by the European Commission. Overall funding is M€ 5.8, including M€ 1.8 from partners, for a project lifetime of 3.5 years. **NEOShield** involves 13 partner institutes in France, Germany, Russia, Spain, UK and USA, and will be coordinated by DLR in Berlin (Germany). The **NEOShield** project, which formally commences in 1 January 2012, covers investigation of physical properties of NEOs, mitigation methods, technology development, demonstration missions, and a global response campaign roadmap. The **NEOShield** kick-off meeting will be held at DLR, 16-17 January 2012. See: http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-2640/year-2012/ http://elib.dlr.de/70019/
2011, Nov 18	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)**, *Information on research in the field of NEOs carried out by Member States, international organizations and other entities.* A/AC.105/C.1/100. See: http://www.oosa.unvienna.org/pdf/reports/ac105/C1/AC105_C1_100E.pdf
2011, Nov 18	**Leonid Fireball** over Tenerife (Canary Islands, Spain). See: http://apod.nasa.gov/apod/ap111122.html
2011, Nov 22	Ph. Plait, 2011, *Bad Astronomy*, 22 November 2011, "My asteroid impact talk is now on TED!" See: http://blogs.discovermagazine.com/badastronomy/2011/11/22/my-asteroid-impact-talk-is-now-on-ted/ http://www.ted.com/talks/phil_plait_how_to_defend_earth_from_asteroids.html
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	See: http://adsabs.harvard.edu/abs/2011sf2a.conf..629B
2011, Dec	D. Bancelin, D. Hestrofer, W. Thuillot, 2011, in: G. Alecian, K. Belkacem, R. Samadi & D. Valls-Gabaud (eds.), *SF2A-2011: Proceedings of the Annual meeting of the French Society of Astronomy and Astrophysics*, "Orbit of potentially hazardous asteroids using ***Gaia*** and ground-based observations." See: http://adsabs.harvard.edu/abs/2011sf2a.conf..263B
2011, Dec	B.E. Clark, R.P. Binzel, E.S. Howell, et al., 2011, *Icarus*, 216, 462, "Asteroid (**101955**) **1999 RQ36**: spectroscopy from 0.4 to 2.4 µm and meteorite analogs." See: http://adsabs.harvard.edu/abs/2011Icar..216..462C
2011, Dec	V.V. Emel'Yanenko, S.A. Naroenkov, B.M. Shustov, 2011, *Solar System Research*, 45, 498, "Distribution of the Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2011SoSyR..45..498E
2011, Dec	L.V. Ksanfomality, 2011, *Solar System Research*, 45, 504, "Dynamical evolution of the nucleus of comet **Hartley 2** and asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2011SoSyR..45..504K
2011, Dec	I.V. Lomakin, M.B. Martynov, V.G. Pol', A.V. Simonov, 2011, *Solar System Research*, 45, 577, "Asteroid hazard, real problems and practical actions." See: http://adsabs.harvard.edu/abs/2011SoSyR..45..577L
2011, Dec	E.T. Lu, 2011, *Scientific American*, 305, 16, "Stop the killer rocks." See: http://www.nature.com/scientificamerican/journal/v305/n6/full/scientificamerican1211-16.html
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2011, Dec	P.A. Taylor, M.C. Nolan, E.S. Howell, et al., 2011, *Bulletin American Astronomical Society*, AAS Meeting #219, #432.11, "Radar observations of **2005 YU55**'s flyby of Earth." See: http://adsabs.harvard.edu/abs/2012AAS...21943211T
2011, Dec	K.A. van der Hucht, 2011, in: *Newsletter* European Astronomical Society, Issue 42, p. 6, "Potential hazards of Near Earth Objects – truth and consequences." See: http://eas.unige.ch/newsletter.jsp
2011, Dec	P. Vemazza, P. Lamy, O. Groussin, et al., 2011, *Icarus*, 216, 650, "Asteroid (**21**) **Lutetia** as a remnant of Earth's precursor planetesimals." See: http://adsabs.harvard.edu/abs/2011Icar..216..650V
2011, Dec 3	Asteroid **2011 XC2** (H = 23.2 mag, $D \approx$ 80 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD. **[2011-29]** See: 2011 XC2 - SSA , 2011 XC2 - JPL See also: https://en.wikipedia.org/wiki/2011_XC2
2011, Dec 7	Apollo NEA **2003 XV** (H = 26.6 mag, $D \approx$ 20 m) passed Earth at a nominal miss distance of 1.06 LD. Minimum miss distance 1.06 LD. See: 2003 XV - SSA , 2003 XV - JPL
2011, Dec 9	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS),** *Near-Earth objects, 2011-2012, Interim report of* ***Action Team 14 on Near-Earth Objects***. See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L316E.pdf
2011, Dec 11	Apollo NEA **2018 XA4** (H = 29.1 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 1.68 LD. Minimum miss distance 0.57 LD. See: 2018 XA4 - SSA , 2018 XA4 - JPL See also: **11 Dec 2018**.
2011, Dec 14	Apollo NEA **2011 YQ1** (H = 25.7 mag, $D \approx$ 26 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.01 LD.

	See: 2011 YQ1 - SSA , 2011 YQ1 - JPL
2011, Dec 15	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), *Near-Earth objects, 2011-2012.*** *Draft recommendations of the Action Team on Near-Earth Objects for an international response to the near-Earth object impact threat.* See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L317E.pdf
2011, Dec 15	A.L. Gronstal, 2011, *Astrobiology Magazine*, 15 December 2011, "Seeking a pot of geological gold", See: http://www.astrobio.net/index.php?option=com_expedition&task=detail&id=4400 See also: http://www.space.com/14069-mass-extinction-earth-impact-triassic-jurassic.html
2011, Dec 28	Apollo NEA **2011 YC40** (H = 29.6 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2011-30]** See: 2011 YC40 - SSA , 2011 YC40 - JPL
2011, Dec 29	Apollo NEA **2012 AQ** (H = 31.1 mag, $D \approx$ 2.2 m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2011-31]** See: 2012 AQ - SSA , 2012 AQ - JPL
2011, Dec 30	Apollo NEA **2011 YC63** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.62 LD. **[2011-32]** See: 2011 YC63 - SSA , 2011 YC63 - JPL
2012, Jan 1	**8453 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, H = 9.45 mag, D = 36.5 km, Amor NEA), of which **1272 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis**, **1989 AC**, H = 15.3 mag, D = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2012	L.D. Schmadel, 2012, *Dictionary of Minor Planet Names*, ISBN ISBN 978-3-642-29717-5 (Berlin Heidelberg: Springer Verlag). See: http://adsabs.harvard.edu/abs/2012domp.book.....S
2012, Jan	K.J. Burleigh, H.J. Melosh, L.L. Tornabene, et al. 2012, *Icarus*, 217, 194, "Impact airblast triggers dust avalanches on **Mars**." See: http://adsabs.harvard.edu/abs/2012Icar..217..194B See also:

	http://redplanet.asu.edu/?p=1157 http://adsabs.harvard.edu/abs/2009LPI....40.1431B
2012, Jan	J. Fang, J.-L. Margot, 2012, *Astronomical Journal*, 143, 24, "Near-Earth binaries and triples: origin and evolution of spin-orbital properties." See: http://adsabs.harvard.edu/abs/2012AJ....143...24F
2012, Jan	J. Fang, J.-L. Margot, 2012, *Astronomical Journal*, 143, 25, "Binary asteroid encounters with terrestrial planets: timescales and effects." See: http://adsabs.harvard.edu/abs/2012AJ....143...25F
2012, Jan	S. Greenstreet, H. Ngo, B. Gladman, 2012, *Icarus*, 217, 355, "The orbital distribution of Near-Earth Objects inside Earth's orbit." See: http://adsabs.harvard.edu/abs/2012Icar..217..355G
2012, Jan 2	Apollo NEA **2011 YB63** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.61 LD. Minimum miss distance 0.61 LD. **[2012-01]** See: 2011 YB63 - SSA , 2011 YB63 - JPL
2012, Jan 12-13	***MarcoPolo-R* Workshop *Physical characterisation of MarcoPolo-R targets***, Observatoire de Paris, Meudon (France), 12-13 January 2012. See: http://smass.mit.edu/MarcoPolo/home.html **Presentations:** **Session 1**. Visible and near-infrared observations. - A. Barucci, 2012, "***MarcoPolo-R*** Near Earth Asteroid sample return mission. Welcome and introduction." See: http://smass.mit.edu/MarcoPolo/presentations/Barucci_MarcoPolo-R_Meudon2012.ppt - F. DeMeo, 2012, "Comparison of the surface properties of asteroids **1996 FG3**, **1999 RQ36**, and **1999 JU3**, targets of ***MarcoPolo-R***, ***OSIRIS-REx***, and ***Hyabusa-2***." See: http://smass.mit.edu/MarcoPolo/presentations/DeMeo_MarcoPolo-R_Meudon2012.pdf - A. Rivkin, E. Howell, R. Vervack, et al., 2012, "New observations of **1996 FG3** from 0.8-4 microns and potential meteorite analogs." See: http://smass.mit.edu/MarcoPolo/presentations/Rivkin_MarcoPolo-R_Meudon2012.pptx - M. Birlan, M. Popescu, F. Colas, A. Nedelcu, 2012, "Focus on (**175706**) **1996 FG3**: modeling spectra using M4AST and new observational results from Pic du Midi." See: http://smass.mit.edu/MarcoPolo/presentations/Birlan_MarcoPolo-R_Meudon2012.ppt

	Session 2. Thermal and radar observations and dynamics. - J. Emery, 2012, "Thermal characterization of surfaces of small asteroids." See: http://smass.mit.edu/MarcoPolo/presentations/Emery_MarcoPolo-R_Meudon2012.ppt - S. Green, 2012, "Constraints on thermal inertia of (**175706**) **1996 FG3** using a rough surface thermophysical model." See: http://smass.mit.edu/MarcoPolo/presentations/Green_MarcoPolo-R_Meudon2012.ppt - H. Campins, J. de León, A. Morbidelli, et al., 2012, "The origin of asteroids accessible to ***Marco Polo-R***." See: http://smass.mit.edu/MarcoPolo/presentations/Campins_MarcoPolo-R_Meudon2012.ppt - K.Walsh, M. Delbo, M. Mueller, R.Binzel, F. De Meo, 2012, "Physical characterization and origin of binary near-Earth asteroid (**175706**) **1996 FG3**." See: http://smass.mit.edu/MarcoPolo/presentations/Delbo_MarcoPolo-R_Meudon2012.pdf - P. Michel, 2012, "Possible formation mechanism of binary asteroids and which assumptions can we make on their regolith properties." See: http://smass.mit.edu/MarcoPolo/presentations/Michel_MarcoPolo-R_Meudon2012.pdf **Session 3**. Shape models and meteorite comparison. - P. Vernazza, 2012, "Among the yet unsampled meteorite classes, which one will we learn the most from?" See: http://smass.mit.edu/MarcoPolo/presentations/Vernazza_MarcoPolo-R_Meudon2012.pdf - J.M. Trigo-Rodríguez, J. Llorca, J.M. Madiedo, et al., 2012, "UV to IR reflectance spectra of Antarctic carbonaceous chondrites to better characterize ***Marco Polo-R*** target." See: http://smass.mit.edu/MarcoPolo/presentations/Trigo_MarcoPolo-R_Meudon2012.pdf - B. Carry, 2012, "Roadmap for characterization of ***MarcoPolo-R*** targets." See: http://smass.mit.edu/MarcoPolo/presentations/Carry_MarcoPolo-R_Meudon2012.pdf **Session 4**. Mission information. - A. Cheng, L. Benner, R. Binzel, et al., 2012, "Physical characterization of ***MarcoPolo-R*** targets." See: http://smass.mit.edu/MarcoPolo/presentations/Cheng_MarcoPolo-R_Meudon2012.pdf - D. Koschny, 2012, "***MarcoPolo-R*** programmatics, science requirements, and engineering requirements for target characterisation." See: http://smass.mit.edu/MarcoPolo/presentations/Detlef_MarcoPolo-R_Meudon2012.ppt

2012, Jan 16-17	***NEOShield Kick-off Meeting***, Berlin (Germany), 16-17 January 2012. See: 17 November 2011, and http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-2640/year-2012/ http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-2640/ http://www.astrium.eads.net/node.php?articleid=8210 http://www.neoshield.net/en/index.htm Ref: - A.W. Harris, M.A. Barucci, J.L. Cano, et al., 15 September 2012, *Acta Astronautica*, online, "The European funded **NEOShield** project: A global approach to Near-Earth Object impact threat mitigation." See: http://elib.dlr.de/70019/1/NEOShield_paper_pdc11.pdf http://www.sciencedirect.com/science/article/pii/S0094576512003360 - A.W. Harris, L. Drube, **NEOShield** Consortium, October 2012, American Astronomical Society, DPS meeting #44, #210.05, "The **NEOShield** project: understanding the mitigation-relevant physical properties of potentially hazardous asteroids." See: http://adsabs.harvard.edu/abs/2012DPS....4421005H See also: http://www.bbc.co.uk/news/science-environment-16633217 http://www.bbc.co.uk/news/science-environment-16651642 http://www.allgov.com/Unusual_News/ViewNews/International_Plan_to_Protect_Earth_from_Comets_and_Asteroids_Could_Mean_Billions_for_Contractors_120122 http://www.space.com/14370-asteroid-shield-earth-threat-protection-meeting.html http://en.wikipedia.org/wiki/NEOShield
2012, Jan 17	M. Wall, 2012, *Space.com*, 17 January 2012, "Rare Mars rocks crashed to Earth in July." **Meteorite fragments** (7 kg) originating from **Mars**, found near Tissint (Morocco), three months after **fireball** seen 18 July 2011 over Tata (Morocco). See: http://www.space.com/14268-rare-mars-meteorite-rocks-tissint.html See also: http://www.space.com/20426-mercury-meteorite-discovery-messenger.html
2012, Jan 17-18	**Sixth NASA *Small Bodies Assessment Group* meeting**, 17-18 January, 2012, Washington (DC, USA). See: http://www.lpi.usra.edu/sbag/ **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Presentations:** - D.S. Lauretta, B.E. Clark, 2012, "***OSIRIS-REx***."

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2012, Jan 20	Apollo NEA **2012 BV1** (H = 31.0 mag, $D \approx$ 2.3 m) passed Earth at a nominal miss distance of 0.83 LD. Minimum miss distance 0.83 LD. **[2012-02]** See: 2012 BV1 - SSA , 2012 BV1 - JPL
2012, Jan 27	Aten NEA **2012 BX34** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.17 LD. **[2012-03]** See: 2012 BX34 - SSA , 2012 BX34 - JPL See also: http://www.space.com/14373-asteroid-2012-bx34-earth-flyby.html http://www.universetoday.com/93177/2012-bx34-behind-the-scenes-in-the-discovery-of-a-near-earth-asteroid/ http://en.wikipedia.org/wiki/2012_BX34 See also: **27 Jan 1959**.
2012, Jan 31	Amor NEA **433 Eros** (**A898 PA**, H = 11.1 mag, D = 34.4 × 11.2 × 11.2 km, orbital P = 1.76 yr), passed Earth at a nominal miss distance of 69.5 LD (= 0.18 AU). See: 433 Eros - SSA , 1898 DQ - JPL See also: http://www.universetoday.com/93101/asteroid-to-make-closest-approach-since-1975/ http://transitofvenus.nl/wp/getting-involved/eros-and-the-solar-parallax/ http://www.skyandtelescope.com/observing/highlights/The-Eros-Parallax-Project-138301789.html http://www.space.com/14472-asteroid-eros-earth-flyby-skywatching.html http://en.wikipedia.org/wiki/433_Eros See also:**13 Aug 1898**, **23 Jan 1975**.
2012, Feb	N. deGrasse Tyson, A. Lang, 2012, *Space Chronicles - Facing the Ultimate Frontier* (New York: Norton & Co). See: http://books.wwnorton.com/books/Space-Chronicles/ See also:

	http://www.npr.org/2012/02/27/147351252/space-chronicles-why-exploring-space-still-matters
2012, Feb	J.P. Sanchez, C.R. McInnes, 2012, *Advances in Space Research*, 49, 667, "Synergistic approach of asteroid exploitation and planetary protection." See: http://adsabs.harvard.edu/abs/2012AdSpR..49..667S
2012, Feb	M. Todd, P. Tanga, D.M. Coward, M.G. Zadnik, 2012, *Monthly Notices Royal Astronomical Society* (Letters), 420, L28, "An optimal Earth Trojan asteroid search strategy." See: http://adsabs.harvard.edu/abs/2012MNRAS.420L..28T
2012, Feb 1-3	***Workshop on the Early Solar System Bombardment II***, Houston (TX, USA), 1-3 February 2012. See: http://www.lpi.usra.edu/meetings/bombardment2012/ **Among the presentations:** - W.F. Bottke, D. Vokrouhlicky, D. Minton, et al., 2012, *LPI Contribution* No. 1649, p.6-7, "The Great Archean Bombardment." See: http://adsabs.harvard.edu/abs/2012LPICo1649....6B - S. Goderis, J. Belza, Ph. Claesy, 2012, *LPI Contribution* No. 1649, p.26-27, "The impact cratering record for clues on the rate of collisions and provenance." See: http://adsabs.harvard.edu/abs/2012LPICo1649...26G - B.C. Johnson, H.J. Melosh, 2012, *LPI Contribution* No. 1649, p.32-33, "New estimates for the number of large impacts throughout Earth's history." See: http://adsabs.harvard.edu/abs/2012LPICo1649...32J - C. Koeberl, 2012, *LPI Contribution* No. 1649, p.40, "Search for a geochemical record of the Late Heavy Bombardment on Earth." See: http://adsabs.harvard.edu/abs/2012LPICo1649...40K - S. Marchi, W.F. Botke, D.A. Kring, A. Morbidelli, 2012, *LPI Contribution* No. 1649, p.45-46, "Two populations of early lunar impactors as recorded in its ancient crater population." See: http://adsabs.harvard.edu/abs/2012LPICo1649...45M - A. Morbidelli, S. Marchi, W.F. Bottke, 2012, *LPI Contribution No. 1649*, p.53-54, "The sawtimeline of the first billon year of lunar bombardment." See: http://adsabs.harvard.edu/abs/2012LPICo1649...53M - N. Schmedemann, T. Kneissl, G. Michael, et al., 2012, *LPI Contribution* No. 1649, p.75-76, "Crater size-frequency distributions and chronologies of asteroids." See: http://adsabs.harvard.edu/abs/2012LPICo1649...75S
2012, Feb 5	BBC Four, 5 February 2012, 00:35, "Asteroids – the Good, the Bad and the Ugly." See: http://www.bbc.co.uk/programmes/b00vv0w8

2012, Feb 13-15	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)** ***Scientific and Technical SubCommittee*****, 49th session,** in Vienna (Austria). **WG NEO and Action Team 14 on NEOs** did meet, chaired by Sergio Camacho (Mexico). **Report:** http://www.unoosa.org/oosa/en/COPUOS/stsc/2012/index.html http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L310E.pdf http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_1001E.pdf **Technical presentations:** - L. Johnson, 2012, "Near Earth Object Observation Program. Close approaches of 2011." See: http://www.unoosa.org/pdf/pres/stsc2012/tech-35E.pdf - J. Prado, 2012, "The case of **Apophis**." See: http://www.unoosa.org/pdf/pres/stsc2012/tech-36E.pdf - R.A. Williamson, 2012, "NEOs, the media, and risk communication. Report of a workshop." See: http://www.unoosa.org/pdf/pres/stsc2012/tech-46E.pdf See also: http://www.space.com/14683-big-asteroid-2011-ag5-threat-earth.html
2012, Feb 16	Aten NEA **367943 Duende** (**2012 DA14**, $H = 24.2$ mag, $D \approx 40 \times 20$ m), discovered by the Spanish **Observatorio Astronomico de la Sagra**, passed Earth at a nominal miss distance of 6.78 LD. Minimum miss distance 6.78 LD. See: 367943 Duende - SSA , 2012 DA14 - JPL See also: http://www.planetary.org/blogs/guest-blogs/3418.html https://en.wikipedia.org/wiki/367943_Duende See also: **17 Feb 1918**, **19 Aug 2004**, **15 Feb 2013**, **15 Feb 2046, 15 Feb 2087.**
2012, Feb 20	Apollo NEA **2012 DY13** ($H = 28.1$ mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2012-04]** See: 2012 DY13 - SSA , 2012 DY13 - JPL
2012, Feb 27	L. David, 2012, *Space.com*, 27 February 2012, "Big asteroid **2011 AG5** could pose threat to Earth in 2040." See: http://www.space.com/14683-big-asteroid-2011-ag5-threat-earth.html See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-051 http://www.jpl.nasa.gov/news/news.cfm?release=2012-051 http://www.space.com/14782-asteroid-threat-earth-impact-2011ag5.html http://blogs.discovermagazine.com/badastronomy/files/2012/03/schweikart_letter_NASA_AG5.pdf http://www.space.com/14872-asteroid-2011-ag5-earth-impact.html

2012, Mar	P.B. Babadzhanov, I.P. Williams, G.I. Kokhirova, 2012, *Monthly Notices Royal Astronomical Society*, 420, 2546, "Near-Earth object **2004 CK39** and its associated meteor showers." See: http://adsabs.harvard.edu/abs/2012MNRAS.420.2546B
2012, Mar	P.A. Bland, P. Spurný, A.W.R. Bevan, et al., 2012, *Australian Journal of Earth Sciences*, 59, 177, "The **Australian Desert Fireball Network**: a new era for planetary science." See: http://adsabs.harvard.edu/abs/2012AuJES..59..177B See also: http://www3.imperial.ac.uk/desertfireballnetwork
2012, Mar	A.S. Betzler, E.P. Borges, 2012, *Astronomy & Astrophysics*, 539, 158, "Non-extensive distributions of rotation periods and diameters of asteroids." The authors argue that the number of NEAs with $D >$ 1 km is 994 ± 30. See: http://adsabs.harvard.edu/abs/2012A%26A...539A.158B
2012, Mar	M. Ćuk, 2012, *Icarus*, 218, 69, "Chronology and sources of lunar impact bombardment." See: http://adsabs.harvard.edu/abs/2012Icar..218...69C
2012, Mar	J. Fang, J.-L. Margot, 2012, *Astronomical Journal*, 143, 59, "The role of Kozai cycles in near-Earth binary asteroids." See: http://adsabs.harvard.edu/abs/2012AJ....143...59F
2012, Mar	M. Granvik, J. Vaubaillon, R. Jedicke, 2012, *Icarus*, 218, 262, "The population of natural Earth satellites." See: http://adsabs.harvard.edu/abs/2012Icar..218..262G See also: http://www.ifa.hawaii.edu/info/press-releases/minimoons/ http://www.space.com/15151-earth-multiple-moons-asteroids.html
2012, Mar	D. Jewitt, 2012, *Astronomical Journal*, 143, 66, "The active asteroids." See: http://adsabs.harvard.edu/abs/2012AJ....143...66J
2012, Mar 1	Apollo NEA **2012 EZ1** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2012-05]** See: 2012 EZ1 - SSA , 2012 EZ1 - JPL
2012, Mar 1	**Oslo Meteorite**. A piece of a meteorite crashed through the roof of a garden hut in the middle of Oslo (Norway). The rock weighing 585 grams, which split in two, probably detached from a meteorite observed over Norway on March 1. The meteorite was identified

	as a breccia, or a rock composed of broken fragments. See: http://www.newsinenglish.no/2012/03/12/meteorite-smashed-through-oslo-roof/ http://news.9msn.com.au/technology/8434050/meteorite-chunk-falls-on-oslo http://www.space.com/14893-meteorite-crash-oslo-norway.html
2012, Mar 7	Apollo NEA **2008 EJ85** (H = 24.4 mag, $D \approx$ 50 m) passed Earth at a nominal miss distance of 7.68 LD. Minimum miss distance 0.92 LD. See: 2008 EJ85 - SSA , 2008 EJ85 - JPL
2012, Mar 7	J. Foust, 2012, *SpaceRef*, 7 March 2012, "Making the case for human missions to asteroids." See: http://www.spaceref.com/news/viewnews.html?id=1620
2012, Mar 9	G.S. Collins, 2012, *Science*, 335, 1176, "Moonstruck magnetism." See: http://www.sciencemag.org/content/335/6073/1176.summary See also: http://www.space.com/14836-asteroid-collision-moon-magnetism.html
2012, Mar 9	M.A. Wieczorek, B.P. Weiss, S.T. Stewart, 2012, *Science*, 335, 1212, "An impactor origin for lunar magnetic anomalies." See: http://www.sciencemag.org/content/335/6073/1212 See also: http://www.space.com/14836-asteroid-collision-moon-magnetism.html
2012, Mar 13	E. Nakamura, A. Makishima, T. Moriguti, et al., 2012, *Proc. National Academy of Sciences*, 109(11), E624, "Space environment of an asteroid preserved on micrograins returned by the ***Hayabusa*** spacecraft." See: http://www.pnas.org/content/109/11/E624.full.pdf+html?sid=e9c82620-acc1-4ac9-a373-aebd661fa82d See also: http://www.space.com/14691-asteroid-impacts-hayabusa-meteorite-samples.html http://adsabs.harvard.edu/abs/2012LPI....43.1375N
2012, Mar 19-23	***43rd Lunar and Planetary Science Conference***, 19-23 March 2012, The Woodlands (TX, USA). See: http://www.lpi.usra.edu/meetings/lpsc2012/ **Among the papers:** - P.A. Abell, B.W. Barbee, R.G. Mink, et al., 2012, *LPI Contribution* No. 1659, p.2842, "The **Near-Earth Object Human Space Flight Accessible Targets Study (NHATS)** list of Near-

	Earth Asteroids: identifying potential targets for future exploration." See: http://adsabs.harvard.edu/abs/2012LPI....43.2842A - M.A. Barucci, P. Michel, A. Cheng, et al., 2012, *LPI Contribution* No. 1659, p.1457, "***MarcoPolo-R***: Near Earth Asteroid sample return mission selected for ESA assessment study phase." See: http://adsabs.harvard.edu/abs/2012LPI....43.1457B - A. Bazso, 2012, *LPI Contribution* No. 1659, p.1809, "Lunar effects on close encounters of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2012LPI....43.1809B - E.B. Bierhaus, L. Dones, 2012, *LPI Contribution* No. 1659, p.2451, "Cratering by impact ejecta, from Mercury to the asteroids." See: http://adsabs.harvard.edu/abs/2012LPI....43.2451B - R.P. Binzel, D. Polishook, F.E. DeMeo, et al., 2012, *LPI Contribution* No. 1659, p.2222, "***Marco Polo-R*** target asteroid (**175706**) **1996 FG3**: possible evidence for an annual thermal wave." See: http://adsabs.harvard.edu/abs/2012LPI....43.2222B - P. Brown, T. Ens, W.N. Edwards, E.A Silber, 2012, *LPI Contribution* No. 1659, p.1581, "Global detection of airbursts: a combined satellite-infrasound study." See: http://adsabs.harvard.edu/abs/2012LPI....43.1581B - M. Bruck Syal, P.H. Schultz, D.S.P. Dearborn, R.A. Managan, 2012, *LPI Contribution* No. 1659, p.2480, "Porosity controls on asteroid defense strategies." See: http://adsabs.harvard.edu/abs/2012LPI....43.2480B - T.L. Dunn, T.H. Burbine, 2012, *LPI Contribution* No. 1659, p.2305, "Mineralogies of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2012LPI....43.2305D - C.W. Hergenrother, D.J. Scheeres, M. Nolan, et al., 2012, *LPI Contribution* No. 1659, p.2219, "Lightcurve and phase function photometry of the ***OSIRIS-REx*** target (**101955**) **1999 RQ36**." See: http://adsabs.harvard.edu/abs/2012LPI....43.2219H - K.R. Housen, K.A. Holsapple, 2012, *LPI Contribution* No. 1659, p.2539, "Deflecting asteroids by impacts: what is Beta?" See: http://adsabs.harvard.edu/abs/2012LPI....43.2539H - D.S. Lauretta, OSIRIS-REx Team, 2012, *LPI Contribution* No. 1659, p.2491, "An overview of the ***OSIRIS-REx*** asteroid sample return mission." See: http://adsabs.harvard.edu/abs/2012LPI....43.2491L - L.F. Lim, J.P. Emery, N.A. Moskovitz, M. Granvik, 2012, *LPI Contribution* No. 1659, id.2202, "The near-Earth encounter of **2005 YU55**: thermal infrared observations from Gemini North." See: http://adsabs.harvard.edu/abs/2012LPI....43.2202L - J.F. McCarthy, 2012, *LPI Contribution* No. 1659, p.1016, "A low

	cost approach to close-up examination of multiple Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2012LPI....43.1016M - N.A. Moskovitz, B. Yang, L.F. Lim, et al., 2012, *LPI Contribution* No. 1659, p.2080, "The near-Earth encounter of asteroid **2005 YU55**: visible and near-infrared spectroscopy." See: http://adsabs.harvard.edu/abs/2012LPI....43.2080M - A.S. Rivkin, E.S. Howell, F.E. DeMeo, et al., 2012, *LPI Contribution* No. 1659, p.1537, "New observations and proposed meteorite analogs of the ***MarcoPolo-R*** target asteroid (**175706**) **1996 FG3**." See: http://adsabs.harvard.edu/abs/2012LPI....43.1537R - I.M. Tielieusova, D.F. Lupishko, 2012, *LPI Contribution* No. 1659, p.1491, "The YORP-effect and axis rotation of Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2012LPI....43.1491T
2012, Mar 20	Website tool made available by the NASA/JPL **Near-Earth Object Program Office**, for identifying mission-accessible Near-Earth Asteroids and their next observing opportunities: the NASA ***Near-Earth Object Human Space Flight Accessible Targets Study* (NHATS)**. See: http://neo.jpl.nasa.gov/news/nhats.html
2012, Mar 26, 05:5	Apollo NEO **2012 FP35** (H = 28.0 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2012-06]** See: 2012 FP35 - SSA , 2012 FP35 - JPL See also: http://www.space.com/15043-small-asteroids-earth-close-shave.html https://en.wikipedia.org/wiki/2012_FP35
2012, Mar 26, 17:0	Apollo NEA **2012 FS35** (H = 30.1 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 0.168 LD. Minimum miss distance 0.167 LD. **[2012-07]** See: 2012 FS35 - SSA , 2012 FS35 - JPL See also: http://www.space.com/15043-small-asteroids-earth-close-shave.html See also: **25 Mar 2072**.
2012, Mar 26	***3rd MarcoPolo-R* Symposium: *Scientific objectives of MarcoPolo-R near-Earth asteroid sample return mission*,** Manchester (UK), 26 March 2012. See: http://www.oca.eu/MarcoPolo-R/Workshops/WorkshopsMarcoPolo-R.html
2012, Mar 27	I. Israde-Alcántara, J.L. Bischoff, G. Domínguez-Vázquez, et al.,

	2012, *Proceedings of the National Academy of Sciences*, 109(13), 4723, "Evidence from central Mexico supporting the Younger Dryas extraterrestrial impact hypothesis." See: http://www.pnas.org/content/109/13/E738.full.pdf+html?sid=aaa1f113-bd1c-44fa-8d8b-8a2fd5ab33e8 See also: http://www.space.com/14793-comet-earth-impact-younger-dryas.html
2012, Mar 27-28	Large new impact crater (48.5 m) on **Mars**, suggesting an impactor several meters in diameter. See: http://www.jpl.nasa.gov/spaceimages/details.php?id=PIA18384 See also: http://www.space.com/25980-huge-mars-crater-photos.html
2012, Mar 31	First light of first telescope of the **Las Cumbres Observatory Global Telescope (LCOGT)** network, Goleta (CA, USA). Eventually, the **LCOGT** network will deploy two or three identical 1-metre telescopes, each costing about US$1 million, at observatories in Hawaii, Chile, South Africa, Australia and the Canary Islands. **LCOGT** also has two 2-metre robotic Faulkes telescopes in Australia and Hawaii. See: http://lcogt.net/ See also: http://www.nature.com/news/global-observatory-sees-first-light-1.10384 http://adsabs.harvard.edu/abs/2012DPS....4421516L
2012, Apr	M.A. Barucci, A.F. Cheng, P. Michel, et al. 2012, *Experimental Astronomy,* 33, 645, "***MarcoPolo-R*** near earth asteroid sample return mission." See: http://adsabs.harvard.edu/abs/2012ExA....33..645B
2012, Apr	G. Cremonese, P. Borin, E. Martellato, et al., 2012, *Astrophysical Journal* (Letters), 749, L40, "New calibration of the micrometeoroid flux on Earth." See: http://adsabs.harvard.edu/abs/2012ApJ...749L..40C
2012, Apr	T.M. Eneev, R.Z. Akhmetshin, G.B. Efimov, 2012, *Cosmic Research*, 50, 93, "On the asteroid hazard." See: http://adsabs.harvard.edu/abs/2012CosRe..50...93E
2012, Apr	S. Greenstreet, B. Gladman, H. Ngo, et al., 2012, *Astrophysical Journal* (Letters), 749, L39, "Production of Near-Earth Asteroids on retrograde orbits." See: http://adsabs.harvard.edu/abs/2012ApJ...749L..39G
2012, Apr	A.W. Harris, G.B. Valsecchi, D. Morrison, 2012, in: I.F. Corbet

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2012, Apr	S.V. Karashevic, A.V. Devyatkin, I.A. Vereshchagina, et al., 2012, *Solar System Research*, 46, 130, "Astrometric and photometric studies of the **2009 WZ104** [**PHA**] asteroid as it approached the Earth." See: http://adsabs.harvard.edu/abs/2012SoSyR..46..130K
2012, Apr	V.A. Shor, Yu. A. Chernetenko, O.M. Kochetova, N.B. Zheleznov, 2012, *Solar System Research*, 46, 119, "On the impact of the Yarkovsky effect on **Apophis**' orbit." See: http://adsabs.harvard.edu/abs/2012SoSyR..46..119S
2012, Apr	K.J. Walsh, M. Delbò, M. Mueller, R.P. Binzel, F.E. DeMeo, 2012, *Astrophysical Journal*, 748, 104, "Physical characterization and origin of binary Near-Earth Asteroid (**175706**) **1996 FG3**." See: http://adsabs.harvard.edu/abs/2012ApJ...748..104W
2012, Apr 1	S. Marchi, W.F. Bottke, D.A. King, A. Morbidelli, 2012, *Earth and Planetary Science Letters*, 325-326, 27, "The onset of the **lunar** cataclysm as recorded in its ancient crater populations." See: http://adsabs.harvard.edu/abs/2012E%26PSL.325...27M See also: http://lunarscience.nasa.gov/articles/nlsi-scientists-shed-light-moons-impact-history/
2012, Apr 1	Apollo NEA **2012 EG5** (H = 24.5 mag, $D \approx$ 50 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2012-08]** See: 2012 EG5 - SSA , 2012 EG5 - JPL Ref: - M. Hicks, S. Teague, C. Strojia, 2012, *The Astronomer's Telegram*, #4016, "Optical photometry of **2012 EG5**: constraints on taxonomy and spin rate." See: http://adsabs.harvard.edu/abs/2012ATel.4016....1H See also: http://www.space.com/15121-april-fools-day-asteroid-earth-flyby.html https://en.wikipedia.org/wiki/2012_EG5
2012, Apr 15	The Chinese spacecraft ***Chang'e-2*** departed from L2 and began a mission to asteroid **4179 Toutatis** (**1989 AC**, H = 15.3 mag, D = 4.6 × 2.4 × 1.9 km, **NEA, PHA**). ***Chang'e 2*** was launched on 1 October 2010 for a lunar survey. On 8 June 2011, ***Chang'e-2*** completed its extended mission, and left lunar orbit for the L2 Lagrangian point, to

	test the Chinese tracking and control network. The spacecraft is expected to make a flyby of Near-Earth Asteroid **4179 Toutatis** on **13 December 2012**. See: http://en.wikipedia.org/wiki/Chang'e_2 Ref: - R. Stone, 2012, *Science*, 29 July 2012, "A new dawn for China's space scientists." See: http://www.sciencemag.org/content/336/6089/1630.summary?sid=87f26ee0-0564-40b0-9367-95573a612cfd
2012, Apr 19	Apollo NEA **2012 HM13** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2012-09]** See: 2012 HM13 - SSA , 2012 HM13 - JPL
2012, Apr 22	Apollo NEA **2017 HY** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 7.98 LD. Minimum miss distance 0.68 LD. See: 2017 HY - SSA , 2017 HY - JPL
2012, Apr 22	**California/Nevada Fireball and Airburst**, **Sutter's Mill Meteorite.** A bright ball of light traveling east to west was seen over the skies of central/northern California (USA) on April 22. Estimates of the object give it the size of a minivan, with a weight of ~70 metric tons and at the time of disintegration releasing an energy equivalent to a 5-kiloton explosion. See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-114 See also: http://www.space.com/15654-meteorite-hunt-california-fireball.html http://www.space.com/15666-meteorite-fragments-searched-sierra-nevada-mountains-video.html http://www.rgj.com/article/20120423/NEWS/304230032/Scientist-says-sound-signal-from-exploding-meteor-lasted-18-minutes?nclick_check=1 http://hscience.kqed.org/quest/2012/12/20/stardust-and-sunbreath-in-the-sutters-mill-meteorite/ http://en.wikipedia.org/wiki/List_of_meteor_air_bursts Ref: - P. Jenniskens, B. Girten, D. Sears, et al., 2012, *Meteoritics and Planetary Science Supplement*, 75, 5376, "Recovery of the **Sutter's Mill Meteorite**." See: http://adsabs.harvard.edu/abs/2012M%26PSA..75.5376J - E. Underwood, Dec. 2012, *Science*, 338, 1521, "**Sutter's Mill Meteorite** produces mother lode of research." See: http://www.sciencemag.org/content/338/6114/1521 - P. Jenniskens, M.D. Fries, Qing-Zhu Yin, et al., (the **Sutter's Mill Meteorite** Consortium), Dec. 2012, *Science*, 338, 1583, "Radar-enabled recovery of the **Sutter's Mill Meteorite**, a

	carbonaceous chondrite regolith breccia." See: http://www.sciencemag.org/content/338/6114/1583.abstract
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2012, May 19	Apollo NEA **2010 KK37** (H = 26.0 mag, $D \approx 23$ m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.15 LD. **[2012-12]** See: 2010 KK37 - SSA , 2010 KK37 - JPL
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2012, May 24-28	***International Space Development Conference***, Washington, D.C. (USA), 24-28 May 2012. See: http://isdc.nss.org/2012/ **Among the papers:**

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2012, May 28	Apollo NEA **2012 KP24** (*H* = 26.2 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.149 LD. Minimum miss distance 0.149 LD. **[2012-13]** See: 2012 KP24 - SSA , 2012 KP24 - JPL See also: http://www.space.com/15891-85-foot-asteroid-zooms-earth-memorial-day-orbit-diagram-video.html http://www.space.com/15895-double-asteroid-earth-flyby.html http://blogs.discovermagazine.com/badastronomy/2012/05/25/small-asteroid-to-buzz-earth-on-may-28/ https://en.wikipedia.org/wiki/2012_KP24 See also: **30 May 1939**.
2012, May 29	***AIDA*** study. The ***Asteroid Impact & Deflection Assessment*** (***AIDA***) mission is a joint study effort of ESA, JHU/APL, NASA, OCA and DLR. The mission design foresees two independent spacecraft, one impactor (***DART***) and one rendezvous probe (***AIM***). As in the separate ***DART*** and ***AIM*** studies, the target of this mission is the binary **NEA** system **65803 Didymos** (**1996 GT**, *H* = 18.1 mag, *D* = 780 + 160 m, **PHA**). Foreseen launch: 2020. Rendez-vous: October 2022. See: 65803 Didymos - SSA , 1996 GT -JPL See also: http://www.esa.int/esaMI/NEO/SEMH9CTWT1H_0.html http://www.esa.int/esaMI/NEO/SEMAWBTWT1H_0.html http://www.esa.int/Our_Activities/Technology/NEO/Asteroid_deflection_mission_seeks_smashing_ideas http://www.lpi.usra.edu/sbag/meetings/jan2013/presentations/sbag8_presentations/MON_1000_SBAG_ESA_NEO_explo%20studies_final.pdf http://www.hou.usra.edu/meetings/ipm2016/pdf/4043.pdf http://kwbu.org/post/nasa-designing-spacecraft-could-nudge-asteroids-out-earth-s-way#stream/0 Ref: - A. Galvez, I. Carnelli, M. Fontaine, C.C. Van Damme, 2012, *European Planetary Science Congress*, September 2012, EPSC Abstracts, Vol. 7 EPSC2012-807, "Asteroid impact mission (***AIM***) & deflection assessment: an opportunity to understand impact dynamics and modelling." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-807.pdf - A.F. Cheng, P. Michel, C. Reed, et al., 2012, *European Planetary Science Congress* September 2012, EPSC Abstracts, Vol. 7

	EPSC2012-935-1, "***DART***: ***Double Asteroid Redirection Test***." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-935-1.pdf - A.F. Cheng, A. Rivkin, A. Galvez, et al., October 2012, American Astronomical Society, DPS meeting #44, #215.03, "***AIDA: Asteroid Impact & Deflection Assessment***." See: http://adsabs.harvard.edu/abs/2012DPS....4421503C - A.M. Stickle,J.A. Atchison, O.S. Barnouin, et al., 2015, AAS DPS meeting #47, #312.14, "Modeling momentum transfer by the DART spacecraft into the moon of Didymos." See: http://adsabs.harvard.edu/abs/2015DPS....4731214S See also: http://www.space.com/19303-asteroid-deflection-europe-spacecraft.html http://www.space.com/20341-asteroid-collision-aida-spacecraft-2022.html https://motherboard.vice.com/en_us/article/bmv3w4/heres-what-the-european-space-agency-agreed-to-pay-for-in-the-next-three-years See also: **12 Nov 2003**, **4 Oct 2022**, **20 Oct 2062**, **4 Nov 2123**.
2012, May 29	**NASA Workshop on** ***Potentially Hazardous Asteroid 2011 AG5***, NASA GSFC, Greenbelt (MD, USA), 29 May 2012. See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-178 http://neo.jpl.nasa.gov/news/news175.html http://neo.jpl.nasa.gov/neo/2011_AG5_Deflection_Study_report_13.pdf http://neo.jpl.nasa.gov/neo/2011_AG5_exec_summary.pdf http://neo.jpl.nasa.gov/neo/2011_AG5_workshop_sum.pdf http://neo.jpl.nasa.gov/neo/2011_AG5_LN_intro_wksp.pdf See also: http://www.space.com/16169-earth-safe-asteroid-2011ag5-flyby.html
2012, May 29	Apollo NEA **2012 KT42** ($H = 28.6$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.054 LD **(= 3.3 R_{Earth} from the geocenter)**. Minimum miss distance 0.054 LD. **[2012-14]** See: 2012 KT42 - SSA , 2012 KT42 - JPL See also: http://www.space.com/15895-double-asteroid-earth-flyby.html http://www.slashgear.com/recently-discovered-asteroid-passes-very-near-earth-29230628/ http://www.nature.com/news/astronomers-catch-video-of-near-miss-asteroid-1.10873 http://www.space.com/16347-close-asteroid-flyby-2012-kt42.html https://en.wikipedia.org/wiki/2012_KT42 See also: **3 Dec 1915**, **4 Dec 1954**.
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2012, Jun 10-11	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS, 55th session) and Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico), did meet in Vienna (Austria). See: http://www.oosa.unvienna.org/oosa/en/COPUOS/index.html http://www.oosa.unvienna.org/pdf/gadocs/A_67_20E.pdf
2012, Jun 14	Amor NEA **2012 LZ1** (*H* = 20.1 mag, *D* ≈ 500 m, **PHA**) passed Earth at a nominal miss distance of 14.2 LD. See: 2012 LZ1 - SSA , 2012 LZ1 - JPL Ref: - M. Hicks, W. Smythe, T. Davtyan, et al., 2012, *The Astronomer's Telegram*, #4252, "Broadband photometry of **2012 LZ1**: a large, dark **P**otentially **H**azardous **A**steroid." See: http://adsabs.harvard.edu/abs/2012ATel.4252....1H See also: http://www.space.com/16131-huge-asteroid-flyby-2012-lz1-webcast.html http://www.space.com/16154-asteroid-2012-lz1-earth-flyby.html http://www.usra.edu/news/pr/2012/asteroid_LZ1/?tw_p=twt http://www.space.com/16263-asteroid-2012lz1-size-earth-flyby.html http://phys.org/news/2012-06-arecibo-observatory-asteroid-lz1-big.html https://en.wikipedia.org/wiki/2012_LZ1
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2012, Jun 21	Apollo NEA **2012 MF7** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2012-15]** See: 2012 MF7 - SSA , 2012 MF7 - JPL
2012, Jun 23	Apollo NEA **496860** (**1999 XL136**, *H* = 19.4 mag, *D* ≈ 500 m, **PHA**) passed Earth at a nominal miss distance of 4.49 LD.

	Minimum miss distance 4.49 LD. See: 1999 XL136 - SSA , 1999 XL136 - JPL See also: **22 Jun 1951**.
2012, Jun 28	***Sentinel Space Telescope Mission***. The **B612 Foundation** announced plans to build, launch and operate the ***Sentinel Space Telescope Mission*** during a press conference at the Morrison Planetarium at the California Academy of Sciences in San Francisco (CA, USA). From the press release: "***Sentinel*** is a space-based infrared (IR) survey mission to discover and catalog 90 percent of the asteroids larger than 140 meters in Earth's region of the solar system. The mission should also discover a significant number of smaller asteroids down to a diameter of 30 meters. ***Sentinel*** will be launched into a Venus-like orbit about the sun which significantly improves the efficiency of asteroid discovery during its 5.5 year mission. The spacecraft and instrument use high-heritage flight proven deep space systems, originally developed by NASA, to minimize technical and programmatic risks. These heritage missions include large space based telescopes (***Spitzer***, ***Kepler***), a large format camera made up of many individual detectors (***Kepler***), and a cryogenically cooled instrument (***Spitzer***). By detecting and tracking nearly all of the Near Earth Objects greater than 50 meters in diameter, ***Sentinel*** will create a map of the solar system in Earth's neighborhood enabling future robotic and manned exploration. The ***Sentinel*** data will also identify objects that are potentially hazardous to humans to provide an early warning to protect the Earth from impact." Foreseen launch: 2018. Ref: - R. Schweickart, 15 February 2013, The Guardian, "Meteor and asteroid events give new focus for our vital ***Sentinel*** telescope." See: http://www.guardian.co.uk/commentisfree/2013/feb/15/meteor-strike-asteroid-pass-sentinel-telescope - E.T. Lu, H. Reitsema, J. Troeltzsch, S. Hubbard, March 2013, *New Space*, 1, 42, "The **B612 Foundation** ***Sentinel Space Telescope***." See: http://online.liebertpub.com/doi/pdfplus/10.1089/space.2013.1500 - M.W. Buie, H. Reitsema, 2015, "Sentinel mission performance for surveying the near-earth object population." See: http://sentinelmission.org/wp-content/uploads/2015/04/sentinel-paper-from-Lunar-P.pdf? See also: http://b612foundation.org/b612/ http://b612foundation.org/media/sentinelmission/ http://b612foundation.org/downloads/pressRelease_6_28.zip http://b612web.ex3host.com/downloads/FactSheet.zip

	http://b612web.ex3host.com/downloads/PRESSKIT.zip http://us5.campaign-archive2.com/?u=bf912fc28576855153d8f5e1c&id=15db3ea5e1 http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1545_Buie_B612 http://b612foundation.org/tedxmarinedsept2012/ http://www.space.com/16214-deep-space-asteroid-telescope-announcement.html http://www.space.com/16337-asteroid-telescope-deep-space-announcement.html http://www.space.com/16338-sentinel-private-telescope-asteroids.html http://blogs.discovermagazine.com/badastronomy/2012/06/28/privately-and-publicly-looking-for-earth-threatening-asteroids/ http://www.space.com/16341-sentinel-space-telescope-asteroid-mission-pictures.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+spaceheadlines+(SPACE.com+Headline+Feed) http://www.space.com/16345-private-foundation-gets-into-hunting-asteroids-business-video.html http://news.nationalgeographic.com/news/2012/06/120628-first-private-asteroid-mission-sentinel-b612-nasa-space-science/ http://www.nature.com/news/private-foundation-plans-space-telescope-1.10918 http://www.thespacereview.com/article/2111/1 http://www.space.com/16501-private-space-telescope-asteroid-mining.html http://www.universetoday.com/96727/schweickart-private-asteroid-mission-is-for-the-benefit-of-humanity/ http://www.space.com/18020-private-asteorid-hunting-telescope-sentinel.html http://www.space.com/20636-private-asteroid-space-telescope-b612.html http://dotearth.blogs.nytimes.com/2013/02/20/can-humans-do-better-than-dinosaurs-when-it-comes-to-incoming-space-objects/ http://spaceref.com/news/viewsr.html?pid=43620 http://b612foundation.org/rustys-post-an-asteroid-with-our-address/ http://b612foundation.org/rustys-post-changing-the-orbit-of-an-asteroid/ http://b612foundation.org/rustys-post-about-keyholes/ See also: **23 Jan 2010**.
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2012, Jul 10-11	**Seventh NASA *Small Bodies Assessment Group* meeting**, 10-11 July 2012, Pasadena (CA, USA). See: http://www.lpi.usra.edu/sbag/ http://www.lpi.usra.edu/sbag/meetings/jul2012/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - M.V. Sykes, 2012, Welkom & Report. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_0830_Sykes_Welcome.pdf - M. Bernstein, 2012, Update on research programs relevant to Small Bodies. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_0915_Bernstein_RA.pptx - L. Johnson, 2012, Status and plans for the **NEOO** program. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_0945_Johnson_NEOO.pptx - L. Johnson, 2012, HQ response to SBAG-6 findings. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_0945_Johnson_Findings.pdf - L.F. Lim, 2012, ***OSIRIS-REx***. Asteroid sample return mission. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1415_Lim_OSIRIS_REx.pdf - M. Zolensky, 2012, ***Hayabusa*** update. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1430_Zolensky_Hayabusa.pdf P. Weissman, 2012, ***Rosetta*** update. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1445_Weissman_Rosetta.pdf - A. Mainzer, Near-Earth Object camera ***NEOCam***. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1515_Mainzer_NEOCam_compressed.pdf - M. Buie, **B612 Foundation**, Ball Aerospace, 2012, The ***Sentinel*** mission. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1545_Buie_B612 - C. Lewicki, 2012, **Planetary Resources, Inc**. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1615_Lewicki%20PRI.pdf - J. Brophy, L. Friedman, F. Culick, 2012, Asteroid retrieval mission study. See: http://www.lpi.usra.edu/sbag/meetings/jul2012/presentations/TUES_1645_Brophy_Asteroid_Return.pdf
2012, Jul 21	First Light Gala celebration for commissioning of the **Discovery Channel Telescope**, a 4.3 m telescope at Lowell Observatory, Flagstaff (AZ, USA) with 2.3-degree FoV, dedicated to NEO research down to $v = 23.8$ mag, in collaboration with Discovery Communications.

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2012, Jul 22	Apollo NEA **153958** (**2002 AM31**, *H* = 18.3 mag, *D* ≈ 800 m, **PHA**) passed Earth at a nominal miss distance of 13.7 LD. See: 153958 2002 AM31 - SSA , 2002 AM31 - JPL See also: http://www.universetoday.com/96384/watch-a-near-earth-asteroid-zoom-by/ http://www.dailymail.co.uk/sciencetech/article-2176561/Asteroid-nearly-mile-wide-sail-past-Earth-Sunday.html?ito=feeds-newsxml http://www.space.com/16802-near-earth-asteroid-fly-by-captured-by-observatory-video.html
2012, Jul 25	**Prince Albert Impact Crater**. Researchers from the University of Saskatchewan (Canada) and the Geological Survey of Canada (GSC) have discovered, in 2010, a massive meteor impact from millions of years ago in Canada's western Arctic. *D* ≈ 25 km. See: http://news.usask.ca/2012/07/25/researcher-discovers-new-impact-crater-in-the-arctic/ http://phys.org/news/2012-08-impact-crater-arctic.html http://www.thestar.com/news/canada/article/1231556--meteorite-crater-25-km-wide-discovered-in-arctic http://en.wikipedia.org/wiki/Prince_Albert_Impact_Crater
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2012, Aug	C.R. Nugent, J.L. Margot, S.R. Chesley, D. Vokrouhlický, 2012, *Astronomical Journal*, 144, 60, "Detection of semi-major axis drifts in 54 Near-Earth Asteroids: new measurements of the Yarkovsky effect." See: http://adsabs.harvard.edu/abs/2012AJ....144...60N
2012, Aug	S. Pizzarello, 2012, *Astrophysical Journal* (Letters), 754, L27, "Hydrogen cyanide in the **Murchison Meteorite**." See: http://adsabs.harvard.edu/abs/2012ApJ...754L..27P
2012, Aug	E. Schunová, M. Granvik, R. Jedicke, et al., 2012, *Icarus*, 220, 1050, "Searching for the first Near-Earth Object family." See: http://adsabs.harvard.edu/abs/2012Icar..220.1050S See also: http://spaceref.com/news/viewsr.html?pid=41300
2012, Aug	D. Qiao, P. Cui, H. Cui, 2012, *Advances in Space Research*, 50(3), 327, "Proposal for a multiple-asteroid-flyby mission with sample return" See: http://adsabs.harvard.edu/abs/2012AdSpR..50..327Q
2012, Aug 8	**Midwest U.S. Fireball**. See: http://www.space.com/12661-meteorites-midwest-meteor-fireball-ohio.html
2012, Aug 10	C.M.O'D. Alexander, R. Bowden, M.L. Fogel, et al., 2012, *Science*, 337, 620; 337, 721, "The provenances of asteroids, and

	their contributions to the volatile inventories of the terrestrial planets." See: http://adsabs.harvard.edu/abs/2012Sci...337..721A See also: http://www.space.com/16556-asteroid-impacts-earth-water.html
2012, Aug 12-17	***75th Annual Meeting of the Meteoritical Society***, Cairns (Australia), 12 - 17 August 2012. See: http://shrimp.anu.edu.au/metsoc2012/Welcome.html http://www.meteoriticalsociety.org/simple_template.cfm?code=news_meetings&CFID=9258641&CFTOKEN=28349361 **Among the papers:** - R.D. Acevedo, M. Rocca, J. Rabassa, et al., 2012, *Meteoritics and Planetary Science Supplement*, 75, 5043, "Near Earth Asteroids: a classification system according to their shapes." See: http://adsabs.harvard.edu/abs/2012M%26PSA..75.5043A - P. Jenniskens, B. Girten, D. Sears, et al., September 2012, *Meteoritics and Planetary Science Supplement*, 75, 5376, "Recovery of the **Sutter's Mill Meteorite**." See: http://adsabs.harvard.edu/abs/2012M%26PSA..75.5376J
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2012, Aug 14	M. Fessenden, 2012, *Scientific American*, 307, 23, "Meteor hunt." See: http://www.nature.com/scientificamerican/journal/v307/n3/full/scientificamerican0912-23.html
2012, Aug 16	Apollo NEA **4581 Asclepius** (**1989 FC**, $H = 20.9$ mag, $D \approx 230$ m, **PHA**) passed Earth at a nominal miss distance of 42.0 LD. Minimum miss distance 42.0 LD. See: 4581 Asclepius - SSA , 1989 FC - JPL See also: http://en.wikipedia.org/wiki/4581_Asclepius See also: **22 Mar 1989**, **24 Mar 2051**.
2012, Aug 21	**Battle Mountain Fireball and Meteorite**. Observed between Reno and Salt Lake City (USA). See: http://www.jpl.nasa.gov/news/news.php?release=2012-320 http://fieldmuseum.org/users/philipp-heck/blog/battle-mountain-

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	The XXVIIIth General Assembly of the International Astronomical Union, *recognizing* - that there is now ample evidence that the probability of catastrophic impacts of Near-Earth Objects (NEOs) onto the Earth, potentially highly destructive to life, and for humankind in particular, is not negligible and that appropriate actions are being developed to avoid such catastrophes; - that for the largest NEOs, thanks to the efforts of the astronomical community and of several space agencies, the cataloguing of the potentially hazardous ones, the monitoring of their impact possibilities, and the analysis of technologically feasible mitigations is reaching a satisfactory level; - that even the impact of small- to moderate-sized objects may represent a great threat to our civilizations and to the international community; - that our knowledge of the number, size, and orbital behaviour of smaller objects is still very limited, thus not allowing any reasonable anticipation on the likelihood of future impacts, *noting* that NEOs are a threat to all nations on Earth, and therefore that all nations should contribute to avert this threat, *recommends* that the IAU National Members work with the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and the International Council for Science (ICSU) to coordinate and collaborate on the establishment of an **International NEO Early Warning System**, relying on the scientific and technical advice of the relevant astronomical community, whose main purpose is the reliable identification of potential NEO collisions with the Earth, and the communication of the relevant parameters to suitable decision makers of the nation(s) involved. Ref: - Montmerle, T. (ed.), 2015, *Transactions IAU XXVIIIB*, Proceedings of the Twenty Eighth General Assembly, Beijing, China, 2012, p.39, "Resolution B3, on the establishment of an international early warning system." See: https://doi.org/10.1017/S1743921315005463
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2012, Sep	**Space Generation Advisory Council *Move an asteroid 2012 competition*** award winner announcement: Sung Wook Paek, a graduate student in the MIT Department of Aeronautics and Astronautics. See: http://spacegeneration.org/index.php/eventstopics/news/604-sgacs-near-earth-object-neo-working-group-announces-the-fifth-annual-move-an-asteroid-technical-p http://spacegeneration.org/index.php/activities/current-projects/neo-working-group/move-asteroid-2012 http://web.mit.edu/newsoffice/2012/deflecting-an-asteroid-with-paintballs-1026.html
2012, Sep 4	NASA announces asteroid naming contest for students. See: http://planetary.org/get-involved/contests/osirisrex/ http://www.nasa.gov/topics/solarsystem/features/name-asteroid.html See also: http://www.space.com/17497-nasa-asteroid-naming-contest-1999-

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2012, Sep 14, 05:14	Apollo NEA **2012 QG42** (H = 20.9 mag, $D \approx$ 230 m, **PHA**) passed Earth at a nominal miss distance of 7.43 LD. Minimum miss distance 7.43 LD. See: 2012 QG42 - SSA , 2012 QG42 - JPL See also: http:///news.nationalgeographic.com/news/potentially-hazardous-asteroid-double-flyby-astronomy/
2012, Sep 14, 22:56	Apollo NEA **2012 QC8** (H = 17.8 mag, $D \approx$ 1000 m) passed Earth at a nominal miss distance of 22.7 LD. Minimum miss distance 22.7 LD. See: 2012 QC8 - SSA , 2012 QC8 - JPL See also: http://news.nationalgeographic.com/news/potentially-hazardous-asteroid-double-flyby-astronomy/
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2012, Sep 21	**U.K. Fireball**. See: http://www.space.com/17740-dazzling-meteor-fireball-video-

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2012, Sep 23-28	***European Planetary Science Congress 2012* (EPSC)**, IFEMA-Feria de Madrid, Madrid (Spain), 23-28 September 2012. See: http://www.epsc2012.eu/ http://meetingorganizer.copernicus.org/EPSC2012/sessionprogramme/SB http://meetingorganizer.copernicus.org/EPSC2012/oral_program/11492 **Among the papers:** - J. Agarwal, D. Jewitt, H. Weaver, et al., 2012, "**P/2010 A2** – impact or rotational break-up?" See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-729.pdf - M.A. Barucci , P. Michel, H. Böhnhardt, et al., 2012, "***MarcoPolo-R*** mission: tracing the origins." See: http://adsabs.harvard.edu/abs/2012epsc.conf..157B - J. Borovička, P. Spurný, 2012, "A semi-empirical model of atmospheric fragmentation of meteoroids." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-31.pdf - A. Campo Bagatin, A. Rossi, R.A. Alemañ, et al., 2012, "**1996 FG3**, ***MarcoPolo-R*** mission target: living on the edge." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-542-1.pdf - A.F. Cheng, P. Michel, C. Reed, et al., 2012, "***DART***: ***Double Asteroid Redirection Test***." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-935-1.pdf - M. Delbò, K. Walsh, 2012, "Where do the primitive NEOs come from? A new asteroid family may be a primary source." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-622.pdf - J. de Leon, V. Lorenzi, V. Alí-Lagoa, et al., 2012, "Additional spectra of binary asteroid **1996 FG3**, primary target of the ESA ***MarcoPolo-R*** mission." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-230-1.pdf - L. Egorova, V. Lokhin, 2012, "On the mechanism of crushing meteoroid with end flash effect." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-769.pdf - J. Flohrer, J. Oberst, D. Heinlein, T. Grau, 2012, "**The European Fireball Network** 2011 - status of cameras and observation results in Germany." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-441.pdf - A. Galvez, I. Carnelli, M. Fontaine, C. Corral Van Damme, 2012, "***Asteroid Impact Mission*** (***AIM***) & deflection assessment: an opportunity to understand impact dynamics and modelling." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-807.pdf - M.I. Gritsevich, 2012, "Coupling approaches used in atmospheric entry models." See: http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-910.pdf - A.W. Harris, M.A. Barucci, J.L. Cano, et al., 2012, "**NEOShield**: working towards an international near-Earth object mitigation

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2012, Oct 9	Apollo NEA **2012 TM79** (*H* = 26.8 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 0.24 LD. Minimum miss distance 0.24 LD. **[2012-17]** See: 2012 TM79 - SSA , 2012 TM79 - JPL
2012, Oct 10-12	***International Workshop on Instrumentation for Planetary Missions***, 10-12 October 2012, NASA Goddard Space Flight Center, Greenbelt (MD, USA). See: http://ssed.gsfc.nasa.gov/IPM/index.html
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2012, Nov 5	Apollo NEA **214869** (**2007 PA8**, $H = 16.6$ mag, $D \approx 1900 \times 1400 \times 1300$ m, **PHA**), passed Earth at a nominal miss distance of 16.85 LD. Minimum miss distance 16.85 LD. See: 214869 2007 PA8 - SSA , 2007 PA8 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-350 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-369 http://adsabs.harvard.edu/abs/2012ATel.4625....1H https://en.wikipedia.org/wiki/(214869)_2007_PA8
2012, Nov 6	Pristine Moon crater **Linné** could help unlock impacts' secrets on Earth. See: http://www.space.com/18354-virgin-moon-crater-reveals-vital-secrets-of-impacts-video.html http://www.space.com/18361-linne-crater-moon-nasa-lro.html http://en.wikipedia.org/wiki/Linn%C3%A9_(crater) Ref.: - J.B. Garvin, M.S. Robinson, J. Frawley, et al., 2011, in: *42nd Lunar and Planetary Science Conference*, "**Linné**: simple lunar mare crater geometry from ***LRO*** observations." See: http://www.lpi.usra.edu/meetings/lpsc2011/pdf/2063.pdf
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	See: 2012 VH77 - SSA , 2012 VH77 - JPL
2012, Nov 14	Apollo NEA **2012 VJ38** (*H* = 28.7 mag, *D* ≈ 6 m), passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD. **[2012-20]** See: 2012 VJ38 - SSA , 2012 VJ38 - JPL
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2012, Nov 20	A. Mainzer, T. Grav, J. Masiero, et al., 2012, *Astrophysical Journal* (Letters), 760, L12, "Physical parameters of asteroids estimated from the ***WISE*** 3 Band data and **NEOWISE** post-cryogenic survey." See: http://adsabs.harvard.edu/abs/2012ApJ...760L..12M
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2012, Dec 11	Apollo NEA **2012 XE54** (H = 24.5 mag, $D \approx$ 50 m), passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.58 LD. **[2012-21]** See: 2012 XE54 - SSA , 2012 XE54 - JPL See also: http://www.universetoday.com/98923/two-asteroids-will-buzz-past-earth-on-december-11/ http://www.space.com/18854-newfound-asteroid-close-flyby-earth.html
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2012, Dec 12	Apollo NEA **4179 Toutatis** (**1989 AC**, H = 15.2 mag, D = 4.6 × 2.4 × 1.9 km, orbital P = 4.03 yr, **PHA**) passed Earth at a nominal miss distance of 18.0 LD. Minimum miss distance 18.0 LD. See: 4179 Toutatis - SSA , 1989 AC - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-397 http://www.jpl.nasa.gov/video/index.php?id=1175 http://www.planetary.org/blogs/emily-lakdawalla/2012/12061004-toutatis-preview.html http://www.space.com/18843-asteroid-toutatis-flyby-webcasts.html

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2012, Dec 13	Flyby of **4179 Toutatis** (**1989 AC**, *H* = 15.3 mag, *D* = 4.6×2.4×1.9 km, Apollo NEA**, PHA**), at an altitude of just 3.2 km and at a relative velocity of 10.73 km/s, by the Chinese spacecraft ***Chang'e-2***, launched on 1 October 2010 for a lunar survey mission. On 8 June 2011, ***Chang'e-2*** left lunar orbit for the L2 Lagrangian point, to test the Chinese tracking and control network. It departed from L2 on 15 April 2012, heading for **4179 Toutatis**, the largest **PHA** known. See: http://en.wikipedia.org/wiki/Chang'e_2 See also: http://www.planetary.org/blogs/emily-lakdawalla/2012/12061004-toutatis-preview.html http://www.planetary.org/blogs/emily-lakdawalla/2012/12141551-change-2-imaging-of-toutatis.html http://cosmiclog.nbcnews.com/_news/2012/12/15/15919205-new-milestone-for-china-probe-snaps-close-ups-of-asteroid-toutatis?lite http://www.lpi.usra.edu/sbag/meetings/jan2013/presentations/sbag8_presentations/TUES_0930_CE_Toutatis.pdf
2012, Dec 14	Apollo NEA **2012 XB112** (*H* = 30.1 mag, *D* ≈ 3 m), passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2012-22]** See: 2012 XB112 - SSA , 2012 XB112 - JPL
2012, Dec 15	Apollo NEA **2012 XL134** (*H* = 28.1 mag, *D* ≈ 9 m), passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.71 LD. **[2012-23]** See: 2012 XL134 - SSA , 2012 XL134 - JPL
2012, Dec 17	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS),** *Near-Earth objects, 2012-2013, Final report of the Action Team 14 on Near-Earth Objects.* See: http://www.unoosa.org/pdf/limited/c1/AC105_C1_L330E.pdf
2012, Dec 21	**UN - Committee on the Peaceful Uses of Outer Space (UN-**

	COPUOS), *Near-Earth objects, 2011-2012. Recommendations of the Action Team on Near-Earth Objects for an international response to the near-Earth object impact threat.* See: http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L329E.pdf
2012, Dec 21	E. Underwood, 2012, *Science*, 338, 1521, "**Sutter's Mill Meteorite** produces mother lode of research." See: http://www.sciencemag.org/content/338/6114/1521
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2013, Jan 15	Apollo NEA **2013 BR27** (H = 28.0 mag, $D \approx$ 9 m), passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.56 LD. **[2013-01]** See: 2013 BR27 - SSA , 2013 BR27 - JPL
2013, Jan 22	**Deep Space Industries, Inc.**, a new private asteroid-mining company, presented an ambitious plan to exploit the resources of asteroids. See: http://www.space.com/19362-asteroid-mining-deep-space-industries.html http://www.space.com/19368-asteroid-mining-deep-space-industries.html http://www.space.com/19380-asteroid-mining-spaceflight-competition.html http://www.space.com/19462-asteroid-mining-deep-space-industries-birth.html
2013, Jan 26	Apollo NEA **2021 CY8** (H = 26.1 mag, $D \approx$ 22 m) passed Earth at a nominal miss distance of 3.02 LD. Minimum miss distance 0.79 LD. See: 2021 CY8 – S2P , 2021 CY8 - JPL
2013, Jan 28	Apollo NEA **2013 CY** (H = 28.4 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.90 LD. **[2013-02]** See: 2013 CY - SSA , 2013 CY - JPL
2013, Feb	M.-J. Kim, Y.-J. Choi, H.-K. Moon, et al., 2013, *Astronomy & Astrophysics*, 550, L11, "Optical observations of NEA **162173** (**1999 JU3**) during the 2011-2012 apparition." See: http://adsabs.harvard.edu/abs/2013A%26A...550L..11K

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2013, Feb 1	K. Miljković, G.S. Collins, S. Mannick, P.A. Bland, 2013, *Earth and Planetary Science Letters*, 363, 121, "Morphology and population of binary asteroid impact craters." See: http://adsabs.harvard.edu/abs/2013E%26PSL.363..121M
2013, Feb 5	Apollo NEA **2013 CY32** (H = 28.4 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[2013-03]** See: 2013 CY32 - SSA , 2013 CY32 - JPL
2013, Feb 8	H. Pälike, 2013, *Science*, 339, 655, "Impact and extinction." See: http://www.sciencemag.org/content/339/6120/655.summary
2013, Feb 8	P.R. Renne, A.L. Deono, F.J. Hilgen, et al. (including Klaudia Kuiper and Jan Smit), 2013, *Science*, 339, 684, "Time scales of critical events around the Cretaceous-Paleogene boundary." See: http://www.sciencemag.org/content/339/6120/684.abstract See also: http://www.livescience.com/26933-chicxulub-cosmic-impact-dinosaurs.html
2013, Feb 11	Apollo NEA **2013 CL129** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2013-04]** See: 2013 CL129 - SSA , 2013 CL129 - JPL
2013, Feb 11-22	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 50th session,**

	11-22 February 2013, Vienna (Austria). **WG NEO** and **Action Team 14 on NEOs**, chaired by Sergio Camacho (Mexico). **Report:** http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_1038E.pdf http://www.unoosa.org/oosa/en/COPUOS/stsc/2013/index.html http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L328E.pdf **Press release:** http://www.oosa.unvienna.org/pdf/misc/2013/at-14/at14-handoutE.pdf **Technical presentations:** - S. Camacho, 2013, "Report of the **Action Team on Near-Earth Objects**: recommendations for an international response to a NEO threat." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-01E.pdf - A. Harris, L. Drube, 2013, "Mitigation of the NEO impact threat." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-03E.pdf - L.N. Johnson, D. Koschny, 2013, "Recommendations of the Action Team on NEOs for an international response to the Near-Earth Object impact threat." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-04E.pdf - L.N. Johnson, 2013, "Flyby of **2012 DA14**: preliminary results." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-05E.pdf - L.N. Johnson, 2013, "**Chelyabinsk Event 15 Feb 2013**: initial preliminary analysis." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-06E.pdf - D. Koschny, "The status of ESA's Near-Earth Object segment." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/tech-36E.pdf - T. Spahr, "NEO threat detection and warning: plans for an international asteroid warning network." See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/2013neo-02E.pdf - D. Yeomans, 2013, NASA's Near-Earth Object Program Office and **2012 DA14**. See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/tech-33E.pdf - M. Yoshikawa, 2013, Japan's asteroid missions ***Hayabusa*** and ***Hayabusa 2***. See: http://www.oosa.unvienna.org/pdf/pres/stsc2013/tech-35E.pdf See also: http://www.space.com/19833-russia-meteor-asteroid-threat.html http://www.space.com/19840-asteroid-impact-threat-united- nations.html
2013, Feb 14	P. Lubin, G. Hughes, 2013, *UC Santa Barbera News Release*, "California scientists propose system to vaporize asteroids that threaten Earth." See: http://www.ia.ucsb.edu/pa/display.aspx?pkey=2943

2013, Feb 15	C.B. Agee, N.V. Wilson, F.M. McCubbin, et al., 2013, *Science*, 339, 780, "Unique meteorite from early Amazonian **Mars**: water-rich basaltic breccia **Northwest Africa 7034**." See: http://www.sciencemag.org/content/early/2013/01/02/science.1228858 See also: http://www.nasa.gov/mission_pages/mars/news/mars20130103.html http://www.space.com/19117-mars-meteorite-martian-missing-link.html
2013, Feb 15, 03:2	**Impact. Chelyabinsk Superbolide, Fireball, Airburst and Meteorite.** Infrasound data taken around the globe indicate that the pre-impacting asteroid had an estimated size of 17 to 20 meters and an estimated mass of 11,000 tons. It was an estimated 24th mag object just before impact. The asteroid approached the Earth along a direction that remained within 15 degrees of the direction of the Sun. Asteroid detection telescopes cannot scan regions of the sky this close to the Sun. The amount of energy released during the event was 440 kT TNT. The event took 32.5 seconds from atmospheric entry, with a velocity of ~18.6 km/s, to the meteorite's airborne disintegration at an altitude of 23.3 km. Three meteorite debris impact sites were found, two of which are in an area near Chebarkul Lake, west of Chelyabinsk (Ural, Russia). The third site was found ~ 80 km further to the northwest, near the town of Zlatoust. One of the fragments that struck near Chebarkul left a hole six meters in diameter in the frozen surface of a lake. The airburst shock wave, which arrived 88 seconds after the superbolide's flash, damaged numerous buildings, and blew out thousands of glass windows amid frigid winter weather. Over 1500 people needed medical attention for minor injuries. See: http://rt.com/news/meteorite-crash-urals-chelyabinsk-283/ http://marateaman.livejournal.com/27910.html http://www.space.com/19801-possible-meteor-blast-russia.html http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-061 http://www.jpl.nasa.gov/news/news.php?release=2013-061 http://blogs.nature.com/news/2013/02/incoming-russia-feels-meteor-blast.html http://science.time.com/2013/02/15/photos-russia-meteor-explosion-shatters-windows-injures-hundreds/#ixzz2OI5RTbA4 http://www.nytimes.com/2013/02/16/world/europe/meteorite-fragments-are-said-to-rain-down-on-siberia.html?nl=todaysheadlines&emc=edit_th_20130216&_r=1& http://articles.washingtonpost.com/2013-02-15/opinions/37117891_1_meteor-da14-earth http://www.space.com/19823-russia-meteor-explosion-complete-coverage.html http://www.space.com/19833-russia-meteor-asteroid-threat.html http://www.space.com/19834-russian-meteor-crash-trail-and-trajectory-

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2013, Feb 15, 19:26	Aten NEA **367943 Duende** (**2012 DA14**, $H = 24.2$ mag, $D \approx 40 \times 20$ m), discovered on 23 February 2012 by the Spanish **Observatorio Astronomico de la Sagra**, passed Earth at a nominal miss distance of 0.0886 LD **(= 5.35 R_{Earth} from the geocenter, i.e. 27,684 km from the Earth surface, i.e., well within the Geostationary Earth Orbit (35,786 km above the equator))**, with a relative velocity of 7.8 km/s. Minimum miss distance 0.086 LD. **[2013-05]** See: 367943 Duende - SSA , 2012 DA14 - JPL Ref: - J. de Leon, J.L. Ortiz, N. Pinilla-Alonso, et al., July 2013, *Astronomy & Astrophysics*, 555, L2, "Visible and near-infrared observations of asteroid **2012 DA14** during its closest approach of February 15th, 2013." See: http://adsabs.harvard.edu/abs/2013A%26A...555L...2D - I.Wlodarczyk, 2012, *Monthly Notices of the Royal Astronomical Society*, 427, 1175, "The potentially dangerous asteroid **2012 DA14**." See: http://adsabs.harvard.edu/abs/2012MNRAS.427.1175W - S. Urakawa, M. Fujii, H. Hanayama, et al., 25 August 2013, *Publications Astronomical Society of Japan*, 65, L9, "Visible spectroscopic observations of Near-Earth Object **2012 DA14**." See: http://adsabs.harvard.edu/abs/2013PASJ...65L...9U - T. Terai, S. Urakawa, J. Takahashi, et al., November 2013, *Astronomy & Astrophysics*, 559, 106, "Time-series photometry of Earth flyby asteroid **2012 DA14**." See: http://adsabs.harvard.edu/abs/2013A%26A...559A.106T - J. Takahashi, S. Urakawa, T. Terai, et al., June 2014, *Publications of the Astronomical Society of Japan*, Advance Access, "Near-infrared colors of asteroid **2012 DA14** at its closest approach to Earth: Observations with the **Nishiharima Infrared Camera (NIC)**." See: http://adsabs.harvard.edu/doi/10.1093/pasj/psu042 See also: http://www.oam.es/Asteroid_2012DA14.htm http://en.ria.ru/science/20120226/171543660.html

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2013, Mar 9, 02:41	Apollo NEA **2013 EC20** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2013-07]** See: 2013 EC20 - SSA , 2013 EC20 - JPL See also: **13 Mar 1999**.
2013, Mar 9, 12:09	Apollo NEA **2013 ET** (*H* = 23.4 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 2.54 LD. Minimum miss distance 2.54 LD. See: 2013 ET - SSA , 2013 ET - JPL See also: http://www.space.com/20149-asteroids-buzz-earth-week.html http://www.jpl.nasa.gov/news/news.php?release=2013-101 https://en.wikipedia.org/wiki/2013_ET See also: **12 Mar 2123**.
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- H. Busemann, C. Alwmark, U. Böttger, et al., 2013, LPI Contribution No. 1719, p.2243, "A Consortium Status Report: the characterisation of the asteroid Itokawa Regolith — a correlated study by X-ray tomography, micro-raman spectroscopy, and high-sensitivity noble gas analysis."
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- T.L. Dunn, T.H. Burbine, W.F. Bottke, J.P. Clark, 2013, LPI Contribution No. 1719, p.1197, "Mineralogies and source regions of Near Earth Asteroids."
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See: http://adsabs.harvard.edu/abs/2013LPICo1719.1479K
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2013, Apr 14	Apollo NEA **2010 GM23** (H = 25 mag, $D \approx$ 341 m) passed Earth at a nominal miss distance of 4.88 LD. Minimum miss distance 0.87 LD. See: 2010 GM23- SSA , 2010 GM23 - JPL
2013, Apr 14-19	***3rd International Academy of Astronautics (IAA) Planetary Defense Conference,*** Flagstaff (Arizona, USA), 15-19 April 2013. See: http://pdc.iaaweb.org/?q=content/2013-flagstaff See also: http://www.parabolicarc.com/2013/04/16/garver-nasa-to-seek-private-sector-partnership-on-asteroid-retrieval-mission/ **Conference videos:** http://livestream.com/pdc2013 **Conference report:** http://iaaweb.org/iaa/Scientific%20Activity/pdc2013report.pdf **Post Exercise report:** http://iaaweb.org/iaa/Scientific%20Activity/postexercisereport2013.pdf **Presentations:** **April 14** **Special Session: Preliminary Look At The Chelyabinsk Event.** - D.A. Kring, 2013, "A geologic and meteoritic perspective of impact airbursts and insights into the **Chelyabinsk event**."

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2013, Jun 8	Apollo NEA **2013 LR6** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.29 LD. **[2013-09]** See: 2013 LR6 - SSA , 2013 LR6 - JPL See also: http://www.jpl.nasa.gov/news/news.php?release=2013-195 http://www.space.com/21477-garbage-truck-sized-asteroid-to-give-earth-close-buzz-video.html http://www.ngrguardiannews.com/index.php?option=com_content&view=article&id=124325:another-asteroid-flyby-awesome-2&catid=93:science&Itemid=608
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	http://www.springer.com/engineering/electronics/book/978-3-642-39243-6
2013, Jun 12-21	**UN - Committee on the Peaceful Uses of Outer Space** (**UN-COPUOS**, 56th session) did meet in Vienna (Austria). **WG NEO and Action Team 14 on NEOs** did meet, chaired by Sergio Camacho (Mexico). See: http://www.oosa.unvienna.org/oosa/en/COPUOS/index.html http://www.oosa.unvienna.org/pdf/limited/l/AC105_L286_advance-edited-versionE.pdf **Report:** http://www.oosa.unvienna.org/pdf/gadocs/A_68_20E.pdf See also: http://www.un.org/apps/news/story.asp?NewsID=45211&Cr=outer+space&Cr1=#.UnePiFOtOSo
2013, Jun 12	M. Green, J. Hess, T. Lacroix, et al., 2013, *Techbriefs Create the Future*, 11 June 2013, "Near Earth Asteroids: the celestial chariots." See: http://adsabs.harvard.edu/abs/2013arXiv1306.3118G http://contest.techbriefs.com/2013/entries/aerospace-and-defense/3431
2013, Jun 14	A.E. Saal, E.H. Hauri, J.A. Van Orman, et al., 2013, *Science*, 340, 1317, "Hydrogen isotopes in **lunar** volcanic glasses and melt inclusions reveal a carbonaceous chondrite heritage." See: http://adsabs.harvard.edu/abs/2013Sci...340.1317S See also: http://www.space.com/21047-earth-moon-water-meteorites.html
2013, Jun 18	**Grand Challenge**. NASA announced a Grand Challenge focused on finding all asteroid threats to human populations and knowing what to do about them. The challenge, which was announced at an **Asteroid Initiative** industry and partner day at NASA Headquarters in Washington, is a large-scale effort that will use multi-disciplinary collaborations and a variety of partnerships with other government agencies, international partners, industry, academia, and citizen scientists. It complements NASA's recently announced mission to redirect an asteroid and send humans to study it. See: http://www.nasa.gov/mission_pages/asteroids/initiative/index.html http://www.nasa.gov/asteroidinitiative See also: http://www.space.com/21610-nasa-asteroid-threat-grand-challenge.html http://www.youtube.com/watch?v=f5rsJwsyni4 http://go.nasa.gov/12tf23l http://go.nasa.gov/19A67iI http://www.nasa.gov/press/2015/march/nasa-announces-next-steps-on-

	journey-to-mars-progress-on-asteroid-initiative
2013, Jun 18	**10,000-st Near Earth Object** registered by the **Minor Planet Center**: Amor NEA **511002** (**2013 MZ5**, *H* = 20.1 mag, *D* ≈ 300 m), when it passed Earth at a nominal distance of 180 LD. See: 2013 MZ5 - SSA , 2013 MZ5 - JPL The NASA site **Near Earth Object Program / Discovery Statistics** lists 10,003 NEOs: 94 Near Earth Comets and 9909 Near Earth Asteroids. The search continues. See: http://neo.jpl.nasa.gov/stats/ http://www.jpl.nasa.gov/news/news.php?release=2013-207 See also: http://www.space.com/21735-asteroid-telescope-finds-10000-space-rock.html https://en.wikipedia.org/wiki/2013_MZ5
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	assist maneuver." See: http://adsabs.harvard.edu/abs/2013SoSyR..47..325E
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2013, Sep 4	Apollo NEA **2013 RO30** (*H* = 28.3 mag, *D* ≈ 8 m), passed Earth at a nominal miss distance of 0.76 LD. Minimum miss distance 0.75 LD. **[2013-13]** See: 2013 RO30 - SSA , 2013 RO30 - JPL
2013, Sep 5	Apollo NEA **2013 RF32** (*H* = 29.0 mag, *D* ≈ 6 m), passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.43 LD. **[2013-14]** See: 2013 RF32 - SSA , 2013 RF32 - JPL
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2013, Oct 6-11	2013 Carl Sagan Medal from the American Astronomical Society received by Donald K. Yeomans, during the AAS Division for Planetary Sciences annual meeting, 6 to 11 October 2013 in Denver (CO, USA). See: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-220
2013, Oct 9	Apollo NEA **2013 TL127** (H = 26.9 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.98 LD. **[2013-17]** See: 2013 TL127 - SSA , 2013 TL127 - JPL
2013, Oct 10	J. Borovička, J. Tóth, A. Igaz, 2013, *Meteorics & Planetary Science*, 48, 1757, "The **Košice meteorite fall**: atmospheric trajectory, fragmentation, and orbit." See: http://onlinelibrary.wiley.com/doi/10.1111/maps.12078/
2013, Oct 17	P. Plait, *Bad Astronomy*, 17 October 2013, "Huge chunk of **Russian meteorite** found at the bottom of a lake." M = 570 kg, $D \approx$ 1 m. See: http://www.slate.com/blogs/bad_astronomy/2013/10/17/chelyabinsk_impact_huge_chunk_of_asteroid_dredged_up_from_lake.html http://www.nytimes.com/2013/10/17/world/europe/meteorite-pulled-from-russian-lake-breaks-into-3-

	pieces.html?emc=edit_tnt_20131016&tntemail0=y&_r=1& http://cdn.rt.com/files/news/20/c7/20/00/946221_meteo_2_web.mp4
2013, Oct 21	Apollo NEA **2013 UR1** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2013-18]** See: 2013 UR1 - SSA , 2013 UR1 - JPL
2013, Oct 22	**UN-COPUOS / AT14** plans to coordinate international efforts to defend the Earth from the threat posed by asteroids, presented to the United Nations General Assembly by **UN-COPUOS** chairman Yasushi Horikawa. The plans were set out in a draft resolution and accompanying report at a meeting of the UN's Fourth Committee of the General Assembly. The plans have yet to be formally adopted as a resolution by the General Assembly and are expected to be fully implemented at a vote in November-December 2013. See: http://www.un.org/apps/news/story.asp?NewsID=36449&Cr=general+assembly&Cr1=#.UneQvFOtOSp
2013, Oct 25	Apollo NEA **2013 UX2** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2013-19]** See: 2013 UX2 - SSA , 2013 UX2 - JPL
2013, Oct 29	Apollo NEA **2013 UV3** (*H* = 27.1 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.73 LD. **[2013-20]** See: 2013 UV3 - SSA , 2013 UV3 - JPL
2013, Oct-Nov	A.F.J. Abercromby, S.P. Chappell, M.L. Gernhardt, 2013, *Acta Astronautica*, 91, 34, "Desert RATS 2011: Human and robotic exploration of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2013AcAau..91...34A
2013, Nov	T. Bose, S. Misra, S. Chakraborty, K. Reddy, 2013, *Earth, Moon, and Planets*, 111, 31, "Gamma (gamma)-ray activity as a tool for identification of hidden ejecta deposits around impact crater on basaltic target: example from **Lonar Crater**, India." See: http://adsabs.harvard.edu/abs/2013EM%26P..111...31B
2013, Nov	M.A. Galiazzo, Á. Bazsó, M.S. Huber, et al., 2013, *Astronomische Nachrichten*, 334, 936, "A statistical dynamical study of meteorite impactors: A case study based on parameters derived from the **Bosumtwi impact** event." See: http://adsabs.harvard.edu/abs/2013AN....334..936G

2013, Nov	C.T. Russell, C.A. Raymond, R. Jaumann, et al., 2013, *Meteoritics & Planetary Science*, 48, 2076, "***Dawn*** completes its mission at **4 Vesta**." See: http://adsabs.harvard.edu/abs/2013M%26PS...48.2076R
2013, Nov	S. Steinberg, C. Kundrot, J. Charles, 2013, *Acta Astronautica*, 92, 119, "Human health and performance considerations for Near Earth asteroids (NEA)." See: http://adsabs.harvard.edu/abs/2013AcAau..92..119S
2013, Nov	T. Terai, S. Urakawa, J. Takahashi, et al., 2013, *Astronomy & Astrophysics*, 559, 106, "Time-series photometry of Earth flyby asteroid 2012 DA14." See: http://adsabs.harvard.edu/abs/2013A%26A...559A.106T
2013, Nov	J.M. Madiedo, J.M. Trigo-Rodríguez, J.L. Ortiz, et al., 2013, *Monthly Notices Royal Astronomical Society*, 435, 2023, "Spectroscopy and orbital analysis of bright bolides observed over the Iberian Peninsula from 2010 to 2012." See: http://adsabs.harvard.edu/abs/2013MNRAS.435.2023M
2013, Nov 1	P. Pergola, 2013, *Advances in Space Research*, 52, 1622, "Small satellite survey mission to the second Earth moon [**3753 Cruithne (1986 TO)**]." See: http://adsabs.harvard.edu/abs/2013AdSpR..52.1622P
2013, Nov 4	M. Tibbits, M. Elvis, J.L. Galache, et al., 2013, in: Proc. *Astronomical Data Analysis Software and Systems XXII*, Champaign (Illinois, USA), 4-8 November 2012, ASP-CS 475, 259, "**NEOview**: Near Earth Object data discovery and query." See: http://adsabs.harvard.edu/abs/2013ASPC..475..259T
2013, Nov 5	S.D. Miller, W.C. Straka, A.B. Scott Bachmeier, et al., 2013, *Proceedings National Academy of Sciences,* 110, 18092, "Earth-viewing satellite perspectives on the **Chelyabinsk meteor** event." See: http://www.pnas.org/content/110/45/18092.short See also: http://www.space.com/23273-russia-meteor-chelyabinsk-satellite-photos.html
2013, Nov 8	Apollo NEA **2013 VJ11** (H = 27.9 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.89 LD. **[2013-21]** See: 2013 VJ11 - SSA , 2013 VJ11 - JPL
2013, Nov 10	K.T. Howard, M.J. Bailey, D. Berhanu, 2013, *Nature Geoscience*,

	6, 1018, "Biomass preservation in impact melt ejecta." See: http://adsabs.harvard.edu/abs/2013NatGe...6.1018H
2013, Nov 11-15	**1st COSPAR Symposium *Planetary systems of our Sun and stars, and the future of space astronomy***, Bangkok (Thailand), 11-15 November 2013. Session 5: Small bodies. See: http://www.cospar2013.gistda.or.th
2013, Nov 14	J. Borovička, P. Spurný, P. Brown, et al., 2013, *Nature,* 503, 235, "The trajectory, structure and origin of the **Chelyabinsk** asteroidal impactor." See: http://adsabs.harvard.edu/abs/2013Natur.503..235B
2013, Nov 14	P.G. Brown, J.D. Assink, L. Astiz, et al., 2013, *Nature*, 503, 238, "A 500-kiloton **airburst** over **Chelyabinsk** and an enhanced hazard from small impactors." See: http://adsabs.harvard.edu/abs/2013Natur.503..238B See also: http://news.sciencemag.org/space/2013/11/siberian-blast-points-more-destructive-meteors-ahead
2013, Nov 15	J.D. Kramers, M.A.G. Andreoli, M. Atanasova, 2013, *Earth and Planetary Science Letters*, 382, 21, "Unique chemistry of a diamond-bearing pebble from the **Libyan Desert Glass** strewnfield, SW Egypt: Evidence for a shocked comet fragment." See: http://adsabs.harvard.edu/abs/2013E%26PSL.382...21K First ever evidence of a comet striking Earth. News release, 8 October 2013, University of the Witwatersrand, Johannesburg (South Africa): "… A comet entered Earth's atmosphere above Egypt about 28 million years ago. As it entered the atmosphere, it exploded, heating up the sand beneath it to a temperature of about 2 000 degrees Celsius, and resulting in the formation of a huge amount of yellow silica glass which lies scattered over a 6 000 square kilometer area in the Sahara. A magnificent specimen of the glass, polished by ancient jewellers, is found in Tutankhamun's brooch with its striking yellow-brown scarab. …" See: http://www.wits.ac.za/newsroom/newsitems/201310/21649/news_item_21649.html
2013, Nov 16	S. Eggl, A. Ivantsov, D. Hestroffer, et al., 2013, in: L. Cambresy et al. (eds.), Proc. Annual Meeting of the French Society of Astronomy and Astrophysics (SF2A-2013), p. 169, "High-precision astrometry in asteroid mitigation - the **NEOShield** perspective." See: http://adsabs.harvard.edu/abs/2013sf2a.conf..169E

2013, Nov 16	D. Hestroffer, F. Deleflie, 2013, in: L. Cambresy et al. (eds.), Proc. Annual Meeting of the French Society of Astronomy and Astrophysics (SF2A-2013), p. 183, "**PôDET**: a centre for Earth dynamical environment." See: http://adsabs.harvard.edu/abs/2013sf2a.conf..183H
2013, Nov 20-22	NASA ***Asteroid Initiative Idea Synthesis Workshop***, 20 - 22 November 2013, Lunar and Planetary Institute, Houston (TX, USA). See: http://www.nasa.gov/asteroidworkshop/
2013, Nov 21	C. de la Fuente Marcos, R. de la Fuente Marcos, 2013, *Monthly Notices Royal Astronomical Society*, 436, L15, "The **Chelyabinsk superbolide**: a fragment of asteroid **2011 EO40**?" See: http://adsabs.harvard.edu/abs/2013MNRAS.436L..15D
2013, Nov 26	Apollo NEA **2013 NJ** (H = 22.1 mag, $D \approx$ 130 m) passed Earth at a nominal miss distance of 2.47 LD. Minimum miss distance 2.47 LD. See: 2013 NJ - JPL , 2013 NJ - SSA See also: **24 Nov 1956**, **24 Nov 1997**, **26 Nov 2067**.
2013, Nov 28	Editorial, 2013, *Nature Geoscience*, 6, 987, "The upside of impacts." See: http://www.nature.com/ngeo/journal/v6/n12/full/ngeo2036.html
2013, Nov 29	C.R. Chapman, 2013, *Science*, 342, 1051, "Calibrating asteroid impact." See: http://adsabs.harvard.edu/abs/2013Sci...342.1051C
2013, Nov 29	O.P. Popova, P. Jenniskens, V. Emel'yanenko, et al., 2013, *Science*, 342, 1069, "**Chelyabinsk Airburst**, damage assessment, meteorite recovery, and characterization." See: http://www.sciencemag.org/content/342/6162/1069
2013, Nov 29	Apollo NEA **2013 WH25** (H = 29.6 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.34 LD. **[2013-22]** See: 2013 WH25 - SSA , 2013 WH25 - JPL
2013, Dec	A. Fazio, M. D'Orazio, L. Folco, et al., 2013, *Meteoritics & Planetary Science*, 48, 2451, "The extremely reduced silicate-bearing iron meteorite **Northwest Africa 6583**: implications on the variety of the impact melt rocks of the IAB-complex parent body."

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2013, Dec	N.A. Konovalova, J.M. Madiedo, J.M. Trigo-Rodríguez, 2013, *Meteoritics & Planetary Science*, 48, 2469, "The **Tajikistan superbolide** of July 23, 2008. I. Trajectory, orbit, and preliminary fall data." See: http://adsabs.harvard.edu/doi/10.1111/maps.12217
2013, Dec 11	A. Ivantsov, S. Eggl, D. Hestroffer, W. Thuillot, 2013, e-print *arXiv:*1312.3175, "On future opportunities to observe gravitational scattering of main belt asteroids into NEO source regions." See: http://adsabs.harvard.edu/abs/2013arXiv1312.3175I See also: http://syrte.obspm.fr/journees2013/powerpoint/ivantsov_poster_jsr13.pdf
2013, Dec 11	Apollo NEA **2013 XS21** (H = 29.4 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2013-23]** See: 2013 XS21 - SSA , 2013 XS21 - JPL
2013, Dec 12	Jiangchuan Huang, Jianghui Ji, Peijian Ye, et al., 2013, *Nature Scientific Reports*, 3, article number 3411, "The ginger-shaped asteroid **4179 Toutatis**: new observations from a successful flyby of ***Chang'e-2***." See: http://adsabs.harvard.edu/abs/2013NatSR...3E3411H
2013, Dec 19	Launch of ESA spacecraft ***Gaia*** to Sun-Earth L2 Lagrangian point for a 5-yr mission. As part of its overall mission, with a limiting magnitude of $v \approx 20$ mag, ***Gaia*** (two 1.4 x 0.5 m telescopes, optical) is expected to detect ~300,000 minor planets, many of which will be NEOs, down to a solar elongation of 45º, with unprecedented accuracy. See: http://www.rssd.esa.int/Gaia http://www.esa.int/Our_Activities/Space_Science/Gaia/Gaia_overview http://blogs.esa.int/gaia/ http://www.esa.int/Our_Activities/Space_Science/Gaia/Countdown_to_launch_of_ESA_s_billion-star_surveyor http://www.esa.int/Our_Activities/Space_Science/Gaia/Gaia_Go_for_science Ref: - S. Mouret, D. Hestroffer, F. Mignard, 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symposium No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 435, "Asteroid mass determination with the ***Gaia*** mission."

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2013, Dec 19	NASA's asteroid hunter spacecraft ***NEOWISE*** returns first images after reactivation. Survey restart on 23 December 2013. See: http://www.jpl.nasa.gov/news/news.php?release=2013-373 http://www.jpl.nasa.gov/news/news.php?release=2014-006 http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2014-023
2013, Dec 21	J.M. Madiedo, J.M. Trigo-Rodríguez, J. Zamorano, et al., 2013, *Monthly Notices Royal Astronomical Society*, 436, 3656, "Analysis of a superbolide from a damocloid observed over Spain on 2012 July 13." See: http://adsabs.harvard.edu/abs/2013MNRAS.436.3656M
2013, Dec 23	Apollo NEA **2013 YB** (H = 31.4 mag, $D \approx$ 1.8 m) passed Earth at a nominal miss distance of 0.071 LD **(= 4.26 R_{Earth} from the geocenter)**. Minimum miss distance 0.069 LD. **[2013-24]** See: 2013 YB - SSA , 2013 YB - JPL
2014, Jan 1	**10476 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, H = 9.45 mag, D = 36.5 km, Amor NEA), of which **1437 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, H = 15.3 mag, D = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2014	***Cancelled***: Launch of ***AsteroidFinder***, a space project of the German Aerospace Center (DLR) with a one-year baseline mission duration, with a 25-cm telescope and a 2º×2º FoV, to operate in a Sun-synchronous low-Earth orbit. The primary goals are to estimate the population of NEOs interior to Earth's orbit (IEOs) down to v = 18.5 mag, their size distribution, and their orbital properties, along with impact hazard assessment. See: http://www.dlr.de/pf/en/desktopdefault.aspx/tabid-174/319_read-18911/ Ref: - M. Hartl, H. Mosebach, J. Schubert, 2010, abstract in:

	International Conference on Space Optics, Rhodes (Greece), 4-8 October 2010, "***AsteroidFinder*** – the space-borne telescope to search for NEO asteroids." See: http://congrex.nl/.../FCXNL-10A02-1986358-2-HARTL_ICSO_PAPER[1].pdf See also: http://www.oosa.unvienna.org/pdf/pres/stsc2008/tech-13.pdf http://www.lpi.usra.edu/meetings/acm2008/pdf/8140.pdf http://www.unoosa.org/pdf/reports/ac105/AC105_976E.pdf **Note:** The project had successfully completed a Phase-B study in October 2011. Unfortunately, however, due to financial constraints, mainly due to the difficulty of procurement of an affordable launcher for the desired orbit, the project has been terminated shortly after (priv. comm.).
2014, Jan	V. Alí-Lagoa, L. Lionni, M. Delbo, et al., 2014, *Astronomy & Astrophysics*, 561, 45, "Thermophysical properties of Near-Earth Asteroid **(341843) 2008 EV5** from ***WISE*** data⋆." See: http://adsabs.harvard.edu/abs/2014A%26A...561A..45A
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	"**Mars** encounters cause fresh surfaces on some near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2014Icar..227..112D See also: http://web.mit.edu/newsoffice/2013/asteroids-mars-1119.html
2014, Jan 1	Apollo NEA **2014 AF5** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2014-01]** See: 2014 AF5 - SSA , 2014 AF5 - JPL See also: https://en.wikipedia.org/wiki/2014_AF5
2014, Jan 2	M. Mommert, J.L. Hora, A.W. Harris, et al., 2014, *Astrophysical Journal*, 781, 25, "The discovery of cometary activity in Near-Earth Asteroid **(3552) Don Quixote**." See: http://adsabs.harvard.edu/abs/2014ApJ...781...25M
2014, Jan 2, 03:13	**Impact.** Apollo NEA **2014 AA** (*H* = 30.9 mag, *D* ≈ 2.3 m), was calculated to hit Earth at a nominal miss distance of 0.00118 LD **(0.071 R_{Earth} = 455 km from the Earth center), with a minimum miss distance of 0.00066 LD.** It probably burned in the Earth atmosphere over the Atlantic Ocean, off the coast of West Africa, 21 hours after observation. See: 2014 AA - SSA , 2014 AA - JPL See also: http://www.minorplanetcenter.net/mpec/K14/K14A02.html http://www.jpl.nasa.gov/news/news.php?release=2014-001 https://en.wikipedia.org/wiki/2014_AA See also: **3 Nov 1967**, **26 May 1994**, **21 Mar 1996**.
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2014, Jan 8	Apollo NEA **2014 AK51** (*H* = 26.5 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.96 LD. **[2014-02]** See: 2014 AK51 - SSA , 2014 AK51 - JPL
2014, Jan 8-9	**10th NASA *Small Bodies Assessment Group Meeting***, 8-9

	January 2014, Washington (DC, USA). See: http://www.lpi.usra.edu/sbag/ http://www.lpi.usra.edu/sbag/meetings/jan2014/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - B.W. Barbee, 2014, "The **Near-Earth Object Human Space Flight Accessible Targets Study (NHATS)**." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1145_Barbee_SBAG_Jan_2014_talk_NHATS.pdf - A. Cheng, 2014, "***MarcoPolo-R***. NASA contribution." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1435_Cheng_MarcoPolo-R_Assessment_Phase_summary_SBAG.pdf - S. Chesley, 2014, "***ISIS - Impactor for Surface and Interior Science***." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1430_Chesley_ISIS_SBAG.pdf - J. Dworkin, 2014, "***OSIRIS-Rex update***." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1350_Dworkin_OSIRIS-REx_SBAG.pdf - L. Johnson, 2014, "Finding Near Earth Objects before they find us! (and knowing what to do about it)", See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1330_Johnson_NASA_Planetary_Defense_Update_SBAG.pdf - M. Gates, 2014, "***Asteroid Redirect Mission*** update." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1000_Gates_ARM_update_SBAG.pdf - R. Harvey, 2014, "**ANSMET, the Antarctic Search for Meteorites** program." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1340_Harvey_ansmet_SBAG.pdf - H. Kuninaka, 2014, "***Hayabusa2***. Asteroid sample reurn mission." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1500_Kuninaka_Haya2-SBAG.pdf - A. Mainzer, J. Bauer, R. Cutri, et al., 2014, "***NEOWISE***: a time-domain mid-infrared survey." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1415_Mainzer_SBAG.pdf - C. Reed, B. Barbee, R. Dissly, D. Stetson, 2014, "***Target NEO 2 Workshop***: summary and findings." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_0945_Barbee_Target_NEO_2_Briefing_for_10th_SBAG.pdf - P.A. Taylor, M.C. Nolan, E.S. Howell, A. Springmann, 2014, "Near-Earth Asteroid observations with the **Arecibo Planetary Radar**." See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/09_1330_Taylor_SBAG.pdf - D.K. Yeomans, 2014, "NAC **Planetary Defense Task Force**."

