

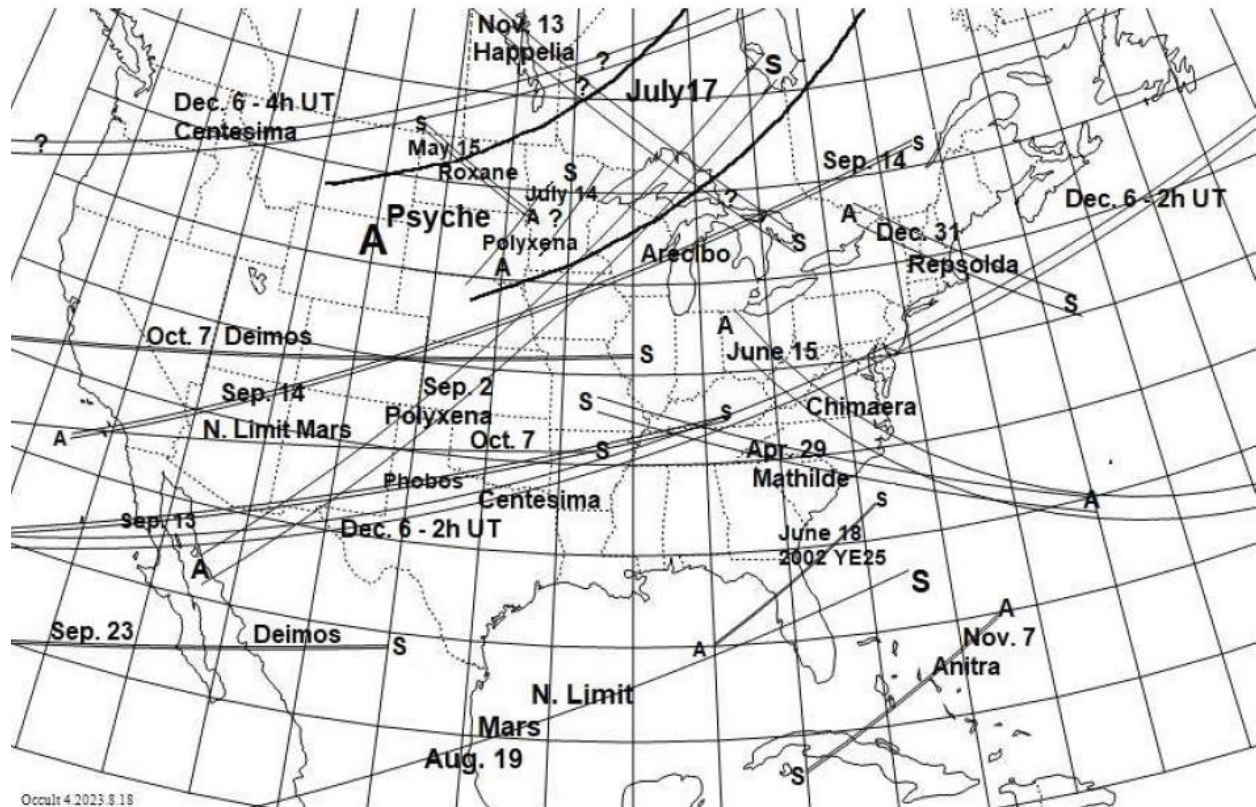
2024 Occultations by Special Main-Belt Asteroids

The map, and the corresponding table, similar to those of the pages for other 2024 asteroidal occultations, shows the paths for occultations of a selected group of Main-Belt asteroids that will be occultated in 2024. These are objects that have unusual shapes, or known or suspected significant moons, for which new observations will be valuable to better characterize them. Most future updates will not be given in this document, but more likely will be on IOTA's special main-belt asteroidal occultations page for 2024 at <https://occultations.org/publications/rasc/2024/nam24MBspecialoccs.htm> .

A good example of a successful campaign for an occultation by an unusual main-belt asteroid was the discovery and confirmation of the large moon of (4337) Arecibo by occultations in 2021 described at <https://occultations.org/publications/rasc/2024/AreciboMoonAccount.pdf>, adopted from an article that was published in the October 2021 issue of *Stardust*, publication of the National Capital Astronomers. We hope to have some further special-object successes in 2024, with the opportunities portrayed below; unfortunately, there are no opportunities with Arecibo in North America in 2022, but there are some chances in other parts of the world.

More about these events is available at the IOTA special Main Belt occultations page at <https://occultations.org/publications/rasc/2024/nam24MBspecialoccs.htm>. With fewer objects than considered in the previous sections, occultations of stars to magnitude 12.0 had to be considered. Two of the stars are brighter than mag. 10.0. Information about the selected objects is given starting at the bottom of the next page.

The best occultations of stars by Special Main-Belt Asteroids in North America during 2024



2024 OCCULTATIONS BY SPECIAL MAIN-BELT ASTEROIDS

Date	UT	Occulting Body	Star	Mag.	RA (2000)			Dec			Dur. s	Path	
					h	m	s	°	'	"			ΔMag.
Apr. 29	01:43	253 Mathilde	EI Tauri	8.9	05	46	56.5	+17	54	31	7.3	1.8	NC-MO
May 15	03:59	317 Roxane	UCAC4 562-032446	11.7	06	37	28.7	+22	20	04	3.4	0.5	SK-ND
Jun. 15	05:15	623 Chimaera	TYC 7404-03568-1	11.7	18	16	13.8	-37	24	58	3.0	3.5	NC-OH
Jun. 18	08:56	172376 2002 YE25	UCAC4 580-006816	12.0	02	59	29.9	+25	58	44	8.8	0.1	FL
Jul. 14	09:21	595 Polyxena	TYC 2413-00257-1	10.1	05	49	14.7	+35	15	53	4.3	2.5	NE-MN
Jul. 17	05:37	16 Psyche	UCAC4 381-166238	11.3	21	18	39.7	-13	54	58	0.3	29.1	QC-WY
Sep. 2	09:21	595 Polyxena	UCAC4 635-039699	11.0	07	04	54.3	+36	59	43	3.4	3.3	Mex-ON
Sep. 13	10:27	Phobos	UCAC4 568-026971	11.7	06	20	48.5	+23	29	40	1.8	1.0	Baja-KY
Sep. 14	09:14	4337 Arecibo	TYC 1895-00394-1	10.8	07	00	15.7	+24	13	20	8.1	0.8	CA-QC
Sep. 23	11:48	Deimos	TYC 1893-01034-1	11.0	07	17	36.4	+22	55	57	3