	See: http://www.lpi.usra.edu/sbag/meetings/jan2014/presentations/08_1400_Yeomans_Task_Force_summary_012014_LNJ.pdf
2014, Jan 9	Apollo NEA **2014 AG51** (*H* = 30.3 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2014-03]** See: 2014 AG51 - SSA , 2014 AG51 - JPL
2014, Jan 10	Apollo NEA **2014 AW32** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2014-04]** See: 2014 AW32 - SSA , 2014 AW32 - JPL See also: **10 Jan 1941**.
2014, Jan 13-14	***First IAWN Steering Group Meeting***, 13-14 January 2014, **Minor Planet Center**, Cambridge (MA, USA). See: http://minorplanetcenter.net/IAWN http://www.minorplanetcenter.net/IAWN/index.html http://minorplanetcenter.net/IAWN/mpc-un/index.html http://www.minorplanetcenter.net/IAWN/2014_cambridge/findings.html http://iawn.net **Presentations:** ***Overview:*** - S. Camacho , 2014, "Welcome and introduction to the **IAWN**, UNCOPUOS." See: http://minorplanetcenter.net/IAWN/mpc-un/camacho.pdf - L. Johnson , 2014, "**NASA's NEO Observations Program**." See: http://minorplanetcenter.net/IAWN/mpc-un/johnson_nasa.pdf - T. Spahr, 2014, "The **International Asteroid Warning Network** and the **Minor Planet Center**." See: http://minorplanetcenter.net/IAWN/mpc-un/spahr_mpc.pdf ***Reports on physical observations:*** - R.S. McMillan, T.H. Bressi, J.A. Larsen, et al., 2014, "**Spacewatch** and follow-up astrometry of Near-Earth Objects." See: http://minorplanetcenter.net/IAWN/mpc-un/mcmillan_iawn2014.pdf - R.P. Binzel, 2014, "Spectroscopic reconnaissance of NEOs." See: http://minorplanetcenter.net/IAWN/mpc-un/binzel.pdf - V. Reddy, J. Sanchez, E. Cloutis, et al., 2014, "Surface composition of small NEOs in light of **Chelyabinsk**: implications for impact hazard assessment." See: http://minorplanetcenter.net/IAWN/mpc-un/reddy_chelyabinsk.pdf - E.V. Ryan, 2014, "NEO physical characterization: spin rates and spectra." See: http://minorplanetcenter.net/IAWN/mpc-un/ryan_iawn2014.pdf - L. Benner, 2014, "**Arecibo** and **Goldstone** radar

	observations of Near-Earth Objects." See: http://minorplanetcenter.net/IAWN/mpc-un/benner.iawn.jan2014.pdf ***Reports on survey status:*** - H. Viggh, 2014, "**Lincoln Near-Earth Asteroid Research** program (**LINEAR**)." See: http://minorplanetcenter.net/IAWN/mpc-un/viggh_iawn2014.pdf - R. Wainscoat, P. Vereš, B. Bolin, et al., 2014, "The **Pan-STARRS** search for Near Earth Asteroids - present status and future plans." See: http://minorplanetcenter.net/IAWN/mpc-un/wainscoat_Pan-STARRS.pdf - E.J. Christensen, A. Boattni, A.R. Gibbs, et al., 2014, "The **Catalina Sky Survey**. Current operations and future capabilities." See: http://minorplanetcenter.net/IAWN/mpc-un/christensen_css.pdf - A. Mainzer, J. Bauer, R. Cutri, et al., 2014, "***NEOWISE*** restart: Initial performance analysis." See: http://minorplanetcenter.net/IAWN/mpc-un/mainzer_iawn2014.pdf ***International cooperation:*** - T. Spahr, 2014, "International cooperation and collaboration: the **MPC** perspective." See: http://minorplanetcenter.net/IAWN/mpc-un/spahr_cooperation.pdf - D. Koschny, 2014, " **ESA's SSA & NEO Coordination Centre**." See: http://minorplanetcenter.net/IAWN/mpc-un/koschny_iawn2014.pdf - G.B. Valsecchi, 2014, "**Near Earth Objects Dynamic Site**." See: http://minorplanetcenter.net/IAWN/mpc-un/valsecchi_neodys.pdf - M. Yoshikawa, 2014, "The Japanese contribution to the **IAWN**." See: http://minorplanetcenter.net/IAWN/mpc-un/yoshikawa.pdf - B. Shustov, 2014, "On the Russian contribution to the **IAWN**." See: http://minorplanetcenter.net/IAWN/mpc-un/shustov.pdf
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	and meteoroids - a wide field survey." See: http://adsabs.harvard.edu/abs/2014arXiv1401.4758V See also: http://www.imo.net/imc2013/meteoroids%202013
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2014, Feb 10-21	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 51st Session**, 10-21 February 2014, Vienna (Austria), including meetings of **STSC WG NEO** and **STSC Action Team 14 on NEOs**. See: http://www.unoosa.org/oosa/en/COPUOS/stsc/2014/index.html http://www.oosa.unvienna.org/pdf/limited/c1/AC105_C1_L332E.pdf **Report:** http://www.oosa.unvienna.org/pdf/reports/ac105/AC105_1065E.pdf [paragraphs 158 to 171] **Technical presentations:** - L. Johnson (NASA, USA), 2014, "Near Earth Objects: 2013 work update." See: http://www.oosa.unvienna.org/pdf/pres/stsc2014/tech-01E.pdf - B. Shustov (Russian Federation), 2014, "The NEO problem: current activities in Russia." See: http://www.oosa.unvienna.org/pdf/pres/stsc2014/tech-02E.pdf - J. Borovicka (Czech Republic), 2014, "**Chelyabinsk event** - what we know one year later." See: http://www.oosa.unvienna.org/pdf/pres/stsc2014/tech-04E.pdf - J.L. Kessler (USA), 2014, "A **Grand Challenge**: find and plan for all asteroid threats." See: http://www.oosa.unvienna.org/pdf/pres/stsc2014/tech-07E.pdf
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2014, Mar 4	Apollo NEA **2014 EG45** ($H = 21.7$ mag, $D \approx 160$ m, **PHA**) passed Earth at a nominal miss distance of 3.21 LD. Minimum miss distance 3.21 LD. See: 2014 EG45 - JPL , 2014 EG45 - SSA See also: **4 Mar 2065**, **6 Mar 2128**.
2014, Mar 5	Apollo NEA **2014 DX110** ($H = 26.0$ mag, $D \approx 22$ m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2014-06]**

	See: 2014 DX110 - SSA , 2014 DX110 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2014-068 https://en.wikipedia.org/wiki/2014_DX110
2014, Mar 6, 03:20	Apollo NEA **2014 EF** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2014-07]** See: 2014 EF - SSA , 2014 EF - JPL See also: **3 Mar 1936**.
2014, Mar 6, 21:18	Apollo NEA **2014 EC** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.16 LD. Minimum miss distance 0.16 LD. **[2014-08]** See: 2014 EC - SSA , 2014 EC - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2014-072 http://www.space.com/24947-asteroid-flyby-2014ec-watch-live.html https://en.wikipedia.org/wiki/2014_EC
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2014, Mar 29	Apollo NEA **2014 FT37** ($H = 28.0$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.02 LD. See: 2014 FT37 - SSA , 2014 FT37 - JPL
2014, Mar 30	Apollo NEA **2014 GY44** ($H = 25.7$ mag, $D \approx 26$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2014-10]** See: 2014 GY44 - SSA , 2014 GY44 - JPL
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2014, May 7	Apollo NEA **2014 JR24** (H = 29.6 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2014-13]** See: 2014 JR24 - SSA , 2014 JR24 - JPL
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2014, May 10	Apollo NEA **2014 JG55** (H = 29.5 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.26 LD. **[2014-14]** See: 2014 JG55 - SSA , 2014 JG55 - JPL See also: http://www.space.com/25894-asteroid-2014jg55-earth-flyby-photos.html

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2014, Jun 3, 17:38	Aten NEA **2014 LY21** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.052 LD **(= 3.15 R_{Earth} from the geocenter)**. Minimum miss distance 0.023 LD. **[2014-18]** See: 2014 LY21 - SSA , 2014 LY21 - JPL See also: https://en.wikipedia.org/wiki/2014_LY21
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2014, Jul 24	Asteroid **2014 OP2** (H = 29.1 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2014-20]** See: 2014 OP2 - SSA , 2014 OP2 - JPL
2014, Jul 25	Apollo NEA **2014 OM207** (H = 29.2 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2014-21]** See: 2014 OM207 - SSA , 2014 OM207 - JPL
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2014, Sep 7	Apollo NEA **2014 RC** (H = 26.9 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.104 LD. Minimum miss distance 0.104 LD. **[2014-23]** See: 2014 RC - SSA , 2014 RC - JPL See also: http://neo.jpl.nasa.gov/news/news184.html http://neo.jpl.nasa.gov/news/news185.html https://en.wikipedia.org/wiki/2014_RC See also: **4 Sep 1945**.
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2014, Sep 8-13	***77th Annual Meeting of the Meteoritical Society***, Casablanca (Morocco), 8-13 September 2014. See: http://meteoriticalsociety.org/?page_id=18 http://www.metsoc2014casablanca.org/
2014, Sep 8-13	***European Planetary Science Congress 2014***, Centro de Congressos do Estoril, Cascais (Portugal). See: http://www.epsc2013.eu/ **Among the papers:** - S. Eggl, D. Hestroffer, W. Thuillot, D. Bancelin, 2014, *EPSC Abstracts*, Vol. 9, id. EPSC2014-678, "NEO hazards : **NEOShield** and **PoDET** perspectives." See: http://adsabs.harvard.edu/abs/2014EPSC....9..678E
2014, Sep 9-10	***Asteroid Impact Communication Workshop*, Secure World Foundation**, Broomfield (CO, USA), 9-10 September 2014. See: http://swfound.org/events/2014/asteroid-impact-risk-communication-workshop/ http://swfound.org/media/186555/iawn_communication_workshop_report.pdf http://www.minorplanetcenter.net/IAWN/first_communication_workshop/ http://iawn.net/category/meetings/ See also: http://www.space.com/27809-asteroid-impact-early-warning-system.html **Case studies:** - L. Delgado López (SWF), 2014, "Impact hazard communication risk study: **2007 VK184**". See: http://www.minorplanetcenter.net/IAWN/first_communication_workshop/2007-vk184-case-study-iawn-delgado-9-14.pdf - J.L. Galache, 2014, "**2012 DA14** and **Chelyabinsk Meteor** case study." See: http://www.minorplanetcenter.net/IAWN/first_communication_workshop/2012-da14-chelyabinsk-case-study-iawn-galache-9-14.pdf - L. David, 2014, "What's up or down with **Apophis**? An open case or case closed?" See: http://www.minorplanetcenter.net/IAWN/first_communication_workshop/apophis-case-study-iawn-david-9-141.pdf

	- L. Billings, 2014, "Impact hazard communication case study: **2011 AG5**." See: http://www.minorplanetcenter.net/IAWN/first_communication_workshop/2011-ag5-case-study-iawn-billings-9-14.pdf
2014, Sep 10	ESA **Fly-Eye Telescope** announced. This European telescope nicknamed 'fly-eye' splits the image into 16 smaller subimages to expand the field of view, similar to the technique exploited by a fly's compound eye. This fly-eyed survey telescope will offer performance equivalent to a 1 m-diameter telescope, and will provide a very large field of view: 6.7° x 6.7° or about 45 square degrees. 6.7° is about 13 times the diameter of the Moon as seen from the Earth. See: http://m.esa.int/Our_Activities/Operations/Space_Situational_Awareness/ESA_s_bug-eyed_telescope_to_spot_risky_asteroids
2014, Sep 11	J.M. Madiedo, J.M. Trigo-Rodriguez, J.L. Ortiz, et al., 2014, *Monthly Notices Roal Astronomical Society*, 443, 1643, "Bright **Fireballs** associated with the **Potentially Hazardous Asteroid 2007 LQ19**." See: http://adsabs.harvard.edu/abs/2014MNRAS.443.1643M
2014, Sep 15	C.D. de Groot-Hedlin, M.AH. Hedlin, 2014, *Earth and Planetary Science Letters*, 402, 337, "Infrasound detection of the **Chelyabinsk meteor** at the **USArray**." See: http://adsabs.harvard.edu/abs/2014E%26PSL.402..337D
2014, Sep 15	P.K. Martin, NASA Inspector General, 2014, "NASA's efforts to identify Near-Earth Objects and mitigate hazards." See: http://oig.nasa.gov/audits/reports/FY14/IG-14-030.pdf See also: http://www.reuters.com/article/2014/09/16/us-space-nasa-asteroids-idUSKBN0HA2CT20140916
2014, Sep 16	C.W. Hergenrother, M.A. Barucci, O. Barnouin, et al., 2014, An ***OSIRIS-Rex*** Document, 2014-April-14, e-print *arXiv:*1409.4704, "The design reference asteroid for the ***OSIRIS-REx*** mission target **(101955) Bennu**." See: http://adsabs.harvard.edu/abs/2014arXiv1409.4704H
2014, Sep 18	S. Eggl, H. Devillepoix, 2014, in: Proc. International Symposium on ***Orbit Propagation and Determination***, Lille (France), 2011, "On the prospects of Near Earth Asteroid orbit triangulation using the ***Gaia*** satellite and Earth-based observations." See: http://adsabs.harvard.edu/abs/2014arXiv1409.5398E

2014, Sep 18-21	***International Meteor Conference 2014***, 18-21 September 2014, Giron (France). See: http://www.imo.net/imc2014/
2014, Sep 20	M. Ansdell, K.J. Meech, O. Hainaut, et al., 2014, *Astrophysical Journal*, 793, 50, "Refined rotational period, pole solution & shape model for **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2014ApJ...793...50A
2014, Sep 20	T. Lamont, 2014, *The Guardian*, 20 September 2014, "Asteroids: between a rock and a hard place." See: http://www.theguardian.com/science/2014/sep/20/asteroids-rock-hard-place-meteor-strike-russia-nicaragua
2014, Sep 20	Apollo NEA **2014 SG1** ($H = 29.2$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.21 LD. Minimum miss distance 0.21 LD. **[2014-24]** See: 2014 SG1 - SSA , 2014 SG1 - JPL
2014, Sep 24	R. Schweickhart, 2014, *Sentinel Mission Blog*, 24 september 2014, presentation at NASA Ames Research Center Director's Colloquium, 17 July 2014, presented by the Office of the Chief Scientist as part of the Center's 75th anniversary celebration, "Dinosaur syndrome avoidance project - how gozit?" See: http://sentinelmission.org/events/rustys-talk-dinosaur-syndrome-avoidance-project-how-gozit/
2014, Oct	M. Beech, 2014, *Earth, Moon, and Planets*, 113, 53, "Grazing impacts upon Earth's surface: towards an understanding of the **Rio Cuarto Crater Field**." See: http://link.springer.com/article/10.1007/s11038-014-9445-7
2014, Oct	B. Bolin, R. Jedicke, M. Granvik, et al., 2014, *Icarus*, 241, 280, "Detecting Earth's temporarily-captured natural satellites - Minimoons." See: http://adsabs.harvard.edu/abs/2014Icar..241..280B
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2014, Oct	T. Katsura, A.M. Nakamura, A. Takabea, et al., 2014, *Icarus*, 241, 1, "Laboratory experiments on the impact disruption of iron meteorites at temperature of near-Earth space." See: http://adsabs.harvard.edu/abs/2014Icar..241....1K

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2014, Oct 1	Apollo NEA **2014 TL** (H = 28.0 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.25 LD. **[2014-25]** See: 2014 TL - SSA , 2014 TL - JPL See also: **29 Mar 2060**.
2014, Oct 6	C. Domercant, A. Gonzalez, 2014, e-print *arXiv*:1410.1589, "A new method of capturing and transporting asteroid to a **lunar** orbit." See: http://adsabs.harvard.edu/abs/2014arXiv1410.1589D
2014, Oct 6	A. Ivantsov, S. Eggl, D. Hestroffer, et al., 2014, in: Z. Knežević (ed.), 2014, *Proceedings IAU Symposium No. 310*, Complex Planetary Systems, "Close encounters of Near Earth Objects with large asteroids." See: http://adsabs.harvard.edu/abs/2014arXiv1410.1357I http://arxiv.org/pdf/1410.1357v1.pdf
2014, Oct 15-17	***1st International Asteroid Impact Deflection Assessment (AIDA) Workshop***, Laurel (MD, USA), 15-17 October 2014. See: http://www-n.oca.eu/michel/AIDAWorkshop2014/index.html http://www.esa.int/Our_Activities/Technology/NEO/Asteroid_Impact_Deflection_Assessment_AIDA_study http://www-n.oca.eu/michel/AIDA/
2014, Oct 16	R. Clemens, 2014, in: ***Space Generation Congress 2014*** - "Move An Asteroid" competition winning paper, e-print *arXiv:*1410.4471, "Global asteroid risk analysis." See: http://adsabs.harvard.edu/abs/2014arXiv1410.4471R http://arxiv.org/ftp/arxiv/papers/1410/1410.4471.pdf

2014, Oct 18	R. Schweickart, 2014, speaking on asteroid detection and deflectionat NASA Ames Research Center on the occasion of its 75th anniversary. See: http://sentinelmission.org/events/rustys-talk-dinosaur-syndrome-avoidance-project-how-gozit/?
2014, Oct 18	Apollo NEA **2016 UD** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.08 LD. **[2014-26]** See: 2016 UD - SSA , 2016 UD - JPL See also: **17 Oct 2016**.
2014, Oct 19	Apollo NEA **2014 UU56** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.68 LD. Minimum miss distance 0.68 LD. **[2014-27]** See: 2014 UU56 - SSA , 2014 UU56 - JPL
2014, Oct 20	Apollo NEA **2014 TW57** (*H* = 19.7 mag, *D* ≈ 470 m) passed Earth at a nominal miss distance of 0.35 AU. Minimum miss distance 0.35 AU. See: 2014 TW57 – SSA , 2014 TW57 – JPL Hefele et al. (February, 2020) predict a close approach of 0.017 AU = 6.62 LD in Sepember 2165. Re: - J.D. Hefele, F. Bortolussi, S. Portegies Zwart, 2020, *Astronomy & Astrophysics*, 634, 45, “Identifying Earth-impacting asteroids using an artificial neural network.” See: https://www.aanda.org/articles/aa/full_html/2020/02/aa35983-19/aa35983-19.html See also: https://www.astronomie.nl/leiden-astronomers-discover-potential-near-earth-objects-76 See also: **September 2165**.
2014, Oct 21	A.J.S. Capistrano, W.L. Roque, and R.S. Valada, 2014, *Monthly Notices of the Royal Astronomical Society*, 444, 1639, "Weyl conformastatic perihelion advance." See: http://adsabs.harvard.edu/abs/2014MNRAS.444.1639C
2014, Oct 27	Apollo NEA **2014 UF56** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2014-28]** See: 2014 UF56 - SSA , 2014 UF56 - JPL
2014, Oct 29	R.P. Binzel, 2014, *Nature*, 514, 559, "Human spaceflight: find asteroids to get to **Mars**."

	See: http://www.nature.com/news/human-spaceflight-find-asteroids-to-get-to-mars-1.16216?WT.ec_id=NATURE-20141030
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2014, Oct-Nov	M. Boslough, 2014, *Acta Astronautica*, 103, 370, "Airburst warning and response." See: http://adsabs.harvard.edu/abs/2014AcAau.103..370B
2014, Oct-Nov	Y. Sugimoto, G. Radice, M. Ceriotti, J.P. Sanchez, 2014, *Acta Astronautica*, 103, 333, "Hazardous Near Earth Asteroid mitigation campaign planning based on uncertain information on fundamental asteroid characteristics." See: http://adsabs.harvard.edu/abs/2014AcAau.103..333S
2014, Nov	J.F.C. Herman, A.K. Zimmer, J.P.J. Reijneveld, et al., 2014, *Acta Astronautica*, 104, 313, "Human exploration of near earth asteroids: Mission analysis for chemical and electric propulsion." See: http://adsabs.harvard.edu/abs/2014AcAau.104..313H
2014, Nov	X. Zhao, Y. Lin, Q.-Z. Yin, et al., 2014, *Meteoritics & Planetary Science*, 49, 2038, "Presolar grains in the CM2 chondrite **Sutter's Mill**." See: http://adsabs.harvard.edu/abs/2014M%26PS...49.2038Z
2014, Nov 1	A.A. Christou, J. Oberst, V. Lupovka, et al., 2014, *Planetary and Space Science*, 102, 164, "The meteoroid environment and impacts on **Phobos**." See: http://adsabs.harvard.edu/abs/2014P%26SS..102..164C
2014, Nov 1	Y. Yu, D.C. Richardson, P. Michel, et al., 2014, *Icarus*, 242, 82, "Numerical predictions of surface effects during the 2029 close approach of asteroid **99942 Apophis**." See: http://adsabs.harvard.edu/abs/2014Icar..242...82Y
2014, Nov 9-14	***46th Annual Meeting of the AAS Division for Planetary Sciences***, Tucson AZ, USA), 9-14 November 2014. See: http://aas.org/meetings/dps46 **Among the papers:** - P. Abell, J.A. Nuth, D. Mazanek, et al., 2014, *DPS meeting* #46, #403.01, "NASA's ***Asteroid Redirect Mission***: the boulder capture option." See: http://adsabs.harvard.edu/abs/2014DPS....4640301A - L. Allen, D. Trilling, F. Valdes, et al., 2014, *DPS meeting* #46, #414.01"The **DECam NEO Survey**: a sensitive, wide-field search

	for near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4641401A - L.A. Benner, M. Brozovic, J.D. Giorgini, et al., 2014, *DPS meeting* #46, #409.01, "**Goldstone** and **Arecibo Radar** Images of Near-Earth Asteroid **2014 HQ124**." See: http://adsabs.harvard.edu/abs/2014DPS....4640901B - E.C. Beshore, D. Lauretta, 2014, *DPS meeting* #46, #214.07, "The ***OSIRIS-REx*** mission sample site selection process." See: http://adsabs.harvard.edu/abs/2014DPS....4621407B - R.P. Binzel, F.E. DeMeo, J.B. Burt, et al., 2014, *DPS meeting* #46, #213.06, " Meteorite source regions as revealed by the Near-Earth Object population." See: http://adsabs.harvard.edu/abs/2014DPS....4621306B - W. Bottke, D. Vokrouhlicky, K. Walsh, et al., *DPS meeting* #46, #400.05, "In search of the source of **Bennu**, the ***OSIRIS-REx*** sample return mission target." See: http://adsabs.harvard.edu/abs/2014DPS....4640005B - P.G. Brown, K. Dube, E. Silber, 2014, *DPS meeting* #46, #403.02, "Detecting NEO impacts using the **International Monitoring System**." See: http://adsabs.harvard.edu/abs/2014DPS....4640302B - M. Brozovic, L. Benner, T. Ford, et al., 2014, *DPS meeting* #46, #409.04, "Radar evidence for diverse shapes of the primaries among binary near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4640904B - M.W. Busch, L. Benner, M. Brozovic, et al., 2014, *DPS meeting* #46, #409.05, "Recent radar speckle observations of Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4640905B - K.C. Chambers, 2014, *DPS meeting* #46, #214.06, "The **Pan-STARRS** discovery machine." See: http://adsabs.harvard.edu/abs/2014DPS....4621406C - S.R. Chesley, D. Farnocchia, P. Brown, P.W. Chodas, 2014, *DPS meeting* #46, #403.03, "Orbit estimation for late warning asteroid impacts: the case of **2014 AA**." See: http://adsabs.harvard.edu/abs/2014DPS....4640303C - E.J. Christensen, F.C. Shelly, A.R. Gibs, et al., 2014, *DPS meeting* #46, #414.03, "Simulating the performance of ground-based optical asteroid surveys." See: http://adsabs.harvard.edu/abs/2014DPS....4641403C - M. Elvis, S. Ranjan, J.L. Galache, 2014, *DPS meeting* #46, #414.05, "The undiscovered country: how many low-delta-*v* Near-Earth Objects emain to be ound?" See: http://adsabs.harvard.edu/abs/2014DPS....4641405E - T. Endicott, N. Moskovitz, R. Binzel, et al., 2014, *DPS meeting* #46, #304.02, "Earth's nearest neighbors: dynamical integrations of NEO-Earth approaches in support of **MANOS**."

	See: http://adsabs.harvard.edu/abs/2014DPS....4630402E - D. DellaGiustina, E. Kinney Spano, 2014, *DPS meeting* #46, #213.01, " A digital terrain model of the ***NEAR-Shoemaker*** landing site on asteroid **(433) Eros**." See: http://adsabs.harvard.edu/abs/2014DPS....4621301D - D. Farnocchia, S.R. Chesley, D. Vokrouhlicky, T.G. Mueller, 2014, *DPS meeting* #46, #403.04, "Apophis: complex rotation and hazard assessment." See: http://adsabs.harvard.edu/abs/2014DPS....4640304F - G. Fedorets, M. Granvik, 2014, *DPS meeting* #46, #403.05, "Properties of Earth's temporarily-captured flybys." See: http://adsabs.harvard.edu/abs/2014DPS....4640305F - T.F. Ford, L.A.M. Benner, M. Brozovic, et al., 2014, *DPS meeting* #46, #213.15, "Radar observations and physical modeling of binary near-Earth asteroid **(1862) Apollo**." See: http://adsabs.harvard.edu/abs/2014DPS....4621315F - J.L. Galache, C.L. Beeson, K.K. McLeod, M. Elvis, 2014*, DPS meeting* #46, #213.18, "The need for speed in Near Earth Asteroid characterization." See: http://adsabs.harvard.edu/abs/2014DPS....4621318G - M. Granvik, A. Morbidelli, R. Jedicke, et al., 2014, *DPS meeting* #46, #403.06, "Depletion of the Near-Earth-Asteroid population at small perihelion distances." See: http://adsabs.harvard.edu/abs/2014DPS....4640306G - A.W. Harris, 2014, *DPS meeting* #46, #403.07, "The population of small NEAs". See: http://adsabs.harvard.edu/abs/2014DPS....4640307H - C.W. Hergenrother, D.H. Hill, A. Spitz, et al., *DPS meeting* #46, #213.04, "Crowd-sourcing Near-Earth Asteroid science with the ***OSIRIS-REx*** Target Asteroids! program." See: http://adsabs.harvard.edu/abs/2014DPS....4621304H - M.L. Hinkle, N. Moskovitz, D. Trilling, 2014, *DPS meeting* #46, #213.07, "The taxonomic distribution of mission-accessible small Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4621307H - Z. Ivezic, L. Jones, 2014, *DPS meeting* #46, #214.14, "**LSST**: Comprehensive NEO detection, characterization, and orbits." See: http://adsabs.harvard.edu/abs/2014DPS....4621414I - J.A. Johnson, E.J. Christensen, A.R. Gibs, et al., 2014, *DPS meeting* #46, #414.09, "The **Catalina Sky Survey**: status, discoveries and the future." See: http://adsabs.harvard.edu/abs/2014DPS....4641409J - A. Jackson, E. Asphaug, L. Elkins-Tanton, 2014, *DPS meeting* #46, #420.01, "Stop hitting yourself: did most terrestrial impactors originate from the terrestrial planets?" See: http://adsabs.harvard.edu/abs/2014DPS....4642001J - J.T. Keane, I. Matsuyama, 2014, *DPS meeting* #46, #403.08,

	"Rejuvenating NEOs: the efficiency of asteroid resurfacing via planetary flybys." See: http://adsabs.harvard.edu/abs/2014DPS....4640308K - S.J. Kortenkamp, 2014, *DPS meeting* #46, #403.09, "The nearest of the Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4640309K - J.A. Larsen, R.S., McMillan, J.V. Scotti, 2014, *DPS meeting* #46, #213.12, "**Spacewatch** taxonomic photometry of Near-Earth Objects detected by ***NEOWISE***." See: http://adsabs.harvard.edu/abs/2014DPS....4621312L - D. Lauretta, 2014, *DPS meeting* #46, #503.01, "The physical, geological, and dynamical nature of asteroid **(101955) Bennu** - target of ***OSIRIS-REx***." See: http://adsabs.harvard.edu/abs/2014DPS....4650301L - T. Lister, E. Gomez, E. Christensen, S. Larson, 2014, *DPS meeting* #46, #414.10, "The **LCOGT** Near Earth Object (NEO) follow-up network." See: http://adsabs.harvard.edu/abs/2014DPS....4641410L - A.K. Mainzer, T. Grav, J. Bauer, et al., 2014, *DPS meeting* #46, #509.01, "Current and future space-based mid-infrared surveys for minor planets." See: http://adsabs.harvard.edu/abs/2014DPS....4650901M - S. Marshall, R.J. Vervack, C. Magri, et al., 2014, *DPS meeting* #46, #509.06, "Shape-based thermal modeling of three Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4650906M - K.J. Miller, P.A. Taylor, C. Magri, et al., 2014, *DPS meeting* #46, #213.13, "Detectability of boulders on Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4621313M - M. Mommert, D. Trilling, T. Axelrod, et al., 2014, *DPS meeting* #46, #213.08, "Rapid response near-infrared spectrophotometric characterization of Near Earth Objects." See: http://adsabs.harvard.edu/abs/2014DPS....4621308M - N. Moskovitz, D. Polishhook, C. Thomas, et al., 2014, *DPS meeting* #46, #503.09"**The Mission Accessible Near-Earth Object Survey (MANOS)**: Project Overview." See: http://adsabs.harvard.edu/abs/2014DPS....4650309M - C. Nugent, A. Mainzer, J. Masiero, et al., 2014, DPS meeting #46, #509.03, "Near-Earth asteroid surface thermal inertias with ***NEOWISE***." See: http://adsabs.harvard.edu/abs/2014DPS....4650903N - V. Reddy, J. Sanchez, R. Klima, et al., *DPS meeting* #46, #213.10, "Was the **Chelyabinsk meteoroid** a fragment of **Potentially Hazardous Asteroid (86039) 1999 NC43**?" See: http://adsabs.harvard.edu/abs/2014DPS....4621310R - B. Rozitis, E. MacLennan, J.P. Emery, 2014, *DPS meeting* #46, #509.08, "Detection of cohesive forces in the rubble-pile asteroid

	(29075) 1950 DA." See: http://adsabs.harvard.edu/abs/2014DPS....4650908R - W. Ryan, E.V. Ryan, L.K. Johnson, 2014, *DPS meeting* #46, #213.17, "Real-time characterization of Near-Earth Objects: new spectral capabilities at the **Magdalena Ridge Observatory** 2.4-meter telescope." See: http://adsabs.harvard.edu/abs/2014DPS....4621317R - J.V. Scotti, R.S. McMillan, J.A. Larsen, 2014, *DPS meeting* #46, #414.17, "Spacewatch astrometry of asteroids and comets with the Bok 2.3-m and Mayall 4-m telescopes.." See: http://adsabs.harvard.edu/abs/2014DPS....4641417S - M. Shao, T. C.-X. Zhai, S. Turyshev, et al., 2014, *DPS meeting* #46, #414.18, "Synthetic tracking observation of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014DPS....4641418S - A. Springmann, P.A. Taylor, M.C. Nolan, et al., 2014, DPS meeting #46, #409.02, "Radar-derived shape model of Near-Earth Binary Asteroid system **(285263) 1998 QE2**." See: http://adsabs.harvard.edu/abs/2014DPS....4640902S - R.D. Stephens, B.D. Warner, A.W. Harris, D.R. Coley, 2014, *DPS meeting* #46, #213.09, "Near-Earth Asteroid program at the **Center for Solar System Studies**." See: http://adsabs.harvard.edu/abs/2014DPS....4621309S - D. Takir, B.E. Clark, D.S. Lauretta, 2014, *DPS meeting* #46, #503.02, "Bidirectional reflectance distribution functions for the ***OSIRIS-REx*** target asteroid **(101955) Bennu**." See: http://adsabs.harvard.edu/abs/2014DPS....4650302T - R.J. Wainscoat, B. Bolin, K. Chambers, et al., 2014, *DPS meeting* #46, #414.19, "The **Pan-STARRS** search for Near Earth Objects." See: http://adsabs.harvard.edu/abs/2014DPS....4641419W - N. Wigton, J.P. Emery, A.S. Rivkin, C.A. Thomas, 2014, *DPS meeting* #46, #213.16, "Near-Infrared (2 - 4 µm) spectroscopy of Near-Earth Asteroids: searching for OH/H_2O on small planetary bodies." See: http://adsabs.harvard.edu/abs/2014DPS....4621316W
2014, Nov 11	***Second meeting International Asteroid Warning Network Steering Committee meeting***, Tucson (AZ, USA), 11 November 2014. See: http://sservi.nasa.gov/iawn/ **Among the presentations:** - T. Spahr, 2014, "**International Asteroid Warning Network**: recent updates and MPC summary." See: http://sservi.nasa.gov/wp-content/uploads/2014/11/Spahr_Tucson_IAWN.pdf - J.L. Galache, 2014, "Workshop on communicating about asteroid impact warnings and mitigation plans." See:

	http://sservi.nasa.gov/wp-content/uploads/2014/11/Galache_DPS-2014-IAWN-Steering-Committee-Meeting1.pdf - B.D. Warner, 2014, "Clearing the dusty filing cabinets." See: http://sservi.nasa.gov/wp-content/uploads/2014/11/Warner_IAWN_ALCDEF.pdf - N. Moskovitz, 2014, "Rapid response characterization of Near Earth Objects." See: http://sservi.nasa.gov/wp-content/uploads/2014/11/IAWN14_Moskovitz.pdf - J. Bauer, 2014, "***NEOWISE/WISE*** characterization results." See: http://sservi.nasa.gov/wp-content/uploads/2014/11/Bauer_IAWNb.pdf - P. Taylor: 2014, "**Arecibo** radar observations of Near-Earth Asteroids." See: http://sservi.nasa.gov/wp-content/uploads/2014/11/Howell_IAWN-Arecibo.pdf
2014, Nov 13	Aten NEA **2014 WE6** (H = 30.6 mag, $D \approx 2.7$ m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2014-29]** See: 2014 WE6 - SSA , 2014 WE6 - JPL
2014, Nov 14	L. Billings & NASA/JPL Near-Earth Object Program Office, 2014, "Newly released map data shows frequency of small asteroid impacts, provides clues on larger asteroid population." See: http://neo.jpl.nasa.gov/news/news186.html http://neo.jpl.nasa.gov/fireball/
2014, Nov 15	Apollo NEA **2014 WJ6** (H = 27.0 mag, $D \approx 14$ m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.86 LD. **[2014-30]** See: 2014 WJ6 - SSA , 2014 WJ6 - JPL
2014, Nov 18	***ESA SSA-NEO Final Presentation Day***, 18 November 2014, ESRIN, Frascati (Italy). See: http://space-env.esa.int/indico/conferenceDisplay.py?ovw=True&confId=68 http://space-env.esa.int/index.php/news-reader/items/final-presentation-day-at-esrin---computing-the-risk-of-neos-imp.html **Proceedings:** - SSA-SN-V: Operation of the NEO Coordination Centre. See: http://space-env.esa.int/indico/getFile.py/access?resId=2&materialId=slides&confId=68 - SSA-SN-VII: NEO impact effects & mitigation measures study. See: http://space-env.esa.int/indico/internalPage.py?pageId=2&confId=68 - Synthetic generation of a NEO population. See: <http://…>.

	- F. Bernardi, 2014, NEODyS, AstDyS, and priority list data provision. See: http://space-env.esa.int/indico/getFile.py/access?resId=1&materialId=slides&confId=68 - SSA-NEO Final Presentation Day 2014 at ESRIN - Part 1. See: http://m.esa.int/spaceinvideos/Videos/2014/11/SSA-NEO_Final_Presentation_Day_2014_at_ESRIN_-_Part_1 - SSA-NEO Final Presentation Day 2014 at ESRIN - Part 2. See: http://m.esa.int/spaceinvideos/Videos/2014/11/SSA-NEO_Final_Presentation_Day_2014_at_ESRIN_-_Part_2
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2014, Nov-Dec	G. Mengali, A.A. Quarta, 2014, *Acta Astronautica*, 104, 450, "Optimal nodal flyby with near-Earth asteroids using electric sail." See: http://adsabs.harvard.edu/abs/2014AcAau.104..450M
2014, Dec	F. Spoto, A. Milani, D. Farnocchia, et al., 2014, *Astronomy & Astrophysics*, 572, 100, "Nongravitational perturbations and virtual impactors: the case of asteroid **(410777) 2009 FD**." See: http://adsabs.harvard.edu/abs/2014A%26A...572A.100S
2014, Dec	X.-Y. Zeng, Sh-P. Gong, J.-F. Li, 2014, *Acta Astronautica*, 105, 40, "Fast solar sail rendezvous mission to Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2014AcAau.105...40Z
2014, Dec	IAA Press Release 14/5, Dec. 2014, Hypothetical asteroid impact exercise posed for 2015 IAA Planetary Defense Conference. See: http://iaaweb.org/iaa/Scientific%20Activity/prpdc2015.pdf
2014, Dec 1	M.G. Sokolova, Y.A. Nefedyev, N.Y. Varaksina, 2014, *Advances in Space Research*, 54, 2415, "Asteroid and comet hazard: identification problem of observed space objects with the parental bodies." See: http://adsabs.harvard.edu/abs/2014AdSpR..54.2415S
2014, Dec 2	M. Yoshikawa (JAXA), J. Watanabe, (NAOJ), N. Takahashi, S. Urakawa (JSGA), 2014, Tokyo (Japan), *APRSAF*-21, "**Asia-Pacific Asteroid Observation Network**." See: https://aprsaf.org/annual_meetings/aprsaf21/pdf/new_cooperation_session/Proposal_4_APAON_AP21_NewCoop_rev.pdf See also:

	http://www.spaceguard.or.jp/apaon/index.html http://iaaweb.org/iaa/Scientific%20Activity/conf/pdc2015/IAA-PDC-15-01-05ab.pdf
2014, Dec 3	Launch of NEA sample return mission ***Hayabusa 2***. This is a follow-on to the ***Hayabusa*** mission, and carried out by the Japanese space agency JAXA. The target is NEA **Ryugu (162173, 1999 JU3)**. The ***Hayabusa 2*** spacecraft is expected to arrive at the target in 2018, survey the NEA for 1.5 year, depart in December 2019, and return to Earth in December 2020. For this mission the Germany space agency DLR built a small lander called ***MASCOT*** (***Mobile Asteroid Surface Scout***) for the mission, in cooperation with the French space agency CNES. See: http://www.jspec.jaxa.jp/e/activity/hayabusa2.html http://blogs.nature.com/news/2012/02/japan%e2%80%99s-second-asteroid-probe-gets-the-green-light.html http://www.dlr.de/irs/en/desktopdefault.aspx/tabid-7902/13482_read-34316 http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-5375/year-all/ http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10080/150_read-5773/year-all/ http://www.space.com/19064-japan-asteroid-sample-mission-hayabusa2.html http://www.lpi.usra.edu/sbag/meetings/jan2013/presentations/sbag8_presentations/TUES_0900_Hayabusa-2.pdf http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-7355/year-all/#gallery/11287 http://b612.jspec.jaxa.jp/hayabusa2/e/index_e.html http://global.jaxa.jp/press/2014/09/20140930_h2af26.html http://global.jaxa.jp/projects/sat/hayabusa2/ http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-12372/year-all/#/gallery/17357 http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-18664/year-all/#/gallery/23720 http://en.wikipedia.org/wiki/Hayabusa_2 Ref: - N. Moskovitz, S. Abe, D. Osip, et al., 2012, American Astronomical Society, DPS meeting #44, #102.04, "Characterization of ***Hayabusa 2*** target asteroid (**162173**) **1999 JU3**." See: http://adsabs.harvard.edu/abs/2012DPS....4410204M - F. Vilas, 2012, American Astronomical Society, *DPS meeting* #44, #102.03, "New spectral reflectance observations of ***Hayabusa 2*** Near-Earth Asteroid target **162173 1999 JU3**." See: http://adsabs.harvard.edu/abs/2012DPS....4410203V - D. Lazzaro, M.A. Barucci, D. Perna, et al., 2012, *Astronomy & Astrophysics*, 549, 2, "Rotational spectra of (**162173**) **1999 JU3**, the target of the ***Hayabusa 2*** mission."

	See: http://adsabs.harvard.edu/abs/2013A%26A...549L...2L - N.A. Moskovitz, S. Abe, K.-S. Pan, et al., 2013, *Icarus*, 224, 24, "Rotational characterization of ***Hayabusa II*** target asteroid (**162173**) **1999 JU3**." See: http://adsabs.harvard.edu/abs/2013Icar..224...24M
2014, Dec 5	Resolution 69/85 adopted by the ***United Nations General Assembly*** on 5 December 2014, 9/10 : "The General Assembly, … 9. Notes the importance of information-sharing in discovering, monitoring and physically characterizing potentially hazardous near-Earth objects to ensure that all countries, in particular developing countries with limited capacity in predicting and mitigating a near-Earth object impact, are aware of potential threats, emphasizes the need for capacity-building for effective emergency response and disaster management in the event of a near-Earth object impact, and recalls in that regard the recommendations for an international response to the near-Earth object impact threat, endorsed by the Scientific and Technical Subcommittee at its fiftieth session and by the Committee at its fifty-sixth session; 10. Notes with satisfaction that progress on establishing an international asteroid warning network and a space mission planning advisory group to implement the recommendations for an international response to the near-Earth object impact threat would be reported to the Subcommittee at its fifty-second session; … See: http://www.unoosa.org/pdf/gares/A_RES_69_085E.pdf
2014, Dec 7	Apollo NEA **2014 WX202** (H = 29.8 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.98 LD. **[2014-31]** See: 2014 WX202 - SSA , 2014 WX202 - JPL See also: **2 Sep 1979**.
2014, Dec 11	C. de la Fuente Marcos, R. de la Fuente Marcos, 2014, *Monthly Notices Royal Astronomical Society*, 445, 2985, "Asteroid **2014 OL339**: yet another Earth quasi-satellite." See: http://adsabs.harvard.edu/abs/2014MNRAS.445.2985D **Erratum,** 1 February 2016**:** *Monthly Notices Royal Astronomical Society*, 455, 4030.
2014, Dec 12	R. Stone, 2014, *Science*, 346, 1281, "Back from the dead." See: http://adsabs.harvard.edu/abs/2014Sci...346.1281S
2014, Dec 18	Preparing for an asteroid strike, ESA *NEO Newsletter*, 18 December 2014.

	See: http://131.176.152.51/web/guest/home/-/journal_content/56_INSTANCE_j5kH/10157/13789?p_p_state=pop_up&_56_INSTANCE_j5kH_viewMode=print
2014, Dec 26	Apollo NEA **2014 YR14** (H = 25.9 mag, $D \approx$ 23 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2014-32]** See: 2014 YR14 - SSA , 2014 YR14 - JPL
2014, Dec 26	G. Leone, P.J. Tackley, T.V. Gerya, et al., 2014, *Geophysical Research Letters*, 41, 8736, "Three-dimensional simulations of the southern polar giant impact hypothesis for the origin of the **Martian** dichotomy." See: http://adsabs.harvard.edu/abs/2014GeoRL..41.8736L See also: https://spaceguardcentre.com/giant-asteroid-collision-may-have-radically-transformed-mars/
2015, Jan 1	**11943 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, H = 9.45 mag, D = 36.5 km, Amor NEA), of which **1527 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, H = 15.3 mag, D = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2015	L.D. Schmadel, 2015, *Dictionary of Minor Planet Names*, Addendum to 6th Edition: 2012-2014, ISBN 978-3-319-17676-5 (Switzerland: Springer International Publishing). See: http://adsabs.harvard.edu/abs/2015dmpn.book.....S
2015, Jan	C.C. Bryce, G.Horneck, E. Rabbow, et al., 2015, *International Journal of Astrobiology*, 14, 115, "Impact shocked rocks as protective habitats on an anoxic early Earth." See: http://adsabs.harvard.edu/abs/2015IJAsB..14..115B
2015, Jan	Yanlong Bu, Geshi Tang, KaiChang Di, et al., 2015, *The Astronomical Journal*, 149, 21. "New insights of asteroid **4179 Toutatis** using China ***Chang'e-2*** close flyby optical measurements." See: http://adsabs.harvard.edu/abs/2015AJ....149...21B
2015, Jan	H.C. Connolly, D.S. Lauretta, K.J. Walsh, et al., 2015, *Earth, Planets and Space*, 67, 12, "Towards understanding the dynamical evolution of asteroid **25143 Itokawa**: constraints from sample analysis." See: http://adsabs.harvard.edu/abs/2015EP%26S...67...12C

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2015, Jan	A.A. Ledkov, N.A. Eismont, M.N. Boyarskii, et al., 2015, *Astronomy Letters*, 41, 67, "Control of the motion of near-Earth asteroids." See: http://adsabs.harvard.edu/abs/2015AstL...41...67L
2015, Jan	D.E. Vavilov,Y.D. Medvedev, 2015, *Monthly Notices of the Royal Astronomical Society*, 446, 705, "A fast method for estimation of the impact probability of near-Earth objects." See: http://adsabs.harvard.edu/abs/2015MNRAS.446..705V
2015, Jan	T.J. Zegmont, J.L. Galache, M. Elvis, 2015, in: ***American Astronomical Society Meeting #225***, #137.18, "Near-Earth Asteroid characterisation: gotta catch 'em all!." See: http://adsabs.harvard.edu/abs/2015AAS...22513718Z
2015, Jan 1	Jianfeng Caoa, Yong Liua, Songjie Hua, et al., 2015, *Advances in Space Research*, 55, 491, "Navigation of ***Chang'E-2*** asteroid exploration mission and the minimum distance estimation during its fly-by of **Toutatis**." See: http://adsabs.harvard.edu/abs/2015AdSpR..55..491C
2015, Jan 1	C. de la Fuente Marcos, R. de la Fuente Marcos, 2015, *Monthly Notices of the Royal Astronomical Society* (Letters), 446, L31, "Recent multi-kiloton impact events: are they truly random?" See: http://adsabs.harvard.edu/abs/2015MNRAS.446L..31D
2015, Jan 1	M. Hirabayashi, D.J. Scheeres, 2015, *The Astrophysical Journal* (Letters), 798, L8, "Stress and failure analysis of rapidly rotating asteroid **(29075) 1950 DA**." See: http://adsabs.harvard.edu/abs/2015ApJ...798L...8H
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2015, Jan 1	M. Schmieder, W.H. Schwarz, M.Trieloff, et al., 2015, *Geochimica et Cosmochimica Acta*, 148, 304, "New $^{40}Ar/^{39}Ar$ dating of the Clearwater Lake impact structures (Québec, Canada) - not the binary asteroid impact it seems?" See: http://adsabs.harvard.edu/abs/2015GeCoA.148..304S

2015, Jan 6	**Minor Planet Center** director steps down. See: http://minorplanetcenter.net/blog/minor-planet-center-director-steps-down/
2015, Jan 6-7	**12th NASA *Small Bodies Assessment Group Meeting***, 6-7 January 2015, Phoenix (AZ, USA). See: http://www.lpi.usra.edu/sbag/meetings/jan2015/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - J. Bauer, A. Mainzer, R. Cutri, et al., 2015, "***NEOWISE*** restart update." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_NEOWISE_Bauer.pdf - D. Lauretta, E. Beshore, H. Enos, et al., 2015, "***OSIRIS-Rex*** - updates and recent highlights." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_OSIRIS-REx_Lauretta.pdf - L. Johnson, 2015, "**NEO Program 2015**." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_NEO_Program_Johnson.pdf - D.E. Trilling (PI), M. Mommert, J.L. Hora, et al., 2015, "**NEOSurvey**: ***Spitzer*** observations of Near-Earth Asteroids." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_mommert.pdf - L. Johnson, M. Gates, 2015, "***Asteroid Redirect Mission*** update." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_ARM_update_Johnson.pdf - P. Chodas, 2015, "Asteroid Redirect Mission: candidate targets." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG12_ARM_Candidates_Chodas.pdf - B.W. Barbee, 2015, "Accessible Near-Earth Objects (NEOs)." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG12_Accessible_NEOs_Barbee.pdf - H. Kuninaka, 2015, "***Hayabusa2*** - asteroid sample return mission." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_Hayabusa2_Kuninaka_new.pdf - J. Castillo-Rogez, 2015, "***Near Earth Asteroid Scout***." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_NEAScout_Castillo-Rogez.pdf - A. Cheng, 2015, "***AIDA: Asteroid Impact & Deflection***." See: http://www.lpi.usra.edu/sbag/meetings/jan2015/presentations/SBAG_AIDA_Cheng.pdf

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2015, Jan 11	C. de la Fuente Marcos, R. de la Fuente Marcos, S.J. Aarseth, 2015, *Monthly Notices of the Royal Astronomical Society*, 446, 1867, "Flipping minor bodies: what comet **96P/Machholz 1** can tell us about the orbital evolution of extreme trans-Neptunian objects and the production of near-Earth objects on retrograde orbits." See: http://adsabs.harvard.edu/abs/2015MNRAS.446.1867D
2015, Jan 14	Apollo NEA **2015 AQ43** ($H = 28.4$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.41 LD. Minimum miss distance 0.41 LD. **[2015-01]** See: 2015 AQ43 - SSA , 2015 AQ43 - JPL See also: **15 Jan 2010**.
2015, Jan 18	Apollo NEA **2015 BP513** ($H = 26.8$ mag, $D \approx 15$ m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2015-02]**

	See: 2015 BP513 - SSA , 2015 BP513 - JPL See also: https://en.wikipedia.org/wiki/2015_BP513
2015, Jan 20	Apollo NEA **2015 BE511** (*H* = 28.7 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2015-03]** See: 2015 BE511 - SSA , 2015 BE511 - JPL
2015, Jan 22	J.F..J. Bryson, C.I.O. Nichols, J. Herrero-Albillos, et al. 2015, *Nature*, 517, 472, "Long-lived magnetism from solidification-driven convection on the pallasite parent body." See: http://adsabs.harvard.edu/abs/2015Natur.517..472B
2015, Jan 26	Apollo NEA **357439** (**2004 BL86**, *H* = 19.1 mag, *D* = 325 m, **PHA** (+ moon **S/2015 (357439) 1**, with *D* = 70 m), passed Earth at a nominal miss distance of 3.12 LD. Minimum miss distance 3.12 LD. See: 357439 2004 BL86 - SSA , 2004 BL86 - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=4441 http://neo.jpl.nasa.gov/news/news188.html http://www.jpl.nasa.gov/news/news.php?feature=4459 http://news.nationalgeographic.com/news/2015/01/150126-starstruck-asteroid-flyby-astronomy/ https://en.wikipedia.org/wiki/(357439)_2004_BL86
2015, Jan 27	H.C. Connolly, D.S. Lauretta, K.J. Walsh, et al., 2015, *Earth, Planets and Space*, 67, 12, "Towards understanding the dynamical evolution of asteroid **25143 Itokawa**: constraints from sample analysis" See: http://adsabs.harvard.edu/abs/2015EP%26S...67...12C
2015, Jan 28	A. Fazekas, 2015, *National Geographic*, 28 January 2015, "Giant asteroid sails past **Earth**, raising safety questions on Terra Firma." See: http://news.nationalgeographic.com/news/2015/01/150126-starstruck-asteroid-flyby-astronomy/
2015, Jan 29	Apollo NEA **2020 BN12** (*H* = 25.9 mag, *D* ≈ 23 m) passed Earth at a nominal miss distance of 7.87 LD. Minimum miss distance 0.87. LD. See: 2020 BN12 – S2P , 2020 BN12 – JPL
2015, Jan-Feb	B.W. Barbee, B. Wieb, M. Steiner, K. Getzandanner, 2015, *Acta Astronautica*, 106, 139, "Conceptual design of a flight validation mission for a ***Hypervelocity Asteroid Intercept Vehicle***." See: http://adsabs.harvard.edu/abs/2015AcAau.106..139B

2015, Feb	W.F. Bottke, D. Vokrouhlický, K.J. Walsh, 2015, *Icarus*, 247, 191, "In search of the source of asteroid **(101955) Bennu**: applications of the stochastic YORP model." See: http://adsabs.harvard.edu/abs/2015Icar..247..191B
2015, Feb	H. Downes, F.A.J. Abernethy, C.L. Smith, et al., 2015, *Meteoritics & Planetary Science*, 50, 255, "Isotopic composition of carbon and nitrogen in ureilitic fragments of the **Almahata Sitta** meteorite." See: http://adsabs.harvard.edu/abs/2015M%26PS...50..255D
2015, Feb	M. Ebihara, N. Shirai, S.Sekimoto, et al., 2015, *Meteoritics & Planetary Science*, 50, 243, "Chemical and mineralogical compositions of two grains recovered from asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2015M%26PS...50..243E
2015, Feb	T.I. Maindl, R. Dvorak, H. Lammer, et al., 2015, *Astronomy & Astrophysics*, 574, 22, "Impact inducted surface heating by planetesimals on early **Mars**." See: http://adsabs.harvard.edu/abs/2015A%26A...574A..22M
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2015, Feb	G. Tancredi,S. Roland, S. Bruzzone, 2015, *Icarus*, 247, 279, "Distribution of boulders and the gravity potential on asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2015Icar..247..279T
2015, Feb 2-13	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 52nd Session**, 2-13 February 2015, Vienna (Austria). Meetings of **STSC - WG NEO** and **STSC - Action Team 14 on NEOs**. See: http://www.unoosa.org/oosa/en/COPUOS/stsc/2015/index.html **Final report:** http://www.unoosa.org/pdf/reports/ac105/AC105_1088E.pdf **Among the Technical Presentations:** - L. Johnson, 2015, "Update on **NASA NEO Program**." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-05E.pdf - V.V. Adushkin, O.D. Baklanov, I.V. Barmin, et al., 2015, " **"CITADEL"** international planetary defence system as proposed

	for establishment." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-07E.pdf - V.Emel'yanenko, 2015, "The NEO problem: current activities in Russia." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-08E.pdf - L. Johnson, NASA NEO PE, 2015, "**IAWN/SMPAG** Report. Status of the **International Asteroid Warning Network (IAWN)**." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-12E.pdf - G. Drolshagen, ESA, Chair of SMPAG, 2015, "**IAWN/SMPAG** Report. Status of the **Space Mission Planning Advisory Group (SMPAG)**" See: http://www.unoosa.org/pdf/pres/stsc2015/tech-12E.pdf - M. Birlan, 2015, "NEO Event: **Fireball** over Romania, January 7, 2015, 1:05:57 UTC." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-13E.pdf - M. Yoshikawa, ***Hayabusa2*** Project Team, JAXA, 2015, "Status update of ***Hayabusa2***." See: http://www.unoosa.org/pdf/pres/stsc2015/tech-17E.pdf See also: http://www.space.com/28755-dangerous-asteroids-united-nations-team.html
2015, Feb 4	**Minor Planet Center** appointed Matthew J. Holman Interim Director. See: http://www.minorplanetcenter.org/blog/?p=922 http://www.minorplanetcenter.net/about
2015, Feb. 4-5	***Workshop on Early Solar System Impact Bombardment III***, Houston (TX, USA), 4-5 February 2015. See: http://www.hou.usra.edu/meetings/bombardment2015/ **Among the papers:** - S. Mazrouei, R. R. Ghent, W.F.Bottke, 2015, *LPI Contribution* No. 1826, p.3032, "Application of a new method for exploring the Copernican cratering record." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3032M - D.A. Minton, A.P. Jackson, E. Asphaug, et al., 2015, *LPI Contribution* No. 1826, p.3033, "Debris from **Borealis Basin** formation as the primary impactor population of **Late Heavy Bombardment**." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3033M - N. Movshovitz, F. Nimmo, D.G. Korycansky, et al., 2015, *LPI Contribution* No. 1826, p.3013, " Destruction and re-Accretion of outer Solar System satellites during the **Late Heavy Bombardment**." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3013M

	- P.H. Schultz, 2015, *LPI Contribution* No. 1826, p.3031, "Sizes of asteroids responsible for large impact basins on the **Moon** during the **Late Heavy Bombardment**." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3031S - T.D. Swindle, D.A. Kring, 2015, *LPI Contribution* No. 1826, p.3030, "Was there a concentration of lunar and asteroidal impacts at ~4000 Ma?" See: http://adsabs.harvard.edu/abs/2015LPICo1826.3030S - D.R. Lowe, G.R. Byerly, 2015, *LPI Contribution* No. 1826, p.3015, "The terrestrial record of an extended **Late Heavy Bombardment**." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3015L - S. Marchi, W.F. Bottke, L.T. Elkins-Tanton, et al., 2015, "The bombardment of the Earth during the Hadean and early Archean eras." See: http://adsabs.harvard.edu/abs/2015LPICo1826.3008M
2015, Feb 5-6	***3rd Meeting of the Space Missions Planning Advisory Group (SMPAG)***, Vienna (Austria). See: http://neo.ssa.esa.int/smpag https://www.cosmos.esa.int/web/smpag/summary-1st-steering-committee-meeting
2015, Feb 6	Anon., 2015, ***NASA/JPL Near-Earth Object Program Office*** *News*, "Number of known accessible Near-Earth Asteroids doubles since 2010." "NASA performed the first **Near-Earth Object Human Space Flight Accessible Targets Study (NHATS)** in September/October of 2010, and 666 of the known near-Earth asteroids (NEAs) were identified as meeting the **NHATS** criteria for mission accessibility (classifying those NEAs as "**NHATS**-compliant"). These are asteroids in near-Earth orbits that are more dynamically accessible (requiring less time and energy to visit) than round-trip spacecraft missions to Mars. … On January 18, 2015 - a little over four years since the **NHATS** assessments began - the 1332nd **NHATS**-compliant asteroid was identified, doubling the number of known accessible NEAs. The first one, **1943 Anteros** (**1973 EC**, H = 15.75 mag, $D \approx 2.48$ km) was discovered on 13 March 1973." See: http://neo.jpl.nasa.gov/news/news189.html See also: http://neo.jpl.nasa.gov/nhats/ https://en.wikipedia.org/wiki/1943_Anteros See also: **13 March 1973**, **23 may 2038**, **20 May 2050**.
2015, Feb 11	Apollo NEA **2015 CH13** (H = 28.7 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73

	LD. **[2015-04]** See: 2015 CH13 - SSA , 2015 CH13 - JPL See also: **14 Feb 2124**.
2015, Feb 14	R. Schweickhart, 2015, *Rusty's Planetary Defense Blog*, "A blog introduction". See: http://www.asteroidday.org/asteroid-day-expert-blog/2015/2/11/a-blog-introduction-by-rusty-schweickart
2015, Feb 15	R. Schweickhart, 2015, *Rusty's Planetary Defense Blog*, "**Chelyabinsk** warning - one day". See: http://www.asteroidday.org/asteroid-day-expert-blog/2015/2/15/r8y9xa3q7vxvhj45snn2ummyd8iouf
2015, Feb 16	Apollo NEA **2020 SN6** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 2.99 LD. Minimum miss distance 0.05 LD. See: 2020 SN6 – 2SP , 2020 SN6 – JPL See also: **4 Oct 2027**.
2015, Feb 17	Apollo NEA **2015 DD1** (H = 30.4 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.10 LD. Minimum miss distance 0.10 LD. **[2015-05]** See: 2015 DD1 - SSA , 2015 DD1 - JPL See also: **19 Feb 1970**.
2015, Feb 17	M. Jutzi, K. Holsapple, K. Wünneman, P. Michel, 2015, e-print *arXiv:*1502.01844, "Modeling asteroid collisions and impact processes." See: http://adsabs.harvard.edu/abs/2015arXiv150201844J
2015, Feb 18	Aten NEA **2015 DQ224** (H = 29.3 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.26 LD. **[2015-06]** See: 2015 DQ224 - SSA , 2015 DQ224 - JPL
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2015, Feb 27	R. Schweickhart, 2015, *Rusty's Planetary Defense Blog* #3 - "How many are we talking about, anyway?" See: http://www.asteroidday.org/asteroid-day-expert-blog/2015/2/26/asteroid-day-blog-3-how-many-are-we-talking-about-anyway

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2015, Mar	X.-L. Zhang, Y. Yu, X.-L. Wang, et al., 2015, *Research in Astronomy and Astrophysics*, 15, 435, "Astrometry of three Near Earth Asteroids with the Lijiang 2.4 m telescope." See: http://adsabs.harvard.edu/abs/2015RAA....15..435Z
2015, Mar	**Proceedings *XXVIIIth General Assembly of the IAU***, Beijing, (China) 20-31 August 2012, T. Montmerle (ed.), *Highlights of Astronomy*, Vol. 16 (Cambridge: CUP), ***Joint Discussion JD5 - From meteors and meteorites to their parent bodies: current status and future developments***. **Preface,** p. 137; http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=9581023&fulltextType=RA&fileId=S1743921315001568 **Among the papers:** **-** D. Green, 2015, p.141, "The legacy of Brian G. Marsden (1937-2010)." See: http://adsabs.harvard.edu/abs/2015HiA....16..141G - T.J. Jopek, I.P. Williams, 2015, p.143, "Stream and sporadic meteoroids associated with Near Eart Objects." See: http://adsabs.harvard.edu/abs/2015HiA....16..143J - H. Yano, 2015, p.152, "Future small body exploration after the investigation of asteroid **Itokawa** by remote sensing and returned sample analyses." See: http://adsabs.harvard.edu/abs/2015HiA....16..152Y - V. Emel'yanenko, 2015, p.153 "Near-Earth objects from the cometary flux." See: http://adsabs.harvard.edu/abs/2015HiA....16..153E - M. Ishiguro, 2015, p158, "Disk-resolved spectra of 25143) Itokawa with ***Hayabusa* / AMICA** observations." See: http://adsabs.harvard.edu/abs/2015HiA....16..158I - P. Michel, Luisa-M. Lara, B. Marty, et al., 2015, p.163,

	"***MarcoPolo-R***: Near Earth Asteroid sample return mission candidate as ESA-M3 class mission". See: http://adsabs.harvard.edu/abs/2015HiA....16..163M - B. Pulat, K. Gulchekhra, 2015, p.169, "Meteor showers of the Earth-crossing asteroids." See: http://adsabs.harvard.edu/abs/2015HiA....16..169P - M. Tichy, M. Honkova, J. Ticha, M. Kocer, 2015, p.185, "Strategy for NEO follow-up observations." See: http://adsabs.harvard.edu/abs/2015HiA....16..185T
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2015, Mar 6	NASA spacecraft ***Dawn*** reached dwarf planet (former "Main-belt asteroid") **1 Ceres** (H = 3.34 mag, D = 952 km) and went into orbit for five months of operations, till July 2015. See: http://dawn.jpl.nasa.gov/ http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2014-313 http://www.jpl.nasa.gov/news/news.php?release=2014-443 http://en.wikipedia.org/wiki/Ceres_(dwarf_planet)
2015, Mar 7	A.Y. Glikson, A.J. Meixner, B. Radke, et al., 2015, *Tectonophysics*, 643, 55, "Geophysical anomalies and quartz deformation of the **Warburton West structure**, central Australia" See: http://www.sciencedirect.com/science?_ob=ArticleListURL&_method=l

	ist&_ArticleListID=-797094824&_sort=r&_st=13&view=c&md5=185d11e1d2b4ca7db170748409a6f775&searchtype=a See also: https://spaceguardcentre.com/worlds-largest-asteroid-impacts-found-in-central-australia/
2015, Mar 10	Apollo NEA **2015 ET** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.32 LD. **[2015-07]** See: 2015 ET - SSA , 2015 ET - JPL
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2015, Mar 26	NASA asteroid hunter spacecraft data available to public. ***NEOWISE***. See: http://www.jpl.nasa.gov/news/news.php?feature=4524 See also: http://wise2.ipac.caltech.edu/docs/release/neowise/ http://www.nasa.gov/mission_pages/neowise/main/index.html
2015, Mar 28	Apollo NEA **2015 FM118** (H = 28.9 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.92 LD. **[2015-10]** See: 2015 FM118 - SSA , 2015 FM118 - JPL
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	Impact & Deflection Assessment (AIDA) mission:. In late 2022, the NASA-led part of ***AIDA*** will arrive: the ***Double Asteroid Redirection Test (DART)***, probe will approach the binary system – then crash straight into the asteroid moon at about 6 km/s. See: http://131.176.152.51/web/guest/home/-/journal_content/56_INSTANCE_9xAQ/10157/14844?p_p_state=pop_up&_56_INSTANCE_9xAQ_viewMode=print https://www.nasa.gov/planetarydefense/dart Ref: - A.M. Stickle, J.A. Atchison, O.S. Barnouin, et al., 2015, AAS DPS meeting #47, #312.14, "Modeling momentum transfer by the ***DART*** spacecraft into the moon of **Didymos**." See: http://adsabs.harvard.edu/abs/2015DPS....4731214S See also: http://www.esa.int/Our_Activities/Space_Engineering_Technology/NEO/Asteroid_Impact_Mission_AIM http://meetingorganizer.copernicus.org/EPSC2012/EPSC2012-935-1.pdf http://www.astrobio.net/topic/solar-system/meteoritescomets-and-asteroids/esas-planetary-defense-test-set-for-2020/ https://astronomynow.com/2017/01/20/future-of-asteroid-deflection-mission-to-be-decided-soon/
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	nominal miss distance of 0.81 LD. Minimum miss distance 0.81 LD. **[2015-15]** See: 2015 JF1 - SSA , 2015 JF1 - JPL
2015, May 23	Apollo NEA **2015 KW121** (*H* = 26.2 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.74 LD. **[2015-16]** See: 2015 KW121 - SSA , 2015 KW121 - JPL
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2015, Jun 8	Apollo NEA **2015 LF** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 0.51 LD. Minimum miss distance 0.51 LD. **[2015-17]** See: 2015 LF - SSA , 2015 LF - JPL
2015, Jun 10	Aten NEA **2021 JW2** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 1.52 LD. Minimum miss distance 0.61 LD. See: 2021 JW2 – S2P , 2021 JW2 - JPL
2015, Jun 10-19	***UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), 58th session***, 10-19 June 2015, Vienna (Austria), including meetings of **STSC WG NEO and STSC Action Team 14 on NEOs.** See: http://www.unoosa.org/pdf/limited/l/AC105_L292AEVE.pdf http://www.unoosa.org/oosa/en/ourwork/copuos/2015/index.html **Final report:** http://www.unoosa.org/res/oosadoc/data/documents/2015/a/a7020_0_html/A_70_20E.pdf
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2015, Jun 16	Apollo NEA **1566 Icarus** (**1949 MA**, *H* = 16.3 mag, *D* ≈ 1.3 km, **PHA**) passed Earth at a nominal miss distance of 20.95 LD. Minimal miss distance 20.95 LD. See: 1566 Icarus - SSA , 1949 MA - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=4625 http://en.wikipedia.org/wiki/1566_Icarus See also: **14 Jun 1968, 14 Jun 2090**
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2015, Jul 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 July 2015. See: http://neo.ssa.esa.int/newsletters
2015, Jul 7	Apollo NEA **2015 HM10** (H = 23.5 mag, $D \approx$ 70 m) passed Earth at a nominal miss distance of 1.15 LD. Minimum miss distance 1.15 LD. See: 2015 HM10 - SSA , 2015 HM10 - JPL See also: https://en.wikipedia.org/wiki/2015_HM10
2015, Jul 7-9	***First International Workshop on Potentially Hazardous Asteroids: characterization, atmospheric entry and risk assessment***, 7-9 July 2015, NASA Ames Research Center,

	Mountain View (CA, USA). See: https://planetary-defense.arc.nasa.gov/workshop2015/ **Among the papers:** - E. Venkatapathy, D. Morrison, 2015, "Vision, goals and products of the Workshop." - P. Chodas, 2015, "Overview of the **NEO Program Office**." - M. Boslough, 2015, "Airburst modeling." - O. Popova, 2015, "Simulations of the entry and damaging effects of asteroid impacts." - P. Brown, 2015, "Energy deposition and infrasonic measurement of bolides." - D. Prabu, 2015, "Meteor entry and breakup based on evolution of NASA's entry capsule design tools." - M. Syal, 2015, "Asteroid characteristics relevant to kinetic and nuclear deflection strategies." - N. Moskovitz, 2015, "Telescopic insight into the physical properties of potentially Earth-impacting asteroids." - D. Richardson, 2015, "Structural modeling of asteroids." - M. Busch, 2015, "Physical properties of asteroids from radar." - D. Sears, 2015, "A meteorite perspective on Planetary Defense." - G. Consolmagno, 2015, "Physical properties of asteroids from meteorites." - K. Holsapple, 2015, "Recent advances in asteroid deflection strategies." - M. Berger, 2015, "Simulations of airburst-generated tsunamis using **GeoClaw**." - S. Ward, 2015, "Impact tsunami, three ways to go: semi-analytical, tsunami by formula, tsunami squares." - V. Titov, 2015, "Tsunami forecast: existing capabilities and gaps." - S. Ezzedine, 2015, "Wave generation, wave propagation and consequences of asteroid impacts on **Earth**." - G. Gisler, 2015, "Airburst vs impact: which makes the greater wave?" - J. Melosh, 2015, "Near-field damage from impacts and airbursts." - M. Aftosmis, 2015, "Far-field propagation of airburst events using a cartesian method." - D. Morrison, 2015, "Changing perspectives on impact risk: 1750-2003." - E. Pate-Cornell, J. Reinhardt, 2015, "Risk analysis for Near Earth Objects and mitigation options." - D. Mathias, 2015, "Sensitivity to uncertainty in Planetary Defense risk assessment." - L.A. Lewis, 2015, "Recent activities of the **US Federal Emergency Management Agency** concerning response to Near Earth Object impacts." - P. Jenniskens, 2015, "Rapid response to asteroid impacts."

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2015, Jul 19	Apollo NEA **436724** (**2011 UW158**, *H* = 20.0 mag, *D* ≈ 600 x 300 m, **PHA**) passed Earth at a nominal miss distance of 6.40 LD. Minimum miss distance 6.40 LD. See: 436724 2011 UW158 - SSA , 2011 UW158 - JPL See also: https://en.wikipedia.org/wiki/(436724)_2011_UW158
2015, Jul 22	J.A. Sanchez, V. Reddy, M. Dykhuis, et al., 2015, *Astrophysical Journal*, 808, 93, "Composition of **Potentially Hazardous Asteroid (214869) 2007 PA8**: an H chondrite from the outer Asteroid Belt." See: http://adsabs.harvard.edu/abs/2015ApJ...808...93S
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	- M. Bruck Syal, L. Chen, E.B. Herbold, et al., 2015, LPI Contribution No. 1856, p.5282, "Meteorite material properties for use in impulsive asteroid deflection simulations." See: http://adsabs.harvard.edu/abs/2015LPICo1856.5282B - B. Schmitz, 2015, LPI Contribution No. 1856, p.5323, "The meteorite flux to **Earth** through the Phanerozoic Eon - the first results." See: http://adsabs.harvard.edu/abs/2015LPICo1856.5323S - B. Schmitz, S. Boschi, A. Cronholm, et al., 2015, "Fragments of Late Eocene **Earth**-impacting asteroids linked to disturbance of Asteroid Belt." See: http://adsabs.harvard.edu/abs/2015LPICo1856.5040S - S. Voropaev, A. Kocherov, R. Gabitov, 2015, LPI Contribution No. 1856, p.5012, "Comparative analysis of micrograins from asteroid **25143 (Itokawa)** and **Chelyabinsk** meteorite." See: http://adsabs.harvard.edu/abs/2015LPICo1856.5012V
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2015, Aug 3-14	***IAU XXIX General Assembly***, 3-14 August 2015, Honolulu, (Hawaii, USA). See: http://astronomy2015.org/
2015, Aug 3-7	***IAU XXIX General Assembly, IAU Symposium No. 318 – Asteroids: New Observations, New Models***, 3-14 August 2015, Honolulu, (Hawaii, USA). See: http://astronomy2015.org/symposium_318 http://astronomy2015.org/sites/default/files/S318_Block_Schedule.pdf **Proceedings:** S. Chesley, A. Morbidelli, R.Jedicke, D. Farnocchia (eds.), January 2016, Proceedings ***IAU Symposium No. 318 – Asteroids: New Observations, New Models***, Honolulu (Hawaii, USA), 3-14 August 2015 (Cambridge, CUP). See: http://www.cambridge.org/nl/academic/subjects/physics/computational-science-and-modelling/asteroids-new-observations-new-models-iau-s318 ***Among the presentations:*** **Session 1: Population Models / Collisions and Cratering** - M. Granvik, 2015, *IAU General Assembly, Meeting* #29, id.2258030, "New population-level insights about Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2015IAUGA..2258030G - C. Thomas, 2015, *IAU General Assembly, Meeting* #29, id.2258202, "Connecting Near-Earth Objects, meteorites, and Main Belt source regions." See: http://adsabs.harvard.edu/abs/2015IAUGA..2258202T - M. Jutzi, 2015, *IAU General Assembly, Meeting* #29, id.2246674, "Modeling asteroid collisions and impact processes." See: http://adsabs.harvard.edu/abs/2015IAUGA..2246674J **Session 2: Main-belt Connections** - P. Spurný, J. Borovicka, 2015, *IAU General Assembly, Meeting* #29, id.2253907, "What do fireballs and meteorites tell us about their parent bodies?"

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Session 12: Ground-based Search and Characterization

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2015, Oct 22	Apollo NEA **2015 UM52** ($H = 28.1$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2015-21]** See: 2015 UM52 - SSA , 2015 UM52 - JPL See also: **22 Oct 1933**.
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2015, Oct 30	G.A. Neumann, M.T. Zuber, M.A. Wieczorek, et al., 2015, *Science Advances*, Vol 1, no.9, e1500852, "Lunar impact basins revealed by ***Gravity Recovery and Interior Laboratory*** measurements." See: http://advances.sciencemag.org/content/1/9/e1500852.full
2015, Oct 31	Apollo NEA **2015 TB145** ($H = 20.2$ mag, $D \approx 600$ m, **PHA**, possibly a dead comet) passed **Earth** at a nominal miss distance of 1.27 LD. Minimum miss distance 1.27 LD. It passed the **Moon at** a nominal miss distance of 0.74 LD and a minimum miss distance 0.74 LD. See: 2015 TB145 - SSA , 2015 TB145 - JPL See also: http://neo.jpl.nasa.gov/news/news190.html http://gawker.com/asteroid-to-strike-earth-on-halloween-scaremongering-1737772849 http://www.jpl.nasa.gov/news/news.php?feature=4760 http://www.jpl.nasa.gov/news/news.php?feature=4763 https://www.space.com/30954-halloween-asteroid-flyby-facts-2015-tb145.html

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2015, Nov	S.J. de Vet, 2015, *Meteoritics & Planetary Science*, 50,1, "The **1925 meteorite fall near Ellemeet** and **Serooskerke**, the Netherlands." See: http://adsabs.harvard.edu/abs/2015M%26PS...50E...1V
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2015, Nov 2	Yun Jiang, Jianghui Ji, Jiangchuan Huang, et al., 2015, *Scientific Reports*, 5, 16029, "Boulders on asteroid **Toutatis** as observed by ***Chang'e-2***." See: http://www.nature.com/articles/srep16029
2015, Nov 2	*ESA SSA-NEO Coordination Centre Newsletter*, 2 November 2015. See: http://neo.ssa.esa.int/newsletters
2015, Nov 5	Apollo NEA **2015 VP64** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73

	LD. **[2015-22]** See: 2015 VP64 - SSA , 2015 VP64 - JPL
2015, Nov 6	Aten NEA **2015 VU64** (H = 30.8 mag, $D \approx$ 2.4 m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.26 LD. **[2015-23]** See: 2015 VU64 - SSA , 2015 VU64 - JPL
2015, Nov 8	***Third meeting of the International Asteroid Warning Network (IAWN) Steering Committee***, National Harbor, Maryland (MD, USA), 8 November 2015. See: http://minorplanetcenter.net/IAWN/2015_national_harbor/ **Presentations:** - L. Johnson (NASA Hq), 2015, "**NASA Near-Earth Object Observations (NEOO)** program." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/NEO_Program_update.pdf - M.J. Holman (MPC), 2015, "The **Minor Planet Center** status report." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/MPC_IAWN_Holman.pdf - G. Drolshagen, D. Koschny (ESA, ESTeC), 2015, "**ESA's SSA-NEO Segment**." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/Koschny_IAWN_SSA-NEO_overview_2015-11-06.pdf - R. Landis (NASA Hq), 2015, "**IAWN** status." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/IAWN_Status_Final_3rd_SCmtg.pdf - V. Reddy (PSI), 2015, "Real-time characterization of **hazardous asteroids**: lessons from recent flybys." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/Reddy_IWAN_NEO.pdf - A.K. Mainzer (JPL), J.M. Bauer, R.M. Cutri, et al., 2015, "***NEOWISE*** views of small bodies; ***NEOCAM Near Earth Object Camera***." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/IAWN2015.pdf - L. Billings (NIA/NASA Hq), 2015, "Communication planning: time for action." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/Communications_planning_LBillings.pdf - L. Billings (NIA), 2015, *Space Policy*, 33, 8, "Words matter: a call for responsible communication about asteroid impact hazards and plans for planetary defense." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/Communications_planning_LBillings.pdf - L. Billings (NASA Hq), S. Camacho, 2015, *Spacenews*, 24 July 2015, "Op-ed | Building international infrastructure for planetary

	defense." See: http://minorplanetcenter.net/IAWN/2015_national_harbor/Op-ed_Building_International_Infrastructure_for_Planetary_Defense_-_SpaceNews.com.pdf
2015, Nov 8-13	***47th Annual AAS Division for Planetary Sciences Meeting***, National Harbor (MD, USA), 8-13 November 2015. See: http://dps.aas.org/ http://aas.org/meetings/dps47 **Among the papers:** - P. Abell, D. Mazanek, D. Reeves, et al., 2015, *AAS DPS meeting* #47, #312.06, "NASA's ***Asteroid Redirect Mission*** (***ARM***)." See: http://adsabs.harvard.edu/abs/2015DPS....4731206A - J. Andres Sanchez, V. Reddy, M. Dykhuis, et al., 2015, *AAS DPS meeting* #47, #213.02, "**Potentially hazardous asteroid (214869) 2007 PA8**: The missing link between H chondrites and the outer asteroid belt." See: http://adsabs.harvard.edu/abs/2015DPS....4721302A - O.S. Barnouin, C. Maurel, D.C. Richardson, et al., 2015, *AAS DPS meeting* #47, #402.09"Geodynamic stability of the primary in the binary asteroid **system 65803 Didymos**." See: http://adsabs.harvard.edu/abs/2015DPS....4740209B - L.A.M. Benner, M. Brozovic, J.D. Giorgini, et al., 2015, *AAS DPS* meeting #47, #204.07, "Radar imaging of binary near-Earth asteroid **(357439) 2004 BL86**." See: http://adsabs.harvard.edu/abs/2015DPS....4720407B - R.P. Binzel, F.E. DeMeo, B.J. Burt, et al., 2015, *AAS DPS meeting* #47, #301.03, "Main-Belt source regions for **Potentially Hazardous Near-Earth Asteroids** and sample return targets." See: http://adsabs.harvard.edu/abs/2015DPS....4730103B - W. Bottke, R. Ghent, S. Mazrouei, et al., 2015, *AAS DPS meeting* #47, #201.07, "Asteroid impacts, crater scaling laws, and a proposed younger age for **Venus**'s surface." See: http://adsabs.harvard.edu/abs/2015DPS....4720107B - M.O. Bowman, J.-L. Margot, 2015, *AAS DPS meeting* #47, #308.20, "A systematic search for undiscovered companions to near-Earth asteroids in radar images." See: http://adsabs.harvard.edu/abs/2015DPS....4730820B - K. Brauer, M.W. Busch, L.A.M. Benner, et al., 2015, *AAS DPS meeting* #47, #213.03, "The shape of Near-Earth Asteroid **275677 (2000 RS11)** from inversion of **Arecibo** and **Goldstone** radar images." See: http://adsabs.harvard.edu/abs/2015DPS....4721303B - A.J. Brown, 2015, *AAS DPS meeting* #47, #213.10, "Spectral bluing on **101955 Bennu** and implications for dynamics of sub micron regolith grains on asteroids."

	See: http://adsabs.harvard.edu/abs/2015DPS....4721310B - P.G. Brown, P. Wiegert, D. Clark, E. Tagliaferri, 2015, *AAS DPS meeting* #47, #402.07, "Orbital and physical characteristics of meter-sized **Earth** impactors." See: http://adsabs.harvard.edu/abs/2015DPS....4740207B http://adsabs.harvard.edu/abs/2015arXiv151107479B - M. Brozovic, L. Benner, J. McMichael, et al., 2015, *AAS DPS meeting* #47, #402.06, "Size estimate **of (99942) Apophis** based on radar imaging." See: http://adsabs.harvard.edu/abs/2015DPS....4740206B - M.J. Brucker, K.A. Nault, M. Hammergren, et al., 2015, *AAS DPS* meeting #47, #307.07, "Preliminary light curve results of neos from the characterization and astrometric follow-up program at **Adler Planetarium**." See: http://adsabs.harvard.edu/abs/2015DPS....4730707B - M.W. Busch, L.AM. Benner, S.P. Naidu, et al., *AAS DPS meeting* #47, #402.05, "Asteroids with tensile strength: the case of **2015 HM10**." See: http://adsabs.harvard.edu/abs/2015DPS....4740205B - H. Campins, J. Licandro, J. de León, et al., 2015, *AAS DPS meeting* #47, #106.05, "Near Earth Asteroid (**4015) Wilson-Harrington**: a possible source of meteorites from the **Polana** or the **Themis Family**." See: http://adsabs.harvard.edu/abs/2015DPS....4710605C - S.R. Chesley, P. Veres, 2015, *AAS DPS meeting* #47, #308.09, "**LSST**'s projected Near-Earth Asteroid iscovery performance." See: http://adsabs.harvard.edu/abs/2015DPS....4730809C - H. Chit Siu, J.T. Keane, N. Moskovitz, R.P. Binzel, 2015, *AAS DPS meeting* #47, #402.03, "Effects of Earth encounters on the rotational properties of Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2015DPS....4740203C - P. Chodas, 2015, *AAS DPS meeting* #47, #214.09, "Overview of the **JPL Center for NEO Studies (CNEOS)**." See: http://adsabs.harvard.edu/abs/2015DPS....4721409C - E.J. Christensen, D. Carson Fuls, A.R. Gibbs, et al., 2015, *AAS DPS meeting* #47, #308.19, "Status of The **Catalina Sky Survey**." See: http://adsabs.harvard.edu/abs/2015DPS....4730819C - D. Cotto-Figueroa, E. Asphaug, L. Garvie, Laurence, et al., 2015, *AAS DPS meeting* #47, #213.20, "Scale-dependent measurements of meteorite strength and fragmentation: **Tamdakht** (H5) and **Allende** (CV3)." See: http://adsabs.harvard.edu/abs/2015DPS....4721320C - J.L. Crowell, E.S. Howell, C. Magri, et al., 2015, *AAS DPS meeting* #47, #213.04, "Thermophysical model of S-complex NEAs: **1627 Ivar**." See: http://adsabs.harvard.edu/abs/2015DPS....4721304C - J. de Leon, N. Pinilla-Alonso, H. Campins, Humberto et al.,

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	#308.16, "**The Las Cumbres Observatory (LCOGT)** network for NEO and Solar System science." See: http://adsabs.harvard.edu/abs/2015DPS....4730816L - A.K. Mainzer, E.L. Wright, J. Bauer, et al., 2015, *AAS DPS meeting* #47, #308.01, "The ***Near-Earth Object Camera***: a next-generation minor planet survey." See: http://adsabs.harvard.edu/abs/2015DPS....4730801M - S.E. Marshall, E.S. Howell, M. Brozovic, et al., 2015, *AAS DPS meeting* #47, #204.09, "**Potentially Hazardous Asteroid (85989) 1999 JD6**: radar, infrared, and lightcurve observations and a preliminary shape model." See: http://adsabs.harvard.edu/abs/2015DPS....4720409M - M. Mommert, A.W. Harris, M. Mueller, et al., 2015, *AAS DPS meeting* #47, #308.04, "Dormant comets in the Near-Earth Asteroid population." See: http://adsabs.harvard.edu/abs/2015DPS....4730804M - D. Morate, J. de León, M. De Prá, et al., 2015, *AAS DPS meeting* #47, #213.21, "Compositional study of asteroids in the **Erigone** collisional family using visible spectroscopy at the 10.4m **GTC**." See: http://adsabs.harvard.edu/abs/2015DPS....4721321M - N. Moskovitz, L. Avner, R. Binzel, et al., 2015, *AAS DPS meeting* #47, #308.10, "The **Mission Accessible Near-Earth Object Survey (MANOS)** --- first results." See: http://adsabs.harvard.edu/abs/2015DPS....4730810M - S.P. Naidu, L.A.M. Benner, M. Brozovic, et al., 2015, *AAS DPS meeting* #47, #204.08, "Radar observations of near-Earth asteroid **(436724) 2011 UW158** using the **Arecibo**, **Goldstone**, and **Green Bank** telescopes." See: http://adsabs.harvard.edu/abs/2015DPS....4720408N - K.A. Nault, M.J. Brucker, M. Hammergren, et al., 2015, *AAS DPS meeting* #47, #308.15, "Astrometric results of NEOs from the characterization and astrometric follow-up program at **Adler Planetarium**." See: http://adsabs.harvard.edu/abs/2015DPS....4730815N - D. Polishook, N. Moskovitz, R.P., Binzel, et al., 2015, *AAS DPS meeting* #47, #402.02, "Challenging the wall of fast rotating asteroids -- constraining internal cohesive strength for MBAs and NEAs." See: http://adsabs.harvard.edu/abs/2015DPS....4740202P - A. Quijano Vodniza, M. Rojas Pereira, 2015, *AAS DPS meeting* #47, #308.05, "The asteroid **2015 KA122**." See: http://adsabs.harvard.edu/abs/2015DPS....4730805Q - J.E. Richardson, P.A. Taylor, E.G. Rivera-Valentin, et al., 2015, *AAS DPS meeting* #47, #308.08, "**Arecibo** and **Goldstone** radar observations of the first-recognized binary Near-Earth Asteroid: **(385186) 1994 AW1**." See: http://adsabs.harvard.edu/abs/2015DPS....4730808R - A.S. Rivkin, L.F. Lim, J.P. Emery, et al., 2015, *AAS DPS meeting*

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2015, Nov 17	S. Brusatte, 2015, *Scientific American*, 313, 54, "What killed the dinosaurs." See: http://www.nature.com/scientificamerican/journal/v313/n6/full/scientificamerican1215-54.html
2015, Nov 17	H.F. Levison, K.A. Kretke, K. Walsh, W. Bottke, 2015, *Proceedings of the National Academy of Sciences*, 112, 14180, "Growing the terrestrial planets from the gradual accumulation of sub-meter sized objects." See: http://intl.pnas.org/content/112/46/14180.abstract
2015, Nov 18	**B612 Foundation**, *Annual Progress Report*, Volume One, 2015. See: http://issuu.com/b612foundation/docs/__b612_donor_report_102215_final010?e=19559864/31095047&utm_source=Master+Mailing+List&utm_

	campaign=d01d8de45d-Nov+2015+Newsletter&utm_medium=email&utm_term=0_a5e19079bd-d01d8de45d-76853353&goal=0_a5e19079bd-d01d8de45d-76853353
2015, Nov 20	Apollo NEA **2015 WP2** (*H* = 30.1 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2015-25]** See: 2015 WP2 - SSA , 2015 WP2- JPL
2015, Nov 23	NASA draft report from the ***Asteroid Redirect Mission*** Formulation Assessment and Support Team (***ARM***), for public comment . See: https://www.nasa.gov/arm http://www.nasa.gov/feature/arm-fast http://www.nasa.gov/sites/default/files/atoms/files/fast-final-report-draft-for-public-comment.pdf http://www.jpl.nasa.gov/news/news.php?feature=6593
2015, Nov 24	Apollo NEA **2015 VO142** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.02 LD. See: 2015 VO142 - SSA , 2015 VO142- JPL
2015, Dec	Ch.-Ch. Bao, H.-W. Yang, B.-Z. Barsbold, H.-X. Baoyin, 2015, *Astrophysics and Space Science*, 360, 61, "Capturing near-Earth asteroids into bounded Earth orbits using gravity assist." See: http://adsabs.harvard.edu/abs/2015Ap%26SS.360...61B
2015, Dec	M. Bhatt, V. Reddy, L. Le Corre, et al., 2015, *Icarus*, 262, 124, "Spectral calibration for deriving surface mineralogy of asteroid **(25143) Itokawa** from ***Hayabusa Near-Infrared Spectrometer (NIRS)*** data." See: http://adsabs.harvard.edu/abs/2015Icar..262..124B
2015, Dec	V.V. Busarev, S.I. Barabanov, V.S. Rusakov, et al., 2015, *Icarus*, 262, 44, "Spectrophotometry of (32) Pomona, (145) Adeona, (704) Interamnia, (779) Nina, **(330825) 2008 XE3**, and **2012 QG42** and laboratory study of possible analog samples." See: http://adsabs.harvard.edu/abs/2015Icar..262...44B
2015, Dec	H.C. Connolly, D.S Lauretta, K.J. Walsh, et al., 2015, *Earth, Planets and Space*, 67, 12, "Towards understanding the dynamical evolution of asteroid **25143 Itokawa**: constraints from sample analysis." See: http://adsabs.harvard.edu/abs/2015EP%26S...67...12C

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2015, Dec	D.D. Mazanek, R.G. Merrill, J.R. Brophy, et al., 2015, *Acta Astronautica*, 117, 163, "***Asteroid Redirect Mission*** concept: a bold approach for utilizing space resources." See: http://adsabs.harvard.edu/abs/2015AcAau.117..163M
2015, Dec	B. Napier, D. Asher, M. Bailey, D. Steel, 2015, *Astronomy & Geophysics*, 56, 6.24, "Centaurs as a hazard to civilization." See: http://adsabs.harvard.edu/abs/2015A%26G....56f6.24N
2015, Dec	C. R. Nugent, A. Mainzer, J. Masiero, et al., 2015, *Astrophysical Journal*, 814, 117, "***NEOWISE*** reactivation mission year one: preliminary asteroid diameters and albedos." See: http://adsabs.harvard.edu/abs/2015ApJ...814..117N
2015, Dec	J. Park, B.D. Turrin, G.F. Herzog, et al., 2015, *Meteoritics & Planetary Science*, 50, 2087, "$^{40}Ar/^{39}Ar$ age of material returned from asteroid **25143 Itokawa**." See: http://adsabs.harvard.edu/abs/2015M%26PS...50.2087P
2015, Dec	C. Tubiana, C. Snodgrass, R. Michelsen, et al., 2015, *Astronomy & Astrophysics*, 584, 97, "2P/Encke, the **Taurid complex NEOs** and the **Maribo** and **Sutter's Mill meteorites**." See: http://adsabs.harvard.edu/abs/2015A%26A...584A..97T
2015, Dec 1	K. Muinonen, M. Granvik, A. Penttilä, M. Gritsevich (eds.), 2015, **Proceedings Part 1 *International Conference Asteroids, Comets, Meteors 2014***, Helsinki (Finland), 30 June - 4 July 2014, *Planetary and Space Science*, 118. **Among the papers:** - K. Muinonen, M. Granvik, A. Penttilä, M. Gritsevich, et al., 2015, *Planetary and Space Science*, 118, 1. "**Asteroids, Comets, Meteors, and their interrelations, Part I**: Editorial review." See: http://adsabs.harvard.edu/abs/2015P%26SS..118....1M - A.V. Andronikov, I.E. Andronikova, D.H. Hill, 2015, *Planetary and Space Science*, 118, 54, "Impact history of the **Chelyabinsk** meteorite: electron microprobe and LA-ICP-MS study of sulfides and metals." See: http://adsabs.harvard.edu/abs/2015P%26SS..118...54A - L. Drube, A. Harris, 2014, "Metallic asteroids in the ***IRAS*** minor planet survey --- a **NEOShield** study." See: http://adsabs.harvard.edu/abs/2014acm..conf..140D - V.V. Emel'yanenko, 2015, *Planetary and Space Science*, 118, 302, "Dynamical evolution of **Chelyabinsk**-type bodies from

	sungrazing orbits to near-Earth space." See: http://adsabs.harvard.edu/abs/2015P%26SS..118..302E - J.A. Fernández, A. Sosa, 2015, , *Planetary and Space Science*, 118, 14, "**Jupiter** family comets in near-Earth orbits: Are some of them interlopers from the asteroid belt." See: http://adsabs.harvard.edu/abs/2015P%26SS..118...14F - T.Yu. Galushina, G.O. Ryabova, P.V. Skripnichenko, 2015, *Planetary and Space Science*, 118, 296, "The force model for asteroid **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2015P%26SS..118..296G - A. Harris, L. Drube, 2014, "How to find metal-rich asteroids --- a **NEOShield** study." See: http://adsabs.harvard.edu/abs/2014acm..conf..204H - D. Koschny, M. Busch, 2015, *Planetary and Space Science*, 118, p. 305, "The Teide Observatory **Tenerife Asteroid Survey**." See: http://adsabs.harvard.edu/abs/2015P%26SS..118..305K - D. Perna, M.A. Barucci, L. Drube, et al., 2015, *Planetary and Space Science*, 118, 311, "A global response roadmap to the asteroid impact threat: the **NEOShield** perspective." See: http://adsabs.harvard.edu/abs/2015P%26SS..118..311P - R. Rudawska, J. Vaubaillon, 2015, *Planetary and Space Science*, 118, 25, "**Don Quixote** - a possible parent body of a meteor shower." See: http://adsabs.harvard.edu/abs/2015P%26SS..118...25R - S. Schwartz, P. Michel, M. Jutzi, 2014, "Analysis of ejecta fate from proposed man-made impactors into near-Earth objects --- a **NEOShield** study." See: http://adsabs.harvard.edu/abs/2014acm..conf..482S
2015, Dec 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 December 2015. See: http://neo.ssa.esa.int/newsletters
2015, Dec 8-9	***AASSA Regional Workshop on SHER Communication***, Jakarta, 8-9 December 2015. See: http://www.interacademies.net/ProjectsAndActivities/10880/28034.aspx
2015, Dec 11	Aten NEA **33342** (**1998 WT24**, H = 18.3 mag, $D \approx$ 415 m, **PHA**) passed Earth at a nominal miss distance of 10.9 LD. Minimum miss distance 10.9 LD. See: 1998 WT24 - SSA , 1998 WT24 - JPL See also: http://neo.jpl.nasa.gov/images/1998wt24.html http://science.nasa.gov/science-news/science-at-nasa/2001/ast14dec_1/ http://www.jpl.nasa.gov/news/news.php?feature=4800 https://en.wikipedia.org/wiki/(33342)_1998_WT24 See also: **16 Dec 1908, 16 Dec 1956, 16 Dec 2001, 18 Dec 2099**

2015, Dec 11	A. Olech, P. Żołądek, M. Wiśniewski, et al., 2015, *Monthly Notices of the Royal Astronomical Society*, 454, 2965, "**PF131010 Ciechanów fireball**: the body possibly related to near earth asteroids **2010 TB54 and 2010 SX11**." See: http://adsabs.harvard.edu/abs/2015MNRAS.454.2965O
2015, Dec 13	Apollo NEA **2015 YJ** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.18 LD. **[2015-26]** See: 2015 YJ - SSA , 2015 YJ - JPL See also: **24 May 2055**.
2015, Dec 14-18	***American Geophysical Union Fall Meeting, session on Asteroids & Planetary Defense Session***, San Francisco (CA, USA), 14-18 December 2015. See: http://fallmeeting.agu.org/2015/ https://agu.confex.com/agu/fm15/preliminaryview.cgi/Session7518 **Among the papers:** - M. Boslough, 2015, "Can plume-forming asteroid airbursts generate meteotsunami in deep water?" - M. Bruck Syal, 2015, "Deflection by kinetic impact or nuclear ablation: sensitivity to asteroid properties." - J.D. Burke, 2015, "Roadmap for an **EArth Defense Initiative (READI)**." - M. Busch, 2015, "Mission designs for demonstrating ***Gravity Tractor*** asteroid deflection." - J. Dotson, 2015, "Near Earth asteroid characteristics for asteroid threat assessment." - S.M. Ezzedine, 2015, "Numerical investigation of the consequences of land impacts, water impacts, or air bursts of asteroids." - M. Galiazzo, 2015, "V-type NEAs: impacts and close encounters with terrestrial planets." - P.M.M. Jenniskens, 2015, "An airborne observing campaign of an announced small asteroid impact for high fidelity impact modeling validation (Invited)." - E. Lindquist, 2015, "Characterization of NEOs from the policy perspective: implications from problem and solution definitions." - D.R. Ostrowski, 2015, "Planetary Defense and the high temperture physical properties of meteorites." - P. Roperch, 2015, "Paleomagnetism and mineralogy of unusual silicate glasses and baked soils on the surface of the Atacama Desert of Northern Chile: a major airburst impact ~12 ka ago?" **-** E.C. Sturkell, 2015, "The **Lockne - Målingen doublet impacts**, the result of a binary asteroid from the 470 Ma Main Asteroid Belt

	event."
2015, Dec 15	Asteroid **2015 XY261** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2015-27]** See: 2015 XY261 - SSA , 2015 XY261 - JPL
2015, Dec 21	M.R. Rampino, K. Caldeira, 2015, *Monthly Notices of the Royal Astronomical Society*, 454, 3480, "Periodic impact cratering and extinction events over the last 260 million years." See: http://adsabs.harvard.edu/abs/2015MNRAS.454.3480R
2015, Dec 21	N. Wang, Q.Y. Peng, X.L. Zhang, et al., 2015, *Monthly Notices of the Royal Astronomical Society*, 454, 3805, "Precise CCD positions of **Apophis** in 2013." See: http://adsabs.harvard.edu/abs/2015MNRAS.454.3805W
2015, Dec 23	T. Reyes, 2016, *Universe Today*, 23 December 2015, "We are not alone: government sensors shed new light on asteroid hazards." See: http://www.universetoday.com/116355/we-are-not-alone-government-sensors-shed-new-light-on-asteroid-hazards/
2015, Dec 24	Aten NEA **163899** (**2003 SD220**, *H* = 17.9 mag, *D* ≈ 1000 m, **PHA**) passed Earth at a nominal miss distance of 28.4 LD. Minimum miss distance 28.4 LD. See: 2003 SD220 - SSA , 2003 SD220 - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=4807 https://en.wikipedia.org/wiki/(163899)_2003_SD220
2015, Dec 24	Aten NEA **2021 BW1**, *H* = 26.6 mag, *D* ≈ 17 m passed Earth at a nominal miss distance of 6.32 LD. Minimum miss distance 0.60 LD. See: 2021 BW1 – S2P , 2021 BW1 – JPL
2015, Dec 31	P. Michel, F. DeMeo, W. Bottke (eds.), 2015, **ASTEROIDS IV**, *Space Science Series* (University of Arizona Press, ISBN 978-0-8165-3213-1), "Surveys, astrometric follow-up & population statistics." See: http://www.uapress.arizona.edu/Books/bid2555.htm http://uapress.arizona.edu/extras/Michel_9780816532131_TOC.pdf See also: https://www.youtube.com/watch?v=IJDGD73aD9s **Among the papers:** - P.A. Abell, B.W. Barbee, P.W. Chodas, et al., 2015, p.855, "Human exploration of Near-Earth Asteroids".

	See: http://adsabs.harvard.edu/abs/2015aste.book..855A - E. Asphaug, G. Collins, M. Jutzi, 2015, p.661, "Global-scale impacts." See: http://adsabs.harvard.edu/abs/2015aste.book..661A - M.A. Barucci, M. Fulchignoni, J. Ji, et al., 2015, p.433 "The flybys of asteroids **2867 Steins**, **21 Lutetia**, and **4179 Toutatis**". See: http://adsabs.harvard.edu/abs/2015aste.book..433B - L.A.M. Benner, M.W. Busch, J.D. Giorgini, P.A. Taylor, J.-L. Margot, 2015, p.165, "**Radar** observations of Near-Earth and Main-Belt asteroids". See: http://adsabs.harvard.edu/abs/2015aste.book..165B - R.P. Binzel, V. Reddy, T.L. Dunn, 2015, p.243, "The Near-Earth Object population: connections to comets, main-belt asteroids, and meteorites." See: http://adsabs.harvard.edu/abs/2015aste.book..243B - J. Borovička, P. Spurný, P. Brown, 2015, p.257, "Small Near-Earth Asteroids as a source of meteorites". See: http://adsabs.harvard.edu/abs/2015aste.book..257B - D. Farnocchia, S.R. Chesley, A. Milani, et al., 2015, p.815, "Orbits, long-term predictions, and impact monitoring." See: http://adsabs.harvard.edu/abs/2015aste.book..815F - A.W. Harris, M. Boslough, C.R. Chapman, L. Drube, P. Michel, A.W. Harris, 2015, p.835, "Asteroid impacts and modern civilization: can we prevent a catastrophe?" See: http://adsabs.harvard.edu/abs/2015aste.book..835H - R. Jedicke, M. Granvik, M. Micheli, et al., 2015, p.795, "Surveys, astrometric follow-up, and population statistics." See: http://adsabs.harvard.edu/abs/2015aste.book..795J - P. Jenniskens, 2015, p.281 "Meteoroid streams and zodiacal dust". See: http://adsabs.harvard.edu/abs/2015aste.book..281J - M. Jutzi, K. Holsapple, K. Wünneman, P. Michel, 2015, "Modeling asteroid collisions and impact processes". See: http://adsabs.harvard.edu/abs/2015arXiv150201844J - P. Michel, F.E. DeMeo, W.F. Bottke, 2015, p.3, "Asteroids: recent advances and new perspectives." See: http://adsabs.harvard.edu/abs/2015aste.book....3M - E.R.D. Scott, J.I. Goldstein, E. Asphaug, et al., 2015, p.573, "Early impact history and dynamical origin of differentiated meteorites and asteroids." See: http://adsabs.harvard.edu/abs/2015aste.book..573S - D. Vokrouhlický, W.F. Bottke, S.R. Chesley, et al., 2015, p.509, "The Yarkovsky and YORP effects." See: http://adsabs.harvard.edu/abs/2015aste.book..509V - M. Yoshikawa, J. Kawaguchi, A. Fujiwara, A. Tsuchiyama, 2015, p.397, "***Hayabusa*** sample return mission".

	See: http://adsabs.harvard.edu/abs/2015aste.book..397Y
2016, Jan 1	**13504 NEAs** known (ranging in size from a few meters up to ~ 37 km: **1036 Ganymed**, **1924 TD**, *H* = 9.45 mag, *D* = 36.5 km), of which **1638 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis**, **1989 AC**, *H* = 15.3 mag, *D* = 4.6 × 2.4 ×1.9 km, **PHA**). See: http://neo.jpl.nasa.gov/stats/
2016, Jan	NASA **Planetary Defense Coordination Office**. This office was established in January 2016 at NASA HQ to oversee planetary defense related activities across NASA, and coordinate both US interagency and international efforts and projects to address and plan response to the asteroid impact hazard. See: www.nasa.gov/planetarydefense
2016, Jan	J. Borovička, L. Shrbený, P. Kalenda, et al., 2016, *Astronomy & Astrophysics*, 585, 90, "A catalog of video records of the **2013 Chelyabinsk superbolide**." See: http://adsabs.harvard.edu/abs/2016A%26A...585A..90B
2016, Jan	S. Chesley, A. Morbidelli, R. Jedicke, D. Farnocchia (eds.), 2016, Proceedings ***IAU Symposium No. 318 – Asteroids: New Observations, New Models***, Honolulu, (Hawaii, USA) 3-14 August 2015 (Cambridge, CUP). See: 2015, Augustus 3-7.
2016, Jan	C. de la Fuente Marcos, R. de la Fuente Marcos, 2016, *Astrophysics and Space Science*, 361, 16, "From horseshoe to quasi-satellite and back again: the curious dynamics of Earth co-orbital asteroid **2015 SO2**." See: http://adsabs.harvard.edu/abs/2016Ap%26SS.361...16D
2016, Jan	K.R. Grazier, 2016, *Astrobiology*, 16, 23, "**Jupiter**: cosmic Jekyll and Hyde." See: http://adsabs.harvard.edu/abs/2016AsBio..16...23G See also: http://www.space.com/35631-jupiter-saturn-asteroids-comets-solar-system-planetary-evolution.html
2016, Jan	A. Higuchi, S. Ida, 2016, *Astronomical Journal*, 151, 16, "Temporary capture of asteroids by a planet: dependence of prograde/retrograde capture on asteroids' semimajor axes." See: http://adsabs.harvard.edu/abs/2016AJ....151...16H
2016, Jan	J. Licandro, T. Müller, C. Alvarez, et al., 2016, *Astronomy & Astrophysics*, 585, 10, "**GTC/CanariCam** observations of **(99942) Apophis**."

	See: http://adsabs.harvard.edu/abs/2016A%26A...585A..10L
2016, Jan	D. Perna, E. Dotto, S. Ieva, et al., 2016, *Astronomical Journal*, 151, 11, "Grasping the nature of **Potentially Hazardous Asteroids**." See: http://adsabs.harvard.edu/abs/2016AJ....151...11P
2016, Jan	A.S. Rivkin, F. Marchis, J.A. Stansberry, et al., 2015, *Publications of the Astronomical Society of the Pacific*, 128, 018003, "Asteroids and the ***James Webb Space Telescope***." See: http://adsabs.harvard.edu/abs/2016PASP..128a8003R
2016, Jan	V.V. Shuvalov, O.P. Popova, V.V. Svettsov, et al., 2016, *Solar System Research*, 50, 1, "Determination of the height of the 'meteoric explosion'." See: http://adsabs.harvard.edu/abs/2016SoSyR..50....1S
2016, Jan	G. Tang, , F.-H. Jiang, 2016, *Astrophysics and Space Science*, 361, 10, "Capture of near-Earth objects with low-thrust propulsion and invariant manifolds." See: http://adsabs.harvard.edu/abs/2016Ap%26SS.361...10T
2016, Jan	C.A. Thomas, P. Abell, J. Castillo-Rogez, et al., 2016, *Publications of the Astronomical Society of Pacific*, 128, 018002, "Observing Near-Earth Objects with the ***James Webb Space Telescope***." See: http://adsabs.harvard.edu/abs/2016PASP..128a8002T
2016, Jan 1	D. Fulvio, D. Perna, S. Ieva, et al., 2016, *Monthly Notices of the Royal Astronomical Society*, 455, 584. "Spectral characterization of V-type asteroids - I. Space weathering effects and implications for V-type NEAs." See: http://adsabs.harvard.edu/abs/2016MNRAS.455..584F
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2016, Jan 4	C.A. Thomas, P. Abell, J. Castillo-Rogez, et al., 2016, *Publications Astronomical Society of the Pacific*, 128, 8002 , "Observing Near-Earth Objects with the ***James Webb Space Telescope***." See: http://adsabs.harvard.edu/abs/2016PASP..128a8002T
2016, Jan 4-8	J. Crowell, E.S. Howell, C. Magri, et al., 2016, in: ***American***

	Astronomical Society 227th Meeting, Kissimmee (FL, USA), 4-8 January 2016, id.141.08, "Thermophysical model of S-complex NEAs: **1627 Ivar**." See: http://adsabs.harvard.edu/abs/2016AAS...22714108C
2016, Jan 4-8	E.L. Wright, 2016, in: ***American Astronomical Society 227th Meeting***, Kissimmee (FL, USA), 4-8 January 2016, id.430.02, "The albedo distribution of Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2016AAS...22743002W
2016, Jan 5	*ESA SSA-NEO Coordination Centre Newsletter*, 5 January 2016. See: http://neo.ssa.esa.int/newsletters
2016, Jan 6	**Small Bodies Assessment Group (SBAG)**, 2016, "Goals and objectives for the exploration and investigation of the Solar System's small bodies." See: http://www.lpi.usra.edu/sbag/goals/GoalsDoc_ver.1.1.2016.pdf
2016, Jan 6	Apollo NEA **85990** (**1999 JV6**, $H = 20.4$ mag, $D \approx 451$ m, **PHA**) passed Earth at a nominal miss distance of 12.6 LD. Minimum miss distance 12.6 LD. See: 85990 1999 JV6 - SSA , 1999 JV6 - JPL See also: http://neo.ssa.esa.int/ January 2016.
2016, Jan 7	***NASA JPL*** *News*, 7 January 2016, "NASA office to coordinate asteroid detection, hazard mitigation." See: http://www.jpl.nasa.gov/news/news.php?feature=4816 http://www.nasa.gov/planetarydefense See also: http://us5.campaign-archive1.com/?u=c7281b61ab362fadf221e16fc&id=7153aef88c&e=b8e2af394f http://www.lpi.usra.edu/sbag/meetings/jan2016/presentations/Johnson2.pdf
2016, Jan 10	Apollo NEA **2016 AQ164** ($H = 29.7$ mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[2016-01]** See: 2016 AQ164 - SSA , 2016 AQ164 - JPL
2016, Jan 12	Apollo NEA **2016 AH164** ($H = 30.0$ mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.069 LD (**= 4.18 R_{Earth} from the geocenter**). Minimum miss distance 0.068 LD. **[2016-02]** See: 2016 AH164 - SSA , 2016 AH164 - JPL See also: **10 Jan 1992**.

2016, Jan 13	Apollo NEA **2016 AN165** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.47 LD. Minimum miss distance 0.47 LD. **[2016-03]** See: 2016 AN165 - SSA , 2016 AN165 - JPL See also: **12 Jan 1966**.
2016, Jan 14	Apollo NEA **2016 AN164** (H = 30.5 mag, $D \approx$ 2.8 m) passed Earth at a nominal miss distance of 0.0964 LD **(= 5.81 R_{Earth} from the geocenter)**. Minimum miss distance 0.0962 LD. **[2016-04]** See: 2016 AN164 - SSA , 2016 AN164 - JPL
2016, Jan 18	Apollo NEA **2018 BF3** (H = 26.1 mag, $D \approx$ 22 m) passed Earth at a nominal miss distance of 4.31 LD. Minimum miss distance 0.37 LD. See: 2018 BF3 - SSA , 2018 BF3 - JPL See also: **19 Jan 2018**.
2016, Jan 21	P. Senthil Kumar, U. Sruthi, N. Krishna, et al., 2016, *Journal of Geophysical Research: Planets*, 121, 147, "Recent shallow moonquake and impact-triggered boulder falls on the **Moon**: new insights from the Schrödinger basin." See: http://adsabs.harvard.edu/abs/2016JGRE..121..147S
2016, Jan 22	V.V. Shuvalov, O.P. Popova, V.V. Svettsov, 2016, *Solar System Research*, 50, 1, "Determination of the height of the “meteoric explosion”." See: http://adsabs.harvard.edu/abs/2016SoSyR..50....1S
2016, Jan 26	Apollo NEA **2019 BV2** (H = 25.6 mag, $D \approx$ 27 m) passed Earth at a nominal miss distance of 9.66 LD. Minimum miss distance 0.58 LD. See: 2019 BV2 - JPL , 2019 BV2 - SSA See also: **1 Aug 1954**, **2 Aug 2064**.
2016, Jan 27 - 29	**14th NASA *Small Bodies Assessment Group Meeting***, 27-29 Jan 2016, Monrovia (CA, USA). See: http://www.lpi.usra.edu/sbag/ http://www.lpi.usra.edu/sbag/meetings/jan2016/agenda.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - L. Johnson, 2016, "**Planetary Defense Coordination Office** brief." See: http://www.lpi.usra.edu/sbag/meetings/jan2016/presentations/Johnson2.pdf - J. Bauer & the ***NEOWISE*** Team, 2016, "***NEOWISE*** reactivation update." See:

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2016, Feb 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 February 2016. See: http://neo.ssa.esa.int/newsletters
2016, Feb 2	J.I. Thorpe, C. Parvini, J.Trigo-Rodriguez, 2015, *Astronomy & Astrophysics*, 586, 107, "Detection and characterization of micrometeoroids with ***LISA Pathfinder***." See: http://adsabs.harvard.edu/abs/2016A%26A...586A.107T
2016, Feb 6, 13:30	Aten NEA **2016 CG18** ($H = 28.3$ mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2016-05]** See: 2016 CG18 - SSA , 2016 CG18 - JPL See also: **5 Feb 2054, 3 Feb 2055**.
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2016, Feb 10	Apollo NEA **2016 CW264** (*H* = 29.8 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.55 LD. Minimum miss distance 0.54 LD. **[2016-06]** See: 2016 CW264 - SSA , 2016 CW264 - JPL
2016, Feb 12	**IAWN** message, 12 February 2016, "2015 a record year for NEO discovery." See: http://iawn.net/2016/02/12/2015-a-record-year-for-neo-discovery/
2016, Feb 13	Apollo NEA **2016 CM194** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.20 LD. Minimum miss distance 0.20 LD. **[2016-07]** See: 2016 CM194 - SSA , 2016 CM194 - JPL
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2016, Feb 15	Aten NEA **2016 DB** (*H* = 28.7 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.32 LD. Minimum miss distance 0.32 LD. **[2016-08]** See: 2016 DB - SSA , 2016 DB - JPL
2016, Feb 15-26	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 53rd Session**, 15-26 February 2016, Vienna (Austria). See: http://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2016/index.html **Final Report:** http://www.unoosa.org/oosa/oosadoc/data/documents/2016/aac.105/aac.1051109_0.html **Among the presentations:** - L. Johnson (NASA), 2016, "**International Asteroid Warning Network**. Report to STSC 2016." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/tech-04E.pdf - G. Drolshagen (ESA), 2016, "**Space Mission Planning Advisory Group**. Report to STSC 2016." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/tech-05E.pdf **UN-COPUOS STSC IAWN and SMPAG Open Forum**. See:

	http://www.unoosa.org/oosa/en/outreach/events/2016/open-forum-on-near-earth-object.html http://www.unoosa.org/documents/pdf/smpag/IAWN_SMPAG.pdf **-** R. Landis (NASA), 2016, "**International Asteroid Warning Network (IAWN)**: Brief summary & status of the current worldwide NEO survey effort". See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-01E.pdf **-** T. Spahr (NEO Sciences LLC), 2016, "Summary of current worldwide NEO survey, orbit computation and follow-up efforts." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-02E.pdf **-** D. Koschny (ESA), 2016, "**IAWN**-related activities in Europe." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-03E.pdf **-** C. Madsen, O. Hainaut (ESO), "ESO observations of potentially hazardous NEOs." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-04E.pdf - L. Billings (NIA, NASA), 2016, "Communication planning for the **International Asteroid Warning Network**." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-05E.pdf - G. Drolshagen (ESA), 2016, "**Space Mission Planning Advisory Group**." See: http://www.unoosa.org/documents/pdf/copuos/stsc/2016/neo-forum-06E.pdf
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2016, Feb 18	M. Granvik, A. Morbidelli, R. Jedicke, et al., 2016, *Nature*, 530, 303, "Super-catastrophic disruption of asteroids at small perihelion distances." See: http://adsabs.harvard.edu/abs/2016Natur.530..303G
2016, Feb 18	***IAWN and SMPAG Open Forum***, Vienna (Austria), 18 February 2016. See: http://iawn.net/meetings/smpag.shtml
2016, Feb 22	E. Zolfagharifard, *Dailymail*.com, 22 Feb 2016, "Largest **fireball** since **Chelyabinsk** falls into the ocean: NASA reports huge explosion of seven meter space rock over the Atlantic". See: http://www.dailymail.co.uk/sciencetech/article-3459057/Largest-fireball-Chelyabinsk-falls-Earth-Nasa-reports-huge-explosion-seven-meter-space-rock-Atlantic.html

2016, Feb 25	Apollo NEA **2016 DY30** (H = 30.7 mag, $D \approx$ 2.5 m) passed Earth at a nominal miss distance of 0.037 LD **(= 2.25 R_{Earth} from the geocenter)** . Minimum miss distance 0.037 LD. **[2016-09]** See: 2016 DY30 - SSA , 2016 DY30 - JPL See also: http://neo.ssa.esa.int/newsletters [June 2020]
2016, Feb 26	Apollo NEA **2016 DK2** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.83 LD. Minimum miss distance 0.82 LD. **[2016-10]** See: 2016 DK2 - SSA , 2016 DK2 - JPL
2016, Feb 29	Apollo NEA **2016 DA31** (H = 30.1 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2016-11]** See: 2016 DA31 - SSA , 2016 DA31 - JPL
2016, Feb-Mar	J. Lyzhoft, J. Basart, B. Wie, 2016, *Acta Astronautica*, 119, 147, "A new terminal guidance sensor system for asteroid intercept or rendezvous missions." See: http://adsabs.harvard.edu/abs/2016AcAau.119..147L
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2016, Mar	K.Yamaguchi, H. Yamakawa, 2016, *The Journal of the Astronautical Sciences*, 63, 1, "Electric solar wind sail kinetic energy impactor for asteroid deflection missions." See: http://adsabs.harvard.edu/abs/2016JAnSc..63....1Y
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	See: http://adsabs.harvard.edu/abs/2016MNRAS.456.2946D
2016, Mar 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 March 2016. See: http://neo.ssa.esa.int/newsletters
2016, Mar 3, 05:17	Apollo NEA **2016 DV1** (H = 24.9 mag, $D \approx 40$ m) passed Earth at a nominal miss distance of 1.03 LD. Minimum miss distance 1.03 LD. See: 2016 DV1 - SSA , 2016 DV1 - JPL See also: **2 March 1989**.
2016, Mar 3, 18:06	Apollo NEA **2016 EK1** (H = 29.2 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.53 LD. **[2016-12]** See: 2016 EK1 - SSA , 2016 EK1 - JPL
2016, Mar 4	Apollo NEA **2016 EL1** (H = 28.1 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2016-13]** See: 2016 EL1 - SSA , 2016 EL1 - JPL
2016, Mar 5-12	***2016 IEEE Aerospace Conference, Session 2.12, Asteroid Detection, Characterization, Sample-Return, and Deflection***, 5-12 March 2016, Big Sky (Montana, USA). See: http://www.aeroconf.org/ **Among the papers:** - S.R. Chesley, P. Vereš, 2016, "The **Large Synoptic Survey Telescope**: projected near-earth object discovery performance."
2016, Mar 8, 00:06	Apollo NEA **2013 TX68** (H = 25.4 mag, $D \approx 30$ m) passed Earth at a nominal miss distance of 12.99 LD. Minimum miss distance 0.081 LD **(= 4.9 R_{Earth} from the geocenter)**. See: 2013 TX68 - SSA , 2013 TX68 - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=4888 http://resources.asteroidday.org/resources/2013-tx68-and-slooh/ https://en.wikipedia.org/wiki/2013_TX68
2016, Mar 8, 05:06	Apollo NEA **2016 EV28** (H = 28.6 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.40 LD. Minimum miss distance 0.40 LD. **[2016-14]** See: 2016 EV28 - SSA , 2016 EV28 - JPL
2016, Mar 10	Apollo NEA **2016 EN157** (H = 28.3 mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84 LD. **[2016-15]** See: 2016 EN157 - SSA , 2016 EN157 - JPL

2016, Mar 11	Apollo NEA **2016 EF195** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 0.082 LD **(= 4.96 R_{Earth} from the geocenter)**. Minimum miss distance 0.082 LD. **[2016-16]** See: 2016 EF195 - SSA , 2016 EF195 - JPL See also: http://pttu.hq.eso.org/blogs/posts/view/455144/ http://earthsky.org/space/asteroid-2016-ef195-detected-4-days-after-passing
2016, Mar 14	Apollo NEA **2016 FC1** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2016-17]** See: 2016 FC1 - SSA , 2016 FC1 - JPL
2016, Mar 15	M. Micheli, D.J. Tholen, P.Jenniskens, 2015, *Icarus*, 267, 64, "Evidence for **2009 WN25** being the parent body of the **November ι Draconids (NIDs)**." See: http://adsabs.harvard.edu/abs/2016Icar..267...64M
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2016, Mar 15	Apollo NEA **2018 SC** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.21 LD. Minimum miss distance 0.19 LD. **[2016-18]** See: 2018 SC - SSA , 2018 SC - JPL See also: http://iawn.net/ See also: **18 Sep 2018**.
2016, Mar 17	D.K. Yeomans, *Asteroid Day* science advisor, 2016, "Asteroid **2013 TX68** and Slooh". See: http://resources.asteroidday.org/resources/2013-tx68-and-slooh/
2016, Mar 17, 18:4	**Impact** on **Jupiter**, by **asteroid** or **comet**, observed by amateur astronomer G. Kernbauer (Mödling, Austria). See: http://us9.campaign-archive2.com/?u=0e9c23265f31e0f37201d19b6&id=431c55bb14&e=db8a8b6284 http://blog.asteroidday.org/2016/03/30/interview-with-gerrit-kernbauer-observing-an-impact-on-jupiter/ http://www.europlanet-eu.org/jupiter-blasted-by-6-5-fireball-impacts-per-year-on-average/
2016, Mar 21	Apollo NEA **2016 FN56** (*H* = 24.3 mag, *D* ≈ 50 m) passed Earth

	at a nominal miss distance of 1.002 LD. Minimum miss distance 0.932 LD. See: 2016 FN56 - SSA , 2016 FN56 - JPL
2016, Mar 21-25	***47th Lunar and Planetary Science Conference***, The Woodlands (TX, USA), 21-25 March 2015. See: http://www.hou.usra.edu//meetings/lpsc2016/ **Among the papers:** - P.A. Abell, D.D. Mazanek, D.M. Reeves, et al., 2016, *LPI Contribution* No. 1903, p.2217, "The ***Asteroid Redirect Mission (ARM)***." See: http://adsabs.harvard.edu/abs/2016LPI....47.2217A - O.S. Barnouin, J. Biele, I. Carnelli, et al., 2016, *LPI Contribution* No. 1903, p.1427, "The ***Asteroid Impact and Deflection Assessment (AIDA)*** mission: science proximity operations." See: http://adsabs.harvard.edu/abs/2016LPI....47.1427B - W.F. Bottke, D. Vokrouhlicky, B. Ghent, et al., 2016, *LPI Contribution* No. 1903, p.2036, "On asteroid impacts, crater scaling laws, and a proposed younger surface age for **Venus**." See: http://adsabs.harvard.edu/abs/2016LPI....47.2036B - K.L. Bryson, D.R. Ostrowski, 2016, *LPI Contribution* No. 1903, p.2657, "**Asteroid Threat Assessment Project (ATAP)** --- meteorite laboratory." See: http://adsabs.harvard.edu/abs/2016LPI....47.2657B - Q.H.S. Chan, M.E. Zolensky, A.S. Burton, D.R. Locke, 2016, *LPI Contribution* No. 1903, p.1402, "Amino acids in the asteroidal water-bearing salt crystals hosted in the **Zag Meteorite**." See: http://adsabs.harvard.edu/abs/2016LPI....47.1402C - A.F. Cheng, P. Michel, O. Barnouin, et al. 2016, *LPI Contribution* No. 1903, p.2032, "***Asteroid Impact and Deflection Assessment (AIDA)*** mission: the ***Double Asteroid Redirection Test (DART)***." See: http://adsabs.harvard.edu/abs/2016LPI....47.2032C - M. Delbo, V. Ali-Lagoa, J. Wilkerson, G. Libourel, 2016, *LPI Contribution* No. 1903, p.2203, "Thermal fracture of **Bennu**, **Phaethon**, and other low-perihelion asteroids." See: http://adsabs.harvard.edu/abs/2016LPI....47.2203D - D.N. DellaGiustina, O.S. Barnouin, M.C. Nolan, et al., *LPI Contribution* No. 1903, p.1668, "Cartographic planning for the ***OSIRIS-REx*** asteroid sample return mission." See: http://adsabs.harvard.edu/abs/2016LPI....47.1668D - J.L. Galache, C.L. Beeson, K.K. McLeod, M. Elvis, 2016, *LPI Contribution* No. 1903, p.2745, "The need for speed in Near-Earth Asteroid characterization." See: http://adsabs.harvard.edu/abs/2016LPI....47.2745G - M.A. Galiazzo, E.A. Silber, D. Bancelin, et al., 2016, *LPI Contribution* No. 1903, p.1393, "V-type NEAs: orbital dynamics

	and collissional interactions with terrestrial planets." See: http://adsabs.harvard.edu/abs/2016LPI....47.1393G - A. Herique, V. Ciarletti, ***AIM*** Team, 2016, *LPI Contribution* No. 1903, p.2096, "A direct observation of the asteroid's structure from deep interior to regolith: two radars on the ***AIM*** mission." See: http://adsabs.harvard.edu/abs/2016LPI....47.2096H - A. Higuchi, S. Ida, 2016, *LPI Contribution* No. 1903, p.1417, "Temporary capture of asteroids by a planet: dependence of prograde/retrograde capture on asteroids' semimajor axes." See: http://adsabs.harvard.edu/abs/2016LPI....47.1417H - C.A.Johnson, D.N. DellaGiustina, 2016, *LPI Contribution* No. 1903, p.1672, "Thematic map of hazards and regions of interest for asteroid **Bennu**." See: http://adsabs.harvard.edu/abs/2016LPI....47.1672J - M.P. Lucas, J.P Emery, T. Hiroi, R.E.Milliken, 2016, *LPI Contribution* No. 1903, p.3003, "Spectral properties of primitive achondrite meteorites: establishing **S-type Asteroid-Meteorite** connections." See: http://adsabs.harvard.edu/abs/2016LPI....47.3003L - J.W. McMahon, L.A.M. Benner, S.P. Naidu, 2016, *LPI Contribution* No. 1903, p.2285, "The predicted BYORP driven evolution of **65803 Didymos**." See: http://adsabs.harvard.edu/abs/2016LPI....47.2285M - P. Michel, M. Kueppers, I. Carnelli, et al., 2016, *LPI Contribution* No. 1903, p.1204, "***Asteroid Impact Mission (AIM)***: the European component of the ***AIDA*** space project." See: http://adsabs.harvard.edu/abs/2016LPI....47.1204M - T. Okada, T. Fukuhara, S. Tanaka, S., et al., 2016, *LPI Contribution* No. 1903, p.1407, "**Thermal-Infrared Imager TIR** on ***Hayabusa2*** and its in-flight performance and calibration using **Earth** and **Moon** thermal images." See: http://adsabs.harvard.edu/abs/2016LPI....47.1407O - C.S. Plesko, J.M. Ferguson, G.R. Gisler, R.P. Weaver, 2016, #2764, "Impact hazard mitigation research at Los Alamos National Laboratory: current status." See: http://www.hou.usra.edu/meetings/lpsc2016/pdf/2764.pdf - L. Pohl, D.T. Britt, 2016, *LPI Contribution* No. 1903, p.2688, "Orbital evolution and the possiblity of thermal dehydration of asteroid **2008 EV5**." See: http://adsabs.harvard.edu/abs/2016LPI....47.2688P - D.C. Richardson, O.S. Barnouin, L.A.M. Benner, et al., 2016, *LPI Contribution* No. 1903, p.1501, "Dynamical and physical properties of **65803 Didymos**." See: http://adsabs.harvard.edu/abs/2016LPI....47.1501R - A.S. Rivkin, J.P. Emery, E.S. Howell, 2016, *LPI Contribution* No. 1903, p.1975, "**The L-band Main-Belt and NEO Observing Program (LMNOP)**: some final results from phase 1."

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2016, Mar 25	Apollo NEA **2016 FU6** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.47 LD. Minimum miss distance 0.46 LD. **[2016-20]** See: 2016 FU6 - SSA , 2016 FU6 - JPL See also: **24 March 1920**.
2016, Mar 28	Apollo NEA **2016 FE15** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2016-21]** See: 2016 FE15 - SSA , 2016 FE15 - JPL
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2016, Apr 2	Apollo NEA **2019 UO8** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.94 LD. Minimum miss distance 0.25 LD. See: 2019 UO8 – SSA , 2019 UO8 - JPL See also**: 25 Oct 2019**.
2016, Apr 4	Apollo NEA **2016 GN134** (*H* = 30.5 mag, *D* ≈ 2.8 m) passed Earth at a nominal miss distance of 0.15 LD. Minimum miss distance 0.15 LD. **[2016-23]** See: 2016 GN134 - SSA , 2016 GN134 - JPL
2016, Apr 5	Apollo NEA **2016 FW13** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2016-24]** See: 2016 FW13 - SSA , 2016 FW13 - JPL See also: **8 Apr 2108**.
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2016, Apr 6	Apollo NEA **2016 GO206** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2016-25]** See: 2016 GO206 - SSA , 2016 GO206 - JPL
2016, Apr 8	Apollo NEO **2016 GO134** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2016-26]** See: 2016 GO134 - SSA , 2016 GO134 - JPL
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2016, May 2	*ESA SSA-NEO Coordination Centre Newsletter*, 2 May 2016. See: http://neo.ssa.esa.int/newsletters
2016, May 5	Apollo NEA **2016 JS5** ($H = 30.7$ mag, $D \approx 2.5$ m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.53 LD. **[2016-27]** See: 2016 JS5 - SSA , 2016 JS5 - JPL
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2016, Jun 5	Apollo NEA **2016 LR51** ($H = 27.7$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2016-28]** See: 2016 LR51 - SSA , 2016 LR51 - JPL Discovery station: **…** See: http://iawn.net/
2016, Jun 6-10	***Meteoroids 2016***, 6-10 June 2016, ESTeC, Noordwijk (the Netherlands). See: http://www.cosmos.esa.int/web/Meteoroids2016 **Proceedings:** D. Koschny, J. Borovička, D. Janches, I. P. Willliams (eds.), 2017, *Planetary and Space Science*, Volume 143. Editorial: p. 1-2. **Among the invited papers:** - P. Brown, 2016, " Global detection and flux of superbolides." See:

	http://www.cosmos.esa.int/documents/653713/1000954/07_INVITED_Brown.pdf/5ee15bfe-2d10-439d-900d-abd522f25334 - P. Jenniskens, 2016, "Meteor showers in review." See: http://www.cosmos.esa.int/documents/653713/1000954/02_ORAL_Jenniskens.pdf/79ad75f5-58ed-4c73-ac89-47ad7f33f88d - P. Spurny, 2016, "Fireballs and meteorite falls." See: http://www.cosmos.esa.int/documents/653713/1000954/07_INVITED_Spurny.pdf/6694c0eb-10b4-4aca-a972-70e9ae78c351 - O. Witasse, 2016, "Meteors on other planets." See: http://www.cosmos.esa.int/documents/653713/1000951/08_INVITED_Witasse.pdf/f266cead-2e3d-4ca1-aee0-fdf9d72ca2e8
2016, Jun 7	Apollo NEA **2016 LT1** (H = 29.3 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2016-29]** See: 2016LT1 - SSA , 2016 LT1 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2016, Jun 7	**IAU, Division F, *Working Group on Near Earth Objects***, membership announced. See: https://www.iau.org/science/scientific_bodies/working_groups/171/ See also: https://www.iau.org/public/themes/neo/nea/
2016, Jun 8-17	***UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)*, 59th session**, Vienna (Austria), 8-17 June 2016. See: http://www.unoosa.org/oosa/en/ourwork/copuos/2016/index.html
2016, Jun 9	Apollo NEA **2016 LP10** (H = 29.5 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2016-30]** See: 2016LP10 - SSA , 2016 LP10 - JPL Discovery station: **…** See: http://iawn.net/
2016, Jun 12	A. Glikson, 2016, *The Conversation*, 12 June 2016, "Ancient asteroid impacts yield evidence for the nature of the early Earth." See: https://theconversation.com/ancient-asteroid-impacts-yield-evidence-for-the-nature-of-the-early-earth-59675
2016, Jun 14	B. Schmitz, Q.-Z. Yin, M.E. Sanborn, et al., 2016, *Nature Communications*, 7, 11851, "A new type of solar-system material recovered from Ordovician marine limestone."

	See: http://www.nature.com/ncomms/2016/160614/ncomms11851/full/ncomms11851.html
2016, Jun 15	P. Michel, A. Cheng, M. Küppers, et al., 2016, *Advances in Space Research*, 57, 2529, "Science case for the ***Asteroid Impact Mission (AIM)***: a component of the ***Asteroid Impact & Deflection Assessment (AIDA)*** mission." See: http://adsabs.harvard.edu/abs/2016AdSpR..57.2529M
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2016, Jun 22	O. Doré, M.W. Werner, M. Ashby, et al., 2016, e-print *arXiv:*1606.07039, "Science impacts of the **SPHEREx** all-sky optical to near-infrared spectral survey: report of a community workshop examining extragalactic, galactic, stellar and planetary science." See: http://adsabs.harvard.edu/abs/2016arXiv160607039D
2016, Jun 22	S. Kohler, 2016, *AAS NOVA*, 22 June 2016, "Mapping Near-Earth hazards." See: http://aasnova.org/2016/06/22/mapping-near-earth-hazards/ See also: http://adsabs.harvard.edu/abs/2016AJ....151..172G
2016, Jun 27	H. Downes, 2016, *Press Release*, ***National Astronomy Meeting 2016***, 27 June - 1 July 2016, Nottingham (U.K.), "Opal discovered in Antarctic meteorite". See: https://nam2016.org/press-releases/84-opal-discovered-in-antarctic-meteorite-ras-pr-16-31-nam-5-embargoed
2016, Jun 28-30	**15th NASA *Small Bodies Assessment Group Meeting***, 28-30 June 2016, Laurel (MD, USA). See: http://www.lpi.usra.edu/sbag/ http://www.lpi.usra.edu/sbag/meetings/jun2016/draft_agenda_20160401.pdf **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the papers:** - Lindley Johnson, 2016, "Review and discussion of ***SBAG 14*** findings." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/johnson.pdf - M. Gates, D. Mazanek, 2016, "***Asteroid Redirect Mission***

	(ARM)." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/gates-mazanek.pdf - Y. Tsuda, M. Yoshikawa, 2016, "***Hayabusa2***." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/Tsuda.pdf - L. Johnson, 2016, " **Planetary Defense Coordination Office (PDCO)** update." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/johnson-neo.pdf See also: https://www.nasa.gov/planetarydefense/overview - D. Lauretta, 2016, "***OSIRIS-REx***." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/Lauretta.pdf - E. Kramer, 2016, "***NEOWISE***." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/kramer.pdf - I. Carnelli, 2016, "***Asteroid Impact Mission (AIM)***." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/carnelli.pdf - B. Barbee, M. Bruck Syal, G. Gisler, 2016, "NEA mitigation studies for short warning time scenarios." See: http://www.lpi.usra.edu/sbag/meetings/jun2016/presentations/barbee.pdf
2016, Jun 30	***Asteroid Day***. 30 June was proclaimed by the UN General Assembly as the annual International ***Asteroid Day***, to raise public awareness about the asteroid impact hazard, the role of **IAWN** and **SMPAG**, UN-OOSA and UN-COPUOS member States in this area. See: http://www.asteroidday.org/ http://blog.asteroidday.org/2016/07/20/outstanding-participation-across-chile-second-asteroid-day/ See also: the seven-part video series "Scientists Rock - an Asteroid Day series": episode 1 , episode 2 , episode 3 , episode 4 , episode 5 , episode 6 , episode 7 See also: http://us9.campaign-archive2.com/?u=0e9c23265f31e0f37201d19b6&id=8471462384&e=db8a8b6284 http://us9.campaign-archive2.com/?u=0e9c23265f31e0f37201d19b6&id=8471462384&e=db8a8b6284
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2016, Jul	M.J. Mashayekhi, A.K. Misra, 2016, *Celestial Mechanics and Dynamical Astronomy*, 125, 363, "Effect of the finite size of an asteroid on its deflection using a tether-ballast system." See: http://adsabs.harvard.edu/abs/2016CeMDA.125..363M
2016, Jul	M. Popescu, J. Licandro, D. Morate, et al., 2016, *Astronomy & Astrophysics*, 591, 115, "Near-infrared colors of minor planets recovered from **VISTA-VHS** survey (**MOVIS**)." See: http://adsabs.harvard.edu/abs/2016A%26A...591A.115P
2016, Jul 1	J. Sebera, A. Bezděk, I. Pešek, T.Henych, 2016, *Icarus*, 272, 70, "Spheroidal models of the exterior gravitational field of asteroids **Bennu** and **Castalia**." See: http://adsabs.harvard.edu/abs/2016Icar..272...70S
2016, Jul 5	S.V. Petersen, A. Dutton, K.C. Lohmann, 2016, *Nature Communications*, 7, 12079, "End-Cretaceous extinction in Antarctica linked to both Deccan volcanism and meteorite impact via climate change." See: http://adsabs.harvard.edu/abs/2016NatCo...712079P See also: http://ns.umich.edu/new/releases/24010-warming-pulses-in-ancient-climate-record-link-volcanoes-asteroid-impact-and-dinosaur-killing-mass-extinction
2016, Jul 5	*ESA SSA-NEO Coordination Centre Newsletter*, 5 July 2016. See: http://neo.ssa.esa.int/newsletters
2016, Jul 7	Aten NEA **2016 NJ22** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.74 LD. **[2016-31]** See: 2016 NJ22 - SSA , 2016 NJ22 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **8 July 2141**.

2016, Jul 11	Apollo NEA **2016 NK22** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2016-32]** See: 2016 NK22 - SSA , 2016 NK22 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Jul 11	A.V. Devyatkin, D.L. Gorshanov, V.N. Yershov, et al., 2016, *Monthly Notices of the Royal Astronomical Society*, 459, 3986, "A study of the asteroid **(367943) Duende** at Pulkovo Observatory." See: http://adsabs.harvard.edu/doi/10.1093/mnras/stw736
2016, Jul 15	D.M.H. Baker, J.W. Head, G.S. Collins, R.W.K. Potter, 2016, *Icarus*, 273, 146, "The formation of peak-ring basins: working hypotheses and path forward in using observations to constrain models of **impact-basin** formation." See: http://adsabs.harvard.edu/abs/2016Icar..273..146B
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2016, Jul 27	P. Murdin, 2016, *Rock Legends – the Asteroids and Their Discoverers* (Cham: Springer International Publishing). See: http://www.springer.com/us/book/9783319318356 See also: http://www.universetoday.com/131840/rock-legends-asteroids-discoverers/
2016, Jul 30 - Aug	***COSPAR 41st Scientific Assembly 2016***, 30 July - 7 August, Istanbul (Turkey) [cancelled]. **Among the program:** Past, present and future of small body science and exploration. See: http://cospar2016.tubitak.gov.tr/en/ - C. Raymond, R., Jaumann, G. Vane, et al., 2016, "Instruments for planetary exploration with ***CubeSats*** and ***SmallSats***."

	See: http://adsabs.harvard.edu/abs/2016cosp...41E1632R
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2016, Aug	J. Hanuš, M. Delbo', D. Vokrouhlický, et al., 2016, *Astronomy & Astrophysics*, 592, 34, "Orbital, spin state and thermophysical characterization of near-Earth asteroid **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2016A%26A...592A..34H
2016, Aug	S. He, Z. Zhu, C. Peng, 2016, *Acta Mechanica Sinica*, 32, 753, "Optimal design of Near-Earth Asteroid sample-return trajectories in the **Sun-Earth-Moon** system." See: http://adsabs.harvard.edu/abs/2016AcMSn..32..753H
2016, Aug	Y. Jiang, H Baoyin, 2016, *New Astronomy*, 47, 91, "Capillary action in a crack on the surface of asteroids with an application to **433 Eros**." See: http://adsabs.harvard.edu/abs/2016NewA...47...91J
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2016, Aug 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 August 2016. See: http://neo.ssa.esa.int/newsletters
2016, Aug 7-12	***79th Annual Meeting of the Meteoritical Society***, 7-12 August 2016, Berlin (Germany). See: http://www.meteoriticalsociety.org/?page_id=18 http://www.metsoc-berlin.de/ **Among the papers:** - K.L. Bryson, D.R. Ostrowski, 2016, *LPI Contribution* No. 1921, id.6483, "Meteorite fractures and scaling for asteroid atmospheric entry." See: http://adsabs.harvard.edu/abs/2016LPICo1921.6483B - D. Krispin, A.A. Mardon, B.G. Fawcett, 2016, *LPI Contribution* No. 1921, id.6560, "Historical uses of meteoritic metals as precedent for modern in-situ asteroid mining." See: http://adsabs.harvard.edu/abs/2016LPICo1921.6560K - C. E. Moyano-Cambero, J. M. Trigo-Rodríguez, Eva Pellicer, et al., 2016, *LPI Contribution* No. 1921, id.6477, "UV-NIR spectra and nanoindentation of **Chelyabinsk** to infer the mechanical properties of hazardous asteroids." See: http://adsabs.harvard.edu/abs/2016LPICo1921.6477M

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2016, Aug 15	K. Ariu, T. Inamori, R. Funase, S. Nakasuka, 2016, *Advances in Space Research*, 58, 528, "A dimensionless relative trajectory estimation algorithm for autonomous imaging of a small astronomical body in a close distance flyby." See: http://adsabs.harvard.edu/abs/2016AdSpR..58..528A
2016, Aug 15	D.C. Agle, 2016, *JPL News*, 15 August 2016, "NASA ***Asteroid Redirect Mission*** completes design milestone." See: http://www.jpl.nasa.gov/news/news.php?feature=6593 http://www.jpl.nasa.gov/news/news.php?feature=6626
2016, Aug 23-24	***Second International Workshop on Asteroid Threat Assessment: Asteroid-generated Tsunami (AGT) and Associated Risk Assessment***, Seattle (WA, USA), 23-24 August. See: https://tsunami-workshop.arc.nasa.gov/workshop2016/ **Summary Report** (final 12 October 2016)**:** https://tsunami-workshop.arc.nasa.gov/workshop2016/doc/AGTWorkshopSummaryfinal.pdf **Guest Speaker:** **-** V.V. Titov (NOAA), "Tsunami generation and propagation from asteroid impact simulations." **Summary:** - D. Morrison, E. Venkatapathy, 2017, *NASA/Technical Memorandum* (NASA/TM-219463) 2017, "Asteroid Generated Tsunami: Summary of NASA/NOAA Workshop." See: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170005214.pdf **Among the papers:** - M. Boslough, 2016, "Computational modeling of airbursts for asteroid-generated tsunami." - L. Johnson, 2016, "NASA PE, **Planetary Defense and NEO**

	Program." - D. Mathias, L. Wheeler, D. Aftosmis, et al., 2016, "Ensemble asteroid threat characterization: water versus land impacts." - D.K. Robertson, 2016, "Tsunami generation from asteroid airburst and ocean impact, and Van Dorn Effect." - L.D. Wheeler, D. Mathias, P. Register, 2016, "Analytical tsunami models for physics-based impact risk assessment."
2016, Aug 28	Aten NEA **2016 QA2** (H = 25.3 mag, $D \approx$ 30 m) passed Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.23 LD. **[2016-33]** See: 2016 QA2 - SSA , 2016 QA2 - JPL Discovery station: **SONEAR Observatory, Oliveira** See: http://iawn.net/
2016, Aug 29	D. Bancelin, D. Hestroffer, W. Thuillot, 2016, Proc. ***2nd Gaia-FUN-SSO International Workshop***, Paris (France), 19-21 September 2012, "Near-Earth Asteroids orbit propagation with ***Gaia*** observations." See: http://adsabs.harvard.edu/abs/2016arXiv160808023B
2016, Aug 29	D. Bancelin, W. Thuillot, A. Ivantsov, et al., 2016, in: Proc. ***3rd Gaia-FUN-SSO International Worshop***, Paris (France), 24-26 November 2014, e-print *arXiv*:1608.08024, "The ***Gaia***-**FUN-SSO** observation campaign of **99942 Apophis**: a preliminary test for the network." See: http://adsabs.harvard.edu/abs/2016arXiv160808024B
2016, Aug 30	I. Steadman, 2016, *How we get to next*, 30 August 2016, "Artificial Intelligence (A.I) is defending the earth from asteroids." See: https://howwegettonext.com/a-i-is-defending-the-earth-from-asteroids-d877cc17164e#.x9yree1tp See also: https://en.wikipedia.org/wiki/Asteroid_impact_avoidance
2016, Aug 31	P. Voosen, 2016, *Science*, 353, 974, "NASA to launch asteroid-sampling mission." See: http://adsabs.harvard.edu/abs/2016Sci...353..974V
2016, Aug 31	V. Zuccarelli, D. Bancelin, S. Weikert, et al., 2016, in: Proc. ***6th International Association for the Advancement of Space Safety (IAASS) Conference "Safety is not an Option"***, Montreal (Canada), 21-23 May 2013, e-print *arXiv*:1608.08816, "**NEOPROP**: a NEO Propagator for Space Situational Awareness." See: http://adsabs.harvard.edu/abs/2016arXiv160808816Z

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2016, Sep	C.R. Nugent, A. Mainzer, J. Bauer, et al., 2016, *Astronomical Journal*, 152, 63, "***NEOWISE*** reactivation mission year two: asteroid diameters and albedos." See: http://adsabs.harvard.edu/abs/2016AJ....152...63N
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2016, Sep 1	A. Olech, P. Zoladek, M. Wisniewski, et al., *Monthly Notices of the Royal Astronomical Society*, 461, 674, "2015 Southern **Taurid fireballs** and asteroids **2005 UR** and **2005 TF50**." See: http://adsabs.harvard.edu/abs/2016MNRAS.461..674O
2016, Sep 1	V. Wennrich, AA. Andreev, P.E. Tarasov, et al., 2016, *Quaternary Science Reviews*, 147, 221, "**Impact processes**, permafrost dynamics, and climate and environmental variability in the terrestrial Arctic as inferred from the unique 3.6 Myr record of Lake El'gygytgyn, Far East Russia - A review." See: http://adsabs.harvard.edu/abs/2016QSRv..147..221W
2016, Sep 1	*ESA SSA-NEO Coordination Centre Newsletter*, 1 September 2016. See: http://neo.ssa.esa.int/newsletters
2016, Sep 2	R. Skibba, 2016, *Nature News*, 2 September 2016, "***OSIRIS-REx*** spacecraft blazes trail for asteroid miners."

	See: https://www.nature.com/news/osiris-rex-spacecraft-blazes-trail-for-asteroid-miners-1.20486
2016, Sep 2	Apollo NEA **2016 RR1** (*H* = 28.1 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2016-34]** See: 2016 RR1 - SSA , 2016 RR1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Sep 3	Apollo NEA **2016 RS1** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.49 LD. **[2016-35]** See: 2016 RS1 - SSA , 2016 RS1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Sep 7	Aten NEA **2016 RB1** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.105 LD **(= 6.35 R_{Earth} from the geocenter)**. Minimum miss distance 0.105 LD. **[2016-36]** See: 2016 RB1 - SSA , 2016 RB1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/news-archive [9 September 2016], http://www.jpl.nasa.gov/news/news.php?feature=6615 See also: **10 Sep 1947, 8 Sep 2078.**
2016, Sep 8	Launch of NASA spacecraft ***Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx)***, an asteroid sample return mission. Target asteroid **101955 (1999 RQ36 = Bennu**, *H* = 20.8 mag, *D* ≈ 575 m, **NEO**, **PHA**). The 2,110-kg spacecraft will launch aboard an Atlas V 411 rocket during a 34-day launch period that begins Sept. 8, and reach its asteroid target in 2018. After a careful survey of **Bennu** to characterize the asteroid and locate the most promising sample sites, ***OSIRIS-REx*** will collect between 60 to 2,000 grams of surface material with its robotic arm and return the sample to Earth via a detachable capsule on 24 September 2023. See: http://www.nasa.gov/osiris-rex http://science.nasa.gov/missions/osiris-rex/ http://www.asteroidmission.org/objectives/ http://www.nasa.gov/topics/solarsystem/features/osiris-rex.html http://www.nasa.gov/mission_pages/osiris-rex/index.html http://pirlwww.lpl.arizona.edu/~guym/OSIRIS-REx.pdf http://www.space.com/11802-nasa-asteroid-mission-dangerous-1999-

	rq36.html http://www.space.com/11808-nasa-asteroid-mission-osiris-rex-1999-rq36-infographic.html http://www.space.com/12065-osiris-rex-asteroid-generations.html http://www.grandpublic.obspm.fr/2016-2023-Retour-sur-Terre-d http://web.mit.edu/newsoffice/2011/asteroid-mission-0726.html http://www.theithacajournal.com/article/20110828/NEWS01/108280327/Campus-Watch-Ithaca-College-professor-receives-NASA-grant-asteroid-study?odyssey=nav%7Chead http://www.space.com/13132-potentially-killer-asteroids-earth-nasa.html http://www.nasa.gov/press/2014/april/construction-to-begin-on-nasa-spacecraft-set-to-visit-asteroid-in-2018/ http://adsabs.harvard.edu/abs/2016Sci...353..974V http://iopscience.iop.org/article/10.1088/2058-7058/29/10/11/meta https://ww2.kqed.org/science/2017/09/29/why-is-nasa-checking-out-this-asteroid/ See also: **29 Dec 2009**.
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2016, Sep 11	Apollo NEA **2016 RN41** (H = 31.0 mag, $D \approx$ 2.2 m) passed Earth at a nominal miss distance of 0.062 LD **(= 3.72 R_{Earth} from the geocenter)**. Minimum miss distance 0.058 LD. **[2016-37]** See: 2016 RN41 - SSA , 2016 RN41 - JPL Discovery station: **…** See: http://iawn.net/
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2016, Sep 21	**The Space Generation Advisory Council (SGAC)** announces the winner of the *2016 Move an Asteroid Competition*: Simon Molgat Laurin (Canada). See: http://spacegeneration.org/home/news/1797-sgac-announces-the-winner-of-the-2016-move-an-asteroid-competition.html
2016, Sep 21	Apollo NEA **2016 SJ** (H = 29.3 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2016-38]** See: 2016 SJ - SSA , 2016 SJ - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2016, Sep 24	Aten NEA **2016 SU2** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2016-39]** See: 2016 SU2 - SSA , 2016 SU2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **27 Sep 2139**.
2016, Sep 25	Apollo NEA **2016 SA2** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.80 LD. **[2016-40]** See: 2016 SA2 - SSA , 2016 SA2 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **22 Sep 2067**.
2016, Sep 26	Apollo NEA **2016 SW3** (H = 28.3 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 1.002 LD. Minimum miss distance 1.001 LD. See: 2016 SW3 - SSA , 2016 SW3 - JPL
2016, Sep 26	**SBAG Special Action Team** Report, 2016, "***ARM*** connections to priority small body science and exploration goals." See: http://www.lpi.usra.edu/sbag/documents/ARM-SAT-2016-09-26.pdf See also:

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2016, Sep 30	Apollo NEA **2016 TD** ($H = 28.4$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD. **[2016-41]** See: 2016 TD - SSA , 2016 TD - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **1 Oct 2108**.
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2016, Oct 5	*ESA SSA-NEO Coordination Centre Newsletter*, 5 October 2016. See: http://neo.ssa.esa.int/newsletters
2016, Oct 8	Apollo NEA **2016 TG94** (H = 29.9 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.56 LD. Minimum miss distance 0.56 LD. **[2016-43]** See: 2016 TG94 - SSA , 2016 TG94 - JPL Discovery station: **…** See: http://iawn.net/
2016, Oct 10	Apollo NEA **2016 TS54** (H = 28.1 mag, $D \approx$ 9 m) passed Earth at

	a nominal miss distance of 0.20 LD. Minimum miss distance 0.19 LD. **[2016-44]** See: 2016 TS54 - SSA , 2016 TS54 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Oct 11	Apollo NEA **2016 TB19** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2016-45]** See: 2016 TB19 - SSA , 2016 TB19 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2016, Oct 13	***4th IAWN Steering Committee Meeting***, Pasadena (CA, USA), 13 October 2016. See: http://iawn.net/2016/11/01/the-4th-iawn-steering-committee-meeting/ **Presentations:** - R. Landis, T. Spahr, 2016, "***4th International Asteroid Warning Network (IAWN) Meeting***. Current status and agenda" See: http://iawn.net/wp-content/uploads/2016/10/Intro_4th_IAWN_13Oct2016.pdf - R. Kofler, 2016, "UNOOSA - **IAWN** Interface."

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2016, Oct 24-27	***3rd International Workshop on Instrumentation for Planetary***

	Missions, 24-27 October 2016, Pasadena (CA, USA). See: http://www.hou.usra.edu/meetings/ipm2016/ **Among the papers:** - Z.J. Fletcher, A.F. Cheng, O.S. Barnouin, et al., 2016, *LPI Contribution* No. 1980, id.4043, "**DRACO**: **Didymos Reconnaissance and Asteroid Camera** for Op-Nav [***DART***]." See: http://adsabs.harvard.edu/abs/2016LPICo1980.4043F - C. Schröder, G. Klingelhöfer, R.V. Morris, et al., 2016, *LPI Contribution* No. 1980, id.4057, "The **Miniaturized Mössbauer Spectrometer MIMOS II** for the ***Asteroid Redirect Mission (ARM)***: quantitative iron mineralogy and oxidation states." See: http://adsabs.harvard.edu/abs/2016LPICo1980.4057S
2016, Oct 24-28	***Exploring the Universe with JWST - II***, 24-28 October 2016, Montréal (Canada). See: http://craq-astro.ca/jwst2016/
2016, Oct 25	**B612 Foundation**, *Annual Progress Report*, Volume Two, 2016, "Engaging the world in planetary defense." See: https://b612foundation.org/b612s-progress-report-vol-1-engaging-the-world-in-planetary-defense-2/? **Summary:** " - The 2008 [US] Congressionally mandated goal of finding 90% of NEOs larger than 140 meters is within reach. We believe this goal can be reached because of the full federal funding for the **Large Synoptic Survey Telescope (LSST)** in addition to potential NASA funding of the ***NEOCam*** infrared space telescope, wich **B612** advocates. Because of this progress, it is our intention to package our research on ***Sentinel*** as a design reference mission for solar orbiting infrared space telescopes so that other scientists can benefit from our findings. - We are investigating a promising new technology called **synthetic tracking** that could allow us to address asteroids smaller than 140 meters. - Impending huge improvements in observing capabilities will lead to a deluge of new asteroid discoveries, and, in response, we are developing the **Asteroid Decision Analysis Machine (ADAM)**, a more capable and open system for understanding, analyzing, and assessing impact and detection scenarios. - The second annual **Asteroid Day** this past June 30th was an international success, with the UN considering for it to be an officially recognized day, and we are preparing for a bigger and better **Asteroid Day 2017**. " See also: http://uk.blastingnews.com/tech/2016/11/b612-foundation-tracks-

	dangerous-neos-asteroids-with-new-technology-001274217.html https://b612foundation.org/asteroid-institute-announces-google-cloud-and-agi-among-new-technology-partners/
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2016, Nov 1	Apollo NEA **2016 VZ17** ($H = 27.5$ mag, $D \approx 11$ m) passed Earth at a nominal miss distance of 3.34 LD. Minimum miss distance 0.28 LD. See: 2016 VZ17 - SSA , 2016 VZ17 - JPL
2016, Nov 2	G. Webster, 2016, *JPL News*, 2 November 2016, ***Curiosity Mars Rover*** checks odd-looking iron meteorite. Laser-zapping of a globular, golf-ball-size object on **Mars** by NASA's ***Curiosity*** rover confirms that it is an iron-nickel meteorite fallen from the Red Planet's sky. See: http://www.jpl.nasa.gov/news/news.php?feature=6667
2016, Nov 2	**Fireball over Pennsylvania**. The **American Meteor Society** received 311 reports so far about of a **fireball event** over seen over Pennsylvania on November 1st, 2016 around 08:15pm EDT (Nov. 2nd ~ 00:15 UT). The fireball was seen primarily from Pennsylvania but witnesses from Maryland, New York, Connecticut, Ohio, Virginia, West Virginia, Michigan, Massachusetts, Delaware and Ontario (Canada) also reported the event. See: http://www.amsmeteors.org/2016/11/fireball-over-pennsylvania/
2016, Nov 2	Aten NEA **2016 VA** ($H = 27.8$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.24 LD. **[2016-47]**

	See: 2016 VA - SSA , 2016 VA - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **2 Nov 1938**, **1 Nov 2024**.
2016, Nov 3	*ESA SSA-NEO Coordination Centre Newsletter*, 3 November 2016. See: http://neo.ssa.esa.int/newsletters
2016, Nov 4	NASA and FEMA conduct asteroid impact emergency planning exercise. See: https://www.nasa.gov/feature/jpl/nasa-and-fema-conduct-asteroid-impact-emergency-planning-exercise http://mashable.com/2016/12/04/what-happens-killer-asteroid-strike/#dnM8PF3x5OqC
2016, Nov 7, 15:47	Apollo NEA **2019 VA** (H = 28.4 mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 3.60 LD. Minimum miss distance 0.11 LD. See: 2019 VA – SSA , 2019 VA - JPL See also: **2 Nov 2019**.
2016, Nov 7, 15:57	Aten NEA **2016 VB1** (H = 28.8 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2016-48]** See: 2016 VB1 – SSA , 2016 VB1 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Nov 10	Apollo NEA **2016 VF18** (H = 30.1 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.16 LD. **[2016-49]** See: 2016 VF18 - SSA , 2016 VF18 - JPL Discovery station: **…** See: http://iawn.net/
2016, Nov 11	C. de la Fuente Marcos, R. de la Fuente Marcos, 2016, *Monthly Notices of the Royal Astronomical Society*, 462, 3441, "Asteroid **(469219) 2016 HO3**, the smallest and closest Earth quasi-satellite." See: http://adsabs.harvard.edu/abs/2016MNRAS.462.3441D See also: https://uanews.arizona.edu/story/earths-new-buddy-asteroid-not-space-junk
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	Communications, 7, 13459, "Amazonian chemical weathering rate derived from stony meteorite finds at Meridiani Planum on **Mars**." See: http://adsabs.harvard.edu/abs/2016NatCo...713459S http://www.stir.ac.uk/news/2016/11/meteorites-reveal-drought-on-mars/
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2016, Nov 17	A. Witze, 2016, *Nature News*, 17 November 2016, "Rock core from **dinosaur-killing impact** reveals how enormous craters form." See: http://www.nature.com/news/rock-core-from-dinosaur-killing-impact-reveals-how-enormous-craters-form-1.20994
2016, Nov 17	Apollo NEA **2016 WT** (H = 29.9 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2016-50]** See: 2016 WT - SSA , 2016 WT - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Nov. 18	P. Barton, 2016, *Science*, 354, 836, "Revealing the dynamics of a large impact." See: http://science.sciencemag.org/content/354/6314/836 See also: http://science.sciencemag.org/content/354/6314/878
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	354, 878, "The formation of peak rings in **large impact craters**." See: http://adsabs.harvard.edu/abs/2016Sci...354..878M See also: http://www.sciencemag.org/news/2016/11/update-drilling-dinosaur-killing-impact-crater-explains-buried-circular-hills http://science.sciencemag.org/content/354/6314/836 https://www.livescience.com/56914-dino-killing-asteroid-punched-through-earths-crust.html?
2016, Nov 21	J. Mccormick, 2016, *Blastingnews*, 21 November 2016, "**B612 Foundation** tracks dangerous NEOs (asteroids) with new technology." See: http://uk.blastingnews.com/tech/2016/11/b612-foundation-tracks-dangerous-neos-asteroids-with-new-technology-001274217.html
2016, Nov 21	Apollo NEA **2016 WT3** ($H = 28.5$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.95 LD. Minimum miss distance 0.94 LD. **[2016-51]** See: 2016 WT3 - SSA , 2016 WT3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Nov 25	Apollo NEA **2016 WW2** ($H = 29.2$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.35 LD. **[2016-52]** See: 2016 WW2 - SSA , 2016 WW2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2016, Nov 30	Apollo NEA **2016 XL23** ($H = 29.5$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.23 LD. **[2016-53]** See: 2016 XL23 - SSA , 2016 XL23 - JPL Discovery station: **…** See: http://iawn.net/
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	[US] National Science and Technology Council. See: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/NSTC/national_neo_preparedness_strategy_final.pdf See also: http://www.space.com/35227-dangerous-asteroids-white-house-report.html http://us5.campaign-archive1.com/ http://blogs.discovermagazine.com/d-brief/2017/01/13/nasa-asteroid-protection-plan/#.WH3g62cixdj
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2016, Dec 7	The United Nations General Assembly (UNGA) has proclaimed that **International Asteroid Day** will be observed globally on 30 June every year. The resolution reads as follows: The United Nations "*declares 30 June **International Asteroid Day** to observe each year at the international level the anniversary of the **Tunguska impact** over Siberia, Russia, on 30 June 1908 and to raise public awareness about the **asteroid impact hazard***." See: http://us9.campaign-archive2.com/?u=0e9c23265f31e0f37201d19b6&id=eeca806afb&e=db8a8b6284 http://www.unoosa.org/oosa/en/informationfor/media/2016-unis-os-478.html http://us5.campaign-archive2.com/?u=c7281b61ab362fadf221e16fc&id=61279d1797&e=b8e2af394f
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2016, Dec 12-16	***Asteroids & Planetary Defense press conferences at the American Geophysical Union Fall Meeting***, 12-16 December 2016, San Francisco (CA, USA). See: https://fallmeeting.agu.org/2016/ **Sessions:** - P31E : Update on results from the IODP-ICDP **Chicxulub Impact Crater** drilling expedition. - NH12A, NH13A : Defending the home planet. See: http://fallmeeting.agu.org/2016/media-center/press-conferences/#defense **Among those:** J. Nuth, 2016, "Comets have largely been ignored by people that are interested in defending the planet,". See also: http://www.space.com/35008-comet-strike-danger-to-earth.html https://www.theguardian.com/science/2016/dec/13/space-asteroid-comet-nasa-rocket http://www.smithsonianmag.com/science-nature/how-threat-getting-hit-asteroid-could-spur-international-collaboration-180961543/
2016, Dec 15	D. Lewis, 2016, *Smithonian.com*, 15 December 2016, "Never fear, an oceanic asteroid impact wouldn't cause apocalyptic tidal waves." See: http://www.smithsonianmag.com/smart-news/asteroid-impact-ocean-wouldnt-cause-apocalyptic-tidal-waves-180961451/
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2017, Jan 1	**15387 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, *H* = 9.45 mag, *D* = 36.5 km, Amor NEA), of which **1751 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, *H* = 15.3 mag, *D* = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: http://neo.jpl.nasa.gov/stats/
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	"Resurrection of **(3200) Phaethon** in 2016." See: http://adsabs.harvard.edu/abs/2017AJ....153...23H
2017, Jan	D. Perna, M. Popescu, F. Monteiro, et al., 2017, *Astronomy & Astrophysics*, 597, 57, "An investigation of the low-Δ*V* Near-Earth asteroids **(341843) 2008 EV5** and **(52381) 1993 HA**, two suitable targets for the ***ARM*** and ***MarcoPolo-M5*** space missions." See: http://adsabs.harvard.edu/abs/2016A%26A...597A..57P
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2017, Jan	J.M. Trigo-Rodríguez, M. Gritsevich, H. Palme (eds.), 2017, ***Assessment and Mitigation of Asteroid Impact Hazards***, Proceedings of the ***2015 Barcelona Asteroid Day***, *Astrophysics and Space Science Proceedings*, Vol. 46 (Springer International Publishing). See: http://adsabs.harvard.edu/abs/2017ASSP...46.....T **Among the papers:** - J.M. Trigo-Rodríguez, H.Palme, M.Gritsevich, 2017, p. 1, "Barcelona **Asteroid Day** 2015: Revisiting the threat by asteroid and comet impact." See: http://adsabs.harvard.edu/abs/2017ASSP...46....1T - J.M. Trigo-Rodríguez, I.P. Williams, 2017, p. 11, "Dynamic sources of contemporary hazard from meteoroids and small asteroids." See: http://adsabs.harvard.edu/abs/2017ASSP...46...11T - H. Palme, J. Zipfel, 2017, p. 33,"The chemistry of Solar System materials: Sun, planets, asteroids, meteorites and dust." See: http://adsabs.harvard.edu/abs/2017ASSP...46...33P - M. Martínez-Jiménez, C.E. Moyano-Cambero, J.M. Trigo-Rodríguez, et al., 2017, p. 73, "Asteroid mining: mineral resources in undifferentiated bodies from the chemical composition of carbonaceous chondrites."

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2017, Jan 9, 12:20	Apollo NEA **2019 WC5** (*H* = 22.6 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 9.98 LD. Minimum miss distance 8.03 LD. See: 2019 WC5 – SSA , 2019 WC5 – JPL
2017, Jan 9, 12:50	Aten NEA **2017 AG13** (*H* = 26.0 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.54 LD. **[2017-01]** See: 2017 AG13 - SSA , 2017 AG13 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: http://www.astronomy.com/news/2017/01/aten-asteroid-close-to-earth See also: **9 Jan 2069**.
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2017, Jan 30	Apollo NEA **2017 BH30** (H = 28.7 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2017-03]** See: 2017 BH30 - SSA , 2017 BH30 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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	distance 6.56 LD. See: 2017 BQ6 - SSA , 2017 BQ6 - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=6742 https://en.wikipedia.org/wiki/2017_BQ6
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2017, Feb 17	Apollo NEA **2016 WF9** (H = 20.3 mag, $D \approx$ 300 m, **PHA**) passed Earth at a nominal miss distance of 133 LD (= 0.341 AU). Minimum miss distance 132 LD (= 0.340 AU). See: 2016 WF9 - SSA , 2016 WF9 - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=6712 https://en.wikipedia.org/wiki/2016_WF9
2017, Feb 18	Aten NEA **2017 DC36** (H = 22.2 mag, $D \approx$ 130 m) passed Earth at a nominal miss distance of 4.23 LD. Minimum miss distance 4.23

	LD. See: 2017 DC36 – SSA , 2017 DC36 – JPL
2017, Feb 23, 19:46	Apollo NEA **2017 DZ37** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 1.006 LD. Minimum miss distance 1.003 LD. See: 2017 DZ37 - SSA , 2017 DZ37 - JPL
2017, Feb 23, 21:08	Apollo NEA **2017 DG16** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.36 LD. **[2017-05]** See: 2017 DG16 - SSA , 2017 DG16 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Feb 24	Aten NEA **5604** (**1992 FE**, *H* = 17.6 mag, *D* ≈ 970 m, **PHA**) passed Earth at a nominal miss distance of 13.07 LD. Minimum miss distance 13.07 LD. See: 1992 FE - SSA , 1992 FE - JPL See also: https://en.wikipedia.org/wiki/(5604)_1992_FE
2017, Feb 25	Apollo NEA **2017 DR34** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.58 LD. **[2017-06]** See: 2017 DR34 - SSA , 2017 DR34 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **26 Feb 1943**, **26 Feb 2105**.
2017, Feb 27	Apollo NEA **2017 DV36** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.02 LD. See: 2017 DV36 - SSA , 2017 DV36 - JPL
2017, Feb 27 - Mar	***Planetary Science Vision 2050 Workshop***, 27 February - 1 March 2017, NASA Headquarters, Washington (DC, USA). See: http://www.hou.usra.edu/meetings/V2050/ **Among the papers:** - A. Mainzer, J. Bauer, T. Grav, et al., 2017, *LPI Contrib*. No. 1989, "The future of planetary defense." See: https://www.hou.usra.edu/meetings/V2050/pdf/8225.pdf - J. A. Nuth, 2017, *LPI Contrib*. No. 1989, "Planetary defense: an integrated system of detection, evaluation and mitigtion." See: https://www.hou.usra.edu/meetings/V2050/pdf/8206.pdf - A.S. Rivkin, B. W. Denevi, R. L. Klima, et al., 2017, *LPI Contrib*. No. 1989, "Asteroid studies: a 35-year forecast."

	See: https://www.hou.usra.edu/meetings/V2050/pdf/8017.pdf - T.D. Swindle, N. Chabot, B. Barbee, et al, and the SBAG Steering Committee, 2017, *LPI Contrib*. No. 1989, "Small bodies exploration in the next 35 years." See: https://www.hou.usra.edu/meetings/V2050/pdf/8041.pdf
2017, Feb 28 - Mar	***NASA Asteroid Deflection Workshop***, Caltech, Pasadena (CA, USA), 28 February - 2 March 2017, hosted by **CNEOS**/JPL. See: https://www.cosmos.esa.int/documents/336356/1197204/Chodas_SMPAG_2016-10.pdf/
2017, Mar	M. Cortese, E. Perozzi, M. Micheli, et al., 2017, *Meteoritics & Planetary Science*, 52, 522, "An efficient algorithm for prioritizing NEA physical observations." See: http://adsabs.harvard.edu/abs/2017M%26PS...52..522C
2017, Mar	A.H. Greenberg, J.-L. Margot, A.K. Verma, et al., 2017, *Astronomical Journal*, 153, 108, "Asteroid **1566 Icarus**' size, shape, orbit, and Yarkovsky drift from radar observations." See: http://adsabs.harvard.edu/abs/2017AJ....153..108G
2017, Mar	T.G. Müller, J. Ďurech, M. Ishiguro, et al., 2017, *Astronomy & Astrophysics*, 599, 103, "***Hayabusa-2*** mission target asteroid **162173 Ryugu (1999 JU3)**: searching for the object's spin-axis orientation." See: http://adsabs.harvard.edu/abs/2017A%26A...599A.103M See also: http://www.seeker.com/hayabusa-jaxa-asteroid-sample-return-mission-solar-system-mystery-2129873742.html
2017, Mar	D. Nesvorný, F. Roig, W.F. Bottke, 2017, *Astronomical Journal*, 153, 103, "Modeling the historical flux of planetary impactors." See: http://adsabs.harvard.edu/abs/2017AJ....153..103N
2017, Mar	D. Perna, M.A. Barucci, M. Ishiguro, et al., 2017, *Astronomy & Astrophysics*, 599, L1, "Spectral and rotational properties of near-Earth asteroid **(162173) Ryugu**, target of the ***Hayabusa2*** sample return mission." See: http://adsabs.harvard.edu/abs/2017A%26A...599L...1P
2017, Mar	A. Waszczak, T.A. Prince, R. Laher, et al., 2017, *Publications of the Astronomical Society of the Pacific*, 129, 034402, "Small near-Earth asteroids in the **Palomar Transient Factory** survey: a real-time streak-detection system." See: http://adsabs.harvard.edu/abs/2017PASP..129c4402W

2017, Mar	H. Yang, X. Bai, H.Baoyin, 2017, *Acta Astronautica*, 132, 78, "Finite-time control for asteroid hovering and landing via terminal sliding-mode guidance." See: http://adsabs.harvard.edu/abs/2017AcAau.132...78Y
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2017, Mar 2	*ESA SSA-NEO Coordination Centre Newsletter*, 2 March 2017. See: http://neo.ssa.esa.int/newsletters
2017, Mar 2	Apollo NEA **2017 EA** (*H* = 31.0 mag, *D* ≈ 2.3 m) passed Earth at a nominal miss distance of 0.054 LD **(= 3.28 R_{Earth} = 20,897 km from the geocenter)**. Minimum miss distance 0.054 LD. See: 2017 EA - SSA , 2017 EA - JPL **[2017-07]** Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: http://cneos.jpl.nasa.gov/news/news194.html
2017, Mar 5	Apollo NEA **2017 DS109** (*H* = 26.2 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2017-08]** See: 2017 DS109 - SSA , 2017 DS109 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2017, Mar 10	L. Speigel, 2017, *The Huffington Post*, 11 March 2017, "Earth doesn't really have any protections in place from asteroids." See: http://www.huffingtonpost.com/entry/asteroid-earth-collision_us_58c06d02e4b0d1078ca39e2b
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2017, Mar 17	NASA selects new research teams to further solar system research in the **Solar System Exploration Research Virtual Institute** (**SSERVI**). See: http://sservi.nasa.gov
2017, Mar 17	T. Shinbrot, T. Sabuwala, T. Siu, et al., 2017, *Physical Review Letters*, 118, 111101, "Size sorting on the rubble-pile asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2017PhRvL.118k1101S See also: https://www.oist.jp/news-center/press-releases/mechanism-underlying-size-sorting-rubble-asteroid-itokawa-revealed

2017, Mar 17 14:10	Apollo NEA **2017 FW158** ($H = 28.3$ mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.32 LD. Minimum miss distance 0.32 LD. **[2017-09]** See: 2017 FW158 - SSA , 2017 FW158 - JPL Discovery station: **…** See: http://iawn.net/
2017, Mar 17 14:28	Apollo NEA **2017 FD3** ($H = 27.9$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.47 LD. Minimum miss distance 0.47 LD. **[2017-10]** See: 2017 FD3 - SSA , 2017 FD3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2017, Mar 19	Apollo NEA **2017 FS** ($H = 29.1$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2017-11]** See: 2017 FS - SSA , 2017 FS - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Mar 20, 02:1(	Apollo NEA **2017 FX158** ($H = 29.3$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.71 LD. Minimum miss distance 0.70 LD. **[2017-12]** See: 2017 FX158 - SSA , 2017 FX158 - JPL Discovery station: **…** See: http://iawn.net/
2017, Mar 20, 21:0	Apollo NEA **2017 FN1** ($H = 30.7$ mag, $D \approx 2.6$ m) passed Earth at a nominal miss distance of 0.16 LD. Minimum miss distance 0.16 LD. **[2017-13]** See: 2017 FN1 - SSA , 2017 FN1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Mar 20, 22:3	Apollo NEA **2017 FM1** ($H = 29.7$ mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2017-14]** See: 2017 FM1 - SSA , 2017 FM1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2017, Mar 20-24	***Science with the Hubble and James Webb Space Telescopes. V***, Venice (Italy), 20-24 March 2017. See: http://www.stsci.edu/institute/conference/hst5

2017, Mar 20-24	***48th Lunar and Planetary Science Conference***, The Woodlands (TX, USA), 20-24 March 2017. See: http://www.hou.usra.edu/meetings/lpsc2017/ **Among the papers:** - M. Abe, T. Yada, T. Okada, et al., 2017, *LPI Contribution* No. 1964, id.1760, "**JAXA's Astromaterials Science Research Group** and curation facility for ***Hayabusa*** and ***Hayabusa2*** asteroids sample returned mission." See: http://adsabs.harvard.edu/abs/2017LPI....48.1760A - P.A. Abell, D.D. Mazanek, D.M. Reeves, et al., 2017, *LPI Contribution* No. 1964, id.2652, "NASA's ***Asteroid Redirect Mission*** *(ARM)*." See: http://adsabs.harvard.edu/abs/2017LPI....48.2652A - T. Arai, H. Demura, T. Kouyama, et al., 2017, *LPI Contribution* No. 1964, id.1708, "Observed data products and asteroid mappings of **Thermal Infrared Imager** onboard ***Hayabusa2***." See: http://adsabs.harvard.edu/abs/2017LPI....48.1708A - E. Asphaug, J. Baker, M. Choukron, et al., 2017, *LPI Contribution* No. 1964, id.1981, "***Spacecraft Penetrator for Increasing Knowledge of NEOs*** (***SPIKE***)." See: http://adsabs.harvard.edu/abs/2017LPI....48.1981A - W.F. Bottke, D. Nesvorny, F. Roig, et al., 2017, *LPI Contribution* No. 1964, id.2572, "Evidence for two impacting populations in the **Early Bombardment** of **Mars** and the **Moon**." See: http://adsabs.harvard.edu/abs/2017LPI....48.2572B - K.L. Bryson, D.R. Ostrowski, 2017, *LPI Contribution* No. 1964, id.2501, "Meteorite fractures and scaling for asteroid atmospheric entry." See: http://adsabs.harvard.edu/abs/2017LPI....48.2501B - T.H. Burbine, R.P. Binzel, B.J. Burt, 2017, *LPI Contribution* No. 1964, id.1968, "How abundant are different meteorite groups among S-complex and Q-type Near-Earth Asteroids?" See: http://adsabs.harvard.edu/abs/2017LPI....48.1968B - A.F. Cheng, P. Michel, O. Barnouin, et al., 2017, *LPI Contribution* No. 1964, id.1510, "The ***Double Asteroid Redirection Test*** (***Dart***) element of the ***Asteroid Impact and Deflection Assessment*** (***AIDA***) mission." See: http://adsabs.harvard.edu/abs/2017LPI....48.1510C - K.L. Craft, O. Barnouin, R. Gaskell, et al., 2017, *LPI Contribution* No. 1964, id.2564, "A stereophotoclinometry model of a physical wall representing asteroid **Bennu**." See: http://adsabs.harvard.edu/abs/2017LPI....48.2564C - M.G. Daly, O.S. Barnouin, C. Dickinson, et al., 2017, *LPI Contribution* No. 1964, id.1996, "The ***OSIRIS-REx*** laser altimeter." See: http://adsabs.harvard.edu/abs/2017LPI....48.1996D - A.B. Davis, D.J. Scheeres, 2017, *LPI Contribution* No. 1964,

	id.1299, "Binary asteroid orbit sensitivity to gravity field coefficients: applications to the ***AIDA*** mission target **65803 Didymos**." See: http://adsabs.harvard.edu/abs/2017LPI....48.1299D - K.L. Donaldson Hanna, D.L. Schrader, N.E. Bowles, et al., 2017, *LPI Contribution* No. 1964, id.1723, "Spectral characterization of analog samples in anticipation of ***OSIRIS-REx's*** arrival at **Bennu**." See: http://adsabs.harvard.edu/abs/2017LPI....48.1723D - C. El Mir, K.T. Ramesh, D.C.Richardson, 2017, *LPI Contribution* No. 1964, id.2590, "A new approach to simulation of asteroidal impact events: from damage to disruption and gravitational accumulation." See: http://adsabs.harvard.edu/abs/2017LPI....48.2590E - H.L. Enos, S. Knutson, W.V. Boynton, et al., 2017, *LPI Contribution* No. 1964, id.2118, "***OSIRIS-REx*** science operations planning and implementation." See: http://adsabs.harvard.edu/abs/2017LPI....48.2118E - T.M. Eubanks, T. Cash, B. Blair, M.E. Eubanks, 2017, *LPI Contribution* No. 1964, id.1577, "The ***Femtospacecraft Asteroid Impact Mission*** (***FAIM***): a low cost mission to monitor the ***DART*** impact on the **Didymoon**." See: http://adsabs.harvard.edu/abs/2017LPI....48.1577E - A.M. Fioretti, C.A. Goodrich, M. Shaddad, P. Jenniskens, et al., 2017, *LPI Contribution* No. 1964, id.1846, "A report on 63 newly sampled stones of the **Almahata Sitta Fall** (asteroid **2008 TC3**) from the University of Khartoum Collection, including a C2 carbonaceous chondrite." See: http://adsabs.harvard.edu/abs/2017LPI....48.1846F - I.A. Franchi, M.A Barucci, J.R. Brucato, ***MarcoPolo-M5*** Proposal Team, 2017, *LPI Contribution* No. 1964, id.2667, "***MarcoPolo-M5*** -- a sample return mission to a D-type Near Earth Asteroid proposed to the ESA Cosmic Vision M5 Call." See: http://adsabs.harvard.edu/abs/2017LPI....48.2667F - G.R. Gisler, T. Heberling, C.S Plesko, R.P. Weaver, 2017, *LPI Contribution* No. 1964, id.1187, "Three-dimensional simulations of oblique asteroid impacts into water." See: http://adsabs.harvard.edu/abs/2017LPI....48.1187G - R.C. Greenwood, T.H. Burbine, I.A.Franchi, 2017, *LPI Contribution* No. 1964, id.2515, "Linking meteorites to asteroids: how many parent bodies do we sample in our meteorite collections?" See: http://adsabs.harvard.edu/abs/2017LPI....48.2515G - P.R. Heck, B. Schmitz, W.F. Bottke, et al., 2017, *LPI Contribution* No. 1964, id.1694, "An achondrite-dominated meteorite flux before the L-chondrite parent asteroid breakup event 466 myr ago?"

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2017, Mar 23	D. Vokrouhlický1, W.F. Bottke, D. Nesvorný, 2017, *Astronomical Journal*, 153, 172, "The **Flora family** event: implications for the near-Earth asteroid population and large impactors of terrestrial worlds." See: http://iopscience.iop.org/article/10.3847/1538-3881/aa64dc/meta
2017, Mar 23	Asteroid **2017 FA159** (H = 28.7 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 3.89 LD. Minimum miss distance 0.99 LD. See: 2017 FA159 - SSA , 2017 FA159 - JPL
2017, Mar 24	E. Bellm, S.Kulkarni, 2017, *Nature Astronomy*, 1, 71, "The unblinking eye on the sky." See: < http://adsabs.harvard.edu/abs/2017NatAs...1E..71B>
2017, Mar 30	P. Wiegert, M. Connors, C. Veillet, 2017, *Nature*, 543, 687, "A retrograde co-orbital asteroid of **Jupiter**." See: http://www.nature.com/articles/nature22029 See also: https://academic.oup.com/mnrasl/article/477/1/L117/4996014 https://www.space.com/40643-first-interstellar-immigrant-asteroid-jupiter-orbit.html? http://www.sciencemag.org/news/2018/05/asteroid-came-another-solar-system-and-it-s-here-stay

	https://en.wikipedia.org/wiki/(514107)_2015_BZ509
2017, Mar 30	Apollo NEA **2017 FJ101** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD. **[2017-15]** See: 2017 FJ101 - SSA , 2017 FJ101 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
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2017, Apr 2	Apollo NEA **2017 FU102** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2017-16]** See: 2017 FU102 - SSA , 2017 FU102 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Apr 3	Asteroid **2017 FT102** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 1.05 LD. Minimum miss distance 1.05 LD. See: 2017 FT102 - SSA , 2017 FT102 - JPL
2017, Apr 4	Apollo NEA **2017 GM** (*H* = 29.9 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.042 LD **(= 2.55 R_{Earth} = 16,267 km from the geocenter)**. Minimum miss distance 0.042 LD. See: 2017 GM - SSA , 2017 GM - JPL **[2017-17]** Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: https://cneos.jpl.nasa.gov/news/news195.html See also: http://neo.ssa.esa.int/newsletters [June 2020]
2017, Apr 6	*ESA SSA-NEO Coordination Centre Newsletter*, 6 April 2017. See: http://neo.ssa.esa.int/newsletters
2017, Apr 10-14	***International Conference Asteroids, Comets, Meteors 2017***, Montevideo (Uruguay), 10-14 April 2017. Proceedings to be published as an special issue of *Planetary & Space Science*. See: info@acm2017.uy http://acm2017.uy/received-abstracts/ **Among the papers:** - C. Avdellidou, "**NELIOTA** - ground-based observations of **lunar** impact flashes." See: http://acm2017.uy/abstracts/Parallel4.a.5.pdf - L. Benner, 2017, "Radar observations of Near-Earth Asteroids and Comets."

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2017, Apr 19	Apollo NEA **2014 JO25** (*H* = 17.8 mag, *D* ≈ 1000 m, **PHA**) passed Earth at a nominal miss distance of 4.57 LD. Minimum miss distance 4.57 LD. See: 2014 JO25 - SSA , 2014 JO25 - JPL See also: https://www.jpl.nasa.gov/news/news.php?feature=6807 https://www.jpl.nasa.gov/news/news.php?feature=6817 https://www.nasa.gov/feature/jpl/nasa-radar-spots-relatively-large-asteroid-prior-to-flyby http://earthsky.org/space/asteroid-2014-jo25-looks-like-comet-67pchuryumov-gerasimenko https://cneos.jpl.nasa.gov/news/news196.html https://www.bloomberg.com/view/articles/2017-05-11/an-asteroid-may-kill-us-all-congress-is-pinching-pennies http://adsabs.harvard.edu/abs/2017DPS....4911702V https://en.wikipedia.org/wiki/2014_JO25
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2017, Apr 22	T. Ubide, P.C. Guyett, G.G. Kenny, et al., 2017, *Journal of Geophysical Research: Planets*, 122, 701, "Protracted volcanism after large impacts: evidence from the **Sudbury impact basin**." See: http://adsabs.harvard.edu/abs/2017JGRE..122..701U See also: https://www.tcd.ie/news_events/articles/ancient-meteorite-impact-sparked-long-lived-volcanic-eruptions-on-earth/7803 http://www.sciencetimes.com/articles/14281/20170504/ancient-

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2017, Apr 22	Aten NEO **2017 HG4** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.61 LD. Minimum miss distance 0.61 LD. **[2017-20]** See: 2017 HG4 - SSA , 2017 HG4 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2017, Apr 23	Apollo NEA **2017 HV2** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2017-21]** See: 2017 HV2 - SSA , 2017 HV2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **24 Apr 2076**.
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2017, May 4 01:16	Apollo NEA **2017 JQ1** ($H = 29.2$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2017-23]** See: 2017 JQ1 - SSA , 2017 JQ1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, May 4 03:18	Apollo NEA **2017 JB2** ($H = 29.3$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.145 LD**.** Minimum miss distance 0.144 LD.

	See: 2017 JB2 - SSA , 2017 JB2 - JPL **[2017-24]** Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **1 May 2085**.
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	from the geocenter). Minimum miss distance 0.157 LD. See: 2017 QP1 - SSA , 2017 QP1 - JPL **[2017-26]** Discovery station: **…** See: http://iawn.net/ See also: https://en.wikipedia.org/wiki/2017_QP1
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2017, Sep 20, 07:34	Apollo NEA **2017 SM2** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.81 LD. Minimum miss distance 0.81 LD. **[2017-31]** See: 2017 SM2 - SSA , 2017 SM2 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: https://www.cnet.com/news/asteroids-near-earth-2012-tc4-2017-space/
2017, Sep 20, 15:49	Apollo NEA **2017 SZ32** (H = 29.3 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.53 LD. **[2017-32]** See: 2017 SZ32 - SSA , 2017 SZ32 - JPL Discovery station: **…** See: http://iawn.net/
2017, Sep 20, 20:29	Apollo NEA **2017 SR2** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.24 LD. Minimum miss distance 0.24 LD. **[2017-33]** See: 2017 SR2 - SSA , 2017 SR2 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: https://www.cnet.com/news/asteroids-near-earth-2012-tc4-2017-space/
2017, Sep 21	T.G.G. Chanut, S. Aljbaae, A.F.B.A. Prado, V. Carruba, 2017, *Monthly Notices of the Royal Astronomical Society*, 470, 2687, "Dynamics in the vicinity of **(101955) Bennu**: solar radiation pressure effects in equatorial orbits."

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2017, Sep 24, 08:12	Apollo NEA **2017 SU17** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2017-34]** See: 2017 SU17 - SSA , 2017 SU17 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2017, Sep 24, 15:32	Apollo NEA **2017 SS12** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.67 LD. **[2017-35]** See: 2017 SS12 - SSA , 2017 SS12 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **26 Sep 2066**.
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2017, Sep 29	Apollo NEA **496817** (**1989 VB** , *H* = 20.1 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 7.87 LD. Minimum miss distance 7.87 LD. See: 1989 VB - SSA , 1989 VB - JPL See also: **13 Oct 1956**, **20 Oct 2078**.
2017, Sep 30	Apollo NEA **2017 TQ2** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[2017-36]** See: 2017 TQ2 - SSA , 2017 TQ2 - JPL Discovery station: **…** See: http://iawn.net/

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2017, Oct 2	Apollo NEA **2017 SX17** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.23 LD. **[2017-37]** See: 2017 SX17 - SSA , 2017 SX17 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **2 Oct 2124**.
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2017, Oct 4	*ESA SSA-NEO Coordination Centre Newsletter*, 4 October 2017. See: http://neo.ssa.esa.int/newsletters
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2017, Oct 10	Apollo NEA **2017 TF5** (H = 25.4 mag, $D \approx$ 30 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.72 LD. **[2017-38]** See: 2017 TF5 - SSA , 2017 TF5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2017, Oct 12	Apollo NEA **2012 TC4** (H = 26.7 mag, $D \approx$ 15 x 8 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2017-39]** See: 2012 TC4 - SSA , 2012 TC4 - JPL Discovery station: **Pan-STARRS 1, Haleakala**

	See: http://iawn.net/ See also: https://cneos.jpl.nasa.gov/news/news197.html https://www.jpl.nasa.gov/news/news.php?feature=6906 https://www.nasa.gov/feature/jpl/asteroid-flyby-will-benefit-nasa-detection-and-tracking-network http://2012tc4.astro.umd.edu/ http://www.esa.int/spaceinimages/Images/2017/08/Asteroid_2012_TC4_will_fly_past_Earth_in_October_2017 https://www.inverse.com/article/37130-nasa-asteroid-armageddon http://www.skyandtelescope.com/astronomy-blogs/astronomy-space-david-dickinson/asteroid-2012-tc4-set-to-zip-past-the-earth-on-thursday https://www.jpl.nasa.gov/news/news.php?feature=6969 http://neo.ssa.esa.int/news-archive https://www.jpl.nasa.gov/news/news.php?feature=6994 https://en.wikipedia.org/wiki/2012_TC4 See also: **11 Oct 1986, 12 Oct 2012**.
2017, Oct 14	**Hyperbolic interstellar asteroid 'Oumuamua** (**1I/2017 U1**, H = 22.01 mag, $D \approx$ 400 x 40 m) passed Earth at a nominal miss distance of 0.162 au (= 62.90 LD). Minimum miss distance 0.162 au (= 62.89 LD). The object approached from the direction of the constellation Lyra at 25.5 km/s, and departed in the direction of the constellation Pegasus at 44 km/s relative to the Sun. See: 2017 U1 - SSA , 2017 U1 - JPL See also: http://www.skyandtelescope.com/astronomy-news/astronomers-spot-first-known-interstellar-comet/ https://www.jpl.nasa.gov/news/news.php?feature=6983 https://www.eso.org/public/archives/releases/sciencepapers/eso1737/eso1737a.pdf https://www.minorplanetcenter.net/mpec/K17/K17V17.html http://www.skyandtelescope.com/astronomy-news/update-on-interstellar-object-oumuamua/ https://www.iau.org/news/announcements/detail/ann17045/ https://www.space.com/38798-first-interstellar-object-name-oumuamua.html https://news.wisc.edu/images-of-strange-solar-system-visitor-peel-away-some-of-the-mystery/ https://www.scientificamerican.com/article/meet-oumuamua-the-first-ever-asteroid-from-another-star/ http://www.nature.com/articles/nature25020 https://www.space.com/39129-oumuamua-interstellar-object-comet-in-disguise.html http://www.eso.org/public/unitedkingdom/news/eso1737/ https://www.jpl.nasa.gov/news/news.php?feature=7006 https://www.nasa.gov/planetarydefense/faq/interstellar https://astronomynow.com/2017/11/22/an-interstellar-interloper-is-dashing-through-our-solar-system/

	https://www.space.com/42216-interstellar-object-oumuamua-one-year-later.html http://neo.ssa.esa.int/news-archive https://en.wikipedia.org/wiki/%CA%BBOumuamua
2017, Oct 15	F. Damme, H. Hussmann, J. Oberst, 2017, *Planetary and Space Science*, 146, 1, "Spacecraft orbit lifetime within two binary near-Earth asteroid systems." See: http://adsabs.harvard.edu/abs/2017P%26SS..146....1D
2017, Oct 15, 03:23	Apollo NEA **2017 UF** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2017-40]** See: 2017 UF - SSA , 2017 UF - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Oct 15, 06:18	Apollo NEA **2017 UK52** (H = 27.2 mag, $D \approx$ 13 m) passed Earth at a nominal miss distance of 6.54 LD. Minimum miss distance 0.26 LD. See: 2017 UK52 - SSA , 2017 UK52 - JPL
2017, Oct 15-20	***49th Annual AAS Division for Planetary Sciences Meeting***, 15-20 October 2017, Provo (UT, USA). See: https://aas.org/meetings/dps49 https://aas.org/meetings/dps49/events **Among the papers:** - C. Avdellidou, D. Koschny, NELIOTA team, 2017, *AAS DPS meeting* #49, id.#204.08, "Lunar impact flashes - tracing the NEO size distribution." See: http://adsabs.harvard.edu/abs/2017DPS....4920408A - M.A. Barucci, D. Perna, S. Fornasier, et al., 2017, *AAS DPS meeting* #49, id.#110.08, "**NEOShield-2** project: final results on compositional characterization of small NEOs." See: http://adsabs.harvard.edu/abs/2017DPS....4911008B - C. Benson, D.J. Scheeres, N. Moskovitz, 2017, *AAS DPS meeting* #49, id.#117.05, "Asteroid **(367943) 2012 DA14** flyby spin state analysis." See: http://adsabs.harvard.edu/abs/2017DPS....4911705B - R.P. Binzel, F.E. DeMeo, C. Lantz, et al., 2017, *AAS DPS meeting* #49, id.#110.09, "Do Near-Earth Asteroids and meteorite falls share the same source regions?" See: http://adsabs.harvard.edu/abs/2017DPS....4911009B - J. Blacksberg, S.R. Chesley, B. Ehlmann, C.A. Raymond, 2017, *AAS DPS meeting* #49, id.#219.22, "***Intrepid***: exploring the NEA population with a fleet of highly autonomous ***SmallSat*** explorers."

	See: http://adsabs.harvard.edu/abs/2017DPS....4921922B - W. Bottke, S. Mazrouei, R. Ghent, A. Parker, 2017, *AAS DPS meeting* #49, id.#100.03, "What really happened to Earth's older craters?" See: http://adsabs.harvard.edu/abs/2017DPS....4910003B - M. Brozovic, L.A.M. Benner, S.P. Naidu, Shantanu P., et al., 2017, *AAS DPS meeting* #49, id.#204.01, "**Goldstone** radar images of near-Earth asteroids **(469896) 2007 WV4**, **2014 JO25**, **2017 BQ6**, and **2017 CS**." See: http://adsabs.harvard.edu/abs/2017DPS....4920401B - M. Brucker, R.S. McMillan, T. Bressi, et al., 2017, *AAS DPS meeting* #49, id.#112.08, "Update on **Spacewatch** observations of Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2017DPS....4911208B - S.R. Chesley, G.M. Hockney, M.J. Holman, 2017, *AAS DPS meeting* #49, id.112.14, " Introducing **ADES**: a new IAU astrometry data exchange standard." See: http://adsabs.harvard.edu/abs/2017DPS....4911214C - B.E. Clark, V.E. Hamilton, J.P. Emery, et al., 2017, *AAS DPS meeting* #49, id.#110.01, "Spectral apping at asteroid **101955 Bennu**." See: http://adsabs.harvard.edu/abs/2017DPS....4911001C - J. Emery, B. Rozitis, P.R. Christensen, et al., 2017, *AAS DPS meeting* #49, id.#110.02, "Thermophysical analysis of **101955 Bennu** with ***OSIRIS-REx***." See: http://adsabs.harvard.edu/abs/2017DPS....4911002E - N. Erasmus, M. Mommert, D.E. Trilling, et al., 2017, *AAS DPS meeting* #49, id.#204.05, "Rapid-response characterization of Near-Earth Asteroids using **KMTNet-SAAO**." See: http://adsabs.harvard.edu/abs/2017DPS....4920405E - D. Farnocchia, D.J. Tholen, M. Micheli, et al., 2017 *AAS DPS meeting* #49, id.#100.09, "Mass estimate and close approaches of near-Earth asteroid **2015 TC25**." See: http://adsabs.harvard.edu/abs/2017DPS....4910009F - D. Fohring, D.J. Tholen, Z. Claytor, et al., 2017, *AAS DPS meeting* #49, id.#111.02, "The University of Hawaii NEO follow-up program." See: http://adsabs.harvard.edu/abs/2017DPS....4911102F - K. Frantseva, M. Mueller, F.F.S. van der Tak, 2017, *AAS DPS meeting* #49, id.#111.06, "Delivery of water and organics to **Mercury** through asteroid and comet impacts." See: http://adsabs.harvard.edu/abs/2017DPS....4911106F - M. Granvik, A. Morbidelli, R. Jedicke, et al., 2017, *AAS DPS meeting* #49, id.#100.02, "Debiased estimates for NEO orbits, absolute magnitudes, and source regions." See: http://adsabs.harvard.edu/abs/2017DPS....4910002G - S. Greenstreet, D. Farnocchia, T. Lister, 2017, *AAS DPS meeting*

	#49, id.#111.08, "Measuring the Yarkovsky effect with Las Cumbres Observatory." See: http://adsabs.harvard.edu/abs/2017DPS....4911108G - A. Gustafsson, D.E. Trilling, M. Mommert, J.L. Hora, 2017, *AAS DPS meeting* #49, id.#110.07, "Albedo corrections for high albedo Near Earth Objects observed with ***Spitzer***." See: http://adsabs.harvard.edu/abs/2017DPS....4911007G - A.W. Harris, 2017, *AAS DPS meeting* #49, id.#100.01, "The population of Near-Earth Asteroids revisited." See: http://adsabs.harvard.edu/abs/2017DPS....4910001H See also: https://phys.org/news/2017-10-undiscovered-near-earth-asteroids-downward.html - A. Heinze, J.L. Tonry, L. Denneau, B. Stalder, 2017, *AAS DPS meeting* #49, id.#103.04, "**ATLAS**: finding the Nearest Asteroids." See: http://adsabs.harvard.edu/abs/2017DPS....4910304H - T. Inasawa, K. Kitazato, N. Hirata, H. Demura, 2017, *AAS DPS meeting* #49, id.#110.03, "Cluster analysis of near-infrared reflectance spectra of asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2017DPS....4911003I - R. Jedicke, B. Boe, B.T. Bolin, et al., 2017, *AAS DPS meeting* #49, id.#112.01, "Minimoon survey with Subaru Hyper Suprime-Cam." See: http://adsabs.harvard.edu/abs/2017DPS....4911201J - R. Jones, M. Juric, C. Slater, et al., 2017, *AAS DPS meeting* #49, id.#103.05, "The **Large Synoptic Survey Telescope** as a Near-Earth Object discovery machine." See: http://adsabs.harvard.edu/abs/2017DPS....4910305J - M. Juric, R. Jones, J. Moeyens, et al., 2017, *AAS DPS meeting* #49, id.#117.09, "**LSST** data products and tools for Solar System science." See: http://adsabs.harvard.edu/abs/2017DPS....4911709J - K. Kitazato, N. Hirata, H. Demura, et al., 2017, *AAS DPS meeting* #49, id.#204.10, "Thermally induced rock breakdown on asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2017DPS....4920410K - L. Le Corre, V. Reddy, J.A. Sanchez, et al., 2017, *AAS DPS meeting* #49, id.#110.05, "Ground-based characterization of ***Hayabusa2*** mission target asteroid **162173 Ryugu**." See: http://adsabs.harvard.edu/abs/2017DPS....4911005L - S.M. Lederer, E. Jensen, D. Smith, et al., 2017, *AAS DPS meeting* #49, id.#117.01, "Evidence of collisional histories of asteroids, comets and meteorites: comparisons with shocked minerals." See: http://adsabs.harvard.edu/abs/2017DPS....4911701L - C. Lejoly, E.S. Howell, P.A. Taylor, et al., 2017, *AAS DPS meeting* #49, id.#110.12, "**Arecibo** radar observation of Near-Earth Asteroids: expanded sample size, determination of radar albedos,

	and measurements of polarization ratios." See: http://adsabs.harvard.edu/abs/2017DPS....4911012L - G.J. Leonard, E.J. Christensen, C. Fuls, et al., 2017, *AAS DPS meeting* #49, id.#117.07, "Recent advances and achievements at the **Catalina Sky Survey**." See: http://adsabs.harvard.edu/abs/2017DPS....4911707L - T.R. Linder, 2017, *AAS DPS meeting* #49, id.#112.12, "Near-Earth Asteroid follow-up observations from the Astronomical Research Institute." See: http://adsabs.harvard.edu/abs/2017DPS....4911212L - T. Lister, S. Greenstreet, E. Gomez, et al., 2017, *AAS DPS meeting* #49, id.#110.10, "The **LCO Follow-up and Characterization Network** and **AgentNEO Citizen Science** project." See: http://adsabs.harvard.edu/abs/2017DPS....4911010L - A.K. Mainzer, NEOCam Science Team, 2017, *AAS DPS meeting* #49, id.#219.01, "The ***Near-Earth Object Camera***." See: http://adsabs.harvard.edu/abs/2017DPS....4921901M - J.-L. Margot, A.H. Greenberg, A.K. Verma, P.A. Taylor, 2017, *AAS DPS meeting* #49, id.#100.06, "The characterization of non-gravitational perturbations that act on Near-Earth Asteroid orbits." See: http://adsabs.harvard.edu/abs/2017DPS....4910006M - S.E. Marshall, E.S. Howell, R.J. Vervack, et al., 2017, *AAS DPS meeting* #49, id.#110.15, "Thermophysical modeling of Potentially Hazardous Asteroid **(85989) 1999 JD6**." See: http://adsabs.harvard.edu/abs/2017DPS....4911015M - J.R. Masiero, C. Nugent, A.K. Mainzer, et al., 2017, *AAS DPS meeting* #49, id.#117.10, "***NEOWISE*** reactivation mission year three: asteroid diameters and albedos." See: http://adsabs.harvard.edu/abs/2017DPS....4911710M - D. Mathias, L. Wheeler, J.L. Dotson, et al., 2017, *AAS DPS meeting* #49, id.#111.05, "Asteroid impact risk: ground hazard versus impactor size." See: http://adsabs.harvard.edu/abs/2017DPS....4911105M - L. McGraw, J.P. Emery, C.A. Thomas, et al., *AAS DPS meeting* #49, id.#110.13, "Volatile characterization on Near Earth Asteroids." See: http://adsabs.harvard.edu/abs/2017DPS....4911013M - N. Moskovitz, A. Thirouin, M. Mommert, et al., 2017, *AAS DPS meeting* #49, id.#204.04, "The **Mission Accessible Near-Earth Object Survey (MANOS)**: project status." See: http://adsabs.harvard.edu/abs/2017DPS....4920404M - N. Myhrvold, 2017, *AAS DPS meeting* #49, id.#117.06, "An empirical examination of WISE/NEOWISE asteroid analysis and results." See: http://adsabs.harvard.edu/abs/2017DPS....4911706M - S.P. Naidu, S.R. Chesley, D. Farnocchia, 2017, *AAS DPS meeting*

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	- D.E. Trilling, J.L. Hora, M. Mommert, et al., 2017, *AAS DPS meeting* #49, id.#110.06, "***Spitzer*** observations of Near Earth Objects." See: http://adsabs.harvard.edu/abs/2017DPS....4911006T - P. Veres, D. Farnocchia, G. Williams, et al., 2017, *AAS DPS meeting* #49, id.#103.01, "Lost Near-Earth Object candidates." See: http://adsabs.harvard.edu/abs/2017DPS....4910301V - A. Vodniza, M. Pereira, 2017, *AAS DPS meeting* #49, id.#117.02, "The asteroid **2014 JO25**." See: http://adsabs.harvard.edu/abs/2017DPS....4911702V - R.J. Weryk, R.J. Wainscoat, G. Williams, 2017, *AAS DPS meeting* #49, id.103.02, "Isolated tracklet linking." See: http://adsabs.harvard.edu/abs/2017DPS....4910302W - Y. Zhao, 2017, *AAS DPS meeting* #49, id.#110.37, "Rotational dynamics and surface environment of the tumbling NEA **(99942) Apophis**." See: http://adsabs.harvard.edu/abs/2017DPS....4911037Z
2017, Oct 16	Apollo NEA **2017 TH5** ($H = 28.5$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.26 LD. **[2017-41]** See: 2017 TH5 - SSA , 2017 TH5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Oct 17	D. Stolte, 2017, *UA News*, 17 October 2017, "Earth's new buddy is asteroid, not space junk." See: https://uanews.arizona.edu/story/earths-new-buddy-asteroid-not-space-junk
2017, Oct 17	Apollo NEA **2017 UR2** ($H = 27.7$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.83 LD. Minimum miss distance 0.83 LD. **[2017-42]** See: 2017 UR2 - SSA , 2017 UR2 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: **16 Oct 2004**, **21 Oct 2119**.
2017, Oct 19	A.W. Harris, More Data!, 2017, *Phys.Org News*, 19 October 2017, "Number of undiscovered near-Earth asteroids revised downward." See: https://phys.org/news/2017-10-undiscovered-near-earth-asteroids-downward.html
2017, Oct 19	D. Remy, E. Lu, 2017, *B612 blog*, "Asteroids and why we need to map the inner Solar System." See: https://b612foundation.org/asteroids-and-why-we-need-to-map-the-inner-solar-system/?

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2017, Oct 19	Apollo NEA **2017 TD6** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2017-43]** See: 2017 TD6 - SSA , 2017 TD6 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2017, Oct 20, 07:38	Aten NEA **2017 UL52** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 4.01 LD**. Minimum miss distance 0 LD**. See: 2017 UL52 - SSA , 2017 UL52 - JPL
2017, Oct 20, 14:07	Apollo NEA **2017 UJ2** (*H* = 31.0 mag, *D* ≈ 2.2 m) passed Earth at a nominal miss distance of 0.047 LD **(= 2.81 R_{Earth} from the geocenter).** Minimum miss distance 0.046 LD. **[2017-44]** See: 2017 UJ2 - SSA , 2017 UJ2 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **20 Oct 1978**, **30 Oct 2030**. See also: http://neo.ssa.esa.int/newsletters [June 2020]
2017, Oct 21	Apollo NEA **2017 UA52** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.51 LD**.** Minimum miss distance 0.50 LD. **[2017-45]** See: 2017 UA52 - SSA , 2017 UA52 - JPL Discovery station: **…** See: http://iawn.net/
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2017, Oct 30	Apollo NEA **2017 UK8** (H = 28.3 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD. **[2017-47]** See: 2017 UK8- SSA , 2017 UK8 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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2017, Nov 4	Apollo NEA **2017 VE** (H = 26.6 mag, $D \approx$ 17 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88 LD. **[2017-48]** See: 2017 VE - SSA , 2017 VE - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: **5 Nov 2090**.
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2017, Nov 13	Apollo NEA **2017 VF14** (H = 28.5 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.79 LD. **[2017-50]** See: 2017 VF14 - SSA , 2017 VF14 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2017, Nov 21 19:18	Apollo NEA **2017 WW1** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.37 LD. Minimum miss distance 0.37 LD. **[2017-51]** See: 2017 WW1- SSA , 2017 WW1- JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **19 Nov 2028**.
2017, Nov 21 19:53	Apollo NEA **2017 WA14** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2017-52]** See: 2017 WA14 - SSA , 2017 WA14 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **25 Nov 2098**.
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	geocenter). Minimum miss distance 0.077 LD. **[2017-53]** See: 2017 WE30- SSA , 2017 WE30- JPL Discovery station: **…** See: http://iawn.net/
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2017, Dec 11	***American Geophysical Union Fall Meeting***, 11-15 December 2017, New Orleans (LO, USA). See: https://fallmeeting.agu.org/2017/ **Notably:** - Session 24316/NH002 on "*Asteroids: surveys, characterization, impact risk, and mitigation*." **Conveners:** M. Boslough, S.M. Ezzedine, P.W. Chodas, C. Burkhard See: https://agu.confex.com/agu/fm17/preliminaryview.cgi/Session24316 **Abstracts submitted to this session:** - B. Barbee, M. Bambacus, M. Bruck Syal, et al., 2017, abstract #NH13A-0104, "Energetic techniques for Planetary Defense." See: http://adsabs.harvard.edu/abs/2017AGUFMNH13A0104B - R.P. Binzel, A.M. Earle, M. Vanatta, D.W. Miller, 2017, abstract #NH13A-0100, "MIT Project **Apophis**: Surface Evaluation & Tomography (SET) mission study for the April 2029 Earth encounter." See: http://adsabs.harvard.edu/abs/2017AGUFMNH13A0100B - M. Borukha, L. Sokolov, N. Petrov, A. Vasiliev, 2017, abstract #NH13A-0107, "The stability of main characteristics of possible impacts of asteroids with the **Earth**." See: http://adsabs.harvard.edu/abs/2017AGUFMNH13A0107B - S. Boschi, B. Schmitz, F. Terfelt, 2017, abstract #EP11B-1557, "The Popigai impact ejecta layer in the Monte Vaccaro section, Piobbico, Italy." See: http://adsabs.harvard.edu/abs/2017AGUFMEP11B1557B - C. Caplan, G.R. Huss, B. Schmitz, K. Nagashima, 2017, abstract #EP11B-1558, "The record of meteorite infall during the Jurassic as derived from chrome-spinel grains." See: http://adsabs.harvard.edu/abs/2017AGUFMEP11B1558C - A.F. Cheng, 2017, abstract #NH13A-0105, "Catastrophic disruption threshold and maximum deflection from kinetic impact." See: http://adsabs.harvard.edu/abs/2017AGUFMNH13A0105C - D. Daou, L. Johnson, K.E. Fast, et al., 2017, abstract #NH13A-0102, "NASA's **Planetary Defense Coordination Office** at NASA HQ." See: http://adsabs.harvard.edu/abs/2017AGUFMNH13A0102D - D.N. DellaGiustina, S. Selznick, M.C. Nolan, et al., 2017, abstract #P33E-2920, "The planetary spatial data infrastructure for the ***OSIRIS-REx*** mission." See: http://adsabs.harvard.edu/abs/2017AGUFM.P33E2920D - S.M. Ezzedine, D.S. Dearborn, P.L. Miller, 2017, abstract #NH13A-0110, "Seismo-acoustic numerical investigation of land

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2017, Dec 12	G. Laughlin, K. Batygin, 2017, *Research Notes of the American Astronomical Society*, 1, 43, "On the consequences of the detection of an interstellar asteroid." See: http://adsabs.harvard.edu/abs/2017RNAAS...1...43L
2017, Dec 13-15	***Workshop on Planning Solar System Observations with JWST***, 13-15 December, ESTeC, Noordwijk (The Netherlands). See: https://www.cosmos.esa.int/web/jwst-ssws-2017

2017, Dec 14	A. Pellacani, P. Kicman, M. Suatoni, et al., 2017, *CEAS Space Journal*, Online First, "Design and validation of a GNC system for missions to asteroids: the ***AIM*** scenario." See: http://adsabs.harvard.edu/doi/10.1007/s12567-017-0189-x
2017, Dec 15	G. Domokos, A.A. Sipos, G.M. Szabó, P.L. Várkonyi, 2017, *Research Notes of the American Astronomical Society*, 1, 50, "Explaining the elongated shape of **'Oumuamua** by the Eikonal abrasion model." See: http://adsabs.harvard.edu/abs/2017RNAAS...1...50D
2017, Dec 16	Apollo NEA **3200 Phaethon** (**1983 TB**, $H = 14.4$ mag, $D \approx 5.1 \pm 0.2$ km, **PHA**, causing the annual **Geminids meteor shower**) passed Earth at a nominal miss distance of 26.83 LD (= 0.07 au), its closest approach to Earth since 1974. Minimum miss distance 26.83 LD. See: 3200 Phaethon - SSA , 1983 TB - JPL Ref: - T. Kasuga, J.-I. Watanabe, M. Sato, 2006, *Monthly Notices of the Royal Astronomical Society*, 373, 1107, "Benefits of an impact mission to **3200 Phaethon**: nature of the extinct comet and artificial meteor shower." See: http://adsabs.harvard.edu/abs/2006MNRAS.373.1107K See also: https://www.jpl.nasa.gov/news/news.php?feature=7030 https://phys.org/news/2017-12-arecibo-radar-asteroid-phaethon-images.html http://en.wikipedia.org/wiki/3200_Phaethon See also: https://www.space.com/42236-weird-blue-asteroid-phaethon.html See also: **16 Dec 1974, 14 Dec 2093**.
2017, Dec 18	M.T. Bannister, M.E. Schwamb, W.C. Fraser, et al., 2017, *Astrophysical Journal Letters*, 851, L38, "Col-OSSOS: colors of the interstellar planetesimal **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2017ApJ...851L..38B
2017, Dec 18	A. Fitzsimmons, C. Snodgrass, B. Rozitis, et al., 2017, *Nature Astronomy*, 2, 133, "Spectroscopy and thermal modelling of the first interstellar object **1I/2017 U1 'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018NatAs...2..133F See also: http://www.qub.ac.uk/News/Allnews/OumuamuahadaviolentpastandhasbeentumblingaroundforbillionsofyearsQueensUniversity.html https://phys.org/news/2018-02-oumuamua-violent-billions-years.html

2017, Dec 18, 00:27	Apollo NEA **2017 YH1** (*H* = 21.4 mag, *D* ≈ 190 m, **PHA**) passed Earth at a nominal miss distance of 2.39 LD. Minimum miss distance 2.38 LD. See: 2017 YH1 - SSA , 2017 YH1 - JPL
2017, Dec 18, 03:55	Apollo NEA **2017 YJ1** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 1.04 LD. Minimum miss distance 1.04 LD. See: 2017 YJ1 - SSA , 2017 YJ1 - JPL
2017, Dec 21	K.J. Meech, R. Weryk, M. Micheli, et al., 2017, *Nature*, 552, 378, "A brief visit from a red and extremely elongated interstellar asteroid." See: http://adsabs.harvard.edu/abs/2017Natur.552..378M
2017, Dec 22	D.C. Agle, D. Brown, S. Farukhi, 2017, *JPL News*, 22 December 2017, "**Arecibo Radar** returns with asteroid **Phaethon** images." See: https://www.jpl.nasa.gov/news/news.php?feature=7030 See also: https://www.space.com/39225-asteroid-phaethon-earth-flyby-arecibo-images.html
2017, Dec 22	B.T. Bolin, H.A. Weaver, Y.R. Fernandez, et al., 2017, *Astrophysical Journal Letters*, 852, L2, "APO time-resolved color photometry of highly-elongated interstellar object **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018ApJ...852L...2B See also: https://b612foundation.org/oumuamua-mia-studying-1ioumuamua-the-first-interstellar-object-iso/? https://b612foundation.org/press-release-b612-asteroid-institute-provides-valuable-analysis-to-discovery-of-oumuamua/
2017, Dec 22	A. Payez, 2017, *Technical Report*, *European Space Agency - Mission Analysis Section*, ESOC, 2017, e-print *arXiv*:1712.08436, "A simple and effective parametrisation for Earth-impacting orbits." See: http://adsabs.harvard.edu/abs/2017arXiv171208436P
2017, Dec 24	Apollo NEA **2017 YK14** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.90 LD. Minimum miss distance 0.19 LD. See: 2017 YK14 - SSA , 2017 YK14 - JPL
2017, Dec 27	A. Grezio, A. Babeyko, M.A. Baptista, et al., 2017, *Reviews of Geophysics*, 55, 1158, "Probabilistic tsunami hazard analysis: multiple sources and global applications."

	See: http://adsabs.harvard.edu/abs/2017RvGeo..55.1158G
2017, Dec 28	D. Nesvorný, F. Roig, 2017, *Astronomical Journal*, 155, 42, "Dynamical origin and terrestrial impact flux of large Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2018AJ....155...42N
2017, Dec 28	Apollo NEA **2017 YZ4** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.58 LD. **[2017-54]** See: 2017 YZ4 - SSA , 2017 YZ4 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2017, Dec 29	B. Hansen, B. Zuckerman, 2017, *Research Notes of the American Astronomical Society*, 1, 55, "Ejection of material ---"**Jurads**"--- from post-main-sequence planetary systems." See: http://adsabs.harvard.edu/abs/2017RNAAS...1...55H
2017, Dec 30	Apollo NEA **2017 YE7** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.80 LD. **[2017-55]** See: 2017 YE7 - SSA , 2017 YE7 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Jan 1	**17439 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, *H* = 9.45 mag, *D* = 36.5 km, Amor NEA), of which **1868 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, *H* = 15.3 mag, *D* = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: https://cneos.jpl.nasa.gov/stats/totals.html
2018, Jan	E.Y. Aristova, A.A. Aushev, V.K. Baranov, et al., 2018, *Journal of Experimental and Theoretical Physics*, 126, 132, "Laser simulations of the destructive impact of nuclear explosions on hazardous asteroids." See: http://adsabs.harvard.edu/abs/2018JETP..126..132A
2018, Jan	B. Carry, *Astronomy & Astrophysics*, 609, 113, "Solar system science with ESA ***Euclid***." See: http://adsabs.harvard.edu/abs/2018A%26A...609A.113C
2018, Jan	J. Ďurech, D. Vokrouhlicky, P. Pravec, et al., 2018, *Astronomy & Astrophysics*, 609, 86, "YORP and Yarkovsky effects in asteroids **(1685) Toro**, **(2100) Ra-Shalom**, **(3103) Eger**, and **(161989)**

	Cacus." See: http://adsabs.harvard.edu/abs/2018A%26A...609A..86D
2018, Jan	V.V. Emel'yanenko, N.Y. Emel'yanenko, 2018, *Solar System Research*, 52, 61, "Long-lived Near-Earth Asteroid **2013 RB6**." See: http://adsabs.harvard.edu/abs/2018SoSyR..52...61E
2018, Jan	N. Lee, S. Close, 2018, *Journal of Spacecraft and Rockets*, 55, 202, "Meteoroid impact detection for exploration of asteroids: small satellites for asteroid characterization." See: http://adsabs.harvard.edu/abs/2018JSpRo..55..202L
2018, Jan	Q. Liu, P. Wei, Z.-H. Shang, 2018, *Research in Astronomy and Astrophysics*, 18, 005, "Research on scheduling of robotic transient survey for Antarctic Survey Telescopes (AST3)." See: http://adsabs.harvard.edu/abs/2018RAA....18....5L
2018, Jan	A.V. Ostrik, A.M. Kazantsev, 2018, *Journal of Physics: Conference Series*, 946, 012078, "Calculation methods for estimating the prospects of a space experiment by means of impact by asteroid **Apophis** on the **Moon** surface." See: http://adsabs.harvard.edu/abs/2018JPhCS.946a2078O
2018, Jan	D. Paikowsky, R. Tzezana, 2018, *Acta Astronautica*, 142, 10, "The politics of space mining – an account of a simulation game." See: http://adsabs.harvard.edu/abs/2018AcAau.142...10P
2018, Jan	W.G. Santos, A.F.B.A. Prado, G.M.C. Oliveira, L.B.T. Santos, 2018, *Astrophysics and Space Science*, 363, 14, "Analysis of impulsive maneuvers to keep orbits around the asteroid **2001 SN263**." See: http://adsabs.harvard.edu/abs/2018Ap%26SS.363...14S See also: https://sciencetrends.com/keep-orbits-around-triple-asteroid-system-2001sn263/
2018, Jan	V.E. Savanevych, S.V. Khlamov, I.B. Vavilova, et al., 2018, *Astronomy & Astrophysics*, 609, 54, "A method of immediate detection of objects with a near-zero apparent motion in series of CCD-frames." See: http://adsabs.harvard.edu/abs/2018A%26A...609A..54S
2018, Jan	O. Vaduvescu, L. Hudin, T. Mocnik, et al., 2018, *Astronomy & Astrophysics*, 609, 105, "280 one-opposition near-Earth asteroids recovered by the **EURONEAR** with the Isaac Newton Telescope." See: http://adsabs.harvard.edu/abs/2018A%26A...609A.105V

2018, Jan 1	Y.-T. Chen, H.-W. Lin, M. Alexandersen, 2018, *Publications of the Astronomical Society of Japan*, 70, 38, "Searching for moving objects in HSC-SSP: pipeline and preliminary results." See: http://adsabs.harvard.edu/abs/2018PASJ...70S..38C
2018, Jan 1	S.C. Koga, S. Sugita, S. Kamata, et al., 2018, *Icarus*, 299, 386, "Spectral decomposition of asteroid **Itokawa** based on principal component analysis." See: http://adsabs.harvard.edu/abs/2018Icar..299..386K
2018, Jan 1	J.L. Smallwood, R.G. Martin, S. Lepp, M. Livio, 2018, *Monthly Notices of the Royal Astronomical Society*, 473, 295, "Asteroid impacts on terrestrial planets: the effects of super-Earths and the role of the ν6 resonance." See: http://adsabs.harvard.edu/abs/2018MNRAS.473..295S
2018, Jan 2	A. Glikson, 2018, *Tectonophysics*, 722, 175, "Structure and origin of Australian ring and dome features with reference to the search for asteroid impact events." See: http://adsabs.harvard.edu/abs/2018Tectp.722..175G
2018, Jan 2	Apollo NEA **2018 AH** (***H*** **= 22.3 mag,** ***D*** **≈ 120 m**) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2018-01]** See: 2018 AH - SSA , 2018 AH - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: https://en.wikipedia.org/wiki/2018_AH
2018, Jan 3	Q. Zhang, 2018, *Astrophysical Journal Letters*, 852, L13, "Prospects for backtracing **1I/'Oumuamua** and future interstellar objects." See: http://adsabs.harvard.edu/abs/2018ApJ...852L..13Z
2018, Jan 4	M. Ćuk, 2018, *Astrophysical Journal Letters*, 852, L15, "**1I/'Oumuamua** as a tidal disruption fragment from a binary star system." See: http://adsabs.harvard.edu/abs/2018ApJ...852L..15C
2018, Jan 8	*ESA SSA-NEO Coordination Centre Newsletter*, 8 January 2018. See: http://neo.ssa.esa.int/newsletters
2018, Jan 8-12	***American Astronomical Society 231st Meeting***, 8-12 January 2018, Washington (DC, USA). See: https://aas.org/meetings/aas231

	Among the papers: - L.R. Chevres Fernandez, B. Bos, 2018, *AAS Meeting* #231, id.#151.07, "***OSIRIS-REx*** asteroid sample return mission image analysis." See: http://adsabs.harvard.edu/abs/2018AAS...23115107C - A. Gagliano, M. Taylor, W. Black, William, et al., 2018, *AAS Meeting* #231, id.#153.02, "Cosmological origins of water." See: http://adsabs.harvard.edu/abs/2018AAS...23115302G - M. Graham, Zwicky Transient Facility (ZTF) Project Team, 2018, *AAS Meeting* #231, id.#354.16, " The Zwicky Transient Facility: overview and commissioning activities." See: http://adsabs.harvard.edu/abs/2018AAS...23135416G - A.N. Heinze, J. Tonry, L. Denneau, B. Stalder, 2018, *AAS Meeting* #231, id.#109.04, "All-sky census of variable stars from the **ATLAS** survey." See: http://adsabs.harvard.edu/abs/2018AAS...23110904H - C.M. Lisse, ***SPHEREx*** Science Team, 2018, *AAS Meeting* #231, id.#354.25, "***SPHEREx***: science opportunities for Solar System astronomy." See: http://adsabs.harvard.edu/abs/2018AAS...23135425L - K.J. Meech, J.T. Kleyna, J.V. Keane, et al., 2018, *AAS Meeting* #231, id.#102.08, " Transformative small body science enabled with **Pan-STARSS** survey data." See: http://adsabs.harvard.edu/abs/2018AAS...23110208M - S.N. Milam, B.J. Holler, J.M. Bauer, et al., 2018, *AAS Meeting #231*, id.#144.15, "***WFIRST***: science in the Solar System." See: http://adsabs.harvard.edu/abs/2018AAS...23114415M - M. Shao, 2018, *AAS Meeting* #231, id.#332.07, "An ultra low cost synthetic tracking telescope for detecting NEOs." See: http://adsabs.harvard.edu/abs/2018AAS...23133207S - C.-X. Zhai, M. Shao, N. Saini, et al., 2018, *AAS Meeting* #231, id.#314.01, "High accuracy ground-based Near-Earth Asteroid astrometry using synthetic tracking." See: http://adsabs.harvard.edu/abs/2018AAS...23131401Z - X.-D. Zou, J.-Y. Li, B.E. Clark, D. Golish, 2018, *AAS Meeting* #231, id.#452.05, "Photometric uncertainties." See: http://adsabs.harvard.edu/abs/2018AAS...23145205Z
2018, Jan 9	F. Feng, H.R.A. Jones, 2018, *Astrophysical Journal Letters*, 852, L27, "**'Oumuamua** as a messenger from the Local Association." See: http://adsabs.harvard.edu/abs/2018ApJ...852L..27F
2018, Jan 10	Q.H.S. Chan, M.E. Zolensky, Y.Kebukawa, et al., 2018, *Science Advances*, 4, eaao3521, "Organic matter in extraterrestrial water-bearing salt crystals." See: http://advances.sciencemag.org/content/4/1/eaao3521 See also:

	https://newscenter.lbl.gov/2018/01/10/organic-meteorites/
2018, Jan 12	D. Oberhaus, 2018, *Motherboard.vice.com*, 12 January 2018, "This asteroid hunter is tasked with saving Earth from killer impacts." See: https://motherboard.vice.com/en_us/article/qvwxnq/this-asteroid-hunter-is-tasked-with-saving-earth-from-killer-impacts
2018, Jan 12	M. Wall, 2018, *Space.com*, 12 January 2018, "**Planetary Resources**' asteroid-mining goals move closer with satellite launch." See: https://www.space.com/39363-planetary-resources-asteroid-mining-satellite-launches.html?
2018, Jan 15	M. Brozović, L.A.M. Benner, J.G. McMichael, et al., 2018, *Icarus*, 300, 115, "**Goldstone** and **Arecibo** radar observations of **(99942) Apophis** in 2012-2013." See: http://adsabs.harvard.edu/abs/2018Icar..300..115B
2018, Jan 15	J.E. Enriquez, A. Siemion, T.J.W. Lazio, et al., 2018, *Research Notes of the American Astronomical Society*, 2,9 , "**Breakthrough Listen** observations of **1I/'Oumuamua** with the GBT." See: http://adsabs.harvard.edu/abs/2018RNAAS...2....9E
2018, Jan 15	K.R. Housen, W.J. Sweet, K.A. Holsapple, 2018, *Icarus*, 300,72, "Impacts into porous asteroids." See: http://adsabs.harvard.edu/abs/2018Icar..300...72H
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2018, Jan 15	K.J. Lawrence, L.A.M. Benner, M. Brozovic, et al., 2018, *Icarus*, 300, 12, "**Arecibo** and **Goldstone** radar images of near-Earth asteroid **(469896) 2005 WC1**." See: http://adsabs.harvard.edu/abs/2018Icar..300...12L
2018, Jan 15	M. Livio, 2018, chapter for the book *Consolidation of Fine Tuning*, e-print *arXiv:*1801.05061, "How special is the Solar System?" See: http://adsabs.harvard.edu/abs/2018arXiv180105061L
2018, Jan 15	C. Palotai, R. Sankar, D.L. Free, et al., 2018, submitted to *Monthly Notices of the Royal Astronomical Society*, e-print *arXiv*:1801.05072, "Analysis of June 2, 2016 bolide event." See: http://adsabs.harvard.edu/abs/2018arXiv180105072P

2018, Jan 15	H. Suzuki, M. Yamada, T. Kouyama, et al., 2018, *Icarus*, 300, 341, "Initial inflight calibration for ***Hayabusa2* Optical Navigation Camera** (**ONC**) for science observations of asteroid **Ryugu**." See: http://adsabs.harvard.edu/abs/2018Icar..300..341S
2018, Jan 15	E. Tatsumi, S. Sugita, 2018, *Icarus*, 300, 227, "Cratering efficiency on coarse-grain targets: implications for the dynamical evolution of asteroid **25143 Itokawa**." See: http://adsabs.harvard.edu/abs/2018Icar..300..227T
2018, Jan 15, 11:52	Apollo NEA **2018 AV2** (H = 28.9 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 6.66 LD. Minimum miss distance 6.66 LD. See: 2018 AV2 - SSA , 2018 AV2 - JPL See also: http://neo.ssa.esa.int/NewsLettersArchive-portlet/DownloadFileServlet?newsLetterName=ESA-SSA-NEO-LE-0035_1_0_SSA-NEO_Newsletter_2018-02-02.pdf
2018, Jan 15, 15:13	Apollo NEA **2018 BW** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2018-02]** See: 2018 BW - SSA , 2018 BW - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Jan 16	***Mini-Workshop to Apply Recent Models for Asteroid Airbursts to the Tunguska Event***, 16 January 2018, NASA Ames Research Center, Moffett Field (CA, USA). See: https://www.lpi.usra.edu/planetary_news/2017/11/27/mini-workshop-to-apply-recent-models-for-asteroid-airbursts-to-the-tunguska-event/ **Proceedings:** published in *Icarus*, March 2019.
2018, Jan 16	Apollo NEA **2018 BR1** (H = 29.5 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2018-03]** See: 2018 BR1 - SSA , 2018 BR1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Jan 17-18	**NASA *18th Small Bodies Assessment Group Meeting***, 17-18 January 2018, NASA Ames Research Center, Moffett Field (CA, USA). See: http://www.lpi.usra.edu/sbag/meetings/ **Findings:** https://www.lpi.usra.edu/sbag/findings/

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	- P. Chodas, 2018, "SBAG goals: Planetary Defense." See: https://www.lpi.usra.edu/sbag/meetings/jan2018/presentations/505-Chodas.pdf
2018, Jan 18 15:43	Apollo NEA **2018 BD** (*H* = 30.2 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.102 LD. Minimum miss distance 0.101 LD. **[2018-04]** See: 2018 BD - SSA , 2018 BD - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ https://www.cnet.com/news/asteroid-2018-bd-earth-potentially-hazardous-2002-aj129/ See also: **20 Jan 2031**.
2018, Jan 19	B. King, 2018, *Sky & Telescope*, 19 January 2018, "Hunters recover meteorites from **Michigan Fireball**." See: http://www.skyandtelescope.com/astronomy-news/observing-news/michigan-fireball/ See also: https://www.amsmeteors.org/members/imo_view/event/2018/168
2018, Jan 19	S. Kohler, 2018, *AAS Nova Highlight*, 19 January 2018, id.3125, "Update on an interstellar asteroid." See: http://adsabs.harvard.edu/abs/2018nova.pres.3125K
2018, Jan 19	M. Mommert, R. Jedicke, D.E. Trilling, 2018, *Astronomical Journal*, 155, 74, "An investigation of the ranges of validity of asteroid thermal models for Near-Earth Asteroid observations." See: http://adsabs.harvard.edu/abs/2018AJ....155...74M
2018, Jan 19 03:00	Apollo NEA **2018 BF3** (*H* = 26.1mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.63 LD. **[2018-05]** See: 2018 BF3 - SSA , 2018 BF3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **18 Jan 2016**.
2018, Jan 19 20:23	Apollo NEA **2018 BC** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2018-06]** See: 2018 BC - SSA , 2018 BC - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Jan 19 23:00	Aten NEA **2018 BX** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73

	LD. **[2018-07]** See: 2018 BX - SSA , 2018 BX - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **19 Jan 2068**.
2018, Jan 20	Apollo NEA **2018 BL11** (H = 28.3 mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.79 LD. Minimum miss distance 0.79 LD. **[2018-08]** See: 2018 BL11 - SSA , 2018 BL11 - JPL Discovery station: **…** See: http://iawn.net/
2018, Jan 21	C. de la Fuente Marcos, R. de la Fuente Marcos, 2018, *Monthly Notices of the Royal Astronomical Society*, 473, 2939, "Dynamical evolution of near-Earth asteroid **1991 VG**." See: http://adsabs.harvard.edu/abs/2018MNRAS.473.2939D
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2018, Jan 24	Apollo NEA **2018 BN6** (H = 26.9 mag, $D \approx 15$ m) passed Earth at a nominal miss distance of 0.94 LD. Minimum miss distance 0.94 LD. **[2018-09]** See: 2018 BN6 - SSA , 2018 BN6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **21 July 1969**, **25 Jan 2045**
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2018, Jan 29-Feb 2	***The Eighth Polyakhov's Reading: Proceedings of the International Scientific Conference on Mechanics***, 29 January - 2 February 2018, Saint Petersburg (Russia). See: **Proceedings:** AIP Conference Proceedings, Vol. 1959. See: https://aip.scitation.org/toc/apc/1959/1?expanded=1959 **Among the papers:** **-** N. Petrov, L. Sokolov, E. Polyakhova , K. Oskina, 2018, id.040012, "Predictions of asteroid hazard to the Earth for the 21st century." See: http://adsabs.harvard.edu/abs/2018AIPC.1959d0012P - L. Sokolov, N. Petrov, G. Kuteeva1, A. Vasilyev, 2018, id.040019, "Scattering of trajectories of hazardous asteroids." See: http://adsabs.harvard.edu/abs/2018AIPC.1959d0019S
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2018, Feb 4, 14:50	Apollo NEA **2018 CS1** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.89 LD. **[2018-10]** See: 2018 CS1 - SSA , 2018 CS1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Feb 4, 21:31	Apollo NEA **276033** (**2002 AJ129**, H = 19.1 mag, $D \approx$ 500 m, **PHA**) passed Earth at a nominal miss distance of 10.95 LD. Minimum miss distance 10.95 LD. **Mercury** crossing asteroid. See: 2002 AJ129 - SSA , 2002 AJ129 - JPL See also: https://www.jpl.nasa.gov/news/news.php?feature=7042 https://en.wikipedia.org/wiki/(276033)_2002_AJ129
2018, Feb 6, 19:16	Apollo NEA **2018 CF2** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2018-11]** See: 2018 CF2 - SSA , 2018 CF2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Feb 6, 20:12	Apollo NEA **2018 CC** (H = 26.7 mag, $D \approx$ 16 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2018-12]** See: 2018 CC - SSA , 2018 CC - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: https://www.jpl.nasa.gov/news/news.php?feature=7055 http://earthsky.org/space/asteroids-feb-2018-cb-and-2018-cc-online-viewing

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2018, Feb 9, 07:26	Apollo NEA **2018 CN2** (H = 27.6 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2018-13]** See: 2018 CN2 - SSA , 2018 CN2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **8 Feb 1935**, **9 Feb 2088**.
2018, Feb 9, 22:29	Apollo NEA **2018 CB** (H = 26.0 mag, $D \approx$ 23 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2018-14]** See: 2018 CB - SSA , 2018 CB - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: https://www.jpl.nasa.gov/news/news.php?feature=7055 http://earthsky.org/space/asteroids-feb-2018-cb-and-2018-cc-online-viewing https://www.livescience.com/61713-asteroid-flyby-late-notice.html
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2018, Feb 15	Apollo NEA **2018 CD3** (H = 28.7 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2018-15]** See: 2018 CD3 - SSA , 2018 CD3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2018, Feb 25	Apollo NEA **2018 DU** (H = 28.3 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.74 LD. **[2018-18]** See: 2018 DU - SSA , 2018 DU - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **24 Feb 2032**.
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2018, Mar 2	Aten NEA **2018 DV1** ($H = 28.4$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.29 LD. **[2018-19]** See: 2018 DV1 - SSA , 2018 DV1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/

2018, Mar 3-10	***2018 IEEE Aerospace Conference***, 3-10 March 2018, Big Sky (Montana, USA). See: http://www.aeroconf.org/ **Notably:** - Session 2.12 on "Asteroid detection, characterization, sample-return, and deflection", chaired by M. Boslough, P. Chodas and J. Webster. See: http://www.aeroconf.org/conference-organizers
2018, Mar 5	*ESA SSA-NEO Coordination Centre Newsletter*, 5 March 2018. See: http://neo.ssa.esa.int/newsletters
2018, Mar 5-9	***ESO Workshop Diversis Mundi: the Solar System in an Exoplanetary Context***, 5-9 March 2018, ESO, Santiago (Chile). See: http://www.eso.org/sci/meetings/2018/ops2018.html **Among the Invited Papers:** - K. Meech, 2018, "Water in small bodies of the Solar System."
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2018, Mar 7	Apollo NEA **2017 VR12** (H = 20.6 mag, $D \approx$ 260 m, **PHA**) passed Earth at a nominal miss distance of 3.76 LD. Minimum miss distance 3.76 LD. See: 2017 VR12 - SSA , 2017 VR12 - JPL See also: https://echo.jpl.nasa.gov/asteroids/2017VR12/2017VR12_planning.2018.html https://en.wikipedia.org/wiki/2017_VR12 See also: **10 Mar 2079**. Ref: -Z.-J. Zhang, Y.-G. Zhang, X.-M. Chen, et al., 2019, *Research in Astronomy and Astrophysics,* 19, 071, "CCD astrometric observations of **2017 VR12**, **Camillo** and **Midas**." See: http://adsabs.harvard.edu/abs/2019RAA....19...71Z
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2018, Mar 14	Apollo NEA **2018 EZ2** (H = 26.6 mag, $D \approx 17$ m) passed Earth at a nominal miss distance of 0.56 LD. Minimum miss distance 0.56 LD. **[2018-20]** See: 2018 EZ2 - SSA , 2018 EZ2 - JPL Discovery station: **Siding Spring-Janess-G, JAXA** See: http://iawn.net/
2018, Mar 15	E.S. Howell, C. Magri, R.J. Vervack, et al., 2017, *Icarus*, 303, 220, "SHERMAN - a shape-based thermophysical model. II. Application to **8567 (1996 HW1)**." See: http://adsabs.harvard.edu/abs/2018Icar..303..220H
2018, Mar 15	R.L. Jones, C.T. Slater, J. Moeyens, et al., 2018, *Icarus*, 303, 181, "The **Large Synoptic Survey Telescope** as a Near-Earth Object discovery machine." See: http://adsabs.harvard.edu/abs/2018Icar..303..181J
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	http://adsabs.harvard.edu/abs/2016PhyW...29g..10C
2018, Mar 17	Apollo NEA **2018 FL29** (*H* = 30.1 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.57 LD. **[2018-21]** See: 2018 FL29 - SSA , 2018 FL29 - JPL Discovery station: **...** See: http://iawn.net/
2018, Mar 18	Aten NEA **2018 FE3** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2018-22]** See: 2018 FE3 - SSA , 2018 FE3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **16 March 2067**.
2018, Mar 19	Apollo NEA **2018 FQ3** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.72 LD. **[2018-23]** See: 2018 FQ3 - SSA , 2018 FQ3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Mar 19-23	***49th Lunar and Planetary Science Conference***, 19-23 March 2018, The Woodlands (TX, USA). See: https://www.hou.usra.edu/meetings/lpsc2018/ **Among the presentations:** - Y. Aoki, H. Demura, N. Hirata, N. et al., 2018, *LPI Contribution* No. 2083, id.1857, "GUI retrieval of FOVs in HARMONICS for 2018 rendezvous of ***Hayabusa2***." See: http://adsabs.harvard.edu/abs/2018LPI....49.1857A - T. Arai, M. Kobayashi, K. Ishibashi, et al., 2018, *LPI Contribution* No. 2083, id.2570, "***DESTINY+*** mission: flyby of **Geminids** parent asteroid **(3200) Phaethon** and in-situ analyses of dust accreting on the **Earth**." See: http://adsabs.harvard.edu/abs/2018LPI....49.2570A - T. Arai, S. Tanaka, T. Kouyama, et al., 2018, *LPI Contribution* No. 2083, id.1912, "thermal infrared imager onboard ***Hayabusa2*** observes the thermophysical properties under the surface layer of the asteroid **Ryugu**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1912A - O.S. Barnouin, N.L. Chabot, C.M. Ernst, et al., 2018, *LPI Contribution* No. 2083, id.1042, "The science proximity operations of the ***Double Asteroid Redirection Test*** mission." See: http://adsabs.harvard.edu/abs/2018LPI....49.1042B - W.F. Bottke, S. Mazrouei, R.R. Ghent, et al., 2018, *LPI*

	Contribution No. 2083, id.1457, "What really happened to Earth's older craters?" See: http://adsabs.harvard.edu/abs/2018LPI....49.1457B - T.H. Burbine, P.C. Buchanan, R.L. Klima, R.P. Binzel, 2018, *LPI Contribution* No. 2083, id.2712, "Can formulas derived from pyroxene and/or HED reflectance spectra be used to determine the mineralogies of V-Type NEAs?" See: http://adsabs.harvard.edu/abs/2018LPI....49.2712B - S. Cambioni, R. Malhotra, C.W. Hergenrother, et al., 2018, *LPI Contribution* No. 2083, id.1149, "An upper limit on **Earth**'s **Trojan Asteroid** population from ***OSIRIS-REx***." See: http://adsabs.harvard.edu/abs/2018LPI....49.1149C - E.A. Cloutis, D. Trang, P.G. Lucey, 2018, *LPI Contribution* No. 2083, id.1591, "The effect of opaque materials on spectral reflectance of the **Cherokee Springs LL Chondrite**: implications for asteroid **Itokawa**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1591C - J.D. Dotson, L.F. Wheeler, D.L. Mathias, D. Farnocchia, 2018, *LPI Contribution* No. 2083, id.2944, "Risk assessment for **2012 TC4** based hypothetical impact scenarios." See: http://adsabs.harvard.edu/abs/2018LPI....49.2944D - E.A. Frank, D.T. Gerhardt, S.M. Anunsen, et al., 2018, *LPI Contribution* No. 2083, id.2892, "**Planetary Resources**' commercial approach to asteroid mineral exploration." See: http://adsabs.harvard.edu/abs/2018LPI....49.2892F - W. Fujiya, P. Hoppe, K. Fukuda, et al., 2018, *LPI Contribution* No. 2083, id.1377, "Carbon isotopic ratios of carbonate in **CM Chondrites** and the **Tagish Lake Meteorite**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1377F - C.A. Goodrich, A.M. Fioretti, M. Zolensky, et al., 2018, *LPI Contribution* No. 2083, id.1321, "The **Almahata Sitta** polymict ureilite from the University of Khartoum collection: classification, distribution of clast types in the strewn field, new meteorite types, and implications for the structure of asteroid **2008 TC3**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1321G - N. Habib, D.R. Golish, C.A. Bennett, et al., 2018, *LPI Contribution* No. 2083, id. 1270, "Examining the impact of image geometries in generation of controlled global mosaics of asteroid **(101955) Bennu**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1270H - N. Hirata, N. Hirata, T. Sugiyama, et al., 2018, *LPI Contribution* No. 2083, id.2892, "Asteroid shape reconstruction efforts in ***Hayabusa2*** mission: a dry-run test for landing site selection with simulated data." See: http://adsabs.harvard.edu/abs/2018LPI....49.1855H - T.M. Ho, S. Ulamec, V. Bartukin, et al., 2018, *LPI Contribution* No. 2083, id.1551, "**MASCOT** on ***Hayabusa2***: The plan to

	perform in-situ science operation of a nano-size landing package on NEA **Ryugu**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1551H - K. Ishibashi, S. Kameda, M. Kagitani, et al., 2018, *LPI Contribution* No. 2083, id.2126, "**Telescopic CAmera for Phaethon (TCAP)** and **Multiband CAmera for Phaethon (MCAP)** to be installed on the ***DESTINY+*** spacecraft." See: http://adsabs.harvard.edu/abs/2018LPI....49.2126I - A.P. Jackson, D. Tamayo, N. Hammond, N., et al., 2018, *LPI Contribution* No. 2083, id.1583, "Ejection of rocky and icy material from binary star systems: implications for the origin and composition of **1I/`Oumuamua**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1583J - Z.L. Jin, M. Bose, Z. Peeters, 2018, *LPI Contribution* No. 2083, id.1670, "New clues to ancient water on **Itokawa**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1670J - J.-Y. Li, L. Le Corre, V. Reddy, 2018, *LPI Contribution* No. 2083, id.1957, " Hapke modeling of asteroid **(25143) Itokawa** using ***Hayabusa***/**AMICA** data." See: http://adsabs.harvard.edu/abs/2018LPI....49.1957L - C.M. Lisse, B.T. Bolin, H.A. Weaver, et al., 2018, *LPI Contribution* No. 2083, id.2610, "APO photometric imaging of the first detected interstellar object in the Solar System: **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018LPI....49.2610L - A. López-Oquendo, A. Virkki, 2018, *LPI Contribution* No. 2083, id.2867, "Cobble distribution on surface of Near-Earth Asteroids using radar observations." See: http://adsabs.harvard.edu/abs/2018LPI....49.2867L - P. Michel, M. Kueppers, A. Cheng, I. Carnelli, 2018, *LPI Contribution* No. 2083, id.1144, "The ***Hera*** mission: European component of the ***Asteroid Impact and Deflection Assessment (AIDA)*** mission to a binary asteroid." See: http://adsabs.harvard.edu/abs/2018LPI....49.1144M - K. Molag, B. de Winter, Z. Toorenburgh, et al., 2018, *LPI Contribution* No. 1950, "***WATER-I*** mission concept: ***Water-Rich Asteroid Technological Extraction Research***." See: http://adsabs.harvard.edu/abs/2018LPI....49.1950M - Y. Nakauchi, D. Takir, C.A. Hibbitts, et al., 2018, *LPI Contribution* No. 2083, id.1850, "Reflectance spectra of carbonaceous chondrites measured under asteroid-like conditions: implications for ***Hayabusa2***'s **NIRS3** instrument." See: http://adsabs.harvard.edu/abs/2018LPI....49.1850N - G.A. Neumann, M.K. Barker, E. Mazarico, et al., 2018, *LPI Contribution* No. 2083, id.1676, "***OSIRIS-REx*** **Laser Altimeter** 1064-nm reflectance investigation at **Bennu**." See: http://adsabs.harvard.edu/abs/2018LPI....49.1676N

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2018, Mar 20	S.N. Raymond, P.J. Armitage, D.Veras, 2018, *Astrophysical Journal Letters,* 856, L7, "Interstellar object **'Oumuamua** as an extinct fragment of an ejected cometary planetesimal." See: http://adsabs.harvard.edu/abs/2018ApJ...856L...7R
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2018, Mar 22	Q.-Z. Ye, P.A. Wiegert, M.-T. Hui, 2018, *Astronomical Journal*, 155, 163, "Finding long lost **Lexell's Comet**: the fate of the first discovered Near-Earth Object." See: http://adsabs.harvard.edu/abs/2018AJ....155..163Y
2018, Mar 23	J. Brainard, *Science News*, 23 March 2018, "Planetary science wins big in NASA's new spending plan." See: http://www.sciencemag.org/news/2018/03/planetary-science-wins-big-nasa-s-new-spending-plan See also: http://www.sciencemag.org/news/2017/10/nasa-weighs-trimming-wfirst-hold-down-costs http://www.planetary.org/blogs/casey-dreier/2018/20180322-fy18-omnibus.html
2018, Mar 23	Apollo NEA **2018 FZ3** ($H = 27.8$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2018-24]** See: 2018 FZ3 - SSA , 2018 FZ3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Mar 26	M.J.S. Belton, O.R. Hainaut, K.J. Meech, et al., 2018, *Astrophysical Journal Letters*, 856, L21, "The excited spin state of **1I/2017 U1 'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018ApJ...856L..21B
2018, Mar 27	Apollo NEA **2018 DH1** ($H = 21.3$ mag, $D \approx 200$ m, **PHA**) passed Earth at a nominal miss distance of 9.17 LD. Minimum miss

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2018, Mar 30	Apollo NEA **2018 FK5** (H = 28.3 mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2018-25]** See: 2018 FK5 - SSA , 2018 FK5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **4 Oct 2027**.
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2018, Apr 5	*ESA SSA-NEO Coordination Centre Newsletter*, 5 April 2018. See: http://neo.ssa.esa.int/newsletters
2018, Apr 6	A. McNeill, D.E. Trilling, M. Mommert, 2018, *Astrophysical Journal Letters*, 857, L1, "Constraints on the density and internal strength of **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018ApJ...857L...1M
2018, Apr 7	Apollo NEA **2018 GR11** (H = 28.5 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.67 LD. **[2018-26]** See: 2018 GR11 - SSA , 2018 GR11 - JPL Discovery station: **…** See: http://iawn.net/
2018, Apr 8-13	***20th European Geosciences Union General Assembly, EGU2018***, 8-13 April 2018, Vienna (Austria).

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2018, Apr 9	***AIDA/DART Spring 2018 Investigation Team Meeting***, 9 April 2018, Johns Hopkins Applied Physics Laboratory, Laurel (MD, USA). See: https://www.lpi.usra.edu/planetary_news/2018/03/19/aidadart-spring-2018-investigation-team-meeting-2/ http://dart.jhuapl.edu/investigationteam_april2018/
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2018, Apr 10	R.S. Park, D.J. Pisano, T.J.W. Lazio, et al., 2018, *Astronomical Journal*, 155, 185, "Search for OH 18 cm radio emission from **1I/2017 U1** with the **Green Bank Telescope**." See: http://adsabs.harvard.edu/abs/2018AJ....155..185P
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2018, Apr 10	Apollo NEA **2018 GY3** ($H = 27.9$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.78 LD. Minimum miss distance 0.78 LD. **[2018-27]** See: 2018 GY3 - SSA , 2018 GY3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2018, Apr 12	Anon., 2018, *ESA Science, Mars Express*, 12 April 2018, "**Mars**

	impact crater or supervolcano?" See: http://www.esa.int/Our_Activities/Space_Science/Mars_Express/Mars_impact_crater_or_supervolcano
2018, Apr 12	Apollo NEA **2018 GD2** (*H* = 29.5 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.78 LD. Minimum miss distance 0.78 LD. **[2018-28]** See: 2018 GD2 - SSA , 2018 GD2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **13 Apr 2005**, **15 Oct 2065**.
2018, Apr 15	M. Tan, C. McInnes, M. Ceriotti, 2018, *Advances in Space Research*, 61, 2099, "Low-energy near Earth asteroid capture using **Earth** flybys and aerobraking." See: http://adsabs.harvard.edu/abs/2018AdSpR..61.2099T
2018, Apr 15	Apollo NEA **2018 GE3** (*H* = 23.9 mag, *D* ≈ 60 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2018-29]** See: 2018 GE3 - SSA , 2018 GE3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: https://www.space.com/40315-asteroid-2018-ge3-surprise-flyby.html http://neo.ssa.esa.int/news-archive https://www.livescience.com/62313-asteroid-flyby-not-detected-sooner.html https://en.wikipedia.org/wiki/2018_GE3
2018, Apr 15-19	***2018 Annual Meeting of the AAS Division on Dynamical Astronomy***, 15-19 April 2018, San Jose (CA, USA). See: https://dda.aas.org/meetings/2018 **Among the presentations:** - M. Campbell-Brown, 2018, *AAS DDA meeting* #49, id.#102.03, "Meteoroid orbits from observations." See: http://adsabs.harvard.edu/abs/2018DDA....4910203C - H. Dones, K.J. Zahnle, J.L. Alvarellos, 2018, *AAS DDA meeting* #49, id.#102.02, "Asteroids and meteorites from **Venus**? Only the Earth goddess knows." See: http://adsabs.harvard.edu/abs/2018DDA....4910202D - A. Harris, 2018, *AAS DDA meeting* #49, id.#401.0, "NEA impactors: what direction do they come from?" See: http://adsabs.harvard.edu/abs/2018DDA....4940101H - P. Jenniskens, 2018, *AAS DDA meeting* #49, id.#102.04, "A shower look-up table to trace the dynamics of meteoroid streams

	and their sources." See: http://adsabs.harvard.edu/abs/2018DDA....4910204J - A. Moorhead, 2018, *AAS DDA meeting* #49, id.#102.01, "The formation and early evolution of meteoroid streams." See: http://adsabs.harvard.edu/abs/2018DDA....4910201M - D. Ragozzine, 2018, *AAS DDA meeting* #49, id.#301.05, "On the detectability of interstellar objects like **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018DDA....4930105R - D. Seligman, G. Laughlin, 2018, *AAS DDA meeting* #49, id.#301.02, "The feasibility and benefits of in situ exploration of **'Oumuamua**-like objects." See: http://adsabs.harvard.edu/abs/2018DDA....4930102S - Q.-Z. Ye, 2018, *AAS DDA meeting* #49, id.#301.03, "Telescopic and meteor observation of **'Oumuamua**, the first known interstellar asteroid." See: http://adsabs.harvard.edu/abs/2018DDA....4930103Y
2018, Apr 16	The ***NEOWISE*** 2018 Data Release, April 19, 2018, "***The Near-Earth Object Wide-field Infrared Survey Explorer*** at IPAC." See: http://wise2.ipac.caltech.edu/docs/release/neowise/ See also: https://www.jpl.nasa.gov/news/news.php
2018, Apr 16-17	***Asteroid Science Intersections with In-Space Mine Engineering (ASIME) 2018***, 16-17 April 2018, Esch sur Alzette (Luxembourg). See: https://asime.uni.lu/ **Abstracts:** http://geophy.uni.lu/users/tonie.vandam/asime-2018/Abstract_book.pdf **Presentations:** http://geophy.uni.lu/users/tonie.vandam/asime-2018/presentations/ **Among the papers:** - A.S. Rivkin, F. E. DeMeo, 2018, "How many hydrated NEOs are there?" - B. Carry, 2018, "The composition of asteroids from sky surveys." - T. Nakamura, 2018, "Japanese second sample return mission: ***Hayabusa2***." - M. Küppers, P. Michel, I. Carnelli, 2018, "***Hera*** mission relevance for asteroid resource exploitation." - J.T.Grundmann, W.Bauer, J.Biele, et al., 2018. "Efficient massively parallel prospection for ISRU by multiple Near-Earth Asteroid rendezvous using near-term solar sails and 'now-term' small spacecraft solutions."
2018, Apr 17	F. Nabiei, J. Badro, T. Dennenwaldt, et al., 2018, *Nature Communications*, 9, 1327, "A large planetary body inferred from diamond inclusions in a ureilite meteorite."

	See: http://www.nature.com/articles/s41467-018-03808-6 See also: http://www.sciencemag.org/news/2018/04/diamond-studded-meteorites-came-collision-lost-planet
2018, Apr 18	Meeting of the **SMPAG** Legal Working Group, in the margins of the **UN COPUOS** Legal Subcommittee, 18 April 2018, Vienna (Austria). Report to appear at http://www.smpag.net
2018, Apr 21	Apollo NEA **2018 HW1** (*H* = 25.8 mag, *D* ≈ 25 m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.89 LD. **[2018-30]** See: 2018 HW1 - JPL , 2018 HW1 - SSA Discovery station: **…** See: http://iawn.net/ See also: **19 Apr 1975**, **24 Apr 2041**.
2018, Apr 22	Apollo NEA **2018 HV** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.40 LD. Minimum miss distance 0.40 LD. **[2018-31]** See: 2018 HV - SSA , 2018 HV - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Apr 25	R.T. Daly, P.H. Schultz, 2018, *Science Advances*, 4, eaar2632, "The delivery of water by impacts from planetary accretion to present." See: http://advances.sciencemag.org/content/4/4/eaar2632 See also: http://news.brown.edu/articles/2018/04/impacts https://www.sciencenews.org/article/asteroids-could-have-delivered-water-early-earth
2018, Apr 27	A.Z. Bonanos, C. Avdellidou, A. Liakos, et al., 2018, *Astronomy & Astrophysics*, 612, 76, "**NELIOTA**: first temperature measurement of **Lunar** impact flashes." See: http://adsabs.harvard.edu/abs/2018A%26A...612A..76B
2018, Apr 30	D. Seligman, G. Laughlin, 2018, *Astronomical Journal*, 155, 217, "The feasibility and benefits of in situ exploration of **'Oumuamua**-like objects." See: http://adsabs.harvard.edu/abs/2018AJ....155..217S
2018, May	A. Drouard, P. Vernazza, S. Loehle, et al., 2018, *Astronomy & Astrophysics*, 613, 54, "Probing the use of spectroscopy to determine the meteoritic analogues of meteors."

	See: http://adsabs.harvard.edu/abs/2018A%26A...613A..54D
2018, May	M.M.M. Meier, L. Bindi, P.R. Heck, et al., 2018, *Earth and Planetary Science Letters*, 490, 122, "Cosmic history and a candidate parent asteroid for the quasicrystal-bearing meteorite **Khatyrka**." See: http://adsabs.harvard.edu/abs/2018E%26PSL.490..122M
2018, May	V.V. Svettsov, V.V. Shuvalov, O.P. Popova, 2018, *Solar System Research*, 52, 195, "Radiation from a **superbolide** [**Chelyabinsk**]." See: http://adsabs.harvard.edu/abs/2018SoSyR..52..195S
2018, May 1	V. Alí-Lagoa1, T.G. Müller, F. Usui, S. Hasegawa, 2018, *Astronomy & Astrophysics*, 612, 85, "The ***AKARI*** **IRC** asteroid flux catalogue: updated diameters and albedos." See: http://adsabs.harvard.edu/abs/2018A%26A...612A..85A
2018, May 1	E.A. Cloutis, V.B. Pietrasz, C. Kiddell, et al., 2018, *Icarus*, 305, 203, "Spectral reflectance "deconstruction" of the **Murchison CM2 carbonaceous chondrite** and implications for spectroscopic investigations of dark asteroids." See: http://adsabs.harvard.edu/abs/2018Icar..305..203C
2018, May 1	C. de la Fuente Marcos, R. de la Fuente Marcos, S.J. Aarseth, 2018, *Monthly Notices of the Royal Astronomical Society*: *Letters*, 476, L1, "Where the Solar System meets the solar neighbourhood: patterns in the distribution of radiants of observed hyperbolic minor bodies." See: http://adsabs.harvard.edu/abs/2018MNRAS.476L...1D See also: https://www.scientificamerican.com/article/will-astronomers-be-ready-for-the-next-lsquo-oumuamua/
2018, May 1	M. Drahus, P. Guzik, W. Waniak, et al., 2018, *Nature Astronomy*, 2, 407, "Tumbling motion of **1I/'Oumuamua** and its implications for the body's distant past." See: http://adsabs.harvard.edu/abs/2018NatAs...2..407D See also: http://www.skyandtelescope.com/astronomy-news/solar-system/oumuamua-red-tumbling-and-silent/
2018, May 1	A. Morbidelli, D. Nesvorny, V. Laurenz, et al., 2018, *Icarus*, 305, 262, "The timeline of the **lunar** bombardment: revisited." See: http://adsabs.harvard.edu/abs/2018Icar..305..262M
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	Advances, 4, eaar4378, "Discovery of moganite in a lunar meteorite as a trace of H_2O ice in the **Moon**'s regolith." See: http://advances.sciencemag.org/content/4/5/eaar4378 See also: https://phys.org/news/2018-05-mineral-lunar-meteorite-moon.html
2018, May 2	D.J. Scheeres, P. Sánchez, 2018, *Progress in Earth and Planetary Science*, 5, 25, "Implications of cohesive strength in asteroid interiors and surfaces and its measurement." See: http://adsabs.harvard.edu/abs/2018PEPS....5...25S
2018, May 3	C. Zhai, M. Shao, S. Lai, et al., 2018, *JPL Publication* 18-1, e-print *arXiv*:1805.01102, "Technical Note: Asteroid detection demonstration from SkySat-3 **B612** data using synthetic tracking." See: http://adsabs.harvard.edu/abs/2018arXiv180501102Z
2018, May 4	*ESA SSA-NEO Coordination Centre Newsletter*, 4 May 2018. See: http://neo.ssa.esa.int/newsletters
2018, May 7	M.J. Holman, M.J. Payne, P. Blankley, et al., 2018, e-print *arXiv*:1805.02638, "Finding asteroids down the back of the couch: a novel approach to the minor planet linking problem." See: http://adsabs.harvard.edu/abs/2018arXiv180502638H
2018, May 14	J. Shewaga, 2018, *Phys.Org.News*, 14 May 2018, "Tracking the threat of asteroids and comets." See: https://phys.org/news/2018-05-tracking-threat-asteroids-comets.html
2018, May 14	J.L. Tonry, L. Denneau, A.N. Heinze, et al., 2018, *Publications of the Astronomical Society of the Pacific*, 130, 064505, "**ATLAS**: a high-cadence all-sky survey system." See: http://adsabs.harvard.edu/abs/2018PASP..130f4505T
2018, May 14	J.I. Zuluaga, O. Sanchez-Hernandez, M. Sucerquia, I. Ferrin, 2018, *Astrophysical Journal*, 155, 236, "A general method for assessing the origin of interstellar small bodies: the case of **1I/2017 U1 ('Oumuamua)**." See: http://adsabs.harvard.edu/abs/2018AJ....155..236Z
2018, May 14 - Jun 8	**Munich Institute for Astro-and Particle Physics (MIAPP)** ***Workshop on Near-Earth Objects: Properties, Detection, Resources, Impacts and Defending Earth***, 14 May - 8 June 2018, Munich (BRD). See: http://www.munich-iapp.de/programmes-topical-workshops/2018/near-earth-objects-properties-detection-resources-impacts-and-defending-earth/

	Organizing Committee: A. Burkert, C. Colombo, R. Jedicke, D. Koschny, R. Wainscoat. **Topics:** - Dynamical structure of asteroid belt and NEO provenance - Science at asteroids - Space law - Asteroid mining - International coordination - Asteroid deflection - Science communication - Spacecraft missions - Impact and atmospheric effects - Interstellar objects as NEOs - Consequences and coordination of impact response - Asteroid astrometric and physical followup - Dynamics and impact monitoring - Physical properties of asteroids **MIAPP Workshop report:** See: https://www.cosmos.esa.int/documents/336356/1803543/ESA-SSA-NEO-HO-0371_1_0_MIAPP_report_2018-10-18.pdf See also: https://www.tum.de/nc/en/about-tum/news/press-releases/detail/article/34696/
2018, May 15	D. Hickson, A. Boivin, M.G. Daly, et al., 2018, *Icarus*, 306, 16, "Near surface bulk density estimates of NEAs from radar observations and permittivity measurements of powdered geologic material." See: http://adsabs.harvard.edu/abs/2018Icar..306...16H
2018, May 15	J. Kruk, *STScI Newsletters*, 35, Issue 1, "***WFIRST*** mission update." See: http://www.stsci.edu/news/newsletters/pagecontent/institute-newsletters/2018-volume-35-issue-01/wfirst-mission-update.html See also: https://wfirst.gsfc.nasa.gov/why_wfirst.html https://www.space.com/wfirst.html [16 Jul 2019] https://www.space.com/nasa-wfirst-space-telescope-moves-forward.html/ [11 Sep 2019] https://www.jpl.nasa.gov/news/news.php?feature=7499 https://www.space.com/nasa-2021-budget-cuts-earth-science-telescopes-stem.html http://www.esa.int/ESA_Multimedia/Images/2020/04/James_Webb_Space_Telescope_s_primary_mirror_unfolded
2018, May 15	M.M. McAdam, J.M. Sunshine, K.T. Howard, et al., 2018, *Icarus*, 306, 32, "Spectral evidence for amorphous silicates in least-processed CO meteorites and their parent bodies."

	See: http://adsabs.harvard.edu/abs/2018Icar..306...32M
2018, May 15	M.M.M. Meier, L. Bindi, P.R. Heck, et al., 2018, *Earth and Planetary Science Letters,* 490, 122, "Cosmic history and a candidate parent asteroid for the quasicrystal-bearing meteorite **Khatyrka**." See: http://adsabs.harvard.edu/abs/2018E%26PSL.490..122M
2018, May 15	T. Ruedas, D. Breuer, 2018, *Icarus*, 306, 94, "“Isocrater” impacts: conditions and mantle dynamical responses for different impactor types." See: http://adsabs.harvard.edu/abs/2018Icar..306...94R
2018, May 15	Apollo NEA **2010 WC9** (H = 23.8 mag, $D \approx$ 60 m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.53 LD. **[2018-32]** See: 2010 WC9 - SSA , 2010 WC9 - JPL Discovery station: calculated See: http://iawn.net/ See also: **15 May 2102**, **17 May 2156** See also: https://watchers.news/2018/05/10/asteroid-2010-wc9/ http://earthsky.org/space/lost-asteroid-to-pass-closely-may-15 https://www.space.com/40576-asteroid-2010-wc9-flyby-slooh-webcast.html? https://www.jpl.nasa.gov/news/news.php?feature=7125 https://en.wikipedia.org/wiki/2010_WC9
2018, May 21	S.N. Raymond, P.J. Armitage, D.Veras, 2018, *Monthly Notices of the Royal Astronomical Society,* 476, 3031, "Implications of the interstellar object **1I/'Oumuamua** for planetary dynamics and planetesimal formation." See: http://adsabs.harvard.edu/abs/2018MNRAS.476.3031R
2018, May 23	W.S. Cassata, B.E. Cohen, D.F. Mark, et al., 2018, *Science Advances*, 4, eaap8306, "Chronology of **Martian** breccia **NWA 7034** and the formation of the **Martian** crustal dichotomy." See: http://advances.sciencemag.org/content/4/5/eaap8306 See also: https://www.llnl.gov/news/ancient-meteorite-tells-tales-mars-topography
2018, May 23	Apollo NEA **2018 KW1** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2018-33]** See: 2018 KW1 - SSA , 2018 KW1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/

2018, May 24	R. Jedicke, B.T. Bolin, W.F. Bottke, et al., 2018, *Frontiers in Astronomy and Space Sciences*, 5, 13, "Earth's minimoons: opportunities for science and technology." See: http://adsabs.harvard.edu/abs/2018FrASS...5...13J See also: https://www.eurekalert.org/pub_releases/2018-08/f-emp081318.php https://www.space.com/41502-earth-has-minimoons-asteroid-science.html
2018, May 24	K.G. MacLeod, P.C. Quinton, J. Sepúlveda, M.H. Negra, 2018, *Science*, 24 May 2018, eaap8525, "Postimpact earliest Paleogene warming shown by fish debris oxygen isotopes (El Kef, Tunisia)." See: http://science.sciencemag.org/content/early/2018/05/24/science.aap8525 See also: https://www.space.com/40690-dino-killing-asteroid-impact-warmed-earth.html#?
2018, May 25	A. Mann, 2018, *Science*, 360, 842, "**B612** plans asteroid hunt with fleet of small satellites." See: http://adsabs.harvard.edu/abs/2018Sci...360..842M
2018, May 26	Apollo NEA **2018 KY2** (H = 27.3 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.78 LD. Minimum miss distance 0.78 LD. **[2018-34]** See: 2018 KY2 - SSA , 2018 KY2 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, May 29	S. Van wal, Y. Tsuda, K. Yoshikawa, et al., 2018, *Journal of Spacecraft and Rockets*, 55, 797, "Prearrival deployment analysis of rovers on ***Hayabusa2*** asteroid explorer." See: http://adsabs.harvard.edu/abs/2018JSpRo..55..797V
2018, May 31	A. Drouard, P. Vernazza, S. Loehle, et al., 2018, *Astronomy & Astrophysics*, 613, 54, "Probing the use of spectroscopy to determine the meteoritic analogues of meteors." See: http://adsabs.harvard.edu/abs/2018A%26A...613A..54D
2018, Jun	Since June 2018, **the IAU Minor Planet Center,** directed by Matthew J. Holman, is operating under the NASA **Planetary Data System's Small Bodies Node (SBN)**. The **SBN** serves as intermediary between the direction of the NASA **Planetary Defense Coordination Office (PDCO)** and the **MPC**. See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/fast.pdf

2018, Jun	M.C.F. Bazzocchi, M.R. Emami, 2018, *Journal of the Astronautical Sciences*, 65, 183, "Asteroid redirection mission evaluation using multiple landers." See: http://adsabs.harvard.edu/abs/2018JAnSc..65..183B
2018, Jun	D.V. Bisikalo, I.S. Savanov, S.A. Naroenkov, 2018, *Astronomy Reports*, 62, 367, "Perspectives for distributed observations of near-Earth space using a Russian-Cuban observatory." See: http://adsabs.harvard.edu/abs/2018ARep...62..367B
2018, Jun	B.L. de Vries, H. Skogby, L.B.F.M. Waters, M. Min, 2018, *Icarus*, 307, 400, "Laboratory mid-IR spectra of equilibrated and igneous meteorites. Searching for observables of planetesimal debris." See: http://adsabs.harvard.edu/abs/2018Icar..307..400D
2018, Jun	G.E. Sambarov, O.M. Syusina, 2018, *Russian Physics Journal*, 61, 373, "Analysis of probabilistic orbital evolution of the asteroids **2011 CQ1** and **2011 MD**." See: http://adsabs.harvard.edu/doi/10.1007/s11182-018-1409-3
2018, Jun	F. Spoto, A. Del Vigna, A. Milani, et al., 2018, *Astronomy & Astrophysics*, 614, 27, "Short arc orbit determination and imminent impactors in the ***Gaia*** era." See: http://adsabs.harvard.edu/abs/2018A%26A...614A..27S
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2018, Jun	B. Williams, P. Antreasian, E. Carranza, et al., 2018, *Space Science Reviews*, 214, 69, "***OSIRIS-REx*** flight dynamics and navigation design." See: http://adsabs.harvard.edu/abs/2018SSRv..214...69W
2018, Jun 1	M.A. Barucci, D. Perna, M. Popescu, et al., 2018, *Monthly Notices of the Royal Astronomical Society*, 476, 4481, "Small D-type asteroids in the NEO population: new targets for space-missions." See: http://adsabs.harvard.edu/abs/2018MNRAS.476.4481B
2018, Jun 1	E. Tasker, 2018, *Nature Astronomy*, 2, 502, "Bringing home a piece of our past." See: http://adsabs.harvard.edu/abs/2018NatAs...2..502T
2018, Jun 1	Y. Qi, A. de Ruiter, 2018, *Monthly Notices of the Royal*

	Astronomical Society, 476, 5464, "Short-term capture of the **Earth-Moon** system." See: http://adsabs.harvard.edu/abs/2018MNRAS.476.5464Q
2018, Jun 2, 16:53	**Impact.** Apollo NEA **2018 LA** (H = 30.5 mag, $D \approx$ 2.8 m) approached Earth at a nominal miss distance of **0 LD**. Minimum miss distance **0 LD**. The object impacted the Earth atmosphere eight hours after discovery by the **Catalina Sky Survey** and disintegrated over Botswana, several miles above the surface, creating a bright fireball that lit up the evening sky. See: 2018 LA - SSA , 2018 LA - JPL Discovery station: **Mt. Lemmon Survey** See also: http://iawn.net/ See also: **6 June 1989**. See also: https://www.jpl.nasa.gov/news/news.php?feature=7148 "The discovery of asteroid **2018 LA** is only the third time that an asteroid has been discovered to be on an impact trajectory, said Paul Chodas, manager of the **Center for Near-Earth Object Studies (CNEOS)** at JPL. "It is also only the second time that the high probability of an impact was predicted well ahead of the event itself." See also: https://www.ifa.hawaii.edu/info/press-releases/ATLAS_2018LA/ https://b612foundation.org/watching-the-worldwide-asteroid-tracking-system-work-by-danica-remy/? https://www.amsmeteors.org/2018/06/asteroid-spotted-hours-before-impact-with-atmosphere-over-botswana/ https://www.seti.org/fragment-impacting-asteroid-recovered-botswana-0 http://adsabs.harvard.edu/abs/2018DPS....5011102F http://neo.ssa.esa.int/news-archive https://en.wikipedia.org/wiki/2018_LA
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2018, Jun 8	P. Vereš, M.J. Payne, M.J. Holman, et al., 2018, *Astronomical Journal*, 156, 5, "Unconfirmed Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2018AJ....156....5V See also: https://www.newscientist.com/article/2168844-weve-lost-track-of-more-than-900-near-earth-asteroids/
2018, Jun 10	Amor NEA **2018 EJ4** ($H = 21.4$ mag, $D \approx 190$ m, **PHA**) passed Earth at a nominal miss distance of 5.56 LD. Minimum miss distance 5.56 LD. See: 2018 EJ4 - SSA , 2018 EJ4 - JPL See also: **11 Jun 2197**.
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2018, Jun 11	F. Namouni, M.H.M. Morais, 2018, *Monthly Notices Royal Astronomical Society: Letters*, 477, L117, "An interstellar origin for Jupiter's retrograde co-orbital asteroid [**514107 (2015 BZ509)**]." See: http://adsabs.harvard.edu/abs/2018MNRAS.477L.117N See also: http://www.sciencemag.org/news/2018/05/asteroid-came-another-solar-system-and-it-s-here-stay https://www.space.com/40643-first-interstellar-immigrant-asteroid-jupiter-orbit.html? https://apod.nasa.gov/apod/astropix.html https://en.wikipedia.org/wiki/(514107)_2015_BZ509
2018, Jun 11	Amor NEA **2015 DP155** ($H = 21.7$ mag, $D \approx 160$ m, **PHA**) passed Earth at a nominal miss distance of 8.96 LD. Minimum miss distance 8.96 LD. See: 2015 DP155 - SSA , 2015 DP155 - JPL See also: **9 Jun 2080**.

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2018, Jun 13-14	**NASA *19th Small Bodies Assessment Group Meeting***, 13-14 June 2018, College Park (MD, USA). See: http://www.lpi.usra.edu/sbag/meetings/ **Agenda:** https://www.lpi.usra.edu/sbag/meetings/jun2018/index.shtml **Findings:** https://www.lpi.usra.edu/sbag/findings/ **Among the presentations:** - J.A.R. Rall, 2018, "**Planetary Science Division** overv iew." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/rall.pdf - T. Swindle, 2018, "**SBAG** preparation for the Decadal Survey." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/swindle.pdf - D.R. Adamo, 2018, "Revisited roles for Small Bodies in ISECG's Global Exploration Roadmap (GER)." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/adamo.pdf - T.S. Statler, 2018, "Common themes in planetary Small Bodies research (2018 update)." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/statler.pdf - K. Fast, 2018, "**Near-Earth Object Observations Program**." and L. Johnson, 2018, "**Planetary Defense Coordination Office**." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/fast.pdf See also: https://ac.arc.nasa.gov/pif3gqw4wu0y?proto=true - F. Vilas, 2018, "National Science Foundation Status for **SBAG**, June 2018." See: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/vilas.pdf

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2018, Jun 15, 02:31	Apollo NEA **2018 LV3** (H = 26.7 mag, $D \approx$ 17 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2018-35]** See: 2018 LV3 - SSA , 2018 LV3 - JPL

	Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
2018, Jun 16	Apollo NEA **2018 MZ4** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.54 LD. **[2018-36]** See: 2018 MZ4 - SSA , 2018 MZ4 - JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/
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2018, Jun 18	Apollo NEA **2018 MC7** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 2.19 LD. Minimum miss distance 2.19 LD. See: 2018 MC7 - SSA , 2018 MC7 - JPL See also: https://cneos.jpl.nasa.gov/sentry/
2018, Jun 19-21	***Didymos Observer Workshop 2018***, 19-21 June 2018, Prague (Czech Republic). See: http://didymos2018-mtg.asu.cas.cz/didymosprague2018_firstannouncement.txt http://didymos2018-mtg.asu.cas.cz/ http://didymos2018-mtg.asu.cas.cz/didymosprague2018_secondannouncement.pdf **Presentations (see:** http://didymos2018-mtg.asu.cas.cz/AbstractsDidymosPrague2018.pdf **):** - M. Birlan, A. Sonka, A. Gornea, et al., 2018, "Surveillance and opportunities for observing Near-Earth Objects." - M. Husarik and O.V. Ivanova, 2018, "Recent observations of **3200 Phaethon** and **1981 Midas**." - M.A. Galiazzo, C. Moni Bidin, F. Mauro, "Photometry of **2002 GZ32** and **2012 DR30**." - N. Moskovitz, 2018, "NEO lightcurves from the **Mission Accessible Near-Earth Object Survey (MANOS)**." - B. Rozitis, E.C. Brown, S.F. Green, et al., 2018, "Thermal inertia of binary near-Earth asteroids." - P. Pravec1, P. Scheirich, and **Didymos** Observer Team, 2018, "Photometric observations of **Didymos** in 2003–2017, and outlook for observations in 2019 and beyond." - P. Scheirich, P. Pravec, 2018, "Determination of the orbit of **Didymoon** from past and future photometric observations."

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	https://cosmosmagazine.com/space/white-house-takes-action-on-asteroid-threats
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2018, Jun 21	Apollo NEA **2017 YE5** (*H* = 19.3 mag, *D* ≈ 900 m + 900 m, **PHA,** binary asteroid) passed Earth at a nominal miss distance of 15.51 LD. Minimum miss distance 15.51 LD. See: 2017 YE5 - SSA , 2017 YE5 - JPL See also: https://www.jpl.nasa.gov/news/news.php?feature=7187 https://www.nasa.gov/feature/jpl/observatories-team-up-to-reveal-rare-double-asteroid https://greenbankobservatory.org/observatories-team-up-to-reveal-rare-double-asteroid/ https://en.wikipedia.org/wiki/2017_YE5
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	Minimum miss distance 7.27 LD. See: 2010 NY65- SSA , 2010 NY65 - JPL See also: **24 Jun 2017, 24 Jun 2019, 24 Jun 2020, 25 Jun 2181**
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2018, Jun 27	T. Sabuwala, C. Butcher, G. Gioia, P. Chakraborty, 2018, *Physical Review Letters*, 120, 264501, "Ray systems in granular cratering." See: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.264501 See also: https://www.oist.jp/news-center/press-releases/space-detectives-sandbox-craters-reveal-secrets-planetary-splash-marks
2018, Jun 27	Arrival at asteroid **162173 Ryugu** (**1999 JU3**, H = 19.5 mag, $D \approx$ 870 km, **PHA**) of the Japanese spacecraft ***Hayabusa2***, a sample return mission, launched on 3 December 2014. Task: survey the asteroid for 1.5 yr, retrieve a sample no earlier than January 2019,

	depart with sample in November/December 2019, and return to Earth (Australia) in late 2020. See: 1999 JU3 - SSA, 1999 JU3 - JPL See also: http://global.jaxa.jp/projects/sat/hayabusa2/ https://particle.scitech.org.au/space/inside-an-asteroid/ http://www.hayabusa2.jaxa.jp/topics/20180611b_e/ http://www.hayabusa2.jaxa.jp/topics/20180614_je/index_e.html https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/yoshikawa.pdf https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/yoshikawa.pdf http://www.hayabusa2.jaxa.jp/topics/20180621je/index_e.html http://www.hayabusa2.jaxa.jp/topics/20180626_e/index_e.html http://www.isas.jaxa.jp/topics/001567.html http://www.isas.jaxa.jp/en/topics/001600.html http://www.hayabusa2.jaxa.jp/topics/20180725je/index_e.html http://global.jaxa.jp/projects/sat/hayabusa2/topics.html#topics12394 https://www.space.com/41413-asteroid-ryugu-space-rock-close-up.html https://www.space.com/41010-ryugu-asteroid-hayabusa2-scientists-funny-predictions.html [2018, Jun 27] http://global.jaxa.jp/projects/sat/hayabusa2/ [2018, Jul 25] https://www.space.com/41287-hayabusa2-asteroid-ryugu-boulders-crater-photo.html 2018, [July 27] https://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10081/151_read-29511/#/gallery/31818 [2018, Aug 23] https://www.space.com/41602-hayabusa2-asteroid-ryugu-landing-site-selected-photos.html [2018, Aug 23] https://www.space.com/41726-asteroid-ryugu-new-images-death-star.html [2018, Sep 5] http://www.hayabusa2.jaxa.jp/en/news/schedule/ [2018, Sep 6] http://www.hayabusa2.jaxa.jp/en/topics/20180919e/ [2018, Sep 9] https://www.space.com/41864-asteroid-ryugu-japan-hayabusa2-shadow-photos.html [2018, Sep 19] https://www.space.com/41885-hayabusa2-rovers-landing-on-asteroid-soon.html [2018, Sep 19] http://www.hayabusa2.jaxa.jp/en/galleries/onc/nav20180920/ [2018, Sep 20] http://www.hayabusa2.jaxa.jp/en/ [2018, Sep 20] https://www.space.com/41892-hayabusa2-asteroid-rover-landing-real-time-photos.html [2018, Sep 20] https://phys.org/news/2018-09-japan-space-probe-rovers-asteroid.html [2018, Sep 21] https://www.space.com/41898-hayabusa2-deploys-hopping-robots-asteroid-ryugu.html [2018, Sep 21] https://www.space.com/41903-hayabusa2-hopping-robots-asteroid-ryugu.html [2018, Sep 21] http://www.hayabusa2.jaxa.jp/en/topics/20180922e/ [2018, Sep 22] https://www.space.com/41912-japanese-hopping-rovers-land-on-asteroid.html [2018, Sep 22] https://www.space.com/41941-hayabusa2-asteroid-rovers-hopping-

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2018, Sep 4-6	***Asteroids and Comets - Inside Out Workshop (ACIO18)***, 4-6 September 2018, Tampere (Finland). See: http://www.tut.fi/en/asteroids-and-comets-inside-out-workshop **Among the Keynote presentations:** - B. Garcia Gutierrez, I. Carnelli, M. Küppers, 2018, "ESA's ***Hera*** mission to asteroid **Didymos**." See: http://www.students.tut.fi/~takala5/acio18_Keynote_abstract_Planetary_missions_and_mission_design.pdf
2018, Sep 5	Apollo NEA **2018 RS** (H = 29.5 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.27 LD. **[2018-42]** See: 2018 RS - SSA , 2018 RS - JPL Discovery station: **…** See: http://iawn.net/
2018, Sep 6	Apollo NEA **2018 RE2** (H = 28.5 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2018-43]** See: 2018 RE2 - SSA , 2018 RE2 - JPL Discovery station: **…** See: http://iawn.net/
2018, Sep 7	Apollo NEA **2018 RJ3** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.43 LD. **[2018-44]** See: 2018 RJ3 - SSA , 2018 RJ3 - JPL See also: http://iawn.net/ Discovery station: **…** See: http://iawn.net/
2018, Sep 8	Aten NEA **2018 RW** (H = 30.5 mag, $D \approx$ 2.8 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2018-45]**

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2018, Sep 9	Aten NEA **2018 RC** (H = 25.0 mag, $D \approx$ 40 m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.58 LD. **[2018-46]** See: 2018 RC - SSA , 2018 RC - JPL Discovery station: **…** See: http://iawn.net/
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2018, Sep 12, 17:12	Apollo NEA **2018 RY5** (H = 26.6 mag, $D \approx$ 17 m) passed Earth at a nominal miss distance of 0.47 LD. Minimum miss distance 0.47 LD. **[2018-47]** See: 2018 RY5 - SSA , 2018 RY5 - JPL Discovery station: **…** See: http://iawn.net/
2018, Sep 12, 20:08	Apollo NEA **2018 RZ5** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2018-48]** See: 2018 RZ5 - SSA , 2018 RZ5 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2018, Sep 15	M. Granvik, A. Morbidelli, R. Jedicke, et al., 2018, *Icarus*, 312, 181, "Debiased orbit and absolute-magnitude distributions for Near-Earth Objects." See: http://adsabs.harvard.edu/abs/2018Icar..312..181G

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2018, Sep 15	Apollo NEA **2018 SM** (H = 29.5 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.11 LD. Minimum miss distance 0.11 LD. **[2018-49]** See: 2018 SM - SSA , 2018 SM - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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2018, Sep 18	***B612*** Newsletter, 18 September 2018. See: https://mailchi.mp/b612foundation/asteroids-beyond-the-b612-foundation-newsletter-vol-784597 See also: https://b612foundation.org/pew-poll-shows-public-believes-asteroid-monitoring-should-be-a-top-priority/
2018, Sep 18	Apollo NEA **2018 SC** (H = 28.0 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.70 LD. **[2018-50]** See: 2018 SC - SSA , 2018 SC - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/

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	LD. **[2018-51]** See: 2018 SD2 - SSA , 2018 SD2 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
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2018, Oct 7	Apollo NEA **2018 TV** ($H = 28.6$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.74 LD. Minimum miss distance 0.74 LD. **[2018-54]** See: 2018 TV - SSA , 2018 TV - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2018, Oct 19	***6th IAWN Steering Committee Meeting***, Knoxville (TE, USA), 19 October 2018. See: http://iawn.net/meetings/6th-steering-cmte.shtml **2. Status Reports from Members:** ***(2a)*** D. Koschny, R. Jehn, G., Sessler, U. Kugel, 2018, "ESA status **IAWN**." See: http://iawn.net/documents/201810_6th_Knoxville/6th_IAWN_ESA.pdf ***(2b)*** Anon., "Korea Astronomy and Space Science Institute (KASI) report" (verbal). ***(2c)*** H. Jiang, 2018, "Chinese National Space Administration (CNSA) report" (verbal). ***(2d)*** T. Prince, 2018, "Zwicky Transient Facility (ZTF)". ***(2e)*** H. Ben-Ami, 2018, "Israel Space Agency (ISA)." ***(2f)*** Anon., 2018, "**NASA's Planetary Defense Coordination Office (PDCO)** status." See: http://iawn.net/documents/201810_6th_Knoxville/6th_IAWN_NASA.pptx ***(2g)*** NASA **Planetary Data System's Small Bodies Node (SBN)**

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2018, Oct 19	Apollo NEA **2018 UA** (H = 30.1 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.036 LD **(= 2.15 R_{Earth} from the geocenter)**. Minimum miss distance 0.036 LD. **[2018-56]** See: 2018 UA - SSA , 2018 UA - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/newsletters [June 2020] https://en.wikipedia.org/wiki/2018_UA
2018, Oct 21-26	***50th Annual Meeting of the AAS Division for Planetary Sciences***, 21-26 October 2018, Knoxville (TN, USA), See: https://aas.org/meetings/dps50 **Special meeting:** The ***NEOCam*** Science Team invites the planetary science community for a discussion of ***NEOCam***. **Oral sessions in the program:** 100. Meteorioids, meteors, meteorites, must and Solar wind 301. **1I/'Oumuamua** 304. Asteroids observational surveys I 401. Asteroids observational surveys II 501. ***Hayabusa2*** **Among the contributions:** - E. Ashton, B. Gladman, J. Kavelaars, G. Williams, 2018, *AAS DPS meeting* #50, id.201.02, "Interstellar interlopers in the outer Solar System." See: http://adsabs.harvard.edu/abs/2018DPS....5020102A - L. Benner, M. Brozovic, S. Naidu, et al., 2018, *AAS DPS meeting* #50, id.508.06, "**Goldstone/Green Bank** radar imaging of Near-Earth Asteroid **2012 TC4**." See: http://adsabs.harvard.edu/abs/2018DPS....5050806B

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2018, Nov 1	D. Jewitt, M. Mutchler, J. Agarwal, J. Li, 2018, *Astronomical Journal*, 156, 238, "***Hubble Space Telescope*** observations of **3200 Phaethon** at closest approach." See: http://adsabs.harvard.edu/abs/2018AJ....156..238J
2018, Nov 1	N. Myhrvold, 2018, *Icarus*, 314, 64, "An empirical examination of ***WISE/NEOWISE*** asteroid analysis and results." See: http://adsabs.harvard.edu/abs/2018Icar..314...64M See also: http://adsabs.harvard.edu/abs/2018arXiv181101454W
2018, Nov 1	H.C.M. Susorney, O.S. Barnouin, 2018, *Icarus*, 314, 299, " The global surface roughness of **433 Eros** from the ***NEAR*** laser rangefinder." See: http://adsabs.harvard.edu/abs/2018Icar..314..299S

2018, Nov 2	Apollo NEA **2018 VP1** (*H* = 309 mag, *D* ≈ 2.3 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2018-57]** See: 2018 VP1 - SSA , 2018 VP1 - JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/ See also: **2 Nov 2020**
2018, Nov 4	E. Wright, A. Mainzer, J. Masiero, et al., 2018, e-print *arXiv*:1811.01454, "Response to "An empirical examination of ***WISE/NEOWISE*** asteroid analysis and results"." See: http://adsabs.harvard.edu/abs/2018arXiv181101454W See also: http://adsabs.harvard.edu/abs/2018Icar..314...64M
2018, Nov 4-7	***The Geological Society of America 130th Annual Meeting***, 4-7 November 2018, Indianapolis (IN, USA). See: https://community.geosociety.org/gsa2018/home
2018, Nov 5	*ESA **SSA-NEO Coordination Centre** Newsletter*, 5 November 2018. See: http://neo.ssa.esa.int/newsletters
2018, Nov 5	A. Thirouin, N.A. Moskovitz, R.P. Binzel, et al., 2018, *Astrophysical Journal Supplement Series*, 239, 4, "The **Mission Accessible Near-Earth Objects Survey**: four years of photometry." See: http://adsabs.harvard.edu/abs/2018ApJS..239....4T
2018, Nov 5	J.L. Tonry, L. Denneau, H. Flewelling, et al., 2018, *Astophysical Journal*, 867, 105, "The **ATLAS** all-sky stellar reference catalog." See: http://adsabs.harvard.edu/abs/2018ApJ...867..105T
2018, Nov 5 01:33	Apollo NEA **2018 VT5** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.48 LD. Minimum miss distance 0.48 LD. **[2018-58]** See: 2018 VT5 - SSA , 2018 VT5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 5 18:00	Apollo NEA **2018 TF3** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) passed **Earth** at a nominal miss distance of 7.77 LD. Minimum miss distance 7.77 LD. See: 2015 TF3 - SSA , 2015 TF3 - JPL
2018, Nov 5	ESA **NEOCC** *Newsletter*: November 2018.

	See: http://neo.ssa.esa.int/
2018, Nov 6	Apollo NEA **2018 VO5** (*H* = 26.5 mag, *D* ≈18 m) passed Earth at a nominal miss distance of 0.37 LD. Minimum miss distance 0.37 LD. **[2018-59]** See: 2018 VO5 - SSA , 2018 VO5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 7	S. Kohler, 2018, *AAS Nova Highlight*, 7 November 2018, id.4232, "Revisiting interstellar asteroid **`Oumuamua**." See: http://adsabs.harvard.edu/abs/2018nova.pres.4232K
2018, Nov 9	E. Landau, 2018, *NASA*, "Cosmic detective work: why we care about space rocks." See: https://www.nasa.gov/feature/jpl/cosmic-detective-work-why-we-care-about-space-rocks See also: https://earthsky.org/space/reasons-to-study-asteroids
2018, Nov 10	Apollo NEA **2018 VX1 = 2018 VA6** (*H* = 27.7 mag, *D* ≈10 m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2018-60]** See: 2018 VX1 - SSA , 2018 VX1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **11 Nov 1959**.
2018, Nov 11	F. Almeida-Fernandes, H.J. Rocha-Pinto, 2018, *Monthly Notices of the Royal Astronomical Society*, 480, 4903, "A kinematical age for the interstellar object **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018MNRAS.480.4903A
2018, Nov 11	Apollo NEA **2015 TB145** (*H* = 20.2 mag, *D* ≈ 600 m, **PHA**, possibly a dead comet) passed Earth at a nominal miss distance of 103.97 LD. Minimum miss distance 103.94 LD. See: 2015 TB145 - SSA , 2015 TB145 - JPL Ref: - T.G. Müller, A. Marciniak, M. Butkiewicz-Bąk, et al., 2017, *Astronomy & Astrophysics*, 598, 63, "Large Halloween asteroid at lunar distance." See: http://adsabs.harvard.edu/abs/2017A%26A...598A..63M See also: http://neo.jpl.nasa.gov/news/news190.html http://gawker.com/asteroid-to-strike-earth-on-halloween-scaremongering-1737772849 http://www.jpl.nasa.gov/news/news.php?feature=4760

	http://www.jpl.nasa.gov/news/news.php?feature=4763 https://www.space.com/39173-halloween-asteroid-2015-tb145-returns-2018.html https://en.wikipedia.org/wiki/2015_TB145 See also: **31 Oct 2015.**
2018, Nov 12	M. Bartels, 2018, *Space.com*, 42389, 12 November 2018, "Astronaut Rusty Schweickart looks back on ***Apollo 9***, and to the next asteroid impact." See: https://www.space.com/42389-apollo-astronaut-rusty-schweickart-asteroid-planetary-protection.html
2018, Nov 12	S. Bialy, A. Loeb, 2018, *Astrophysical Journal Letters*, 868, L1, "Could solar radiation pressure explain **'Oumuamua**'s peculiar acceleration?" See: http://adsabs.harvard.edu/abs/2018ApJ...868L...1B See also: https://www.space.com/42352-oumuamua-interstellar-object-alien-light-sail.html https://www.forbes.com/sites/startswithabang/2018/11/08/aliens-is-not-a-scientific-explanation-for-interstellar-asteroid-%CA%BBoumuamua/#6c604fda3719
2018, Nov 13 02:24	Aten NEA **2018 VC7** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.87 LD. **[2018-61]** See: 2018 VC7 - SSA , 2018 VC7 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2018, Nov 13 18:28	Aten NEA **2018 WA1** (H = 30.1 mag, $D \approx$ m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2018-62]** See: 2018 WA1- SSA , 2018 WA1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 14	C. Cofield, 2018, *NASA JPL News*, 14 November 2018, "NASA learns more about interstellar visitor **'Oumuamua**." See: https://www.jpl.nasa.gov/news/news.php?release=2018-262
2018, Nov 14	K.H. Kjær, N.K. Larsen, T. Binder, et al., 2018, *Science Advances*, 4, eaar8173, "A **large impact crater** beneath Hiawatha Glacier in northwest Greenland." See: http://advances.sciencemag.org/content/4/11/eaar8173 See also: https://www.science.ku.dk/english/press/news/2018/massive-impact-

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2018, Nov 14	D.E. Trilling, M. Mommert, J.L. Hora, et al., 2018, *Astronomical Journal*, 156, 261, "***Spitzer*** observations of interstellar object **1I/'Oumuamua**." See: http://adsabs.harvard.edu/abs/2018AJ....156..261T See also: https://www.jpl.nasa.gov/news/news.php?feature=7280
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2018, Nov 14	Apollo NEA **2018 VJ10** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.51 LD. **[2018-63]** See: 2018 VJ10 - SSA , 2018 VJ10 - JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/ See also: **15 Nov 1946**.
2018, Nov 15	L.F. Wheeler, D.L. Mathias, E. Stokan, P.G. Brown, 2018, *Icarus*, 315, 79, "Atmospheric energy deposition modeling and inference for varied meteoroid structures." See: http://adsabs.harvard.edu/abs/2018Icar..315...79W
2018, Nov 15-16	***Hera Community Workshop***, 15-16 November 2018, Berlin (Germany). See: https://www.cosmos.esa.int/web/hera-community-workshop/
2018, Nov 16	T.A. Goudge, C.I. Fassett, D. Mohrig, 2018, *Geology*, 47, 7, "Incision of paleolake outlet canyons on **Mars** from overflow flooding ." See: https://pubs.geoscienceworld.org/gsa/geology/article-abstract/566640/incision-of-paleolake-outlet-canyons-on-mars-from

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2018, Nov 16	P. Voosen, 2018, *Science*, 362, 738, "Ice age impact." See: http://cdsads.u-strasbg.fr/abs/2018Sci...362..738V
2018, Nov 16 05:49	Apollo NEA **2018 WH** (H = 30.0 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2018-64]** See: 2018 WH - SSA , 2018 WH - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **16 Nov 2022**.
2018, Nov 16 19:14	Apollo NEA **2018 WG** (H = 29.4 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.080 LD **(= 4.84 R_{Earth} from the geocenter)**. Minimum miss distance 0.080 LD. **[2018-65]** See: 2018 WG - SSA , 2018 WG - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **16 Nov 2073**.
2018, Nov 18	Apollo NEA **2018 WE** (H = 28.4 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2018-66]** See: 2018 WE - SSA , 2018 WE - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 18	K. Haynes, 2018, *Astronomy*, 19 November 2018, "How would we save the planet from a killer asteroid?" See: http://www.astronomy.com/news/2018/11/how-would-we-save-the-planet-from-a-killer-asteroid
2018, Nov 19	Apollo NEA **2018 WJ** (H = 27.8 mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.31 LD. **[2018-67]** See: 2018 WJ - SSA , 2018 WJ - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 20	D.N. DellaGiustina, C.A. Bennett, K. Becker, et al., 2018, submitted to *Earth and Space Science*, 5, 929, "Overcoming the challenges associated with image-based mapping of small bodies in preparation for the ***OSIRIS-REx*** mission to **(101955) Bennu**."

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2018, Nov 21	G. Stenborg, J.R. Stauffer, R.A. Howard, 2018, *Astrophysical Journal*, 868, 74, "Evidence for a circumsolar dust ring near **Mercury**'s orbit." See: http://adsabs.harvard.edu/abs/2018ApJ...868...74S See also: https://www.space.com/dust-ring-discovered-mercury-orbit.html
2018, Nov 25	S. Siegert, L.Hecht, 2018, *Meteoritics & Planetary Science*, Early View, "Heterogeneity of melts in impact deposits and implications for their origin (**Ries suevite**, Germany)." See: https://onlinelibrary.wiley.com/doi/10.1111/maps.13210
2018, Nov 25	Apollo NEA **2018 WE1** (H = 26.2 mag, $D \approx$ 20 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2018-68]** See: 2018 WE1 - SSA , 2018 WE1 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: **25 Nov 1959.**
2018, Nov 27	Apollo NEA **2018 WZ1** (H = 29.4 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2018-69]** See: 2018 WZ1 - SSA , 2018 WZ1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 28	Apollo NEA **2018 WA3** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84 LD. **[2018-70]**

	See: 2018 WA3 - SSA , 2018 WA3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2018, Nov 29	T. Kareta, V. Reddy, C. Hergenrother, et al., 2018, *Astronomical Journal*, 156, 287, "Rotationally resolved spectroscopic characterization of Near-Earth Object **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2018AJ....156..287K
2018, Nov 29	A. Witze, 2019, *Nature News*, 29 Nov 2018, "Asteroid-sampling mission zeroes in on tiny space rock." See: https://www.nature.com/articles/d41586-018-07563-y
2018, Nov 29	Andrea Milani (1948-2018) passed away in Pisa (Italy), 28 November 2018. He has been a passionate advocate of the Planetary Defence discipline in the last 20 years, in order to ensure that our society is prepared to face the threat posed by the near-Earth asteroids. See: http://neo.ssa.esa.int/news-archive http://www.esa.int/Our_Activities/Space_Engineering_Technology/Hera/Andrea_Milani_1948_2018
2018, Nov 30	Apollo NEA **2018 WG2** (H = 30.2 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2018-71]** See: 2018 WG2 - SSA , 2018 WG2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **28 Nov 1982**.
2018, Dec	P. Bambach, J. Deller, E. Vilenius, et al., 2018, *Advances in Space Research*, 62, 3357, "***DISCUS*** – The ***Deep Interior Scanning CubeSat*** mission to a rubble pile near-Earth asteroid." See: http://adsabs.harvard.edu/abs/2018AdSpR..62.3357B
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2018, Dec	J. Hanus, D.Vokrouhlicky, M. Delbo, et al., 2018, *Astronomy &*

	Astrophysics, 620, L8, "**(3200) Phaethon**: bulk density from Yarkovsky drift detection." See: http://adsabs.harvard.edu/abs/2018A%26A...620L...8H
2018, Dec	P. Jenniskens, J. Albers, C.E. Tillier, et al., 2018, *Meteoritics & Planetary Science*, 53, 2445, "Detection of meteoroid impacts by the **Geostationary Lightning Mapper** on the ***GOES-16*** satellite." See: http://adsabs.harvard.edu/abs/2018M%26PS...53.2445J
2018, Dec	D. Morrison, 2018, ***Tunguska Workshop: applying modern tools to understand the* 1908 Tunguska impact**. *NASA/Technical Memorandum* (NASA/TM--220174) 2018. See: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20190002302.pdf See also: https://www.lpi.usra.edu/sbag/meetings/jan2018/presentations/1150-Morrison.pdf See also: **15 July 2019**.
2018, Dec	E.A. Nikolaeva, O.L Starinova, 2018, *Journal of Physics: Conference Series,* 1096, 012153, "Simulation of Earth's protection by kinetic interceptor from asteroid hazard." See: http://adsabs.harvard.edu/abs/2018JPhCS1096a2153N
2018, Dec	A. Pellacani, P. Kicman, M. Suatoni, et al., 2018, *CEAS Space Journal*, 10, 555, "Design and validation of a GNC system for missions to asteroids: the ***AIM*** scenario." See: http://adsabs.harvard.edu/abs/2018CEAS...10..555P
2018, Dec.	N.C. Wickramasinghe, D.T. Wickramasinghe, E.J. Steele, 2018, *Astrophysics and Space Science*, 363, 244, "Comets, **Enceladus** and panspermia." See: http://adsabs.harvard.edu/abs/2018Ap%26SS.363..244W
2018, Dec	M. Zheltobryukhov, E. Chornaya, A. Kochergin, et al., 2018, *Astronomy & Astrophysics*, 620, 179, "Umov effect in asteroid **(3200) Phaethon**." See: http://adsabs.harvard.edu/abs/2018A%26A...620A.179Z
2018, Dec 1	K.L. Bryson, D.R. Ostrowski, A.Blasizzo, 2018, *Planetary and Space Science*, 164, 85, "Meteorite flaws and scaling for atmospheric entry." See: http://adsabs.harvard.edu/abs/2018P%26SS..164...85B
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	implications for crater production, catastrophic disruption, momentum transfer and dust production on asteroids." See: http://adsabs.harvard.edu/abs/2018P%26SS..164...91F
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2018, Dec 1	Q.-Z. Ye, 2018, *Planetary and Space Science*, 164, 7, "Meteor showers from active asteroids and dormant comets in near-Earth space: a review." See: http://adsabs.harvard.edu/abs/2018P%26SS..164....7Y
2018, Dec 2	R. Seaman, P. Abell, E. Christensen, et al., 2018, White Paper submitted in response to the Call for **LSST** Cadence Optimization White Papers, e- print *arXiv*:1812.00466, "A near-Sun Solar System **Twilight Survey** with **LSST**." See: http://adsabs.harvard.edu/abs/2018arXiv181200466S
2018, Dec 2	Apollo NEA **2018 WV1** (H = 30.0 mag, $D \approx 4$ m) **passed** Earth at a nominal miss distance of **0.086 LD (= 5.19 R_{Earth} from the geocenter). Minimum miss distance 0.086 LD**. **[2018-72]** See: 2018 WV1 - SSA , 2018 WV1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: https://cneos.jpl.nasa.gov/news/news202.html https://en.wikipedia.org/wiki/2018_WV1

2018, Dec 3	Arrival of NASA spacecraft ***Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx)***, an asteroid sample return mission, at target asteroid **101955 (1999 RQ36 = Bennu**, *H* = 20.8 mag, *D* ≈ 525 m, **NEO**, **PHA**). The 2,110-kg spacecraft was launched on 8 September 2016. After a careful survey of **Bennu** to characterize the asteroid and locate the most promising sample sites, ***OSIRIS-REx*** will collect between 60 to 2,000 grams of surface material with its robotic arm, depart from **Bennu** in May 2021, and return the sample to Earth via a detachable capsule on 24 September 2023. See: http://www.nasa.gov/osiris-rex http://science.nasa.gov/missions/osiris-rex/ https://www.nasa.gov/sites/default/files/atoms/files/osiris_rex_factsheet5-9.pdf http://www.asteroidmission.org/ https://osirisrex.arizona.edu/content/information-media http://www.space.com/11802-nasa-asteroid-mission-dangerous-1999-rq36.html http://www.space.com/11808-nasa-asteroid-mission-osiris-rex-1999-rq36-infographic.html http://www.space.com/12065-osiris-rex-asteroid-generations.html http://web.mit.edu/newsoffice/2011/asteroid-mission-0726.html http://www.space.com/13132-potentially-killer-asteroids-earth-nasa.html http://www.nasa.gov/press/2014/april/construction-to-begin-on-nasa-spacecraft-set-to-visit-asteroid-in-2018/ http://adsabs.harvard.edu/abs/2016Sci...353..974V https://ww2.kqed.org/science/2017/09/29/why-is-nasa-checking-out-this-asteroid/ https://www.nasa.gov/image-feature/from-the-earth-moon-and-beyond https://www.space.com/39701-earth-moon-40-million-miles-nasa-photo.html https://www.space.com/20920-nasa-osiris-rex-asteroid-mission-photos.html https://www.space.com/39958-asteroid-bennu.html https://cneos.jpl.nasa.gov/news/news201.html https://www.space.com/41544-nasa-osiris-rex-asteroid-bennu-final-approach.html https://uanews.arizona.edu/story/osirisrex-captures-first-glimpse-asteroid-bennu https://www.space.com/41620-osiris-rex-asteroid-bennu-first-photo.html [2018, Aug 24] https://www.space.com/42201-osiris-rex-checks-for-asteroid-hazards.html [2018, Oct 22] http://www.iac.es/divulgacion.php?op1=16&id=1466&lang=en [2018, Oct 31] https://www.nasa.gov/image-feature/goddard/2018/osiris-rex-zooms-in-on-bennu [2018, Nov 2] https://www.nasa.gov/image-feature/goddard/2018/bennu-from-all-sides [2018, Nov 6]

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2018, Dec 5	ESA **NEOCC** *Newsletter*: December 2018. See: http://neo.ssa.esa.int/newsletters
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2018, Dec 8	Apollo NEA **2018 XP2** ($H = 28.2$ mag, $D \approx 8$ m) passed Earth at a nominal miss distance of 1.009 LD. Minimum miss distance 1.003 LD. See: 2018 XP2 - SSA , 2018 XP2 - JPL
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	See: http://iawn.net/technical/neos.shtml#Kamchatka https://www.jpl.nasa.gov/news/news.php?feature=7355 https://cneos.jpl.nasa.gov/fireballs/ See also: https://www.skyandtelescope.com/astronomy-news/amazing-images-giant-fireball-bering-sea/ https://www.syfy.com/syfywire/the-largest-asteroid-impact-since-chelyabinsk-exploded-harmlessly-over-bering-sea
2018, Dec 22	Aten NEA **163899** (**2003 SD220**, *H* = 17.9 mag, *D* ≈ 1000 m, **PHA**) passed Earth at a nominal miss distance of 7.36 LD. Minimum miss distance 7.36 LD. See: 163899 2003 SD220 - SSA , 2003 SD220 - JPL See also: https://www.jpl.nasa.gov/news/news.php?feature=7312 https://phys.org/news/2018-12-mile-wide-potentially-hazardous-asteroid-sd220.html https://en.wikipedia.org/wiki/(163899)_2003_SD220
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2018, Dec 28 06:27	Apollo NEA **2018 YO2** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.51 LD. Minimum miss distance 0.51 LD. **[2018-75]** See: 2018 YO2 - SSA , 2018 YO2 - JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/ See also: **11 Jan 1906**.

2018, Dec 28 12:36	Apollo NEA **2019 AW2** (H = 25.4 mag, $D \approx$ 30 m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2018-76]** See: 2019 AW2 - SSA , 2019 AW2 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
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2019, Jan 1	**19285 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, H = 9.45 mag, D = 36.5 km, Amor NEA), of which **1957 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, H = 15.3 mag, D = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: https://cneos.jpl.nasa.gov/stats/totals.html
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2019, Jan 6-10	***American Astronomical Society 233rd Meeting***, 6-10 January 2019, Seattle (WA, USA). See: https://aas.org/meetings/aas233 **Among the abstracts:** - B. Bolin, E. Lu, M. Loucks, et al., 2019, *AAS Meeting* #233, id.#263.02, "Impact probability evolution of virtual impacting asteroids." See: http://adsabs.harvard.edu/abs/2019AAS...23326302B - R. De Rosa, P. Kalas, 2019, *AAS Meeting* #233, id.#301.03, "***Gaia*** search for close stellar fly-bys within the Sco-Cen star forming region." See: http://adsabs.harvard.edu/abs/2019AAS...23330103D - S. Greenstreet, M. Loucks, J. Carrico, E. Lu, T. Kichkaylo, 2019, *AAS Meeting* #233, id.#263.03, "Required deflection impulses as a function of time before impact for **Earth**-impacting asteroids." See: http://adsabs.harvard.edu/abs/2019AAS...23326303G See also: https://b612foundation.org/understanding-what-it-takes-to-divert-asteroids-by-dr-ed-lu/ [Sept 24, 2019] - M. Juric, E. Bellm, L. Guy, 2019, *AAS Meeting* #233, id.#126.01, "Machine learning applications with **LSST**: from data processing to knowledge discovery." See: http://adsabs.harvard.edu/abs/2019AAS...23312601J - G. Laughlin, 2019, *AAS Meeting* #233, id.#101.01, "A color out of space: **'Oumuamua**'s brief and mysterious visit to the Solar System." See: http://adsabs.harvard.edu/abs/2019AAS...23310101L See also: https://www.space.com/43015-interstellar-visitor-oumuamua-not-that-special.html - M. Loucks, J. Carrico, M. Juric, B. Bolin, E. Lu, 2019, *AAS Meeting* #233, id.#263.02, "Impact probability evolution of virtual impacting asteroids." See: http://adsabs.harvard.edu/abs/2019AAS...23326302L - J. Masiero, A. Mainzer, E.L. Wright, 2019, *AAS Meeting* #233, id.#363.10, " The ***NEOCam*** mid-infrared survey."

	See: http://adsabs.harvard.edu/abs/2019AAS...23336310M - R. McGlasson, S. Marshall, F. Venditti, et al., 2019, *AAS Meeting* #233, id.#255.03, "Shape model of **Potentially Hazardous Asteroid (1981) Midas** from radar and lightcurve observations." See: http://adsabs.harvard.edu/abs/2019AAS...23325503M - A.M. Meisner, D. Lang, E. Schlafly, D. Schlegel, 2019, *AAS Meeting* #233, id.#363.07, "Repurposing ***NEOWISE***-reactivation for astrophysics beyond the inner Solar System." See: http://adsabs.harvard.edu/abs/2019AAS...23336307M - P. Pokorny, P. Wiegert, C. Gregg, et al., 2009, *AAS Meeting* #233, id.#401.05, "Evidence for super-catastrophic asteroid disruption in the near-Sun meteoroid environment?" See: http://adsabs.harvard.edu/abs/2019AAS...23340105P - M. Rice, G. Laughlin, 2019, *AAS Meeting* #233, id.#302.02, "An occultation network as a detector of distant solar system objects." See: http://adsabs.harvard.edu/abs/2019AAS...23330202R - P. Wiegert, P. Brown, P. Pokorny, et al., 2019, *AAS Meeting* #233, id.#401.05, "Evidence for super-catastrophic asteroid disruption in the near-**Sun** meteoroid environment?" See: http://adsabs.harvard.edu/abs/2019AAS...23340105W - E.L. Wright, 2019, *AAS Meeting* #233, id.#263.04, "Testing the ***WISE*** saturation correction with asteroids." See: http://adsabs.harvard.edu/abs/2019AAS...23326304W - L.F. Zambrano Marin, A.K. Virkki, S. Marshall, et al., 2019, *AAS Meeting* #233, id.#347.07, "**Arecibo Observatory** radar observations: 2017-2018." See: http://adsabs.harvard.edu/abs/2019AAS...23334707Z
2019, Jan 8	T. Stefanut, V. Bacu, C. Nandra, et al., 2019, in: ***IEEE 14th International Conference on Intelligent Computer Communication and Processing (ICCP)***, 6-8 September, 2018, Cluj-Napoca (Romania), e-print *arXiv*:1901.02545, "**NEARBY** platform: algorithm for automated asteroids detection in astronomical images." See: http://adsabs.harvard.edu/abs/2019arXiv190102545S
2019, Jan 8, 00:37	Apollo NEA **2019 AS5** (H = 32.3 mag, $D \approx$ 1.2 m) passed Earth at a **nominal miss distance of 0.039 LD (= 2.37 R_{Earth} from the geocenter)**. Minimum miss distance 0.039 LD. **[2019-01]** It passed **the Moon** at a nominal miss distance of 0.415 LD. Minimum miss distance 0.414 LD. See: 2019 AS5 - SSA , 2019 AS5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/newsletters [June 2020] https://en.wikipedia.org/wiki/2019_AS5

	See also: **9 Jan 2055**.
2019, Jan 12	Apollo NEA **2019 AE9** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.26 LD. **[2019-02]** See: 2019 AE9 - SSA , 2019 AE9 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2019, Jan 13	M.A. Cox, A.J. Cavosie, L. Ferrière, et al., 2019, *Meteoritics & Planetary Science*, 54, 621, "Shocked quartz in polymict impact breccia from the Upper Cretaceous Yallalie impact structure in Western Australia." See: http://adsabs.harvard.edu/abs/2019M%26PS...54..621C See also: https://news.curtin.edu.au/media-releases/curtin-university-crater-hunters-score-meteoric-hole-in-one/
2019, Jan 14	V. Bacu, A. Sabou, T. Stefanut, et al., 2019, submitted to ***IEEE 14th International Conference on Intelligent Computer Communication and Processing (ICCP)***, Cluj-Napoca (Romania), e-print *arXiv*:1901.04248, "**NEARBY** platform for detecting asteroids in astronomical images using cloud-based containerized applications." See: https://arxiv.org/abs/1901.04248
2019, Jan 16, 01:13	Apollo NEA **2019 BO** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2019-03]** See: 2019 BO - SSA , 2019 BO - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Jan 16, 16:53	Apollo NEA **2020 CD3** (*H* = 31.8 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.23 LD**.** **[2019-04]** See: 2020 CD3 - S2P , 2020 CD3 – JPL Discovery station: calculated See also**: 4 Apr 2019, 30 Jun 2019**, **10 Sep 2019**, **18 Nov 2019**, **13 Feb 2020**. See also: https://www.theatlantic.com/science/archive/2020/02/mini-moon-earth/607171/ https://www.theatlantic.com/science/archive/2020/03/mini-moon-earth-lost/608455/
2019, Jan 18	C. Koeberl, 2019, *Science*, 363, 224, "When **Earth** got

	pummeled." See: http://adsabs.harvard.edu/abs/2019Sci...363..224K
2019, Jan 18	S. Mazrouei, R.R. Ghent, W.F. Bottke, et al., 2019, *Science*, 363, 253, "**Earth** and **Moon** impact flux increased at the end of the Paleozoic." See: http://adsabs.harvard.edu/abs/2019Sci...363..253M See also: https://www.swri.org/press-release/swri-moon-craters-compare-earth-impact-history-lro https://www.livescience.com/64531-huge-asteroid-impacts-are-common.html http://science.sciencemag.org/content/363/6424/224
2019, Jan 18	A. Siraj, A. Loeb, 2019, *Research Notes of the American Astronomical Society*, 3, 15, "`**Oumuamua**'s geometry could be more extreme than previously inferred." See: http://adsabs.harvard.edu/abs/2019RNAAS...3a..15S
2019, Jan 21	F. Valdes, 2019, e-print *arXiv*:1901.07111, "A new method for estimating the absolute magnitude frequency distribution of Near Earth Asteroids (NEAs)." See: http://adsabs.harvard.edu/abs/2019arXiv190107111V
2019, Jan 22	M. Bartels, 2019, *Space.com*, 22 January 2019, "Watch a meteor smack the **Blood Moon** in this lunar eclipse video!." See: https://www.space.com/43075-blood-moon-2019-meteor-impact-video.html See also: https://www.syfy.com/syfywire/an-asteroid-impacted-the-moon-during-the-lunar-eclipse http://spaceweather.com/archive.php?view=1&day=23&month=01&year=2019
2019, Jan 23	D.S. Grewal, R. Dasgupta, C. Sun, et al., 2019, *Science Advances*, 5, eaau3669, "Delivery of carbon, nitrogen, and sulfur to the silicate Earth by a giant impact." See: http://advances.sciencemag.org/content/5/1/eaau3669 See also: http://news.rice.edu/2019/01/23/planetary-collision-that-formed-the-moon-made-life-possible-on-earth-2/ https://www.space.com/43103-planetary-collision-life-earth.html https://www.space.com/43110-moon-forming-impact-life-on-earth.html
2019, Jan 22-24	***ESA NEO and Debris Detection Conference -- Exploiting Synergies***, 22-24 January 2019, ESA/ESOC, Darmstadt (BRD). See: https://neo-sst-conference.sdo.esoc.esa.int/

	http://neo.ssa.esa.int/news-archive See: https://neo-sst-conference.sdo.esoc.esa.int/page/programme **Among the presentations:** - J. Nomen, N. Sanchez-Ortiz, R. Domínguez - González, 2019, "From NEO to LEO optical observations and back: sensors features and observing strategies." - V. Reddy, R.Furfaro, E. Christensen, 2019, "Synergistic NEO-debris activities at University of Arizona." - J.L.Cano, M. Ceccaroni, L. Faggioli, R. Jehn, D. Koschny, S. Lemmens, F. Letizia, S. Löhle, J. Martin, M. Micheli, 2019, "ESA's activities on the boundaries between NEO and debris detection." - K. Davies, J.S. Pedersen, K. Mokos, et al., 2019, "An opportunity model strategy for scheduling NEO observations." - G. Valsecchi, 2019, "Comparing NEA surveys." - I. Molotov,V. Voropaev,Y. Krugly, et al., 2019, "**ISON** search and study of near-Earth space objects." - A. Liakos, A.Z. Bonanos, M. Xilouris,et al., 2019, "**NELIOTA lunar** impact flash detection and event validation." See: http://adsabs.harvard.edu/abs/2019arXiv190111414L - E. Perozzi,C. Pardini, L. Anselmo, et al., 2019, "The ***Tiangong-1*** re-entry: lessons learned for NEO hazard and communication." -L. Cibin, M. Chiarini, OHB Italia, 2019, "The **Fly-Eye Telescope**, a reality that will provide an effective solution for NEO." - S. Schmalz, I. Molotov, V. Voropaev, et al., 2019, "**ISON**'s sub-network of small aperture telescopes for observations of NEOs, space debris and meteors." - J. Ticha, M. Tichy, M. Honkova, 2019, "**Klet Observatory** preparedness and plans for planetary defence." - T. Yanagisawa1, H. Kurosaki1, T. Ikenaga, et al., 2019, "Small NEO search technology using small telescopes and **FPGA** [Field Programmable Gate Array]." - O.R. Torralba1, R. Jehn, L.S. Jehn, A. Praus, 2019, "Simulation of sky surveys with the **Fly-Eye Telescope**." - D. Gorgan, O. Vaduvescu, 2019, "**NEARBY** platform for automatic asteroids detection and **EURONEAR** surveys." - J. Toth, J. Silha, P. Matlovic, 2019, "**AMOS** [Automatic Meteor Orbit System] - the Slovak worldwide all-sky meteor detection system." - E. Drolshagen, T. Ott, P. Mialle, D. Koschny, G. Drolshagen, et al., 2019, "**NEMO** [NEar real-time MOnitoring system] - a global near real-time fireball monitoring system." - V. Abbasi, S. Thorsteinson, D. Balam, et al., 2019, "The ***NEOSSat*** Experience: 5 years in the life of Canada's space surveillance telescope." - J. Utzmann, 2019, "Towards European space-based optical observations of debris and NEOs."

	- N. Rambaux, J. Vaubaillon, …, F. Deleflie, et al., 2019, "***Meteorix***: a cubesat mission dedicated to the detection of meteors and space debris." - B. Shustov, A. Shugarov, S. Naroenkov, 2019, "System of Observation of Day-time Asteroids (***SODA***)." - M. Losacco, M. Romano, P. Di Lizia, et al., 2019, "Advanced Monte Carlo sampling techniques for orbital conjunctions analysis and NEO impact probability computation." - M. Frühauf, M. Micheli, T. Santana-ros, R. Jehn, D.V. Koschny, 2019, "A systematic ranging technique for follow-ups of NEOs detected with the **Fly-Eye Telescope**." - G. Tommei, A. Milani Comparetti, 2019, "A new way of thinking about impact monitoring of NEOs." -P. Sybilski, S. Kozłowski, R. Pawłaszek, et al., 2019, "**Astrometry24.net** – precise astrometry for SST and NEO." - J. Doubek, P. Sybilski, P. Duźniak, 2019, "**NEOSTEL** [Fly-Eye] data processing chain." **Among the Posters:** - A. Białkowski, P. Duźniak, …, A. Adamczyk, et al., 2019, "Scheduling and commanding message standard usage in telescope tasking activities for NEO and SST." - A. Di Cecco, E. Perozzi, C. Marzo, et al., 2019, "Analysis of Italian sites for NEO and space debris observations with the ESA **Fly-Eye Telescope**." - M. Kim, H.-s. Yim, J.-h. Park, et al., 2019, "Characterization of Earth closing approaching NEAs using **OWL-Net**." - N. Sánchez Ortiz, J. Nomen Torres, J.L. Cano, M. Micheli, 2019, "Identification of SST community support to reduce false positives in the identification of NEO imminent impactors." - O. Wilkman, A. Raja-halli, J. Näränen, N. Kareinen, 2019, "Capabilities of satellite laser ranging systems in NEO observations." - J. Silha, S. Krajcovic, D. Zilkova, et al., 2019, "Slovak optical telescope and image processing pipeline for the space debris and NEA observations and research." -E. Kuznetsov, D. Glamazda, G. Kaiser,Y. Vibe, 2019, "NEO observations at the SBG telescope of the Kourovka Astronomical Observatory." - J. Vaubaillon, F.J. Deleflie, G. Legras, A. Egal, 2019, "Wide field optical sky survey applied to meteors and debris." - A. Suryanarayanan, 2019, "A novel approach to orbit prediction of Near Earth Objects affected by resonances." - A. Di Cecco, E. Perozzi, E. Dotto, et al., 2019, "Ground based physical characterization: from asteroids to space debris (and viceversa." - S.J. Weddell, R. Clare, A. Lambert, 2019, "Near Earth Object image restoration with multi-object adaptive optics."

2019, Jan 24	Apollo NEA **2019 BV1** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.35 LD. **[2019-05]** See: 2019 BV1 - SSA , 2019 BV1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Jan 25	V. Gajjar, N. Gizani, G. Hellbourg, H. Isaacson, 2019, *Research Notes of the American Astronomical Society*, 3, 19, "**Breakthrough Listen** observations of asteroid **(514107) 2015 BZ509** with the Parkes Radio Telescope." See: http://adsabs.harvard.edu/abs/2019RNAAS...3a..19P
2019, Jan 27	Apollo NEA **2019 BZ3** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2019-06]** See: 2019 BZ3 - SSA , 2019 BZ3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Jan 28	C. Chen, J.L. Smallwood, R.G. Martin, M. Livio, 2019, *Astronomical Journal*, 157, 80, "Late delivery of nitrogen to **Earth**." See: http://adsabs.harvard.edu/abs/2019AJ....157...80C
2019, Jan 28	World's largest digital sky survey issues biggest astronomical data release ever -- **Pan-STARRS** releases 1.6 petabytes of data from its over 3-year survey. The **PanSTARRS** Data Release 2 (DR2) was opened to the public on 2019 January 28. The release includes a new database with the multi-epoch photometry and astrometry (typically there are 60 epochs of observation over 3 years from the 5 PS1 filters). See: https://outerspace.stsci.edu/display/PANSTARRS/PS1+News#PS1News-2019.01.28:PS1DataRelease2 https://panstarrs.stsci.edu/ https://www.ifa.hawaii.edu/research/Pan-STARRS.shtml http://hubblesite.org/news_release/news/2019-12 https://www.wired.com/story/now-you-can-join-the-search-for-killer-asteroids/
2019, Jan 29-31	***20th Meeting* of the NASA *Small Bodies Assessment Group***, 29-31 January 2019, Houston (TX, USA). See: http://www.lpi.usra.edu/sbag/meetings/ **Among the presentations:** - J. Castillo-Rogez, K. Meech, S.-J. Chung, D. Landau, and KISS

	Study Team, 2019, "Approach to exploring interstellar objects and long-period comets" - Y. Tsuda, JAXA, ***Hayabusa2*** project Team2019, "***Hayabusa2*** update." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Tuesday-PM/Tsuda.pdf - D.S. Lauretta, NASA-GSFC, 2019, "***OSIRIS-REx*** update." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Wednesday-AM/Lauretta.pdf - K. Righter, NASA-JSC, 2019, "Asteroid-meteorite connections: new asteroid curation facilities and US **Antarctic meteorite collection** at JSC." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Wednesday-AM/Righter.pdf - R. Binzel, MIT, 2019, "**Apophis** 2029, a once-per-thousand year opportunity for science and Planetary Defense." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Wednesday-AM/Binzel.pdf - A. Mainzer, NASA-JPL, 2019, "***NEOCam*** update." - Anon., 2019, "**SBAG** and the Decadal Survey" - E. Adams, 2019, "***DART*** update." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Wednesday-PM/Adams.pdf - J. Masiero, A.K. Mainzer, J.M. Bauer, et al., NASA-JPL, 2019, "Update on the ***NEOWISE*** project." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Wednesday-PM/Masiero.pdf - T. Swindle, 2019, "**SBAG** goals." - C. Ernst, 2019, "Goals – Diversity and workforce." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Ernst.pdf - D. Britt, UCF, 2019, "**SBAG** Resource Utilization (RU) Goals document." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Britt.pdf - A. Rivkin, JHU/APL, 2019, "**SBAG** Goals document Science Section discussion." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Rivkin.pdf - P. Chodas, NASA-JPL/Caltech, J. Dotson, ARC, T. Grav, PSI, et al., 2019, "**SBAG** Goal 2: defend Planet Earth." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Chodas.pdf - D.R. Adamo, LPI, 2019, "In-Space Resource Utilization (ISRU) related to **SBAG** Goal 3 (Enable Human Exploration)." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Adamo.pdf - C. Mercer, J. Castillo-Rogez, E. Adams, 2019, "Technology

	goals for small bodies." See: https://www.lpi.usra.edu/sbag/meetings/jan2019/presentations/Thursday-AM/Mercer.pdf
2019, Jan 30	Z. Sekanina, 2019, e-print *arXiv*:1901.08704, "**1I/'Oumuamua** as debris of dwarf interstellar comet that disintegrated before perihelion." See: https://arxiv.org/abs/1901.08704 See also: https://www.space.com/43229-oumuamua-monstrous-fluffy-comet-dust.html
2019, Jan 31	A. Bonanos, M. Xilouris, P. Boumis. et al., 2019, in: T. Flohrer, R. Jehn, F. Schmitz (eds), Proc. ESA *NEO and Debris Detection Conference -Exploiting Synergies-*, ESA/ESOC, Darmstadt (Germany), 22-24 January 2019, "**NELIOTA Lunar** impact flash detection and event validation." See: https://conference.sdo.esoc.esa.int/proceedings/neosst1/paper/401 http://adsabs.harvard.edu/abs/2019arXiv190111414L
2019, Jan 31	**Meteor-Radar Station** opened in Natural History Museum of Vienna (Austria). See: https://www.nhm-wien.ac.at/en/research/mineralogy__petrography/meteor See also: https://mailchi.mp/asteroidday/asteroid-day-55-austria-bar-lauretta
2019, Feb	C. de la Fuente Marcos, R. de la Fuente Marcos, 2019, *Monthly Notices of the Royal Astronomical Society: Letters*, 483, L37, "Dancing with **Venus** in the shadow of the **Earth**: a pair of genetically related near-Earth asteroids trapped in a mean-motion resonance." See: http://adsabs.harvard.edu/abs/2019MNRAS.483L..37D
2019, Feb	K.L. Donaldson Hanna, D.L. Schrader, E.A. Cloutis, et al., 2019, *Icarus*, 319, 701, "Spectral characterization of analog samples in anticipation of ***OSIRIS-REx***'s arrival at **Bennu**: a blind test study." See: http://adsabs.harvard.edu/abs/2019Icar..319..701D
2019, Feb	G.R. Harp, J. Richards, P. Jenniskens, S. Shostak, J.C. Tarter, 2019, *Acta Astronautica*, 155, 51, "Radio **SETI** observations of the interstellar object **'Oumuamua**." See: http://adsabs.harvard.edu/abs/2019AcAau.155...51H Erratum, February 2020: https://ui.adsabs.harvard.edu/abs/2020AcAau.167..483H/abstract
2019, Feb	Z.-Y. Lin, W.-H. Ip, C.-C. Ngeow, 2019, *Planetary and Space*

	Science, 166, 54, "**2012 TC4** - an unusual fast-rotating **PHA** with C-type taxonomy." See: http://adsabs.harvard.edu/abs/2019P%26SS..166...54L
2019, Feb	R. Neves, J.-P. Sánchez, 2019, *Journal of Guidance, Control, and Dynamics*, 42, 335, "Multifidelity design of low-thrust resonant captures for Near-Earth Asteroids." See: http://adsabs.harvard.edu/abs/2019JGCD...42..335N
2019, Feb	A.C. Quillen, Y.-H. Zhao, Y.-Y. Chen, R.C. Nelson, 2019, *Icarus*, 319, 312, "Impact excitation of a seismic pulse and vibrational normal modes on asteroid **Bennu** and associated slumping of regolith." See: http://adsabs.harvard.edu/abs/2019Icar..319..312Q
2019, Feb	M. Shyam Prasad, N.G. Rudraswami, A A. De Araujo, V.D. Khedekar, 2019, *Meteoritics & Planetary Science*, 54, 290, "Rare, metal micrometeorites from the Indian Ocean." See: http://adsabs.harvard.edu/abs/2019M%26PS...54..290S
2019, Feb	M.S. Thompson, M.J. Loeffler, R.V. Morris, et al., 2019, *Icarus*, 319, 499, "Spectral and chemical effects of simulated space weathering of the **Murchison CM2 carbonaceous chondrite**." See: http://adsabs.harvard.edu/abs/2019Icar..319..499T
2019, Feb	J.M. Trigo-Rodríguez, A. Rimola, S. Tanbakouei, et al., 2019, *Space Science Reviews*, 215, 18, "Accretion of water in carbonaceous chondrites: current evidence and implications for the delivery of water to early **Earth**." See: http://adsabs.harvard.edu/abs/2019SSRv..215...18T
2019, Feb	L. Zhou, Y.-B. Xu, L.-Y. Zhou, et al., 2019, *Astronomy & Astrophysics*, 622, 97, "Orbital stability of **Earth** Trojans." See: http://adsabs.harvard.edu/abs/2019A%26A...622A..97Z
2019, Feb 1	A. Moro-Martín, 2019, *Astronomical Journal*, 157, 86, "Origin of **1I/'Oumuamua**. II. An ejected exo-**Oort Cloud** object?" See: http://adsabs.harvard.edu/abs/2019AJ....157...86M
2019, Feb 5	ESA **NEOCC** *Newsletter*: February 2019. See: http://neo.ssa.esa.int/
2019, Feb 5	Anon., 2019, *Zwicky Transient Facility News*, 5 February 2019, "Asteroid from 'Rare Species' sighted in the cosmic wild." See: https://www.ztf.caltech.edu/news/asteroid-from-rare-species-sighted-in-the-cosmic-wild See also:

	https://edition.cnn.com/2019/02/07/world/rare-asteroid-venus-zwicky/index.html
2019, Feb 5	D. Byrd, 2019, *EarthSky*, 5 February 2019, "A plan to knock an asteroid off course." See: https://earthsky.org/spac e/aida-didymoon-plan-to-deflect-asteroid
2019, Feb 5	ESA **NEOCC** *Newsletter*: February 2019. See: http://neo.ssa.esa.int/newsletters
2019, Feb 11	L. Foschini, L. Gasperini, C. Stanghellini, et al., 2019, e-print *arXiv*:1810.07427, "The atmospheric fragmentation of the 1908 **Tunguska** cosmic body: reconsidering the possibility of a ground impact." See: http://adsabs.harvard.edu/abs/2018arXiv181007427F
2019, Feb 11	J.A. MacGregor, W.F. Bottke, M.A. Fahnestock, et al., 2019, *Geophysical Research Letters*, 46, 1496, "A possible second large subglacial impact crater in Northwest Greenland." See: https://ui.adsabs.harvard.edu/abs/2019GeoRL..46.1496M/abstract See also: https://news.agu.org/press-release/new-research-finds-possible-second-impact-crater-hiding-under-greenland-ice/
2019, Feb 11	A. Siraj, A. Loeb, 2019, *Astrophysical Journal Letters*, 872, L10, "Identifying interstellar objects trapped in the Solar System through their orbital parameters." See: http://adsabs.harvard.edu/abs/2019ApJ...872L..10S See also: https://www.space.com/astronomers-expect-more-interstellar-objects.html
2019, Feb 11	Apollo NEA **2019 CN5** (H = 27.8 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.31 LD. **[2019-07]** See: 2019 CN5 - SSA , 2019 CN5 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Feb 11-22	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)** ***Scientific and Technical SubCommittee***, **56th Session**, 11-22 February 2019, Vienna (Austria). See: http://www.unoosa.org/oosa/en/ourwork/copuos/schedule.html http://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2019/index.html http://www.unoosa.org/oosa/en/ourwork/copuos/current.html **Among the Technical Presentations:**

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2019, Feb 26, 21:11	Apollo NEA **2019 DF** (H = 29.8 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.41 LD. **[2019-09]** See: 2019 DF - SSA , 2019 DF - JPL Discovery station: … See: http://iawn.net/
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2019, Mar 1	Apollo NEA **2019 EH1** ($H = 29.9$ mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.061 LD **(= 3.68 R_{Earth} from geocenter)**. Minimum miss distance 0.061 LD **(= 3.68 R_{Earth} from geocenter)** . **[2019-10]** See: 2019 EH1 - SSA , 2019 EH1 - JPL Discovery station: … See: http://iawn.net/ See also: **1 Mar 2032**.

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2019, Jun 19	H.J. Melosh (chair), A.W. Harris, I. Bhavya Lal, L. McFadden, M. Mommert, G. Rieke, A. Rivkin, D.J. Scheeres, E. Tedesco, **Committee on Near Earth Object Observations in the Infrared and Visible Wavelengths**, 2019, *Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes*." A Consensus Study Report of the National Academies of Sciences, Engineering and Medicine, See: https://www.nap.edu/catalog/25476/finding-hazardous-asteroids-using-infrared-and-visible-wavelength-telescopes https://www.nap.edu/read/25476/chapter/1 https://www.nap.edu/login.php?record_id=25476&page=https%3A%2F%2Fwww.nap.edu%2Fdownload%2F25476 See also: http://spaceref.com/news/viewsr.html?pid=52605 https://spacepolicyonline.com/news/space-based-infrared-telescope-for-planetary-defense-gets-boost-from-national-academies/
2019, Jun 19	ESA's new mission to intercept a comet: '***Comet Interceptor***', has been selected as ESA's new fast-class mission in its Cosmic Vision Programme. Comprising three spacecraft, it will be the first to visit a truly pristine comet or other interstellar object that is only just starting its journey into the inner Solar System. Foreseen launch to in 2028, to Sun-Earth Lagrange point L2 at 1.5 million kilometres 'behind' Earth as viewed from the Sun. See: http://www.esa.int/Our_Activities/Space_Science/ESA_s_new_mission_to_intercept_a_comet
2019, Jun 20	G. Hautaluoma, A. Johnson, D.C. Agle, 2019, *NASA JPL News*, 20 June 2019, "Small Satellite Concept finalists target **Moon**, **Mars** and beyond," including ***Janus: Reconnaissance Missions to Binary Asteroids*** that will study the formation and evolutionary implications for small "rubble pile" asteroids and build an accurate model of two binary asteroid bodies. PI: Daniel Scheeres, University of Colorado. See: https://www.jpl.nasa.gov/news/news.php?feature=7431
2019, Jun 22, 21:26	**Impact.** Apollo NEA **2019 MO** (H = 29.3 mag, $D \approx 6$ m)

	impacted the **Earth** atmosphere over the Caribbean Sea on 22 June 2019, and exploded at an altitude of ~ 25 km over the sea surface, releasing an energy of 6 kT of TNT. See: 2019 MO - JPL , 2019 MO - SSA See also: **27 Jun 1987**. Object impacted Earth on **22 June 2019,** 21:25:48 Discovery station: **ATLAS-MLO, Mauna Loa** See also: http://iawn.net/ See also: https://www.jpl.nasa.gov/news/news.php?feature=7438 https://www.jpl.nasa.gov/news/news.php?release=2019-127 https://cneos.jpl.nasa.gov/fireballs/ http://neo.ssa.esa.int/newsletters
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2019, Jun 24	Apollo NEA **441987** (**2010 NY65**, $H = 21.4$ mag, $D \approx 228$ m, **PHA**) passed Earth at a nominal miss distance of 7.63 LD. Minimum miss distance 7.63 LD. See: 2010 NY65- SSA , 2010 NY65 - JPL See also: **24 Jun 2017, 24 Jun 2018, 24 Jun 2020, 25 Jun 2181**.
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- K. Fast, "**NEOO** program." See: https://www.lpi.usra.edu/sbag/meetings/jun2019/presentations/Fast.pdf
- L. Johnson, 2019, **Planetary Defense Coordination Office**. See: https://www.lpi.usra.edu/sbag/meetings/jun2019/presentations/Johnson-2.pdf
- B. Barbee, 2019, "Summary of the 6th IAA ***Planetary Defense Conference***." See: https://www.lpi.usra.edu/sbag/meetings/jun2019/presentations/Barbee.pdf
- P. Chodas, 2019, "***Planetary Defense Conference*** impact exercise." See: https://www.lpi.usra.edu/sbag/meetings/jun2019/presentations/Chodas.pdf
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- A. Virkki, 2019, "**Arecibo Observatory**, Puerto Rico. **Planetary Radar Program**." See: https://www.lpi.usra.edu/sbag/meetings/jun2019/presentations/Virkki.pdf
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2019, Jun 30	Apollo NEA **2020 CD3** (*H* = 31.8 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2019-29]** See: 2020 CD3 - S2P , 2020 CD3 – JPL Discovery station: calculated See also**: 16 Jan 2019, 4 Apr 2019**, **10 Sep 2019**, **18 Nov 2019, 13 Feb 2020**.
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2019, Jul 5	ESA **NEOCC** *Newsletter*: July 2019. Known NEO's: 20323 asteroids and 107 comets. See: http://neo.ssa.esa.int/newsletters
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	Contribution No. 2089, id.6013, “Fresh impact craters and clusters on **Mars**: what do they tell us about **Mars** and asteroids?” See: http://adsabs.harvard.edu/abs/2019LPICo2089.6013H - H. Kato, H. Yabuta, 2019, *LPI Contribution* No. 2157, 2019, id.6353, "Polycyclic aromatic hydrocarbons and aliphatic hydrocarbons in **Jbilet Winselwan** carbonaceous cm chondrite, a possible analog of asteroid **Ryugu**'s surface." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6353K/abstract - M.S. Kelly, R.R. Landis, V. Reddy, 2019, *LPI Contribution* No. 2157, 2019, id.6410, "Planetary Defense exercises with real asteroids: **2012 TC4** and **1999 KW4**." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6410K/abstract - G.G. Kochemasov, 2019, *LPI Contribution* No. 2157, 2019, id.6038, "Asteroid **Ryugu**: a "Diamond" in the sky like many other small celestial bodies." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6038K/abstract - A.A. Mardon, G. Zhou, 2019, *LPI Contribution* No. 2157, 2019, id.6189, "Asteroid mining and in-situ mineral resource utilization." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6189M/abstract - A.A. Mardon, G. Zhou, 2019, LPI Contribution No. 2157, 2019, id.6498, "**Asteroid Impact ALert System** [**ATLAS**]." See: http://adsabs.harvard.edu/abs/2019LPICo2157.6498M - T. Matsumoto, A. Miyake, D. Harries, et al., 2019, *LPI Contribution* No. 2157, 2019, id.6213, "Shock melting features in regolith particles of S-type asteroid **Itokawa**." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6213M/abstract - T.J. McCoy, H.C. Connolly, C.M. Corrigan, …, ***Osiris-REx*** Team, 2019, *LPI Contribution* No. 2157, 2019, id.6428, "Brecciated boulders: evidence for impact mixing on **Bennu**'s parent body." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6428M/abstract - S. McMullan, G.S. Collins, T.M. Davison, 2019, *LPI Contribution* No. 2157, 2019, id.6354, "Asteroid to **Airburst**; comparing semi-analytical **Airburst** models to hydrocodes." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6354M/abstract - T. Nakamura, S. Watanabe, M. Hirabayashi, M. et al., 2019, *LPI Contribution* No. 2157, 2019, id.6306, "***Hayabusa2***: current summary." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6306N/abstract - K. Nakamura-Messenger, H.C. Connolly, D.S. Lauretta, S. Messenger, 2019, "The ***OSIRIS-REx*** science value map of asteroid **Bennu**." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6188N/abstract - T. Okada, T. Fukuhara, S. Tanaka, et al., 2019, *LPI Contribution* No. 2157, 2019, id.6303, "Thermal inertia of C-type Near-Earth Asteroid **162173 Ryugu** determined from the dawn side observations by **Thermal Infrared Imager**." See: https://ui.adsabs.harvard.edu/abs/2019LPICo2157.6303O/abstract

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2019, Jul 9 07:20	Amor NEA **2019 MB4** (*H* = 26.1 mag, *D* ≈ 22 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2019-31]** See: 2019 MB4 - SSA , 2019 MB4 - JPL Discovery station: … See: http://iawn.net/
2019, Jul 9 12:07	Apollo NEA **2019 NF7** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.98 LD. **[2019-32]** See: 2019 NF7 - SSA , 2019 NF7 - JPL Discovery station: … See: http://iawn.net/
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2019, Jul 10	Amor NEA **2019 NN3** (*H* = 24.8 mag, *D* ≈ 40 m) passed Earth at a nominal miss distance of 0.83 LD. Minimum miss distance 0.83 LD. **[2019-33]** See: 2019 NN3 - SSA , 2019 NN3 - JPL See: http://iawn.net/
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2019, Jul 24	Apollo NEA **2019 OD** ($H = 23.5$ mag, $D \approx 70$ m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.93 LD. **[2019-34]** See: 2019 OD - SSA , 2019 OD - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2019, Jul 25	Apollo NEA **2019 OK** ($H = 23.1$ mag, $D \approx 80$ m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2019-35]** Largest asteroid to pass this close to **Earth** in a century See: 2019 OK - SSA , 2019 OK - JPL Discovery station: **SONEAR Observatory, Oliveira** See: http://iawn.net/ See also:

	http://www.sci-news.com/astronomy/asteroid-2019-ok-07446.html http://neo.ssa.esa.int/newsletters [August] https://cneos.jpl.nasa.gov/news/news203.html https://en.wikipedia.org/wiki/2019_OK
2019, Jul 26	Aten NEA **2010 PK9** (*H* = 22.0 mag, *D* ≈ 143 m, **PHA**) passed Earth at a nominal miss distance of 8.20 LD. Minimum miss distance 8.20 LD. See: 2010 PK9 - SSA , 2010 PK9 - JPL
2019, Jul 28	Apollo NEA **2019 OD3** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2019-36]** See: 2019 OD3 - SSA , 2019 OD3 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2019, Jul 29	Apollo NEA **2019 ON3** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.56 LD. Minimum miss distance 0.55 LD. **[2019-37]** See: 2019 ON3 - SSA , 2019 ON3 - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
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2019, Aug	J.V. DeMartini, D.C. Richardson, O.S. Barnouin, et al., 2019, *Icarus*, 328, 93, "Using a discrete element method to investigate seismic response and spin change of **99942 Apophis** during its 2029 tidal encounter with **Earth**." See: http://adsabs.harvard.edu/abs/2019Icar..328...93D

2019, Aug	S.K. Fieber-Beyer, M.J. Gaffey, 2019, *Icarus*, 328, 23, "NEA **162385 (2000 BM19)**: near-infrared compositional analysis of a mining target." See: http://adsabs.harvard.edu/abs/2019Icar..328...23F
2019, Aug	M.P. Gillman, H.E. Erenler, P.J. Sutton, 2019, *International Journal of Astrobiology*, 18, 323, "Mapping the location of terrestrial impacts and extinctions onto the spiral arm structure of the Milky Way." See: http://adsabs.harvard.edu/abs/2019IJAsB..18..323G
2019, Aug	E. Grishin, H.B. Perets, Y. Avni, 2019, *Monthly Notices of the Royal Astronomical Society*, 487, 2335, "Planet seeding and lithopanspermia through gas-assisted capture of interstellar objects." See: http://adsabs.harvard.edu/doi/10.1093/mnras/stz1505
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2019, Aug 1	Apollo NEA **2019 PM** (*H* = 23.5 mag, *D* ≈ 70 m) passed Earth at a nominal miss distance of 7.88 LD. Minimum miss distance 7.84 LD. See: 2019 PM - SSA , 2019 PM – JPL
2019, Aug 5	ESA **NEOCC** *Newsletter*: August 2019. See: http://neo.ssa.esa.int/newsletters
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2019, Aug 10	Aten NEA **2006 QQ23** (*H* = 20.1 mag, *D* ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 19.37 LD. Minimum miss distance 19.37 LD. See: 2006 QQ23 - SSA , 2006 QQ23 - JPL See also: https://www.space.com/large-asteroid-2006-QQ23-earth-flyby.html https://en.wikipedia.org/wiki/2006_QQ23
2019, Aug 16	Apollo NEA **2019 PJ** (*H* = 24.1 mag, *D* ≈ 50 m) passed Earth at a nominal miss distance of 8.74 LD. Minimum miss distance 8.68 LD. See: 2019 PJ - SSA , 2019 PJ – JPL

2019, Aug 19	M. Bartels, 2019, *Space.com*, 19 August 2019, "Let's talk asteroid Apophis, Planetary Defense and Elon Musk." See: https://www.space.com/elon-musk-asteroid-apophis-and-planetary-defense.html
2019, Aug 20, 11:5	Apollo NEA **2019 QB1** (H = 27.5 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.32 LD. Minimum miss distance 0.32 LD. **[2019-38]** See: 2019 QB1 - SSA , 2019 QB1 – JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
2019, Aug 20 18:12	Apollo NEA **2019 QH2** (H = 30.4 mag, $D \approx$ 2.9 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2019-39]** See: 2019 QH2 – SSA , 2019 QH2 - JPL Discovery station: … See: http://iawn.net/
2019, Aug 22	Apollo NEA **2019 QD** (H = 28.6 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.78 LD. Minimum miss distance 0.78 LD. **[2019-40]** See: 2019 QD - SSA , 2019 QD – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Aug 23	R. Jaumann, N. Schmitz, T.-M. Ho, et al., 2019, *Science*, 365, 817, "Images from the surface of asteroid **Ryugu** show rocks similar to carbonaceous chondrite meteorites." See: https://science.sciencemag.org/content/365/6455/817 See also: https://www.dlr.de/dlr/presse/en/desktopdefault.aspx/tabid-10172/213_read-37306/year-all/#/gallery/36381
2019, Aug 26	Z. Kotala, 2019, *UCFToday, College and Campus News*, 26 August 2019, "**Arecibo Observatory** gets $19 million NASA grant to help protect **Earth** from asteroids." See: https://www.ucf.edu/news/arecibo-observatory-gets-19-million-nasa-grant-to-help-protect-earth-from-asteroids/ See also: https://www.space.com/arecibo-observatory-hunting-asteroids-for-nasa.html
2019, Aug 26 08:51	Apollo NEA **2019 QR8** (H = 28.1 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.77 LD. **[2019-41]** See: 2019 QR8 – SSA , 2019 QR8 - JPL

	Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2019, Aug 26 15:14	Apollo NEA **2019 QQ3** (H = 29.1 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2019-42]** See: 2019 QQ3 – SSA , 2019 QQ3 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Aug 28	Apollo NEA **2019 OU1** (H = 23.1 mag, $D \approx$ 90 m) passed Earth at a nominal miss distance of 2.68 LD. Minimum miss distance 2.67 LD. See: 2019 OU1 - SSA , 2019 OU1 - JPL
2019, Aug 30	Discovery of interstellar comet **C/2019 Q4 (Borisov) = I/Borisov**. Perihelium at 2.01 AE on 8 December 2019. Close Earth approach at 1.9 AE late December 2019. See: https://ssd.jpl.nasa.gov/sbdb.cgi?ID=dK19Q040 https://www.iau.org/news/pressreleases/detail/iau1910/ https://commons.wikimedia.org/wiki/File:The_Solar_System_as_seen_from_interstellar_comet_Borisov_C2019_Q4.gif https://en.wikipedia.org/wiki/2I/Borisov
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2019, Sep 5	Apollo NEA **2019 RP1** (H = 27.6 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.099 LD (**= 5.9 R_{Earth} from the geocenter**). Minimum miss distance 0.098 LD. **[2019-44]** See: 2019 RP1 – SSA , 2019 RP1 - JPL Discovery station: **Catalina Sky Survey** See also: http://iawn.net/
2019, Sep 6	ESA **NEOCC** *Newsletter*: September 2019. See: http://neo.ssa.esa.int/newsletters
2019, Sep 7	Apollo NEA **2019 RC1** (H = 28.9 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.48 LD. Minimum miss distance 0.48 LD. **[2019-45]** See: 2019 RC1 – SSA , 2019 RC1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/

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2019, Sep 11-13	***AIDA International Workshop***, 11-13 September 2019, Rome (Italy). See: https://www.cosmos.esa.int/web/aida-international-workshop/home **Presentations:** ftp://ssh.esac.esa.int/pub/mkueppers/AIDAWorkshopRome2019
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2019, Sep 16	Apollo NEA **2019 SJ** ($H = 27.6$ mag, $D \approx 11$ m) passed Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.64 LD. **[2019-47]** See: 2019 SJ – SSA , 2019 SJ - JPL Discovery station: … See: http://iawn.net/
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2019, Sep 21 02:48	Apollo NEA **2019 SU2** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2019-48]** See: 2019 SU2 – SSA , 2019 SU2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 21 06:46	Apollo NEA **2019 SD1** (H = 28.4 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2019-49]** See: 2019 SD1 – SSA , 2019 SD1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 21 07:12	Apollo NEA **2019 SS2** (H = 30.5 mag, $D \approx$ 2.9 m) passed Earth at a nominal miss distance of 0.30 LD. Minimum miss distance 0.30 LD. **[2019-50]** See: 2019 SS2 – SSA , 2019 SS2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 22	Apollo NEA **2019 SS3** (H = 26.4 mag, $D \approx$ 19 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2019-51]** See: 2019 SS3 – SSA , 2019 SS3 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2019, Sep 22-25	***2019 Geological Society of America Annual Meeting***, 22-25 September 2019, Phoenix (AZ, USA). See:

	https://www.geosociety.org/GSA/Events/Annual_Meeting/GSA/Events/gsa2019.aspx
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2019, Sep 24	S.P.S. Gulick, T.J. Bralower, J.Ormö, et al., 2019, *Proceedings National Academy of Sciences*, 116, 19342, "The first day of the Cenozoic." See: https://www.pnas.org/content/early/2019/09/04/1909479116 https://doi.org/10.1073/pnas.1909479116 See also: https://news.utexas.edu/2019/09/09/rocks-at-asteroid-impact-site-record-first-day-of-dinosaur-extinction/ https://www.jsg.utexas.edu/news/2018/05/life-recovered-rapidly-at-impact-site-of-dino-killing-asteroid/ http://www.jsg.utexas.edu/news/2016/11/dino-killing-asteroid-made-rocks-behave-like-liquid-and-could-have-provided-habitat-for-new-life/
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2019, Sep 27	Apollo NEA **2006 QV89** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 18.02 LD. Minimum miss distance 18.02 LD. See: 2019 QV89 – SSA , 2019 QV89 – JPL See also: https://cneos.jpl.nasa.gov/news/news204.html http://neo.ssa.esa.int/newsletters [September]
2019, Sep 28 07:50	Apollo NEA **2019 SX8** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2019-52]** See: 2019 SX8 – SSA , 2019 SX8 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 28 20:31	Apollo NEA **2019 TE** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.88 LD. **[2019-53]** See: 2019 TE – SSA , 2019 TE - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 29	Apollo NEA **2019 TD** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2019-54]** See: 2019 TD – SSA , 2019 TD - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Sep 30-Oct 3	***Large Meteorite Impacts and Planetary Evolution VI***, 30 September – 3 October, 2019, Brasília (Brazil). See: https://www.hou.usra.edu/meetings/lmi2019/

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2019, Oct 3	Apollo NEA **2019 SP3** ($H = 26.6$ mag, $D \approx 17$ m) passed Earth at a nominal miss distance of 0.97 LD. Minimum miss distance 0.97 LD. **[2019-56]** See: 2019 SP3 – SSA , 2019 SP3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2019, Oct 3-6	***38th International Meteor Conference (IMC 2019)***, 3-6 October, 2019, Bollmansruh (Germany). See: https://imc2019.imo.net/
2019, Oct 5	ESA **NEOCC** *Newsletter*. October 2019. See: http://neo.ssa.esa.int/newsletters

2019, Oct 5	Apollo NEA **2019 TN5** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.32 LD. Minimum miss distance 0.32 LD. **[2019-57]** See: 2019 TN5 – SSA , 2019 TN5 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2019, Oct 7	Y. Marrocchi, L. Piani, 2019, *Nature Astronomy*, 3, 889, "The tumultuous childhood of the Solar System." See: https://ui.adsabs.harvard.edu/abs/2019NatAs...3..889M/abstract
2019, Oct 7	C. Zhu, S. Góbi, M.J. Abplanalp, et al., 2019, *Nature Astronomy*, Letter, published 7 October 2019, "Regenerative water sources on surfaces of airless bodies." See: https://www.nature.com/articles/s41550-019-0900-2 See also: https://news.curtin.edu.au/media-releases/curtin-scientist-helps-discover-how-water-is-regenerated-on-asteroids/
2019, Oct 10	National Academies of Sciences, Engineering, and Medicine, 2019, *Finding hazardous asteroids using infrared and visible wavelength telescopes* (Washington, DC: The National Academies Press) https://doi.org/10.17226/25476 . **Contributors** National Academies of Sciences, Engineering, and Medicine; Division on Engineering and Physical Sciences; Space Studies Board; Committee on Near Earth Object Observations in the Infrared and Visible Wavelengths. **Description** Near Earth objects (NEOs) have the potential to cause significant damage on Earth. In December 2018, an asteroid exploded in the upper atmosphere over the Bering Sea (western Pacific Ocean) with the explosive force of nearly 10 times that of the Hiroshima bomb. While the frequency of NEO impacts rises in inverse proportion to their sizes, it is still critical to monitor NEO activity in order to prepare defenses for these rare but dangerous threats. Currently, NASA funds a network of ground-based telescopes and a single, soon-to-expire space-based asset to detect and track large asteroids that could cause major damage if they struck Earth. This asset is crucial to NEO tracking as thermal-infrared detection and tracking of asteroids can only be accomplished on a space-based platform. *Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes* explores the advantages and disadvantages of infrared (IR) technology and visible wavelength observations of NEOs. This report reviews the techniques that could be used to obtain NEO sizes from an infrared spectrum and delineate the

	associated errors in determining the size. It also evaluates the strengths and weaknesses of these techniques and recommends the most valid techniques that give reproducible results with quantifiable errors.
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2019, Oct 10	S.R. Schwartz, J. Thangavelautham, E. Asphaug, et al., 2019, presented at ***International Astronautical Congress 2019***, e-print *arXiv*:1910.04632, "Investigating asteroid surface geophysics with an ultra-low-gravity centrifuge in low-earth orbit." See: https://ui.adsabs.harvard.edu/abs/2019arXiv191004632S/abstract
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2019, Oct 14	P.M. Shober, T. Jansen-Sturgeon, E.K. Sansom, et al., 2019, *Astronomical Journal*, 158, 183, "Identification of a minimoon fireball." See: http://adsabs.harvard.edu/abs/2019AJ....158..183S See also: https://www.space.com/minimoon-fireball-over-australia-desert.html
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2019, Oct 18, 06:23	Apollo NEA **2019 UU1** ($H = 30.5$ mag, $D \approx 2.9$ m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD. **[2019-58]** See: 2019 UU1 – SSA , 2019 UU1 - JPL Discovery station: **Mt. Lemmon Survey**

	See: http://iawn.net/ See also: **16 Apr 1994**.
2019, Oct 18, 09:23	Apollo NEA **2019 UG** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84 LD. **[2019-59]** See: 2019 UG – SSA , 2019 UG - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Oct 19	Apollo NEA **2019 UL3** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2019-60]** See: 2019 UL3 – SSA , 2019 UL3 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Oct 22	D. Bamberger, G. Wells, 2019, *Research Notes of the American Astronomical Society*, 3, 159, "The difficulty of predicting stellar occultations by interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2019RNAAS...3..159B/abstract
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2019, Oct 23	Apollo NEA **2019 UN8** (*H* = 29.7 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.94 LD. Minimum miss distance 0.93 LD. **[2019-61]** See: 2019 UN8 – SSA , 2019 UN8 - JPL

	Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Oct 24	Z. Sekanina, 2019, e-print *arXiv*:1910.11457, "Note on the ***HST*** image of comet **2I/Borisov** taken on 2019 October 12." See: http://adsabs.harvard.edu/abs/2019arXiv191011457S
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2019, Oct 25, 13:30	Apollo NEA **2019 UO8** (H = 29.2 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.41 LD. Minimum miss distance 0.41 LD. **[2019-62]** See: 2019 UO8 – SSA , 2019 UO8 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also**: 2 April 2016**.
2019, Oct 25, 17:21	Apollo NEA **162082** (**1998 HL1**, H = 19.1 mag, $D \approx 500$ m, **PHA**) passed Earth at a nominal miss distance of 16.17 LD. Minimum miss distance 16.17 LD. See: 1998 HL1 – SSA , 1998 HL1 - JPL See also: http://neo.ssa.esa.int/newsletters [October, November] https://www.space.com/asteroid-1998-hl1-earth-flyby-october-2019-webcast.html
2019, Oct 26, 03:07	Apollo NEA **2019 UX12** (H = 28.8 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2019-63]** See: 2019 UX12 – SSA , 2019 UX12 - JPL

	Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **26 Oct 2065.**
2019, Oct 26, 22:02	Apollo NEA **2019 UJ12** (*H* = 22.5 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 7.16 LD. Minimum miss distance 7.15 LD. See: 2019 UJ12 – SSA , 2019 UJ12 – JPL
2019, Oct 27	Apollo NEA **2019 UD10** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2019-64]** See: 2019 UD10 - SSA , 2019 UD10 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Oct 29	Apollo NEA **2019 UB8 = 2019 US8** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.49 LD. **[2019-65]** See: 2019 UB8 – SSA , 2019 UB8 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Oct 31	Aten NEA **2019 UN13** (*H* = 32.2 mag, *D* ≈ 1.3 m) passed Earth at a nominal miss distance of 0.033 LD **(= 1.98 R_{Earth} from the geocenter)**. Minimum miss distance 0.032 LD **(=1.95 R_{Earth} from the geocenter**). **[2019-66]** See: 2019 UN13 – SSA , 2019 UN13 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **2 Nov 2145**. See also: http://neo.ssa.esa.int/newsletters [June 2020] https://en.wikipedia.org/wiki/2019_UN13
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2019, Nov	C.A. Goodrich, M.E. Zolensky, A.M. Fioretti, et al., 2019, *Meteoritics & Planetary Science*, 54, 2769, "The first samples from **Almahata Sitta** showing contacts between ureilitic and chondritic lithologies: Implications for the structure and

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2019, Nov 1	Apollo NEA **2019 UG11** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.55 LD. Minimum miss distance 0.55 LD. **[2019-67]** See: 2019 UG11 – SSA , 2019 UG11 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2019, Nov 2	Apollo NEA **2019 VA** (*H* = 28.4 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2019-68]** See: 2019 VA – SSA , 2019 VA - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **7 Nov 2016**.
2019, Nov 4, 09:56	Apollo NEA **2019 VD** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2019-69]** See: 2019 VD – SSA , 2019 VD - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
2019, Nov 4, 10:30	Apollo NEA **2019 VR** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.35 LD. **[2019-70]** See: 2019 VR – SSA , 2019 VR - JPL Discovery station: … See: http://iawn.net/
2019, Nov 5	ESA **NEOCC** *Newsletter*. November 2019. See: http://neo.ssa.esa.int/newsletters
2019, Nov 5-7	***Asteroid Science in the Age of Hayabusa2 and OSIRIS-REx Workshop***, 5-7 November 2019, Tucson (AZ, USA). See: https://corex.lpl.arizona.edu/international-workshop **Program:** https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/asteroidscience2019_program.htm **Among the oral papers:** - M.A. Barucci, P.H. Hasselmann, M. Fulchignoni, et al., 2019, "**Ryugu** and **Bennu**: multivariate statistical analysis of spectral

	data obtained by the ***Hayabusa2*** and ***OSIRIS-REx*** missions [#2039].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2039.pdf - E.B. Bierhaus, D. Trang, O.S. Barnouin, et al., 2019, “Impact craters on **Bennu**: their morphology, size-frequency distribution, and correlation with other data sets [#2129].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2129.pdf - W.F. Bottke, A. Moorhead, C.W. Hergenrother, et al., 2019, “Meteoroid impacts as the source of Bennu’s particle ejection events [#2064].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2064.pdf - S.R. Chesley, A.B. Davis, A.S. French, et al., 2019, “Trajectories of ejected particles in Bennu’s environment [#2124].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2124.pdf - B.E. Clark, S.M. Ferrone, H.H. Kaplan,et al., 2019, “Overview of the search for space weathering signals on the surface of **Bennu**: one rock type, or two? [#2125].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2125.pdf - R.T. Daly, E.B. Bierhaus, O.S. Barnouin, et al., 2019, “The variable depth-to-diameter ratios of candidate impact craters on **Bennu**: inferences and implications [#2030].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2030.pdf - D. Domingue, K. Kitazato, M. Matsuoka, et al., 2019, “Photometric properties of **Ryugu**’s the surface from both ***Hayabusa2*** **NIRS3** and **ONC-T** Instruments [#2104].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2104.pdf - C.A. Goodrich, M.E. Zolensky, A.M. Fioretti, et al., 2019, “Distinguishing differentiated dark asteroids from primitive dark asteroids: clues and cautions from asteroid **2008 TC3** and the **Almahata Sitta Meteorite** [#2107].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2107.pdf - M. Grott, J. Biele, P. Michel, et al., 2019, “Macro-porosity and grain density of C-type asteroid **(162173) Ryugu** [#2038].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2038.pdf - V.E. Hamilton, A.A. Simon, H.H. Kaplan, et al., 2019, “The global mineralogy of **(101955) Bennu** from **VNIR** and **TIR** observations during the detailed survey phase of the ***OSIRIS-REx*** mission [#2044].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2044.pdf - R.D. Hanna, V.E. Hamilton, C.W. Haberle, et al., 2019, “What is the hydrated phase on **Bennu**’s surface? [#2029].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2029.pdf - M. Hirabayashi, Y. Cho, T. Morota, et al., 2019, “Spin-driven evolution of top-shaped asteroids at fast and slow spins seen from **(101955) Bennu** and **(162173) Ryugu** [#2047].” See: https://www.hou.usra.edu/meetings/asteroidscience2019/pdf/2047.pdf - H.H. Kaplan, D.N. DellaGiustina, A.A. Simon, et al., 2019, “Detection of pyroxenes on **Bennu** with the ***OSIRIS-REx*** **Visible**

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2019, Oct 11	X.-P. Lu, D. Jewitt, 2019, *Astronomical Journal*, 158, 220, “Dependence of lightcurves on phase angle and asteroid shape.” See: https://ui.adsabs.harvard.edu/abs/2019AJ....158..220L/abstract
2019, Nov 6	Apollo NEA **2019 VS4** (H = 28.0 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.36

	LD. **[2019-71]** See: 2019 VS4 – SSA , 2019 VS4 - JPL Discovery station: **ISON-Byurakan Observatory** See: http://iawn.net/
2019, Nov 9, 17:29	Apollo NEA **2019 VB5** (*H* = 31.7 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2019-72]** See: 2019 VB5 – SSA , 2019 VB5 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **25 Apr 2010**.
2019, Nov 9, 23:16	Apollo NEA **2019 VF5** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2019-73]** See: 2019 VF5 – SSA , 2019 VF5 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **10 Nov 1990**.
2019, Nov 11	E.G. Flekkøy, J.X. Luu, R. Toussaint, 2019, *Astrophysical Journal Letters*, 885, L41, "The interstellar object **'Oumuamua** as a fractal dust aggregate." See: https://ui.adsabs.harvard.edu/abs/2019ApJ...885L..41F/abstract
2019, Nov 13	Apollo NEA **2019 UN12** (*H* = 22.2 mag, *D* ≈ 130 m) passed Earth at a nominal miss distance of 3.74 LD. Minimum miss distance 3.74 LD. See: 2019 UN12 – SSA , 2019 UN12 – JPL
2019, Nov 13	The "Goodbye **Ryugu**" campaign. On November 13, 2019 at 10:05 JST (onboard time), the ***Hayabusa2*** spacecraft departed from asteroid **Ryugu** to return to **Earth**. Until November 18 ~ 19, images of the receding Ryugu will be captured by the camera mounted on the spacecraft. After this time, the spacecraft will perform an attitude control maneuver to the orientation needed to operate the ion engines and will no longer be able to take photographs of **Ryugu**. Asteroid sample return to **Earth** in December 2020. See: https://global.jaxa.jp/press/2019/11/20191113a.html http://www.hayabusa2.jaxa.jp/en/galleries/onc/nav20191113/ http://www.hayabusa2.jaxa.jp/en/topics/20191113e_SAYONARA_Ryugu/ https://www.space.com/hayabusa2-spacecraft-leaves-asteroid-ryugu.html See also **27 June 2018**.

2019, Nov 15	M.W. Busch, S.J. Ostro, L.A.M. Benner, et al., 2019, *Icarus*, 333, 548, "Corrigendum to "Radar observations and the shape of near-Earth asteroid **2008 EV5**" [*Icarus* 212 (2011) 649–660]." See: https://ui.adsabs.harvard.edu/abs/2019Icar..333..548B/abstract
2019, Nov 15	O.G. Gladysheva, 2019, *Planetary and Space Science*, 178, 104709, "Disintegration of the **Chelyabinsk** cosmic body." See: http://adsabs.harvard.edu/abs/2019P%26SS..17804709G
2019, Nov 15	F.M. McCubbin, J.J. Barnes, 2019, *Earth and Planetary Science Letters*, 526, 115771, "Origin and abundances of H_2O in the terrestrial planets, **Moon**, and asteroids." See: http://adsabs.harvard.edu/abs/2019E%26PSL.52615771M
2019, Nov 15	N. Moskovitz, P. Fatka, D. Farnocchia, et al., 2019, *Icarus*, 333, 165, "A common origin for dynamically associated Near-Earth Asteroid pairs." See: http://adsabs.harvard.edu/abs/2019Icar..333..165M
2019, Nov 15	K. Ogawa , M. Hamm, M. Grott, et al., 2019, *Icarus*, 333, 318, "Possibility of estimating particle size and porosity on **Ryugu** through **MARA** temperature measurements." See: https://ui.adsabs.harvard.edu/abs/2019Icar..333..318O/abstract
2019, Nov 15	S. Potin, P. Beck, B. Schmitt, F. Moynie, 2019, *Icarus*, 333, 415, "Some things special about NEAs: geometric and environmental effects on the optical signatures of hydration." See: http://adsabs.harvard.edu/abs/2019Icar..333..415P
2019, Nov 15	Y. Qi, A. de Ruiter, 2019, *Icarus*, 333, 52, "Planar Near-Earth Asteroids in resonance with the **Earth**." See: http://adsabs.harvard.edu/abs/2019Icar..333...52Q
2019, Nov 15	L. Sokolov, G. Kuteeva, N. Petrov, B. Eskin, 2019, *AIP Conference Proceedings*,2171, 130019, "Hazardous near-Earth asteroids approach." See: https://ui.adsabs.harvard.edu/abs/2019AIPC.2171m0019S/abstract
2019, Nov 15	X. Zeng, X. Li, D.J.P. Martin, et al., 2019, *Icarus*, 333, 371, "The **Itokawa** regolith simulant IRS-1 as an S-type asteroid surface analogue." See: https://ui.adsabs.harvard.edu/abs/2019Icar..333..371Z/abstract
2019, Nov 18	Z. Sekanina, 2019, e-print *arXiv*:1911.06271, "Sublimation of water ice from a population of large, long-lasting grains near the

	nucleus of **2I/Borisov**?" See: https://ui.adsabs.harvard.edu/abs/2019arXiv191106271S/abstract
2019, Nov 18	Apollo NEA **2020 CD3** (*H* = 31.8 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2019-74]** See: 2020 CD3 - S2P , 2020 CD3 – JPL Discovery station: calculated See also**: 16 Jan 2019, 4 Apr 2019**, **30 Jun 2019**, **10 Sep 2019, 13 Feb 2020**.
2019, Nov 19, 08:0	Apollo NEA **2019 WH** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.22 LD. **[2019-75]** See: 2019 WH – SSA , 2019 WH - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2019, Nov 19, 23:4	Apollo NEA **2019 WV1** (*H* = 28.0 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.72 LD. **[2019-76]** See: 2019 WV1 – SSA , 2019 WV1 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2019, Nov 21	Aten NEA **481394** (**2006 SF6**, *H* = 19.7 mag, *D* ≈ 400 m, **PHA**) passed Earth at a nominal miss distance of 11.23 LD. Minimum miss distance 11.23 LD. See: 2006 SF6 – SSA , 2006 SF6 - JPL See also: http://neo.ssa.esa.int/newsletters (November) https://www.newsweek.com/enormous-asteroid-whiz-planet-tomorrow-1472726
2019, Nov 22	D. Jewitt, J. Luu, 2019, *Astrophysical Journal Letters*, 886, L29, "Initial characterization of interstellar comet **2I/2019 Q4 (Borisov)**." See: https://ui.adsabs.harvard.edu/abs/2019ApJ...886L..29J/abstract
2019, Nov 22	N. Kiselev, N. Karpov, O. Ivanova, et al., 2019, *Research Notes of the American Astronomical Society*, 3, 178, "Polarimetry and photometry of the NEA **(162082) 1998 HL1**." See: https://ui.adsabs.harvard.edu/abs/2019RNAAS...3..178K/abstract
2019, Nov 23	Apollo NEA **2019 WG2** (*H* = 25.1 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 0.47 LD. Minimum miss distance 0.47 LD. **[2019-77]**

	See: 2019 WG2 – SSA , 2019 WG2 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2019, Nov 26	P.A. Dybczyński, M. Królikowska, R. Wysoczańska, 2019, e-print *arXiv*:1909.10952, "**Kruger 60** -- a plausible home system of the interstellar comet **C/2019 Q4**." See: https://ui.adsabs.harvard.edu/abs/2019arXiv190910952D/abstract
2019, Nov 26	ESA Council meeting at ordinary level, Sevilla (Spain). See: https://www.esa.int/About_Us/Welcome_to_ESA/ESA_on_the_way_to_Space19_and_beyond
2019, Nov 26	M. Gannon, 2019, *Space.com*, 26 November 2019, "Will Europe finally get its asteroid-deflection mission off the ground?" See: https://www.space.com/hera-asteroid-deflection-mission-european-support.html See also: https://videos.space.com/m/23qvbGX9/esa-hera-mission-to-test-asteroid-deflection-technique-overview?list=9wzCTV4g https://www.space.com/hera-self-driving-spacecraft-asteroid-defense.html https://www.space.com/19933-asteroid-deflection-mission-aida-didymos.html https://www.space.com/brian-may-video-asteroid-mission-hera.html
2019, Nov 26	J. Shelton, 2019, *Yale News*, 26 November 2016, "New image offers close-up view of interstellar comet." See: https://news.yale.edu/2019/11/26/new-image-offers-close-view-interstellar-comet See also: https://www.space.com/interstellar-comet-borisov-photo-keck-observatory.html
2019, Nov 27-28	ESA Council meeting at ministerial level, called '*Space19+*', Sevilla (Spain). See: https://www.esa.int/About_Us/Welcome_to_ESA/ESA_on_the_way_to_Space19_and_beyond http://blogs.esa.int/space19plus/ http://esamultimedia.esa.int/docs/corporate/Space19+flyers_SSA_LR.pdf https://www.esa.int/Safety_Security/Hera https://mailchi.mp/asteroidday/asteroid-day-62-hera-puerto-rico-fiaschetti-tomorrow-street?e=db8a8b6284 https://www.esa.int/About_Us/Corporate_news/Record_funding_for_European_space_investments_in_Seville https://www.esa.int/Newsroom/Press_Releases/ESA_ministers_commit_to_biggest_ever_budget

2019, Nov 30, 03:0	Apollo NEA **2019 WQ3** (*H* = 22.6 mag, *D* ≈ 110 m) passed Earth at a nominal miss distance of 9.66 LD. Minimum miss distance 9.65 LD. See: 2019 WQ3 – SSA , 2019 WQ3 - JPL
2019, Nov 30, 20:0	Apollo NEA **2019 WJ4** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD. **[2019-78]** See: 2019 WJ4 – SSA , 2019 WJ4 - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
2019, Dec	M. Cortés-Contreras, F.M. Jiménez-Esteban, M. Mahlke, et al., 2019, *Monthly Notices of the Royal Astronomical Society*, 490, 3046, "Identification of asteroids using the Virtual Observatory: the WFCAM Transit Survey." See: https://ui.adsabs.harvard.edu/abs/2019MNRAS.490.3046C/abstract
2019, Dec	A.J. King, H.C. Bates, D. Krietsch, et al., 2019, *Geochemistry*, 79, 125531, "The Yamato-type (CY) carbonaceous chondrite group: analogues for the surface of asteroid **Ryugu**?" See: https://ui.adsabs.harvard.edu/abs/2019ChEG...7915531K/abstract
2019, Dec	S. Kohler, 2019, *AAS Nova Highlight*, 18 Dec 2019, id.6062, "Selections from 2019: Explanation for an interstellar visitor." See: https://ui.adsabs.harvard.edu/abs/2019nova.pres.6062K/abstract
2019, Dec	H. Kučáková, O. Mikhalchenko, M. Popescu, et al., 2019, *Contributions of the Astronomical Observatory Skalnaté Pleso*, 49, 532, "Optical spectra of near-Earth asteroids **(381906) 2010 CL19** and **(453778) 2011 JK**." See: https://ui.adsabs.harvard.edu/abs/2019CoSka..49..532K/abstract
2019, Dec	C.C. Monson, D. Sweet, B. Segvic, et al., 2019, *Meteoritics & Planetary Science*, 54, 2927, "The Late Ordovician (Sandbian) **Glasford structure**: a marine-target impact crater with a possible connection to the **Ordovician meteorite** event." See: https://ui.adsabs.harvard.edu/abs/2019M%26PS...54.2927M/abstract
2019, Dec	T. Ott, E. Drolshagen, D. Koschny, et al., 2019, *Planetary and Space Science*, 179, 104715, "Combination of infrasound signals and complementary data for the analysis of bright **fireballs.**" See: https://ui.adsabs.harvard.edu/abs/2019P%26SS..17904715O/abstract

2019, Dec	F. Preusker, F. Scholten, S. Elgner, et al., 2019, *Astronomy & Astrophysics*, *Letter*, 632, L4, "The **MASCOT** landing area on asteroid **(162173) Ryugu**: stereo-photogrammetric analysis using images of the **ONC** onboard the ***Hayabusa2*** spacecraft." See: https://ui.adsabs.harvard.edu/abs/2019A%26A...632L...4P/abstract
2019, Dec	F. Scholten, F. Preusker, S. Elgner, et al., 2019a, *Astronomy & Astrophysics*, *Letter*, 632, L3, "The descent and bouncing path of the ***Hayabusa2*** lander **MASCOT** at asteroid **(162173) Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2019A%26A...632L...3S/abstract
2019, Dec	F. Scholten, F. Preusker, S. Elgner, et al., 2019b, *Astronomy & Astrophysics*, *Letter*, 632, L5, "The ***Hayabusa2*** lander **MASCOT** on the surface of asteroid **(162173) Ryugu** - stereo-photogrammetric analysis of **MASCam** image data." See: https://ui.adsabs.harvard.edu/abs/2019A%26A...632L...5S/abstract
2019, Dec 2	C. Gohd, 2019, *Space.com*, 2 December 2019, "Scientists spot rare minimoon **fireball** over Australia." See: https://www.space.com/minimoon-fireball-over-australia-desert.html See also: **14 Oct 2019**.
2019, Dec 2	R. Tartèse, M. Anand, J. Gattacceca, et al., 2019, *Space Science Reviews*, 215, 54, "Constraining the evolutionary history of the **Moon** and the inner Solar System: a case for new returned lunar samples." See: https://ui.adsabs.harvard.edu/abs/2019SSRv..215...54T/abstract
2019, Dec 2	I. Wlodarczyk, 2019, *Open Astronomy*, 28, 180, "The potentially hazardous NEA **2001 BB16**." See: https://ui.adsabs.harvard.edu/abs/2019OAst...28..180W/abstract
2019, Dec 3	J. Liu, J. Zheng, M. Li, 2019, *Astrophysics and Space Science*, 364, 215, "Dry mass optimization for the impulsive transfer trajectory of a near-Earth asteroid sample return mission." See: https://ui.adsabs.harvard.edu/abs/2019Ap%26SS.364..215L/abstract
2019, Dec 4	M.-T. Hui, M.M. Knight, 2019, *Astronomical Journal*, 158, 256, "New insights into interstellar object **1I/2017 U1 ('Oumuamua)** from ***SOHO/STEREO*** nondetections." See: https://ui.adsabs.harvard.edu/abs/2019AJ....158..256H/abstract
2019, Dec 5	ESA **NEOCC** *Newsletter*. December 2019. Among the items:

	* The ESA Ministerial Council took place in Seville (Spain) on 27-28 November. Budgets for the various ESA programmes were approved for the coming three years. In particular, the **Space Safety Programme (S2P)** has been adopted as the successor of the **Space Situational Awareness (SSA)** programme. * ESA's Planetary Defence contribution to the ***AIDA*** mission has been adopted. This includes the approval for implementation of the ***Hera*** mission for a nominal launch date in October 2024. See: http://neo.ssa.esa.int/newsletters
2019, Dec 6	D.S. Lauretta, C.W. Hergenrother, S.R. Chesley, et al., 2019, *Science*, 366, eaay3544, "Episodes of particle ejection from the surface of the active asteroid **(101955) Bennu**." See: https://ui.adsabs.harvard.edu/abs/2019Sci...366.3544L/abstract See also: https://www.jpl.nasa.gov/news/news.php?feature=7553 https://www.wired.com/story/no-one-knows-why-rocks-are-exploding-from-asteroid-bennu/
2019, Dec 8	S. Mathewson, 2019, *Space.com*, 8 December 2019, "Interstellar comet **Borisov** makes closest approach to the Sun." See: https://www.space.com/interstellar-comet-borisov-perihelion-telescope-viewing.html See also: https://www.skyandtelescope.com/astronomy-news/will-amateurs-be-able-to-see-the-new-interstellar-comet/
2019, Dec 9	C.-H. Lee, H.-W. Lin, Y.-T. Chen, S.-F. Yen, 2019, *Research Notes of the American Astronomical Society*, 3, 184, "FLAMINGOS-2 infrared photometry of **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2019RNAAS...3..184L/abstract
2019, Dec 9	K. Meech, S.N. Raymond, 2019, chapter to appear in *Planetary Astrobiology* (V. Meadows, et al., eds.), e-print *arXiv*:1912.04361, "Origin of **Earth**'s water: sources and constraints." See: https://ui.adsabs.harvard.edu/abs/2019arXiv191204361M/abstract http://astrobiology.com/2019/12/origin-of-earths-water-sources-and-constraints.html
2019, Dec 12	B. Gladman, A. Boley, D. Balam, 2019, *Research Notes of the American Astronomical Society*, 3, 187, "The inbound light curve of **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2019RNAAS...3..187G/abstract
2019, Dec 12	D. Jewitt, S. Wolpert, B. Downer, 2019, *Spacetelescope.org*, heic1922 – Photo Release, "***Hubble*** watches interstellar comet

	Borisov speed past the Sun." See: https://www.spacetelescope.org/news/heic1922/ See also: https://www.space.com/interstellar-comet-borisov-new-hubble-telescope-photos.html
2019, Dec 12	P. Voosen, 2020, *Science*, 12 December 2019, "NASA picks challenging landing site for its asteroid-sampling robot." See: https://www.sciencemag.org/news/2019/12/nasa-selects-target-asteroid-sampling-campaign-summer
2019, Dec 12	A. Witze, 2019, *Nature News*, 12 December 2019, "NASA asteroid hunter chooses landing site on boulder-strewn space rock." See: https://www.nature.com/articles/d41586-019-03795-8 https://www.scientificamerican.com/article/nasa-asteroid-hunter-chooses-landing-site-on-boulder-strewn-space-rock/
2019, Dec 13	Full Moon **Geminids**, *Astronomy Picture of the Day*, 13 December 2019. As Earth crosses through the dusty trail of active asteroid **3200 Phaethon** the meteors will flash through the sky from the shower's radiant in Gemini. See: https://apod.nasa.gov/apod/astropix.html
2019, Dec 16	T.S. Kruijer, T. Kleine, L.E. Borg, 2019, *Nature Astronomy*, 4, 32, "The great isotopic dichotomy of the early Solar System." See: https://www.nature.com/articles/s41550-019-0959-9
2019, Dec 17	C.-H. Lee, 2019, *Geosciences*, 9, 519, "Early observations of the interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2019Geosc...9..519L/abstract
2019, Dec 18	S. Kohler, 2019, *AAS Nova Highlight*, 18 December 2019, id.6062, "Selections from 2019: Explanation for an interstellar visitor." See: https://ui.adsabs.harvard.edu/abs/2019nova.pres.6062K/abstract
2019, Dec 18, 00:12	Apollo NEA **2019 YB** (H = 29.7 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.43 LD. **[2019-79]** See: 2019 YB – S2P , 2019 YB – JPL Discovery station: … See: http://iawn.net/
2019, Dec 18, 15:12	Apollo NEA **2019 YS** (H = 31.5 mag, $D \approx 1.8$ m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.17 LD. **[2019-80]**

	See: 2019 YS – S2P , 2019 YS – JPL Discovery station: … See: http://iawn.net/
2019, Dec 23	V.V. Ivashkin, P. Guo, 2019, *Doklady Physics*, 64, 418, "Analysis of the possibility of creating a stable satellite of the asteroid **Apophis** as a homogeneous triaxial ellipsoid." See: https://ui.adsabs.harvard.edu/abs/2019DokPh..64..418I/abstract
2019, Dec 23	Apollo NEA **2019 YU2** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.26 LD. Minimum miss distance 0.26 LD. **[2019-81]** See: 2019 YU2 – S2P , 2019 YU2 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2019, Dec 25	Apollo NEA **2019 YV4** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.89 LD. **[2019-82]** See: 2019 YV4 – S2P , 2019 YV4 – JPL Discovery station: **Kitt Peak-Bok** See: http://iawn.net/
2019, Dec 27	R. Hyodo, K. Kurosawa, H. Genda, 2019, *Scientific Reports*, 9, 19833, "Transport of impact ejecta from **Mars** to its moons as a means to reveal Martian history." See: https://ui.adsabs.harvard.edu/abs/2019NatSR...919833H/abstract
2019, Dec 28	D.S. Zimnukhov, V.M. Lipunov, E.S. Gorbovskoy, et al., 2019, *Astronomy Reports*, 63, 1056, "The MASTER global robotic telescope network: observations of asteroid NEA **2015 TB145**." See: https://ui.adsabs.harvard.edu/abs/2019ARep...63.1056Z/abstract
2019, Dec 30	K. Sieh, J. Herrin, B. Jicha, et al., 2019, *Proceedings of the National Academy of Sciences of the United States of America*, first pubished 30 December 2019, "**Australasian impact crater** buried under the Bolaven volcanic field, Southern Laos." See: https://www.pnas.org/content/early/2019/12/24/1904368116
2020, Jan 1	**21725 NEAs** known (ranging in size up to ~37 km: **1036 Ganymed, A924 UB**, *H* = 9.45 mag, *D* = 36.5 km, Amor NEA), of which **2037 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, *H* = 15.3 mag, *D* = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: https://cneos.jpl.nasa.gov/stats/totals.html

2020, Jan	O.S. Barnouin, M.G. Daly, E.E. Palmer, et al., 2020, *Planetary and Space Science*, 180, 104764, "Digital terrain mapping by the ***OSIRIS-REx*** mission." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004764B/abstract
2020, Jan	H.C. Bates, A.J. King, K.L. Donaldson Hanna, et al., 2020, *Meteoritics & Planetary Science*, 55, 77, "Linking mineralogy and spectroscopy of highly aqueously altered CM and CI carbonaceous chondrites in preparation for primitive asteroid sample return." See: https://ui.adsabs.harvard.edu/abs/2020M%26PS...55...77B/abstract
2020, Jan	J.M. Bauer, A.K. Mainzer, E.A. Kramer, et al., 2020, *The Astronomer's Telegram*, No. 13407, "***NEOWISE*** CO upper limits of **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ATel13407....1B/abstract
2020, Jan	M. Carvalho Fraga, C. SilveiraVega, 2020, *Journal of South American Earth Sciences*, 97, 102398, "Asterozoans from the Devonian of the Paraná Basin, South Brazil" See: https://ui.adsabs.harvard.edu/abs/2020JSAES..9702398F/abstract
2020, Jan	D.S.P. Dearborn, M. Bruck Syal, B.W. Barbee, et al., 2020, *Acta Astronautica*, 166, 290, "Options and uncertainties in planetary defense: impulse-dependent response and the physical properties of asteroids." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.166..290D/abstract
2020, Jan	A.V. Devyatkin, D.L. Gorshanov, K.N. Naumov, et al., 2020, *Planetary and Space Science*, 180, 104739, "Astrometric and photometric observations of the **potentially hazardous asteroid 2017 VR12**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004739D/abstract
2020, Jan	P. Guzik, M. Drahus, K. Rusek, et al., 2020, *Nature Astronomy*, Letter, 4, 53, published 14 October 2019, "Initial characterization of interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020NatAs...4...53G/abstract
2020, Jan	D. Hercik, H.-U. Auster, D. Constantinescu, et al., 2020, *Journal of Geophysical Research: Planets*, 125, e06035, "Magnetic properties of asteroid **(162173) Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2020JGRE..12506035H/abstract
2020, Jan	A. Liakos, A. Bonanos, E. Xilouris, D. Koschny, et al., 2020, *Astronomy & Astrophysics*, 633, 112, "**NELIOTA**: methods,

	statistics and results for meteoroids impacting the **Moon**." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...633A.112L/abstract
2020, Jan	Z.-Y. Lin, H.-C. Chi, B.-H. Wang, et al., 2020, *Planetary and Space Science*, 180, 104763, "The current development of the **Taiwan Meteor Detector System (TMDS)** with a dedication to the **Geminids 2017** and **2018**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004763L/abstract
2020, Jan	K. Nishiyama, S. Hosoda, R. Tsukizaki, H. Kuninaka, 2020, *Acta Astronautica*, 166, 69, "In-flight operation of the ***Hayabusa2*** ion engine system on its way to rendezvous with asteroid **162173 Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.166...69N/abstract
2020, Jan	R. Okazaki, T. Sekiguchi, M. Ishiguro, et al., 2020, *Planetary and Space Science*, 180, 104774, "Polarimetric and photometric observations of NEAs: **(422699) 2000 PD3** and **(3200) Phaethon** with the 1.6m Pirka telescope." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004774O/abstract
2020, Jan	R. Rudawska, J. Zender, D. Koschny, et al., 2020, *Planetary and Space Science*, 180, 104773, "A spectroscopy pipeline for the Canary island long baseline observatory meteor detection system." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004773R/abstract
2020, Jan	Y. Saito, P.K. Hong, T. Niihara, et al., 2020, *Meteoritics & Planetary Science*, 55, 193, "Data-driven taxonomy matching of asteroid and meteorite." See: https://ui.adsabs.harvard.edu/abs/2020M%26PS...55..193S/abstract
2020, Jan	S.A. Sandford, E.B. Bierhaus, P. Antreasian, et al., 2020, *Acta Astronautica*, 166, 391, "Outgassing from the ***OSIRIS-REx*** sample return capsule: characterization and mitigation." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.166..391S/abstract
2020, Jan	S. Soldini, S.Takana, H. Ikeda, et al., 2020, *Planetary and Space Science*, 180, 104740, "A generalised methodology for analytic construction of 1:1 resonances around irregular bodies: application to the asteroid **Ryugu**'s ejecta dynamics." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18004740S/abstract

2020, Jan	F. Thuillet, P. Michel, S. Tachibana, et al., 2020, *Monthly Notices of the Royal Astronomical Society*, 491, 153, "Numerical modelling of medium-speed impacts on a granular surface in a low-gravity environment application to ***Hayabusa2*** sampling mechanism." See: https://ui.adsabs.harvard.edu/abs/2020MNRAS.491..153T/abstract
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2020, Jan 1	A.H.D. Koeppel, B.A. Black, S. Marchi, 2020, *Icarus*, 335, 113422, "Differentiation in impact melt sheets as a mechanism to produce evolved magmas on **Mars**." See: https://ui.adsabs.harvard.edu/abs/2020Icar..33513422K/abstract
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2020, Jan 2	B.T. Bolin, 2020, submitted to *Monthly Notices of the Royal Astronomical Society: Letters*, e-print *arXiv*:1912.07386, "Evolving coma morphology of interstellar comet **2I/Borisov** with deep ***HST*** imaging." See: https://ui.adsabs.harvard.edu/abs/2019arXiv191207386B/abstract [Substantial text overlap with *arXiv*:1910.14004, 5 November 2019]

2020, Jan 2	Apollo NEA **2020 AP1** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD. **[2020-01]** See: 2020 AP1 – S2P , 2020 AP1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **7 Jan 2022**.
2020, Jan 3	L.F. Golubeva, D.I. Shestopalov, O.I. Kvaratskhelia, 2020, e-print *arXiv*:2001.00789, "Polarimetric properties of asteroid **3200 Phaethon**." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200100789G/abstract
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	quality." See: https://ui.adsabs.harvard.edu/abs/2020AAS...23532903S/abstract - A. Vasquez Soto, N. Law, H. Corbett, et al., 2020, id. 278.02, "A new Near Earth Object survey using the Evryscopes." See: https://ui.adsabs.harvard.edu/abs/2020AAS...23527802V/abstract - R. Wainscoat, R. Weryk, Y. Ramanjooloo, K. Chambers, 2020, id. 329.02, "The **Pan-STARRS** search for Near-Earth Asteroids." See: https://ui.adsabs.harvard.edu/abs/2020AAS...23532902W/abstract - R. Weryk, G. Williams, R. Wainscoat, 2020, id. 329.05, "Linking isolated tracklets to improve asteroid discovery." See: https://ui.adsabs.harvard.edu/abs/2020AAS...23532905W/abstract - C. Woo, A. Hu, M. Farae, 2020, id. 277.04, "Orbit determination of Near-Earth Asteroid **12538 (1998 OH).**" See: https://ui.adsabs.harvard.edu/abs/2020AAS...23527704W/abstract
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2020, Jan 7	M. Carreau, 2020, *AerospaceDaily*, 7 January 2020, "NEO mission funding gets Trump green light." See: https://aviationweek.com/defense-space/neo-mission-funding-gets-trump-green-light
2020, Jan 8	*Planetary Science and Astrobiology Decadal Survey (2023-2032)* Statement of Task. See: https://sites.nationalacademies.org/SSB/ssb_197330
2020, Jan 11	Apollo NEA **2019 WC5** (H = 22.3 mag, $D \approx$ 120 m) passed Earth at a nominal miss distance of 6.33 LD. Minimum miss distance 6.33 LD. See: 2019 WC5 – S2P , 2019 WC5 - JPL
2020, Jan 13	D. Jewitt, M.-T. Hui, Y. Kim, et al., 2020, *Astrophysical Journal Letters*, 888, L23, "The nucleus of interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...888L..23J/abstract
2020, Jan 13	T. Kasuga, M. Sato, M. Ueda, et al., 2020, *Astronomical Journal*, 157, 49, "A **fireball** and **Potentially Hazardous** binary Near-Earth Asteroid **(164121) 2003 YT1**." See: https://ui.adsabs.harvard.edu/abs/2020AJ....159...47K/abstract
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2020, Jan 14-16	***22nd Meeting* of the NASA *Small Bodies Assessment Group***, 14-16 Jan 2020, Washington (DC, USA). See: https://www.lpi.usra.edu/sbag/meetings/jan2020/ **Among the agenda items:** - T.S. Statler, L. Glaze, 2020, "Explore science." - T.S. Statler, 2020, "Responses to findings from **SBAG** Meeting 21." - D. Lauretta, and the ***OSIRIS-Rex*** Team 2020, "***OSIRIS-REx*** update and report on **Asteroid Science in the age of *Hayabusa2 and OSIRIS-REx Workshop***." See: https://www.youtube.com/watch?v=dqxd7KyFuNU&feature=youtu.be - M. Schwamb, 2020, "**LSST** Solar System science update." (New name: The Vera C. Rubin Observatory and the Legacy Survey of Space and Time (LSST)) - A. Rivkin, Announcement of ***ACM 2020*** Flagstaff June 14-19, 2020. - L. Johnson, 2020, "**Planetary Defense Coordination Office**." - K. Fast, 2020, "**Near-Earth Object Observations Program**." See: https://www.youtube.com/watch?v=di9zFlpKLj4&feature=youtu.be - E.A. Kramer, A.K. Mainzer, J.R. Masiero, et al., and the ***NEOWISE*** Team, 2020, "Update on the ***NEOWISE*** project." - A. Mainzer, 2020, "The ***Near-Earth Object Surveillance Mission*** (formerly ***NEOCam***)." - E.Y. Adams, E.L. Reynolds, A.F. Cheng, et al., and the ***DART*** Team, 2020, "***DART* – *Double Asteroid Redirection Test***." - P. Chodas, J. Roa, A. Chamberlin, 2020, "**NHATS** (**NEO Human Spaceflight Accessible Targets Study**) update." - G. Bauer, M. Holman, 2020, "The Planetary Science Data System's **Small Bodies Node** and the **Minor Planet Center**c - update - P. Michel, I. Carnelli, 2020, "***Hera*** mission, status update." - J. Castillo-Rogez, L. Johnson, J. Matus, 2020, "***NEA Scout***." - M.M. Knight, 2020, "Comet **2I/Borisov** science (review)." - Y. Tsuda, 2020, "***Hayabusa2*** mission status." - B. Barbee, 2020, "Near Earth Object characterization priorities for Planetry Defense." See: https://www.youtube.com/watch?v=qm5OaXZmKJw&feature=youtu.be
2020, Jan 17	P.M. Hull, A. Bornemann, D.E. Penman, et al., 2020, *Science*, 367, 266, "On impact and volcanism across the Cretaceous-Paleogene boundary." See: https://science.sciencemag.org/content/367/6475/266

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2020, Jan 17	Apollo NEA **2020 AN3** (H = 20.4 mag, $D \approx$ 290 m, **PHA**) passed Earth at a nominal miss distance of 7.92 LD. Minimum miss distance 7.92 LD. See: 2020 AN3 – S2P , 2020 AN3 – JPL See also: **15 Jan 2055**.
2020, Jan 20	A.J. McKay, A.L. Cochran, N. Dello Russo, M. DiSanti, 2020, *Astrophysical Journal Letters*, 889, L10, "Detection of a water tracer in interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...889L..10M/abstract http://astrobiology.com/2019/10/detection-of-a-water-tracer-in-interstellar-comet-2iborisov.html
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2020, Jan 20	Apollo NEA **2020 BK3** (H = 26.9 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.78 LD. Minimum miss distance 0.78 LD. **[2020-02]** See: 2020 BK3 – S2P , 2020 BK3 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: **20 Jan 2091**.
2020, Jan 21	T.M. Erickson, C.L. Kirkland, N.E. Timms, et al., 2020, *Nature Communications*, 11, 300, "Precise radiometric age establishes **Yarrabubba**, Western Australia, as Earth's oldest recognised meteorite impact structure." See: https://ui.adsabs.harvard.edu/abs/2020NatCo..11..300E/abstract See also: https://news.curtin.edu.au/media-releases/new-research-finds-earths-oldest-asteroid-strike-linked-to-big-thaw/ https://www.space.com/earth-oldest-impact-crater-snowball-earth.html https://en.wikipedia.org/wiki/Yarrabubba_crater

2020, Jan 21	K. Sieh, J. Herrin, B. Jicha, et al., 2020, *Proceedings National Academy of Sciences of the United States of America*, 117, 1346, "**Australasian impact crater** buried under the Bolaven volcanic field, Southern Laos." See: https://www.pnas.org/content/117/3/1346 https://www.pnas.org/content/suppl/2019/12/24/1904368116.DCSupplemental See also: http://neo.ssa.esa.int/newsletters (5 February 2020) https://phys.org/news/2020-01-evidence-ancient-impact-crater-bolaven.html
2020, Jan 22	A. Freeman, 2020, *CEAS Space Journal*, "Exploring our solar system with ***CubeSats*** and ***SmallSats***: the dawn of a new era." See: https://ui.adsabs.harvard.edu/abs/2020CEAS..tmp....8F/abstract
2020, Jan 22	Apollo NEA **2020 BB5** (H = 29.6 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2020-03]** See: 2020 BB5 – S2P , 2020 BB5 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Jan 23	D.R. Golish, C. Drouet d'Aubigny, B. Rizk, et al., 2020, *Space Science Reviews*, 216, 12, "Ground and in-flight calibration of the ***OSIRIS-REx*** camera suite." See: https://ui.adsabs.harvard.edu/abs/2020SSRv..216...12G/abstract
2020, Jan 23	Q. Ye, F.J. Masci, W.-H. Ip, et al., 2020, *Astronomical Journal*, 159, 70, "A twilight search for Atiras, Vatiras, and co-orbital asteroids: preliminary results." See: https://ui.adsabs.harvard.edu/abs/2020AJ....159...70Y/abstract
2020, Jan 25	Apollo NEA **2020 BH6** (H = 28.7 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2020-04]** See: 2020 BH6 – S2P , 2020 BH6 – JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2020, Jan 27	H.W. Lin, C.-H. Lee, D.W. Gerdes, et al., 2020, *Astrophysical Journal Letters*, 889, "Detection of diatomic carbon in **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...889L..30L/abstract

2020, Jan 27	Apollo NEA **2020 BA13** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.51 LD. Minimum miss distance 0.51 LD. **[2020-05]** See: 2020 BA13 – S2P , 2020 BA13 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2020, Jan 28	P.R. Heck, J. Greer, L. Kööp, et al., 2020, *Proceedings of the National Academy of Sciences of the United States of America*, 117, 1884, "Lifetimes of interstellar dust from cosmic ray exposure ages of presolar silicon carbide." See: https://www.pnas.org/content/117/4/1884 https://doi.org/10.1073/pnas.1904573117 See also: http://nccr-planets.ch/blog/2020/01/13/meteorite-contains-the-oldest-material-on-earth/ https://www.space.com/stardust-oldest-material-on-earth.html
2020, Jan 28	Apollo NEA **2020 BA15** (*H* = 27.5 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.98 LD. Minimum miss distance 0.98 LD. **[2020-06]** See: 2020 BA15 – S2P , 2020 BA15 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2020, Jan 29	Apollo NEA **2020 BZ13** (*H* = 29.9 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2020-07]** See: 2020 BZ13 – S2P , 2020 BZ13 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Jan 30	M.T. Bannister, C. Opitom, A. Fitzsimmons, et al., 2020, e-print *arXiv*:2001.11605, "Interstellar comet **2I/Borisov** as seen by MUSE: C_2, NH_2 and red CN detections." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200111605B/abstract
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2020, Jan 31, 03:51	Apollo NEA **2020 CZ** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82 LD. **[2020-08]** See: 2020 CZ – S2P , 2020 CZ - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Jan 31, 19:03	Apollo NEA **2020 CJ** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2020-09]** See: 2020 CJ – S2P , 2020 CJ – JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/
2020, **Feb**	C.A.L. Bailer-Jones, D. Farnocchia, Q. Ye, et al., 2020, *Astronomy & Astrophysics*, 634, 14, "A search for the origin of the interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...634A..14B/abstract
2020, Feb	J.A. Dallas, S. Raval, J.P. Alvarez Gaitan, 2020, et al., 2020, *Acta Astronautica*, 167, 181, "Mining beyond **Earth** for sustainable development: will humanity benefit from resource extraction in outer space?" See: https://ui.adsabs.harvard.edu/abs/2020AcAau.167..181D/abstract
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2020, Feb	A. Higuchi, E. Kokubo, 2020, *Monthly Notices of the Royal*

	Astronomical Society, 492, 268, "Hyperbolic orbits in the Solar System: interstellar origin or perturbed **Oort cloud** comets?" See: https://academic.oup.com/mnras/article/492/1/268/5621505
2020, Feb	O.N. Letner, T.Y. Galushina, 2020, *Planetary and Space Science*, 181, 104818, "Motion features of the asteroid **137924 2000 BD19**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18104818L/abstract
2020, Feb	P. Machuca, J.P. Sánchez, J.J. Masdemont, G.Gómez, 2020, *Acta Astronautica*, 167, 146, "High-fidelity trajectory design to flyby near-Earth asteroids using ***CubeSats***." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.167..146M/abstract
2020, Feb	S.W. Paek, O. de Weck, J. Hoffman, et al., 2020, *Acta Astronautica*, 167, 23, "Optimization and decision-making framework for multi-staged asteroid deflection campaigns under epistemic uncertainties." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.167...23P/abstract
2020, Feb	P.J. Register, M.J. Aftosmis, E.C. Stern, et al., 2020, *Icarus*, 337, 113468, "Interactions between asteroid fragments during atmospheric entry." See: https://ui.adsabs.harvard.edu/abs/2020Icar..33713468R/abstract
2020, Feb	I. Wlodarczyk, 2020, *Bulgarian Astronomical Journal*, 32, 27, "Special group of the **Potentially Hazardous Asteroids**." See: https://ui.adsabs.harvard.edu/abs/2020BlgAJ..32...27W/abstract
2020, Feb	E. Wright, A.C.Quillen, J. South, et al., 2020, *Icarus*, 337, 113424, "Boulder stranding in ejecta launched by an impact generated seismic pulse." See: https://ui.adsabs.harvard.edu/abs/2020Icar..33713424W/abstract
2020, Feb	B. Yang, M.S.P. Kelley, K.J. Meech, et al., 2020, *Astronomy & Astrophysics*, *Letter*, 634, L6, "Searching for water ice in the coma of interstellar object **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...634L...6Y/abstract
2020, Feb	J.I. Zuluaga, M. Tangmatitham, P.A. Cuartas-Restrepo, et al., 2020, *Monthly Notices of the Royal Astronomical Society*, 492, 1432, "Location, orbit and energy of a meteoroid impacting the moon during the **lunar** eclipse of January 21, 2019." See: https://academic.oup.com/mnras/article-abstract/492/1/1432/5682492?redirectedFrom=fulltext
2020, Feb 1	Apollo NEA **2020 CW** (H = 32.6 mag, $D \approx$ 1.1 m) passed Earth at a nominal miss distance of **0.041 LD (= 2.47 R_{Earth} from the**

	geocenter). Minimum miss distance **0.041 LD**. **[2020-10]** See: 2020 CW – S2P , 2020 CW - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/newsletters [June 2020]
2020, Feb 2	Aten NEA **2020 CA** (*H* = 29.4 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2020-11]** See: 2020 CA – S2P , 2020 CA – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **4 Feb 2179**.
2020, Feb 3	R.J. Jennings, J.M. Cordes, S. Chatterjee, 2020, *Astrophysical Journal*, 889, 145, "Detecting gravitational scattering of interstellar objects using pulsar timing." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...889..145J/abstract
2020, Feb 3	T. Kareta, J. Andrews, J.W. Noonan, et al., 2020, *Astrophysical Journal Letters*, 889, L38, "Carbon chain depletion of **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...889L..38K/abstract
2020, Feb 3	R.t. Nallapu, Y. Xu, A. Marquez, et al., 2020, in: *AAS GNC Conferences 2020/Advances in Astronautical Sciences*, e-print *arXiv*:2002.00984, "The design of a space-based observation and tracking system for interstellar objects." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200200984T/abstract
2020, Feb 3,08:19	Apollo NEA **2020 BT14** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2020-12]** See: 2020 BT14 – S2P , 2020 BT14 – JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ See also: **3 Feb 2087**.
2020, Feb 3,18:56	Binary Apollo NEA **2020 BX12** (*H* = 20.7 mag, *D* ≈ 250 m, **PHA**) passed Earth at a nominal miss distance of 11.34 LD. Minimum miss distance 11.34 LD. See: 2020 BX12 – S2P , 2020 BX12 – JPL See also: https://www.space.com/near-earth-binary-asteroid-2020-bx12-has-moon.html https://en.wikipedia.org/wiki/2020_BX12

2020, Feb 3-14	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 57th Session**, 3-14 February 2020, Vienna (Austria). See: www.unoosa.org/oosa/en/ourwork/copuos/stsc/2020/index.html http://www.unoosa.org/oosa/en/ourwork/topics/neos/index.html **Among the Technical Presentations:** - F. Al Aydaoos, 2020, "The **UAE Meteor Monitoring Network**." See: www.unoosa.org/documents/pdf/copuos/stsc/2020/tech-18E.pdf - Y.S. Bondarenko, D.A. Marshalov, D.E. Vavilov, Y.D. Medvedev, 2020, "Physical parameters of near-Earth objects from radar observations." See: www.unoosa.org/documents/pdf/copuos/stsc/2020/tech-04E.pdf - G. Borisov, 2020, "The first interstellar comet **2I/Borisov** : a new touch in the NEO problem." See: www.unoosa.org/documents/pdf/copuos/stsc/2020/tech-40E.pdf - I. Molotov, 2020, "International cooperation in field of observations of the near-Earth objects within **ISON** project." See: www.unoosa.org/documents/pdf/copuos/stsc/2020/tech-63E.pdf **IAWN Statement:** See: http://iawn.net/documents/20200205_10th_Vienna/20200207_IAWN%20statement_STSC.pdf
2020, Feb 4	A. Siraj, A. Loeb, 2020, e-print *arXiv*:2002.01476, "Observational signatures of sub-relativistic meteors." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200201476S/abstract
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	Report: http://iawn.net/meetings/10-steering-cmte.shtml **Among the presentations**: - G. Borisov (MARGO), 2020, "The discovery of comet **2I/Borisov**." See: http://iawn.net/documents/20200205_10th_Vienna/presentations/IAWN-Cr.pdf http://iawn.net/documents/20200205_10th_Vienna/presentations/Comet Borisov-by-NEOWISE.pdf - H.-K. Moon (KASI), 2020, "Surveying southern sky to find NEO & PHA." See: http://iawn.net/documents/20200205_10th_Vienna/presentations/2020Feb05_IAWN_KASI_report_2.pdf - T. Spahr (NEO Sciences, LCC), 2020, "**IAWN** status report." See: http://iawn.net/documents/20200205_10th_Vienna/presentations/iawn_update.pdf - T. Spahr (NEO Sciences, LCC), J. Bauer (UMD), M. Holman (MPC, CfA), 2020, "**Minor Planet Center** update & status." See: http://iawn.net/documents/20200205_10th_Vienna/presentations/MPC_update.pdf **Discussion:** - T. Spahr (NEO Sciences, LCC), 2020, "***Starlink*** satellite situation." See: http://iawn.net/documents/20200205_10th_Vienna/presentations/starlink.pdf
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2020, Feb 13, 13:22	Apollo NEA **2020 DU** (H = 28.7 mag, $D \approx$ 6 m) passed Earth at a

	nominal miss distance of 0.85 LD. Minimum miss distance 0.84 LD. **[2020-14]** See: 2020 DU – S2P , 2020 DU - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Feb 13, 16:19	Apollo NEA **2020 CD3** (*H* = 31.8 mag, *D* ≈ 1.6 m) passed Earth at a nominal miss distance of 0.12 LD. Minimum miss distance 0.12 LD. **[2020-15]** See: 2020 CD3 – S2P , 2020 CD3 - JPL Discovery station: **Mt. Lemmon Survey** See: https://minorplanetcenter.net/mpec/K20/K20DA4.html See also: **16 Jan 2019, 4 Apr 2019, 30 Jun 2019, 10 Sep 2019, 18 Nov 2019**. See also: https://twitter.com/WierzchosKacper/status/1232460436634656769 https://cneos.jpl.nasa.gov/news/news205.html https://www.nationalastro.org/news/gemini-telescope-images-minimoon-orbiting-earth-in-color/ https://www.theatlantic.com/science/archive/2020/02/mini-moon-earth/607171/ https://earthsky.org/space/new-natural-temporary-moon-for-earth-2020-cd3 https://www.newscientist.com/article/2235427-earth-has-acquired-a-brand-new-moon-thats-about-the-size-of-a-car/ https://www.space.com/mini-moon-2020-cd3-discovered.html https://www.space.com/minimoon-2020-cd3-discovery-around-earth-explained.html https://videos.space.com/m/1fxT4Hwc/earth-has-a-new-mini-moon-temporarily-see-its-orbit http://neo.ssa.esa.int/newsletters (March 2020) https://www.theatlantic.com/science/archive/2020/03/mini-moon-earth-lost/608455/ https://en.wikipedia.org/wiki/2020_CD3
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2020, Feb 14	Aten NEA **2020 CQ2** (*H* = 28.7 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2020-16]** See: 2020 CQ2 – S2P , 2020 CQ2 - JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/

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2020, Feb 18, 10:32	Apollo NEA **2020 DA1** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.50 LD. Minimum miss distance 0.50 LD. **[2020-17]** See: 2020 DA1 – S2P , 2020 DA1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **18 Feb 2006**.
2020, Feb 18, 17:02	Aten NEA **2020 DW** (*H* = 30.2 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.63 LD. **[2020-18]** See: 2020 DW – S2P , 2020 DW - JPL Discovery station: **Mt. Lemmon Survey** See: https://www.minorplanetcenter.net/mpec/K20/K20D44.html
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2020, Feb 25, 07:15	Apollo NEA **2020 DV3** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 1.06 LD. Minimum miss distance 1.06 LD. See: 2020 DV3 – S2P , 2020 DV3 - JPL
2020, Feb 25, 20:30	Aten NEA **2020 DR4** (*H* = 29.7 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.24 LD. Minimum miss distance 0.24 LD. **[2020-19]** See: 2020 DR4 – S2P , 2020 DR4 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/

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2020, Mar 31	Apollo NEA **2020 FB7** (H = 26.4 mag, $D \approx$ 19 m) passed Earth at a nominal miss distance of 0.20 LD. Minimum miss distance 0.20 LD. **[2020-25]** See: 2020 FB7 – S2P , 2020 FB7 - JPL Discovery station: **Roving Observer** See: http://iawn.net/
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2020, Apr 1	Apollo NEA **2020 GO1** ($H = 27.8$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2020-26]** See: 2020 GO1 – S2P , 2020 GO1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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2020, Apr 3	ESA **NEOCC** *Newsletter*. April 2020. See: http://neo.ssa.esa.int/newsletters
2020, Apr 3	Apollo NEA **2020 GH** (H = 29.1 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2020-27]** See: 2020 GH – S2P , 2020 GH - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Apr 5, 07:37	Apollo NEA **2020 GY1** (H = 26.6 mag, $D \approx 17$ m) passed Earth at a nominal miss distance of 0.21 LD. Minimum miss distance 0.21 LD. **[2020-28]** See: 2020 GY1 – S2P , 2020 GY1 - JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/ See also: **2 Apr 1913**, **5 Apr 2033**.
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	SpaceX Starlink constellation." See: https://iopscience.iop.org/article/10.3847/2041-8213/ab8016
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2020, Apr 11, 15:57	Apollo NEA **2020 GA2** ($H = 21.1$ mag, $D \approx 210$ m, **PHA**) passed Earth at a nominal miss distance of 8.54 LD. Minimum miss distance 8.51 LD. See: 2020 GA2 – S2P , 2020 GA2 - JPL See also: **13 Apr 2162**.
2020, Apr 13	S. Kohler, 2020, *AAS Nova Highlight*, 13 Apr 2020, id.6432, "Astronomy impacts of satellite megaconstellations." See: https://aasnova.org/2020/04/13/astronomy-impacts-of-satellite-

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2020, Apr 15, 10:06	Apollo NEA **2020 HO** (H = 28.9 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2020-29]** See: 2020 HO – S2P , 2020 HO - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Apr 15, 12:47	Apollo NEA **2020 GH2** (H = 26.7 mag, $D \approx$ 16 m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.93 LD. **[2020-30]** See: 2020 GH2 – S2P , 2020 GH2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: https://www.space.com/house-size-asteroid-2020-gh2-earth-flyby-april-2020.html
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2020, Apr 21	S. Bouquillon, D. Souami, 2020, *Proceeding 8th ADeLA meeting*, 2018, Tarija (Bolivia), e-print *arXiv*:2004.09961, "The **GBOT** asteroid survey (First years: Jan. 2015 - May 2018)." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200409961B/abstract
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2020, Apr 22, 05:52	Apollo NEA **2020 HM6** (*H* = 26.6 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 0.42 LD. Minimum miss distance 0.42 LD. **[2020-31]** See: 2020 HM6 – S2P , 2020 HM6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Apr 22, 16:41	Apollo NEA **2020 HF5** (*H* = 26.8 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2020-32]** See: 2020 HF5 – S2P , 2020 HF5 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **26 Apr 1975**, **26 Apr 2079**.
2020, Apr 22, 20:19	Apollo NEA **2020 HU7** (*H* = 29.7 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.34 LD. **[2020-33]** See: 2020 HU7 – S2P , 2020 HU7 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Apr 23-24	***Apophis T–9 Years: Knowledge Opportunities for the Science of Planetary Defense workshop***, Nice (France). ~~23-24 April 2020~~. **Rescheduled for:** 9-10 November 2020. See: https://www.hou.usra.edu/meetings/apophis2020/
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2020, Apr 24	Apollo NEA **2020 HX3** (*H* = 27.2 mag, *D* ≈ 13 m) passed Earth at a nominal miss distance of 0.66 LD. Minimum miss distance 0.66 LD. **[2020-34]** See: 2020 HX3 – S2P , 2020 HX3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **24 Apr 2006**. See also: https://www.space.com/house-size-asteroid-2020-gh2-earth-flyby-april-

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2020, Apr 26, 04:03	Apollo NEA **2020 HY5** (H = 25.6 mag, $D \approx$ 27 m) passed Earth at a nominal miss distance of 16.28 LD. Minimum miss distance 16:15 LD. See: 2020 HY5 – S2P , 2020 HY5 – JPL See also: http://neo.ssa.esa.int/newsletters [June 2020] http://neo.ssa.esa.int/neocc-riddles http://neo.ssa.esa.int/c/document_library/get_file?uuid=a92c9171-b162-4ded-a542-1cba65636cb1&groupId=10157
2020, Apr 26, 13:33	Apollo NEA **2020 HT8** (H = 28.5 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2020-35]** See: 2020 HT8 – S2P , 2020 HT8 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Apr 27	Z. Xing, D. Bodewits, J. Noonan, M.T. Bannister, 2020, *Astrophysical Journal Letters*, 893, L48, "Water production rates and activity of interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020ApJ...893L..48X/abstract See also: http://astrobiology.com/2020/01/water-production-rates-and-activity-of-interstellar-comet-2iborisov.html
2020, Apr 27, 14:40	Apollo NEA **2020 HP6** (H = 28.2 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2020-36]** See: 2020 HP6 – S2P , 2020 HP6 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Apr 28	D. Takir, T. Kareta, J.P. Emery, et al., 2020, *Nature Communications*, 11, 2050, "Near-infrared observations of active asteroid (3200) Phaethon reveal no evidence for hydration."

	See: https://ui.adsabs.harvard.edu/abs/2020NatCo..11.2050T/abstract
2020, Apr 28	Johannes Andersen (1943-2020), General Secretary 1997-2000 of the **International Astronomical Union**, passed away on 28 April 2020 in Copenhagen (Denmark). Among his many achievments, on behalf of the IAU, he took part in meetings of the **United Nations Committee on the Peaceful Uses of Outer Space** between 1997 and 2003, when the Committee began to give serious consideration to the potential threat from Near-Earth Objects. See: https://www.iau.org/news/announcements/detail/ann20015/?lang
2020, Apr 28, 18:49	Apollo NEA **2020 HS7** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.11 LD. Minimum miss distance 0.11 LD. **[2020-37]** See: 2020 HS7 – S2P , 2020 HS7 - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ See also: https://www.nasa.gov/feature/small-asteroid-to-safely-fly-by-earth/ https://www.esa.int/Safety_Security/An_Agency_for_asteroids https://www.space.com/small-asteroid-2020-hs7-buzzes-earth-ahead-of-big-space-rock.html
2020, Apr 29	Amor NEA **52768** (**1998 OR2**, *H* = 16.0 mag, *D* ≈ 2100 m, **PHA**) passed Earth at a nominal miss distance of 16.36 LD. Minimum miss distance 16.36 LD. See: 1998 OR2 – SSA , 1998 OR2 – JPL See also: https://www.space.com/asteroid-1998-or2-earth-flyby-april-2020.html http://neo.ssa.esa.int/newsletters [3 April 2020] http://neo.ssa.esa.int/newsletters [23 April 2020] https://www.space.com/asteroid-1998-or2-photo-arecibo-observatory-april-2020.html https://www.jpl.nasa.gov/news/news.php?feature=7649&utm_source=iContact&utm_medium=email&utm_campaign=nasajpl&utm_content=daily20200428-2 https://cneos.jpl.nasa.gov/news/news206.html https://www.space.com/asteroid-1998-or2-earth-flyby-no-danger.html https://www.space.com/asteroid-1998-or2-wearing-mask.html https://www.space.com/big-asteroid-1998-or2-tumbling-radar-video.html http://www.astronomerstelegram.org/?read=13733 https://en.wikipedia.org/wiki/(52768)_1998_OR2
2020, Apr 30	Aten NEA **2020 JG** (*H* = 25.9 mag, *D* ≈ 24 m) passed Earth at a nominal miss distance of 0.56 LD. Minimum miss distance 0.55 LD. **[2020-38]** See: 2020 JG – S2P , 2020 JG – JPL

	Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/ See also: **30 Apr 1922**.
2020, **May**	M.A. Barucci, P.H. Hasselmann, A. Praet, et al., 2020, *Astronomy & Astrophysics, Letters*, 637, L4, "***OSIRIS-REx*** spectral analysis of **(101955) Bennu** by multivariate statistics," See: https://ui.adsabs.harvard.edu/abs/2020A%26A...637L...4B/abstract
2020, May	C. de la Fuente Marcos, R. de la Fuente Marcos, 2020a, *Monthly Notices of the Royal Astronomical Society: Letters*, 494, L6, "On the orbital evolution of **2020 AV2**, the first asteroid ever observed to go around the Sun inside the orbit of **Venus**." See: https://ui.adsabs.harvard.edu/abs/2020MNRAS.494L...6D/abstract See also: https://physicstoday.scitation.org/do/10.1063/PT.6.1.20200416a/full/
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2020, May	E. Drolshagen, T. Ott, D. Koschny, et al., 2020, *Planetary and Space Science*, 184, 104869, "Velocity distribution of larger meteoroids and small asteroids impacting Earth." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18404869D/abstract
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2020, May	T.J. Jopek, 2020, *Monthly Notices of the Royal Astronomical Society*, 494, 680, "The orbital clusters among the near-Earth asteroids." See: https://academic.oup.com/mnras/article-abstract/494/1/680/5805210 https://ui.adsabs.harvard.edu/abs/2020MNRAS.tmp..673J/abstract
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2020, May	Y.-B. Xu, L.-Y. Zhou, W.-H. Ip, 2020, *Astronomy & Astrophysics*, 637, 19, "Transit of asteroids across the 7/3 Kirkwood gap under the Yarkovsky effect." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...637A..19X/abstract
2020, May 1	J. Moeyens, N. Myhrvold, Ž. Ivezić, 2020, *Icarus*, 341, 113575, "**ATM**: an open-source tool for **Asteroid Thermal Modeling** and its application to ***NEOWISE*** data." See: https://ui.adsabs.harvard.edu/abs/2020Icar..34113575M/abstract
2020, May 2	J. O'Callaghan, 2020, *New Scientist*, 246, 10, "A glut of interstellar asteroids?" See: https://ui.adsabs.harvard.edu/abs/2020NewSc.246...10O/abstract
2020, May 3	Apollo NEA **2020 JA** ($H = 27.3$ mag, $D \approx 13$ m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2020-39]** See: 2020 JA – S2P , 2020 JA – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, May 4	P. Michel, 2020, Annual Report 2019 ***IAU Working Group on Near Earth Objects***. See: https://www.iau.org/static/science/scientific_bodies/divisions/f/division-f-annual-report-2019.pdf
2020, May 4	E. Rondón, D. Lazzaro, T. Rodrigues, et al., 2020, *Publications of the Astronomical Society of the Pacific*, 132, 065001, "**OASI**: a Brazilian observatory dedicated to the study of small Solar System bodies—some results on NEO's physical properties." See: https://ui.adsabs.harvard.edu/abs/2020PASP..132f5001R/abstract

2020, May 4	Apollo NEA **2020 JJ** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of **0.035 LD (= 2.104 R_{Earth} from the geocenter)**. Minimum miss distance **0.035 LD**. **[2020-40]** See: 2020 JJ – S2P , 2020 JJ - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/newsletters [June 2020] https://en.wikipedia.org/wiki/2020_JJ
2020, May 5	Apollo NEA **2020 JN** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2020-41]** See: 2020 JN – S2P , 2020 JN - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2020, May 5	ESA **NEOCC** *Newsletter*. May 2020. See: http://neo.ssa.esa.int/newsletters
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2020, May 7	Apollo NEA **438908** (**2009 XO**, *H* = 20.1 mag, *D* ≈ 300 m, **PHA**) passed Earth at a nominal miss distance of 8.83 LD. Minimum miss distance 8.83 LD. See: 2009 XO - SSA , 2009 XO - JPL See also: **7 May 2096**. See also: http://neo.ssa.esa.int/newsletters [June 2020]
2020, May 8	T. Morota, S. Sugita, Y. Cho, et al., 2020, *Science*, 368, 654, "Sample collection from asteroid **(162173) Ryugu** by ***Hayabusa2***: implications for surface evolution." See: https://science.sciencemag.org/content/368/6491/654 See also: https://www.eurekalert.org/pub_releases/2020-05/aaft-hto050420.php https://www.space.com/asteroid-ryugu-sun-encounter-hayabusa2-spacecraft-footage.html
2020, May 8	K.T. Smith, 2020, *Science*, 368, 616, "Collecting a sample of asteroid **Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2020Sci...368S.616S/abstract

2020, May 9	Aten/Apollo NEA **2021 GM1** (H = 30.5 mag, $D \approx$ 2.9 m) passed Earth at a nominal miss distance of 0.71 LD. Minimum miss distance 0.70 LD. **[2020-42]** See: 2021 GM1 – S2P , 2021 GM1 - JPL
2020, May 14	Asteroids & Beyond: *The B612 Foundation Newsletter* Vol. 44. See: https://mailchi.mp/b612foundation/asteroids-beyond-the-b612-foundation-newsletter-vol-44?e=b8e2af394f
2020, May 10	Apollo NEA **388945** (**2008 TZ3**, H = 20.5 mag, $D \approx$ 280 m, **PHA**) passed Earth at a nominal miss distance of 7.27 LD. Minimum miss distance 7.27 LD. See: 388945 2008 TZ3 - SSA , 2008 TZ3 - JPL See also: **9 May 2018**. See also: http://neo.ssa.esa.int/newsletters [June 2020]
2020, May 12	Q. Hoi Shan Chan, R. Stroud, Z. Martins, H. Yabuta, 2020, *Space Science Reviews*, 216, 56, "Concerns of organic contamination for sample return space missions." See: https://ui.adsabs.harvard.edu/abs/2020SSRv..216...56C/abstract
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2020, May 12	Apollo NEA **2000 KA** (H = 21.9 mag, $D \approx$ 150 m, **PHA**) passed Earth at a nominal miss distance of 8.84 LD. Minimum miss distance 8.84 LD. See: 2000 KA - SSA , 2000 KA - JPL See also: **27 Nov 2128**, **15 May 2158**.
2020, May 13	R. Villanueva, J. Ricra, M. Zegarra-Valles, et al., 2020, *Atel* #13733, "Astrometric observations of the **Potentially Hazardous Asteroid (52768) 1998 OR2** near its maximum approach to Earth." See: http://www.astronomerstelegram.org/?read=13733 See also: **29 Apr 2020**.
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2020, May 22	E. Salguero-Hernández, L. Pérez-Cruz, J. Urrutia-Fucugauchi, 2020, *Acta Geophysica*, 68, 627, "Seismic attribute analysis of **Chicxulub impact crater**." See: https://link.springer.com/article/10.1007%2Fs11600-020-00442-z
2020, May 23	Apollo NEA **2020 KU** ($H = 28.5$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 1.01 LD. Minimum miss distance 1.01 LD. See: 2020 KU – S2P , 2020 KU – JPL
2020, May 26	G.S. Collins, N. Patel, T.M. Davison, et al., 2020, *Nature Communications*, 11, 1480, "A steeply-inclined trajectory for the **Chicxulub impact**." See: https://ui.adsabs.harvard.edu/abs/2020NatCo..11.1480C/abstract
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2020, May 28, 12:4	Apollo NEA **2020 KF5** ($H = 29.4$ mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.64 LD. **[2020-43]** See: 2020 KF5 – S2P , 2020 KF5 – JPL Discovery station: **Mt. Lemmon Survey**

	See: http://iawn.net/
2020, May 28, 13:2	Aten NEA **2020 KJ4** (*H* = 29.9 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.37 LD. Minimum miss distance 0.37 LD. **[2020-44]** See: 2020 KJ4 – S2P , 2020 KJ4 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **28 May 2006**.
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2020, May 29	Apollo NEA **2020 KC5** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.96 LD. **[2020-45]** See: 2020 KC5 – S2P , 2020 KC5 – JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
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	dynamical modelling of ejected particles to the **Earth**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..18504897K/abstract
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	https://ui.adsabs.harvard.edu/abs/2020AAS...23612901V/abstract
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	- Mainzer, A., et al., 2020, "What threat do Near-Earth Objects pose to civilization and life on Earth, and how can we quantify and mitigate that threat?" - J.G. Bauer, M. Holman, M. Payne, et al., 2020, "The **Planetary Science Data System's Small Bodies Node** update and the **MPC** Database Beta Distribution." See: https://www.lpi.usra.edu/sbag/meetings/jun2020/presentations/sbn_MPC_Update20Bx.pdf
2020, Jun 1-3	***American Astronomical Society 236th Meeting***, ~~Madison (WI, USA),~~ 1 – 3 June 2020, held virtual. See: https://aas.org/meetings/aas236
2020, Jun 4	ESA **NEOCC** *Newsletter*. June 2020. See: http://neo.ssa.esa.int/newsletters [June 2020]
2020, Jun 5	Apollo NEA **2020 LD** (H = 22.4 mag, $D \approx$ 120 m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.80 LD. **[2020-46]** See: 2020 LD – S2P , 2020 LD - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: https://watchers.news/2020/06/09/asteroid-2002-ld/ https://theskylive.com/2020ld-info http://neo.ssa.esa.int/newsletters [July 2020] https://en.wikipedia.org/wiki/2020_LD
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2020, Jun 6	Aten NEA **163348** (**2002 NN4** (H = 20.1 mag, $D \approx$ 400 m, **PHA**) passed Earth at a nominal miss distance of 13.25 LD. Minimum miss distance 13.25 LD. See: 2002 NN4 – SSA , 2002 NN4 – JPL See also: http://neo.ssa.esa.int/***newsletters*** [June 2020]
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2020, Jun 12	W.F. Bottke, D. Vokrouhlický, R.-L. Ballouz, et al., 2020, *Astronomical Journal*, 160, 14, "Interpreting the cratering histories of **Bennu**, **Ryugu**, and other spacecraft-explored asteroids." See: https://ui.adsabs.harvard.edu/abs/2020AJ....160...14B/abstract
2020, Jun 12	K. Yamamoto, T. Otsubo, K. Matsumoto, et al., 2020, *Earth, Planets and Space*, 72, 85, "Dynamic precise orbit determination of ***Hayabusa2*** using laser altimeter (**LIDAR**) and image tracking data sets." See: https://ui.adsabs.harvard.edu/abs/2020EP%26S...72...85Y/abstract
2020, Jun 13, 04:45	Apollo NEA **2020 ML2** ($H = 28.0$ mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.92 LD. **[2020-47]** Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ See: 2020 ML2 – S2P , 2020 ML2 – JPL
2020, Jun 13, 21:36	Amor NEA **2020 KB3** ($H = 24.4$ mag, $D \approx 50$ m) passed Earth at a nominal miss distance of 3.14 LD. Minimum miss distance 3.10 LD. See: 2020 KB3 – S2P , 2020 KB3 – JPL See also: http://neo.ssa.esa.int/newsletters [June 2020]

2020, Jun 14	Apollo NEA **2017 MF7** (*H* = 26.1 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 3.68 LD. Minimum miss distance 0.91 LD. See: 2017 MF7 - SSA , 2017 MF7 - JPL
2020, Jun 14-19	***Asteroids, Comets, Meteors Conference 2020***, Flagstaff (AZ, USA), ~~14-19 June 2020~~. **Rescheduled for:** 20-25 June 2021. See: https://www.hou.usra.edu/meetings/acm2021/
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2020, Jun 17	B.T. Bolin, C.M. Lisse, M.M. Kasliwal, et al., 2019, *Astronomical Journal*, 160, 26, "Characterization of the nucleus, morphology and activity of interstellar comet **2I/Borisov** by optical and near-infrared GROWTH, Apache Point, IRTF, ZTF and Keck observations." See: https://ui.adsabs.harvard.edu/abs/2020AJ....160...26B/abstract
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2020, Jun 19	S. Kohler, 2020, *AAS Nova Highlight*, 19 Jun 2020, id.6694, "Exploring links between nearby asteroids." See: https://ui.adsabs.harvard.edu/abs/2020nova.pres.6694K/abstract
2020, Jun 19	T. Yoshizaki, W.F. McDonough, 2020, e-print *arXiv*:2006.11051, "**Earth** and **Mars** -- distinct inner Solar System products."

	See: https://ui.adsabs.harvard.edu/abs/2020arXiv200611051Y/abstract See also: http://astrobiology.com/2020/06/earth-and-mars----distinct-inner-solar-system-products.html
2020, Jun 23	K.W. Smith, S.J. Smartt, D.R. Young, 2020, *Publications of the Astronomical Society of the Pacific*, 132, 085002, "Design and operation of the **ATLAS** (**Asteroid Terrestrial impact Last Alert System**) **Transient Science Server**." See: https://ui.adsabs.harvard.edu/abs/2020PASP..132h5002S/abstract
2020, Jun 23	G. Tancredi, L. Lindberg Christensen, 2020, *IAU Press Release*, IAU2007, "IAU approves name of target of first NASA and ESA planetary defence missions --- Asteroid **Didymos**' moon receives its new name [**Dimorphos**] just over a year before deflection mission launch." On 22 July 2021 NASA will launch the ***Double Asteroid Redirection Test*** (***DART***) mission. This demonstration of asteroid deflection technology will target the smaller body in the binary asteroid **Didymos**, and will be followed in 2024 by the ESA space probe ***Hera***. In recognition of the asteroid's moon significance in these pioneering missions, it has been given an official name by the **International Astronomical Union**: **Dimorphos**. ***DART*** is scheduled to reach **Dimorphos** in 2022, deliberately colliding with it and creating a kinetic impact to alter the satellite's trajectory. The ESA space probe ***Hera*** will be launched in 2024, and is scheduled to arrive at **Dimorphos** in 2027, where it will perform a close-up survey to assess the effects of the ***DART*** impact on the satellte's form and orbit. See: https://www.iau.org/news/pressreleases/detail/iau2007/?lang See also: https://www.nasa.gov/planetarydefense/dart https://www.esa.int/Safety_Security/Hera https://en.wikipedia.org/wiki/65803_Didymos https://en.wikipedia.org/wiki/Dimorphos
2020, Jun 24	Apollo NEA **441987** (**2010 NY65**, $H = 21.4$ mag, $D \approx 228$ m, **PHA**) passed Earth at a nominal miss distance of 9.78 LD. Minimum miss distance 9.78 LD. See: 2010 NY65- SSA , 2010 NY65 - JPL See also: **24 Jun 2017, 24 Jun 2018, 24 Jun 2019, 25 Jun 2181**.
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	http://astrobiology.com/2020/06/risks-for-life-on-proxima-b-from-sterilizing-asteroid-impacts.html
2020, Jun 30	***Asteroid Day 2020***. See: http://www.asteroidday.org/ https://content.govdelivery.com/accounts/EUESA/bulletins/29349c0 https://en.wikipedia.org/wiki/Asteroid_Day https://www.esa.int/Safety_Security/An_Agency_for_asteroids
2020, Jun 30	ESA **NEOCC** *Newsletter*. July 2020. See: http://neo.ssa.esa.int/newsletters [July 2020] http://neo.ssa.esa.int/neocc-riddles
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2020, Jul	E. Tatsumi, D. Domingue, S. Schröder, et al., 2020, *Astronomy & Astrophysics*, 639, 83, "Global photometric properties of **(162173) Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...639A..83T/abstract
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2020, Jul 28	Apollo NEA **2020 OY4** (H = 30.3 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.108 LD. Minimum miss distance 0.108 LD. **[2020-49]** See: 2020 OY4 – S2P , 2020 OY4 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **28 Jul 1989**. See also: http://neo.ssa.esa.int/newsletters [27 July 2020] http://neo.ssa.esa.int/c/document_library/get_file?uuid=3bbc9d97-f8b9-4224-bddd-db0f220230a7&groupId=10157 https://twitter.com/esaoperations/status/1288042510607159302 https://www.space.com/car-size-asteroid-2020-oy4-earth-flyby.html
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2020, Aug 12	Apollo NEA **2020 QJ5** (H = 26.9 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.76 LD. **[2020-52]** See: 2020 QJ5 – S2P , 2020 QJ5 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
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2020, Aug 15-22	***43rd COSPAR Scientific Assembly***, ~~15-22 August~~, Sydney (Australia). **Rescheduled for:** 28 January – 4 February 2021. See: https://www.cospar2020.org https://mailchi.mp/cosparhq.cnes.fr/cospar-2020-scientific-assembly-postponed **In the Scientific Program:** B1.1 Small Body exploration science in the new decade. B1.2 Asteroids, friends or foe: Planetary Defense and resources.
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2020, Aug 20, 23:5	Apollo NEA **2020 QY2** (*H* = 31.2 mag, *D* ≈ 2 m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.17 LD. **[2020-57]** See: 2020 QY2 – S2P , 2020 QY2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Aug 21	Apollo NEA **2020 QN4** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.71 LD. Minimum miss distance 0.71 LD. **[2020-58]** See: 2020 QN4 – S2P , 2020 QN4 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/ See also: **16 Feb 2006**, **21 Feb 2050**.
2020, Aug 22	Apollo NEA **2020 QQ4** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.80 LD. Minimum miss distance 0.80 LD. **[2020-59]** See: 2020 QQ4 – S2P , 2020 QQ4 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
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2020, Sep 9	Apollo NEA **2020 RE5** (H = 29.1 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.64 LD. **[2020-61]** See: 2020 RE5 – S2P , 2020 RE5 – JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/
2020, Sep 10, 11:33	Apollo NEA **2020 RG10** (H = 29.0 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.35 LD. Minimum miss distance 0.35 LD. **[2020-62]** See: 2020 RG10 – S2P , 2020 RG10 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Sep 10, 21:04	Amor NEA **2020 QU6** (H = 18.2 mag, $D \approx 800$ m) passed Earth at a nominal miss distance of 104.60 LD. Minimum miss distance 104.60 LD. See: 2020 QU6 – S2P , 2020 QU6 - JPL Discovery station: **Observatorio Campo dos Amarais. Observer**

	L.S. Amaral. See also: https://skyandtelescope.org/astronomy-news/amateur-astronomer-finds-kilometer-size-asteroid/
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2020, Sep 13	Aten/Apollo NEA **2020 SP** (H = 27.1 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.86 LD. Minimum miss distance 0.86 LD. **[2020-63]** See: 2020 SP – S2P , 2020 SP - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2020, Sep 14	Y. Wang, M. Li, Z. Gong, et al., 2020, e-print *arXiv*:2009.06495, "Assembled kinetic impactor for deflecting asteroids via combining the spacecraft with the launch vehicle final stage." See: https://ui.adsabs.harvard.edu/abs/2020arXiv200906495W/abstract
2020, Sep 14, 06:49	Aten NEA **2020 RF3** (H = 28.6 mag, $D \approx$ 7 m) passed Earth at a nominal miss distance of 0.24 LD. Minimum miss distance 0.24 LD. **[2020-64]** See: 2020 RF3 – S2P , 2020 RF3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **14 Sep 1961, 15 Sep 2070**.
2020, Sep 14, 20:33	Aten → Apollo NEA **2020 RD4** (H = 29.8 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.27 LD. **[2020-65]** See: 2020 RD4 – S2P , 2020 RD4 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **15 Sep 2002**, **15 Sep 2079**.
2020, Sep 15	Anon., 2020, *Jaxa.Japan*, 15 September 2020, "JAXA ***Hayabusa2*** project." **Contents:** 0. ***Hayabusa2*** and mission flow outline 1. Current status and overall schedule of the project 2. Extended mission selection [**1998 KY26**] 3. Scientific significance of extended mission

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	asteroids originating in the outer main belt: a model study with dynamical trajectories." See: https://ui.adsabs.harvard.edu/abs/2020Icar..34813865S/abstract
2020, Sep 15	Y. Shimaki, H. Senshu, N. Sakatani, et al., 2020, *Icarus*, 348, 113835, "Thermophysical properties of the surface of asteroid **162173 Ryugu**: nfrared observations and thermal inertia mapping." See: https://ui.adsabs.harvard.edu/abs/2020Icar..34813835S/abstract
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2020, Sep 17	Apollo NEA **2020 RZ6** (H = 26.7 mag, $D \approx$ 16 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88 LD. **[2020-66]** See: 2020 RZ6 – S2P , 2020 RZ6 – JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2020, Sep 18	Apollo NEA **2020 SO3** (H = 27.2 mag, $D \approx$ 13 m) passed Earth at a nominal miss distance of 1.03 LD. Minimum miss distance 1.03 LD. See: 2020 SO3 – S2P , 2020 SO3 - JPL
2020, Sep 19	Apollo NEA **2020 SZ2** (H = 29.4 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.95 LD. Minimum miss distance 0.95 LD. **[2020-67]** See: 2020 SZ2 – S2P , 2020 SZ2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2020, Sep 21 – Oct	***Europlanet Science Congress 2020***, ~~Granada (Spain), 27 September – 2 October 2020.~~ **Rescheduled for a virtual meeting**, 21 September – 9 October 2020. EPSC Session SB11: Physical properties of small bodies: observations and techniques. See: https://www.europlanet-society.org/epsc-2020-in-the-heart-of-granada/ https://www.epsc2020.eu/
2020, Sep 23	K. Beatty, 2020, *Sky & Telescope*, 23 September 2020, "Is **Phaethon** a "rock comet"?" See: https://skyandtelescope.org/astronomy-news/is-phaethon-a-rock-comet/
2020, Sep 23	***11th International Asteroid Warning Network Steering Committee Meeting***, Cambridge (MA, USA), 23 September 2020. **Among the agenda items:** - D. Koschny, 2020, "**ESA Planetary Defence Office**". Update. - K. Fast, 2020, "**NASA Planetary Coordination Office**." Update. - G. Valsecchi, 2020, "Italian Institute for Astrophysics (INAF)." Update. - P. Michel, 2020, "Observatoire de la Côte d'Azur (OCA)." Update. - H.-K. Moon, 2020, "Korea Astronomy and Space Science Institute (KASI)." Update. - S. Camacho, 2020, "Instituto Nacional de Astrofísica, Óptica y

	Electrónica (INAOE).” Update. - G. Bauer, 2020, “**IAWN.net**.” Update - D. Daou, 2020, “**International Year of Planetary Defense** (2029?).” Concept. - G. Bauer, 2020, “**Minor Planet Center**.” Update. - P. Chodas, **NASA JPL**, 2020, “Recent modifications to computations of **Palermo Scale**.” - R. Kofler, **UNOOSA**, 2020, “***Planetary Defense Conference 2021***.” See: http://iawn.net/meetings.shtml http://iawn.net/meetings/11-steering-cmte.shtml http://iawn.net/documents/20200923_11th_virtual/11th_IAWN_Mtg_Summary.pdf
2020, Sep 23	Apollo NEA **2020 SG6** (H = 29.3 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.58 LD. Minimum miss distance 0.58 LD. **[2020-68]** See: 2020 SG6 – S2P , 2020 SG6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Sep 24	E. Morton, 2020, 24 September 2020, *Asteroidmission*.org, “***OSIRIS-REx*** begins its countdown to TAG.” See: https://www.asteroidmission.org/?latest-news=osiris-rex-begins-its-countdown-to-tag
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	moving forward." See: https://www.cosmos.esa.int/documents/336356/336472/LWG_ways_forward_2020-09-24.pdf/
2020, Sep 24, 11:13	Aten → Apollo NEA **2020 SW** (H = 28.9 mag, $D \approx$ 6 m) passed Earth at a **nominal miss distance of 0.0730 LD (= 4.41 R_{Earth} = 28,079 km from the geocenter). Minimum miss distance 0.0730 LD (= 4.41 R_{Earth} = 28,072 km from the geocenter)**. **[2020-69]** See: 2020 SW – S2P , 2020 SW - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: http://neo.ssa.esa.int/ [ESA-S2P-PD-CAFS-0003_1_0_2020SW_2020-09-22.pdf] https://www.jpl.nasa.gov/news/news.php?feature=7752 https://en.wikipedia.org/wiki/List_of_asteroid_close_approaches_to_Earth_in_2020
2020, Sep 24, 12:47	Apollo NEA **2020 SN5** (H = 28.1 mag, $D \approx$ 8 m) passed Earth at a nominal miss distance of 0.53 LD. Minimum miss distance 0.52 LD. **[2020-70]** See: 2020 SN5 – S2P , 2020 SN5 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2020, Sep 26	Apollo NEA **2020 SQ4** (H = 28.9 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.91 LD. **[2020-71]** See: 2020 SQ4 – S2P , 2020 SQ4 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Sep 29	Apollo NEA **2020 PM7** (H = 22.4 mag, $D \approx$ 120 m) passed Earth at a nominal miss distance of 7.47 LD. Minimum miss distance 7.47 LD. See: 2020 PM7 – S2P , 2020 PM7 - JPL
2020, **Oct**	H.F. Agrusa, D.C. Richardson, A.B. Davis, et al., 2020, *Icarus*, 349, 113849, "A benchmarking and sensitivity study of the full two-body gravitational dynamics of the ***DART*** mission target, binary asteroid **65803 Didymos**." See: https://ui.adsabs.harvard.edu/abs/2020Icar..34913849A/abstract
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	See: https://ui.adsabs.harvard.edu/abs/2020MNRAS.497.4031B/abstract
2020, Oct	T. Saiki, Y. Takei, Y. Mimasu, et al., 2020, *Acta Astronautica*, 175, 362, "***Hayabusa2***'s kinetic impact experiment: operational planning and results." See: https://ui.adsabs.harvard.edu/abs/2020AcAau.175..362S/abstract
2020, Oct	O. Vaduvescu, L. Curelaru, M. Popescu, et al., 2020, *Astronomy & Astrophysics*, 642, 35, "Dozens of virtual impactor orbits eliminated by the **EURONEAR** VIMP DECam data mining project." See: https://ui.adsabs.harvard.edu/abs/2020A%26A...642A..35V/abstract
2020, Oct 1	M. Froncisz, P. Brown, R.J. Weryk, 2020, *Planetary and Space Science*, 190, 104980, "Possible interstellar meteoroids detected by the **Canadian Meteor Orbit Radar (CMOR)**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19004980F/abstract
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2020, Oct 1	S.I. Ipatov, E.A. Feoktistova, V.V. Svettsov, 2020, *Solar System Research*, 54, 384, "Number of Near-Earth Objects and formation of **lunar** craters over the last billion years." See: https://ui.adsabs.harvard.edu/abs/2020SoSyR..54..384I/abstract
2020, Oct 1	Y. Jiang, J. Schmidt, 2020, Heliyon, 6, E05275, "Motion of dust ejected from the surface of asteroid **(101955) Bennu**." See: https://www.cell.com/heliyon/fulltext/S2405-8440(20)32118-6
2020, Oct 1	S.-Y. Liao, M.H.Huyskens, Q.-Z. Yin, B. Schmitz, 2020, *Earth and Planetary Science Letters*, 547, 116442, "Absolute dating of the L-chondrite parent body breakup with high-precision U-Pb zircon geochronology from Ordovician limestone." See: https://ui.adsabs.harvard.edu/abs/2020E%26PSL.54716442L/abstract
2020, Oct 1, 11:09	Apollo NEA **2020 TA** ($H = 25.5$ mag, $D \approx 28$ m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2020-72]** See: 2020 TA – S2P , 2020 TA - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/

2020, Oct 1, 14:59	Apollo NEA **2001 GP2** (*H* = 26.9 mag, *D* ≈ 15 m) passed Earth at a nominal miss distance of 6.09 LD. Minimum miss distance 0.35 LD. See: 2001 GP2 - SSA , 2001 GP2 - JPL
2020, Oct 4-7	***European Astronomical Society Annual Meeting EAS 2020 (EWASS)***, ~~Leiden (The Netherlands)~~, 4 - 7 Oct 2020, **a virtual meeting**. See: https://eas.unige.ch/EAS2020/
2020, Oct 5	ESA **NEOCC** *Newsletter*. October 2020. See: http://neo.ssa.esa.int/newsletters [October 2020] http://neo.ssa.esa.int/neocc-riddles
2020, Oct 6	S. Jaworski, J. Kindracki, 2020, *Journal of Spacecraft and Rockets*, 57, 1232, "Feasibility of synchronized ***CubeSat*** missions from low Earth orbit to Near-Earth Asteroids." See: https://ui.adsabs.harvard.edu/abs/2020JSpRo..57.1232J/abstract
2020, Oct 8	B. Enos, 2020, *NASA.gov/feature*, 8 October 2020, "NASA's ***OSIRIS-REx*** unlocks more secrets from asteroid **Bennu**." See: https://www.nasa.gov/feature/goddard/2002/osiris-rex-unlocks-more-secrets-from-asteroid-bennu
2020, Oct 8	B. Rozitis, A.J. Ryan, J.P. Emery, et al., 2020, *Science Advances*, 6, eabc3699, "Asteroid **(101955) Bennu**'s weak boulders and thermally anomalous equator." See: https://advances.sciencemag.org/content/6/41/eabc3699 See also: https://www.sciencemag.org/news/2020/10/nasa-mission-about-capture-carbon-rich-dust-former-water-world
2020, Oct 8	D.J. Scheeres, A.S. French, P. Tricarico, et al., 2020, *Science Advances*, 6, eabc3350, "Heterogeneous mass distribution of the rubble-pile asteroid **(101955) Bennu**." See: https://advances.sciencemag.org/content/6/41/eabc3350 See also: https://www.sciencemag.org/news/2020/10/nasa-mission-about-capture-carbon-rich-dust-former-water-world
2020, Oct 8	D.E. Trilling, C. Lisse, D.P. Cruikshank, et al., 2020, *Nature Astronomy*, 4, 940, "***Spitzer***'s Solar System studies of asteroids, planets and the zodiacal cloud." See: https://ui.adsabs.harvard.edu/abs/2020NatAs...4..940T/abstract
2020, Oct 8	P. Voosen, 2020, *Science*, 8 October 2020, "A NASA mission is

	about to capture carbon-rich dust from a former water world." See: https://www.sciencemag.org/news/2020/10/nasa-mission-about-capture-carbon-rich-dust-former-water-world
2020, Oct 8	Apollo NEA **2020 TP1** (H = 26.8 mag, $D \approx$ 16 m) passed Earth at a nominal miss distance of 1.006 LD. Minimum miss distance 1.004 LD. See: 2020 TP1 – S2P , 2020 TP1 - JPL
2020, Oct 9	P. Voosen, 2020, *Science*, 370, 158, "NASA mission set to sample carbon-rich asteroid." See: https://science.sciencemag.org/content/370/6513/158 See also: https://www.sciencemag.org/news/2020/10/nasa-mission-about-capture-carbon-rich-dust-former-water-world
2020, Oct 9	Apollo NEA **2020 TE5** (H = 29.0 mag, $D \approx$ 6 m) passed Earth at a nominal miss distance of 0.15 LD. Minimum miss distance 0.15 LD. **[2020-73]** See: 2020 TE5 – S2P , 2020 TE5 - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2020, Oct 12	Aten NEA **2020 TS1** (H = 29.1 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.66 LD. Minimum miss distance 0.66 LD. **[2020-74]** See: 2020 TS1 – S2P , 2020 TS1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Oct 13	Apollo NEA **2020 TD7** (H = 26.8 mag, $D \approx$ 15 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88 LD. **[2020-75]** See: 2020 TD7 – S2P , 2020 TD7 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Oct 14	Live Tonight! 14 October 2020. The ASP presents a special virtual event: "Asteroid Hunters", a virtual panel discussion with filmmakers and Planetary Defense experts, including writer/producer Phil Groves, planetary scientist Dr. Donald Yeomans, and Planetary Defense experts. See: https://myemail.constantcontact.com/LIVE-TONIGHT--Open-to-All---ASP-Special-Event--Oct--14----Asteroid-Hunters----A-Panel-Discussion-with-Documentary-Filmaker---Sci.html https://www.youtube.com/watch?v=uW-P35CNwBI&feature=emb_logo

2020, Oct 14, 07:05	Atira NEA **2020 AV2** (*H* = 16.4 mag, ***D* ≈ 1900 m**) passed Earth at a nominal miss distance of 136 LD (= 0.35 AU). Minimum miss distance 136 LD (= 0.35 AU). See: 2020 AV2 – S2P , 2020 AV2 – JPL See also: **13 Jan 2020**. Re: - S. Greenstreet, 2020, *Monthly Notices of the Royal Astronomical Society: Letters*, 493, L129, "Orbital dynamics of **2020 AV2**: the first **Vatira asteroid**." See: https://ui.adsabs.harvard.edu/abs/2020MNRAS.tmpL..23G/abstract It is the first asteroid discovered to have an orbit entirely within **Venus**'s orbit, and is thus the first and only known member of the intra-Venusian Vatira population of Atira-class asteroids. **2020 AV2** has the smallest known aphelion and second-smallest known semi-major axis among all asteroids. See also: https://en.wikipedia.org/wiki/2020_AV2
2020, Oct 14, 16:00	Apollo/Aten (?) NEA **2020 TK7** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.20 LD. Minimum miss distance 0.20 LD. **[2020-76]** See: 2020 TK7 – S2P , 2020 TK7 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **14 Oct 2091**.
2020, Oct 15	H.A.R. Devillepoix, M. Cupák, P.A. Bland, et al., 2020, *Planetary and Space Science*, 191, 105036, "A **Global Fireball Observatory**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19105036D/abstract
2020, Oct 15	D. Harries, A. Bischoff, 2020, *Earth and Planetary Science Letters*, 548, 116506, "Petrological evidence for the existence and disruption of a 500 km-sized differentiated planetesimal of enstatite-chondritic parentage." See: https://ui.adsabs.harvard.edu/abs/2020E%26PSL.54816506H/abstract
2020, Oct 15	S. Kikuchi, S.-i. Watanabe, […] Y. Tsuda, 2020, *Space Science Reviews*, 216, 116, "***Hayabusa2*** landing site selection: surface topography of **Ryugu** and touchdown safety." See: https://ui.adsabs.harvard.edu/abs/2020SSRv..216..116K/abstract
2020, Oct 15	K. Ohtsuka, T. Ito, D. Kinoshita, et al., 2020, *Planetary and Space Science*, 191, 104940, "Full rotationally phase-resolved visible

	reflectance spectroscopy of **3200 Phaethon**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19104940O/abstract
2020, Oct 15	Apollo NEA **2020 UE** (*H* = 25.6 mag, *D* ≈ 27 m) passed Earth at a nominal miss distance of 0.71 LD. Minimum miss distance 0.71 LD. **[2020-77]** See: 2020 UE – S2P , 2020 UE - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **15 Oct 2034**.
2020, Oct 16	A. Witze, 2020, *Nature*, 586, 484, "NASA `fist bumps' an asteroid to reveal Solar System's secrets." See: https://ui.adsabs.harvard.edu/abs/2020Natur.586..484W/abstract
2020, Oct 16	Apollo NEA **2020 UU1** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.07 LD. Minimum miss distance 1.06 LD. See: 2020 UU1 – S2P , 2020 UU1 - JPL
2020, Oct 17	Apollo NEA **2020 TG6** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.36 LD. **[2020-78]** See: 2020 TG6 – S2P , 2020 TG6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Oct 18	Apollo NEA **2020 TE6** (*H* = 27.6 mag, *D* ≈ 11 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2020-79]** See: 2020 TE6 – S2P , 2020 TE6 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Oct 19	B. Cheng, Y. Yu, E. Asphaug, P. Michel, et al., 2020, *Nature Astronomy*, 5, 134, "Reconstructing the formation history of top-shaped asteroids from the surface boulder distribution." See: https://ui.adsabs.harvard.edu/abs/2021NatAs...5..134C/abstract
2020, Oct 19, 06:56	Apollo NEA **2020 UX** (*H* = 31.1mag, *D* ≈ 2.1 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2020-80]** See: 2020 UX – S2P , 2020 UX - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/

	See also: https://www.space.com/2-asteroids-earth-flyby-same-day-october-2020
2020, Oct 19, 19:24	Apollo NEA **2020 TF6** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.40 LD. Minimum miss distance 0.40 LD. **[2020-81]** See: 2020 TF6 – S2P , 2020 TF6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: https://www.space.com/2-asteroids-earth-flyby-same-day-october-2020
2020, Oct 20	The NASA ***OSIRIS-REx*** mission prepares for touchdown to asteroid **Bennu** this October 20th with a final rehearsal earlier this month. The spacecraft, which has been circling **Bennu** since December 2018 mapping its surface, will be using Touch-and-Go sequence (TAG) to pick up samples of the asteroid to return home. See: https://us9.campaign-archive.com/?u=0e9c23265f31e0f37201d19b6&id=98145b6d5a https://www.fox10phoenix.com/video/842725 See also: https://www.sciencemag.org/news/2020/10/nasa-mission-about-capture-carbon-rich-dust-former-water-world https://www.space.com/nasa-osiris-rex-asteroid-sampling-360-video https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-successfully-touches-asteroid http://www.nasa.gov/osiris-rex http://science.nasa.gov/missions/osiris-rex/ https://www.nasa.gov/press-release/nasa-invites-public-media-to-watch-asteroid-mission-begin-return-to-earth https://en.wikipedia.org/wiki/OSIRIS-REx
2020, Oct 20	G. Hautaluoma, J. Handal, N. Neal Jones, E. Morton, 2020, *NASA.gov/press-release*, 20 October 2020, "NASA's ***OSIRIS-REx*** spacecraft successfully touches asteroid." See: https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-successfully-touches-asteroid See also: http://www.nasa.gov/osiris-rex http://science.nasa.gov/missions/osiris-rex/ https://en.wikipedia.org/wiki/OSIRIS-REx
2020, Oct 21	B. Enos, N. Neal Jones, E. Morton, 2020, *NASA.gov/feature/goddard*, 22 October 2020, "***OSIRIS-REx*** TAGs surface of asteroid Bennu." See: https://www.nasa.gov/feature/goddard/2020/osiris-rex-tags-surface-of-asteroid-bennu/

	See also: https://www.space.com/nasa-osiris-rex-asteroid-bennu-sampling-results https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-collects-significant-amount-of-asteroid https://asteroidday.org/news-updates/nasas-osiris-rex-mission-successfully-makes-contact-with-asteroid-bennu/
2020, Oct 21, 02:24	Aten NEA **2020 UA** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.12 LD. Minimum miss distance 0.12 LD. **[2020-82]** See: 2020 UA – S2P , 2020 UA - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **21 Oct 2047**.
2020, Oct 21, 04:18	Apollo NEA **2020 UY** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2020-83]** See: 2020 UY – S2P , 2020 UY - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Oct 22, 09:46	Apollo NEA **2020 UL2** (*H* = 28.7 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 1.07 LD. Minimum miss distance 1.06 LD. See: 2020 UL2 – S2P , 2020 UL2 - JPL
2020, Oct 22, 15:53	Apollo NEA **2020 UO3** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2020-84]** See: 2020 UO3 – S2P , 2020 UO3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Oct 22, 22:28	Aten/Apollo (?) NEA **2020 UF3** (*H* = 28.3 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.11 LD. Minimum miss distance 0.11 LD. **[2020-85]** See: 2020 UF3 – S2P , 2020 UF3 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **23 Oct 2019**. [CHECK]
2020, Oct 26	G. Danger, A. Ruf, J. Maillard, et al., 2020, *Planetary Science Journal*, 1, 55, "Unprecedented molecular diversity revealed in meteoritic Insoluble Organic Matter (IOM): the **Paris meteorite**'s case." See: https://ui.adsabs.harvard.edu/abs/2020PSJ.....1...55D/abstract

2020, Oct 26	G. Hautaluoma, A. Johnson, N. Neal Jones, E. Morton, 2020, *nasa.gov/press release*, 26 October 2020, "NASA's ***OSIRIS-REx*** spacecraft goes for early stow of asteroid sample." See: https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-goes-for-early-stow-of-asteroid-sample See also: https://www.space.com/osiris-rex-asteroid-sample-stowage-begins
2020, Oct 26-30	***52nd Annual Meeting of the AAS Division for Planetary Sciences***, 20-26 October 2020, virtual. **Among the sessions:** - Ground-based asteroid surveys - Asteroid hazards and Planetary Defense - Asteroid surveys in the era of **LSST** **Plenary panel**: Interstellar objects and active small bodies See: https://aas.org/meetings/dps52 See also: https://dps.aas.org/meetings/future **Among the presentations:** - H.F. Agrusa, K. Tsiganis, I. Gkolias, et al., 2020, *AAS DPS #52*, id. 217.04, "On the post-impact spin state of the secondary component of the **Didymos-Dimorphos** binary asteroid system." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5221704A/abstract - B. Allen, J. Hong, D. Hoak, et al., 2020, *AAS DPS #52*, id. 405.06, "Observation performance prediction and evaluation for the Regolith X-ray Imaging Spectrometer (REXIS) through simulation." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240506A/abstract - B. Aponte-Hernández, E. Rivera-Valentín, P. Taylor, 2020, *AAS DPS #52*, id. 409.06, "Revisiting the relationship between Near-Earth Asteroid radar properties and taxonomic class." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240906A/abstract - M. Arakawa, R. Honda, Y. Yokota, et al., 2020, *AAS DPS #52*, id. 405.01, "Resurfacing processes on asteroid **(162173) Ryugu** caused by an artificial impact of ***Hayabusa2***'s **Small Carry-on Impactor**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240501A/abstract - A.N. Bair, D.G. Schleicher, M.M. Knight, et al., 2020, *AAS DPS #52*, id. 313.06, "The unusual chemical composition of interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5231306B/abstract - R. Ballouz, K. Walsh, W. Bottke, et al., 2020, *AAS DPS #52*, id. 112.01, "Craters on **(101955) Bennu**'s boulders." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240201B/abstract - M. Bannister, 2020, *AAS DPS #52*, id. 402.01, "Interstellar worlds: the emerging picture of **1I/'Oumuamua** and **2I/Borisov**."

	See: https://ui.adsabs.harvard.edu/abs/2020DPS....5211201B/abstract - D. Bodewits, J. Noonan, P. Feldman, et al., 2020, *AAS DPS #52*, id. 313.05, "Composition and evolution of interstellar comet **2I/Borisov**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5231305B/abstract - B.T. Bolin, W. Ip, F.J. Masci, G. Helou, 2020, *AAS DPS #52*, id. 214.02, "The discovery and characterization of the first inner-**Venus** asteroid, **2020 AV2**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5221402B/abstract - W. Bottke, K. Walsh, D. Vokrouhlicky, D. Nesvorny, 2020, *AAS DPS #52*, id. 402.02, "The mix is in! Exploring the origin of exogenous material in asteroids and meteorites." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240202B/abstract - M.J. Brucker, R.S. McMillan, J.A. Larsen, et al., 2020, *AAS DPS #52*, id. 107.02, "**Spacewatch** NEO astrometry and characterization." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5210702B/abstract - M.T. Burkey, R.A. Managan, K. Howley, et al., 2020, *AAS DPS #52*, id. 512.02, "Effects of asteroid composition on energy deposition for deflection and disruption missions." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5251202B/abstract - B. Chagas, A. Prado, O. Winter, 2020, *AAS DPS #52*, id. 512.01, "Deflect an hazardous asteroid through kinetic impact: application in **101955 Bennu** and **4179 Toutatis**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5251201C/abstract - M. Cordiner, S. Milam, N. Biver, et al., 2020, *AAS DPS #52*, id. 313.04, "Probing the chemical composition of interstellar comet **2I/Borisov** using **ALMA**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5231304C/abstract - D. Cotto-Figueroa, F. Rabbi, L.A. Garvie, E. Asphaug, et al., 2020, *AAS DPS #52*, id. 512.03, "On the strength of the Aba Panu (L3) meteorite: implications for NEO hazard mitigation." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5251203C/abstract - D.N. DellaGiustina, H.H. Kaplan, A.A. Simon, et al., 2020, *AAS DPS #52*, id. 400.02, "Material from **(4) Vesta** on **(101955) Bennu**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240002D/abstract - M. Devogèle, A. Virkki, S.E. Marshall, et al., 2020, *AAS DPS #52*, id. 415.04, "Heterogeneous surface of **1998 OR2**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5241504D/abstract - E. Dotto, V. Della Corte, M. Amoroso, et al. 2020, *AAS DPS #52*, id. 412.06, "Physical characterization of NEOs with a CubeSat: ***LICIACube*** at **(65803) Didymos**." See: https://ui.adsabs.harvard.edu/abs/2020DPS....5241206D/abstract - G. Fedorets, M. Micheli, R. Jedicke, et al., 2020, *AAS DPS #52*, id. 415.03, "Characterization of **2020 CD3**, Earth's second minimoon."

	See: https://ui.adsabs.harvard.edu/abs/2020DPS....5241503F/abstract - O. Fuentes-Munoz, D. Scheeres, 2020, *AAS DPS #52*, id. 214.03, “Long-term NEO evolution statistics using a semi-analytical propagation approach.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5221403F/abstract - M. Granvik, P. Brown, 2020, *AAS DPS #52*, id. 214.07, “Source regions for meteorite falls.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5221407G/abstract - T. Grav, A. Mainzer, S. Sonnett, et al., 2020, *AAS DPS #52*, id. 208.03, “The ***NEO Surveillance Mission (NEOSM)*** survey simulations.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5220803G/abstract - A. Gustafsson, N. Moskovitz, N., 2020, *AAS DPS #52*, id. 409.01, “Revealing regolith properties of Near-Earth Asteroids.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240901G/abstract - M. Hinkle, E. Howell, Y. Fernandez, et al., 2020, *AAS DPS #52*, id. 415.05, “The rotationally-resolved thermophysical properties of **(433) Eros** from ground-based observations.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5241505H/abstract L. - M. Hirabayashi, R. Nakano, E. Tatsumi, E., et al., 2020, *AAS DPS #52*, id. 405.02, “Spin-driven evolution of asteroids' top-shapes at fast and slow spins seen from **(101955) Bennu** and **(162173) Ryugu**.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240502H/abstract - D. Hoak, R. Binzel, B. Allen, et al., 2020, *AAS DPS #52*, id. 405.08, “Performance and results of the **Regolith X-ray Imaging Spectrometer (REXIS)**.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240508H/abstract - C.E. Holt, M.M. Knight, M.S. Kelley, et al., 2020, *AAS DPS #52*, id. 412.05, “Small perihelion effects on Near-Sun asteroids.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5241205H/abstract - E.S. Howell, M.C. Nolan, C. Lejoly, et al., 2020, *AAS DPS #52*, id. 409.02, “Near-Earth Asteroid CW radar observations at **Arecibo Observatory** 1998-2016.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240902H/abstract - H. Hsu, X. Wang, A. Carroll, et al., 2020, *AAS DPS #52*, id. 402.06, “Electrostatic removal of fine-grained regolith on sub-km asteroids.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240206H/abstract - Y. Huang, B. Gladman, 2020, *AAS DPS #52*, id. 205.03, “Four billion year stability of the **Earth-Mars** belt.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5220503H/abstract - E.R. Jawin, K. Walsh, T. McCoy, et al., 2020, *AAS DPS #52*, id. 400.04, “Diverse boulders and recent mass movement: two years of ***OSIRIS-REx*** observations of the geology of asteroid **(101955) Bennu**.” See: https://ui.adsabs.harvard.edu/abs/2020DPS....5240004J/abstract

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2020, Nov 2, 11:33	Apollo NEA **2018 VP1** (*H* = 30.9 mag, *D* ≈ 2.3 m) passed Earth at a nominal miss distance of 1.13 LD. Minimum miss distance 0.28 LD. See: 2018 VP1 - SSA , 2018 VP1 - JPL See also: http://iawn.net/ See also: **2 Nov 2018**, https://b612foundation.org/good-news-2018-vp1-hitting-earth-is-nothing-to-worry-about/ http://neo.ssa.esa.int/newsletters [November 2020] https://en.wikipedia.org/wiki/2018_VP1
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2020, Nov 6	Apollo NEA **2020 VO1** (H = 28.1 mag, $D \approx 9$ m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2020-87]** See: 2020 VO1 – S2P , 2020 VO1 - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ See also: **7 Nov 2037**.
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2020, Nov 9	Apollo NEA **2020 VR1** (H = 28.9 mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2020-88]**

	See: 2020 VR1 – S2P , 2020 VR1 - JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/
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2020, Nov 10	***Hera Community Workshop,*** ~~11-13 November 2020, Nice (France)~~. **Postponed**. A status update on the mission was given by videoconference on November 10. **Topics:** - ***DART*** status (Andy Cheng) - ***LICIAcube*** status (Elisabetta Dotto) - ***Hera*** status (Ian Carnelli) - ***Hera*** science in the context of latest results from ***OSIRIS-REx*** and ***Hayabusa2*** (Patrick Michel) - ***Hera*** team structure and working groups (Michael Küppers) - Juventas status (Hannah Goldberg) - Milani status (Margherita Cardi) See: https://www.cosmos.esa.int/web/hera-community-workshop/
2020, Nov 11	Apollo NEA **2020 VP1** (H = 27.7 mag, $D \approx$ 10 m) passed Earth at a nominal miss distance of 0.48 LD. Minimum miss distance 0.48 LD. **[2020-89]** See: 2020 VP1 – S2P , 2020 VP1 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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2020, Nov 12	I.J. O'Neill, J. Handal, 2020, *JPL News Feature*, 7783, "Earth may have captured a 1960s-era rocket booster." See: https://www.jpl.nasa.gov/news/news.php?feature=7783
2020, Nov 13, 17:2	Apollo → Aten NEA **2020 VT4** (H = 28.8 mag, $D \approx$ 6 m) passed Earth at a **nominal miss distance of 0.01755 LD (= 1.059 R_{Earth}**

	from the geocenter = 370 km over the Pacific Ocean). **Minimum miss distance 0.01752 LD (= 1.057 R_{Earth} from the geocenter).** **[2020-90]** See: 2020 VT4 – S2P , 2020 VT4 – JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/ Closest **Earth** flyby to date. See also: **17 Nov 1937**. See also: https://www.syfy.com/syfywire/on-friday-a-small-asteroid-passed-just-400-km-from-earth https://www.youtube.com/watch?v=Fl5JYZMuTb8 https://en.wikipedia.org/wiki/2020_VT4
2020, Nov 13, 19:4(	Apollo NEA **2020 VH5** (H = 29.2 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.66 LD. Minimum miss distance 0.66 LD. **[2020-91]** See: 2020 VH5 – S2P , 2020 VH5 – JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/ See also: **16 Nov 2082**.
2020, Nov 15	K.L. Craft, O.S. Barnouin, R. Gaskell, et al., 2020, *Planetary and Space Science*, 193, 105077, "Assessing stereophotoclinometry by modeling a physical wall representing asteroid **Bennu**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19305077C/abstract
2020, Nov 15	A. Galiano, E. Palomba, M. D'Amore, et al., 2020, *Icarus*, 351, 113959, "Characterization of the **Ryugu** surface by means of the variability of the near-infrared spectral slope in **NIRS3** data." See: https://ui.adsabs.harvard.edu/abs/2020Icar..35113959G/abstract
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2020, Nov 15-21	***Erice School on Neos,*** 15-21 November 2020, Erice (Italy). See: https://www.cosmos.esa.int/documents/336356/336472/Erice_school_on

	NEOs-_Kofler_2020-06-02+%281%29.pdf/8a1bc340-9e34-c480-f066-d713f07b9685?t=1580993910684
2020, Nov 19	Anon., 2020, *NSF News Release*, 20-010, 19 November 2020, "NSF begins planning for decommissioning of **Arecibo Observatory**'s 305-meter telescope due to safety concerns." See: https://www.nsf.gov/news/news_summ.jsp?cntn_id=301674 https://www.nsf.gov/news/news_summ.jsp?cntn_id=301737 The **Arecibo Observatory** was from 1963 to 2016 the world's largest single dish radiotelescope. The 305 m **Arecibo radio telescope** was during 57 year active in many fields of radio astronomy. In recent years it acted frequently as 'radar-eye', imaging passing asteroids. See also: https://www.space.com/arecibo-observatory-loss-for-planetary-defense-asteroids https://www.space.com/arecibo-observatory-radio-telescope-collapse-photos https://www.space.com/arecibo-observatory-loss-nasa-planetary-defense https://en.wikipedia.org/wiki/Arecibo_Observatory https://www.space.com/china-fast-radio-telescope-open-international-scientists https://www.space.com/arecibo-telescope-loss-underscores-astronomy-conference-aas237 https://www.lpi.usra.edu/sbag/documents/SBAG_RadarRecovery_20210217.pdf
2020, Nov 23	G. Fedorets, M. Micheli, R. Jedicke, et al., 2020, *Astronomical Journal*, 160, 277, "Establishing Earth's minimoon population through characterization of asteroid **2020 CD3**." See: https://ui.adsabs.harvard.edu/abs/2020AJ....160..277F/abstract https://ui.adsabs.harvard.edu/abs/2021yCat..51600277F/abstract
2020, Nov 24	Apollo NEA **2020 WY4** ($H = 28.9$ mag, $D \approx 6$ m) passed Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.29 LD. **[2020-92]** See: 2019 WY4 – S2P , 2019 WY4 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Nov 26, 02:3	Apollo NEA **2020 WG5** ($H = 27.7$ mag, $D \approx 10$ m) passed Earth at a nominal miss distance of 0.94 LD. Minimum miss distance 0.94 LD. **[2020-93]** See: 2020 WG5 – S2P , 2020 WG5 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/

2020, Nov 26, 08:1[illegible]	Apollo NEA **2020 WF5** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2020-94]** See: 2020 WF5 – S2P , 2020 WF5 - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2020, Nov 27	T. Jansen-Sturgeon, B.A.D. Hartig, G.J. Madsen, et al., 2019, *Publications of the Astronomical Society of Australia*, 37, e049, "Recreating the ***OSIRIS-REx*** slingshot manoeuvre from a network of ground-based sensors." See: https://ui.adsabs.harvard.edu/abs/2020PASA...37...49J/abstract
2020, Nov 27	C. Tardioli, D. Farnocchia, M. Vasile, S.R. Chesley, 2020, *Celestial Mechanics and Dynamical Astronomy*, submitted, e-print *arXiv*:2011.13632, "Impact probability under aleatory and epistemic uncertainties." See: https://ui.adsabs.harvard.edu/abs/2020arXiv201113632T/abstract
2020, Nov 30	A. Siraj, A. Loeb, 2020, e-print *arXiv*:2011.14900, "Interstellar objects outnumber Solar System objects in the **Oort Cloud**." See: https://ui.adsabs.harvard.edu/abs/2020arXiv201114900S/abstract
2020, Nov 30	Aten/Apollo NEA **2020 XC** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.32 LD. Minimum miss distance 0.31 LD. **[2020-95]** See: 2020 XC – S2P , 2020 XC – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **22 Dec 2003**, **30 May 2013**.
2020, **Dec**	S. Abe, T. Ogawa, K. Maeda, T. Arai, 2020, *Planetary and Space Science*, 194, 105040, "Sodium variation in **Geminid meteoroids** from **(3200) Phaethon**." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19405040A/abstract
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2020, Dec	R.T. Daly, E.B. Bierhaus, O.S. Barnouin, et al., 2020, *Geophysical Research Letters*, 47, e89672, "The morphometry of impact craters on **Bennu**." See: https://ui.adsabs.harvard.edu/abs/2020GeoRL..4789672D/abstract
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2020, Dec	F. Hörz, A.T. Basilevsky, J.W.Head, M.J.Cintala, 2020, *Planetary and Space Science*, 194, 105105, "Erosion of lunar surface rocks by impact processes: a synthesis." See: https://ui.adsabs.harvard.edu/abs/2020P%26SS..19405105H/abstract
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2020, Dec	M. Langbroek, 2020, *Zenit*, December 2020, p. 36, "De bijzondere vuurbol van 22 september 2020." See: https://zenitonline.nl/product/zenit-december-2/
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2020, Dec 1, 08:47	**2020 SO** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.13131 LD. Minimum miss distance 0.13130 LD. See: 2020 SO – S2P , 2020 SSO - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ Upper Centauer rocket booster from the 1960's. See also: **2 Feb 2021**. See also: https://edition.cnn.com/2020/09/23/us/mini-moon-scn-trnd/index.html https://www.sciencealert.com/earth-might-be-about-to-get-a-temporary-minimoon-but-what-is-it https://www.space.com/earth-minimoon-2020-so-may-be-vintage-space-junk http://neo.ssa.esa.int/newsletters [October 2020] https://www.space.com/disguise-asteroid-actually-old-rocket-body https://www.jpl.nasa.gov/news/news.php?feature=7783 https://www.jpl.nasa.gov/news/news.php?feature=7795 https://www.space.com/2020-so-space-junk-asteroid-lessons https://ui.adsabs.harvard.edu/abs/2020ATel14241....1W/abstract https://en.wikipedia.org/wiki/2020_SO
2020, Dec 1	Apollo NEA **2020 XE** (*H* = 26.3 mag, *D* ≈ 20 m) passed Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2020-96]** See: 2020 XE – S2P , 2020 XE – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Dec 1-17	***American Geophysical Union Fall Meeting***, 1-17 December 2020, Online everywhere. See: https://www.agu.org/Fall-Meeting See also: https://www.nasa.gov/topics/earth/agu/index.html
2020, Dec 3	B. Weiner, E. Pearce, H. Krantz, et al., 2020, *ATel* #14241, "MMT/Binospec spectroscopy of near earth object **2020 SO**

	distinguishes it from common natural asteroids." See: https://ui.adsabs.harvard.edu/abs/2020ATel14241....1W/abstract
2020, Dec 3, 08:23	Apollo NEA **2020 XE1** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.85 LD. Minimum miss distance 0.85 LD. **[2020-97]** See: 2020 XE1 – S2P , 2020 XE1 – JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/ See also: **7 Dec 2143**.
2020, Dec 3, 09:00	Aten NEA **2020 XF** (*H* = 26.7 mag, *D* ≈ 16 m) passed Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.23 LD. **[2020-98]** See: 2020 XF – S2P , 2020 XF – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **2 Dec 2027**.
2020, Dec 3, 10:06	Apollo NEA **2020 VZ6** (*H* = 25.2 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 0.91 LD. Minimum miss distance 0.91 LD. **[2020-99]** See: 2020 VZ6 – S2P , 2020 VZ6 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Dec 5	ESA **NEOCC** *Newsletter*. December 2020. See: http://neo.ssa.esa.int/newsletters [December 2020] http://neo.ssa.esa.int/neocc-riddles
2020, Dec 5	**Return** of asteroid sample return mission ***Hayabusa2.*** 2nd asteroid sample return mission (following ***Hayabusa***). Target: asteroid **Ryugu**, a C-type asteroid. Main objective: collect organic matter from the beginning of the Solar System. Launch: 3 December 2014; arrival at **Ryugu**: 27 June 2018; return on Earth (Woomera Test Range, Australia): 6 December 2020. See: https://www.cosmos.esa.int/documents/336356/336472/Hayabusa2_2020-02-06.pdf/ http://neo.ssa.esa.int/newsletters [August 2020] https://www.space.com/hayabusa2-asteroid-capsule-return-australia-approved.html https://www.nasaspaceflight.com/2020/12/hayabusa2-returns-to-australia/ https://www.hayabusa2.jaxa.jp/en/ https://www.hayabusa2.jaxa.jp/en/topics/20201206_fireball/

	https://www.youtube.com/watch?v=9fQGsBKnH-U https://www.space.com/hayabusa2-asteroid-ryugu-samples-arrive-in-japan https://phys.org/news/2020-12-black-sand-like-asteroid-japan-probe.html https://phys.org/news/2020-12-japanese-spacecraft-gifts-asteroid-chips.html https://www.hayabusa2.jaxa.jp/en/topics/20201116_extMission/ https://subarutelescope.org/en/news/topics/2020/11/25/2914.html https://scitechdaily.com/next-target-asteroid-for-hayabusa2-photographed-by-subaru-telescope/ https://en.wikipedia.org/wiki/Hayabusa2
2020, Dec 7, 16:15	Apollo NEA **2020 XK1** (*H* = 30.6 mag, *D* ≈ 2.7 m) passed Earth at a **nominal miss distance of 0.0541 LD (= 3.27 R_{Earth} from the geocenter)**. **Minimum miss distance 0.0541 LD (=3.27 R_{Earth} from the geocenter)**. **[2020-100]** See: 2020 XK1 – S2P , 2020 XK1 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2020, Dec 7, 19:15	Apollo NEA **2020 XG2** (*H* = 27.9 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2020-101]** See: 2020 XG2 – S2P , 2020 XG2 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2020, Dec 9	Anon, 2020, *National Space Policy United States of America*. On p. 24: “The Administrator of NASA, in collaboration with other appropriate agencies, Federal laboratories, and commercial partners, shall, consistent with applicable law: … Pursue capabilities, in cooperation with other agencies, commercial, and international partners, to detect, track, catalog, and characterize near Earth objects to warn of any predicted Earth impact and to identify potentially resource-rich planetary objects; and Develop options, in collaboration with other agencies, and international partners, for planetary defense actions both on Earth and in space to mitigate the potential effects of a predicted near Earth object impact or trajectory. … .” See: https://www.whitehouse.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf
2020, Dec 12	S. Aljbaae, D.M. Sanchez, A.F.B.A. Prado, et al., 2020, e-print *arXiv*:2012.06781, “First approximation for spacecraft motion relative to **(99942) Apophis**.” See: https://ui.adsabs.harvard.edu/abs/2020arXiv201206781A/abstract

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2020, Dec 13	G. Nishiyama T. Kawamura N. Namiki, et al., 2020, *Journal of Geophysical Research: Planets*, 126, e06594, "Simulation of seismic wave propagation on asteroid **Ryugu** induced by the impact experiment of the ***Hayabusa2*** mission: limited mass transport by low yield strength of porous regolith." See: https://ui.adsabs.harvard.edu/abs/2021JGRE..12606594N/abstract
2020, Dec 13	G.R. Zengilowski, C.W. McMurtry, J.L. Pipher, et al., 2020, *Proceedings of the SPIE*, 11454, 1145435, "Signal nonlinearity measurements and corrections in MWIR and LWIR HgCdTe H2RG arrays for ***NEO Surveyor***." See: https://ui.adsabs.harvard.edu/abs/2020SPIE11454E..35Z/abstract
2020, Dec 16	H.-J. Lee, J. Ďurech, D. Vokrouhlický, et al., 2020, *Astronomical Journal*, in press, e-print *arXiv*:2012.08771, "Spin change of asteroid **2012 TC4** probably by radiation torques." See: https://ui.adsabs.harvard.edu/abs/2020arXiv201208771L/abstract
2020, Dec 16	Apollo NEA **2020 XF4** ($H = 27.5$ mag, $D \approx 11$ m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.89 LD. **[2020-102]** See: 2020 XF4 – S2P , 2020 XF4 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **17 Dec 2000**.
2020, Dec 18	Apollo NEA **2020 XX3** ($H = 28.5$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.15 LD. Minimum miss distance 0.15 LD. **[2020-103]** See: 2020 XX3 – S2P , 2020 XX3 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2020, Dec 19	Anon., 2020, *SciTechDaily*, 19 December 2020, "Next target [**1998KY26**] asteroid for ***Hayabusa2*** photographed by Subaru telescope."

	See: https://scitechdaily.com/next-target-asteroid-for-hayabusa2-photographed-by-subaru-telescope/ See also: http://www.hayabusa2.jaxa.jp/enjoy/material/press/Hayabusa2_Press_20200915_ver9_en2.pdf http://www.parabolicarc.com/2020/09/22/hayabusa2-to-visit-rapidly-spinning-asteroid-in-extended-mission/ https://www.space.com/japan-hayabusa2-asteroid-probe-extended-mission
2020, Dec 19	Apollo NEA **2020 YR2** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2020-104]** See: 2020 YR2 – S2P , 2020 YR2 – JPL Discovery station: **Mt Lemmon Survey** See: http://iawn.net/
2020, Dec 20	Aten NEA **2020 YS2** (*H* = 31.0 mag, *D* ≈ 2.2 m) passed Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.23 LD. **[2020-105]** See: 2020 YS2 – S2P , 2020 YS2 – JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2020, Dec 21	Anon., 2020, *planetary.org*, "NASA's budget for fiscal year (FY) 2021." … called for a 2025 launch of the ***NEO Surveyor*** mission, which would help identify potentially hazardous asteroids. … See: https://www.planetary.org/space-policy/nasas-fy-2021-budget#
2020, Dec 21	V.E. Hamilton, C.A. Goodrich, A.H. Treiman, et al., 2020, *Nature Astronomy*, 21 December 2021, "Meteoritic evidence for a **Ceres**-sized water-rich carbonaceous chondrite parent asteroid." See: https://www.nature.com/articles/s41550-020-01274-z
2020, Dec 21	J.-L. Margot, 2020, *Journal of Astronomical Instrumentation*, Online Ready, 21 December 2020, "A data-taking system for planetary radar applications." See: https://ui.adsabs.harvard.edu/abs/2021JAI....1050001M/abstract
2020, Dec 21	Apollo NEA **2020 YJ2** (*H* = 27.3 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.89 LD. **[2020-106]** See: 2020 YJ2 – S2P , 2020 YJ2 – JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/

2020, Dec 22	Apollo NEA **2020 YN2** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 1.02 LD. See: 2020 YN2 – S2P , 2020 YN2 – JPL See also: **22 Dec 2097**.
2020, Dec 28	Ö. Karatekin, V. Dehant, 2020, *Press Release Royal Observatory of Belgium*, 28 December 2020, "The Royal Observatory of Belgium and EMXYS receive go for participation in planetary defence ***Hera*** space mission." See: https://www.astro.oma.be/en/the-royal-observatory-of-belgium-and-emxys-receive-go-for-participation-in-planetary-defence-hera-space-mission/ The Royal Observatory of Belgium and EMXYS (Spain) have been selected by the European Space Agency to provide a gravimeter for the ***Juventas*** spacecraft that will land on asteroid **Dimorphos** as part of the **European Space Agency's planetary defence programme**. The Royal Observatory of Belgium with EMXYS will provide the **GRASS** instrument that will make measurements on the gravity field of the asteroid **Dimorphos**. The gravimeter is part of the ***Juventas CubeSat***, manufactured by GomSpace Luxemburg, that will land on the asteroid in 2027, after travelling onboard the ESA's ***Hera*** spacecraft to its vicinity. **GRASS** will be the first gravimeter ever on an asteroid. Due for launch in 2024, ***Hera*** is the European contribution to an international double-spacecraft collaboration to a binary asteroid system: The 780 m-diameter main body **Didymos** is orbited by a 160 m moon, **Dimorphos**. NASA's ***DART*** mission will first perform a kinetic impact on **Dimorphos**, then ***Hera*** will follow up with a detailed post-impact survey that will turn this grand-scale experiment into a well understood and repeatable planetary defence technique.
2020, Dec 28	Apollo NEA **2020 YS4** (*H* = 27.7 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.25 LD. Minimum miss distance 0.25 LD. **[2020-107]** See: 2020 YS4 – S2P , 2020 YS4 – JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2020, Dec 30	M.V. Sergienko, M.G. Sokolova, Yu.A. Nefedyev, A.O. Andreev, 2020, *Astronomy Reports*, 64, 1087, "The **κ-Cygnid** meteor shower and its relationship with Near-Earth Asteroids." See: https://ui.adsabs.harvard.edu/abs/2020ARep...64.1087S/abstract
2021, Jan 1	**24691** **NEAs** known (ranging in size up to ~37 km: **1036**

	Ganymed, A924 UB, *H* = 9.45 mag, *D* = 36.5 km, Amor NEA), of which **2153 PHAs** (ranging in size from 140 m up to ~5 km: **4179 Toutatis, 1989 AC**, *H* = 15.3 mag, *D* = 4.6×2.4×1.9 km, Apollo NEA, **PHA**). See: https://cneos.jpl.nasa.gov/stats/totals.html
2021	[project cancelled] Expected launch of NASA robotic spacecraft ***Asteroid Redirect Mission*** (***ARM***). Potential targets: **2010 MD** (*D* ≈ 6 m), **2008 HU4** (*D* ≈ 8 m), **2009 BD** (*D* ≈ 3 - 4 m). See: https://www.nasa.gov/arm http://www.jpl.nasa.gov/news/news.php?release=2014-052 http://www.jpl.nasa.gov/news/news.php?release=2014-193 http://www.jpl.nasa.gov/news/news.php?release=2014-195 http://www.nasa.gov/jpl/spitzer/asteroid-infrared-20140619/ https://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect-mission http://www.nasa.gov/mission_pages/asteroids/initiative/index.html http://www.nasa.gov/asteroidforum/ http://www.nasa.gov/press/2015/march/nasa-announces-next-steps-on-journey-to-mars-progress-on-asteroid-initiative/ http://www.space.com/34834-nasa-asteroid-mission-robot-prototype-photo.html https://www.space.com/39050-trump-directs-nasa-humans-to-moon.html http://en.wikipedia.org/wiki/Asteroid_Redirect_Mission Ref: - M. Mommert, D. Farnocchia, J.L. Hora, et al., July 2014, *Astrophysical Journal* (Letters), 789, L22, "Physical properties of Near-Earth Asteroid **2011 MD**." See: http://adsabs.harvard.edu/abs/2014ApJ...789L..22M
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	lander during its descent and stay on asteroid **(162173) Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2021P%26SS..19505150G/abstract
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2021, Jan	K.A. Otto, K.-D. Matz, S.E. Schröder, et al., 2021, *Monthly Notices of the Royal Astronomical Society*, 500, 3178, "Surface roughness of asteroid **(162173) Ryugu** and comet **67P/Churyumov–Gerasimenko** inferred from *in situ* observations." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.500.3178O/abstract
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2021, Jan 1	Apollo NEA **2021 AA** (H = 26.9 mag, $D \approx$ 14 m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.61 LD. **[2021-01]** See: 2021 AA – S2P , 2021 AA - JPL

	Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 3	Apollo NEA **2021 AH** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.13 LD. Minimum miss distance 0.13 LD. **[2021-02]** See: 2021 AH – S2P , 2021 AH - JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2021, Jan 4	K. Kitazato, R.E. Milliken, […] Y. Tsuda, 2021, *Nature Astronomy*, Advanced Online Publication, 4 January 2021, "Thermally altered subsurface material of asteroid **(162173) Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2021NatAs.tmp....1K/abstract
2021, Jan 4	Apollo NEA **2021 AH8** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.14 LD. Minimum miss distance 0.14 LD. **[2021-03]** See: 2021 AH8 – S2P , 2021 AH8 - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 5	ESA **NEOCC** *Newsletter*. January 2021. See: http://neo.ssa.esa.int/newsletters [January 2021] http://neo.ssa.esa.int/neocc-riddles
2021, Jan 8	S. Turner, L. McGee, M. Humayun, et al., 2021, *Science*, 371, 164, "Carbonaceous chondrite meteorites experienced fluid flow within the past million years." See: https://science.sciencemag.org/content/371/6525/164 See also: https://www.space.com/meteorites-flow-water-ice-asteroids
2021, Jan 9, 03:10	Apollo NEA **2021 AC4** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 1.005 LD. Minimum miss distance 1.002 LD. See: 2021 AC4 – S2P , 2021 AC4 - JPL
2021, Jan 9, 09:39	Apollo NEA **2021 AS2** (*H* = 29.6 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.28 LD. **[2021-04]** See: 2021 AS2 – S2P , 2021 AS2 - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 11-15	***American Astronomical Society 237th Meeting***, ~~Phoenix (AZ,~~

	~~USA), 3-7 January 2021~~, **rescheduled for a virtual meeting, 11-15 January 2021.** See: https://aas.org/meetings/aas237 **Among the abstracts:** - K.M. Fasbender, D. Nidever, 2021, *AAS meeting* #237, id. 405.06, "**CANFind**: solar system object detection in the NOAO Source Catalog." See: https://ui.adsabs.harvard.edu/abs/2021AAS...23740506F/abstract - D. Trilling, 2021, *AAS meeting* #237, id. 423.06, "The Solar System Notification Alert Processing System (**SNAPS**)." See: https://ui.adsabs.harvard.edu/abs/2021AAS...23742306T/abstract
2021, Jan 15	A.A. Christou, G. Borisov, A. Dell'Oro, et al., 2021, *Icarus*, 354, 113994, "Composition and origin of L5 Trojan asteroids of Mars: insights from spectroscopy." See: https://www.sciencedirect.com/science/article/abs/pii/S0019103520303602 See also: https://armaghplanet.com/mars-plays-shepherd-to-our-moons-long-lost-twin-aop-scientists-find.html
2021, Jan 15	J. Eschrig, L. Bonal, P. Beck, T.J. Prestgard, 2021, *Icarus*, 354, 114034, "Spectral reflectance analysis of type 3 carbonaceous chondrites and search for their asteroidal parent bodies." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35414034E/abstract
2021, Jan 15	S.H. Halim, N. Barrett, S.J. Boazman, et al., 2021, *Icarus*, 354, 113992, "Numerical modeling of the formation of **Shackleton crater** at the **lunar** south pole." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35413992H/abstract
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2021, Jan 15	A. Krishnakumar, S. Ganesh, K. Venkataramani, et al., 2021, *Monthly Notices of the Royal Astronomical Society*, Advance Access, 15 January 2021, "Activity of the first interstellar comet **2I/Borisov** around perihelion: results from Indian observatories." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp..132K/abstract
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2021, Jan 15	R. Noguchi, N. Hirata, N. Hirata, et al., 2021, *Icarus*, 354, 114016, "Crater depth-to-diameter ratios on asteroid **162173 Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35414016N/abstract
2021, Jan 16	Apollo NEA **2021 BR2** (H = 30.9 mag, $D \approx$ 2.4 m) passed Earth at a nominal miss distance of 0.19 LD. Minimum miss distance 0.19 LD. **[2021-05]** See: 2021 BR2 – S2P , 2021 BR2 - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 18, 01:16	Apollo NEA **2021 BK** (H = 30.3 mag, $D \approx$ 3 m) passed Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.29 LD. **[2021-06]** See: 2021 BK – S2P , 2021 BK - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 18, 01:44	Apollo NEA **2021 BV1** (H = 28.0 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2021-07]** See: 2021 BV1 – S2P , 2021 BV1 - JPL Discovery station: **Pan-STARRA 1, Haleakala** See: http://iawn.net/
2021, Jan 18, 08:09	Apollo NEA **2021 BO** (H = 33.0 mag, $D \approx$ 0.9 m) passed Earth at a nominal miss distance of **0.0624 LD (= 3.77 R_{Earth} from the geocenter)**. Minimum miss distance **0.0624 LD (= 3.76 R_{Earth} from the geocenter)**. **[2021-08]** See: 2021 BO – S2P , 2021 BO - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/ See also: **19 Jan 2136**. Possibly the second-smallest asteroid ever discovered in space. See: http://neo.ssa.esa.int/newsletters [February 2021]
2021, Jan 19	G. Baccolo, B. Delmonte, P.B. Niles, et al., 2021, *Nature Communications*, 19 January 2021, "Jarosite formation in deep Antarctic ice provides a window into acidic, water-limited weathering on **Mars**." See: https://www.nature.com/articles/s41467-020-20705-z See also: https://www.space.com/martian-mineral-in-antarctica.html
2021, Jan 19	J. Tyler, A. Wittig, 2021, submitted to *Acta Astronautica*, e-print *arXiv*:2101.07610, "On asteroid retrieval missions enabled by invariant manifold dynamics."

	See: https://ui.adsabs.harvard.edu/abs/2021arXiv210107610T/abstract
2021, Jan 20	Apollo NEA **2021 BO1** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2021-09]** See: 2021 BO1 – S2P , 2021 BO1 - JPL Discovery station: **Mt Lemon Survey** See: http://iawn.net/
2021, Jan 22	A.C. Rabeendran, L. Denneau, 2021, e-print *arXiv*:2101.08912, "A two-stage deep learning detection classifier for the **ATLAS** asteroid survey." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210108912C/abstract
2021, Jan 25	Apollo NEA **2018 BA3** (*H* = 26.5 mag, *D* ≈ 18 m) passed Earth at a nominal miss distance of 1.47 LD. Minimum miss distance 0.71 LD. See: 2018 BA3 - SSA , 2018 BA3 - JPL
2021, Jan 26	Anon., 2021, *Emirates News Agency*, 26 January 2021, "Sharjah Astronomical Observatory detects rare sequential impacts on Moon." See: http://wam.ae/en/details/1395302904554
2021, Jan 26	S.M. Ferrone, B.E. Clark, C.L. Hawley, et al., 2021, *Earth and Space Science*, 8, e00613, "Analysis of projection effects in ***OSIRIS REx*** spectral mapping methods: recommended protocols for facet based mapping." See: https://ui.adsabs.harvard.edu/abs/2021E%26SS....800613F/abstract
2021, Jan 26	A. Loeb, 2021, "Extraterrestrial – The first sign of intelligent life beyond Earth" (Boston, MA, USA: Houghton Mifflin Harcourt). See: https://www.hmhbooks.com/shop/books/Extraterrestrial/9780358274551 See also: https://earthsky.org/space/book-avi-loeb-extraterrestrial-1st-sign-of-intelligent-life
2021, Jan 26-27	***24th Meeting of the NASA Small Bodies Assessment Group,*** 26 - 27 Jan 2021, **virtual**. See: http://www.lpi.usra.edu/sbag/meetings/ **Presentations:** See: https://www.lpi.usra.edu/sbag/meetings/jan2021/SBAG2021-AgendaPreliminary-LG.pdf https://www.lpi.usra.edu/sbag/meetings/jan2021/ - L.S. Glaze, 2021, "Planetary Science Division overview."

	See: https://www.youtube.com/watch?v=2YxNw2oM_lI&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=13 - R. Binzel, 2021, "**Apophis** Workshop summary and the path ahead." See: https://www.youtube.com/watch?v=v7C6klg7ZBU&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=15 - D. Lauretta, 2021, "***OSIRIS-REx*** at asteroid **(101955) Bennu**" See: https://www.youtube.com/watch?v=g3a6u57Xbyo&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=5 - D. Hickson, 2021, "Revealing NEA surfaces using radar polarimetry from the **Arecibo Observatory**." See: https://www.youtube.com/watch?v=dqj04OHv0ng&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=7 - D. Bischoff, 2021, "A method to distinguish between granular and consolidated surfaces of small Solar System bodies." - Lightning Talks, see: https://www.lpi.usra.edu/sbag/meetings/jan2021/SBAG24_CompiledEarlyCareerLightningTalks.pdf - B. Bolin, 2021, "Observations of small Solar System objects with ground- and space-based observatories." See: https://www.youtube.com/watch?v=D6f-Q4IZcLk&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=4 - K. Fast, 2021, "**NEOO** program." - A. Mainzer, 2021, "***NEO Surveillance*** update." - J. Masiero, 2021, "***NEOWISE*** update." - C. Thomas, 2021, "***DART***." - Y. Tsuda, 2021 "***Hayabusa2***." - M. Kueppers, 2021, "***Hera*** mission." See: https://www.youtube.com/watch?v=EP4xv9yc4LM&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=28 - M. Juric, M. Schwamb, S. Eggl, et al., 2021, "Project update: **Rubin Observatory** and the **Legacy Survey of Space and Time (LSST)**." See: https://www.youtube.com/watch?v=Cykzc7PLYSU&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=27 - D. Lawrence, 2021, "**MMX**." - J. Bauer, M. Holman, M. Payne, et al., 2021, "The NASA **Planetary Data System**'s **Small Bodies Node** and **MPC** update." See: https://www.youtube.com/watch?v=apgFH8A5es8&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=24

	- A. Virkki, 2021, "The next-generation **Arecibo Telescope** -- future visions of planetary radar projects." See: https://www.youtube.com/watch?v=jwifHEmeBLo&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=19 - K. O'Neil, 2021, "Planetary radar: **Greenbank**." - L. Benner, 2021, "**Goldstone** Solar System radar status." See: https://www.youtube.com/watch?v=gg8Wgddvvq0&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=25 - M.W. Busch, 2021, "Near-term options for continuing asteroid radar observations." See: https://www.youtube.com/watch?v=cqZXp3EnoKE&list=PLQ7WzZtg-qMBaWCIbcYj5S9PkrJ1M2W1L&index=27
2021, Jan 27	Anon., 2021, *Asteroidday.org Newsupdates,* 27 January 2021, "The ***FastKD*** project: how to deflect an asteroid – and do it fast!" See: https://asteroidday.org/news-updates/the-fastkd-project-how-to-deflect-an-asteroid-and-do-it-fast/ See also: https://www.airbus.com/newsroom/stories/Protecting-Earth-from-asteroids-Airbus-has-a-solution.html
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2021, Jan 28 – Feb	***43rd COSPAR Scientific Assembly***, ~~15-22 August 2020~~, Sydney (Australia). **Rescheduled** for: 28 January – 4 February 2021. See: https://www.cospar2020.org https://mailchi.mp/cosparhq.cnes.fr/cospar-2020-scientific-assembly-postponed https://mailchi.mp/cosparhq/cospar-2020-scientific-assembly-postponed-6411865 https://mailchi.mp/cosparhq.cnes.fr/cospar-news-issue-7 **In the Scientific Program:** B1.1 Small Body exploration science in the new decade. B1.2 Asteroids, friends or foe: Planetary Defense and resources.
2021, Feb	E.B. Bierhaus, J.T. Songer, B.C. Clark, et al., 2021, *Icarus*, 355, 114142, "**Bennu** regolith mobilized by **TAGSAM**: expectations

	for the ***OSIRIS-REx*** sample collection event and application to understanding naturally ejected particles." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35514142B/abstract
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2021, Feb	D. Gardiol, D. Barghini, A. Buzzoni, et al., 2021, *Monthly Notices of the Royal Astronomical Society*, 501, 1215, "**Cavezzo**, the first Italian meteorite recovered by the **PRISMA** fireball network. Orbit, trajectory, and strewn-field." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.501.1215G/abstract
2021, Feb	D.R. Golish, N.K. Shultz, T.L. Becker, et al., 2021, *Icarus*, 355, 114133, "A high-resolution normal albedo map of asteroid **(101955) Bennu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35514133G/abstract
2021, Feb	A. Hibberd, A.M. Hein, 2021, *Acta Astronautica*, 179, 594, "***Project Lyra***: catching **1I/'Oumuamua** using nuclear thermal rockets." See: https://ui.adsabs.harvard.edu/abs/2021AcAau.179..594H/abstract
2021, Feb	M.R. Kirchoff, S. Marchi, W.F.Bottke, et al., 2021, *Icarus*, 355, 114110, "Suggestion that recent (≤ 3 Ga) flux of kilometer and larger impactors in the **Earth-Moon** system has not been constant." See: https://ui.adsabs.harvard.edu/abs/2021Icar..35514110K/abstract
2021, Feb	D. Kuroda, M. Ishiguro, H. Naito, et al., 2021, *Astronomy & Astrophysics*, 646, A51, "**(85989) 1999 JD6** : a first **Barbarian** asteroid detected by polarimetry in the NEA population." See: https://ui.adsabs.harvard.edu/abs/2021A%26A...646A..51K/abstract
2021, Feb	D. Pavela, B. Novaković, V. Carruba, V. Radović, 2021, *Monthly*

	Notices of the Royal Astronomical Society, 501, 356, “Analysis of the **Karma** asteroid family.” See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.501..356P/abstract
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2021, Feb 1-12	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS)** ***Scientific and Technical SubCommittee***, **58th Session**, ~~1-12 February 2021~~, **rescheduled for 19-30 April 2021**, Vienna (Austria), VIC Online. See: https://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2021/index.html https://www.unoosa.org/documents/pdf/copuos/stsc/2021/VIC_Meeting_Guidelines_Covid_19_Participants_20201125_V1.pdf http://www.unoosa.org/oosa/en/ourwork/topics/neos/index.html https://news.yahoo.com/nasa-un-sign-memorandum-understanding-172900649.html
2021, Feb 2	***12th International Asteroid Warning Network Steering Committee Meeting***, 2 February 2021, Vienna (Austria) or virtual. **Postponed till 30-31 March 2021**. See: http://iawn.net/meetings.shtml http://iawn.net/meetings/11-steering-cmte.shtml

2021, Feb 2	**2020 SO** (*H* = 28.4 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD See: 2020 SO – S2P , 2020 SSO - JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ Upper Centauer rocket booster from the 1960's. See also: **1 Dec 2020**. See also: https://edition.cnn.com/2020/09/23/us/mini-moon-scn-trnd/index.html https://www.sciencealert.com/earth-might-be-about-to-get-a-temporary-minimoon-but-what-is-it https://www.space.com/earth-minimoon-2020-so-may-be-vintage-space-junk http://neo.ssa.esa.int/newsletters [October 2020] https://www.space.com/disguise-asteroid-actually-old-rocket-body https://www.jpl.nasa.gov/news/news.php?feature=7783 https://www.jpl.nasa.gov/news/news.php?feature=7795 https://ui.adsabs.harvard.edu/abs/2020ATel14241....1W/abstract https://en.wikipedia.org/wiki/2020_SO
2021, Feb 3	***16th Meeting Space Mission Planning Advisory Group (SMPAG)***, 3 February 2021, Vienna (Austria) or virtual. **Postponed till 24-25 March 2021.** See: https://www.cosmos.esa.int/web/smpag/ https://www.cosmos.esa.int/web/smpag/meeting_15_-_sep_2020
2021, Feb 4	Apollo NEA **2021 CV** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.52 LD. **[2021-10]** See: 2021 CV – S2P , 2021 CV – JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
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2021, Feb 7	O. Unsalan, P. Jenniskens, Q.-Z. Yin, et al., 2021, e-print

	arXiv:2102.03733, "The **Sariçiçek howardite fall** in Turkey: source crater of HED meteorites on **Vesta** and impact risk of **Vestoids**." See: https://arxiv.org/abs/2102.03733
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2021, Feb 9	Apollo NEA **2021 CZ3** (H = 31.0 mag, $D \approx 2.3$ m) passed Earth at a nominal miss distance of 0.0593 LD **(= 3.58 R_{Earth} from the geocenter)**. Minimum miss distance 0.0593 LD. **[2021-11]** See: 2021 CZ3 – S2P , 2021 CZ3 – JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/
2021, Feb 11	H.-J. Lee, J. Ďurech, D. Vokrouhlický, et al., 2021, *Astronomical Journal*, 161, 112, "Spin change of asteroid **2012 TC4** probably by radiation torques." See: https://ui.adsabs.harvard.edu/abs/2021AJ....161..112L/abstract
2021, Feb 11, 15:22	Apollo NEA **2021 CO** (H = 25.3 mag, $D \approx 30$ m) passed Earth at a nominal miss distance of 0.94 LD. Minimum miss distance 0.94 LD. **[2021-12]** See: 2021 CO – S2P , 2021 CO – JPL Discovery station: **Catalina Sky Survey** See: http://iawn.net/
2021, Feb 11, 22:35	Apollo NEA **2021 CQ5** (H = 28.6 mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.46 LD. Minimum miss distance 0.46 LD. **[2021-13]** See: 2021 CQ5 – S2P , 2021 CQ5 – JPL Discovery station: **Pan-STARRS 2, Haleakala** See: http://iawn.net/ See also: **12 Feb 2076**.
2021, Feb 12, 10:59	Apollo NEA **2021 CC6** (H = 30.1 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 0.44 LD. Minimum miss distance 0.44 LD. **[2021-14]** See: 2021 CC6 – S2P , 2021 CC6 – JPL Discovery station: **Kitt Peak-Bok** See: http://iawn.net/
2021, Feb 12, 20:27	Apollo NEA **2021 CC7** (H = 29.6 mag, $D \approx 4$ m) passed Earth at a nominal miss distance of 0.84 LD. Minimum miss distance 0.84

	LD. **[2021-15]** See: 2021 CC7 – S2P , 2021 CC7 – JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/
2021, Feb 13	Apollo NEA **2021 CA6** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2021-16]** See: 2021 CA6 – S2P , 2021 CA6 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/ See also: **14 Feb 1936** , **13 Feb 2054**.
2021, Feb 14, 12:09	Apollo NEA **2021 CS6** (*H* = 27.8 mag, *D* ≈ 10 m) passed Earth at a nominal miss distance of 0.39 LD. Minimum miss distance 0.39 LD. **[2021-17]** See: 2021 CS6 – S2P , 2021 CS6 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Feb 14, 16:14	Apollo NEA **2021 CW7** (*H* = 31.0 mag, *D* ≈ 2.2 m) passed Earth at a nominal miss distance of **0.073 LD (= 4.40 R_{Earth} from the geocenter)**. Minimum miss distance **0.073 LD**. **[2021-18]** See: 2021 CW7 – S2P , 2021 CW7 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Feb 15	D. Remy, 2021, *B612foundation.org*, "Eight year anniversary of the **Chelyabinsk asteroid** blast and it's time to take a long view." See: https://b612foundation.org/eight-year-anniversary-of-the-chelyabinsk-asteroid-blast-and-its-time-to-take-a-long-view-by-danica-remy/
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2021, Feb 18, 03:18	Apollo NEA **2021 DN1** (*H* = 28.1 mag, *D* ≈ 8 m) passed Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.88

	LD. **[2021-19]** See: 2021 DN1 – S2P , 2021 DN1 – JPL Discovery station: **Palomar Mountain--ZTF** See: http://iawn.net/
2021, Feb 18, 14:21	Apollo NEA **2021 DG** (H = 30.1 mag, $D \approx 3$ m) passed Earth at a nominal miss distance of 0.43 LD. Minimum miss distance 0.43 LD. **[2021-20]** See: 2021 DG – S2P , 2021 DG – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **18 Feb 1980**, **19 Feb 2031**.
2021, Feb 19	J.I. Katz, 2021, e-print *arXiv*:2102.07871, "`**Oumuamua** is not artificial." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210207871K/abstract
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2021, Feb 21	Aten NEA **2021 DA2** (H = 29.1 mag, $D \approx 5$ m) passed Earth at a nominal miss distance of 0.51 LD. Minimum miss distance 0.51 LD. **[2021-21]** See: 2021 DA2 – S2P , 2021 DA2 – JPL Discovery station: **GINOP-KHK, Piszkesteto** See: http://iawn.net/ See also: **22 Feb 1955**, **21 Feb 2050**
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2021, Mar 5	ESA **NEOCC** *Newsletter*. March 2021. See: http://neo.ssa.esa.int/newsletters [March 2021] http://neo.ssa.esa.int/neocc-riddles
2021, Mar 6	Aten NEA **99942 Apophis** (**2004 MN4**, H = 19.7 mag, $D \approx 370$ m, **PHA**) will pass Earth at a nominal miss distance of 43.84 LD. Minimum miss distance 43.84 LD. See: 99942 Apophis - SSA , 2004 MN4 - JPL See also: **13 April 2029**. http://en.wikipedia.org/wiki/99942_Apophis The **99942 Apophis 2021 Observing Campaign** provides a central clearinghouse for basic information about the Near Earth

	Asteroid **99942 Apophis** and about the observations that will be obtained during its 2021 apparition. See: http://iawn.net/obscamp/Apophis/ See also: https://solarsystem.nasa.gov/asteroids-comets-and-meteors/asteroids/apophis/in-depth/ https://www.space.com/defending-earth-asteroids-nasa-lindley-johnson-interview https://www.space.com/asteroid-apophis-2029-flyby-planetary-defense.html https://www.space.com/osiris-rex-asteroid-probe-could-visit-apophis-2029 https://www.space.com/asteroid-apophis-march-2021-flyby-science-preparations https://www.space.com/apophis-2021-flyby-for-planetary-defense-practice https://www.space.com/asteroid-apophis-march-2021-flyby http://neo.ssa.esa.int/newsletters [March 2021] Lightcurve, see: http://neo.ssa.esa.int/newsletters [February 2021] Stellar occultation, see: http://neo.ssa.esa.int/newsletters [April 2021] https://neo.ssa.esa.int/documents/20126/0/Newsletter+April+2021.pdf/
2021, Mar 8	Apollo NEA **2021 EF1** (H = 29.7 mag, $D \approx$ 4 m) passed Earth at a nominal miss distance of 0.73 LD. Minimum miss distance 0.73 LD. **[2021-23]** See: 2021 EF1 – S2P , 2021 EF1 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2021, Mar 9	Apollo NEA **2021 EG3** (H = 29.1 mag, $D \approx$ 5 m) passed Earth at a nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2021-24]** See: 2021 EG3 – S2P , 2021 EG3 – JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
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2021, Mar 15, 03:5	Apollo NEA **2021 EN4** (*H* = 29.8 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.18 LD. Minimum miss distance 0.18 LD. **[2021-25]** See: 2021 EN4 – S2P , 2021 EN4 – JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Mar 15, 18:0	Apollo NEA **2021 EP4** (*H* = 29.3 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.97 LD. Minimum miss distance 0.97 LD. **[2021-26]** See: 2021 EP4 – S2P , 2021 EP4 – JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/
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2021, Apr 4	Apollo NEA **2021 GV** (*H* = 29.2 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.87 LD. **[2021-34]** See: 2021 GV – S2P , 2021 GV - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 5	E.A. Pavlova, M.V. Zakhvatkin, A.I. Streltsov, et al., 2021, *Cosmic Research*, 59, 104, "Development of the common classification of hazard events in near-**Earth** space." See: https://ui.adsabs.harvard.edu/abs/2021CosRe..59..104P/abstract
2021, Apr 5, 09:06	Apollo NEA **2021 GS** (*H* = 28.7 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2021-35]** See: 2021 GS – S2P , 2021 GS - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 5, 18:39	Apollo NEA **2021 GZ7** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.49 LD. **[2021-36]** See: 2021 GZ7 – S2P , 2021 GZ7 - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 6	ESA **NEOCC** *Newsletter*. April 2021. See: http://neo.ssa.esa.int/newsletters [April 2021] http://neo.ssa.esa.int/neocc-riddles
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2021, Apr 8	Apollo NEA **2021 GV4** (*H* = 29.0 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.82

	LD. **[2021-37]** See: 2021 GV4 – S2P , 2021 GV4 - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 9	Aten/Apollo NEA **2021 GL16** (*H* = 26.2 mag, *D* ≈ 21 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.96 LD. **[2021-38]** See: 2021 GL16 – S2P , 2021 GL16 – JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 10	Apollo NEA **2021 GT3** (*H* = 26.4 mag, *D* ≈ .. m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.66 LD. **[2021-39]** See: 2021 GT3 – S2P , 2021 GT3 - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 11	M. Ntumba, S. Gore, J.-B. Awanyo, 2021, e-print *arXiv*:2104.06249, "Prediction of **Apophis** asteroid flyby optimal trajectories and data fusion of **Earth-Apophis** mission launch windows using deep neural networks." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210406249N/abstract
2021, Apr 11	Aten NEA **2021 GQ5** (*H* = 28.6 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.97 LD. Minimum miss distance 0.97 LD. **[2021-40]** See: 2021 GQ5 – S2P , 2021 GQ5 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Apr 12	Apollo NEA **2021 GW4** (*H* = 29.5 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of **0.0682 LD (= 4.112 R_{Earth} from the geocenter)**. Minimum miss distance **0.0681 LD**. **[2021-41]** See: 2021 GW4 – S2P , 2021 GW4 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **12 Apr 2176**. See also: https://www.space.com/near-earth-asteroid-close-approach-2021-gw4
2021, Apr 13	W. Herbst, J.P. Greenwood, Teng Ee Yap, 2021, *Planetary Science Journal*, in press, e-print *arXiv*:2104.06484, "The macroporosity of rubble pile asteroid **Ryugu** and implications for the origin of chondrules." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210406484H/abstract

2021, Apr 13, 02:36	Apollo NEA **2021 GC13** (*H* = 29.1 mag, *D* ≈ 5 m) passed Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.89 LD. **[2021-42]** See: 2021 GC13 – S2P , 2021 GC13 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2021, Apr 13, 22:05	Apollo NEA **2021 GC8** (*H* = 30.6 mag, *D* ≈ 2.7 m) passed Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.57 LD. **[2021-43]** See: 2021 GC8 – S2P , 2021 GC8 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2021, Apr 14, 05:29	Aten/Apollo NEA **2021 GQ10** (*H* = 26.7 mag, *D* ≈ 17 m) passed Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.45 LD. **[2021-44]** See: 2021 GQ10 – S2P , 2021 GQ10 - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 14, 21:54	Apollo NEA **2021 GW16** (*H* = 30.1 mag, *D* ≈ 3 m) passed Earth at a nominal miss distance of **0.0760 LD (= 4.59 R_{Earth} from the geocenter)**. Minimum miss distance **0.0759 LD**. **[2021-45]** See: 2021 GW16 – S2P , 2021 GW16 - JPL Discovery station: **…** See: http://iawn.net/
2021, Apr 15	J. Rojas, J. Duprat, C. Engrand, et al., 2021, *Earth and Planetary Science Letters*, 560, 116794, "The micrometeorite flux at Dome C (Antarctica), monitoring the accretion of extraterrestrial dust on Earth." See: https://ui.adsabs.harvard.edu/abs/2021E%26PSL.56016794R/abstract See also: https://www.cnrs.fr/en/more-5000-tons-extraterrestrial-dust-fall-earth-each-year
2021, Apr 15, 04:44	Apollo NEA **2021 HC1** (*H* = 28.1 mag, *D* ≈ 9 m) passed Earth at a nominal miss distance of 0.60 LD. Minimum miss distance 0.60 LD. **[2021-46]** See: 2021 HC1 – S2P , 2021 HC1 - JPL Discovery station: **MAP, San Pedro de Atacama** See: http://iawn.net/
2021, Apr 15, 09:29	Apollo NEA **2021 GF10** (*H* = 28.2 mag, *D* ≈ 8 m) passed Earth at

	a nominal miss distance of 0.30 LD. Minimum miss distance 0.30 LD. **[2021-47]** See: 2021 GF10 – S2P , 2021 GF10 - JPL Discovery station: **MAP, San Pedro de Atacama** See: http://iawn.net/
2021, Apr 15, 22:31	Apollo NEA **2021 GN10** (*H* = 28.4 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.75 LD. **[2021-48]** See: 2021 GN10 – S2P , 2021 GN10 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Apr 17	M. Hirabayashi, Y. Mimasu, N. Sakatani, et al., 2021, *Advances in Space Research*, in press, e-print *arXiv*:2104.08660, "***Hayabusa2*** extended mission: new voyage to rendezvous with a small asteroid rotating with a short period." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210408660H/abstract
2021, Apr 17	Apollo NEA **2021 HE1** (*H* = 28.9 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.59 LD. Minimum miss distance 0.59 LD. **[2021-49]** See: 2021 HE1 – S2P , 2021 HE1 - JPL Discovery station: **…** See: http://iawn.net/ See also: **20 Apr 2124**.
2021, Apr 19	Apollo NEA **2021 HN** (*H* = 26.9 mag, *D* ≈ 14 m) passed Earth at a nominal miss distance of 0.66 LD. Minimum miss distance 0.66 LD. **[2021-50]** See: 2021 HN – S2P , 2021 HN - JPL Discovery station: **GINOP-KHK, Piszkesteto** See: http://iawn.net/
2021, Apr 19-30	**UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS) *Scientific and Technical SubCommittee*, 58th Session**, ~~1-12 February 2021~~, **rescheduled for 19-30 April 2021**, Vienna (Austria). See: https://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2021/index.html https://www.unoosa.org/documents/pdf/copuos/stsc/2021/VIC_Meeting_Guidelines_Covid_19_Participants_20201125_V1.pdf https://www.unoosa.org/documents/pdf/copuos/stsc/2021/Remote_Conferences_visual.pdf http://www.unoosa.org/oosa/en/ourwork/topics/neos/index.html https://news.yahoo.com/nasa-un-sign-memorandum-understanding-172900649.html

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2021, Apr 20	D. Kuroda, J. Geem, H. Akitaya, et al., 2021, *Astrophysical Journal Letters*, 911, L24, "Implications of high polarization degree for the surface state of **Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2021ApJ...911L..24K/abstract
2021, Apr 21	A. Tsuchiyama, A. Miyake4, S. Okuzumi, et al., 2021, *Science Advances*, 7, eabg9707, "Discovery of primitive CO2-bearing fluid in an aqueously altered carbonaceous chondrite." See: https://advances.sciencemag.org/content/7/17/eabg9707 See also: http://www.ritsumei.ac.jp/research/member/news/detail/?id=270
2021, Apr 22	B. Bucha, F. Sansò, 2021, *Journal of Geodesy*, 95, 56, "Gravitational field modelling near irregularly shaped bodies using spherical harmonics: a case study for the asteroid **(101955) Bennu**." See: https://ui.adsabs.harvard.edu/abs/2021JGeod..95...56B/abstract
2021, Apr 23	P. Jenniskens, M. Gabadirwe, Q.-Z. Yin, et al., 2021, *Meteoritics & Planetary Science*, Early View, 23 April 2021, "The impact and recovery of asteroid **2018 LA**," See: https://onlinelibrary.wiley.com/doi/full/10.1111/maps.13653 See also: https://www.seti.org/press-release/asteroid-hit-botswana-2018-likely-came-vesta https://www.seti.org/sites/default/files/2021-04/Poster-Jenniskens-PDC2021-Asteroid2018LA.pdf https://www.seti.org/press-release/fragment-impacting-asteroid-recovered-botswana-0
2021, Apr 23	L. Le Corre, V. Reddy, W.F. Bottke, et al., 2021, e-print *arXiv*:2104.11802, "Characterization of exogenic boulders on Near-Earth Asteroid **(101955) Bennu** from **OSIRIS-REx** color images." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210411802L/abstract
2021, Apr 26	O. Vaduvescu, R. Cornea, A. Aznar Macias, et al., 2021, *Earth, Moon, and Planets*, 125, 3, "The **EURONEAR** lightcurve survey of near earth asteroids—Teide Observatory, Tenerife, 2015." See: https://ui.adsabs.harvard.edu/abs/2021EM%26P..125....3V/abstract

2021, Apr 26-30	***7th International Academy of Astronautics (IAA) Planetary Defense Conference***, 26-30 April 2021, **virtual conference**. See: https://iaaspace.org/event/7th-iaa-planetary-defense-conference-2021/ https://atpi.eventsair.com/QuickEventWebsitePortal/7th-iaa-planetary-defense-conference-2021/website/Agenda See also: http://neo.ssa.esa.int/newsletters [December 2020] **Preliminary programme of oral presentations:** See: https://atpi.eventsair.com/QuickEventWebsitePortal/7th-iaa-planetary-defense-conference-2021/website/Agenda ***Day 1, Tuesday, 27 April 2021*** ***KEYNOTE*** by Director of the **UN Office for Outer Space Affairs**, Simonetta Di Pippo ***ADDRESS*** by Chair of the **Committee on the Peaceful Uses of Outer Space**, Marius Piso **Session 1**: ***Hera*** - P. Michel, 2021, "The ESA ***Hera*** mission: planetary defence and science return." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/333d4d900f8a42b2bf912e294626f5f4 - M. Küppers, 2021, "The measurement goals and payload of the ***Hera*** mission to **Dimorphos**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/2762140fc01541d0a3c295016b5f2d13 - F. Topputo, 2021, "The ***Hera Milani CubeSat*** mission." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/036dc338eac84fcbb5ada8576cb43082 - O. Karatekin, 2021, "***Juventas Cubesat*** for the ***Hera*** mission." **Session 2**: ***Hayabusa2*** - Y. Tsuda, 2021, "Summary of ***Hayabusa2*** mission." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c82d899151b949efb7e915dfb0593df3 - T. Saiki, H. Imamura, H. Sawada, et al., 2021, "***Hayabusa2***'s kinetic impactor." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/2342b8db1e294e7c83683598b9b0c00a - M. Arakawa, K. Wada, K. Ogawa, et al., 2021, "Artificial impact crater on **Ryugu** formed in the gravity dominated regime." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/175bd8c820f94e278cd04bfd00ca3b8a - S. Sugita, T. Morota, R. Honda, et al., 2021, "Physical properties of **Ryugu** revealed by proximity observations with ***Hayabusa2*** science instruments." - T. Okada, S. Tanaka, N. Sakatani, et al., 2021, "Thermal imaging

	to reveal the highly porous nature of C-type asteroid **Ryugu** in ***Hayabusa2*** mission." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/931bc6d5811e45ee9f1a3095c1be5f3e - M. Hirabayashi, Y. Kim, Y. Mimasu, et al., 2021, "***Hayabusa2*** extended mission to rendez-vous with asteroid **1998 KY26**: investigations of a extremely small fast rotator for planetary defense." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/1883c6477aaa4941b4897317b0cba574 ***EXERCISE SESSION: First notice of (hypothetical) threat*** **Session 3**: ***DART*** - T.S. Statler, 2021, "Overview of the ***DART*** mission seven months to launch." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c3e6a28b5e8945af9306076e47e12da8 - E. Adams, 2021, "***DART*** mission status." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/6fbb31040935429f90cbb68736b66bdb - E. Dotto, V. Della Corte, E. Mazzotta Epifani, et al., 2021, "Spacecraft and technology, SmartNav & terminal approach, data to be returned by ***DART*** ans ***LICIACube***." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/49a8f1f53d17424b9502444ffbd2c9ce - A. Rivkin, 2021, "Pre- and postimpact observations, potentially detectable dynamical effects." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/6fbb31040935429f90cbb68736b66bdb - A. Cheng, 2021, "***DART*** "legacy": determination of beta, data archive, kinetic impactor demonstration." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c63591e28085431c9331fe465fc0f7a1 **Session 4**: ***OSIRIS-REx*** - A.A. Simon, 2021, "Overview and highlights of the ***OSIRIS-REx*** mission." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/acd604321cdf462591f19cc740cf8204 - R. Balouz, R.T. Daly, O.S. Barnouin, et al., 2021, "Constraining the strength of 100-m scale asteroids through craters on **Bennu**'s boulders and NEO population estimates." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/9d64d4b9e5804a03a1d7e1b0714f2162 - B. Bierhaus, 2021, "**Bennu** craters in the context of planetary defense." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/a093edfb0ae6485cb579a20ffb69af2b - M.C. Nolan, J.M. Leonard, D.J. Scheeres, et al., 2021,

	"Observations of **Bennu**'s increasing rotation rate, YORP, and implications for **Bennu**'s evolution." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/3c51d4b637304396ac7dc6b317199087 ***Day 2, Wednesday, 28 April 2021*** **Session 5: NEO discovery** - A. Shugarov, B. Shustov, D. Dunham, 2021, "System of observations of daytime asteroids (**SODA**)." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/61bff2d8da3742f09b62179b16367b4c - S. Urakawa, K. Sugiura, N. Maeda, et al., 2021, "Development of asteroid detection application 'COIAS' for the Subaru HSC data." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/8df1a37de28844c2a10b72174f5a98f5 **-** F. Bernardi, 2021, "New **NEODys** tools for the EU funded **NEOROCKS** project: observations support and priority lists." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/53cfc16988be49869ecaa3b5124a9fe8 - L. Conversi, R. Koschny, D. Föhring, et al., 2021, "ESA **PDO** observating network." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/4e78ba52fd09400cbae5a881016e10dc - I. Molotov, L. Elenin, Y. Krugly, 2021, "Asteroid survey and follow up observations with small telescopes in framework of **ISON** network." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c69f4782c54445a4828d79889a1fccfd - L. Jones, S. Eggl, M. Jurić , Ž. Ivezić 2021, "Discovering and characterizing Near Earth Objects with **Vera C. Rubin Observatory**'s **Legacy Survey of Space and Time** (**LSST**)." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/99625ad9759549c786d71debc677a370 - A. Mainzer, NEO Surveyor Investigation Team, 2021, "NEO detection, and the future of Planetary Defense." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/f79431602ce24fdf8199f33b58a3c06d - F. Spoto, M. Payne, M. Holman, P. Vereš, 2021, "The new **MPC** Confirmation Page: improvements and results." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/36c635b219b84244af3f8522112d5adb - R. Weryk, R. Wainscoat, P. Vereš, 2021, "NEOs in the isolated tracklet file." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/df7f7357faa94da382d48a7d3f1a222b - M. Keley, D. Darg, J.G. Bauer, 2021, "**CATCH**ing Near-Earth Objects in archival survey data."

	See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/d53d5f4dd2e84bb1b645e344c178ee86 **Session 6: NEO characterization** - P. Pravec, P. Scheiricha, D.J. Scheeres, et al., 2021, "Photometric observations of the unrelaxed binary Near-Earth Asteroid **(35107) 1991 VH** in support of the NASA ***Janus*** space mission – detection of a spin-orbit interaction." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/1bd11fd7a0ba4e2f8435d7b250fbd7bf - J. de León, J. Licandro, M. Popescu, et al., 2021, "Characterization of NEAs in the frame of **NHATS** program using the 10.4 m Gran Telescopio Canaría." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/30be03d123f742b09e60bae7dd8fac27 - M. Fenucci, B. Novakovi´c, D. Vokrouhlický, R.J. Weryk, 2021, "The low thermal conductivity of the super-fast rotator **(499998) 2011 PT**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/af3c7a84fee7422d9814be8f8b4e89de - A. Sergeyev, B. Carry, 2021, "Photometry of hundreds of NEO's from SDSS." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/e59101b8bd65491792c5fae3a34e37c1 - N. Moskovitz, M. Devogèle, A. Gustafsson, 2021, "Planetary Defense capabilities of the 4.3m Lowell Discovery Telescope (LDT)." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/7e37af4209a9496e99ee19e2cd2fd47c - J. Masierio, A. Mainzer, J.M. Bauer, et al., 2021, "Characterization of near-Earth asteroids from ***NEOWISE*** survey data." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/593fa3f532c04a1e9c58fdca9563e3cd - M. Devogèle, N. Moskovitz, 2021, "Polarimetry as a tool for the physical characterization of potentially hazardous asteroids." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/3aedf97c5b26499f8686a2be8a63ee7a - V. Reddy, 2021, "Challenges in differentiating NEO's and rocket bodies: **2020 SO** study." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/f9eb9fc4b536496e8026c1f8750d903a - D.W. Dunham, J.B. Dunham, M. Buie, et al., 2021, "Accurate NEO orbits from occultation observations." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/ea9efb409a864420b5dea30fa43b01b0 - J. Roa Vicens, D. Farnocchia, S.R. Chesley, 2021, "A new method for asteroid impact monitoring and hazard assessment."

	See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/eb160d93589f41b0a23c52ced450107b ***EXERCISE SESSION: Update on space-based mitigation options*** ***EXERCISE: INJECT #2. Update on threat region*** ***Day 3, Thursday, 29 April 2021*** **Session 7: Deflection & disruption testing** - S. Raducan, J. Ormö, M.I. Herreros, et al., 2021, "Cratering processes on rubble-pile asteroids: insights from laboratory experiments and numerical models." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/96458bda681f4d5688e9e3691b6f4fdc - R. Luther, S.D. Raducan, M. Jutzi, et al., 2021, "Kinetic impactor technique: benchmark and validation studies with iSALE and SPH." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/e4e9c12dde24409d862a3e612f7bd031 - R. Nakano, M. Hirabayashi, 2021, "NASA ***Double Asteroid Redirection Test***: orbital perturbation by the ejecta-collision driven reshaping of **Didymos** after the impact event." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/0c35ed498293487e805cc9bf86d92639 - P. King, M. Bruck Syal, D.S.P. Dearborn, et al., 2021, "Late-time nuclear disruption in the **PDC 2021** scenario." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/f4fb7a06a0eb41419c118c7c1ac1f79a - N.A. Gentile, 2021, "An overview of numerical radiation transport techniques in asteroid deflection modeling." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/677f15e012ee4c13945763a72db3a159 - M. Burkey, R. Managan, K. Howley, 2021, "Progress on developing a simplified model of X-ray energy disposition for nuclear mitigation missions." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/2901d2a20d73442db4f1c87b3111ee65 - A.M. Stickle, M. Bruck Syal, W.K. Caldwell, et al., 2021, "***The Double Asteroid Redirection Test*** (***DART***) Impact Modeling Working Group **Inverse Test**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/13a1f760602145a7a47c8fdfa96236a8 - C. Raskin, T. Remington, J. Pearl, 2021, "Accelerated root finding for the ***DART*** **Inverse Test** using machine learning decision trees." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/a6bdf7dd6f4c452da08bf6354945f566 - M.E. DeCoster, D. Graninger, E. Rainey, 2021, "Projectile

	geometry effects on momentum enhancement of hypervelocity impact simulations." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/fd729923a19d46b18d0bfe3571f5f441 - J.M. Owen, M.E. DeCoster, D. Graninger, 2021, "Spacecraft geometry effects on cratering and deflection in the ***DART*** mission." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/b8408c90a2c2405b86787ca8b34c9c38 **Session 8: Mission & campaign design** - Y. Wang, M. Li, Z. Gong, et al., 2021, "Assembled Kinetic Impactor (AKI) for deflecting asteroids via combining spacecraft with launch vehicle upper stage." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/37dcb12e5eac466b885f702128727a71 - A. Herique, 2021, "**JuRa**: the **Juventas Radar** on ***Hera*** to fathom **Didymoon**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/fb336f2a4b71478abe269ee3ce2e84fa - G. Di Girolamo, J. Klug, E. Brendel, et al., 2021, "ESA's **Planetary Defence NEO Coordination Centre** DevOps model based operations." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/37e49f83978941e5bcfdf8d94b0181e0 - P. Tortora, M. Zannoni1, E. Gramigna, et al., 2021, "***Hera*** radio science experiments through ground-based and satellite-to-satellite Doppler tracking." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/5a6890cb55c84a4d88ed3fca6997a272 - A. Falke, K. Atkinson, M. Chapuy, 2021, "Hijacking a satellite for short-warning asteroid deflection – FastKD mission, design and implementation." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/8195e7b8bd394ac6bde779211787ebac - D. Perna, M. Pajola, L. Casalino, et al., 2021, "The '***Asteroid Nodal Intersection Multiple Encounters***' (***ANIME***) ***CubeSat*** mission: science and planetary protection." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/d7695f04a1624a8189884179dda3b592 - D.J. Scheeres, J.W. McMahon, E.B. Bierhaus, et al., 2021, "***Janus***: a NASA ***SIMPLEX*** mission to explore two NEO binary asteroids." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/03e5f1f200dd46fca0b04a12b23b987b - S. Sonnett, A. Mainzer, T. Grav, et al., 2021 "***NEO Surveyor*** cadence and simulations." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-

atpi-public/a5bbb816373143f2ab26b79ffba91268
- B. Barbee, B. Benson, P. Chodas, et al., "Risk-informed spacecraft mission design for the **2021 PDC** hypothetical asteroid impact scenario."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/4be503d216474a9cbbdb50c3039e0264
- J. Bell, L. Papsider, 2021, "The MILO Space Science Institute: enabling new, science-focussed deep space ***SmallSat*** missions to Near Earth Objects."
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EXERCISE: INJECT #3. Updated threat corridor & detailed overview of consequences
EXERCISE: Final impact area

Day 4: Friday, 30 April 2021
Session 9: Impact effects
- A. Losiak, C. Belcher, J. Plado, et al., 2021, "Environnemental effects of very small crater formation."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/f9d6acfe915441a39da854e10cf8ad48
- S. Haihao, L. Yue, D. Leining, et al., 2021, "The melting ablation analysis of meteorite in high temperature flow."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/fc5744be62544232b4fbc66b08eb4c0c
- S. Liu, L. Sen, D. Leiling, Z. Zhigang "Numerical analysis of aerodynamic heating on asteroid during entry to **Earth**'s atmosphere."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/ce87d313a5194e6db506fa25842c8162
- D.O. Glazachev, O.P. Popova, V.V. Svetsov, et al., "**Impact Effects Calculator**. Shock wave effects from impacts of cosmic objects with diameter from a few meters to 3 km."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/f04bcc396f6d4882ad6fb460e80166e8
- O. Popova, V. Svetsov, V. Shuvalov, et al., 2021, "**Impact Effects Calculator**. Radiation and some other effects."
See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c83dfd5cc9284e0eb389a70145e2b43c
- J. Pearl, C. Raskin, M. Owen, 2021, "SPH simulation of bolide entry."
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- M.J. Berger, R.J. LeVeque, 2021, "Towards adaptive simulation of dispersive tsunami propagation from an asteroid impact."
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	- T.N. Titus, D. Robertson, J. Sankey, L. Mastin, 2021, "Asteroid impacts – downwind and downstream effects." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/d53e1199597b4a10b56dd822dbc8258b - C. Berk Senel, O. Temel, O. Karatekin, 2021, "Environmental consequences of asteroid impacts by General Circulation Model (GCM) simulations." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/37afa538e63d4f288b10e1de0014bdcd - J. Dotson, L. Wheeler, C. Rumpf, D. Mathias, 2021, "Bayesian inference of asteroid physical properties: application to impact scenarios." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/1bec84807d554520b62bfaf1a5cec50c **Session 10: Disaster management** - D.C. Chandola, 2021, "Key aspects of disaster management." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/489cd7c11986447a9751502faa468fa1 - J. Lim, 2021, "The decision to act – a human rights based approach to disaster management and response." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/9178be4934d04c90ae972effbe9c43c2 - A. Marwah, A. Grover, 2021, "Prevention, mitigation and preparedness for disaster: Role of **UN-COPUOS** in disaster management and Indian progress." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/a3e513c215654c75b450a4ced2146a74 - A.L. Pegetti, G. F. Perroni da Silva, M.C. Neyra Belderrain, 2021, "Communication protocol on PHO for disaster management by legitimate Brazilian institutions." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/a38a7d9407a24119a43d1cf7bd49da1a - J. Venkataramaiah, 2021, "Real-time community enabling to care for planetary disaster risk reduction." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/762b080c6aed46c4be25113bfb4b4c55 - R. Albrecht, M.H.I. Dore, 2021, "Towards plans for mitigating possible socio-economic effects due to a physical impact of an asteroid on **Earth**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/695a5479f74b460cace9258621a5a2b2 - T. Kohout, S. Turunen, 2021, "Rapid evacuation of the Viipuri (Vyborg) city – Experience from the Finnish winter war 1939-1941." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/9adf5318ff7b4519b753886329a2e34f

	Day 5, Friday, 30 April 2021 **Session 11: The decision to act** - L.Vaz Ferreira, 2021, "Liability exoneration and Planetary Defense." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/c0d8cb0f7b4d44f19cd02d7fcc0606b3 - K. Niewęgłowski, 2021, "Obligation to participate in Planetary Defense action as part of international *jus cogens*." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/96422aa3f56f42a192d423d341903d5c - A-S. Martin, 2021, "Reacting to Near-Earth Object impact: exceptional circumstances justifying non-compliance with international law." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/4752b4160de64cbca40f4408dc9293ee - A. Melamed, 2021, "Planetary Defense as entrepreneurial politics." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/ad38ceae71b1465dbcf0fe5903383dbd - A.J.Haddaji, 2021, "Understanding the social-anthropolocical aspects of an asteroid impact threat response from transdiciplinary lessons learned in natural disaster management." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/51258bb58c0c4b688bcb2277530e6a5b - A. Boley, M. Byers, 2021, "Precautionary Planetary Defence." See: https://az659834.vo.msecnd.net/eventsairwest euprod/production-atpi-public/5e1d3758b20c47c7b8b25181333b2419 - D. Koschny, ESA Planetary Defence Team, "ESA's activities in Planetary Defence." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/ca5fd4039c234cfd8c7ae745d95da405 - G. Drolshagen, R. Kofler, D. Koschny, 2021, "Scope, objectives and first results of the **Space Mission Planning Advisory Group (SMPAG)**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/bdfa2e645c9b4dd8bd271f98e74a9c42 **Session 12: Public education & communication** - N. Melamed, L. McGinley, M. Maynard, 2021, "Teaming up for asteroid deflection." See: https://www.youtube.com/watch?v=sQao8HwWcqc https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/43b49f1de73548139c19e88d6a7e0259 - A. Nath, A. Nath, 2021, "Aiming for **Apophis**: how we did asteroid astrometry and taught others during COVID-19 lockdowns." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/3a61685c23884c08bbd5185c6c9badb6 - J. L. Cano, G. Valletta, D. Oliviero, G. Fasano, R. Opromolla, M.

	Micheli, D. Koschny, 2021, "Evaluation of an NEO close approach frequency index for public/media release purposes." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/7614f0aa69a94cbaacb129669dc3f54e - S. Srivastava, 2021, "Role of Space Generation Advisory Council (SGAC) in global Planetary Defense outreach." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/3bcbc36f8466434fa7312353d7e1d095 - A. Karl, "Engaging the audience – what can we learn from them?" See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/bcdbe86256964cc281f7aee7935cfda3 - S. Schmalz, F. Graziani, R. di Roberto, V. Voropaev, 2021, "Observations of NEAs and national public outreach at the Astronomical Observatory of Castelgrande (Italy)." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/688a87a4e8fe4f7282066a763d75b75a - C. Nugent, L. Billings, 2021, "Public communication in the case of impending impact. Lessons from the Covid-19 pandemic." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/1f9742fff3564e32b33b6e6997ef866e **Session 13**: **Apophis and others, far and near: future characterization opportunities from NEO close approaches** - M. Granvik, Morbidelly, Jedicke, et al., 2021, "Frequency of close Earth approaches by Near Earth Objects." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/02516d641e444c06812fb5a650f0ac66 - M. Kelley, V. Reddy, D.Farnocchia, et al., 2021, "International Asteroid Warning Network (IAWN) **Apophis Campaign**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/64851a6caad54fbbb59e7724f7f89bc4 - D.J. Tholen, D. Farnocchia, 2021, "Detection of Yarkovsky acceleration of **(99942) Apophis.**" See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/374fb0c00e144047b962896fc6cc7f2f - J.-Y. Prado, D. Hestroffer, A. Herique, 2021, "***Apophis Express***, a unique opportunity for visiting **Apophis** in 2029." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/862c33b687964022a9f8341c5ed0c453 - P.A. Taylor, E.L. Wright, J.R. Masiero, et al., 2021, "Characterization of Near-Earth Asteroid **153814 (2001 WN5)** and prospects for the 2028 close encounter with **Earth**." See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/eed068f68aad40c7b789d580018dc659 - N.A. Eismont, M.V. Pupkov, K.S. Fedyaev, V.A. Zubko, 2021, "Extension of the **Earth** libration point missions by targeting a spacecraft to Near-Earth Asteroids."

	See: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-atpi-public/4145e7acdde3422cab38c2ba77edb4be ***PANEL: PROPOSAL: INTERNATIONAL YEAR OF PLANETARY DEFENSE.*** The conference included a hypothetical NEO/Earth impact event scenario as part of the conference (similar to what was done at the 2013, 2015, 2017 & 2019 PDCs): **2021 PDC Hypothetical Asteroid Impact Scenario**. See: https://cneos.jpl.nasa.gov/pd/cs/pdc21/ https://cneos.jpl.nasa.gov/nda/nda.html https://www.jpl.nasa.gov/news/nasa-to-participate-in-tabletop-exercise-simulating-asteroid-impact See also: https://www.esa.int/Safety_Security/Lessons_learnt_from_simulated_strike https://cneos.jpl.nasa.gov/pd/cs/ https://cneos.jpl.nasa.gov/pd/cs/pdc21/ https://www.space.com/planetary-defense-asteroid-impact-scenario-exercise-2021?utm_source=notification
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2021, May	P. Abell, C. Raymond, T. Daly, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 270, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 270, "Near-Earth Object characterization priorities and considerations for Planetary Defense." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.270A/abstract
2021, May	D. Adamo, P.A. Abell, R.C. Anderson, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 043, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 043, "Near-Earth Object exploration leading to human visits." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.043A/abstract
2021, May	B. Barbee, P.A. Abell, D.R. Adamo, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 114, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 114, "Research and analysis for Planetary Defense in situ spacecraft missions to Near-Earth Objects." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.114B/abstract
2021, May	B. Barbee, P.A. Abell, J. Atichson, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 113, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 113, "Technology development for Planetary Defense in situ spacecraft missions to Near-Earth Objects." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.113B/abstract
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2021, May	R. Binzel, B.W. Barbee, O.S. Barnouin, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 045, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 045, "**Apophis** 2029: decadal opportunity for the science of Planetary Defense." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.045B/abstract
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2021, May	M. Haynes, A. Virkki, F. Venditti, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 116, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 116, "Asteroids inside out: radar tomography." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.116H/abstract
2021, May	A. Lang, 2021, *Acta Astronautica*, 182, 251, "Spacecraft orbital stability zones around asteroid **99942 Apophis**." See: https://ui.adsabs.harvard.edu/abs/2021AcAau.182..251L/abstract
2021, May	J.N. Larson, G. Sarid, 2021, *Monthly Notices of the Royal Astronomical Society*, 503, 1070, "An N-body approach to modelling debris and ejecta off small bodies: implementation and application." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.503.1070L/abstract
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2021, May	M. Nolan, P. Michel, F.C.F. Venditti, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 220, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 220, "Near-Earth Objects." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.220N/abstract
2021, May	A. Rivkin, T. Daly, J. Atchison, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 336, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 336, "The case for a Planetary Defense-optimized NEO characterization tour." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.336R/abstract
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2021, May	A. Stickle, B. Barbee, P. Chodas, et al., 2021, *Bulletin of the American Astronomical Society*, 53, 468, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 468, "The need for a well-defined modeling pipeline for Planetary Defense." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.468S/abstract
2021, May	T. Titus, D. Robertson, J. B. Sankey, 2021, *Bulletin of the American Astronomical Society*, 53, 050, Planetary Science and Astrobiology Decadal Survey 2023-2032 white paper e-id. 050, "Planetary Defense preparedness: identifying the potential for post-asteroid impact time delayed and geographically displaced hazards." See: https://ui.adsabs.harvard.edu/abs/2021BAAS...53d.050T/abstract
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2021, May 1	J.B. Pezent, R. Sood, A. Heaton, 2021, *Advances in Space Research*, 67, 2890, "Contingency target assessment, trajectory design, and analysis for NASA's ***NEA Scout*** solar sail mission." See: https://ui.adsabs.harvard.edu/abs/2021AdSpR..67.2890P/abstract
2021, May 1	M. Vergaaij, C.R. McInnes, M. Ceriotti, 2021, *Advances in Space Research*, 67, 3045, "Economic assessment of high-thrust and solar-sail propulsion for near-earth asteroid mining." See: https://ui.adsabs.harvard.edu/abs/2021AdSpR..67.3045V/abstract
2021, May 2	Apollo NEA **2021 JW** (H = 27.6 mag, $D \approx$ 11 m) passed Earth at a nominal miss distance of 0.67 LD. Minimum miss distance 0.67 LD. **[2021-51]** See: 2021 JW – S2P , 2021 JW - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2021, May 4	Apollo NEA **2021 AF8** (H = 20.1 mag, $D \approx$ 300 m, **PHA**) passed Earth at a nominal miss distance of 8.47 LD. Minimum miss distance 8.47 LD. See: 2021 AF8 – S2P , 2021 AF8 - JPL Discovery station: **Mt. Lemmon Survey** See also: https://www.minorplanetcenter.net/mpec/K21/K21AE4.html https://www.spacereference.org/asteroid/2021-af8
2021, May 4, 21:29	Apollo NEA **2021 JV** (H = 27.4 mag, $D \approx$ 12 m) passed Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.36 LD. **[2021-52]** See: 2021 JV – S2P , 2021 JV - JPL Discovery station: **ATLAS-HKO, Haleakala** See: http://iawn.net/
2021, May 5	ESA **NEOCC** *Newsletter*. May 2021. See: http://neo.ssa.esa.int/newsletters [May 2021] http://neo.ssa.esa.int/neocc-riddles https://neo.ssa.esa.int/documents/20126/0/Newsletter+May+2021.pdf/
2021, May 6	D. Robertson, P. Pokorný, M. Granvik, et al., 2021, *Planetary Science Journal*, 2, Issue 3, 88, "Latitude variation of flux and impact angle of asteroid collisions with **Earth** and the **Moon**."

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2021, May 6	Apollo NEA **2021 JS1** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.29 LD. **[2021-53]** See: 2021 JS1 – S2P , 2021 JS1 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/
2021, May 8	Aten NEA **2021 JQ2** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.17 LD. **[2021-54]** See: 2021 JQ2 – S2P , 2021 JQ2 - JPL Discovery station: **Mt. Lemmon Survey** See: http://iawn.net/ See also: **8 May 2076**.
2021, May 10	A. Johnson, K. Fox, R. Gran, 2021, *www.nasa.gov*, press-release 21-061, "NASA's ***OSIRIS-REx*** spacecraft heads for **Earth** with asteroid sample." See: https://www.nasa.gov/press-release/nasa-s-osiris-rex-spacecraft-heads-for-earth-with-asteroid-sample See also: **31 Dec 2018**, **24 Sep 2023**.
2021, May 13	P.M. Shober, E.K. Sansom, P.A. Bland, et al., 2021, *Planetary Science Journal*, 2, 98, "The main asteroid belt: the primary source of debris on comet-like orbits." See: https://iopscience.iop.org/article/10.3847/PSJ/abde4b See also: https://theconversation.com/where-do-meteorites-come-from-we-tracked-hundreds-of-fireballs-streaking-through-the-sky-to-find-out-160096
2021, May 13	Apollo NEA **2021 JB6** (*H* = 28.8 mag, *D* ≈ 6 m) passed Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.27 LD. **[2021-55]** See: 2021 JB6 – S2P , 2021 JB6 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, May 14	Apollo NEA **2021 JU6** (*H* = 27.4 mag, *D* ≈ 12 m) passed Earth at a nominal miss distance of 0.17 LD. Minimum miss distance 0.17 LD. **[2021-56]** See: 2021 JU6 – S2P , 2021 JU6 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/

2021, May 15	S. Kameda, Y. Yokota, T. Kouyama, et al., 2021, *Icarus*, 360, 114348, "Improved method of hydrous mineral detection by latitudinal distribution of 0.7-µm surface reflectance absorption on the asteroid **Ryugu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36014348K/abstract
2021, May 15	P. Scheirich, P. Pravec, P. Kušnirák, et al., 2021, *Icarus*, 360, 114321, "A satellite orbit drift in binary near-Earth asteroids **(66391) 1999 KW4** and **(88710) 2001 SL9** -- indication of the BYORP effect." See: https://ui.adsabs.harvard.edu/abs/2019arXiv191206456S/abstract
2021, May 15	D. Uribe-Suárez, M. Delbo, P.-O. Bouchard, D. Pino Muñoz, 2021, *Icarus*, 360, 114347, "Diurnal temperature variation as the source of the preferential direction of fractures on asteroids: theoretical model for the case of **Bennu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36014347U/abstract
2021, May 15	S. Wakita, B.C. Johnson, C.A. Denton, Th.M. Davison, *Icarus*, 360, 114365, "Jetting during oblique impacts of spherical impactors." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36014365W/abstract
2021, May 17	S.F. Dermott, D. Li, A.A Christou, et al., 2021, *Monthly Notices of the Royal Astronomical Society*, Advance Access, "Dynamical evolution of the inner asteroid belt." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp.1361D/abstract
2021, May 17-21	***52nd Annual Meeting American Astronomical Society Division on Dynamical Astronomy*** - **Virtual meeting**. See: https://aas.org/meetings/dda52 https://dda.aas.org/meetings/2021
2021, May 18	S. Desch, A. Jackson, J. Noviello, A. Anbar, 2021, *Astronomy and Geophysics*, in press, e-print *arXiv*:2105.08768, "The **Chicxulub Impactor**: comet or asteroid?" See: https://ui.adsabs.harvard.edu/abs/2021arXiv210508768D/abstract
2021, May 18	S.P. Naidu, M. Micheli, D. Farnocchia, et al., 2021, *Astrophysical Journal Letters*, 913, L6, "Precovery observations confirm the capture time of asteroid **2020 CD3** as **Earth**'s minimoon." See: https://ui.adsabs.harvard.edu/abs/2021ApJ...913L...6N/abstract
2021, May 19	S.J. Curran, 2021, *Astronomy & Astrophysics Letters*, in press, e-print *arXiv*:2105.09435, "**'Oumuamua** as a light sail -- evidence against artificial origin."

	See: https://ui.adsabs.harvard.edu/abs/2021arXiv210509435C/abstract
2021, May 19	P. Guzik, M. Drahus, 2021, *Nature*, 593, 375, "Gaseous atomic nickel in the coma of interstellar comet **2I/Borisov**." See: https://www.nature.com/articles/s41586-021-03485-4
2021, May 19	Y. Marrocchi, G. Avice, J.-A. Barrat, 2021, *Astrophysical Journal Letters*, 913, L9, "The **Tarda Meteorite**: a window into the formation of D-type asteroids." See: https://ui.adsabs.harvard.edu/abs/2021ApJ...913L...9M/abstract
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2021, May 25	A. Siraj, A. Loeb, 2021, e-print *arXiv*:2105.09940, "Reply to Desch et al. (2021) on "Breakup of a long-period comet as the origin of the dinosaur extinction"." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210509940S/abstract
2021, May 26	T. Arai, T. Okada, S. Tanaka, et al., 2021, *Earth, Planets and Space*, 73, 115, "Geometric correction for thermographic images of asteroid **162173 Ryugu** by **TIR** (thermal infrared imager) onboard ***Hayabusa2***." See: https://ui.adsabs.harvard.edu/abs/2021EP%26S...73..115A/abstract
2021, May 26	N. Lifset, N. Golovich, E. Green, et al., 2021, *Astronomical Journal*, 161, 282, "A search for L4 **Earth Trojan Asteroids** using a novel track-before-detect multiepoch pipeline." See: https://ui.adsabs.harvard.edu/abs/2021AJ....161..282L/abstract
2021, May 28	S. Aljbaae, J. Souchay, V. Carruba, et al., 2021, e-print *arXiv*:2105.14001, "Influence of **Apophis**' spin axis variations on a spacecraft during the 2029 close approach with **Earth**." See: https://ui.adsabs.harvard.edu/abs/2021arXiv210514001A/abstract
2021, May 30	Aten NEA **2021 KO2** (H = 28.1 mag, $D \approx$ 9 m) passed Earth at a nominal miss distance of 0.96 LD. Minimum miss distance 0.96 LD. **[2021-57]** See: 2021 KO2 – S2P , 2021 KO2 - JPL Discovery station: **Tokyo-Kiso** See: http://iawn.net/ See also: **30 May 2022**, **31 May 2164**.
2021, May 31, 02:1	Apollo NEA **2021 KN2** (H = 27.7 mag, $D \approx$ 7 m) passed Earth at a

	nominal miss distance of 0.38 LD. Minimum miss distance 0.38 LD. **[2021-58]** See: 2021 KN2 – S2P , 2021 KN2 - JPL Discovery station: **ATLAS-MLO, Mauna Loa** See: http://iawn.net/
2021, May 31, 05:4	Aten NEA **2021 KQ2** (*H* = 30.0 mag, *D* ≈ 4 m) passed Earth at a nominal miss distance of 0.46 LD. Minimum miss distance 0.46 LD. **[2021-59]** See: 2021 KQ2 – S2P , 2021 KQ2 - JPL Discovery station: **Pan-STARRS 1, Haleakala** See: http://iawn.net/
2021, Jun	G.M. Gartrelle, P.S. Hardersen, M.R.M. Izawac, M.C.Nowinski, 2021, *Icarus*, 361, 114349, “Round up the unusual suspects: Near-Earth Asteroid **17274 (2000 LC16)** a plausible D-type parent body of the **Tagish Lake meteorite**.” See: https://ui.adsabs.harvard.edu/abs/2021Icar..36114349G/abstract
2021, Jun	T.-M. Ho, R. Jaumann, J.-P. Bibring, et al., 2021, *Planetary and Space Science*, 200, 105200, “The **MASCOT** lander aboard ***Hayabusa2***: the in-situ exploration of NEA **(162173) Ryugu**.” See: https://ui.adsabs.harvard.edu/abs/2021P%26SS..20005200H/abstract
2021, Jun	L.S.Horan, D.E. Holland, M. Bruck Syal, et al., 2021, *Acta Astronautica*, 183, 29, “Impact of neutron energy on asteroid deflection performance.” See: https://ui.adsabs.harvard.edu/abs/2021AcAau.183...29H/abstract
2021, Jun	D.L. Schrader, J. Davidson, T.J. McCoy, et al., 2021, *Geochimica et Cosmochimica Acta*, 303, 66, “The Fe/S ratio of pyrrhotite group sulfides in chondrites: an indicator of oxidation and implications for return samples from asteroids **Ryugu** and **Bennu**.” See: https://ui.adsabs.harvard.edu/abs/2021GeCoA.303...66S/abstract
2021, Jun 1	Anon., 2021, *ESA Safety & Security*, 1 June 2021, “The incredible adventures of the ***Hera*** mission – presenting ***Hera***.” See: https://www.esa.int/Safety_Security/Hera/The_Incredible_Adventures_of_the_Hera_mission_Presenting_Hera
2021, Jun 1	L. Walker, M. Di Carlo, C. Greco, et al., 2021, *Advances in Space Research*, 67, 3880, “A mission concept for the low-cost large-scale exploration and characterisation of near earth objects.” See: https://ui.adsabs.harvard.edu/abs/2021AdSpR..67.3880W/abstract

2021, Jun 1	Aten NEA **2018 LB**, $H = 26.0$ mag, $D \approx 22$ m) will pass Earth at a nominal miss distance of 2.90 LD. Minimum miss distance 0.91 LD. See: 2018 LB - SSA , 2018 LB - JPL
2021, Jun 1	Apollo NEA **2021 KT2** ($H = 28.4$ mag, $D \approx 7$ m) passed Earth at a nominal miss distance of 0.76 LD. Minimum miss distance 0.75 LD. **[2021-60]** See: 2021 KT2 – S2P , 2021 KT2 - JPL Discovery station: **…** See: http://iawn.net/
2021, Jun 7-8	***25th Meeting of the NASA Small Bodies Assessment Group,*** 7-8 June 2021, **virtual meeting**. See: http://www.lpi.usra.edu/sbag/meetings/ https://www.lpi.usra.edu/sbag/meetings/jun2021/SBAG_2021_June_Agenda.pdf **On the preliminary agenda:** - T. Statler, 2021, **Planetary Science Division** update. - L. Johnson, 2021, **PDCO** update. - L. Benner, 2021, Planetary radar update (short-term capabilities, Greenbank, Goldstone, etc.). - Flaviane Venditti, 2021, Planetary radar update (long-term, e.g., Arecibo recovery). - B. Barbee, 2021, ***Planetary Defense Conference*** summary. - L. Wheeler, 2021, ***Planetary Defense Conference*** tabletop exercise. - J. Castillo-Rogez, 2021, ***NEAScout***.
2021, Jun 7-9	***American Astronomical Society 238th Meeting***, 7-9 June 2021, **virtual meeting**. See: https://aas.org/meetings/aas238
2021**,** Jun 20-25	***Asteroids, Comets, Meteors Conference 2021***, Flagstaff (AZ, USA), ~~20-25 June 2021~~. **Postponed till 2023**. See: http://www.hou.usra.edu/meetings/acm2021
2021, Jun 28 - Jul 2	***European Astronomical Society Annual Meeting EAS 2021***, ~~Leiden (The Netherlands)~~. **Virtual meeting**, 28 June – 2 July 2021. See: https://eas.unige.ch/EAS2021/
2021, Jun 30	***Asteroid Day 2021*.** See: http://www.asteroidday.org/
2021, Jul	M. Micheli, D. Koschny, L. Conversi, et al., 2021, Acta Astronautica, 184, 251, "Optical observations of the ***BepiColombo***

	spacecraft as a proxy for a potential threatening asteroid." See: https://ui.adsabs.harvard.edu/abs/2021AcAau.184..251M/abstract
2021, Jul	E. Peña-Asensio, J. M. Trigo-Rodríguez, M. Gritsevich, A. Rimola, 2021, *Monthly Notices of the Royal Astronomical Society*, 504, 4829, "Accurate 3D fireball trajectory and orbit calculation using the 3D-FireTOC automatic Python code." See: https://ui.adsabs.harvard.edu/abs/2021MNRAS.504.4829P/abstract
2021, Jul 1	L. Krämer Ruggiua, P. Beck, J. Gattacceca, J. Eschrig, 2021, *Icarus*, 362, 114393, "Visible-infrared spectroscopy of ungrouped and rare meteorites brings further constraints on meteorite-asteroid connections." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36214393K/abstract
2021, Jul 1	Y. Zhang, P. Michel, D.C. Richardson, O.S. Barnouin, et al., 2021, *Icarus*, 362, 114433, "Creep stability of the ***DART/Hera*** mission target **65803 Didymos**: II. The role of cohesion." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36214433Z/abstract
2021, Jul 15	A. Praet, M.A. Barucci, B.E. Clark, et al., 2021, *Icarus*, 363, 114427, "Hydrogen abundance estimation and distribution on **(101955) Bennu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36314427P/abstract
2021, July 22	Foreseen launch of NASA ***Double Asteroid Redirection Test*** (***DART***) mission. **Delayed till backup launch window 24 November 2021 - 15 February 2022.** ***DART*** is the first demonstration of the kinetic impact technique to change the motion of an asteroid in space. ***DART*** is a planetary defense-driven test of one of the technologies for preventing the Earth impact of a hazardous asteroid: the kinetic impactor. ***DART***'s primary objective is to demonstrate a kinetic impact on a small asteroid. The binary near-Earth asteroid **(65803) Didymos** is the target for ***DART***. While **Didymos**' primary body is approximately 800 meters across, its secondary body (or "moonlet") has a 150-meter size, which is more typical of the size of asteroids that could pose a more common hazard to Earth. The ***DART*** spacecraft will achieve the kinetic impact by deliberately crashing itself into the moonlet at a speed of approximately 6 km/s, with the aid of an onboard camera and sophisticated autonomous navigation software. The collision will change the speed of the moonlet in its orbit around the main body by a fraction of one percent, enough to be measured using telescopes on Earth. It will intercept **Didymos**' moonlet on September 2022, when the **Didymos** system is within 0.07 AU (11.000.000 km) of Earth,

	enabling observations by ground-based telescopes and planetary radar to measure the change in momentum imparted to the moonlet. See: https://www.nasa.gov/planetarydefense/dart See also: https://www.lpi.usra.edu/sbag/meetings/jun2018/presentations/stickle.pdf https://www.cosmos.esa.int/documents/336356/336472/SMPAG_DART_Update_-_Johnson_2020-02-06+%281%29.pdf https://www.cosmos.esa.int/documents/336356/336472/PDCO_Brief_to_SMPAG_-_Johnson_2020-02-06+%281%29.pdf/ https://www.iau.org/news/pressreleases/detail/iau2007/?lang https://www.esa.int/Safety_Security/Hera https://en.wikipedia.org/wiki/65803_Didymos https://en.wikipedia.org/wiki/Dimorphos https://en.wikipedia.org/wiki/AIDA_(mission)#Hera https://en.wikipedia.org/wiki/Double_Asteroid_Redirection_Test https://www.space.com/nasa-delays-dart-asteroid-mission-launch-2022 https://www.cosmos.esa.int/documents/336356/336472/Johnson_DART-NEOSM_SMPAG_2021-03-25.pdf/ See also: **23 June 2020**.
2021, Aug	T.Yu. Galushina, O.N. Letner, E.N. Niganova, 2021, *Planetary and Space Science*, 202, 105232, "Notes on force models for near-Sun asteroids." See: https://ui.adsabs.harvard.edu/abs/2021P%26SS..20205232G/abstract
2021, Aug	N. Hirata, R.Ikeya, 2021, *Icarus*, 364, 114474, "Ejecta distribution from impact craters on **Ryugu**: possible origin of the bluer units." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36414474H/abstract
2021, Aug	T.A. Lister, E. Gomez, J. Chatelain, et al., 2021, *Icarus*, 364, 114387, "**NEOExchange** -- an online portal for NEO and Solar System science." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36414387L/abstract
2021, Aug	J.L. Rizos, J. de León, J. Licandro, et al., 2021, *Icarus*, 364, 114467, "**Bennu**'s global surface and two candidate sample sites characterized by spectral clustering of ***OSIRIS-REx*** multispectral images." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36414467R/abstract
2021, Aug 14-21	***84th Annual Meeting of the Meteoritical Society***, 14-21 August 2021, Chicago (USA). See: https://meteoritical.org/society/annual-meetings
2021, Aug 16-27	***IAU XXXI General Assembly***, Busan (Republic of Korea), ~~16-27 August 2021~~. **Postponed to August 2022**.

	See: https://www.iau.org/science/meetings/future/general_assemblies/1181/ The ***IAU GA Business Meetings***, including the elections for the next three years provided for in the IAU Bye-Laws, will take place in August 2021, as virtual meetings. **Including:** ***IAU Symposium No. 374, Astronomical hazards for life on Earth,*** Busan, ~~16-19 August 2021~~. **Postponed to August 2022.** See: https://www.iau.org/science/meetings/future/symposia/2591/
2021, Aug 25 – 3 S	***UN - Committee on the Peaceful Uses of Outer Space (UN-COPUOS), 63*****th** **session**, Vienna (Austria), 25 August – 3 September 2021**.** See: https://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2021/index.html
2021, Sep 1	A.W. Harris, P.W. Chodas, 2021, *Icarus*, 365, 114452, "The population of near-earth asteroids revisited and updated." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36514452H/abstract
2021, Sep 1	M. Hirabayashi, Y. Kim, M. Brozović, 2021, *Icarus*, 365, 114493, "Finite element modeling to characterize the stress evolution in asteroid **(99942) Apophis** during the 2029 **Earth** encounter." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36514493H/abstract
2021, Sep 1	K. Sugiura, H. Kobayashi, S. Watanabe, et al., 2021, *Icarus*, 365, 114505, "SPH simulations for shape deformation of rubble-pile asteroids through spinup: the challenge for making top-shaped asteroids **Ryugu** and **Bennu**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36514505S/abstract
2021, Sep 15	R. Honda, M. Arakawa, Y. Shimaki, et al., 2021, *Icarus*, 366, 114530, "Resurfacing processes on asteroid **(162173) Ryugu** caused by an artificial impact of ***Hayabusa2***'s **Small Carry-on Impactor**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36614530H/abstract
2021, Sep 15	E.M. MacLennan, A. Toliou, M. Granvik, 2021, *Icarus*, 366, 114535, "Dynamical evolution and thermal history of asteroids **(3200) Phaethon** and **(155140) 2005 UD**." See: https://ui.adsabs.harvard.edu/abs/2021Icar..36614535M/abstract
2021, Oct	O. Vaduvescu, D. Gorgan, D. Copandean, et al., 2021, *New Astronomy*, 88, 101600, "Ready for **EURONEAR** NEA surveys using the **NEARBY** moving source detection platform." See: https://ui.adsabs.harvard.edu/abs/2021NewA...8801600V/abstract

2021, Oct 3-8	***53rd Annual Meeting of the AAS Division for Planetary Sciences***, 3-8 October 2021, Providence (RI, USA). See: https://dps.aas.org/meetings/current
2021, Oct 7	Apollo NEA **2015 TQ21** (*H* = 27.6 mag, *D* ≈11 m) will pass Earth at a nominal miss distance of 7.79 LD. Minimum miss distance 0.89 LD. See: 2015 TQ21 - SSA , 2015 TQ21 - JPL See also: **7 Oct 2015**, **6 Oct 2092**.
2021, Oct 13-14	***17th Meeting Space Mission Planning Advisory Group (SMPAG)***, 13-14 Oct 2021, WebEx Virtual meeting. See: https://www.cosmos.esa.int/web/smpag/ https://www.cosmos.esa.int/web/smpag/meeting-16-mar-2021-
2021, Oct 31	Anticipated launch of the ***James Webb Space Telescope***. First scientific data becoming available 6 months after launch. **Launch postponed to 31 October 2021** due to technical challenges and the ongoing COVID-19 pandemic. See: https://www.nasa.gov/webb https://content.govdelivery.com/accounts/EUESA/bulletins/1e5452e https://www.nasa.gov/sites/default/files/atoms/files/webb_irb_report_and_response_0.pdf http://m.esa.int/spaceinvideos/Videos/2018/07/JWST_a_beacon_for_science https://www.surveymonkey.com/r/JWSTSurvey https://www.space.com/nasa-james-webb-space-telescope-worth-wait.html https://www.jpl.nasa.gov/news/news.php?feature=7579 http://www.esa.int/ESA_Multimedia/Images/2020/04/James_Webb_Space_Telescope_s_primary_mirror_unfolded https://content.govdelivery.com/accounts/EUESA/bulletins/2961158 https://www.nasa.gov/press-release/nasa-announces-new-james-webb-space-telescope-target-launch-date/ https://www.nytimes.com/2020/07/16/science/nasa-james-webb-space-telescope-delay.html https://www.nasa.gov/feature/goddard/2021/nasa-s-james-webb-space-telescope-completes-final-functional-tests-to-prepare-for-launch https://www.space.com/james-webb-space-telescope-final-mirror-test https://en.wikipedia.org/wiki/James_Webb_Space_Telescope
2021, Nov	Foreseen first light of the **Large Synoptic Survey Telescope (LSST),** a 6.7-m effective diameter telescope with a 9.6 square degree field and a 3.2 gigapixel camera, under development since 2000, to scan the sky from Cerro Pachón (northern Chile) near the Gemini South and Southern Astrophysical Research (SOAR) telescopes. Taking more than 800 panoramic images each night, it

	can cover the accessible sky twice a week. Limiting magnitude: $v = 24.5$ mag. The planned **LSST** baseline survey will be capable of providing orbits for 82% of PHAs with $D > 140$ m after ~ 10 yr of operation, and 90% complete for objects with $D > 230$ m. During its 10-year survey, **LSST** will produce 30 terabytes of raw astronomical data each night, resulting in a database catalog of 22 petabytes and an image archive of 100 petabytes**.** **LSST** is on schedule for full science operations in 2023. On 6 January 2020, **LSST** was renamed the **Vera C. Rubin Observatory**. Its first 10 years of work will be dedicated entirely to a project now known as the Legacy Survey of Space and Time. See: http://www.lsst.org/lsst Ref: - Z. Ivezić, J.A. Tyson, M. Jurić, et al., 2007, in: A. Milani, G.B. Valsecchi & D. Vokrouhlický (eds.), Proc. IAU Symp. No. 236 on *Near Earth Objects, our Celestial Neighbors: Opportunity and Risk*, Prague (Czech Republic), 14-18 August 2006 (Cambridge: CUP), p. 353, "**LSST**, comprehensive NEO detection, characterization, and orbits." See: http://adsabs.harvard.edu/abs/2007IAUS..236..353I - R.L. Jones, S.R. Chesley, A.J. Connolly, A.W. Harris, et al., 2009, *Earth, Moon, and Planets*, 105, 101, "Solar System Science with **LSST**." See: http://adsabs.harvard.edu/abs/2009EM%26P..105..101J - B. Corbin, 2010, presented at the *61st International Astronautical Congress*, Prague (Czech Republic), 27 September - 1 October 2010, "Implementing advanced technologies and models to reduce uncertainty in a global, cost-effective asteroid mitigation system." See: http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=115 http://www.lsst.org/overview/overview_v1.0.pdf http://www.lsst.org/Science/docs/DRM2.pdf http://www.lsst.org/lsst/scibook http://www.lsst.org/lsst/news http://www.lsst.org/News/enews/director-201010.html http://adsabs.harvard.edu/abs/2012AAS...21915605T http://targetneo.jhuapl.edu/pdfs/sessions/TargetNEO-Session6-Jones.pdf http://www.space.com/15447-3-2-billion-pixel-camera-telescope-critical.html https://www.space.com/lsst-named-vera-rubin-observatory.html https://videos.space.com/m/zCJlubA6/nsf-vera-c-rubin-observatory-will-be-revolutionary

2021, Dec 11	Apollo NEA **4660 Nereus** (**1982 DB**, H = 18.5 mag, $D \approx$ 510 x 330 x 240 m, **PHA**) will pass Earth at 10.2 LD. Minimum miss distance 10.2 LD. See: 4660 Nereus - SSA , 1982 DB - JPL Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B See also: http://en.wikipedia.org/wiki/4660_Nereus See also: **29 Jan 1900**, **22 Jan 2002**, **14 Feb 2060**, **4 Feb 2071, 23 Dec 2112**, **4 Feb 2166**.
2022	Foreseen launch of JAXA spacecraft ***DESTINY+*** (***Demonstration and Experiment of Space Technology for INterplanetary voYage Phaethon fLyby dUSt science***), a planned mission to flyby the meteor shower parent body **3200 Phaethon**, as well as various minor bodies originating from the "rock comet". See: http://fanfun.jaxa.jp/jaxatv/files/20170920_dlr_e.pdf See also: https://en.wikipedia.org/wiki/DESTINY%2B
2022, Jan 9-13	***American Astronomical Society 239th Meeting***, 9-13 January 2022, Salt Lake City (UT, USA). See: https://aas.org/meetings/future-aas-meetings
2022, Jan 7	Apollo NEA **2020 AP1** (H = 29.6 mag, $D \approx$ 4 m) will pass Earth at a nominal miss distance of 4.54 LD. Minimum miss distance 0.0027 LD **(= 0.16** $\mathbf{R_{Earth}}$ **from the geocenter).** See: 2020 AP1 – S2P , 2020 AP1 - JPL See also: **2 Jan 2020**.
2022, Jan 18	Apollo NEA **7482** (**1994 PC1**, H = 16.7 mag, $D \approx$ 1300 m, **PHA**) will pass Earth at 5.15 LD. Minimum miss distance 5.15 LD. See: 7482 1994 PC1 - SSA , 1994 PC1 -JPL See also: https://en.wikipedia.org/wiki/(7482)_1994_PC1 See also: **17 Jan 1933**.
2022, Mar 4	Apollo NEA **138971** (**2001 CB21**, H = 18.6 mag, $D \approx$ 578 m, **PHA**) will pass Earth at 12.78 LD. Minimum miss distance 12.78 LD. Flyby target for ***AIDA*** mission. See: 138971 2001 CB21- SSA , 2001 CB21 - JPL
2022, Mar 28	Atira NEA **2019 LF6** (H = 17.2 mag, $D \approx$ 1300 m) will pass Earth at 103 LD. Minimum miss distance 102 LD.

	See: 2019 LF6 - SSA , 2019 LF6 - JPL See also: https://www.caltech.edu/about/news/ztf-spots-asteroid-shortest-year
2022, May 30	Aten NEA **2021 KO2** (*H* = 28.1 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 2.81 LD. Minimum miss distance 0.90 LD. See: 2021 KO2 – S2P , 2021 KO2 - JPL See also: **30 May 2021**, **31 May 2164**.
2022, Jun 12-16	***American Astronomical Society 240th Meeting***, 12-16 June 2022, Pasadena (CA, USA). See: https://aas.org/meetings/future-aas-meetings
2022, Jun 30	***Asteroid Day 2022*.** See: http://www.asteroidday.org/
2022, Jul 16-24	***44th COSPAR Scientific Assembly***, 16-24 July, Athens (Greece). See: https://www.cospar-assembly.org
2022, Aug	***85th Annual Meeting of the Meteoritical Society***, Aug 2022, Glasgow (UK). See: https://meteoritical.org/society/annual-meetings
2022, Aug	***IAU XXXI General Assembly***, Busan (Republic of Korea), ~~16-27 August 2021~~. **Postponed to August 2022**. See: https://www.iau.org/science/meetings/future/general_assemblies/1181/ The ***IAU GA Business Meetings***, including the elections for the next three years provided for in the IAU Bye-Laws, will take place in August 2021, as virtual meetings. **Including:** ***IAU Symposium No. 374, Astronomical hazards for life on Earth,*** Busan, ~~16-19 August 2021~~**. Postponed to August 2022.** See: https://www.iau.org/science/meetings/future/symposia/2591/
2022, Oct 2-7	***54th Annual Meeting of the AAS Division for Planetary Sciences***, 2-7 October 2022, London (Canada). See: https://dps.aas.org/meetings/future
2022, Oct 4	Apollo NEA **65803 Didymos** (**1996 GT**, *H* = 18.1 mag, *D* ≈ 780 + 160 m, **PHA**) will pass Earth at 27.72 LD (= 0.07 AU). Minimum miss distance 27.72 LD. Flyby target for ***AIDA*** mission. See: 65803 Didymos - SSA , 1996 GT - JPL See also: https://en.wikipedia.org/wiki/65803_Didymos See also: **12 Nov 2003**, **29 May 2012**, **20 Oct 2062**, **4 Nov 2123**.

2022, Nov 16	Apollo NEA **2018 WH** (*H* = 30.0 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 2.55 LD. Minimum miss distance 0.38 LD. See: 2018 WH - SSA , 2018 WH - JPL See also: **16 Nov 2018**.
2022, Nov 23	Apollo NEA **2005 LW3** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 2.96 LD. Minimum miss distance 2.96 LD. See: 2005 LW3 - JPL , 2005 LW3 - SSA See also: **20 Nov 1928**, **22 Nov 2084**.
2022, Dec 27	Aten NEA **2010 XC15** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 2.01 LD. Minimum miss distance 2.01 LD. See: 2010 XC15 - SSA , 2010 XC15 - JPL See also: http://en.wikipedia.org/wiki/2010_XC15 See also: **26 Dec 1907**, **27 Dec 1914**, **27 Dec 1976**, **28 Dec 2059**, **26 Dec 2064**, **26 Dec 2096**.
2023, Jan 8-12	***American Astronomical Society 241th Meeting***, 8-12 January 2023, Seattle (WA, USA). See: https://aas.org/meetings/future-aas-meetings
2023, Jan 20	Apollo NEA **2020 BP** (*H* = 25.7 mag, *D* ≈ 26 m) will pass Earth at a nominal miss distance of 5.47 LD. Minimum miss distance 0.43 LD. See: 2020 BP – S2P , 2020 BP – JPL
2023, Feb 3	Apollo NEA **367789** (**2011 AG5**, *H* = 22.0 mag, *D* ≈ 140 m, **PHA**) will pass Earth at a nominal miss distance of 4.73 LD. Minimum miss distance 4.72 LD. See: 367789 2011 AG5 - SSA , 2011 AG5 - JPL See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-051 http://www.jpl.nasa.gov/news/news.cfm?release=2012-051 http://www.space.com/14683-big-asteroid-2011-ag5-threat-earth.html http://www.space.com/14782-asteroid-threat-earth-impact-2011ag5.html http://blogs.discovermagazine.com/badastronomy/files/2012/03/schweikart_letter_NASA_AG5.pdf http://www.space.com/14872-asteroid-2011-ag5-earth-impact.html http://en.wikipedia.org/wiki/2011_AG5 See also: **26 Feb 2011**, **4 Feb 2040**.

2023, Jun 4-8	***American Astronomical Society 242th Meeting***, 4-8 June 2023, Albuquerque (NM, USA). See: https://aas.org/meetings/future-aas-meetings
2023, Jun 30	***Asteroid Day 2023*.** See: http://www.asteroidday.org/
2023, Jul 3-8	***86th Annual Meeting of the Meteoritical Society***, 3-8 July 2023, Perth (Australia). See: https://meteoritical.org/society/annual-meetings
2023, Sep 24	Expected return of NASA spacecraft ***Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx)***, an asteroid sample return mission, from target asteroid **101955 (1999 RQ36 = Bennu**, $H = 20.8$ mag, $D \approx 575$ m, **NEO**, **PHA**). The 2,110-kg spacecraft, launched aboard an Atlas V 411 rocket on 8 September 2016; rendezvous 3 December 2018. After a careful survey of **Bennu** to characterize the asteroid and locate the most promising sample sites, ***OSIRIS-REx*** will collect between 60 to 2,000 grams of surface material with its robotic arm and return the sample to Earth via a detachable capsule on 24 September 2023. The capsule containing the sample will be collected at the Utah Test and Training Range. For two years after the sample return (from late 2023-2025) the science team will catalog the sample and conduct the analysis needed to meet the mission science goals. NASA will preserve at least 75% of the sample at NASA's Johnson Space Flight Center in Houston for further research by scientists worldwide, including future generations of scientists. See: http://www.nasa.gov/osiris-rex http://science.nasa.gov/missions/osiris-rex/ http://www.asteroidmission.org/objectives/ http://www.nasa.gov/topics/solarsystem/features/osiris-rex.html http://www.nasa.gov/mission_pages/osiris-rex/index.html http://pirlwww.lpl.arizona.edu/~guym/OSIRIS-REx.pdf http://www.space.com/11802-nasa-asteroid-mission-dangerous-1999-rq36.html http://www.space.com/11808-nasa-asteroid-mission-osiris-rex-1999-rq36-infographic.html http://www.space.com/12065-osiris-rex-asteroid-generations.html http://www.grandpublic.obspm.fr/2016-2023-Retour-sur-Terre-d http://web.mit.edu/newsoffice/2011/asteroid-mission-0726.html http://www.theithacajournal.com/article/20110828/NEWS01/108280327/Campus-Watch-Ithaca-College-professor-receives-NASA-grant-asteroid-study?odyssey=nav%7Chead http://www.space.com/13132-potentially-killer-asteroids-earth-nasa.html http://www.nasa.gov/press/2014/april/construction-to-begin-on-nasa-spacecraft-set-to-visit-asteroid-in-2018/

	http://adsabs.harvard.edu/abs/2016Sci...353..974V http://iopscience.iop.org/article/10.1088/2058-7058/29/10/11/meta https://ww2.kqed.org/science/2017/09/29/why-is-nasa-checking-out-this-asteroid/ https://www.cosmos.esa.int/documents/336356/336472/SMPAG_OREx_Update_-_Johnson_2020-02-06+%281%29.pdf/ https://www.nasa.gov/press-release/nasa-invites-public-media-to-watch-asteroid-mission-begin-return-to-earth https://en.wikipedia.org/wiki/OSIRIS-REx See also: **29 Dec 2009**.
2023, Oct 1-6	***55th Annual Meeting of the AAS Division for Planetary Sciences***, 1-6 October 2023, San Antonio (TX, USA). See: https://dps.aas.org/meetings/future
2023, Oct 17	Apollo NEA **1998 HH49** (H = 21.6 mag, $D \approx$ 170 m, **PHA**) will pass Earth at a nominal miss distance of 3.05 LD. Minimum miss distance 3.01 LD. See: 1998 HH49 - JPL , 1998 HH49 - SSA
2023, Nov 25	Apollo NEA **2019 UT6** (H = 22.2 mag, $D \approx$ 130 m) will pass Earth at a nominal miss distance of 6.36 LD. Minimum miss distance 6.02 LD. See: 2019 UT6 – SSA , 2019 UT6 – JPL
2023, Dec 23	Apollo NEA **2020 YO3** (H = 24.7 mag, $D \approx$ 40 m) will pass Earth at a nominal miss distance of 3.55 LD. Minimum miss distance 0.52 LD. See: 2020 YO3 – S2P , 2020 YO3 – JPL
2024	Launch of the ESA spacecraft ***Hera***, which will be, along with NASA's ***DART*** spacecraft, the first mission to rendezvous with the binary asteroid **Didymos** ($D \approx$ 780 m + 160 m). In October 2022 ***DART*** will perform a kinetic impact on the smaller binary component, **Dimorphos**. In 2026 ***Hera*** will follow-up with a post-impact survey of the binaery asteroid, to investigate the effect of this planetary defence technique. ***DART*** and ***Hera*** were conceived together as part of the international ***Asteroid Impact Deflection Assessment*** (***AIDA***) collaboration. The two missions are valuable individually, but by being flown in concert their overall scientific and technological return is more than doubled. ***Hera***, a further optimisation of ESA's earlier ***Asteroid Impact Mission*** (***AIM***), was agreed for launch at the Agency's Space19+ Council of Ministers at European Level in November 2019. See: https://www.esa.int/Safety_Security/Hera See also:

	https://www.nasa.gov/planetarydefense/dart https://www.iau.org/news/pressreleases/detail/iau2007/?lang https://en.wikipedia.org/wiki/65803_Didymos https://en.wikipedia.org/wiki/Dimorphos https://en.wikipedia.org/wiki/AIDA_(mission)#Hera https://en.wikipedia.org/wiki/Double_Asteroid_Redirection_Test https://www.space.com/nasa-delays-dart-asteroid-mission-launch-2022
2024, Jan 7-11	***American Astronomical Society 243th Meeting***, 7-11 January 2024, New Orleans (LA, USA). See: https://aas.org/meetings/future-aas-meetings
2024, Jan 16	Aten NEA **2021 CZ2** (H = 22.5 mag, $D \approx$ 110 m) will pass Earth at a nominal miss distance of 5.64 LD. Minimum miss distance 0.52 LD. See: 2021 CZ2 – S2P , 2021 CZ2 - JPL
2024, Mar 18	Apollo NEA **2020 FD** (H = 27.7 mag, $D \approx$ 10 m) will pass Earth at a nominal miss distance of 5.80 LD. Minimum miss distance 0.04 LD. See: 2020 FD – S2P , 2020 FD - JPL See also: **18 March 2020**
2024, Apr 18	Apollo NEA **2017 SA20** (H = 28.5 mag, $D \approx$ 7 m) will pass Earth at a nominal miss distance of 6.68 LD. Minimum miss distance 0.03 LD. See: 2017 SA20 - JPL , 2017 SA20 - SSA See also: **26 Apr 1997**.
2024, Jun 30	***Asteroid Day 2024*.** See: http://www.asteroidday.org/
2024, Jul/Aug	***87th Annual Meeting of the Meteoritical Society***, July/August 2024, Brussels (Belgium, EU). See: https://meteoritical.org/society/annual-meetings
2024, Oct 6-11	***56th Annual Meeting of the AAS Division for Planetary Sciences***, 6-11 October 2024, Boise (ID, USA). See: https://dps.aas.org/meetings/future
2024, Oct 13	Amor NEA **1036 Ganymed** (**A924 UB**, H = 9.6 mag, D = 36.5 km), largest NEA known, will pass Earth at a nominal miss distance of 146 LD. Minimum miss distance 146 LD. See: 1036 Ganymed - SSA , 1924 TD - JPL Ref: J. Meeus, M. Drummen, September 2011, *Zenit*, "**Ganymed** in aantocht."

	See: http://www.dekoepel.nl/zenit/september2011.html See also: http://en.wikipedia.org/wiki/1036_Ganymed See also: **13 Oct 2011**.
2024, Nov 1	Aten NEA **2016 VA** (H = 27.8 mag, $D \approx$ 10 m) will pass Earth at a nominal miss distance of 1.35 LD. Minimum miss distance 0.30 LD. See: 2016 VA - SSA , 2016 VA - JPL See also: **2 Nov 1938**, **2 Nov 2016**.
2024, Nov 12	Apollo NEA **2020 UL3** (H = 23.3 mag, $D \approx$ 80 m) will pass Earth at a nominal miss distance of 3.43 LD. Minimum miss distance 0.99 LD. See: 2020 UL3 – S2P , 2020 UL3 – JPL
2024, Dec 11	Apollo NEA **2007 XB23** (H = 27.1 mag, $D \approx$ 14 m) will pass Earth at a nominal miss distance of 1.16 LD. Minimum miss distance 0.25 LD. See: 2007 XB23 - SSA , 2007 XB23 - JPL See also: **13 Dec 2007**.
2024, late	Foreseen launch of the ***Near Earth Object Surveillance Mission (NEOSM)***. The new ***NEO Surveillance Mission*** will be similar to the ***NEOCam*** mission previously proposed to NASA's Discovery program, but instead run as a directed mission as part of the agency's planetary defense efforts. The spacecraft will have a total mass of no more than 1,300 kg, allowing it to launch on a vehicle like an Atlas 5 or Falcon 9 to the Sun–Earth Lagrange point L1. Foreseen launch date: late 2024. In 2005, the US Congress mandated NASA to achieve by the year 2020 a completeness level of 90% for discovering, cataloging, and characterizing dangerous asteroids larger than 140 meters. However, the 140-m NEO threat discovery estimate was just under 36% at the end of 2019. ***NEOSM*** should reach the 90% congressional goal within 10 years, with an anticipated mission lifetime of 12 years. Re: - J. Foust, *SpaceNews*, 23 September 2019, “NASA to develop mission to search for near-Earth asteroids.” See: https://spacenews.com/nasa-to-develop-mission-to-search-for-near-earth-asteroids/ See also: https://neocam.ipac.caltech.edu/ https://www.sciencemag.org/news/2019/09/nasa-build-telescope-detecting-asteroids-threaten-earth

	https://www.universetoday.com/143527/this-summers-asteroid-near-miss-helped-greenlight-nasas-neocam-mission-to-search-the-skies-for-killer-spacerocks/ https://www.cosmos.esa.int/documents/336356/336472/PDCO_Brief_to_SMPAG_-_Johnson_2020-02-06+%281%29.pdf/ https://en.wikipedia.org/wiki/Near-Earth_Object_Surveillance_Mission
2025, Jan 12-16	***American Astronomical Society 245th Meeting***, 12-16 January 2025, National Harbour (MD, USA). See: https://aas.org/meetings/future-aas-meetings
2025, Jun	***American Astronomical Society 246th Meeting***, June 2025, Anchorage (AK, USA). See: https://aas.org/meetings/future-aas-meetings
2025, Jun 30	***Asteroid Day 2025*****.** See: http://www.asteroidday.org/
2025, late	Foreseen launch of the ***Nancy Grace Roman Space Telescope***, formerly known as the ***Wide-Field InfraRed Survey Telescope***. The ***Roman Space Telescope*** will be NASA's next large space astrophysics observatory after ***JWST***. Both missions are built on the legacy of ***Hubble***. Whereas ***JWST*** offers superior sensitivity over ***Hubble***, ***Roman*** will provide a panoramic field of view that is 100 times greater than ***Hubble***'s, leading to the first wide-field maps of the universe at space-based resolution … . ***Roman*** can search for new dwarf planets, comets, and asteroids in our solar system. See: https://www.stsci.edu/roman http://www.stsci.edu/wfirst/about/wfirst-advisory-committee-wstac See also: https://www.stsci.edu/contents/newsletters/2020-volume-37-issue-01/community-science-with-the-nancy-grace-roman-space-telescope
2026, Jan 4-8	***American Astronomical Society 247th Meeting***, 4-8 January 2026, Phoenix (AZ, USA). See: https://aas.org/meetings/future-aas-meetings
2026, Feb 12	Aten NEA **1999 AO10** ($H = 24.0$ mag, $D \approx 60$ m) will pass Earth at a nominal miss distance of 10.43 LD. Minimum miss distance 10.36 LD. Possible target for NASA manned mission, with launch date **19 September 2025** and a 155 day mission duration. See: 1999 AO10 - SSA , 1999 AO10 - JPL See also: http://ww.aviationweek.com/aw/generic/story_channel.jsp?channel=space&id=news/awst/2010/08/16/AW_08_16_2010_p30-

	247032.xml&headline=NASA%20Narrows%20Potential%20Asteroid%20List http://www.nasaspaceflight.com/2010/01/nasas-flexible-path-2025-human-mission-visit-asteroid/ http://www.nasa.gov/pdf/474223main_Johnson_ExploreNOW.pdf http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf http://en.wikipedia.org/wiki/1999_AO10
2026, Apr 14	Aten NEA **2013 GM3** (H = 26.3 mag, $D \approx$ 20 m) will pass Earth at a nominal miss distance of 1.02 LD. Minimum miss distance 0.014 LD **(= 0.82 R_{Earth} from the geocenter)**. See: 2013 GM3 - SSA , 2013 GM3 - JPL
2026, Jun 30	***Asteroid Day 2026*.** See: http://www.asteroidday.org/
2026, Oct 25-30	***58th Annual Meeting of the AAS Division for Planetary Sciences***, 25-30 October 2026, Spokane (WA, USA). See: https://dps.aas.org/meetings/future
2027, Jan 28	Apollo NEA **2020 OP3** (H = 20.8 mag, $D \approx$ 230 m, **PHA**) will pass Earth at a nominal miss distance of 7.67 LD. Minimum miss distance 5.13 LD. See: 2020 OP3 – S2P , 2020 OP3 - JPL See also: **29 Jan 1986**, **29 Jan 2046**.
2027, Jun 6	Apollo NEA **4953** (**1990 MU**, H = 15.2 mag, $D \approx$ 2800 m, **PHA**) will pass Earth at a nominal miss distance of 12.0 LD. Minimum miss distance 12.0 LD. See: 4953 1990 MU - SSA , 1990 MU - JPL See also: https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html http://en.wikipedia.org/wiki/(4953)_1990_MU See also: **5 Jun 2058**.
2027, Jun 30	***Asteroid Day 2027*.** See: http://www.asteroidday.org/
2027, Aug 7	Apollo NEA **137108** (**1999 AN10**, H = 18.4 mag, $D \approx$ 700 m, **PHA**) will pass Earth at a nominal miss distance of 1.014 LD. Minimum miss distance 1.010 LD. See: 137108 1999 AN10 - SSA , 1999 AN10 - JPL Ref: - P.W. Chodas, 18 May 1999, "The continuing story of asteroid

	1999 AN10." See: http://neo.jpl.nasa.gov/news/news017.html - A. Milani, S.R. Chesley, G.B. Valsecchi, 1999, *Astronomy & Astrophysics* (Letters), 346, L65, "Close approaches of asteroid **1999 AN10**: resonant and non-resonant returns." See: http://adsabs.harvard.edu/abs/1999A%26A...346L..65M - D. Morrison, C.R. Chapman, D. Steel, R.P. Binzel, 2004, in: M.J.S. Belton, et al. (eds.), 2004, *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 353, "Impacts and the public: communicating the nature of impact hazard." See: http://adsabs.harvard.edu/abs/2004mhca.conf..353M - B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998 – 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B See also: https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html http://en.wikipedia.org/wiki/(137108)_1999_AN10 See also: **7 Aug 1946**.
2027, Oct 4, 00:14	Apollo NEA **2018 FK5** (H = 28.3 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 4.46 LD. Minimum miss distance 0.18 LD. See: 2018 FK5 - SSA , 2018 FK5 - JPL See also: **30 Mar 2018**.
2027, Oct 4, 01:28	Apollo NEA **2020 SN6** (H = 28.8 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 3.68 LD. Minimum miss distance 0.17 LD. See: 2020 SN6 – 2SP , 2020 SN6 – JPL See also: **16 Feb 2015**.
2027, Dec 2	Aten NEA **2020 XF** (H = 26.7 mag, $D \approx$ 16 m) will pass Earth at a nominal miss distance of 1.77 LD. Minimum miss distance 0.88 LD. See: 2020 XF – S2P , 2020 XF – JPL See also: **3 Dec 2020**.
2028, Jan 19	Aten NEA **2020 AW** (H = 28.7 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 4.22 LD. Minimum miss distance 0.98 LD. See: 2020 AW – S2P , 2020 AW – JPL
2028, May 7	Aten NEA **2000 SG344** (H = 25.1 mag, $D \approx$ 30 m) will pass Earth at a nominal miss distance of 7.63 LD. Minimum miss distance 7.51 LD.

	See: 2000 SG344 - SSA , 2000 SG344 - JPL See also: http://en.wikipedia.org/wiki/2000_SG344 See also: **6 May 1999, 13 Sep 2072**.
2028, May 21	Apollo NEA **2009 WR52** (*H* = 28.6 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 4.69 LD. Minimum miss distance 0.54 LD. See: 2009 WR52 - SSA , 2009 WR52 - JPL
2028, Jun 26	Apollo NEA **153814** (**2001 WN5**, *H* = 18.5 mag, *D* ≈ 932 m, **PHA**) will pass Earth at a nominal miss distance of 0.65 LD. Minimum miss distance 0.65 LD. **[2028-01]** See: 153814 2001 WN5 - SSA , 2001 WN5 - JPL See also: https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html http://en.wikipedia.org/wiki/(153814)_2001_WN5
2028, Jun 30	***Asteroid Day 2028*.** See: http://www.asteroidday.org/
2028, Jul 25	Apollo NEA **2011 LJ19** (*H* = 21.2 mag, *D* ≈ 210 m, **PHA**) will pass Earth at a nominal miss distance of 3.06 LD. Minimum miss distance 0.73 LD. See: 2011 LJ19 - SSA , 2011 LJ19 - JPL
2028, Oct 26	Apollo NEA **35396** (**1997 XF11**, *H* = 17.3 mag, ***D* = 1200 m**, **PHA**) will pass Earth at a nominal miss distance of 2.417 LD. Minimum miss distance 2.416 LD. See: 35396 1997 XF11 - SSA , 1997 XF11 - JPL See also: **11 Mar 1998, 27 Oct 2095**. See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=60 https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html http://en.wikipedia.org/wiki/(35396)_1997_XF11
2028, Nov 2	Aten NEA **2015 VL64** (*H* = 28.5 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 2.46 LD. Minimum miss distance 0.98 LD. See: 2015 VL64 - SSA , 2015 VL64 - JPL See also: **2 Nov 2008**.
2028, Nov 19	Apollo NEA **2017 WW1** (*H* = 29.8 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 9.78 LD. Minimum miss distance 0.30 LD. See: 2017 WW1- SSA , 2017 WW1- JPL See also: **21 Nov 2017**.

2028, Dec 30	Aten NEA **2012 XE133** (*H* = 23.5 mag, *D* ≈ 70 m) will pass Earth at a nominal miss distance of 3.26 LD. Minimum miss distance 0.85 LD. See: 2012 XE133 - SSA , 2012 XE133 - JPL Ref: - C. de la Fuente Marcos, R. de la Fuente Marcos, 21 June 2013, *Monthly Notices of the Royal Astronomical Society*, 432, 886, "Asteroid **2012 XE133**, a transient companion to **Venus**." See: http://adsabs.harvard.edu/abs/2013MNRAS.432..886D See also: https://en.wikipedia.org/wiki/2012_XE133
2029, Jan 28 04:24	Apollo NEA **292220** (**2006 SU49**, *H* = 19.7 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 3.19 LD. Minimum miss distance 3.19 LD. See: 2006 SU49 - JPL , 2006 SU49 - SSA See also: https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html https://en.wikipedia.org/wiki/(292220)_2006_SU49 See also: **29 Jan 1977**, **30 Jan 1982**.
2029, Apr 13, 21:46	Aten NEA **99942 Apophis** (**2004 MN4**, *H* = 19.7 mag, *D* ≈ 370 m, orbital *P* = 0.89 yr, **PHA**) will pass Earth at a nominal miss distance of 0.098 LD **(= 5.92 R_{Earth} = 37,727 km from the geocenter)** with a relative velocity of 7.42 km/s. Minimum miss distance 0.096 LD **(= 5.81 R_{Earth} = 37,030 km from the geocenter)**. **[2029-01]** As a result of its close passage, this minor planet will move from the **Aten** to the **Apollo** class. Probability of impact on **12 April 2068:** ~1:150,000. See: 99942 Apophis - SSA , 2004 MN4 - JPL See also: http://neo.jpl.nasa.gov/risk/a99942.html http://neo.jpl.nasa.gov/apophis/ https://cneos.jpl.nasa.gov/doc/apophis/ http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-017 http://neo.jpl.nasa.gov/news/news178.html https://www.space.com/six-asteroids-will-buzz-earth-late-2020s.html https://iaaweb.org/iaa/Scientific%20Activity/pdcstatement3.pdf https://www.space.com/asteroid-apophis-2029-flyby-planetary-defense.html http://en.wikipedia.org/wiki/99942_Apophis Ref: - A.M. MacRobert, 15 February 2005, *Sky & Telescope*, 109 (5),

	16, "Asteroid **2004 MN4**: a really near miss!" See: http://adsabs.harvard.edu/abs/2005S%26T...109e..16M - D. Chandler, 2005, *New Scientist*, 25 June 2005, issue 2505, "Killer asteroid: too close for comfort." See: http://www.newscientist.com/article/mg18625051.200-killer-asteroid-too-close-for-comfort.html - B.G. Marsden, 2007, in: P. Bobrowsky & H. Rickman (eds.), 2007, *Comet/Asteroid Impacts and Human Society* (Berlin: Springer), p. 505, "Impact risk communication management (1998 – 2004): Has it improved?" See: http://adsabs.harvard.edu/abs/2007caih.book.....B - J.D. Giorgini, L.A.M. Benner, S.J. Ostro, et al., 2008, *Icarus*, 193, 1, "Predicting the Earth encounters of **(99942) Apophis**." See: http://adsabs.harvard.edu/abs/2008Icar..193....1G - S.R. Chesley, A. Milani, et al., 2009, *AAS-DPS*, 41.4306, "An updated assessment of the impact threat from **99942 Apophis**." See: http://adsabs.harvard.edu/abs/2009DPS....41.4306C - J. Žižka, D. Vokrouhlický, 2011, *Icarus*, 211, 511, "Solar radiation pressure on **(99942) Apophis**." See: http://adsabs.harvard.edu/abs/2011Icar..211..511Z - D. Bancelin, D. Hestrofer, W. Thuillot, October 2012, American Astronomical Society, DPS meeting #44, #210.01, "Asteroid **Apophis** from past, present and future observations." See: http://adsabs.harvard.edu/abs/2012DPS....4421001B - D. Farnocchia, S.R. Chesley, P.W. Chodas, et al., May 2013, *Icarus*, 224, 192, "Yarkovsky-driven impact risk analysis for asteroid **(99942) Apophis**." See: http://adsabs.harvard.edu/abs/2013Icar..224..192F - M. Brozovic, L. Benner, J. McMichael, et al., 2015, AAS DPS meeting #47, #402.06, "Size estimate of **(99942) Apophis** based on radar imaging." See: http://adsabs.harvard.edu/abs/2015DPS....4740206B See also: http://neo.jpl.nasa.gov/news/news164.html http://adsabs.harvard.edu/abs/2009DPS....41.4306C http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=Apophis&orb=1 http://newton.dm.unipi.it/neodys/index.php?pc=1.1.8&n=Apophis http://news.bbc.co.uk/2/hi/science/nature/8296796.stm http://content.usatoday.com/communities/sciencefair/post/2010/11/apophis-asteroid-2013/1 http://docs.google.com/leaf?id=0B-ocLfVN8v3OZmViODUxMjQtNzA1YS00OTIwLThhYTAtMjU4N2U5OGI1YzQz&sort=name&layout=list&pid=0B-ocLfVN8v3OYWEwMzM2ODktOTEwMC00ZmVjLWI4MDItNzc4OTNhMmU2YmUx&cindex=1 https://phys.org/news/2017-06-impact-threat-asteroid-apophis.html https://phys.org/news/2017-08-asteroid-apophis-chance-earth-expert.html

	https://www.space.com/asteroid-apophis-2029-flyby-planetary-defense.html See also: https://ui.adsabs.harvard.edu/abs/2020DPS....5221406T/abstract https://skyandtelescope.org/astronomy-news/apophis-impact-small-chance-2068/ https://www.space.com/osiris-rex-asteroid-probe-could-visit-apophis-2029 See also: **13 Apr 1907**, **14 Apr 1949**, **14 Apr 1998**, **30 Mar 2036**, **7 Apr 2123**.
2029, May 14	Apollo NEA **2000 SL10** (*H* = 22.5 mag, *D* ≈ 110 m, **PHA**) will pass Earth at a nominal miss distance of 4.27 LD. Minimum miss distance 4.26 LD. See: 2000 SL10 - JPL , 2000 SL10 - SSA See also: **15 May 1915**.
2029, Jun 30	***Asteroid Day 2029*.** See: http://www.asteroidday.org/
2029, Oct 20	Apollo NEA **2008 UA202** (*H* = 29.3 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 6.09 LD. Minimum miss distance 0.05 LD. See: 2008 UA202 - SSA , 2008 UA202 - JPL See also: **18 Oct 2008.**
2029, Nov 11	Apollo NEA **2001 AV43** (*H* = 24.7 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 0.81 LD. Minimum miss distance 0.81 LD. **[2029-02]** See: 2001 AV43 - SSA , 2001 AV43 - JPL See also: https://en.wikipedia.org/wiki/2001_AV43
2029, Dec 24	Apollo NEA **2020 YB1** (*H* = 26.8 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 2.04 LD. Minimum miss distance 0.76 LD. See: 2020 YB1 – S2P , 2020YB1 – JPL
2030, Apr 2	Apollo NEA **2021 GE2** (*H* = 29.0 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 5.89 LD. Minimum miss distance **0.0045 LD (= 0.273 R_{Earth} from the geocenter)**. See: 2021 GE2 – S2P , 2021 GE2 - JPL See also: **2 Apr 1942**, **3 Apr 2021**.
2030, Jun 30	***Asteroid Day 2030*.** See: http://www.asteroidday.org/

2030, Oct 30	Apollo NEA **2017 UJ2** (*H* = 31.0 mag, *D* ≈ 2.2 m) will pass Earth at a nominal miss distance of 31.66 LD. Minimum miss distance 0.75 LD. See: 2017 UJ2 - SSA , 2017 UJ2 - JPL See also: **20 Oct 1978**, **20 Oct 2017**.
2031, Jan 20	Apollo NEA **2018 BD** (*H* = 30.2 mag, *D* ≈ 3 m) will pass Earth at a nominal miss distance of 5.83 LD. Minimum miss distance 0.08 LD. See: 2018 BD - SSA , 2018 BD - JPL See also: https://www.cnet.com/news/asteroid-2018-bd-earth-potentially-hazardous-2002-aj129/ See also: **18 Jan 2018**.
2031, Feb 19	Apollo NEA **2021 DG** (*H* = 30.1 mag, *D* ≈ 3 m) will pass Earth at a nominal miss distance of 2.87 LD. Minimum miss distance 0.18 LD. See: 2021 DG – S2P , 2021 DG – JPL See also: **18 Feb 1980**, **18 Feb 2021**.
2031, Mar 19	Apollo NEA **2019 UH1** (*H* = 24.2 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 8.34 LD. Minimum miss distance 0.40 LD. See: 2019 UH1 – SSA , 2019 UH1 – JPL
2031, May 24	Apollo NEA **2020 KQ4** (*H* = 26.5 mag, *D* ≈ 18 m) will pass Earth at a nominal miss distance of 3.72 LD. Minimum miss distance 0.92 LD. See: 2020 KQ4 – S2P , 2020 KQ4 – JPL See also: **23 May 1971**.
2031, Sep 26	Apollo NEA **2016 SW1** (*H* = 28.8 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 6.32 LD. Minimum miss distance 0.50 LD. See: 2016 SW1 – SSA , 2016 SW1 – JPL
2032, Feb 9	Aten NEA **2020 DK** (*H* = 26.1 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 2.64 LD. Minimum miss distance 0.73 LD. See: 2020 DK – S2P , 2020 DK – JPL See also: **7 Feb 2089**.
2032, Feb 11	Aten NEA **2021 DR** (*H* = 27.8 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 1.97 LD. Minimum miss distance 0.39 LD. See: 2021 DR – S2P , 2021 DR - JPL

2032, Feb 25	Apollo NEA **2018 DU** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.93 LD. Minimum miss distance 0.66 LD. See: 2018 DU - SSA , 2018 DU - JPL See also: **25 Feb 2018**.
2032, Feb 29	Apollo NEA **2019 EH1** (*H* = 29.9 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 0.89 LD. **Minimum Earth miss distance 0.046 LD (= 2.78 R_{Earth} from geocenter).** **[2032-01]** See: 2019 EH1 - SSA , 2019 EH1 - JPL See also: **1 Mar 2019**.
2032, Aug 14	Apollo NEA **2008 DB** (*H* = 26.0 mag, *D* ≈ 22 m) will pass Earth at a nominal miss distance of 0.33 LD. Minimum miss distance 0.33 LD. **[2032-02]** See: 2008 DB - SSA , 2008 DB - JPL
2033, Mar 17	Apollo NEA **2019 FA** (*H* = 28.7 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 3.21 LD. Minimum miss distance 0.03 LD. See: 2019 FA - SSA , 2019 FA - JPL See also: **16 Mar 2019.**
2033, Apr 5	Apollo NEA **2020 GY1** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 2.42 LD. Minimum miss distance 0.22 LD. See: 2020 GY1 – S2P , 2020 GY1 - JPL See also: **2 Apr 1913**, **5 Apr 2020**.
2033, Oct 17	Apollo NEA **2020 VV** (*H* = 27.3 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 3.94 LD. Minimum miss distance 0.29 LD. See: 2020 VV – S2P , 2020 VV - JPL
2034, Jan 6	Apollo NEA **2019 AH3** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 5.19 LD. Minimum miss distance 0.22 LD. See: 2019 AH3 - SSA , 2019 AH3 - JPL
2034, Jan 29	Apollo NEA **2019 BG3** (*H* = 26.2 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 6.86 LD. Minimum miss distance 0.54 LD. See: 2019 BG3 - SSA , 2019 BG3 - JPL
2034, Feb 8	Apollo NEA **2018 CC** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at

	a nominal miss distance of 8.27 LD. Minimum miss distance 0.13 LD. See: 2018 CC - SSA , 2018 CC - JPL See also: https://www.jpl.nasa.gov/news/news.php?feature=7055 http://earthsky.org/space/asteroids-feb-2018-cb-and-2018-cc-online-viewing See also: **6 Feb 2018**.
2034, May 6	Apollo NEA **2014 HB177** (*H* = 28.4 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 1.34 LD. Minimum miss distance 0.21 LD. ~~**[2034-01]**~~ See: 2014 HB177 - SSA , 2014 HB177 - JPL See also: **6 May 1974, 6 May 2014.**
2034, May 11	Aten NEA **2021 JZ5** (*H* = 28.4 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 4.92 LD. Minimum miss distance 0.45 LD. See: 2021 JZ5 – S2P , 2021 JZ5 - JPL See also: **11 May 1971.**
2034, Oct 5	Apollo NEA **2017 TB** (*H* = 29.3 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 4.05 LD. Minimum miss distance 0.24 LD. See: 2017 TB - SSA , 2017 TB - JPL
2034, Oct 15	Apollo NEA **2020 UE** (*H* = 25.6 mag, *D* ≈ 27 m) will pass Earth at a nominal miss distance of 2.92 LD. Minimum miss distance 0.17 LD. See: 2020 UE – S2P , 2020 UE - JPL See also: **15 Oct 2020**.
2035, Feb 17	Apollo NEA **2016 DY21** (*H* = 25.7 mag, *D* ≈ 25 m) will pass Earth at a nominal miss distance of 6.59 LD. Minimum miss distance 0.23 LD. See: 2016DY21 - SSA , 2016 DY21 - JPL
2035, Mar 30	Aten NEA **2002 GQ** (*H* = 26.8 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 7.04 LD. Minimum miss distance 0.77 LD. See: 2002 GQ - SSA , 2002 GQ - JPL See also: **30 Mar 1962**.
2035, Apr 4	Apollo NEA **2008 GM2** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.66 LD. Minimum miss distance 0.71 LD. See: 2008 GM2 - SSA , 2008 GM2 - JPL

2035, Apr 7	Apollo NEA **2020 GB1** (*H* = 27.0 mag, *D* ≈ 14 m) will pass Earth at a nominal miss distance of 1.27 LD. Minimum miss distance 0.13 LD. See: 2020 GB1 – S2P , 2020 GB1 – JPL See also: **10 Oct 2000**.
2035, May 3	Apollo NEA **2020 TJ3** (*H* = 24.6 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 3.01 LD. Minimum miss distance 0.75 LD. See: 2020 TJ3 – S2P , 2020 TJ3 - JPL
2035, Oct 6	Apollo NEA **536531** (**2015 DV215**, *H* = 20.4 mag, *D* ≈ 290 m, **PHA**) will pass Earth at a nominal miss distance of 2.91 LD. Minimum miss distance 2.91 LD. See: 2015 DV215 - JPL , 2015 DV215 - SSA See also: **8 Oct 2134**.
2035, Oct 18	Apollo NEA **2020 HJ4** (*H* = 20.2 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 8.01 LD. Minimum miss distance 8.00 LD. See: 2020 HJ4 – S2P , 2020 HJ4 – JPL See also: **21 Oct 1934**.
2035, Dec 2	Aten NEA **2020 XG** (*H* = 28.1 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 2.21 LD. Minimum miss distance 0.60 LD. See: 2020 XG – S2P , 2020 XG – JPL
2036, Feb 13	Apollo NEA **2021 CN5** (*H* = 27.8 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 7.07 LD. Minimum miss distance 0.62 LD. See: 2021 CN5 – S2P , 2021 CN5 - JPL
2036**,** Feb 15	Aten NEA **2020 CL1** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 8.93 LD. Minimum miss distance 7.64 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1940, 15 Feb 1991, 14 Feb 2081, 16 Feb 2118, 16 Feb 2155**
2036, Mar 15	Apollo NEA **216985** (**2000 QK130**, *H* = 21.3 mag, *D* ≈ 200 m, **PHA**) will pass Earth at a nominal miss distance of 4.43 LD. Minimum miss distance 4.43 LD. See: 2000 QK130 - JPL , 2000 QK130 - SSA See also: **12 Mar 1916**, **14 Mar 1968**, **15 Mar 2089**.

2036, Mar 30	Apollo NEA **99942 Apophis** (**2004 MN4**, H = 19.7 mag, D = 310 ± 30 m, orbital P = 0.89 yr, **PHA**) will pass Earth at a nominal miss distance of 91.89 LD. Minimum miss distance 21.82 LD. See: 99942 Apophis - SSA , 2004 MN4 - JPL See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-017 http://neo.jpl.nasa.gov/apophis/ https://cneos.jpl.nasa.gov/doc/apophis/ http://news.bbc.co.uk/2/hi/science/nature/8296796.stm http://www.scientificamerican.com/blog/post.cfm?id=planetary-bombardments-past-and-fut-2009-10-08 http://en.rian.ru/science/20110126/162318648.html http://www.space.com/10752-apophis-asteroid-hit-earth.html http://www.space.com/19221-asteroid-apophis-earth-safe-2036.html https://phys.org/news/2017-06-impact-threat-asteroid-apophis.html https://phys.org/news/2017-08-asteroid-apophis-chance-earth-expert.html http://en.wikipedia.org/wiki/99942_Apophis See also: **13 Apr 1907**, **14 Apr 1949**, **14 Apr 1998**, **13 Apr 2029**, **7 Apr 2123**.
2036, Apr 2	Apollo NEA **2017 FU102** (H = 29.0 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 0.34 LD. Minimum miss distance 0.26 LD. **[2036-01]** See: 2017 FU102 - SSA , 2017 FU102 - JPL
2037, Mar 22	Aten NEA **2006 GB** (H = 20.2 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.10 LD. Minimum miss distance 4.10 LD. See: 2006 GB - JPL , 2006 GB - SSA See also: **22 Mar 1942**, **22 Mar 2081**.
2037, Jul 8	Aten NEA **2020 QN1** (H = 23.2 mag, $D \approx$ 80 m) will pass Earth at a nominal miss distance of 2.87 LD. Minimum miss distance 0.94 LD. See: 2020 QN1 – S2P , 2020 QN1 - JPL
2037, Nov 7	Apollo NEA **2020 VO1** (H = 28.1 mag, $D \approx$ 9 m) will pass Earth at a nominal miss distance of 6.09 LD. Minimum miss distance 0.52 LD. See: 2020 VO1 – S2P , 2020 VO1 - JPL Discovery station: **Pan-STARRS 2, Haleakala** See also: **6 Nov 2020**.
2038, Feb 11	Apollo NEA **2002 NY40** (H = 19.3 mag, $D \approx$ 280 m, **PHA**) will

	pass Earth at a nominal miss distance of 2.84 LD. Minimum miss distance 2.83 LD. See: 2002 NY40 - SSA , 2002 NY40 - JPL See also: **18 Aug 2002**.
2038, Apr 21	Apollo NEA **2011 WL2** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.70 LD. Minimum miss distance 4.70 LD. See: 2011 WL2 - JPL , 2011 WL2 - SSA See also: **25 Oct 2077**. See also: https://en.wikipedia.org/wiki/2011_WL2
2038, May 23	Amor NEA **1943 Anteros** (**1973 EC**, *H* = 15.9 mag, *D* ≈ 2.48 km) will pass Earth at a nominal miss distance of 25.84 LD. Minimum miss distance 25.84 LD. See: 1973 EC - SSA , 1973 EC - JPL See also: **13 Mar 1973**, **6 Feb 2015**, **20 May 2050.** See also: https://en.wikipedia.org/wiki/1943_Anteros
2038, Aug 18	Apollo NEA **2016 CK137** (*H* = 27.6 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 8.66 LD. Minimum miss distance 0.80 LD. See: 2016 CK137 - SSA , 2016 CK137 - JPL
2039, Feb 28	Apollo NEA **369057 (2008 DK5**, *H* = 21.3 mag, *D* ≈ 180 m, **PHA**) will pass Earth at a nominal miss distance of 4.46 LD. Minimum miss distance 4.45 LD. See: 2008 DK5 - JPL , 2008 DK5 - SSA
2039, Apr 4	Apollo NEA **2019 OQ2** (*H* = 20.4 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.83 LD. Minimum miss distance 4.82 LD. See: 2019 OQ2 – SSA , 2019 OQ2 – JPL
2039, May 7	Apollo NEA **2009 TD17** (*H* = 27.9 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 4.46 LD. Minimum miss distance 0.05 LD. See: 2009 TD17 - SSA , 2009 TD17 - JPL See also: **23 Apr 1992**, **5 Oct 2009**.
2039**,** May 12	Aten NEA **2020 JQ1 (***H* = 26.0 mag, *D* ≈ 22 m) will pass Earth at a nominal miss distance of 1.58 LD. Minimum miss distance 0.53 LD. See: 2020 JQ1 – S2P , 2020 JQ1 – JPL See also: **11 May 1948**, **12 May 1967**.

2039, Nov 12	Aten NEA **2005 VN5** (H = 27.1 mag, $D \approx$ 13 m) will pass Earth at a nominal miss distance of 6.06 LD. Minimum miss distance 0.36 LD. See: 2005 VN5 - SSA , 2005 VN5 - JPL
2040, Feb 4	Apollo NEA **367789** (**2011 AG5**, H = 22.0 mag, $D \approx$ 140 m, **PHA**) will pass Earth at a nominal miss distance of 2.81 LD. Minimum miss distance 2.51 LD. See: 367789 2011 AG5 - SSA , 2011 AG5 - JPL Ref: - S.R. Chesley, S. Bhaskaran, P.W. Chodas, et al., October 2012, American Astronomical Society, DPS meeting #44, #305.09, "Impact hazard assessment for **2011 AG5**." See: http://adsabs.harvard.edu/abs/2012DPS....4430509C See also: http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2012-051 http://www.jpl.nasa.gov/news/news.cfm?release=2012-051 http://www.space.com/14683-big-asteroid-2011-ag5-threat-earth.html http://www.space.com/14782-asteroid-threat-earth-impact-2011ag5.html http://blogs.discovermagazine.com/badastronomy/files/2012/03/schweikart_letter_NASA_AG5.pdf http://www.space.com/14872-asteroid-2011-ag5-earth-impact.html http://www.space.com/16169-earth-safe-asteroid-2011ag5-flyby.html http://tv.ibtimes.com/asteroid-headed-for-earth-in-2040/3777.html http://neo.jpl.nasa.gov/news/news176.html http://www.ifa.hawaii.edu/info/press-releases/allclear2011AG5.shtml http://www.space.com/19045-asteroid-earth-impact-2040-debunked.html http://en.wikipedia.org/wiki/2011_AG5 **Workshop**: 29 May 2012. See also: **26 Feb 2011**, **3 Feb 2023**.
2040, Feb 7	Apollo NEA **2013 VA10** (H = 22.4 mag, $D \approx$ 120 m) will pass Earth at a nominal miss distance of 3.90 LD. Minimum miss distance 3.90 LD. See: 2013 VA10 – SSA , 2013 VA10 – JPL See also: **6 Feb 1944**, **8 Feb 2161**.
2041, Apr 8	Apollo NEA **2012 UE34** (H = 23.1 mag, $D \approx$ 90 m) will pass Earth at a nominal miss distance of 0.29 LD. Minimum miss distance 0.28 LD. **[2041-01]** See: 2012 UE34 - SSA , 2012 UE34 - JPL See also: **8 Apr 1991**. See also: https://en.wikipedia.org/wiki/2012_UE34
2041, Apr 24	Apollo NEA **2018 HW1** (H = 25.8 mag, $D \approx$ 25 m) will pass Earth at a nominal miss distance of 7.63 LD. Minimum miss distance

	0.58 LD. See: 2018 HW1 - JPL , 2018 HW1 - SSA See also: **19 Apr 1975**, **21 Apr 2018**.
2041, May 15	Apollo NEA **2016 GD135** (*H* = 20.9 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.69 LD. Minimum miss distance 4.65 LD. See: 2016 GD135 - JPL , 2016 GD135 - SSA
2041, Jul 24	Apollo NEA **2013 PG10** (*H* = 27.8 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 5.76 LD. Minimum miss distance 0.64 LD. See: 2013 PG10 - SSA , 2013 PG10 - JPL See also: **25 Jul 1990**.
2041, Oct 4	Apollo NEA **2008 QS11** (*H* = 19.7 mag, *D* ≈ 472 m, **PHA**) will pass Earth at a nominal miss distance of 3.64 LD. Minimum miss distance 3.64 LD. See: 2008 QS11 - SSA , 2008 QS11- JPL
2041, Nov 7	Apollo NEA **144898** (**2004 VD17**, *H* = 19.0 mag, *D* ≈ 320 m, **PHA**) will pass Earth at a nominal miss distance of 5.09 LD. Minimum miss distance 5.09 LD. See: 144898 2004 VD17 - SSA , 2004 VD17 - JPL Ref: - F. de Luise, D. Perna, E. Dotto, et al., 2007, *Icarus*, 191, 628, "Physical investigation of the potentially hazardous asteroid (**144898**) **2004 VD17**." See: http://adsabs.harvard.edu/abs/2007Icar..191..628D See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=167 http://www.thespacereview.com/article/581/2 http://en.wikipedia.org/wiki/(144898)_2004_VD17 See also: **7 May 2148**, **5 May 2196**.
2042, May 22	Asteroid **2017 KJ32** (*H* = 29.2 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 0.90 LD. Minimum miss distance 0.88 LD. **[2042-01]** See: 2017 KJ32 - JPL , 2017 KJ32 - SSA See also: **18 May 1994**.
2042, Jun 16	Aten NEA **513171** (**2004 MD6**, *H* = 20.2 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.78 LD. Minimum miss distance 3.78 LD. See: 2004 MD6 - JPL , 2004 MD6 - SSA
2042, Oct 3	Apollo NEA **2018 TP5** (*H* = 25.7 mag, *D* ≈ 25 m) will pass Earth

	at a nominal miss distance of 1.59 LD. Minimum miss distance 0.33 LD. See: 2018 TP5 -JPL , 2018 TP5 - SSA
2042, Oct 30	Apollo NEA **2018 GE2** (*H* = 27.0 mag, *D* ≈ 14 m) will pass Earth at a nominal miss distance of 0.36 LD. Minimum miss distance 0.28 LD. **[2042-02]** See: 2018 GE2 - SSA , 2018 GE2 - JPL See also: **2 Nov 1985**.
2043, Jul 23	Apollo NEA **2018 AB12** (*H* = 24.5 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 2.70 LD. Minimum miss distance 0.72 LD. See: 2018 AB12 - SSA , 2018 AB12 - JPL
2043, Aug 4	Apollo NEA **2020 NK1** (*H* = 19.0 mag, *D* ≈ 600 m, **PHA**) will pass Earth at a nominal miss distance of 8.81 LD. Minimum miss distance 8.21 LD. See: 2020 NK1 – S2P , 2020 NK1 - JPL See also: **4 Aug 1969**.
2043, Sep 21	Apollo NEA **2019 SX** (*H* = 29.6 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 1.47 LD. Minimum miss distance 0.04 LD. See: 2019 SX – SSA , 2019 SX – JPL
2044, Mar 18	Apollo NEA **2019 WL4** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 5.82 LD. Minimum miss distance 4.60 LD. See: 2019 WL4 – SSA , 2019 WL4 – JPL
2044, Jun 11	Aten NEA **2014 GQ17** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 1.25 LD. Minimum miss distance 0.06 LD. See: 2014 GQ17 - SSA , 2014 GQ17 - JPL
2044, Sep 17	Apollo NEA **2020 QL2** (*H* = 23.6 mag, *D* ≈ 70 m) will pass Earth at a nominal miss distance of 1.04 LD. Minimum miss distance 0.99 LD. See: 2020 QL2 – S2P , 2020 QL2 - JPL
2044, Sep 27	Aten NEA **2011 TO** (*H* = 26.8 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 1.20 LD. Minimum miss distance 0.67 LD. See: 2011 TO - SSA , 2011 TO - JPL See also: **28 Sep 1980, 28 Sep 2011.**

2045, Jan 25	Apollo NEA **2018 BN6** (*H* = 26.9 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 6.45 LD. Minimum miss distance 1.01 LD. See: 2018 BN6 - SSA , 2018 BN6 - JPL See also: **21 July 1969**, **24 Jan 2018**
2045, Apr 18	Aten NEA **2019 KJ4** (*H* = 27.3 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 3.67 LD. Minimum miss distance 0.57 LD. See: 2019 KJ4 - SSA , 2019 KJ4 - JPL.
2046, Jan 29	Apollo NEA **2020 OP3** (*H* = 20.8 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.89 LD. Minimum miss distance 4.56 LD. See: 2020 OP3 – S2P , 2020 OP3 - JPL See also: **29 Jan 1986**, **28 Jan 2027**.
2046, Feb 15	Aten NEA **367943 Duende** (**2012 DA14**, *H* = 24.2 mag, *D* ≈ 40 × 20 m) will pass Earth at a nominal miss distance of 5.80 LD. Minimum miss distance 5.77 LD. See: 367943 Duende - SSA , 2012 DA14 - JPL See also: http://en.wikipedia.org/wiki/2012_DA14 See also: **17 Feb 1918**, **19 Aug 2004, 16 Feb 2012, 15 Feb 2013**, **15 Feb 2087**.
2046, Apr 3	Apollo NEA **267221** (**2001 AD2**, *H* = 19.7 mag, *D* ≈ 562 m, **PHA**) will pass Earth at a nominal miss distance of 4.37 LD. Minimum miss distance 4.37 LD. See: 2001 AD2 - JPL , 2001 AD2 - SSA See also: **5 Apr 2133**, **6 Apr 2150**.
2046, Jun 13	Apollo NEA **2000 LF3** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 2.71 LD. Minimum miss distance 2.66 LD. See: 2000 LF3 - JPL , 2000 LF3 - SSA
2046, Jul 21	Amor NEA **2003 SM84** (*H* = 22.9 mag, *D* ≈ 90 m) will pass Earth at a nominal miss distance of 19.98 LD. Minimum miss distance 19.97 LD. This NEA is being considered by ESA as a candidate target for the ***Don Quijote*** mission to study the effects of impacting a spacecraft into an asteroid. Also possible target for NASA manned mission, with launch date 22 March 2046, and 180 day mission duration. See: 2003 SM84 - SSA , 2003 SM84 - JPL See also:

	http://ww.aviationweek.com/aw/generic/story_channel.jsp?channel=space&id=news/awst/2010/08/16/AW_08_16_2010_p30-247032.xml&headline=NASA%20Narrows%20Potential%20Asteroid%20List http://www.nasa.gov/pdf/474223main_Johnson_ExploreNOW.pdf http://en.wikipedia.org/wiki/2003_SM84
2046, Aug 1	Apollo NEA **2016 BQ15** (*H* = 25.3 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 2.40 LD. Minimum miss distance 0.80 LD. See: 2016 BQ15 - SSA , 2016 BQ15 - JPL
2046, Nov 25	Aten NEA **1994 WR12** (*H* = 22.7 mag, *D* ≈ 100 m) will pass Earth at a nominal miss distance of 4.23 LD. Minimum miss distance 4.22 LD. See: 1994 WR12 - SSA , 1994 WR12 - JPL See also: **25 Nov 1994**. See also: http://en.wikipedia.org/wiki/1994_WR12
2047, Jan 13	Apollo NEA **2010 WZ8** (*H* = 20.9 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.17 LD. Minimum miss distance 4.17 LD. See: 2010 WZ8 - JPL , 2010 WZ8 - SSA See also: **13 Jan 1903**.
2047, Feb 12	Apollo NEA **2012 HG2** (*H* = 27.2 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 0.37 LD. Minimum miss distance **0.00012 LD (= 0.0071 R_{Earth} from the geocenter)**. **[2047-01]** See: 2012 HG2 - SSA , 2012 HG2 - JPL See also: **10 Apr 1981**.
2047, Apr 29	Aten NEA **2017 HW4** (*H* = 22.0 mag, *D* ≈ 140 m) will pass Earth at a nominal miss distance of 4.51 LD. Minimum miss distance 4.49 LD. See: 2017 HW4 – SSA , 2017 HW4 – JPL
2047, Jul 19	Apollo NEA **2021 AZ6** (*H* = 26.3 mag, *D* ≈ 19 m) will pass Earth at a nominal miss distance of 0.93 LD. Minimum miss distance 0.74 LD. **[2047-02]** See: 2021 AZ6 – S2P , 2021 AZ6 – JPL
2047, Aug 14	Apollo NEA **2011 DS** (*H* = 26.8 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 9.25 LD. Minimum miss distance 0.81 LD. See: 2011 DS – SSA , 2011 DS – JPL

2047, Sep 4	Apollo NEA **2018 RR1** (H = 30.0 mag, $D \approx$ 4 m) will pass Earth at a nominal miss distance of 2.08 LD. Minimum miss distance 0.85 LD. See: 2018 RR1 - SSA , 2018 RR1 - JPL See also: **3 Sep 2018**.
2047, Sep 5	Apollo NEA **2016 RD34** (H = 27.6 mag, $D \approx$ 11 m) will pass Earth at a nominal miss distance of 0.27 LD. Minimum miss distance 0.26 LD. **[2047-03]** See: 2016 RD34 - SSA , 2016 RD34 - JPL
2047, Oct 21	Aten NEA **2020 UA** (H = 28.4 mag, $D \approx$ 7 m) will pass Earth at a nominal miss distance of 2.06 LD. Minimum miss distance 0.43 LD. See: 2020 UA – S2P , 2020 UA - JPL See also: **21 Oct 2020**.
2048, Feb 28	Apollo NEA **162162** (**1999 DB7**, H = 20.2 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 2.54 LD. Minimum miss distance 2.54 LD. See: 1999 DB7 - JPL , 1999 DB7 - SSA
2048, May 1	Apollo NEA **2015 HQ171** (H = 27.0 mag, $D \approx$ 14 m) will pass Earth at a nominal miss distance of 1.22 LD. Minimum miss distance 0.93 LD. See: 2015 HQ171- SSA , 2015 HQ171- JPL
2048**,** Jun 2	Apollo NEA **2007 VK184** (H = 22.2 mag, $D \approx$ 130 m) will pass Earth at a nominal miss distance of 5.06 LD. Minimum miss distance 5.00 LD. See: 2007 VK184 - SSA , 2007 VK184 - JPL Ref: - B. Corbin, 2010, presented at the *61st International Astronautical Congress*, Prague (Czech Republic), 27 September - 1 October 2010, "Implementing advanced technologies and models to reduce uncertainty in a global, cost-effective asteroid mitigation system." See: http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition See also: http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf http://neo.jpl.nasa.gov/news/news183.html http://neo.jpl.nasa.gov/risk/2007vk184.html http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-42.pdf http://en.wikipedia.org/wiki/2007_VK184 See also: **6 Nov 2007, 6 Jun 2118.**

2048, Oct 18	Apollo NEA **2007 UD6** (H = 28.2 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.09 LD. **[2048-01]** See: 2007 UD6 - SSA , 2007 UD6 - JPL See also: **18 Oct 2007**.
2048, Nov 11	Aten NEA **2018 XQ2** (H = 28.1 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 12.28 LD. Minimum miss distance 0.64 LD. See: 2018 XQ2 - JPL , 2018 XQ2 - SSA See also: **9 Nov 1980**, **11 Jan 1985**.
2049, Feb 20	Apollo NEA **2012 DY13** (H = 28.1 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 1.76 LD. Minimum miss distance 0.28 LD. See: 2012 DY13 - SSA , 2012 DY13 - JPL
2049, Oct 23	Apollo NEA **2007 UN12** (H = 28.7 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 8.82 LD. Minimum miss distance 0.18 LD. See: 2007 UN12 - SSA , 2007 UN12 - JPL
2049, Nov 12	Apollo NEA **2004 VM24** (H = 25.5 mag, $D \approx$ 28 m) will pass Earth at a nominal miss distance of 3.95 LD. Minimum miss distance 0.18 LD. See: 2004 VM24 - SSA , 2004 VM24 - JPL
2049, Dec 25	Apollo NEA **450293** (**2004 LV3**, H = 19.1 mag, $D \approx$ 500 m, **PHA**) will pass Earth at 4.52 LD. Minimum miss distance 4.52 LD. See: 2004 LV3 - JPL , 2004 LV3 - SSA See also: **24 Dec 1952**.
2050, Feb 18	Apollo NEA **2011 DS** (H = 26.8 mag, $D \approx$15 m) will pass Earth at a nominal miss distance of 6.82 LD. Minimum miss distance 0.54 LD. See: 2011 DS - SSA , 2011 DS - JPL See also: **14 Aug 1901**, **18 Feb 1966**.
2050, Feb 21, 13:04	Aten NEA **2021 DA2** (H = 29.1 mag, $D \approx$ 5 m) will pass Earth at a nominal miss distance of 0.30 LD. Minimum miss distance 0.29 LD. **[2050-01]** See: 2021 DA2 – S2P , 2021 DA2 – JPL See also: **22 Feb 1955**, **21 Feb 2021**.
2050, Feb 21	Apollo NEA **2020 QN4** (H = 28.6 mag, $D \approx$ 7 m) will pass Earth at a nominal miss distance of 4.94 LD. Minimum miss distance 0.46 LD.

	See: 2020 QN4 – S2P , 2020 QN4 - JPL See also: **16 Feb 2006**, **21 Aug 2020**.
2050, Feb 28	Aten NEA **2021 ER** (H = 27.0 mag, $D \approx$ 14 m) will pass Earth at a nominal miss distance of 5.53 LD. Minimum miss distance 0.15 LD. See: 2021 ER – S2P , 2021 ER - JPL
2050, Nov 5	Apollo NEA **2015 JJ** (H = 22.3 mag, $D \approx$ 130 m) will pass Earth at a nominal miss distance of 1.07 LD. Minimum miss distance 1.07 LD. See : 2015 JJ - SSA , 2015 JJ - JPL See also: **4 Nov 1989**, **6 Nov 2110**.
2051, Jan 5	Apollo NEA **2018 BM3** (H = 22.0 mag, $D \approx$ 140 m, **PHA**) will pass Earth at a nominal miss distance of 1.48 LD. Minimum miss distance 1.42 LD. See: 2018 BM3 - JPL , 2018 BM3 - SSA See also: **5 Jan 1979**.
2051, Mar 24	Apollo NEA **4581 Asclepius** (**1989 FC**, H = 20.9 mag, $D \approx$ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.78 LD. Minimum miss distance 4.78 LD. See: 4581 Asclepius - SSA , 1989 FC - JPL See also: **22 Mar 1989**, **16 Aug 2012.** See also: http://en.wikipedia.org/wiki/4581_Asclepius
2051, Aug 11	Apollo NEA **162422 (2000 EV70** (H = 20.7 mag, $D \approx$ 400 m, **PHA**) will pass Earth at a nominal miss distance of 4.79 LD. Minimum miss distance 4.78 LD. See: 2000 EV70 - JPL , 2000 EV70 - SSA See also: https://en.wikipedia.org/wiki/(162421)_2000_ET70
2051, Oct 14	Aten NEA **2000 SZ162** (H = 27.2 mag, $D \approx$ 13 m) will pass Earth at a nominal miss distance of 2.60 LD. Minimum miss distance 0.84 LD. See: 2000 SZ162 – SSA , 2000 SZ162 – JPL
2051, Oct 25	Apollo NEA **497117** (**2004 FU4**, H = 18.4 mag, $D \approx$ 700 m, **PHA**) will pass Earth at 3.17 LD. Minimum miss distance 3.16 LD. See: 2004 FU4 - JPL , 2004 FU4 - SSA
2052, Mar 19	Apollo NEA **221455** (**2006 BC10**, H = 19.4 mag, $D \approx$ 500 m, **PHA**) will pass Earth at 3.05 LD. Minimum miss distance 3.04 LD.

	See: 2006 BC10 - JPL , 2006 BC10 - SSA
2052, Mar 22	Apollo NEA **231937 (2001 FO32**, *H* = 17.6 mag, *D* ≈ 1100 m, **PHA**) will pass Earth at a nominal miss distance of 7.37 LD. Minimum miss distance 7.37 LD. See: 2001 FO32 – S2P , 2001 FO32 – JPL But, ***NEOWISE***: *D* ≈ 440 - 680 m. See: http://neo.ssa.esa.int/newsletters [March 2021] https://www.jpl.nasa.gov/news/asteroid-2001-fo32-will-safely-pass-by-earth-march-21 See also: **21 Mar 2021**, **23 Mar 2103**.
2052, May 13	Aten NEA **2018 JL1** (*H* = 26.8 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 4.36 LD. Minimum miss distance 0.82 LD. See: 2018 JL1 - SSA , 2018 JL1 - JPL
2052, May 16	Aten NEA **2021 JY3** (*H* = 28.4 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.03 LD. Minimum miss distance 0.66 LD. See: 2021 JZ5 – S2P , 2021 JZ5 - JPL See also: **20 May 1971**, **8 May 2059**.
2052, Oct 20	Aten NEA **2015 UH52** (*H* = 26.2 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 2.83 LD. Minimum miss distance 0.99 LD. See: 2015 UH52 - SSA , 2015 UH52 - JPL See also: **20 Oct 1988**, **19 Oct 2000**.
2052, Nov 13	Aten NEA **2018 WR** (*H* = 26.2 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 0.72 LD. Minimum miss distance 0.59 LD. **[2052-01]** See: 2018 WR - SSA , 2018 WR - JPL
2052, Nov 30	Apollo NEA **2020 KS** (*H* = 25.7 mag, *D* ≈ 26 m) will pass Earth at a nominal miss distance of 2.07 LD. Minimum miss distance 0.14 LD. See: 2020 KS – S2P , 2020 KS – JPL See also: **28 Nov 1984**.
2053, Feb 14	Aten NEA **2016 DB** (*H* = 28.7 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 5.60 LD. Minimum miss distance 0.49 LD. See: 2016 DB - SSA , 2016 DB - JPL
2053, Mar 23	Apollo NEA **2020 SK4** (*H* = 30.4 mag, *D* ≈ 3 m) will pass Earth at

	a nominal miss distance of 3.45 LD. Minimum miss distance 0.56 LD. See: 2020 SK4 – S2P , 2020 SK4 - JPL
2053, Apr 28	Apollo NEA **2018 JN** (*H* = 25.1 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 3.49 LD. Minimum miss distance 0.04 LD. See: 2018 JN – SSA , 2018 JN – JPL
2053, Jun 1	Apollo NEA **2015 XA378** (*H* = 25.9 mag, *D* ≈ 23 m) will pass Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.22 LD. **[2053-01]** See: 2015 XA378 - SSA , 2015 XA378 - JPL See also: **16 Dec 1968**.
2053, Sep 30	Apollo NEA **360191 (1988 TA**, *H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 2.22 LD. Minimum miss distance 2.22 LD. See: 1988 TA - JPL , 1988 TA - SSA See also: **29 Sep 1988, 3 Oct 2189**.
2054, Feb 5	Aten NEA **2016 CG18** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 4.80 LD. Minimum miss distance 0.08 LD. See: 2016 CG18- SSA , 2016 CG18- JPL See also: **6 Feb 2016, 3 Feb 2055**.
2054, Feb 13	Apollo NEA **2021 CA6** (*H* = 28.6 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 3.48 LD. Minimum miss distance 0.15 LD. See: 2021 CA6 – S2P , 2021 CA6 – JPL See also: **14 Feb 1936, 13 Feb 2021**.
2054, May 8	Aten NEA **2007 JB21** (*H* = 25.8 mag, *D* ≈ 25 m) will pass Earth at a nominal miss distance of 6.18 LD. Minimum miss distance 0.37 LD. See: 2007 JB21 – SSA , 2007 JB21 – JPL
2054, Jul 12	Amor NEA **2020 UQ4** (*H* = 20.2 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.48 LD. Minimum miss distance 2.65 LD. See: 2020 UQ4 – S2P , 2020 UQ4 - JPL
2054, Jul 13	Apollo NEA **2013 LM31** (*H* = 20.6 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 2.73 LD. Minimum miss distance 1.60 LD. See: 2013 LM31 - JPL , 2013 LM31 - SSA

2054, Dec 10	Apollo NEA **2021 JE1** (H = 26.7 mag, $D \approx$ 16 m) will pass Earth at a nominal miss distance of 0.28 LD. Minimum miss distance 0.21 LD. . **[2054-01]** See: 2021 JE1 – S2P , 2021 JE1 - JPL
2055, Jan 1	Aten NEA **2009 YR** (H = 28.2 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 5.76 LD. Minimum miss distance 0.30 LD. See: 2009 YR - SSA , 2009 YR - JPL
2055, Jan 9	Asteroid **2019 AS5** (H = 32.3 mag, $D \approx$ 1.2 m) will pass Earth at a nominal miss distance of 5.66 LD. Minimum miss distance 0.92 LD. See: 2019 AS5 - SSA , 2019 AS5 - JPL See also: **8 Jan 2019**.
2055, Jan 15	Apollo NEA **2020 AN3** (H = 20.4 mag, $D \approx$ 290 m, **PHA**) will pass Earth at a nominal miss distance of 3.23 LD. Minimum miss distance 3.15 LD. See: 2020 AN3 – S2P , 2020 AN3 – JPL See also: **17 Jan 2020**
2055, May 13	Aten NEA **2011 AX22** (H = 24.9 mag, $D \approx$ 40 m) will pass Earth at a nominal miss distance of 1.20 LD. Minimum miss distance 0.86 LD. See: 2011 AX22 - SSA , 2011 AX22 - JPL See also: **13 May 1930.**
2055, May 24	Apollo NEA **2015 YJ** (H = 28.2 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 4.61 LD. Minimum miss distance 0.27 LD. See: 2015 YJ - SSA , 2015 YJ - JPL See also: **13 Dec 2015**.
2055, Jun 29	Apollo NEA **2018 NL** (H = 25.5 mag, $D \approx$ 29 m) will pass Earth at a nominal miss distance of 0.55 LD. Minimum miss distance 0.13 LD. **[2055-01]** See: 2018 NL - SSA , 2018 NL - JPL
2056, Feb 5	Aten NEA **2016 CE** (H = 28.7 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 2.70 LD. Minimum miss distance 0.15 LD. See: 2016 CE - SSA , 2016 CE - JPL See also: **5 Feb 1971**.
2056, Apr 26	Apollo NEA **2019 TK5** (H = 27.3 mag, $D \approx$ 12 m) will pass Earth

	at a nominal miss distance of 0.73 LD. Minimum miss distance 0.39 LD. **[2056-01]** See: 2019 TK5 – SSA , 2019 TK5 - JPL
2056, Jul 21	Apollo NEA **2016 BA15** (*H* = 27.0 mag, *D* ≈ 14 m) will pass Earth at a nominal miss distance of 13.9 LD. Minimum miss distance 0.06 LD **(= 3.3 R_{Earth} from the geocenter).** See: 2016 BA15 - JPL , 2016 BA15 - SSA See also: **19 Jul 1945**.
2056, Sep 4	Aten NEA **2018 RW** (*H* = 30.5 mag, *D* ≈ 2.8 m) will pass Earth at a nominal miss distance of 9.37 LD. Minimum miss distance 0.66 LD. See: 2018 RW – SSA , 2018 RW – JPL
2057, Apr 29	Apollo NEA **2014 UU56** (*H* = 28.5 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 8.32 LD. Minimum miss distance 0.57 LD. See: 2014 UU56 – SSA , 2014 UU56 – JPL
2057, Sep 2	Amor NEA **3122 Florence** (**1981 ET3** , *H* = 13.8 mag, *D* ≈ 4350 m, **PHA**) will pass Earth at a nominal miss distance of 19.442 LD. Minimum miss distance 19.442 LD. See: 3122 Florence - SSA , 1981 ET3 - JPL See also: **1 Sep 2017**. See also: https://en.wikipedia.org/wiki/3122_Florence
2057, Oct 12	Apollo NEA **162120 (1998 SH36**, *H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 4.49 LD. Minimum miss distance 4.49 LD. See: 1998 SH36 - JPL , 1998 SH36 - SSA
2058, Feb 11	Aten NEA **2009 BE58** (*H* = 21.8 mag, *D* ≈ 150 m, **PHA**) will pass Earth at a nominal miss distance of 4.84 LD. Minimum miss distance 4.83 LD. See: 2009 BE58 - JPL , 2009 BE58 - SSA See also: **10 Feb 1950**, **13 Feb 2194**.
2058, Apr 21	Apollo NEA **2019 HE** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 7.38 LD. Minimum miss distance 0.61 LD. See: 2019 HE - SSA , 2019 HE - JPL See also: **20 Apr 2019**.
2058, May 8	Apollo NEA **2018 VO6** (*H* = 24.3 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 8.61 LD. Minimum miss distance

	0.11 LD See: 2007 VO6 - SSA , 2007 VO6 - JPL See also: **7 May 1977**, **8 May 2063**.
2058, Jun 5	Apollo NEA **4953** (**1990 MU**, *H* = 15.2 mag, *D* ≈ 2800 m, **PHA**) will pass Earth at a nominal miss distance of 8.99 LD. Minimum miss distance 8.99 LD. See: 4953 1990 MU - SSA , 1990 MU - JPL See also: http://en.wikipedia.org/wiki/(4953)_1990_MU See also: **6 Jun 2027**
2058, Sep 22	Apollo NEA **523809** (**2007 TV18**, *H* = 23.8 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.92 LD. **[2058-01]** See: 2007 TV18 - SSA , 2007 TV18 - JPL
2058, Nov 7	Apollo NEA **525484** (**2005 GL** (*H* = 21.0 mag, *D* ≈ 220 m, **PHA**) will pass Earth at a nominal miss distance of 4.12 LD. Minimum miss distance 4.12 LD. See: 2005 GL - JPL , 2005 GL - SSA See also: **8 Nov 2125**.
2058, Nov 20	Apollo NEA **2015 WP2** (*H* = 30.1 mag, *D* ≈ 3 m) will pass Earth at a nominal miss distance of 3.07 LD. Minimum miss distance 0.11 LD. See: 2015 WP2 - SSA , 2015 WP2 - JPL
2059, Feb 24	Aten NEA **2020 DR4** (*H* = 29.7 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 4.87 LD. Minimum miss distance 0.28 LD. See: 2020 DR4 – S2P , 2020 DR4 - JPL See also: **25 Feb 2020**.
2059, May 8	Aten NEA **2021 JY3** (*H* = 28.4 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 4.86 LD. Minimum miss distance 0.61 LD. See: 2021 JZ5 – S2P , 2021 JZ5 - JPL See also: **20 May 1971**, **16 May 2052**.
2059, May 21	Apollo NEA **2012 WS3** (*H* = 26.1 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 2.22 LD. Minimum miss distance 0.34 LD. See: 2012 WS3 - SSA , 2012 WS3 - JPL
2059, Oct 2	Apollo NEA **2016 JA** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 1.43 LD. Minimum miss distance 0.85

	LD. See: 2016 JA - SSA , 2016 JA - JPL See also: **1 Oct 2060**.
2059, Nov 1	Aten NEA **2010 UJ7** (H = 25.6 mag, $D \approx$ 27 m) will pass Earth at a nominal miss distance of 3.93 LD. Minimum miss distance 0.65 LD. See: 2010 UJ7 - SSA , 2010 UJ7 - JPL
2059, Nov 23	Apollo NEA **529366** (**2009 WM1**, H = 20.4 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 1.82 LD. Minimum miss distance 1.82 LD. See: 2009 WM1 - SSA , 2009 WM1 - JPL See also: http://en.wikipedia.org/wiki/2009_WM1
2059, Dec 14	Aten NEA **2004 YC** (H = 25.9 mag, $D \approx$ 23 m) will pass Earth at a nominal miss distance of 4.95 LD. Minimum miss distance 0.88 LD. See: 2004 YC - SSA , 2004 YC - JPL
2059, Dec 28	Aten NEA **2010 XC15** (H = 21.6 mag, $D \approx$ 170 m, **PHA**) will pass Earth at a nominal miss distance of 4.94 LD. Minimum miss distance 4.84 LD. See: 2010 XC15 - JPL , 2010 XC15 - SSA See also: https://en.wikipedia.org/wiki/2010_XC15 See also: **26 Dec 1907**, **27 Dec 1914**, **27 Dec 1976**, **27 Dec 2022**, **26 Dec 2064**, **26 Dec 2096**.
2060, Jan 30	Aten NEA **2019 BE5** (H = 25.1 mag, $D \approx$ 30 m) will pass Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.99 LD. **[2060-01]** See: 2019 BE5 – SSA , 2019 BE5 – JPL See also: **29 Jan 2079**.
2060, Feb 14	Apollo NEA **4660 Nereus** (**1982 DB**, H = 18.5 mag, $D \approx$ 510 x 330 x 240 m, **PHA**) will pass Earth at 3.12 LD. Minimum miss distance 3.12 LD. See: 4660 Nereus - SSA , 1982 DB - JPL Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B See also: **29 Jan 1900**, **22 Jan 2002**, **11 Dec 2021**, **4 Feb 2071**, **23 Dec 2112**, **4 Feb 2166**.

	See also: http://en.wikipedia.org/wiki/4660_Nereus
2060, Mar 30	Apollo NEA **2014 TL** (*H* = 28.0 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 5.88 LD. Minimum miss distance 0.65 LD. See: 2014 TL - SSA , 2014 TL - JPL See also: **1 Oct 2014.**
2060, Apr 23	Apollo NEA **2017 KN34** (*H* = 19.8 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 2.71 LD. Minimum miss distance 2.64 LD. See: 2017 KN34 – SSA , 2017 KN34 - JPL
2060**,** May 15	Apollo NEA **2015 KG158 (***H* = 28.1 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 6.43 LD. Minimum miss distance 0.17 LD. See: 2015 KG158 - SSA , 2015 KG158 - JPL See also: **15 May 1943.**
2060, Sep 23	Apollo NEA **101955 Bennu, (1999 RQ36**, *H* = 20.2 mag, *D* = 492 m, **PHA**) will pass Earth at a nominal miss distance of 1.949 LD. Minimum miss distance 1.949 LD. Possible Earth impact in **2182**. See: 101955 Bennu - SSA , 1999 RQ36 - JPL Ref: - A. Milani, S.R. Chesley, M.E. Sansaturio, et al., 2009, *Icarus*, 203, 460, "Long term impact risk for (**101955**) **1999 RQ36**." See: http://adsabs.harvard.edu/abs/2009Icar..203..460M - H. Campins, A. Morbidelli, K. Tsiganis, et al., 2010, *Astrophysical Journal Letters*, 721, L53, "The origin of asteroid **101955 (1999 RQ36)**." See: http://adsabs.harvard.edu/abs/2010ApJ...721L..53C - D.S. Lauretta, M.J. Drake, R.P.Binzel, et al., 2010, presented in: *73rd Annual Meeting of the Meteoritical Society*, 26-30 July 2010, New York (NY, USA), *Meteoritics and Planetary Science Supplement*, id.5153, "Asteroid (**101955**) **1999 RQ36**: optimum target for an asteroid sample return mission." See: http://adsabs.harvard.edu/abs/2010M%26PSA..73.5153L - B. Corbin, 2010, presented at the *61st International Astronautical Congress*, Prague (Czech Republic), 27 September - 1 October 2010, "Implementing advanced technologies and models to reduce uncertainty in a global, cost-effective asteroid mitigation system." See: http://www.spacegeneration.org/index.php/eventstopics/news/227-sgac-announces-the-winner-of-the-2010-move-an-asteroid-competition http://www.spacegeneration.org/images/stories/Projects/NEO/Corbin_Asteroid_Paper.pdf - M. Delbò, P. Michel, 2011, *Astrophysical Journal (Letters)*, 728,

	L42, "Temperature history and dynamical evolution of (**101955**) **1999 RQ36**: a potential target for sample return from a primitive asteroid." See: http://adsabs.harvard.edu/abs/2011ApJ...728L..42D See also: http://neo.jpl.nasa.gov/risk/a101955.html http://www.space.com/scienceastronomy/dangerous-asteroid-impact-earth-2182-100727.html http://en.wikipedia.org/wiki/(101955)_1999_RQ36 See also: **22 Sep 1999, 25 Sep 2135**.
2060, Oct 1	Apollo NEA **2016 JA** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 5.18 LD. Minimum miss distance 0.18 LD. See: 2016 JA - SSA , 2016 JA - JPL See also: **2 Oct 2059**.
2060, Oct 30	Apollo NEA **2017 VJ** (*H* = 24.5 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 2.74 LD. Minimum miss distance 0.48 LD. See: 2017 VJ - SSA , 2017 VJ - JPL
2061, Jan 17	Apollo NEA **2012 YQ1** (*H* = 21.2 mag, *D* ≈ 200 m, **PHA**) will pass Earth at a nominal miss distance of 3.81 LD. Minimum miss distance 2.15 LD. See: 2012 YQ1 - JPL , 2012 YQ1 - SSA See also: https://en.wikipedia.org/wiki/2012_YQ1
2061, Feb 12	Apollo NEA **2017 CP32** (*H* = 23.8 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 3.26 Minimum miss distance 0.72 LD. See: 2017 CP32 - SSA , 2017 CP32 - JPL See also: **12 Feb 1974**.
2061, Feb 16	Aten NEA **2010 CK19** (*H* = 27.8 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 9.18. Minimum miss distance 0.38 LD. See: 2010 CK19 - SSA , 2010 CK19 - JPL
2061, Dec 14	Apollo NEA **2016 WJ1** (*H* = 21.4 mag, *D* ≈ 180 m, **PHA**) will pass Earth at a nominal miss distance of 1.59 Minimum miss distance 1.59 LD. See: 2016 WJ1 - SSA , 2016 WJ1 - JPL See also: **13 Dec 1920, 14 Dec 2097**.
2061, Dec 19	Apollo NEA **2019 YV1** (*H* = 25.2 mag, *D* ≈ 30 m) will pass Earth

	at a nominal miss distance of 0.83. Minimum miss distance 0.67 LD. **[2065-01]** See: 2019 YV1 – SSA , 2019 YV1 – JPL
2062, Mar 30	Apollo NEA **2014 GY44** (*H* = 25.7 mag, *D* ≈ 26 m) will pass Earth at a nominal miss distance of 4.19. Minimum miss distance 0.61 LD. See: 2014 GY44 - SSA , 2014 GY44 - JPL
2062, Mar 31	Aten NEA **2020 VA4** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 4.42. Minimum miss distance 0.88 LD. See: 2020 VA4 – S2P , 2020 VA4 – JPL
2062, Apr 23	Apollo NEA **2007 VG** (*H* = 21.4 mag, *D* ≈ 190 m, **PHA**) will pass Earth at a nominal miss distance of 3.53 LD. Minimum miss distance 3.53 LD. See: 2007 VG - SSA , 2007 VG - JPL See also: **24 Apr 1903**.
2062, Oct 20	Apollo NEA **65803 Didymos** (**1996 GT**, *H* = 18.1 mag, *D* ≈ 780 + 160 m, **PHA**) will pass Earth at 19.32 LD (= 0.05 AU). Minimum miss distance 19.32 LD. Flyby target for ***AIDA*** mission. See: 65803 Didymos - SSA , 1996 GT - JPL See also: https://en.wikipedia.org/wiki/65803_Didymos See also: **12 Nov 2003**, **29 May 2012**, **4 Oct 2022**, **4 Nov 2123**.
2063, Mar 11	Apollo NEA **2006 EC** (*H* = 26.5 mag, *D* ≈ 18 m) will pass Earth at a nominal miss distance of 8.66. Minimum miss distance 0.75 LD. See: 2006 EC - SSA , 2006 EC - JPL See also: **8 Mar 2006**.
2063, Mar 26	Apollo NEA **2018 EM4** (*H* = 25.3 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 7.73 LD. Minimum miss distance 0.69 LD. See: 2018 EM4 - JPL , 2018 EM4 - SSA See also: **27 Mar 1943**.
2063, May 8	Apollo NEA **2018 VO6** (*H* = 24.3 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 4.16 LD. **Minimum miss distance 0.091 LD (= 5.46 R_{Earth} from the geocenter)**. See: 2007 VO6 - SSA , 2007 VO6 - JPL See also: **7 May 1977**.
2063, Jul 27	Apollo NEA **2015 CV13** (*H* = 20.6 mag, *D* ≈ 270 m, **PHA**) will pass Earth at a nominal miss distance of 3.93 LD. Minimum miss

	distance 3.93 LD. See: 2015 CV13 - SSA , 2015 CV13 - JPL
2063, Nov 21	Apollo NEA **2009 WJ6** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 4.10 LD. Minimum miss distance 0.26 LD. See: 2009 WJ6 - SSA , 2009 WJ6 - JPL
2064, Mar 2	Aten NEA **2018 DU1** (*H* = 27.6 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 2.70. Minimum miss distance 0.18 LD. See: 2018 DU1 - SSA , 2018 DU1 - JPL
2064, Mar 31	Aten NEA **2021 FW2** (*H* = 25.4 mag, *D* ≈ 30 m) passed Earth at a nominal miss distance of 2.86 LD. Minimum miss distance 0.48 LD. See: 2021 FW2 – S2P , 2021 FW2 – JPL See also: **31 Mar 2006**.
2064, Jul 27	Apollo NEA **2021 BN**, *H* = 28.3 mag, *D* ≈ 8 m will pass Earth at a nominal miss distance of 4.00 LD. Minimum miss distance 0.56 LD. See: 2021 BN – S2P , 2021 BN – JPL See also: **21 Jul 1977**.
2064, Aug 2	Apollo NEA **2019 BV2** (*H* = 25.6 mag, *D* ≈ 27 m) will pass Earth at a nominal miss distance of 2.95 LD. Minimum miss distance 0.39 LD. See: 2019 BV2 - JPL , 2019 BV2 - SSA See also: **26 Jan 2016**, **2 Aug 2064**.
2064, Oct 12	Aten NEA **2015 TG24** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 1.17. Minimum miss distance 0.69 LD. See: 2015 TG24 - SSA , 2015 TG24 - JPL
2064, Oct 19	Apollo NEA **2019 UE4** (*H* = 27.9 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 6.83. Minimum miss distance 0.19 LD. See: 2019 UE4 – SSA , 2019 UE4 – JPL See also: **21 Oct 2008**.
2064, Dec 20	Aten NEA **2017 YO3** (*H* = 28.2 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 2.45 LD. Minimum miss distance 0.0096 LD (**= 0.58 R_{earth} from the geocenter**). See: 2017 YO3 - JPL , 2017 YO3 - SSA

	See also: **19 Dec 1973**.
2064, Dec 26	Aten NEA **2010 XC15** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 3.42 LD. Minimum miss distance 3.19 LD. See: 2010 XC15 - SSA , 2010 XC15 - JPL See also: https://en.wikipedia.org/wiki/2010_XC15 See also: **26 Dec 1907**, **27 Dec 1914**, **27 Dec 1976**, **27 Dec 2022**, **28 Dec 2059**, **26 Dec 2096**.
2065, Mar 4	Apollo NEA **2014 EG45** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 4.66 LD. Minimum miss distance 4.63 LD. See: 2014 EG45 - SSA , 2014 EG45 - JPL See also: **4 Mar 2014**, **6 Mar 2128**.
2065, May 28	Apollo NEA **2005 WY55** (*H* = 20.6 mag, *D* ≈ 270 m, **PHA**) will pass Earth at a nominal miss distance of 0.87 LD. Minimum miss distance 0.86 LD. **[2065-01]** See: 2005 WY55 - SSA , 2005 WY55 - JPL See also: http://en.wikipedia.org/wiki/2005_WY55
2065, Jun 8	Aten NEA **2014 HQ124** (*H* = 19.0 mag, *D* ≈ 410 m, **PHA**) will pass Earth at a nominal miss distance of 7.61 LD. Minimum miss distance 7.60 LD. See: 2014 HQ124 - SSA , 2014 HQ124 - JPL See also: http://www.jpl.nasa.gov/news/news.php?release=2014-178 http://www.jpl.nasa.gov/news/news.php?release=2014-186 http://www.jpl.nasa.gov/video/index.php?id=1310 https://en.wikipedia.org/wiki/2014_HQ124 See also: **7 Jun 1901**, **7 Jun 1952, 8 Jun 2014**.
2065, Oct 15	Apollo NEA **2018 GD2** (*H* = 29.5 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 4.56 LD. Minimum miss distance 0.57 LD. See: 2018 GD2 - SSA , 2018 GD2 - JPL See also: **13 Apr 2005**, **12 Apr 2018**.
2065, Oct 17	Aten NEA **2013 UG1** (*H* = 22.5 mag, *D* ≈ 110 m), will pass Earth at a nominal miss distance of 2.83 LD. Minimum miss distance 2.83 LD. See: 2013 UG1 - SSA , 2013 UG1 - JPL

	See also: http://rt.com/news/asteroid-potentially-hazardous-earth-695/ See also: **17 Oct 1976**.
2066, Feb 6	Apollo NEA **2008 CE22** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 0.75 LD. Minimum miss distance 0.52 LD. **[2065-01]** See: 2008 CE22 - SSA , 2008 CE22 - JPL See also: **6 Feb 2008**.
2066, Mar 1	Aten NEA **2019 ED1** (*H* = 27.7 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 2.11 LD. Minimum miss distance 0.05 LD. See: 2019 ED1 - SSA , 2019 ED1 - JPL See also: **1 Mar 2019**.
2066, Apr 16	Apollo NEA **2004 RQ252** (*H* = 22.5 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 1.65 LD. Minimum miss distance 0.53 LD. See: 2004 RQ252 - SSA , 2004 RQ252 - JPL
2066, Sep 23	Apollo NEA **523654** (**2011 SR5**, *H* = 20.8 mag, *D* ≈ 250 m, **PHA**) will pass Earth at a nominal miss distance of 1.24 LD. Minimum miss distance 1.23 LD. See: 2011 SR5 - SSA , 2011 SR5 - JPL See also: **22 Sep 1988**.
2066, Sep 26	Apollo NEA **2017 SS12** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 6.06 LD. Minimum miss distance 0.06 LD. See: 2017 SS12 - SSA , 2017 SS12 - JPL See also: **24 Sep 2017**.
2066, Oct 18	Apollo NEA **2014 UX34** (*H* = 22.3 mag, *D* ≈ 120 m) will pass Earth at a nominal miss distance of 7.23 LD. Minimum miss distance 0.58 LD. See: 2014 UX34 – SSA , 2014 UX34 – JPL
2066, Nov 15	Apollo NEA **2017 RU2** (*H* = 25.8 mag, *D* ≈ 24 m) will pass Earth at a nominal miss distance of 5.68 LD. Minimum miss distance 0.88 LD. See: 2017 RU2 - SSA , 2017 RU2 - JPL
2066, Dec 15	Aten NEA **487577** (**2014 YQ15**, *H* = 20.9 mag, *D* ≈ 240 m, **PHA**) will pass Earth at a nominal miss distance of 4.92 LD. Minimum miss distance 4.90 LD. See: 2014 YQ15 - SSA , 2014 YQ15 - JPL

	See also: **15 Dec 1959**, **16 Dec 2122**.
2067, Mar 3	Apollo NEA **2009 DD45** (H = 25.9 mag, $D \approx$ 19 m) will pass Earth at a nominal miss distance of 1.46 LD. Minimum miss distance 0.28 LD. See: 2009 DD45 - SSA , 2009 DD45 - JPL See also: http://en.wikipedia.org/wiki/2009_DD45 See also: **2 Mar 2009**.
2067, Mar 6	Apollo NEA **410627** (**2008 RG1**, H = 21.0 mag, $D \approx$ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.70 LD. Minimum miss distance 4.70 LD. See: 2008 RG1 - SSA , 2008 RG1 - JPL
2067, Sep 10	Apollo NEA **387668** (**2002 SZ**, H = 20.4 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.77 LD. Minimum miss distance 3.77 LD. See: 2002 SZ - SSA , 2002 SZ - JPL See also: **10 Sep 2150**.
2067, Sep 24	Apollo NEA **2016 SA2** (H = 27.8 mag, $D \approx$ 10 m) will pass Earth at a nominal miss distance of 3.00 LD. Minimum miss distance 0.25 LD. See: 2016 SA2 - SSA , 2016 SA2 - JPL See also: **25 Sep 2016**.
2067, Nov 26	Apollo NEA **2013 NJ** (H = 22.1 mag, $D \approx$ 130 m) will pass Earth at a nominal miss distance of 2.80 LD. Minimum miss distance 2.80 LD. See: 2013 NJ - SSA , 2013 NJ - JPL See also: **24 Nov 1956**, **24 Nov 1997**, **26 Nov 2013.**
2068, Jan 19	Aten NEA **2018 BX** (H = 28.8 mag, $D \approx$ 6 m) will pass Earth at a nominal miss distance of 1.10 LD. Minimum miss distance 0.996 LD. See: 2018 BX - SSA , 2018 BX - JPL See also: **19 Jan 2018**.
2068, Jan 24	Apollo NEA **2019 EH** (H = 24.7 mag, $D \approx$ 40 m) will pass Earth at a nominal miss distance of 6.55 LD. Minimum miss distance 0.83 LD. See: 2019 EH – SSA , 2019 EH – JPL
2068, Feb 9	Apollo NEA **2016 TA11** (H = 27.4 mag, $D \approx$ 12 m) will pass Earth at a nominal miss distance of 4.62 LD. Minimum miss distance

	0.92 LD. See: 2016 TA11 - SSA , 2016 TA11 - JPL
2068, Mar 12	Apollo NEA **2016 CY135** (*H* = 24.5 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 3.88 LD. Minimum miss distance 0.43 LD. See: 2016 CY135 - SSA , 2016 CY135 - JPL See also: **9 Mar 1914**.
2068, Oct 19	Aten NEA **2020 UO4** (*H* = 28.7 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 4.32 LD. Minimum miss distance 0.72 LD. See: 2020 UO4 – S2P , 2020 UO4 – JPL See also: **23 Oct 1957**.
2069, Jan 9	Aten NEA **2017 AG13** (*H* = 26.0 mag, *D* ≈ 22 m) will pass Earth at a nominal miss distance of 5.82 LD. Minimum miss distance 0.41 LD. See: 2017 AG13 - SSA , 2017 AG13 - JPL See also: http://www.astronomy.com/news/2017/01/aten-asteroid-close-to-earth https://en.wikipedia.org/wiki/2017_AG13 See also: **9 Jan 2017**.
2069, Feb 28	Aten NEA **2019 EM1** (*H* = 22.2 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 2.77 LD. Minimum miss distance 2.01 LD. See: 2019 EM1 - JPL , 2019 EM1 - SSA See also: **2 Mar 2114**.
2069, Oct 21	Aten NEA **2340 Hathor** (**1976 UA**, *H* = 20.5 mag, *D* ≈ 210 m, **PHA**) will pass Earth at a nominal miss distance of 2.55 LD. Minimum miss distance 2.55 LD. See: 1976 UA - SSA , 1976 UA - JPL See also: https://en.wikipedia.org/wiki/2340_Hathor See also: **20 Oct 1921**, **20 Oct 1976**, **21 Oct 2086**.
2069, Nov 5	Apollo NEA **4179 Toutatis** (**1989 AC**, *H* = 15.2 mag, *D* = 4.6×2.4×1.9 km, orbital *P* = 4.03 yr, **PHA**) will pass Earth at a nominal miss distance of 7.72 LD. Minimum miss distance 7.72 LD. See: 4179 Toutatis - SSA , 1989 AC - JPL See also: http://en.wikipedia.org/wiki/4179_Toutatis See also: **8 Dec 1992**, **30 Nov 1996**, **31 Oct 2000**, **29 Sep 2004**, **9 Nov 2008**, **12 Dec 2012**.

2069, Dec 12	Apollo NEA **2013 YP139** (*H* = 21.2 mag, *D* ≈ 968 m, **PHA**) will pass Earth at a nominal miss distance of 3.08 LD. Minimum miss distance 3.07 LD. See: 2013 YP139 - SSA , 2013 YP139 - JPL See also: https://en.wikipedia.org/wiki/2013_YP139 See also: **3 Aug 2002**.
2070, Mar 15	Aten NEA **2020 FK1** (*H* = 27.3 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 2.27 LD. Minimum miss distance 0.70 LD. See: 2020 FK1 – S2P , 2020 FK1 - JPL See also: **15 Mar 2020.**
2070, May 27	Apollo NEA **2008 KT** (*H* = 28.0 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 6.97 LD. Minimum miss distance 0.90 LD. See: 2008 KT - JPL , 2008 KT - SSA
2070, Jun 6	Aten NEA **163348** (**2002 NN4**, *H* = 20.3 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.95 LD. Minimum miss distance 3.95 LD. See: 2002 NN4 - SSA , 2002 NN4- JPL See also: **5 Jun 1924**, **6 Jun 1965**, **7 Jun 2130**.
2070, Sep 12	Apollo NEA **2017 BL3** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 4.44 LD. Minimum miss distance 4.43 LD. See: 2017 BL3 - SSA , 2017 BL3 - JPL
2070, Sep 15	Aten NEA **2020 RF3** (*H* = 28.6 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 2.18 LD. Minimum miss distance 0.27 LD. See: 2020 RF3 – S2P , 2020 RF3 - JPL See also: **14 Sep 1961** , **14 Sep 2020**.
2070, Oct 5	Apollo NEA **2016 TH** (*H* = 29.4 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 1.48 LD. Minimum miss distance 0.52 LD. See: 2016 TH - SSA , 2016 TH - JPL See also: **3 Oct 2016**.
2071, Feb 4	Apollo NEA **4660 Nereus** (**1982 DB**, *H* = 18.5 mag, *D* ≈ 510 x 330 x 240 m, **PHA**) will pass Earth at 5.81 LD. Minimum miss distance 5.80 LD.

	See: 4660 Nereus - SSA , 1982 DB - JPL Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B See also: http://en.wikipedia.org/wiki/4660_Nereus See also: **29 Jan 1900**, **22 Jan 2002**, **11 Dec 2021**, **14 Feb 2060**, **23 Dec 2112**, **4 Feb 2166**.
2071, Apr 13	Apollo NEA **2018 GN** (H = 26.3 mag, $D \approx$ 20 m) will pass Earth at a nominal miss distance of 2.26 LD. Minimum miss distance 0.28 LD. See: 2018 GN - SSA , 2018 GN - JPL
2071, May 26	Binary Aten NEA **66391** (**1999 KW4**, H = 16.9 mag, $D \approx$ 1600 m, **PHA**) will pass Earth at 6.82 LD. Minimum miss distance 6.82 LD. See: 66391 1999 KW4 - SSA , 1999 KW4 - JPL See also: http://en.wikipedia.org/wiki/(66391)_1999_KW4 See also: **25 May 2001**, **25 May 2019**.
2071, Oct 30	Apollo NEA **154276** (**2002 SY50**, H = 17.6 mag, $D \approx$ 1060 m, **PHA**) will pass Earth at a nominal miss distance of 3.41 LD. Minimum miss distance 3.41 LD. See: 154276 2002 SY50 - SSA , 2002 SY50 - JPL
2071, Nov 22	Apollo NEA **2017 KB3** (H = 25.1 mag, $D \approx$ 30 m) will pass Earth at a nominal miss distance of 8.66 LD. Minimum miss distance 0.30 LD. See: 2017 KB3 - SSA , 2017 KB3 - JPL
2071, Dec 25	Aten NEA **2007 YS56** (H = 25.6 mag, $D \approx$ 27 m) will pass Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.51 LD. **[2065-01]** See: 2007 YS56 - SSA , 2007 YS56 - JPL
2072, Mar 25	Apollo NEA **2012 FS35**, H = 30.1 mag, $D \approx$ 3 m) will pass Earth at a nominal miss distance of 4.23 LD. Minimum miss distance 0.29 LD. See: 2012 FS35 - SSA , 2012 FS35 - JPL See also: **25 Mar 2012**.
2072, Apr 3	Apollo NEA **2007 SQ6** (H = 22.0 mag, $D \approx$ 140 m, **PHA**) will pass Earth at a nominal miss distance of 4.68 LD. Minimum miss

	distance 4.58 LD. See: 2007 SQ6 - SSA , 2007 SQ6 - JPL See also: **4 Apr 1929**.
2072, Jul 26	Apollo NEA **2017 MB1** (*H* = 18.6 mag, *D* ≈ 700 m, **PHA**) will pass Earth at a nominal miss distance of 1.22 LD. Minimum miss distance 1.21 LD. See: 2017 MB1 - SSA , 2017 MB1 - JPL
2072, Oct 17	Apollo NEA **453446** (**2011 SM68**, *H* = 19.4 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 1.88 LD. Minimum miss distance 1.87 LD. See: 2011 SM68 - SSA , 2011 SM68 - JPL
2072, Dec 18	Aten NEA **2017 YV8** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 9.97 LD. Minimum miss distance 0.0010 LD **(= 0.062** $\mathbf{R_{Earth}}$ **from the geocenter)**. See: 2017 YV8 - SSA , 2017 YV8 - JPL
2073, Apr 28	Apollo NEA **395207** (**2010 HQ80**, *H* = 19.9 mag, *D* ≈ 660 m, **PHA**) will pass Earth at a nominal miss distance of 3.23 LD. Minimum miss distance 3.23 LD. See: 2010 HQ80 - SSA , 2010 HQ80 - JPL
2073, Apr 29	Apollo NEA **164121** (**2003 YT1**, *H* = 16.4 mag, ***D* ≈ 1100 m**, **PHA**) will pass Earth at a nominal miss distance of 4.41 LD. Minimum miss distance 4.41 LD. See: 164121 2003 YT1 - SSA , 2003 YT1 - JPL See also: **1 May 2175**.
2073, Oct 8	Apollo NEA **2018 QT** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**) will pass Earth at a nominal miss distance of 4.05 LD. Minimum miss distance 4.05 LD. See: 2018 QT – SSA , 2018 QT – JPL See also: **10 Oct 2180**.
2073, Nov 16	Apollo NEA **2018 WG** (*H* = 29.4 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 8.39 LD. Minimum miss distance 0.34 LD. See: 2018 WG - SSA , 2018 WG - JPL See also: **16 Nov 2018**.
2074, Mar 24	Aten NEA **2010 FN** (*H* = 26.4 mag, *D* ≈ 18 m) will pass Earth at a nominal miss distance of 5.91 LD. Minimum miss distance 0.29 LD. See: 2010 FN - SSA , 2010 FN - JPL

	See also: **24 Oct 2001**.
2074, May 3	Apollo NEA **2006 JY26** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 2.59 LD. Minimum miss distance **0.0035 LD (= 0.23 R_{Earth} from the geocenter).** See: 2006 JY26 - SSA , 2006 JY26 - JPL Ref: - R. Brasser, P. Wiegert, 2008, *Monthly Notices of the Royal Astronomical Society*, 386, 2931, "Asteroids on Earth-like orbits and their origin." See: http://adsabs.harvard.edu/abs/2008MNRAS.386.2031B See also: http://fromthegonzo.wordpress.com/2006/05/12/asteroid-impact-effects/ https://en.wikipedia.org/wiki/2006_JY26 See also: **10 May 2006.**
2074, Jun 9	Apollo NEA **2019 LW4** (*H* = 26.8 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 9.00 LD. Minimum miss distance 0.17 LD. See: 2019 LW4 - SSA , 2019 LW4 - JPL See also: **7 Jun 1976**, **8 Jun 2019**.
2074, Jun 22	Aten NEA **2020 LV** (*H* = 25.3 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 4.61 LD. Minimum miss distance 0.73 LD. See: 2020 LV – S2P , 2020 LV - JPL
2074, Nov 2	Aten NEA **2020 VW** (*H* = 28.5 mag, *D* ≈ 7 m) passed Earth at a nominal miss distance of 1.07 LD. **Minimum miss distance 0.0019 LD (= 0.12 R_{Earth} from the geocenter)**. See: 2020 VW – S2P , 2020 VW - JPL See also: **2 Nov 2020**.
2075, Apr 3	Apollo NEA **2020 FN3** (*H* = 24.5 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 7.69 LD. Minimum miss distance 0.88 LD. See: 2020 FN3 – S2P , 2020 FN3 – JPL See also: **20 Oct 1977**.
2075, Apr 16	Apollo NEA **2021 HC2** (*H* = 28.8 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 7.33 LD. Minimum miss distance 0.45 LD. See: 2021 HC2 – S2P , 2021 HC2 – JPL
2075, Nov 2	Apollo NEA **2016 VP1** (*H* = 27.3 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 1.71 LD. Minimum miss distance 0.55 LD.

	See: 2016 VP1 - SSA , 2016 VP1 - JPL See also: **1 Nov 1929**.
2075, Nov 8	Apollo NEA **308635** (**2005 YU55**, *H* = 21.6 mag, *D* = 306 m, P_o = 1.22 yr, **PHA**) will pass Earth at a nominal miss distance of 0.58 LD. Minimum Earth miss distance 0.50 LD. **[2075-01]** See: 308635 2005 YU55 - SSA , 2005 YU55 - JPL See also: http://en.wikipedia.org/wiki/2005_YU55 See also: **18 Nov 2011**.
2076, Jan 13	Apollo NEA **2020 QR7** (*H* = 19.2 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 3.18 LD. Minimum miss distance 2.51 LD. See: 2020 QR7 – S2P , 2020 QR7 - JPL
2076, Feb 12	Apollo NEA **2021 CQ5** (*H* = 28.6 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 4.09 LD. Minimum miss distance 0.85 LD. See: 2021 CQ5 – S2P , 2021 CQ5 – JPL See also: **11 Feb 2021**.
2076, May 8	Aten NEA **2021 JQ2** (*H* = 30.0 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 3.47 LD. Minimum miss distance 0.92 LD. See: 2021 JQ2 – S2P , 2021 JQ2 - JPL See also: **8 May 2021**.
2076, May 15	Apollo NEA **2019 JH7** (*H* = 29.7 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 1.48 LD. Minimum miss distance 0.40 LD. See: 2019 JH7 - SSA , 2019 JH7 - JPL See also: **16 May 2019**.
2076, Aug 4	Apollo NEA **385343** (**2002 LV**, *H* = 16.8 mag, ***D* ≈ 1730 m**, **PHA**) will pass Earth at a nominal miss distance of 4.18 LD. Minimum miss distance 4.18 LD. See: 385343 2002 LV - SSA , 2002 LV - JPL
2076, Dec 6	Apollo NEA **162173 Ryugu** (**1999 JU3**, *H* = 19.5 mag, *D* ≈ 865 m, **PHA**) will pass Earth at a nominal miss distance of 4.06 LD. Minimum miss distance 4.06 LD. See: 1999 JU3 - SSA , 1999 JU3 - JPL See also: https://en.wikipedia.org/wiki/162173_Ryugu
2077, Jan 1	Aten NEA **2020 YA1** (*H* = 26.8 mag, *D* ≈ 16 m) will pass Earth at

	a nominal miss distance of 2.46 LD. Minimum miss distance 0.45 LD. See: 2020 YA1 – S2P , 2020 YA1 – JPL
2077, Mar 16	Apollo NEA **2015 PM** (*H* = 20.3 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.96 LD. Minimum miss distance 4.95 LD. See: 2015 PM - SSA , 2015 PM - JPL See also: **18 Mar 2198**.
2077, Oct 25	Apollo NEA **2011 WL2** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 2.21 LD. Minimum miss distance 2.19 LD. See: 2011 WL2 - SSA , 2011 WL2 - JPL See also: https://en.wikipedia.org/wiki/2011_WL2 See also: **21 Apr 2038**.
2078, May 14	Asteroid **2017 FE1** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 1.72 LD. Minimum miss distance 1.62 LD. See: 2017 FE1 - SSA , 2017 FE1 - JPL
2078, Aug 10	Apollo NEA **277475** (**2005 WK4**, *H* = 20.1 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.98 LD. Minimum miss distance 4.97 LD. See: 2005 WK4- SSA , 2005 WK4- JPL See also: **9 Aug 2013**.
2078, Oct 12	Apollo NEA **496817** (**1989 VB**, *H* = 20.1 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 6.75 LD. Minimum miss distance 6.75 LD. See: 1989 VB - SSA , 1989 VB - JPL See also: **13 Oct 1956**, **29 Sep 2017**.
2079, Jan 16	Aten NEA **2021 CZ2** (*H* = 22.5 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 3.05 LD. Minimum miss distance 0.96 LD. See: 2021 CZ2 – S2P , 2021 CZ2 - JPL
2079, Jan 29	Aten NEA **2019 BE5** (*H* = 25.1 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 0.64 LD. Minimum miss distance 0.59 LD. **[2079-01]** See: 2019 BE5 – SSA , 2019 BE5 – JPL See also: **30 Jan 2060**.

2079, Feb 23	Aten NEA **2020 DO3** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 4.08 LD. Minimum miss distance 0.91 LD. See: 2020 DO3 – S2P , 2020 DO3 - JPL
2079, Mar 10	Apollo NEA **2017 VR12** (*H* = 20.6 mag, *D* ≈ 260 m, **PHA**) will pass Earth at a nominal miss distance of 4.56 LD. Minimum miss distance 4.56 LD. See: 2017 VR12 - SSA , 2017 VR12 - JPL See also: **7 Mar 2018**. See also: https://en.wikipedia.org/wiki/2017_VR12
2079, Apr 16	Amor NEA **52768** (**1998 OR2**, *H* = 16.1 mag, ***D* ≈ 2100 m**, **PHA**) will pass Earth at a nominal miss distance of 4.61 LD. Minimum miss distance 4.61 LD. See: 52768 1998 OR2 - SSA, 1998 OR2 - JPL See also: **16 Apr 2127**. See also: https://en.wikipedia.org/wiki/(52768)_1998_OR2
2079, Apr 26	Apollo NEA **2020 HF5** (*H* = 26.8 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 9.95 LD. Minimum miss distance 0.80 LD. See: 2020 HF5 – S2P , 2020 HF5 - JPL See also: **26 Apr 1975**, **22 Apr 2020**.
2079, Sep 15	Apollo NEA **2020 RD4** (*H* = 29.8 mag, *D* ≈ 4 m) will pass Earth at a nominal miss distance of 0.49 LD. Minimum miss distance 0.27 LD. **[2079-02]** See: 2020 RD4 – S2P , 2020 RD4 - JPL See also: **15 Sep 2002, 14 Sep 2020**.
2080, Jun 9	Amor NEA **2015 DP155** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 9.50 LD. Minimum miss distance 9.50 LD. See: 2015 DP155 - SSA , 2015 DP155 - JPL See also: **11 Jun 2018**.
2080, Aug 31	Apollo NEA **163132** (**2002 CU11**, *H* = 18.7 mag, *D* ≈ 460 m, **PHA**) will pass Earth at a nominal miss distance of 1.65 LD. Minimum miss distance 1.65 LD. See: 2002 CU11 - SSA, 2002 CU11 - JPL See also: https://en.wikipedia.org/wiki/(163132)_2002_CU11 See also: **30 Aug 1925.**

2080, Nov 1	Apollo NEA **2020 HM7** (*H* = 26.0 mag, *D* ≈ 23 m) will pass Earth at a nominal miss distance of 6.03 LD. Minimum miss distance 0.82 LD. See: 2020 HM7 – S2P , 2020 HM7 – JPL
2081, Feb 14	Aten NEA **2020 CL1** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 5.60 LD. Minimum miss distance 5.13 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1940, 15 Feb 1991, 15 Feb 2036, 16 Feb 2118, 16 Feb 2155**
2081, Mar 17	Aten NEA **2020 FL** (*H* = 24.8 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 2.59 LD. Minimum miss distance 0.98 LD. See: 2020 FL – S2P , 2020 FL - JPL
2081, Mar 22	Aten NEA **2006 GB** (*H* = 20.2 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.83 LD. Minimum miss distance 3.83 LD. See: 2006 GB - SSA , 2006 GB - JPL See also: **22 Mar 1942**, **22 Mar 2037**.
2081, Sep 5	Aten NEA **2020 RY2** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 9.98 LD. Minimum miss distance 0.65 LD. See: 2020 RY2 – S2P , 2020 RY2 - JPL
2082, Feb 11	Apollo NEA **2013 PS13** (*H* = 27.2 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 4.35 LD. Minimum miss distance 0.20 See: 2013 PS13 - SSA , 2013 PS13 - JPL See: **9 Aug 2013**.
2082, Nov 16	Apollo NEA **2020 VH5** (*H* = 29.2 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 1.54 LD. Minimum miss distance 0.68 LD. See: 2020 VH5 – S2P , 2020 VH5 – JPL See also: **13 Nov 2020**.
2082, Dec 13	Apollo NEA **2010 MU112** (*H* = 20.9 mag, *D* ≈ 599 m, **PHA**) will pass Earth at a nominal miss distance of 2.69 LD. Minimum miss distance 2.68 LD. See: 2010 MU112 - SSA , 2010 MU112 - JPL See also: **13 Dec 1933**.

2083, May 3	Aten NEA **467460** (**2006 JF42**, *H* = 19.0 mag, *D* ≈ 600 m, **PHA**) will pass Earth at a nominal miss distance of 3.55 LD. Minimum miss distance 3.55 LD. See: 2006 JF42 - SSA , 2006 JF42 - JPL See also: **4 May 2159**.
2083, Jun 2	Amor NEA **423321** (**2005 ED318**, *H* = 20.7 mag, *D* ≈ 202 m, **PHA**) will pass Earth at a nominal miss distance of 3.44 LD. Minimum miss distance 3.44 LD. See: 2005 ED318 - SSA , 2005 ED318 - JPL See also: **14 Jun 2166**.
2084, Nov 22	Apollo NEA **2005 LW3** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 1.17 LD. Minimum miss distance 1.15 LD. See: 2005 LW3 - SSA , 2005 LW3 - JPL See also: **20 Nov 1928**, **23 Nov 2022**.
2085, May 1	Apollo NEA **2017 JB2** (*H* = 29.3 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 3.01 LD**.** Minimum miss distance 0.80 LD. See: 2017 JB2 - SSA , 2017 JB2 - JPL See also: **4 May 2017**.
2085**,** Sep 22	Apollo NEA **2016 CW193** (*H* = 21.8 mag, *D* ≈ 160 m, **PHA**), will pass Earth at a nominal miss distance of 4.48 LD. Minimum miss distance 4.48 LD. See: 2016 CW193– SSA , 2016 CW193 - JPL
2085**,** Sep 25	Apollo NEA **2018 BP** (*H* = 20.7 mag, *D* ≈ 260 m, **PHA**), will pass Earth at a nominal miss distance of 1.68 LD. Minimum miss distance 1.64 LD. See: 2018 BP – SSA , 2018 BP - JPL
2085**,** Nov 21	Aten NEA **2019 OR1** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**), will pass Earth at a nominal miss distance of 4.41 LD. Minimum miss distance 4.38 LD. See: 2019 OR1 - JPL , 2019 OR1 - SSA See also: **19 Nov 1902** , **21 Nov 2100**, **21 Nov 2178**.
2086, Feb 28	Aten NEA **2019 EM1** (*H* = 22.3 mag, *D* ≈ 120 m), will pass Earth at a nominal miss distance of 8.85 LD. Minimum miss distance 0.08 LD. See: 2019 EM1 – SSA , 2019 EM1 – JPL
2086, Jul 5	Aten NEA **2018 NX** (*H* = 27.9 mag, *D* ≈ 9 m) will pass Earth at a

	nominal miss distance of 0.70 LD. Minimum miss distance 0.69 LD. **[2086-01]** See: 2018 NX - SSA , 2018 NX - JPL See also: **7 July 1990**, **7 July 2018**.
2086, Oct 21	Aten NEA **2340 Hathor** (**1976 UA**, *H* = 20.5 mag, *D* ≈ 210 m, **PHA**) will pass Earth at a nominal miss distance of 2.15 LD. Minimum miss distance 2.15 LD. See: 2340 Hathor - SSA , 1976 UA - JPL See also: https://en.wikipedia.org/wiki/2340_Hathor See also: **20 Oct 1921**, **20 Oct 1976**, **21 Oct 2069**.
2086, Oct 22	Apollo NEA **171576** (**1999 VP11**, *H* = 18.7 mag, *D* ≈ 700 m, **PHA**) will pass Earth at a nominal miss distance of 3.03 LD. Minimum miss distance 3.03 LD. See: 1999 VP11 - JPL , 1999 VP11 - SSA See also: **21 Oct 1965**, **21 Oct 1982**.
2086, Oct 31	Apollo NEA **69230 Hermes** (**1937 UB**, *H* = 17.5 mag, *D* ≈ 1100 m, **PHA**) will pass Earth at a nominal miss distance of 9.48 LD. Minimum miss distance 9.48 LD. See: 69230 Hermes - SSA , 1937 UB - JPL See also: http://en.wikipedia.org/wiki/69230_Hermes See also: **29 Oct 1914**, **30 Oct 1937, 26 Apr 1942, 1 Nov 1954**, **30 Apr 2123.**
2087, Jan 5	Apollo NEA **2014 AD16** (*H* = 27.7 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 10.00 LD. Minimum miss distance 0.57 LD. See: 2014 AD16 - SSA , 2014 AD16 - JPL
2087**,** Feb 15	Aten NEA **367943 Duende** (**2012 DA14**, *H* = 24.2 mag, *D* ≈ 40 × 20 m) will pass Earth at a nominal miss distance of 4.51 LD. Minimum miss distance 3.78 LD. See: 367943 Duende - SSA , 2012 DA14 - JPL See also: http://en.wikipedia.org/wiki/2012_DA14 See also: **17 Feb 1918**, **19 Aug 2004, 16 Feb 2012, 15 Feb 2013, 15 Feb 2046**.
2087**,** Jul 23	Apollo NEA **2016 CE31** (*H* = 27.7 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 4.53 LD. Minimum miss distance 0.44 LD. See: 2016 CE31 - SSA , 2016 CE31 - JPL

2088, Feb 9	Apollo NEA **2018 CN2** (*H* = 27.6 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 5.45 LD. Minimum miss distance 0.90 LD. See: 2018 CN2 - SSA , 2018 CN2 - JPL See also: **8 Feb 1935**, **9 Feb 2018**.
2088, Mar 17	Apollo NEA **2019 FE** (*H* = 24.2 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 1.59 LD. Minimum miss distance 0.09 LD. See: 2019 FE – SSA , 2019 FE – JPL
2088, May 15	Apollo NEA **2012 HZ33** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 4.74 LD. Minimum miss distance 4.74 LD. See: 2012 HZ33 - SSA , 2012 HZ33 - JPL
2089, Jan 10	Apollo NEA **2016 AB166** (*H* = 24.6 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 7.36 LD. Minimum miss distance 0.36 LD. See: 2016 AB166 - SSA , 2016 AB166 - JPL
2089, Feb 7	Aten NEA **2020 DK** (*H* = 26.1 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 1.68 LD. Minimum miss distance 0.80 LD. See: 2020 DK – S2P , 2020 DK – JPL See also: **9 Feb 2032**.
2089, Mar 15	Apollo NEA **216985** (**2000 QK130**, *H* = 21.3 mag, *D* ≈ 200 m, **PHA**) will pass Earth at a nominal miss distance of 3.85 LD. Minimum miss distance 3.74 LD. See: 2000 QK130 - SSA , 2000 QK130 - JPL See also: **12 Mar 1916**, **14 Mar 1968**, **15 Mar 2036**.
2089, Oct 9	Apollo NEA **2015 TC25** (*H* = 29.3 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 5.84 LD. Minimum miss distance 0.62 LD. See: 2015 TC25 - SSA , 2015 TC25 - JPL
2090, Apr 11	Aten NEA **2015 XF261** (*H* = 25.3 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 0.99 LD. Minimum miss distance 0.92 LD. **[2090-01]** See: 2015 XF261 - SSA , 2015 XF261 - JPL
2090, Jun 14	Apollo NEA **1566 Icarus** (**1949 MA**, *H* = 16.3 mag, *D* ≈ 1300 m, **PHA**) will pass Earth at a nominal miss distance of ~17 LD. Minimal miss distance ~17 LD.

	See: 1566 Icarus - SSA , 1949 MA - JPL See also: http://www.jpl.nasa.gov/news/news.php?feature=4625 http://en.wikipedia.org/wiki/1566_Icarus See also: **14 Jun 1968, 16 Jun 2015**.
2090, Nov 5	Apollo NEA **2017 VE** (H = 26.6 mag, $D \approx$ 17 m) will pass Earth at a nominal miss distance of 7.59 LD. Minimum miss distance 0.74 LD. See: 2017 VE - SSA , 2017 VE - JPL See also: **4 Nov 2017**.
2091, Oct 14	Apollo/Aten (?) NEA **2020 TK7** (H = 29.6 mag, $D \approx$ 4 m) will pass Earth at a nominal miss distance of 9.97 LD. Minimum miss distance 0.70 LD. See: 2020 TK7 – S2P , 2020 TK7 - JPL See also: **14 Oct 2020**.
2091, Nov 2	Apollo NEA **2019 VA1** (H = 27.5 mag, $D \approx$ 11 m) will pass Earth at a nominal miss distance of 5.73 LD. Minimum miss distance 0.73 LD. See: 2019 VA1 – SSA , 2019 VA1 – JPL
2092, Apr 26	Aten NEA **2014 JU15** (H = 24.9 mag, $D \approx$ 40 m) will pass Earth at a nominal miss distance of 7.64 LD. Minimum miss distance 0.32 LD. See: 2014 JU15 - SSA, 2014 JU15 - JPL See also: **28 Apr 2110**.
2092, May 12	Apollo NEA **2021 JY5** (H = 27.4 mag, $D \approx$ 12 m) will pass Earth at a nominal miss distance of 3.92 LD. Minimum miss distance 0.08 LD. See: 2021 JY5 – S2P , 2021 JY5 – JPL
2092, Jun 8	Apollo NEA **2020 KR4** (H = 20.9 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 6.96 LD. Minimum miss distance 0.33 LD. See: 2020 KR4 – S2P , 2020 KR4 – JPL
2092, Oct 6	Apollo NEA **2015 TQ21** (H = 27.6 mag, $D \approx$ 11 m) will pass Earth at a nominal miss distance of 2.40 LD. Minimum miss distance 0.53 LD. See: 2015 TQ21 - SSA , 2015 TQ21 - JPL See also: **7 Oct. 2015**.
2092, Oct 26	Apollo NEA **2019 UB6** (H = 28.4 mag, $D \approx$ 8 m) will pass Earth at a nominal miss distance of 3.08 LD. Minimum miss distance 0.97

	LD. See: 2019 UB6 – SSA , 2019 UB6 – JPL
2092, Oct 27	Aten NEA **2004 TD10** (*H* = 22.2 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 3.05 LD. Minimum miss distance 3.05 LD. See: 2004 TD10 – SSA , 2004 TD10 – JPL
2093, Apr 1	Apollo NEA **2011 GG60** (*H* = 22.3 mag, *D* ≈ 140 m) will pass Earth at a nominal miss distance of 2.51 LD. Minimum miss distance 0.38 LD. See: 2011 GG60 - SSA , 2011 GG60 - JPL
2093, Apr 19	Apollo NEA **2014 SM143** (*H* = 20.4 mag, *D* ≈ 290 m, **PHA**) will pass Earth at a nominal miss distance of 3.87 LD. Minimum miss distance 3.87 LD. See: 2014 SM143 - SSA , 2014 SM143 - JPL See also: **20 Apr 1934**, **23 Oct 2197**.
2093, Sep 27	Apollo NEA **2018 TR** (*H* = 25.5 mag, *D* ≈ 28 m) will pass Earth at a nominal miss distance of 1.50 LD. Minimum miss distance 0.54 LD. See: 2018 TR - SSA , 2018 TR - JPL
2093, Oct 5	Apollo NEA **350751** (**2002 AW**, *H* = 21.1 mag, *D* ≈ 210 m, **PHA**) will pass Earth at a nominal miss distance of 4.21 LD. Minimum miss distance 4.13 LD. See: 2002 AW - SSA , 2002 AW - JPL
2093, Nov 30	Aten NEA **153201** (**2000 WO107**, *H* = 19.1 mag, *D* ≈ 510 m, **PHA**) will pass Earth at 3.23 LD. Minimum miss distance 3.23 LD. See: 2000 WO107 - JPL , 2000 WO107 - SSA See also: https://en.wikipedia.org/wiki/(153201)_2000_WO107 See also: **29 Nov 1953**, **1 Dec 2140**.
2093, Dec 14	Apollo NEA **3200 Phaethon** (**1983 TB**, *H* = 14.4 mag, *D* ≈ 5.1 ± 0.2 km, **PHA**) will pass Earth at a nominal miss distance of 7.71 LD. Minimum miss distance 7.71 LD. See: 3200 Phaethon - SSA , 1983 TB - JPL See also: http://en.wikipedia.org/wiki/3200_Phaethon See also: **16 Dec 2017**.
2094, Mar 13	Apollo NEA **2017 FD157** (*H* = 22.1 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 6.99 LD. Minimum miss

	distance 0.48 LD. See: 2017 FD157 - JPL , 2017 FD157 - SSA See also: **12 Mrt 1932**.
2094, May 24	Apollo NEA **2013 YD48** (*H* = 22.8 mag, *D* ≈ 100 m) will pass Earth at a nominal miss distance of 6.59 LD. Minimum miss distance 0.12 LD. See: 2013 YD48 - SSA , 2013 YD48 - JPL
2094, Nov 5	Apollo NEA **2015 JJ** (*H* = 22.3 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 4.00 LD. Minimum miss distance 1.96 LD. See: 2015 JJ - SSA , 2015 JJ - JPL See also: **4 Nov 1989**, **5 Nov 2050**, **6 Nov 2110**.
2095, Mar 24	Aten NEA **2016 FZ13** (*H* = 28.5 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 6.47 LD. Minimum miss distance 0.39 LD. See: 2016 FZ13 - SSA , 2016 FZ13 - JPL See also: **23 March 2016**.
2095, Apr 2	Apollo NEA **2006 GC1** (*H* = 20.9 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.11 LD. Minimum miss distance 1.94 LD. See: 2006 GC1 - JPL , 2006 GC1 - SSA
2095, Apr 9	Apollo NEA **297300** (**1998 SC15**, *H* = 19.3 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 3.30 LD. Minimum miss distance 3.30 LD. See: 1998 SC15 - JPL , 1998 SC15 - SSA
2095, May 13	Apollo NEA **2019 JJ3** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 5.86 LD. Minimum miss distance 0.30 LD. See: 2019 JJ3 – SSA , 2019 JJ3 – JPL See also: **7 May 1970**.
2095, Sep 6	Apollo NEA **2010 RF12** (*H* = 28.1 mag, *D* ≈ 9 m) will pass Earth at a **nominal miss distance of 0.102 LD (= 6.14 R_{Earth} from the geocenter). Minimum miss distance 0.0037 LD (= 0.22 R_{Earth} from the geocenter).** **[2095-01]** See: 2010 RF12 - SSA , 2010 RF12 - JPL See also: http://en.wikipedia.org/wiki/2010_RF12 See also: **10 Sep 1915**, **8 Sep 2010**.
2095, Oct 27	Apollo NEA **35396** (**1997 XF11**, *H* = 17.3mag, *D* = 1200 m,

	PHA) will pass Earth at a nominal miss distance of 5.09 LD. Minimum miss distance 5.05 LD. See: 35396 1997 XF11 - SSA , 1997 XF11 - JPL See also: http://impact.arc.nasa.gov/news_detail.cfm?ID=60 http://www.minorplanetcenter.net/iau/pressinfo/1997XF11Globe.html http://en.wikipedia.org/wiki/(35396)_1997_XF11 See also: **11 Mar 1998, 26 Oct 2028**.
2095, Dec 9	Apollo NEA **2015 XX128** (*H* = 26.1 mag, *D* ≈ 22 m) will pass Earth at a nominal miss distance of 0.92 LD. Minimum miss distance 0.49 LD. **[2095-02]** See: 2015 XX128- SSA , 2015 XX128 - JPL
2095, Dec 11	Apollo NEA **2013 XY8** (*H* = 25.0 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 0.89 LD. Minimum miss distance 0.84 LD. **[2095-03]** See: 2013 XY8 - SSA , 2013 XY8 - JPL See also: https://en.wikipedia.org/wiki/2013_XY8
2096, Feb 29	Apollo NEA **269690** (**1996 RG3**, *H* = 18.5 mag, *D* ≈ 879 m, **PHA**) will pass Earth at a nominal miss distance of 2.43 LD. Minimum miss distance 2.43 LD. See: 1996 RG3 - JPL , 1996 RG3 - SSA
2096, Apr 11	Apollo NEA **2018 TJ6** (*H* = 23.5 mag, *D* ≈ 70 m) will pass Earth at a nominal miss distance of 9.37 LD. Minimum miss distance 0.58 LD. See: 2018 TJ6 - SSA , 2018 TJ6 - JPL
2096, May 7	Apollo NEA **438908** (**2009 XO**, *H* = 20.1 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.02 LD. Minimum miss distance 4.02 LD. See: 2009 XO - JPL , 2009 XO - SSA Se also: **7 May 2020**.
2096, Oct 12	Apollo NEA **475016** (**2005 UO**, *H* = 21.9 mag, *D* ≈ 164 m) will pass Earth at a nominal miss distance of 1.26 LD. Minimum miss distance 1.26 LD. See: 2005 UO - SSA , 2005 UO - JPL
2096, Dec 26	Aten NEA **2010 XC15** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 1.89 LD. Minimum miss distance 1.67 LD. See: 2010 XC15 - JPL , 2010 XC15 - SSA See also:

	https://en.wikipedia.org/wiki/2010_XC15 See also: **26 Dec 1907**, **27 Dec 1914**, **27 Dec 1976**, **27 Dec 2022**, **28 Dec 2059**, **26 Dec 2064**.
2097, Dec 14	Apollo NEA **2016 WJ1** (*H* = 21.4 mag, *D* ≈ 180 m, **PHA**) will pass Earth at a nominal miss distance of 1.23 LD. Minimum miss distance 0.21 LD. See: 2016 WJ1 - SSA , 2016 WJ1 - JPL See also: **14 Dec 1920**, **14 Dec 2061**.
2097, Dec 23	Apollo NEA **2020 YN2** (*H* = 28.4 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 1.82 LD. Minimum miss distance 0.90 LD. See: 2020 YN2 – S2P , 2020 YN2 – JPL See also: **22 Dec 2020**.
2098, Jan 12	Apollo NEA **2021 AX1** (*H* = 27.6 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.36 LD. **[2098-01]** See: 2021 AX1 – S2P , 2021 AX1 – JPL
2098, Mar 23	Apollo NEA **2021 FT1** (*H* = 24.4 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 0.23 LD. Minimum miss distance 0.15 LD. **[2098-02]** See: 2021 FT1 – S2P , 2021 FT1 - JPL
2098, Nov 25	Apollo NEA **2017 WA14** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 9.55 LD. Minimum miss distance 0.98 LD. See: 2017 WA14 - SSA , 2017 WA14 - JPL See also: **21 Nov 2017**.
2099, Jan 28	Apollo NEA **2020 BK13** (*H* = 28.5 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 1.05 LD. Minimum miss distance 0.76 LD. See: 2020 BK13 – S2P , 2020 BK13 – JPL
2099, Apr 3	Apollo NEA **2018 GZ** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 3.44 LD. Minimum miss distance 0.06 LD. See: 2018 GZ - SSA , 2018 GZ - JPL
2099, Aug 5	Aten NEA **2018 MD7** (*H* = 22.6 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 5.52 LD. Minimum miss distance 0.79 LD. See: 2018 MD7 – SSA , 2018 MD7 – JPL

2099, Dec 18	Aten NEA **33342** (**1998 WT24**, H = 18.3 mag, $D \approx$ 415 m, **PHA**) will pass Earth at a nominal miss distance of 4.92 LD. Minimum miss distance 4.92 LD. See: 33342 1998 WT24 - SSA , 1998 WT24 - JPL Ref: - A.M. MacRobert, *Sky & Telescope*, 25 June 2004, "A close visitor tumbles by." See: http://www.skyandtelescope.com/news/3304726.html - M.W. Busch, L.A.M. Benner, S.J. Ostro, et al., 2008, *Icarus*, 195, 614, "Physical properties of near-Earth asteroid (**33342**) **1998 WT24**." See: http://adsabs.harvard.edu/abs/2008Icar..195..614B corrigendum 2008, *Icarus*, 197, 375. See: http://adsabs.harvard.edu/abs/2008Icar..197..375B See also: http://antwrp.gsfc.nasa.gov/apod/ap011224.html http://en.wikipedia.org/wiki/(33342)_1998_WT24 See also: **16 Dec 1908, 16 Dec 1956, 16 Dec 2001, 11 Dec 2015**.
2100, Apr 26	Apollo NEA **2011 JA** (H = 21.4 mag, $D \approx$ 190 m, **PHA**) will pass Earth at a nominal miss distance of 0.54 LD. Minimum miss distance 0.54 LD. **[2100-01]** See: 2011 JA - SSA , 2011 JA – JPL
2100, Apr 27	Apollo NEA **363116** (**2001 GQ2**, H = 20.0 mag, $D \approx$ 400 m, **PHA**) will pass Earth at a nominal miss distance of 1.32 LD. Minimum miss distance 1.32 LD. See: 2001 GQ2 - JPL , 2001 GQ2 - SSA
2100, Jun 30	Apollo NEA **2020 ME1** (H = 26.3 mag, $D \approx$ 20 m) will pass Earth at a nominal miss distance of 3.41 LD. Minimum miss distance 0.27 LD. See: 2020 ME1 – S2P , 2020 ME1 - JPL
2100, Nov 21	Aten NEA **2019 OR1** (H = 21.0 mag, $D \approx$ 220 m, **PHA**) will pass Earth at a nominal miss distance of 4.95 LD. Minimum miss distance 4.91 LD. See: 2019 OR1 – S2P , 2019 OR1 – JPL See als: **19 Nov 1902**, **20 Nov 2085**, **21 Nov 2178**.
2101, Jan 2	Apollo NEA **456938** (**2007 YV56**, H = 21.0 mag, $D \approx$ 220 m, **PHA**) will pass Earth at a nominal miss distance of 0.62 LD. Minimum miss distance 0.62 LD. **[2101-01]** See: 2007 YV56 - SSA , 2007 YV56 - JPL See also: https://en.wikipedia.org/wiki/2007_YV56

2101, Aug 6	Apollo NEA **399457** (**2002 PD43**, H = 19.2 mag, $D \approx$ 500 m, **PHA**) will pass Earth at a nominal miss distance of 2.43 LD. Minimum miss distance 2.41 LD. See: 2002 PD43 - JPL , 2002 PD43 - SSA
2101, Oct 25	Apollo NEA **2020 FM6** (H = 21.9 mag, $D \approx$ 150 m, **PHA**) will pass Earth at a nominal miss distance of 7.90 LD. Minimum miss distance 3.97 LD. See: 2020 FM6 – S2P, 2020 FM6 - JPL See also: **24 Oct 1964**.
2102, Jan 7	Apollo NEA **471240** (**2011 BT15**, H = 21.7 mag, $D \approx$ 160 m, **PHA**) will pass Earth at a nominal miss distance of 3.42 LD. Minimum miss distance 3.33 LD. See: 2011 BT15 - JPL , 2011 BT15 - SSA See also: https://en.wikipedia.org/wiki/(471240)_2011_BT15 See also: **3 Jan 1983**.
2102, Mar 13	Aten NEA **2021 ER4** (H = 27.2 mag, $D \approx$ 13 m) will pass Earth at a nominal miss distance of 2.03 LD. Minimum miss distance 0.34 LD. See: 2021 ER4 – S2P , 2021 ER4 - JPL
2102, May 15	Apollo NEA **2010 WC9** (H = 23.8 mag, $D \approx$ 60 m) will pass Earth at a nominal miss distance of 14.82 LD. Minimum miss distance 0.89 LD. See: 2010 WC9 - SSA , 2010 WC9 - JPL See also: https://en.wikipedia.org/wiki/2010_WC9 See also: **15 May 2018, 17 May 2156**
2102, Aug 30	Aten NEA **2020 QV6** (H = 22.5 mag, $D \approx$ 110 m) will pass Earth at a nominal miss distance of 8.35 LD. Minimum miss distance 8.35 LD. See: 2020 QV6 – S2P , 2020 QV6 - JPL See also: **28 Aug 2020, 30 Aug 2184**
2102, Aug 31	Apollo NEA **2009 DM45** (H = 21.2 mag, $D \approx$ 200 m, **PHA**) will pass Earth at a nominal miss distance of 4.72 LD. Minimum miss distance 4.70 LD. See: 2019 DM45 – S2P , 2019 DM45 – JPL
2102, Sep 12	Apollo NEA **2020 DR2** (H = 18.8 mag, $D \approx$ 600 m, **PHA**) will pass Earth at a nominal miss distance of 11.44 LD. Minimum miss distance 2.14 LD.

	See: 2020 DR2 – S2P , 2020 DR2 - JPL
2102, Oct 31	Aten NEA **2015 VK1** (*H* = 26.2 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 7.62 LD. Minimum miss distance 0.71 LD. See: 2015 VK1 - SSA , 2015 VK1 - JPL
2103, Feb 22	Aten NEA **1995 CR**, *H* = 21.9 mag, *D* ≈ 100 m, **PHA**) will pass Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 4.28 LD. See: 1995 CR - JPL , 1995 CR - SSA
2103, Mar 21	Apollo NEA **231937 (2001 FO32**, *H* = 17.6 mag, *D* ≈ 1100 m, **PHA**) will pass Earth at a nominal miss distance of 8.22 LD. Minimum miss distance 8.17 LD. See: 2001 FO32 – S2P , 2001 FO32 – JPL But, ***NEOWISE***: *D* ≈ 440 - 680 m. See: http://neo.ssa.esa.int/newsletters [March 2021] https://www.jpl.nasa.gov/news/asteroid-2001-fo32-will-safely-pass-by-earth-march-21 See also: **21 Mar 2021**, **22 Mar 2052**.
2103, Oct 10	Apollo NEA **2010 TW54** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 7.96 LD. Minimum miss distance 0.16 LD. See: 2010 TW54 - SSA , 2010 TW54 - JPL See also: **9 Oct 2010**.
2104, Sep 24	Aten NEA **2008 ST** (*H* = 27.4 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 9.75 LD. **Minimum miss distance 0 LD**. See: 2008 ST - SSA , 2008 ST - JPL
2105, Feb 26	Apollo NEA **2017 DR34** (*H* = 29.2 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 3.92 LD. Minimum miss distance 0.997 LD. See: 2017 DR34 - SSA , 2017 DR34 - JPL
2105, Aug 24	Apollo NEA **2020 QR5** (*H* = 27.3 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 2.97 LD. Minimum miss distance 0.11 LD. See: 2020 QR5 – S2P , 2020 QR5 – JPL See also: **20 Aug 1959**, **23 Aug 2020**.
2106, Apr 21	Apollo NEA **162416** (**2000 EH26**, *H* = 21.7 mag, *D* ≈ 141 m, **PHA**) will pass Earth at a nominal miss distance of 3.61 LD. Minimum miss distance 3.59 LD.

	See: 2000 EH26 - JPL , 2000 EH26 - SSA See also: **22 Jun 2167**.
2107, May 7	Aten NEA **2015 KE** (*H* = 26.3 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 1.81 LD. Minimum miss distance 0.10 LD. See: 2015 KE - SSA , 2015 KE - JPL See also: **18 Sep 1955**.
2108, Jan 17	Apollo NEA **2011 BU59** (*H* = 26.3 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 1.34 LD. Minimum miss distance 0.34 LD. See: 2011 BU59 – SSA , 2011 BU59 – JPL
2108, Jul 2	Asteroid **436724** (**2011 UW158**, *H* = 20.0 mag, *D* ≈ 600 x 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.26 LD. Minimum miss distance 4.26 LD. See: 2011 UW158 - JPL , 2011 UW158 - SSA See also: https://en.wikipedia.org/wiki/(436724)_2011_UW158 See also: **1 Jul 1978**.
2108, Oct 1	Apollo NEA **2016 TD** (*H* = 28.4 mag, *D* ≈ 7 m) will pass Earth at a nominal miss distance of 1.69 LD. Minimum miss distance 0.87 LD. See: 2016 TD - SSA , 2016 TD - JPL See also: **30 Sep 2016**.
2110, Apr 28	Aten NEA **2014 JU15** (*H* = 24.9 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 5.39 LD. Minimum miss distance 0.07 LD. See: 2014 JU15 - SSA , 2014 JU15 - JPL See also: **26 Apr 2092**.
2110, Jun 4	Aten NEA **437844** (**1999 MN**, *H* = 20.8 mag, *D* ≈ 240 m, **PHA**) will pass Earth at a nominal miss distance of 2.64 LD. Minimum miss distance 2.64 LD. See: 1999 MN - JPL , 1999 MN - SSA See also: **2 Jun 1938**, **2 Jun 1943**, **4 Jun 2137**, **3 Jun 2148**.
2110, Nov 6	Apollo NEA **2015 JJ** (*H* = 22.3 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 4.97 LD. Minimum miss distance 0.53 LD. See: 2015 JJ - SSA , 2015 JJ - JPL See also: **4 Nov 1989**, **5 Nov 2050**, **5 Nov 2094**.
2110, Dec 16	Apollo NEA **2019 YS** (*H* = 31.5 mag, *D* ≈ 1.8 m) will pass Earth

	at a nominal miss distance of 7.35 LD. Minimum miss distance 0.21 LD. See: 2019 YS – SSA , 2019 YS – JPL
2111, Aug 3	Apollo NEA **2019 YB4** (*H* = 26.4 mag, *D* ≈ 19 m) will pass Earth at a nominal miss distance of 5.67 LD. Minimum miss distance 0.86 LD. See: 2019 YB4 – S2P , 2019 YB4 – JPL See also: **2 Aug 2112**.
2111, Aug 19	Apollo NEA **2020 QF2** (*H* = 27.9 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 4.89 LD. Minimum miss distance 0.70 LD. See: 2020 QF2 – S2P , 2020 QF2 - JPL See also: **18 Aug 2020**.
2111, Aug 26	Aten NEA **2018 QS1** (*H* = 27.5 mag, *D* ≈ 11 m) will pass Earth at a nominal miss distance of 8.75 LD. Minimum miss distance 0.57 LD. See: 2018 QS1 - SSA , 2018 QS1 - JPL
2112, Aug 2	Apollo NEA **2019 YB4** (*H* = 26.4 mag, *D* ≈ 19 m) will pass Earth at a nominal miss distance of 6.15 LD. Minimum miss distance 0.85 LD. See: 2019 YB4 – S2P , 2019 YB4 – JPL See also: **3 Aug 2111**.
2112, Nov 8	Apollo NEA **2017 UJ43** (*H* = 27.9 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 0.45 LD. Minimum miss distance 0.18 LD. **[2112-01]** See: 2017 UJ43 - SSA , 2017 UJ43 - JPL
2112, Dec 23	Apollo NEA **4660 Nereus** (**1982 DB**, *H* = 18.8 mag, *D* ≈ 510 x 320 x 240 m, **PHA**) will pass Earth at a nominal distance of 6.96 LD. Minimum distance 6.89 LD See: 4660 Nereus - SSA , 1982 DB - JPL Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B - K. Kitazato, S. Abe, M. Ishiguro, et al., October 2012, American Astronomical Society, DPS meeting #44, #210.20, "Measuring the YORP effect of asteroid **4660 Nereus**." See: http://adsabs.harvard.edu/abs/2012DPS....4421020K See also: http://en.wikipedia.org/wiki/4660_Nereus

	See also: **22 Jan 2002, 11 Dec 2021**, **14 Feb 2060**, **4 Feb 2071**, **4 Feb 2166**.
2114, Jan 4	Apollo NEA **2019 NW5** (*H* = 23.8 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 4.31 LD. Minimum miss distance 0.93 LD. See: 2019 NW5 - JPL , 2019 NW5 - SSA
2114**,** Mar 2	Aten NEA **2019 EM1** (*H* = 22.5 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 0.95 LD. Minimum miss distance 0.89 LD. **[2114-01]** See: 2019 EM1 - JPL , 2019 EM1 - SSA See also: **28 Feb 2086**.
2115, Jul 29	Aten NEA **2018 PZ21** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 8.54 LD. Minimum miss distance 0.34 LD. See: 2018 PZ21 - SSA , 2018 PZ21 - JPL See also: **30 Jul 2119**.
2116, Apr 4	Aten NEA **2014 GC49** (*H* = 28.9 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 6.99 LD. Minimum miss distance 0.63 LD. See: 2014 GC49 - SSA , 2014 GC49 - JPL
2116, Nov 26	Apollo NEA **152685** (**1998 MZ**, *H* = 19.4 mag, *D* ≈ 590 m, **PHA**) will pass Earth at 1.07 LD. Minimum miss distance 1.07 LD. See: 1998 MZ - JPL , 1998 MZ - SSA
2117, Nov 1	Aten NEA **2000 UK11** (*H* = 25.5 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 2.40 LD. Minimum miss distance 0.17 LD. See: 2000 UK11 - SSA , 2000 UK11 - JPL
2118, Feb 16	Aten NEA **2020 CL1** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 4.89 LD. Minimum miss distance 4.61 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1940, 15 Feb 1991, 15 Feb 2036, 14 Feb 2018, 16 Feb 2155.**
2118, Jun 6	Apollo NEA **2007 VK184** (*H* = 22.2 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 4.95 LD. Minimum miss distance 0.35 LD. See: 2007 VK184 - SSA , 2007 VK184 - JPL See also:

	http://neo.jpl.nasa.gov/news/news183.html https://en.wikipedia.org/wiki/2007_VK184 See also: **6 Nov 2007, 2 Jun 2048.**
2119, May 20	Aten NEA **2004 KG1** (*H* = 24.2 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 1.60 LD. Minimum miss distance 0.25 LD. See: 2004 KG1 - SSA , 2004 KG1 - JPL
2119, 30 Jul	Aten NEA **2018 PZ21** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 1.76 LD. Minimum miss distance 0.12 LD. See: 2018 PZ21 - SSA , 2018 PZ21 - JPL See also: **29 Jul 2115**.
2119, Oct 21	Apollo NEA **2017 UR2** (*H* = 27.7 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 8.23 LD. Minimum miss distance 0.98 LD. See: 2017 UR2 - SSA , 2017 UR2 - JPL See also: **16 Oct 2004**, **17 Oct 2017**.
2119, Oct 23	Apollo NEA **2017 TA6** (*H* = 26.8 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 7.85 LD. Minimum miss distance 0.65 LD. See: 2017 TA6 - SSA , 2017 TA6 - JPL
2120, Jan 23	Apollo NEA **2018 BL11** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.65 LD. Minimum miss distance 0.03 LD. See: 2018 BL 11 – SSA , 2018 BL11 – JPL
2120, Apr 25	Aten NEA **2011 DV** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 2.23 LD. Minimum miss distance 0.28 LD. See: 2011 DV - SSA , 2011 DV - JPL See also: **25 Apr 1928**.
2120, Dec 20	Apollo NEA **2008 YF** (*H* = 21.0 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.89 LD. Minimum miss distance 2.05 LD. See: 2008 YF - JPL, 2008 YF - SSA
2121, Jun 5	Aten NEA **2020 LO** (*H* = 26.8 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 0.52 LD. Minimum miss distance 0.51 LD. . **[2121-01]** See: 2020 LO – S2P , 2020 LO – JPL

2122, Feb 14	Aten NEA **2014 WQ202** (*H* = 23.9 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 2.62 LD. Minimum miss distance 0.98 LD. See: 2014 WQ202 - SSA , 2014 WQ202 - JPL
2122, Nov 2	Aten NEA **2019 VV** (*H* = 25.5 mag, *D* ≈ 29 m) will pass Earth at a nominal miss distance of 2.81 LD. Minimum miss distance 0.53 LD. See: 2019 VV – SSA , 2019 VV – JPL
2122, Nov 30	Apollo NEA **416801** (**2005 GC120**, *H* = 19.6 mag, *D* ≈ 906 m, **PHA**) will pass Earth at a nominal miss distance of 2.08 LD. Minimum miss distance 2.07 LD. See: 2005 GC120 - JPL , 2005 GC120 - SSA
2122, Dec 16	Aten NEA **487577** (**2014 YQ15**, *H* = 20.9 mag, *D* ≈ 240 m, **PHA**) will pass Earth at a nominal miss distance of 3.87 LD. Minimum miss distance 2.61 LD. See: 2014 YQ15 - JPL, 2014 YQ15 - SSA See also: **15 Dec 1959**, **15 Dec 2066**.
2123, Mar 13	Apollo NEA **2013 ET** (*H* = 23.4 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 9.05 LD. Minimum miss distance 0.69 LD. See: 2013 ET - SSA , 2013 ET - JPL See also: https://en.wikipedia.org/wiki/2013_ET See also: **9 Mar 2013.**
2123, Apr 7	Apollo NEA **99942 Apophis** (**2004 MN4**, *H* = 19.7 mag, *D* = 310 ± 30 m, orbital *P* = 0.89 yr, **PHA**) will pass Earth at a nominal miss distance of 43.42 LD. Minimum miss distance 0.39 LD. See: 2004 MN4 – SSA , 2004 MN4 - JPL See also: http://www.esa.int/Our_Activities/Space_Science/Herschel_intercepts_asteroid_Apophis http://www.jpl.nasa.gov/asteroidwatch/newsfeatures.cfm?release=2013-017 http://neo.jpl.nasa.gov/apophis/ https://cneos.jpl.nasa.gov/doc/apophis/ http://news.bbc.co.uk/2/hi/science/nature/8296796.stm http://www.scientificamerican.com/blog/post.cfm?id=planetary-bombardments-past-and-fut-2009-10-08 http://en.rian.ru/science/20110126/162318648.html http://www.space.com/10752-apophis-asteroid-hit-earth.html http://www.space.com/19221-asteroid-apophis-earth-safe-2036.html https://phys.org/news/2017-06-impact-threat-asteroid-apophis.html https://phys.org/news/2017-08-asteroid-apophis-chance-earth-

	expert.html http://en.wikipedia.org/wiki/99942_Apophis See also: **13 Apr 1907**, **14 Apr 1949**, **14 Apr 1998**, **13 Apr 2029**, **30 Mar 2036**.
2123, Apr 30	Apollo NEA **69230 Hermes** (**1937 UB**, *H* = 17.5 mag, *D* ≈ 1100 m, **PHA**) will pass Earth at a nominal miss distance of 8.43 LD. Minimum miss distance 5.70 LD. See: 69230 Hermes - SSA , 1937 UB - JPL See also: http://en.wikipedia.org/wiki/69230_Hermes See also: **29 Oct 1914**, **30 Oct 1937, 26 Apr 1942, 1 Nov 1954, 31 Oct 2086.**
2123, Nov 4	Apollo NEA **65803 Didymos** (**1996 GT**, *H* = 18.1 mag, *D* ≈ 780 + 160 m, **PHA**) will pass Earth at 15.23 LD (= 0.04 AU). Minimum miss distance 15.23 LD. Flyby target for ***AIDA*** mission. See: 65803 Didymos - SSA , 1996 GT - JPL See also: https://en.wikipedia.org/wiki/65803_Didymos See also: **12 Nov 2003**, **29 May 2012**, **4 Oct 2022**.
2124, Apr 20	Apollo NEA **2021 HE1** (*H* = 28.9 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 7.81 LD. Minimum miss distance 0.95 LD. See: 2021 HE1 – S2P , 2021 HE1 - JPL See also: **17 Apr 2021**.
2124, Oct 1	Apollo NEA **2017 SX17** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 9.45 LD. Minimum miss distance 0.14 LD. See: 2017 SX17 - SSA , 2017 SX17 - JPL See also: **2 Oct 2017**.
2125, Feb 26	Apollo NEA **2019 DS1 (***H* = 25.6 mag, *D* ≈ 26 m) will pass Earth at a nominal miss distance of 8.65 LD. Minimum miss distance 0.42 LD. See: 2019 DS1 - SSA , 2019 DS1 - JPL See also: **26 Feb 1970**
2125, Aug 19	Apollo NEA **2017 RV (***H* = 21.9 mag, *D* ≈ 150 m, **PHA**) will pass Earth at a nominal miss distance of 2.56 LD. Minimum miss distance 2.53 LD. See: 2017 RV - JPL , 2017 RV - SSA See also: **17 Aug 1979**, **19 Aug 2175**.
2125, Nov 8	Apollo NEA **525484** (**2005 GL**, *H* = 21.0 mag, *D* ≈ 220 m, **PHA**)

	will pass Earth at a nominal miss distance of 4.25 LD. Minimum miss distance 4.24 LD. See: 2005 GL - JPL, 2005 GL - SSA See also: **7 Nov 2058**.
2127, Mar 29	Apollo NEA **2016 FU6** (*H* = 28.8 mag, *D* ≈ 6 m) will pass Earth at a nominal miss distance of 6.12 LD. Minimum miss distance 0.74 LD. See: 2016 FU6 - SSA , 2016 FU6 - JPL
2127, Apr 12	Apollo NEA **2018 GG** (*H* = 24.7 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 3.91 LD. Minimum miss distance 0.28 LD. See: 2018 GG - SSA , 2018 GG - JPL
2127, Apr 16	Amor NEA **52768** (**1998 OR2**, *H* = 16.1 mag, *D* ≈ 2100 m, **PHA**) will pass Earth at a nominal miss distance of 6.53 LD. Minimum miss distance 6.53 LD. See: 52768 1998 OR2 - SSA , 1998 OR2 - JPL See also: https://en.wikipedia.org/wiki/(52768)_1998_OR2 See also: **16 April 2079**.
2127, Oct 10	Apollo NEA **2016 QE45** (*H* = 21.9 mag, *D* ≈ 150 m, **PHA**) will pass Earth at a nominal miss distance of 2.25 LD. Minimum miss distance 2.24 LD. See: 2016 QE45– S2P , 2016 QE45 – JPL
2128, Mar 6	Apollo NEA **2014 EG45** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 3.79 LD. Minimum miss distance 1.45 LD. See: 2014 EG45 - JPL, 2014 EG45 - SSA See also: **4 Mar 2014**, **4 Mar 2065**.
2128, Jun 26	Apollo NEA **2020 JX1** (*H* = 23.8 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 1.38 LD. Minimum miss distance 0.73 LD. See: 2020 JX1 – S2P , 2020 JX1 - JPL
2128, Nov 27	Apollo NEA **2000 KA** (*H* = 21.9 mag, *D* ≈ 150 m, **PHA**) will pass Earth at a nominal miss distance of 5.73 LD. Minimum miss distance 5.73 LD. See: 2000 KA - SSA , 2000 KA - JPL See also: **12 May 2020**, **15 May 2158**.
2129, May 30	Apollo NEA **2019 KG2** (*H* = 25.4 mag, *D* ≈ 29 m) will pass Earth

	at a nominal miss distance of 6.47 LD. Minimum miss distance 0.08 LD. See: 2019 KG2 – SSA , 2019 KG2 – JPL
2129, Jun 20	Apollo NEA **443104** (**2013 XK22**, *H* = 24.3 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 3.30 LD. Minimum miss distance 0.44 LD. See: 443104 2013 XK22 - SSA , 2013 XK22 - JPL
2129, Oct 19	Aten NEA **2007 UW1** (*H* = 22.9 mag, *D* ≈ 90 m) will pass Earth at a nominal miss distance of 0.22 LD. Minimum miss distance 0.15 LD. **[2129-01]** See: 2007 UW1 - SSA , 2007 UW1 - JPL See also: https://en.wikipedia.org/wiki/2007_UW1
2130, Jan 27	Apollo NEA **85182** (**1991 AQ**, *H* = 17.2 mag, ***D* ≈ 1098 m**, **PHA**) will pass Earth at a nominal miss distance of 4.14 LD. Minimum miss distance 4.14 LD. See: 85182 1991 AQ - SSA , 1991 AQ - JPL See also: https://en.wikipedia.org/wiki/(85182)_1991_AQ
2130, Jun 7	Aten NEA **163348** (**2002 NN4**, *H* = 20.3 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 2.75 LD. Minimum miss distance 2.75 LD. See: 2002 NN4 - JPL, 2002 NN4 - SSA See also: **5 Jun 1924**, **6 Jun 1965**, **6 Jun 2070**.
2130, Jul 31	Apollo NEA **2020 OO1** (*H* = 26.5 mag, *D* ≈ 18 m) will pass Earth at a nominal miss distance of 3.65 LD. Minimum miss distance 0.18 LD. See: 2020 OO1 – S2P , 2020 OO1 - JPL
2130, Aug 24	Aten NEA **2004 QA22**, (*H* = 28.2 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.62 LD. **Minimum miss distance 0.0010 LD (= 0.062 R_{Earth} from the geocenter).** See: 2004 QA22 - SSA , 2004 QA22 - JPL
2131, Mar 21	Aten NEA **2019 EA2** (*H* = 25.9 mag, *D* ≈ 24 m) will pass Earth at a nominal miss distance of 1.15 LD. Minimum miss distance 0.65 LD. See: 2019 EA2 - SSA , 2019 EA2 - JPL See also: **22 Mar 2019**.
2131, Jun 17	Apollo NEA **2016 LK49**, (*H* = 26.1 mag, *D* ≈ 21 m) will pass Earth at a nominal miss distance of 6.36 LD. Minimum miss

	distance 0.31 LD. See: 2016 LK49 - SSA , 2016 LK49- JPL
2131, Dec	Apollo NEA **2017 DQ36** (*H* = 19.0 mag, *D* ≈ 600 m) will pass Earth at a nominal miss distance of 0.016 AU = 6.23 LD. See: 2017 DQ36 – SSA , 2017 DQ36 - JPL Re: - J.D. Hefele, F. Bortolussi, S. Portegies Zwart, 2020, *Astronomy & Astrophysics*, 634, 45, "Identifying Earth-impacting asteroids using an artificial neural network." See: https://www.aanda.org/articles/aa/full_html/2020/02/aa35983-19/aa35983-19.html See also: https://www.astronomie.nl/leiden-astronomers-discover-potential-near-earth-objects-76 See also: **24 Jan 2017**.
2132, Jan 8	Aten NEA **2020 AD3** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 9.80 LD. Minimum miss distance 6.77 LD. See: 2020 AD3 – S2P , 2020 AD3 - JPL See also: **12 Jan 2132**.
2132, Jun 18, 13:40	Apollo NEA **2016 JB29** (*H* = 24.8 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 6.12 LD. Minimum miss distance 0.71 LD. See: 2016 JB29 - SSA , 2016 JB29 - JPL
2132, Jun 18, 03:16	Apollo NEA **2018 TO1** (*H* = 21.8 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 3.56 LD. Minimum miss distance 3.49 LD. See: 2018 TO1 – SSA , 2018 TO1 – JPL
2133, Apr 5	Apollo NEA **267221** (**2001 AD2**, *H* = 19.7 mag, *D* ≈ 562 m, **PHA**) will pass Earth at a nominal miss distance of 3.41 LD. Minimum miss distance 3.41 LD. See: 2001 AD2 - JPL , 2001 AD2 - SSA See also: **3 Apr 2046**, **6 Apr 2150**.
2133, Sep 26	Apollo NEA **429584** (**2011 EU29**, *H* = 19.9 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 4.00 LD. Minimum miss distance 3.99 LD. See: 2011 EU29 - JPL , 2011 EU29 - SSA
2133, Dec 29	Aten NEA **2012 AP10** (*H* = 26.5 mag, *D* ≈ 18 m) will pass Earth at a nominal miss distance of 4.33 LD. Minimum miss distance 0.50 LD.

	See: 2012 AP10 - SSA , 2012 AP10 - JPL
2134, Apr 17	Apollo NEA **2019 GC6** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 7.49 LD. Minimum miss distance 0.52 LD. See: 2019 GC6 - SSA , 2019 GC6 - JPL See also: **17 Apr 1983**, **18 Apr 2019**.
2134, Oct 8	Apollo NEA **536531** (**2015 DV215**, *H* = 20.4 mag, *D* ≈ 290 m, **PHA**) will pass Earth at a nominal miss distance of 2.85 LD. Minimum miss distance 1.88 LD. See: 2015 DV215 - JPL, 2015 DV215 - SSA See also: **6 Oct 2035**.
2134, Oct 22	Apollo NEA **2020 FN3** (*H* = 24.4 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.80 LD. **[2134-01]** See: 2020 FN3 – S2P , 2020 FN3 – JPL
2135, Aug 6	Apollo NEA **2017 BL30** (*H* = 23.5 mag, *D* ≈ 70 m) will pass Earth at a nominal miss distance of 3.22 LD. Minimum miss distance 0.71 LD. See: 2017 BL30- SSA , 2017 BL30- JPL
2135, Sep 25	Apollo NEA **101955 Bennu** (**1999 RQ36**, *H* = 20.4 mag, *D* ≈ 245 m, **PHA**) will pass Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.31 LD. **[2135-01]** Possible Earth impact in **2182** ? See: 101955 Bennu - SSA , 1999 RQ36 - JPL See also: http://en.wikipedia.org/wiki/(101955)_1999_RQ36 See also: **22 Sep 1999, 23 Sep 2060.**
2136, Jan 19	Apollo NEA **2021 BO** (*H* = 33.0 mag, *D* ≈ 0.9 m) will pass Earth at a nominal miss distance of 1.80 LD. Minimum miss distance 0.72 LD. See: 2021 BO – S2P , 2021 BO - JPL See also: **18 Jan 2021**.
2136, Jan 25	Apollo NEA **523804** (**2000 YF29**, *H* = 20.5 mag, *D* ≈ 290 m, **PHA**) will pass Earth at a nominal miss distance of 4.91 LD. Minimum miss distance 4.89 LD. See: 2000 YF29 - JPL, 2000 YF29 - SSA See also: **22 Jan 2193**.
2137, Mar 24	Aten NEA **2020 CB2** (*H* = 20.3 mag, *D* ≈ 300 m, **PHA**) will pass

	Earth at a nominal miss distance of 12.88 LD. Minimum miss distance 10.42 LD. See: 2020 CB2 – S2P , 2020 CB2 – JPL
2137, Jun 4	Aten NEA **437844** (**1999 MN**, *H* = 20.8 mag, *D* ≈ 270 m, **PHA**) will pass Earth at a nominal miss distance of 2.15 LD. Minimum miss distance 2.15 LD. See: 1999 MN - JPL, 1999 MN - SSA See also: **2 Jun 1938**, **2 Jun 1943**, **4 Jun 2110**, **3 Jun 2148**.
2139, Jul 31	Apollo NEA **457768** (**2009 KN4**, *H* = 18.4 mag, *D* ≈ 700 m, **PHA**) will pass Earth at a nominal miss distance of 4.98 LD. Minimum miss distance 4.98 LD. See: 2009 KN4 - JPL , 2009 KN4 - SSA
2139, Sep 27	Aten NEA **2016 SU2** (*H* = 27.7 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 0.57 LD. Minimum miss distance 0.24 LD. **[2139-01]** See: 2016 SU2 - SSA , 2016 SU2 - JPL See also: **24 Sep 2016**.
2139, Dec 18	Apollo NEA **2018 YM** (*H* = 27.1 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 0.70 LD. Minimum miss distance 0.46 LD. **[2139-02]** See: 2018 YM - SSA , 2018 YM - JPL
2140, Jun 11	Apollo NEA **2021 KN1** (*H* = 24.5 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 6.81 LD. Minimum miss distance 0.12 LD. See: 2021 KN1 – S2P , 2021 KN1 – JPL
2140, Dec 1	Aten NEA **153201** (**2000 WO107**, *H* = 19.4 mag, *D* ≈ 510 m, **PHA**) will pass Earth at a nominal miss distance of 0.63 LD. Minimum miss distance 0.63 LD. **[2140-01]** See: 153201 2000 WO107 - SSA , 2000 WO107 - JPL See also: https://en.wikipedia.org/wiki/(153201)_2000_WO107 See also: **29 Nov 1953**, **30 Nov 2093**.
2141, Feb 21	Apollo NEA **2012 DX** (*H* = 27.1 mag, *D* ≈ 14 m) will pass Earth at a nominal miss distance of 7.96 LD. Minimum miss distance 0.12 LD. See: 2012 DX - SSA , 2012 DX - JPL
2141, May 8	Aten NEA **525498** (**2005 GE60**, *H* = 22.2 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 2.06 LD. Minimum miss distance 2.06 LD.

	See: 2005 GE60 – SSA , 2005 GE60 – JPL
2141, Jul 8	Aten NEA **2016 NJ22** (*H* = 28.2 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 4.47 LD. Minimum miss distance 0.43 LD. See: 2016 NJ22 - SSA , 2016 NJ22 - JPL See also: **7 July 2016**.
2141, Sep 4	Apollo NEA **196625** (**2003 RM10**, *H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 3.17 LD. Minimum miss distance 3.17 LD. See: 2003 RM10 - JPL, 2003 RM10 - SSA
2141, Nov 16	Apollo NEA **2016 VX1** (*H* = 25.3 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 6.30 LD. Minimum miss distance 0.09 LD. See: 2016 VX1 - SSA , 2016 VX1 - JPL
2142, Nov 29	Apollo NEA **2017 WN16** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 4.68 LD. Minimum miss distance 3.99 LD. See: 2017 WN16 - JPL , 2017 WN16 - SSA
2142, Dec 10	Aten NEA **2015 YU7** (*H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 4.56 LD. Minimum miss distance 4.56 LD. See: 2015 YU7 - JPL , 2015 YU7 - SSA See also: **10 Dec 2174**.
2143, Mar 6	Apollo NEA **474158** (**1999 FA**, *H* = 20.9 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.74 LD. Minimum miss distance 4.46 LD. See: 1999 FA - JPL , 1999 FA - SSA See also: **6 Mar 1909**, **6 Mar 1999**, **7 Mar 2194**.
2143, Dec 7	Apollo NEA **2020 XE1** (*H* = 26.7 mag, *D* ≈ 16 m) will pass Earth at a nominal miss distance of 3.84 LD. Minimum miss distance 0.42 LD. See: 2020 XE1 – S2P , 2020 XE1 – JPL See also: **3 Dec 2020**.
2145, Nov 2	Aten NEA **2019 UN13** (*H* = 32.2 mag, *D* ≈ 1.3 m) will pass Earth at a nominal miss distance of 3.42 LD. Minimum miss distance 0.58 LD. See: 2019 UN13 – SSA , 2019 UN13 - JPL See also: **31 Oct 2019**.

2146, Mar 23	Apollo NEA **2009 DO111** (*H* = 22.6 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 0.88 LD. Minimum miss distance 0.74 LD. **[2146-01]** See: 2009 DO111 - SSA , 2009 DO111 - JPL
2147, Feb 25	Aten NEA **2004 DA 53** (*H* = 28.3 mag, *D* ≈ 8 m) will pass Earth at a nominal miss distance of 1.04 LD. Minimum miss distance 0.16 LD. See: 2004 DA 53 - SSA , 2004 DA 53 - JPL
2147, Oct 9	Apollo NEA **2018 EB** (*H* = 22.0 mag, *D* ≈ 140 m, **PHA**) will pass Earth at a nominal miss distance of 3.96 LD. Minimum miss distance 3.94 LD. See: 2018 EB - JPL, 2018 EB - SSA
2148, Jan 22	Apollo NEA **85640** (**1998 OX4** = **2002 PJ34**, *H* = 20.9 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 0.77 LD. Minimum miss distance 0.77 LD. **[2148-01]** See: 85640 1998 OX4 - SSA , 1998 OX4 - JPL See also: https://en.wikipedia.org/wiki/(85640)_1998_OX4 See also: **18 Jan 1985**.
2148, May 7	Apollo NEA **144898** (**2004 VD17**, *H* = 19.0 mag, *D* ≈ 320 m, **PHA**) will pass Earth at a nominal miss distance of 16.5 LD. Minimum miss distance 5.7 LD. See: 144898 2004 VD17 - SSA , 2004 VD17 - JPL Ref: - F. de Luise, D. Perna, E. Dotto, et al., 2007, *Icarus*, 191, 628, "Physical investigation of the potentially hazardous asteroid **(144898) 2004 VD17**." See: http://adsabs.harvard.edu/abs/2007Icar..191..628D See also: http://en.wikipedia.org/wiki/(144898)_2004_VD17 See also: **7 Nov 2041**, **5 May 2196**.
2148, Jun 3	Aten NEA **437844** (**1999 MN**, *H* = 20.8 mag, *D* ≈ 250 m, **PHA**) will pass Earth at a nominal miss distance of 3.28 LD. Minimum miss distance 3.27 LD. See: 1999 MN - JPL, 1999 MN - SSA See also: **2 Jun 1938**, **2 Jun 1943**, **4 Jun 2110**, **4 Jun 2137**.
2148, Dec 26	Apollo NEA **2018 FQ4** (*H* = 27.2 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 1.771 LD. Minimum miss distance **0.0014 LD (= 0.083 R_{Earth} from the geocenter)**. See: 2018 FQ4 - SSA , 2018 FQ4 - JPL

2149, Feb 18	Aten NEA **2020 CX1** (H = 24.2 mag, $D \approx$ 50 m), will pass Earth at a nominal miss distance of 3.12 LD. Minimum miss distance 0.10 LD See: 2020 CX1 – S2P , 2020 CX1 – JPL
2149, May 28	Aten NEA **2017 JF3** (H = 22.0 mag, $D \approx$ 140 m, **PHA**) will pass Earth at a nominal miss distance of 3.57 LD. Minimum miss distance 3.43 LD. See: 2017 JF3 – SSA , 2017 JF3 – JPL See also: **28 May 2168**.
2149, Oct 24	Apollo NEA **497117** (**2004 FU4**, H = 18.4 mag, $D \approx$ 700 m, **PHA**) will pass Earth at a nominal miss distance of 10.4 LD. Minimum miss distance 0.83 LD. See: 2004 FU4 - SSA , 2004 FU4 - JPL
2149, Dec 7	Apollo NEA **279744** (**1998 KM3**, H = 20.2 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.53 LD. Minimum miss distance 3.52 LD. See: 1998 KM3 - JPL , 1998 KM3 - SSA
2150, Apr 6	Apollo NEA **267221** (**2001 AD2**, H = 19.7 mag, $D \approx$ 562 m, **PHA**) will pass Earth at a nominal miss distance of 4.82 LD. Minimum miss distance 4.76 LD. See: 2001 AD2 - JPL , 2001 AD2 - SSA See also: **3 Apr 2046**, **5 Apr 2133**.
2150, Sep 10	Apollo NEA **387668** (**2002 SZ**, H = 20.4 mag, $D \approx$ 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 4.27 LD. See: 2002 SZ - JPL, 2002 SZ - SSA See also: **10 Sep 2067**.
2150, Sep 21	Apollo NEA **2018 BP** (H = 20.6 mag, $D \approx$ 270 m, **PHA**) will pass Earth at nominal miss distance of 9.30 LD. Minimum miss distance 0.76 LD. See: 2018 BP – SSA , 2018 BP - JPL
2151, Nov 10	Aten NEA **2018 VR3** (H = 26.1 mag, $D \approx$ 21 m) will pass Earth at nominal miss distance of 5.40 LD. Minimum miss distance 0.61 LD. See: 2018 VR3 - SSA , 2018 VR3 - JPL
2152, Jan 27	Apollo NEA **2020 TB12** (H = 21.7 mag, $D \approx$ 160 m, **PHA**) will pass Earth at a nominal miss distance of 1.67 LD. Minimum miss distance 1.18 LD.

	See: 2020 TB12 – S2P , 2020 TB12 - JPL
2153, Apr 15	Apollo NEA **2004 HM** (*H* = 23.1 mag, *D* ≈ 80 m) will pass Earth at nominal miss distance of 5.95 LD. Minimum miss distance 0.22 LD. See: 2004 HM - SSA , 2004 HM - JPL
2153, Sep 21	Apollo NEA **1997 GL3**, *H* = 19.1 mag, *D* ≈ 200 m, **PHA**) will pass Earth at a nominal miss distance of 2.01 LD. Minimum miss distance 2.00 LD. See: 1997 GL3 - JPL , 1997 GL3 - SSA
2154, May 9	Aten NEA **525498** (**2005 GE60**, *H* = 22.2 mag, *D* ≈ 130 m) will pass Earth at a nominal miss distance of 5.12 LD. Minimum miss distance 5.01 LD. See: 2005 GE60 - JPL , 2005 GE60 - SSA
2154, Jun 13	Amor NEA **2020 DB5** (*H* = 19.3 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 7.71 LD. Minimum miss distance 4.74 LD. See: 2020 DB5 – S2P , 2020 DB5 - JPL
2155, Feb 16	Aten NEA **2020 CL1** (*H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 5.97 LD. Minimum miss distance 4.39 LD. See: 2020 CL1 – S2P , 2020 CL1 – JPL See also: **15 Feb 1940**, **15 Feb 1991**, **15 Feb 2036**, **14 Feb 2018**, **16 Feb 2118**.
2155, Jun 16	Apollo NEA **530520** (**2011 LT17**, *H* = 21.6 mag, *D* ≈ 170 m, **PHA**) will pass Earth at a nominal miss distance of 1.75 LD. Minimum miss distance 1.74 LD. See: 2011 LT17 - JPL , 2011 LT17 - SSA See also: **15 Jun 2011**, **16 Dec 2156**.
2155, Aug 5	Apollo NEA **2018 PY7** (*H* = 26.9 mag, *D* ≈ 15 m) will pass Earth at a nominal miss distance of 0.31 LD. Minimum miss distance 0.30 LD. **[2155-01]** See: 2005 GE60 - JPL , 2005 GE60 - SSA
2156, May 17	Apollo NEA **2010 WC9** (*H* = 23.8 mag, *D* ≈ 60 m) will pass Earth at a nominal miss distance of 12.49 LD. Minimum miss distance 0.49 LD. See: 2010 WC9 - SSA , 2010 WC9 - JPL See also: https://en.wikipedia.org/wiki/2010_WC9 See also: **15 May 2018**, **15 May 2102**.

2156, Dec 16	Apollo NEA **530520** (**2011 LT17**, H = 21.6 mag, $D \approx$ 170 m, **PHA**) will pass Earth at nominal miss distance of 0.98 LD. Minimum miss distance 0.96 LD. **[2156-01]** See: 2011 LT17 - SSA , 2011 LT17 - JPL See also: **15 Jun 2011**, **16 Jun 2155**.
2157, Jan 1	Aten NEA **2012 XE133** (H = 23.3 mag, $D \approx$ 80 m) will pass Earth at a nominal miss distance of 0.69 LD. Minimum miss distance 0.69 LD. **[2157-01]** See: 2012 XE133 – S2P , 2012 XE 133 – JPL
2158, May 15	Apollo NEA **2000 KA** (H = 21.9 mag, $D \approx$ 150 m, **PHA**) will pass Earth at a nominal miss distance of 8.67 LD. Minimum miss distance 8.64 LD. See: 2000 KA - SSA , 2000 KA - JPL See also: **12 May 2020**, **27 Nov 2128**.
2158, Nov 6	Apollo NEA **2012 TY52** (H = 21.3 mag, $D \approx$ 190 m, **PHA**) will pass Earth at a nominal miss distance of 4.11 LD. Minimum miss distance 3.97 LD. See: 2012 TY52 - JPL, 2012 TY52 - SSA See also: **4 Nov 1982**.
2158, Dec 20	Apollo NEA **2015 BW310** (H = 22.2 mag, $D \approx$ 130 m) will pass Earth at a nominal miss distance of 4.63 LD. Minimum miss distance 3.31 LD. See: 2015BW310 - SSA , 2015 BW310 - JPL
2158, Dec 25	Apollo NEA **2020 YA3** (H = 26.1 mag, $D \approx$ 22 m) will pass Earth at a nominal miss distance of 6.60 LD. **Minimum miss distance 0.0000085 LD (= 0.0005 R_{Earth} from the geocenter).** See: 2020 YA3 – S2P , 2020 YA3 – JPL
2159, May 4	Aten NEA **467460** (**2006 JF42**, H = 19.0 mag, $D \approx$ 600 m, **PHA**) will pass Earth at a nominal miss distance of 2.87 LD. Minimum miss distance 2.87 LD. See: 2006 JF42 - JPL , 2006 JF42 - SSA
2160, Mar 23	Apollo NEA **434734** (**2006 FX**, H = 20.0 mag, $D \approx$ 400 m, **PHA**) will pass Earth at a nominal miss distance of 4.39 LD. Minimum miss distance 4.37 LD. See: 2006 FX - JPL , 2006 FX - SSA
2161, Feb 8	Apollo NEA **2013 VA10** (H = 22.4 mag, $D \approx$ 120 m) will pass Earth at a nominal miss distance of 4.89 LD. Minimum miss

	distance 3.87 LD. See: 2013 VA10 – SSA , 2013 VA10 – JPL See also: **6 Feb 1944**, **7 Feb 2040**.
2161, Nov 6	Apollo NEA **2011 VU5** (*H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 5.95 LD. Minimum miss distance 1.81 LD. See: 2011 VU5 - JPL , 2011 VU5 - SSA
2161, Dec 8	Aten NEA **2019 YA3** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 4.62 LD. Minimum miss distance 0.93 LD. See: 2019 YA3 – S2P , 2019 YA3 – JPL
2162, 13 Apr	Apollo NEA **2020 GA2** (*H* = 21.1 mag, *D* ≈ 210 m, **PHA**) will pass Earth at a nominal miss distance of 9.02 LD. Minimum miss distance 7.39 LD. See: 2020 GA2 – S2P , 2020 GA2 - JPL See also: **11 Apr 2020**.
2162, Jun 1	Aten NEA **2017 HZ4** (*H* = 25.9 mag, *D* ≈ 23 m) will pass Earth at nominal miss distance of 0.95 LD. Minimum miss distance 0.17 LD. **[2162-01]** See: 2017 HZ4 - SSA , 2017 HZ4 - JPL
2163, Dec 14	Apollo NEA **162474** (**2000 LB16**, *H* = 18.7 mag, *D* ≈ 600 m, **PHA**) will pass Earth at a nominal miss distance of 4.29 LD. Minimum miss distance 4.29 LD. See: 2000 LB16 - JPL , 2000 LB16 - SSA
2164, May 31	Aten NEA **2021 KO2** (*H* = 28.1 mag, *D* ≈ 9 m) will pass Earth at a nominal miss distance of 2.58 LD. Minimum miss distance 0.69 LD. See: 2021 KO2 – S2P , 2021 KO2 - JPL See also: **30 May 2021**, **30 May 2022**.
2165, Mar 3	Apollo NEA **2003 DW10** (*H* = 26.2 mag, *D* ≈ 21 m) will pass Earth at nominal miss distance of 1.63 LD. Minimum miss distance 0.50 LD. See: 2003 DW10 - SSA , 2003 DW10 - JPL
2165, Sep	Apollo NEA **2014 TW57** (*H* = 19.7 mag, *D* ≈ 470 m) will pass Earth at a nominal miss distance of 0.017 AU = 6.62 LD. See: 2014 TW57 – SSA , 2014 TW57 – JPL Re: - J.D. Hefele, F. Bortolussi, S. Portegies Zwart, 2020, *Astronomy & Astrophysics*, 634, 45, “Identifying Earth-impacting asteroids

	using an artificial neural network." See: https://www.aanda.org/articles/aa/full_html/2020/02/aa35983-19/aa35983-19.html See also: https://www.astronomie.nl/leiden-astronomers-discover-potential-near-earth-objects-76 See also: **20 Oct 2014**.
2165, Oct 21	Aten NEA **2007 US12**, $H = 21.9$ mag, $D \approx 150$ m, **PHA**) will pass Earth at a nominal miss distance of 4.27 LD. Minimum miss distance 4.27 LD. See: 2007 US12 - JPL , 2007 US12 - SSA
2166, Feb 3	Apollo NEA **4660 Nereus** (**1982 DB**, $H = 18.8$ mag, $D \approx 510 \times 330 \times 240$ m, **PHA**) will pass Earth at 7.30 LD. Minimum miss distance 6.81 LD. See: 4660 Nereus - SSA , 1982 DB - JPL Ref: - M. Brozovic, S.J. Ostro, L.A.M. Benner, et al., 2009, *Icarus*, 201, 153, "Radar observations and a physical model of asteroid **4660 Nereus**, a prime space mission target." See: http://adsabs.harvard.edu/abs/2009Icar..201..153B See also: http://en.wikipedia.org/wiki/4660_Nereus See also: **29 Jan 1900**, **22 Jan 2002**, **11 Dec 2021**, **14 Feb 2060**, **4 Feb 2071**, **23 Dec 2112**.
2166, Jun 14	Amor NEA **423321** (**2005 ED318**, $H = 20.7$ mag, $D \approx 202$ m, **PHA**) will pass Earth at a nominal miss distance of 4.43 LD. Minimum miss distance 4.43 LD. See: 2005 ED318 - JPL, 2005 ED318 - SSA See also: **2 Jun 2083**.
2167, Apr 9	Apollo NEA **25143 Itokawa** (**1998 SF36**, $H = 19.1$ mag, $D = 520 \times 270 \times 230$ m, $M = 3.6 \times 10^{10}$ kg, **PHA**) will pass Earth at a nominal miss distance of 9.79 LD. Minimum miss distance 9.76 LD. See: 25143 Itokawa - SSA , 1998 SF36 - JPL See also: https://en.wikipedia.org/wiki/25143_Itokawa See also: **27 Jun 1905**, **26 Jun 2004.**
2167, Jun 22	Apollo NEA **162416** (**2000 EH26**, $H = 21.7$ mag, $D = 141$ m, **PHA**) will pass Earth at a nominal miss distance of 3.53 LD. Minimum miss distance 2.34 LD. See: 2000 EH26 - SSA , 2000 EH26 - JPL See also: **21 Apr 2106**.

2168, Jan 30	Asteroid **2007 TU24** (*H* = 20.5 mag, *D* = 250 m, **PHA**) will pass Earth at a nominal miss distance of 3.44 LD. Minimum miss distance 0.46 LD. See: 2007 TU24 - SSA , 2007 TU24 - JPL See also: https://en.wikipedia.org/wiki/2007_TU24 See also: **29 Jan 2008**.
2168, May 28	Aten NEA **2017 JF3** (*H* = 22.0 mag, *D* ≈ 140 m, **PHA**) will pass Earth at a nominal miss distance of 4.02 LD. Minimum miss distance 3.19 LD. See: 2017 JF3 – SSA , 2017 JF3 – JPL See als: **28 May 2149**.
2168, Nov 1	Apollo NEA **374158** (**2004 UL**, *H* = 18.7 mag, *D* ≈ 600 m, **PHA**) will pass Earth at a nominal miss distance of 3.24 LD. Minimum miss distance 2.99 LD. See also: https://en.wikipedia.org/wiki/(374158)_2004_UL See: 2004 UL - JPL , 2004 UL - SSA
2169, Feb 9	Apollo NEA **2018 DA1**, *H* = 19.0 mag, *D* = 600 m, **PHA**) will pass Earth at a nominal miss distance of 3.78 LD. Minimum miss distance 3.75 LD. See: 2018 DA1 - SSA , 2018 DA1 - JPL
2169, Jul 29	Apollo NEA **2014 SP142**, *H* = 21.8 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 5.81 LD. Minimum miss distance 1.05 LD. See: 2014 SP142 - JPL , 2014 SP142 - SSA
2169, Aug 23	Aten NEA **3362 Khufu** (**1984 QA**, *H* = 17.5 mag, *D* ≈ 700 m, **PHA**) will pass Earth at a nominal miss distance of 4.38 LD. Minimum miss distance 4.25 LD. See: 1984 QA - JPL , 1984 QA - SSA See also: https://en.wikipedia.org/wiki/3362_Khufu
2172, Jan 14	Apollo NEA **2013 BY2** (*H* = 27.3 mag, *D* ≈ 12 m) will pass Earth at a nominal miss distance of 1.60 LD. Minimum miss distance 0.18 LD. See: 2013 BY2 - SSA , 2013 BY2 - JPL
2172, Feb 8	Apollo NEA **276033** (**2002 AJ129**, *H* = 19.1 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 1.78 LD. Minimum miss distance 1.77 LD.

	See: 2002 AJ129 - JPL , 2002 AJ129 - SSA See also: https://en.wikipedia.org/wiki/(276033)_2002_AJ129
2172, Mar 7	Apollo NEA **2007 ED125** (*H* = 21.3 mag, *D* = 200 m, **PHA**) will pass Earth at a nominal miss distance of 4.64 LD. Minimum miss distance 4.63 LD. See: 2007 ED125 - SSA , 2007 ED125 - JPL
2174, Jul 16	Apollo NEA **2019 NB7** (*H* = 27.3 mag, *D* = 13 m) will pass Earth at a nominal miss distance of 0.65 LD. **Minimum miss distance 0.021 LD (= 1.27 R_{Earth} from the geocenter).** **[2174-01]** See: 2019 NB7 - SSA , 2019 NB7 - JPL
2174, Dec 10	Aten NEA **2015 YU7** (*H* = 21.6 mag, *D* = 170 m, **PHA**) will pass Earth at a nominal miss distance of 3.53 LD. Minimum miss distance 3.53 LD. See: 2015 YU7 - SSA , 2015 YU7 - JPL See also: **10 Dec 2142**.
2175, May 1	Apollo NEA **164121** (**2003 YT1**, *H* = 16.4 mag, *D* ≈ 1100 m, **PHA**) will pass Earth at a nominal miss distance of 6.35 LD. Minimum miss distance 6.11 LD. See: 164121 2003 YT1 - SSA , 2003 YT1 - JPL See also: https://en.wikipedia.org/wiki/(164121)_2003_YT1 See also: **29 Apr 2073**.
2175, Aug 19	Apollo NEA **2017 RV** (*H* = 22.1 mag, *D* ≈ 140 m, **PHA**) will pass Earth at a nominal miss distance of 4.78 LD. Minimum miss distance 3.44 LD. See: 2017 RV – SSA , 2017 RV – JPL See also: **17 Aug 1979**, **19 Aug 2125**.
2176, Apr 12	Apollo NEA **2021 GW4** (*H* = 29.5 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 2.19 LD. Minimum miss distance 0.89 LD. See: 2021 GW4 – S2P , 2021 GW4 - JPL See also: **12 Apr 2021**.
2176, Apr 27	Apollo NEA **2012 HM** (*H* = 24.4 mag, *D* ≈ 50 m) will pass Earth at a nominal miss distance of 5.09 LD. Minimum miss distance 0.14 LD. See: 2012 HM - SSA , 2012 HM - JPL
2177, Jan 28	Apollo NEA **2017 BA7** (*H* = 27.8 mag, *D* ≈ 10 m) will pass Earth at a nominal miss distance of 1.52 LD. Minimum miss distance

	0.81 LD. See: 2017 BA7 - SSA , 2017 BA7 - JPL
2177, Mar 24	Aten NEA **2016 BC14** (*H* = 21.1 mag, *D* ≈ 210 m, **PHA**), will pass Earth at a nominal miss distance of 3.38 LD. Minimum miss distance 2.94 LD. See: 2016 BC14 – SSA , 2016 BC14 – JPL
2177, Mar 29	Apollo NEA **374851** (**2006 VV2** , *H* = 16.9 mag, *D* ≈ 1800 m, **PHA**) will pass Earth at a nominal miss distance of 12.4 LD. Minimum miss distance 12.4 LD. See: 374851 2006 VV2 - SSA , 2006 VV2 - JPL See also: **31 Mar 2007**.
2177, Nov 11	Aten NEA **2017 XS2** (*H* = 26.0 mag, *D* ≈ 22 m) will pass Earth at a nominal miss distance of 2.27 LD. Minimum miss distance 0.03 LD. See: 2017 XS2 - SSA , 2017 XS2 - JPL
2178, Apr 18	Apollo NEA **2013 CE129** (*H* = 22.4 mag, *D* ≈ 120 m), will pass Earth at a nominal miss distance of 4.46 LD. Minimum miss distance 3.85 LD. See: 2013 CE129 – SSA , 2013 CE129 - JPL
2178**,** Nov 21	Aten NEA **2019 OR1** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**), will pass Earth at a nominal miss distance of 3.52 LD. Minimum miss distance 3.51 LD. See: 2019 OR1 - JPL , 2019 OR1 - SSA See also: **19 Nov 1902** , **20 Nov 2085**, **21 Nov 2100**.
2179, Feb 4	Aten NEA **2020 CA** (*H* = 29.4 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 5.65 LD. Minimum miss distance 0.08 LD. See: 2020 CA – S2P , 2020 CA – JPL See also: **2 Feb 2020**.
2179, Apr 13	Apollo NEA **2016 FV13** (*H* = 26.0 mag, *D* ≈ 23 m) will pass Earth at a nominal miss distance of 1.29 LD. Minimum miss distance 0.52 LD. See: 2016 FV13 - SSA , 2016 FV13 - JPL
2179, Dec 28	Apollo NEA **452302** (**1995 YR1**, *H* = 20.6 mag, *D* = 270 m, **PHA**) will pass Earth at a nominal miss distance of 4.15 LD. Minimum miss distance 3.94 LD. See: 1995 YR1 - SSA , 1995 YR1 - JPL

2180, Oct 10	Apollo NEA **2018 QT** (*H* = 21.1 mag, *D* ≈ 220 m, **PHA**) will pass Earth at a nominal miss distance of 4.81 LD. Minimum miss distance 4.76 LD. See: 2018 QT – SSA , 2018 QT – JPL See also: **8 Oct 2073**.
2181, Feb 9	Apollo NEA**523606** (**2005 CJ**, *H* = 20.3 mag, *D* = 300 m, **PHA**) will pass Earth at a nominal miss distance of 4.16 LD. Minimum miss distance 4.16 LD. See: 2005 CJ - SSA , 2005 CJ - JPL
2181, Jun 25	Apollo NEA **441987** (**2010 NY65**, *H* = 21.4 mag, *D* ≈ 228 m, **PHA**) will pass Earth at a nominal miss distance of 8.49 LD. Minimum miss distance 8.49 LD. See: 2010 NY65- SSA , 2010 NY65 - JPL See also: **24 Jun 2017, 24 Jun 2018, 24 Jun 2019, 24 Jun 2020**
2181, Dec 29	Aten NEA **2019 AQ2** (*H* = 25.7 mag, *D* ≈ 26 m) will pass Earth at a nominal miss distance of 4.45 LD. Minimum miss distance 0.63 LD. See: 2019 AQ2 – SSA , 2019 AQ2 - JPL
2183, Jan 12	Apollo NEA **332446** (**2008 AF4**, *H* = 19.7 mag, *D* = 400 m, **PHA**) will pass Earth at a nominal miss distance of 5.41 LD. Minimum miss distance 3.96 LD. See: 332446 2008 AF4 - SSA , 2008 AF4 - JPL See also: http://en.wikipedia.org/wiki/2008_AF4
2184, Aug 30	Aten NEA **2020 QV6** (*H* = 22.5 mag, *D* ≈ 110 m) will pass Earth at a nominal miss distance of 7.76 LD. Minimum miss distance 7.55 LD. See: 2020 QV6 – S2P , 2020 QV6 - JPL See also: **28 Aug 2020**, **30 Aug 2102**.
2184, Sep 10	Aten NEA **523950** (**1998 SZ27**, *H* = 20.5 mag, *D* = 280 m, **PHA**) will pass Earth at a nominal miss distance of 3.04 LD. Minimum miss distance 3.03 LD. See: 1998 SZ27 - SSA , 1998 SZ27 - JPL
2185, Feb 20	Aten NEA **2019 BE5** (*H* = 25.1 mag, *D* ≈ 30 m) will pass Earth at a nominal miss distance of 6.65 LD. Minimum miss distance 0.18 LD. See: 2019 BE5 – SSA , 2019 BE5 - JPL
2185, Mar 29	Apollo NEA **410777** (**2009 FD**, *H* = 22.3 mag, *D* ≈ 472 m, **PHA**)

	will pass Earth at a nominal miss distance of 13.16 LD. Minimum miss distance 6.16 LD. See: 410777 2009 FD - SSA , 2009 FD - JPL Ref: - F. Spoto, A. Milani, D. Farnocchia, S.R. Chesley, M. Micheli, G.B. Valsecchi, D. Perna, O. Hainaut, 2014, *Astronomy & Astrophysics*, 572, 100, "Non-gravitational perturbations and virtual impactors: the case of asteroid **2009 FD**." See: http://adsabs.harvard.edu/abs/2014A%26A...572A.100S See also: http://www.space.com/12645-asteroid-deflection-doomsday-earth-capability.html http://www.eso.org/public/announcements/ann14004/ http://neo.ssa.esa.int/ http://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness/European_cooperation_reduces_asteroid_risk http://en.wikipedia.org/wiki/2009_FD See also: **27 Mar 2009**.
2185, Jul 22	Aten NEO **2017 OO1** (*H* = 24.7 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 1.44 LD. Minimum miss distance 0.16 LD. See: 2017 OO1 - SSA , 2017 OO1 - JPL See also: https://watchers.news/2017/07/25/asteroid-2017-oo1/ http://earthsky.org/space/asteroid-2017-oo1-close-pass-undetected https://en.wikipedia.org/wiki/2017_OO1 See also: **21 July 2017**
2185, Aug 4	Apollo NEA **2011 EL11** (*H* = 19.9 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 3.07 LD. Minimum miss distance 2.85 LD. See: 2011 EL11 - SSA , 2011 EL11 - JPL
2186, Jun 17	Apollo NEA **152685** (**1998 MZ**, *H* = 19.4 mag, *D* ≈ 500 m, **PHA**) will pass Earth at a nominal miss distance of 19.55 LD. Minimum miss distance 0.48 LD. See: 152685 1998 MZ - SSA , 1998 MZ - JPL See also: **13 Jun 2175**.
2186, Jul 16	Apollo NEA **314082 Dryope** (**2005 CZ36**, *H* = 17.4 mag, ***D* ≈ 1200 m**, **PHA**) will pass Earth at a nominal miss distance of 3.69 LD. Minimum miss distance 3.00 LD. See: 314082 2005 CZ36 - SSA , 2005 CZ36 - JPL
2186, Oct 12	Aten NEA **2020 TK5** (*H* = 23.7 mag, *D* ≈ 70 m) will pass Earth at a nominal miss distance of 8.16 LD. Minimum miss distance 0.96

	LD. See: 2020 TK5 – S2P , 2020 TK5 – JPL See also: **11 Oct 1978**.
2187, Apr 28	Apollo NEA **2014 HM4** (*H* = 27.2 mag, *D* ≈ 13 m) will pass Earth at a nominal miss distance of 6.72 LD. Minimum miss distance 0.85 LD. See: 2014 HM4 – SSA , 2014 HM4 – JPL
2187, Sep 2	Aten NEA **2017 RH16** (*H* = 26.2 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 7.14 LD. Minimum miss distance 0.54 LD. See: 2017 RH16 - SSA , 2017 RH16 - JPL
2189, Jan 21	Apollo NEA **2011 BM45** (*H* = 21.7 mag, *D* ≈ 160 m, **PHA**) will pass Earth at a nominal miss distance of 4.76 LD. Minimum miss distance 4.76 LD. See: 2011 BM45 – SSA , 2011 BM45 - JPL
2189, Oct 3	Apollo NEA **360191** (**1988 TA**, *H* = 20.0 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 4.75 LD. Minimum miss distance 4.12 LD. See: 1988 TA - SSA , 1988 TA - JPL See also: **29 Sep 1988**, **30 Sep 2053**.
2189, Oct 27	Apollo NEA **2011 WL2** (*H* = 20.7 mag, *D* ≈ 250 m, **PHA**) will pass Earth at a nominal miss distance of 1.79 LD. Minimum miss distance 0.16 LD. See: 2011 WL2 – SSA , 2011 WL2 – JPL
2189, Nov 18	Aten NEA **2009 WQ6** (*H* = 29.1 mag, *D* ≈ 5 m) will pass Earth at a nominal miss distance of 0.82 LD. Minimum miss distance 0.14 LD. **[2189-01]** See: 2009 WQ6 - SSA , 2009 WQ6 - JPL See also: **16 Nov 2009**.
2190, May 21	Apollo NEA **452807** (**2006 KV89**, *H* = 21.8 mag, *D* = 160 m, **PHA**) will pass Earth at a nominal miss distance of 4.48 LD. Minimum miss distance 4.41 LD. See: 2006 KV89 - SSA , 2006 KV89 - JPL
2190, Nov 22	Aten NEA **413577** (**2005 UL5**, *H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 6.29 LD. Minimum miss distance 6.28 LD. See: 413577 2005 UL5 - SSA , 2005 UL5 - JPL See also: **23 Nov 2200**.

2191, Jan 11	Aten NEA **2018 AM12** (*H* = 20.9 mag, *D* ≈ 230 m, **PHA**) will pass Earth at a nominal miss distance of 4.13 LD. Minimum miss distance 2.94 LD. See: 2018 AM12 - JPL , 2018 AM12 - SSA See also: **9 Jan 1982**.
2191, Feb 19	Aten NEA **2018 CW2** (*H* = 25.7 mag, *D* = 25 m) will pass Earth at a nominal miss distance of 3.83 LD. Minimum miss distance 0.29 LD. See: 2018 CW2 – SSA , 2018 CW2 – JPL See also: **19 Feb 2193**.
2192, Feb 15	Apollo NEA **2007 PV27** (*H* = 20.5 mag, *D* = 300 m, **PHA**) will pass Earth at a nominal miss distance of 2.25 LD. Minimum miss distance 2.24 LD. See: 2007 PV27 - SSA , 2007 PV27 - JPL
2192, Aug 21	Apollo NEA **137126** (**1999 CF9**, *H* = 18.2 mag, *D* ≈ 900 m, **PHA**) will pass Earth at a nominal miss distance of 4.97 LD. Minimum miss distance 4.97 LD. See: 137126 1999 CF9 - SSA , 1999 CF9 - JPL
2193, Jan 23	Apollo NEA **523804** (**2000 YF29**, *H* = 20.5 mag, *D* = 290 m, **PHA**) will pass Earth at a nominal miss distance of 2.60 LD. Minimum miss distance 2.58 LD. See: 2000 YF29 - SSA , 2000 YF29- JPL See also: **25 Jan 2136.**
2193, Feb 19	Aten NEA **2018 CW2** (*H* = 25.7 mag, *D* = 25 m) will pass Earth at a nominal miss distance of 2.12 LD. **Minimum miss distance 0.00090 LD (= 0.054 R_{Earth} from the geocenter).** See: 2018 CW2 – SSA , 2018 CW2 – JPL See also: **19 Feb 2191**.
2193, Mar 21	Apollo NEA **354182** (**2002 DU3**, *H* = 20.6 mag, *D* = 270 m, **PHA**) will pass Earth at a nominal miss distance of 1.60 LD. Minimum miss distance 1.54 LD. See: 2002 DU3 - SSA , 2002 DU3 - JPL
2194, Feb 13	Aten NEA **2009 BE58** (*H* = 21.8 mag, *D* = 150 m, **PHA**) will pass Earth at a nominal miss distance of 2.53 LD. Minimum miss distance 2.48 LD. See: 2009 BE58 - SSA , 2009 BE58 - JPL See also: **10 Feb 1950**, **11 Feb 2058**.

2194, Mar 7	Apollo NEA **474158** (**1999 FA**, *H* = 20.9 mag, *D* = 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.58 LD. Minimum miss distance 1.89 LD. See: 1999 FA - SSA , 1999 FA - JPL See also: **6 Mar 1909**, **6 Mar 1999**, **6 Mar 2143**.
2194, Nov 16	Apollo NEA **374855** (**2006 VQ13**, *H* = 19.9 mag, *D* ≈ 400 m, **PHA**) will pass Earth at a nominal miss distance of 2.31 LD. Minimum miss distance 2.31 LD. See: 374855 2006 VQ13 - SSA , 2006 VQ13 - JPL
2195, Feb 26	Apollo NEA **2017 BY93** (*H* = 23.2 mag, *D* ≈ 80 m) will pass Earth at a nominal miss distance of 3.66 LD. Minimum miss distance 0.91 LD. See: 2017 BY93 - SSA , 2017 BY93 - JPL
2196, Mar 25	Apollo NEA **2017 FZ2** (*H* = 26.6 mag, *D* ≈ 17 m) will pass Earth at a nominal miss distance of 3.75 LD. Minimum miss distance 0.69 LD. See: 2017 FZ2 - SSA , 2017 FZ2 - JPL See also: https://en.wikipedia.org/wiki/2017_FZ2
2196, May 5	Apollo NEA **144898** (**2004 VD17**, *H* = 19.0 mag, *D* ≈ 320 m, **PHA**) will pass Earth at a nominal miss distance of 2.56 LD. Minimum miss distance 1.70 LD. See: 2004 VD17 - SSA , 2004 VD17 - JPL See also: https://en.wikipedia.org/wiki/(144898)_2004_VD17 See also: **7 Nov 2041**, **7 May 2148**.
2196, Jul 11	Apollo NEA **2017 MC4** (*H* = 22.0 mag, *D* ≈ 140 m) will pass Earth at a nominal miss distance of 4.66 LD. Minimum miss distance 1.10 LD. See: 2017 MC4 – SSA , 2017 MC4 - JPL
2197, Mar 13	Aten NEA **2021 EL4** (*H* = 25.8 mag, *D* ≈ 24 m) will pass Earth at a nominal miss distance of 1.96 LD. Minimum miss distance 0.59 LD. See: 2021 EL4 – S2P , 2021 EL4 – JPL
2197, Apr 22	Apollo NEA **2013 WT45** (*H* = 20.4 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 2.50 LD. Minimum miss distance 0.89 LD. See: 2013 WT45 - SSA , 2013 WT45 - JPL
2197, Jun 11	Amor NEA **2018 EJ4** (*H* = 21.4 mag, *D* ≈ 190 m, **PHA**) will pass

	Earth at a nominal miss distance of 4.82 LD. Minimum miss distance 4.57 LD. See: 2018 EJ4 - SSA , 2018 EJ4 - JPL See also: **10 Jun 2018**.
2197, Oct 23	Apollo NEA **2014 SM143**, (*H* = 20.4 mag, *D* ≈ 290 m, **PHA**) will pass Earth at a nominal miss distance of 1.94 LD. Minimum miss distance 0.36 LD. See: 2014 SM143 - SSA , 2014 SM143 - JPL See also: **20 Apr 1934**, **19 Apr 2093**.
2198, Mar 18	Apollo NEA **2015 PM** (*H* = 20.3 mag, *D* ≈ 300 m, **PHA**) will pass Earth at a nominal miss distance of 3.22 LD. Minimum miss distance 3.21 LD. See: 2015 PM - SSA , 2015 PM - JPL See also: **16 Mar 2077**.
2198, Mar 25	Apollo NEA **2011 FV6** (*H* = 24.9 mag, *D* ≈ 40 m) will pass Earth at a nominal miss distance of 3.85 LD. Minimum miss distance 0.93 LD. See: 2011 FV6 - SSA , 2011 FV6 - JPL
2198, May 5	Apollo NEA **290772** (**2005 VC**, *H* = 17.4 mag, ***D* ≈ 1200 m**, **PHA**) will pass Earth at a nominal miss distance of 1.97 LD. Minimum miss distance 1.82 LD. See: 290772 2005 VC - SSA , 2005 VC - JPL
2199, Apr 22	Apollo NEA **2014 YS34** (*H* = 20.7 mag, *D* = 260 m, **PHA**) will pass Earth at a nominal miss distance of 4.69 LD. Minimum miss distance 4.63 LD. See: 2014 YS34 - SSA , 2014 YS34 - JPL
2199, Jul 6	Apollo NEA **2020 NB** (*H* = 26.3 mag, *D* ≈ 20 m) will pass Earth at a nominal miss distance of 7.55 LD. Minimum miss distance 0.47 LD. See: 2020 NB – S2P , 2020 NB – JPL See also : **5 Jul 2020**.
2200, Nov 1	Aten NEA **475534** (**2006 TS7**, *H* = 21.3 mag, *D* = 200 m, **PHA**) will pass Earth at a nominal miss distance of 4.47 LD. Minimum miss distance 4.47 LD. See: 2006 TS7 - SSA , 2006 TS7 - JPL See also: **29 Oct 2018**.
2200, Nov 23	Aten NEA **413577** (**2005 UL5**, *H* = 20.5 mag, *D* ≈ 280 m, **PHA**) will pass Earth at a nominal miss distance of 5.84 LD. Minimum

	miss distance 5.78 LD. See: 413577 2005 UL5- SSA , 2005 UL5 - JPL See also: **22 Nov 2190**.
…	
2880, Mar 16	Apollo NEA **29075** (**1950 DA** = **2000 YK66**, *H* = 17.5 mag, *D* ≈ 1.39 km | 1.46 km | 1.07 km, **PHA**) has a 1-in-8330 chance of impacting in 2880. See: 29075 1950 DA - SSA , 1950 DA - JPL Ref: - J.D. Giorgini, S.J. Ostro, L.A.M. Benner, et al., 2002, *Science*, 296, 132, "Asteroid **1950 DA**'s encounter with Earth in 2880: physical limits of collision probability prediction." See: http://adsabs.harvard.edu/abs/2002Sci...296..132G - A.P.J. Abdul Kalam, President of India, 4 January 2003, Space Summit address to the 90th Indian Science Congress, "Vision for the global space community: prosperous, happy and secure planet earth." See: http://neo.jpl.nasa.gov/1950da/1950DA_Kalam_90th_Indian_Congress.pdf - K. Wong, 2003, *Scientific American*, "2880 asteroid impact simulation suggests tsunamis could hammer Atlantic coast." See: http://www.scientificamerican.com/article.cfm?id=2880-asteroid-impact-simu - S.N. Ward, E. Asphaug, 2003, *Geophysical Journal International*, 153, F6, "Asteroid impact tsunami of 2880 March 16." See: http://adsabs.harvard.edu/abs/2003GeoJI.153F...6W - S.J. Ostro, J.D. Giorgini, 2004, in: M.J.S. Belton, et al. (eds.), *Mitigation of Hazardous Comets and Asteroids* (Cambridge: CUP), p. 54, "The role of radar in predicting and preventing asteroid and comet collisions with Earth." See: http://adsabs.harvard.edu/abs/2004mhca.conf...38O - M.W. Busch, J.D. Giorgini, S.J. Ostro, et al., 2007, *Icarus*, 190, 608, "Physical modeling of near-Earth asteroid (**29075**) **1950 DA**." See: http://adsabs.harvard.edu/abs/2007Icar..190..608B - D. Farnocchia, S.R. Chesley, 2014, *Icarus*, 229, 321, "Assessment of the 2880 impact threat from asteroid **(29075) 1950 DA**." See: http://adsabs.harvard.edu/abs/2014Icar..229..321F See also: http://neo.jpl.nasa.gov/1950da/ https://cneos.jpl.nasa.gov/doc/1950da/ http://neo.jpl.nasa.gov/risk/a29075.html http://impact.arc.nasa.gov/news_detail.cfm?ID=111 http://www.planetary.org/news/2002/0412_A_Close_Call_for_Earth_in_

	878_Years.html http://www.scientificamerican.com/article.cfm?id=asteroid-impact-possible http://neo.ssa.esa.int/ # January 2016. http://en.wikipedia.org/wiki/(29075)_1950_DA See also: **5 Mar 2001**.

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EXTERNAL LINKS

American Meteor Society	http://www.amsmeteors.org/fireballs/
ANSMET	http://geology.cwru.edu/~ansmet/
Arcetri NEO Procovery Program	http://www.arcetri.astro.it/science/aneopp/
Asia-Pacific Asteroid Observation Network	http://www.spaceguard.or.jp/apaon/index.html
Asiago DLR Asteroid Survey	http://dipastro.pd.astro.it/planets/adas/#team
Association of Space Explorers	http://www.space-explorers.org/committees/NEO/neo.html
Asteroid Day	http://www.asteroidday.org/
Asteroid Deflection Research Center	http://www.adrc.iastate.edu/
Asteroid and Comet Impact Hazards	http://impact.arc.nasa.gov/
Asteroid Impact & Deflection Assessment (***AIDA***)	http://www.esa.int/esaMI/NEO/SEMAWBTWT1H_0.html https://www.nasa.gov/planetarydefense/aida
Asteroid Impact Mission (***AIM***)	http://www.esa.int/Our_Activities/Space_Engineering_Technology/NEO/Asteroid_Impact_Mission_AIM
Asteroid Threat Assessment Project (ATAP)	https://www.lpi.usra.edu/sbag/meetings/jun2017/presentations/Mathias.pdf
Asteroid Watch	http://www.jpl.nasa.gov/asteroidwatch/
AsteroidWatch (on Twitter)	http://twitter.com/AsteroidWatch
Astrophysics Data System	http://www.adsabs.harvard.edu/
Asteroid Radar Research	http://echo.jpl.nasa.gov/
AsteroidFinder	http://www.dlr.de/pf/en/desktopdefault.aspx/tabid-174/319_read-18911/
ATLAS	http://www.fallingstar.com/index.php
B612 Foundation	http://www.b612foundation.org/
B612 Foundation Asteroid Institute	https://b612foundation.org/resource_subjects/asteroid-institute/
Cameras for Allsky Meteor Surveillance (CAMS)	http://cams.seti.org/
Catalina Sky Survey	http://www.lpl.arizona.edu/css/index.html
Chang'e-2	http://en.wikipedia.org/wiki/Chang'e_2
China NEO Survey (NEOST)	http://english.pmo.cas.cn/rh/dcm/nsb/200908/t20090831_35079.html
CINEOS	http://en.wikipedia.org/wiki/Campo_Imperatore_Near-Earth_Object_Survey
Daily Minor Planet	http://www.minorplanetcenter.net/daily-minor-planet
Discovery Channel Telescope	http://www.lowell.edu/dct/
DANEOPS	http://earn.dlr.de/daneops/
DARPA Space Surveillance Telescope (SST)	http://www.darpa.mil/program/space-surveillance-telescope
Desert Fireball Network (DFN)	http://www3.imperial.ac.uk/desertfireballnetwork
DLR Institute of Planetary Research	http://www.dlr.de/pf/en/
European Asteroid Research Node	http://earn.dlr.de/
EARN NEA Data Base	http://earn.dlr.de/nea/
Earth Impact Effects Program	http://impact.ese.ic.ac.uk/ImpactEffects/
Ephemerides of Minor Planets	http://www.ipa.nw.ru/PAGE/DEPFUND/LSBSS/engephem.htm
ESA Fly-eye telescope	http://www.esa.int/spaceinimages/Images/2016/10/Fly-eye_telescope
ESA ***Hera***	http://www.esa.int/Our_Activities/Space_Engineering_Technology/Hera/Hera

ESA NEO Coordination Center http://neo.ssa.esa.int/
ESA NEO Space Mission Studies http://www.esa.int/Our_Activities/Technology/NEO
ESA Planetary Defence Office
http://www.esa.int/Enabling_Support/Operations/Planetary_Defence_Office_contact_details
ESA Space Situational Awareness http://www.esa.int/ssa/neo
http://www.esa.int/Our_Activities/Operations/Near-Earth_Objects_-_NEO
ESA Tenerife Observatory Teide Asteroid Survey (TOTAS) https://totas.cosmos.esa.int/mover.php?id=220640
European Fireball Network http://www.dlr.de/pf/desktopdefault.aspx/tabid-623
European Planetary Science Congress http://www.europlanet-ri.eu/epsc
European NEA Search Observatories http://earn.dlr.de/euneaso.htm
EURONEAR http://euronear.imcce.fr/tiki-index.php?page=HomePage
Earth Impact Database http://www.passc.net/EarthImpactDatabase/index.html
Hayabusa http://www.isas.jaxa.jp/e/enterp/missions/hayabusa/index.shtml
Hayabusa-2 http://www.jspec.jaxa.jp/e/activity/hayabusa2.html
IAF NEOs Technical Committee
http://www.iafastro.com/index.html?title=Committee_on_Near_Earth_Objects
IAU Minor Planet Center http://www.cfa.harvard.edu/iau/mpc.html
IAU Meteor Data Center http://www.astro.amu.edu.pl/~jopek/MDC2007/
International Asteroid Warning Network (IAWN) http://iawn.net
Impact Database http://impacts.rajmon.cz/index.html
IMPACTON http://www.on.br/impacton/
International Academy of Astronautics (IAA) http://www.iaaweb.org/
International Asteroid Warning Network http://www.minorplanetcenter.net/IAWN/ , http://iawn.net/
99942 Apophis 2021 Observing Campaign http://iawn.net/obscamp/Apophis/
International Astronomical Union (IAU) http://www.iau.org
International Meteor Organization (IMO) http://www.imo.net/
International Primitive Body Exploration Working Group http://ipewg.caltech.edu/
International Scientific Optical Network (ISON) http://lfvn.astronomer.ru/report/0000029/index.htm
International Asteroid Warning Network (IAWN) http://www.minorplanetcenter.net/IAWN/
Jet Propulsion Laboratory's Center for NEO Studies (CNEOS) http://cneos.jpl.nasa.gov/
KLENOT http://www.klet.org/?stranka=klenot&menu_id=4&uroven=2
La Sagra Sky Survey http://lasagraskysurvey.org/
Large Synoptic Survey Telescope http://www.lsst.org/lsst
LCOGT network http://lcogt.net/
LINEAR http://www.ll.mit.edu/mission/space/linear/
Lowell Discovery Telescope https://lowell.edu/research/research-facilities/4-3-meter-ldt/
LPI http://www.lpi.usra.edu/publications/slidesets/craters/ crater_index.shtml
Marco Polo-R http://www.oca.eu/MarcoPolo-R/
Meteoritical Society http://www.meteoriticalsociety.org/
MIT Project Apophis https://eapsweb.mit.edu/mit-project-apophis
NASA All Sky Fireball Network http://fireballs.ndc.nasa.gov/
NASA Asteroid Initiative and Grand Challenge http://www.nasa.gov/asteroidinitiative
NASA Asteroid and Comet Hazard http://impact.arc.nasa.gov/index.cfm
NASA Asteroid Watch http://www.jpl.nasa.gov/asteroidwatch
NASA Asteroid and Comet Watch http://www.nasa.gov/mission_pages/asteroids/main/index.html
NASA Asteroid Radar Research http://echo.jpl.nasa.gov/
NASA Asteroid Redirect Mission http://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect- mission
https://www.nasa.gov/arm
NASA Meteoroid Environment Office http://www.nasa.gov/offices/meo/home/aboutMEO-rd.html
http://www.nasa.gov/offices/meo/outreach/
NASA Near Earth Object Program http://neo.jpl.nasa.gov/
NASA Planetary Data System https://pds.nasa.gov/
NASA Planetary Data System Small Bodies Node https://pds-smallbodies.astro.umd.edu/
NASA Planetary Defense Coordination Office (PDCO) http://www.nasa.gov/planetarydefense
NASA Planetary Science, Asteroids http://nssdc.gsfc.nasa.gov/planetary/planets/asteroidpage.html
NASA Solar System Exploration Research Virtual Institute (SERVI) http://sservi.nasa.gov

Near-Earth object Lunar Impacts and Optical TrAnsients (NELIOTA)	http://neliota.astro.noa.gr/
NEOCam	http://neocam.ipac.caltech.edu/
NEODyS (University of Pisa)	http://newton.dm.unipi.it/neodys/
NELIOTA	https://neliota.astro.noa.gr/
NEOShield	http://www.neoshield.net/en/index.htm
NEO Scout	https://www.nasa.gov/content/nea-scout
NEOSSat	http://www.asc-csa.gc.ca/eng/satellites/neossat/
NEOStel	http://creotech.pl/project/neostel
NEO-WISE	http://neo.jpl.nasa.gov/stats/wise/ http://neowise.ipac.caltech.edu/ https://www.nasa.gov/mission_pages/WISE/main/index.html
OSIRIS-Rex	http://osiris-rex.lpl.arizona.edu/
Near-Earth Object Human Space Flight Accessible Targets Study (NHATS)	http://neo.jpl.nasa.gov/nhats/
Pan-STARRS	http://pan-starrs.ifa.hawaii.edu/public/
Planetary Data System	http://pds.nasa.gov/
Planetary Defense	http://planetary.org/defense
Planetary Resources	http://www.planetaryresources.com/
Planetary Society	http://www.planetary.org/home/
Radar Astronomy	http://mel.ess.ucla.edu/radar/
Space Mission Planning Advisory Group (SMPAG)	http://www.cosmos.esa.int/web/smpag/home http://smpag.net
Secure World Foundation	http://www.secureworldfoundation.org/
Sentinel Space Telescope Mission	http://b612foundation.org/media/sentinelmission/
SENTRY (JPL)	http://neo.jpl.nasa.gov/risk/
Siding Spring Survey	http://www.mso.anu.edu.au/~rmn/
Slooh SpaceCamera	http://events.slooh.com/
Small Bodies Assessment Group	http://www.lpi.usra.edu/sbag/
Small Solar System Objects Spectroscopic Survey (S^3OS^2)	http://sbn.psi.edu/pds/resource/s3os2.html
Space Missions Planning Advisory Group	http://www.cosmos.esa.int/web/smpag
Solar System Object Search	http://www3.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/ssos/
Space Foundation	http://www.spacefoundation.org/
Space Generation Advisory Council	http://spacegeneration.org/
The Spaceguard Center	https://spaceguardcentre.com/
Spaceguard Foundation	http://spaceguard.iasf-roma.inaf.it/
Spaceguard Central Node	http://www.esa.int/esaMI/NEO/SEMS58OVGJE_0.html
Spaceguard Australia	http://users.tpg.com.au/users/tps-seti/spacegd.html
Spaceguard Croatia	http://www.astro.hr/spaceguard/
Spaceguard Japan	http://www.spaceguard.or.jp/ja/e_index.html
Spaceguard Spain	http://www.spaceguardspain.org/
Spaceguard United Kingdom	http://www.spaceguarduk.com/
Spacewatch	http://spacewatch.lpl.arizona.edu/
TOTAS	http://vmo.estec.esa.int/totas
UAO-DLR Asteroid Survey (UDAS)	http://earn.dlr.de/udas/
UN-COPUOS	http://www.oosa.unvienna.org/oosa/COPUOS/copuos.html
UN-COPUOS STSC	http://www.unoosa.org/oosa/en/ourwork/copuos/stsc/2019/index.html
UN Office for Outer Space Affaires	http://www.unoosa.org/
UN OOSA Near Earth Objects	http://www.unoosa.org/oosa/en/ourwork/topics/neos/index.html
Warm ***Spitzer*** NEO Survey	http://ssc.spitzer.caltech.edu/spitzermission/observingprograms/es/
WFIRST	https://wfirst.gsfc.nasa.gov/ https://wfirst.gsfc.nasa.gov/about.html https://www.nasa.gov/wfirst

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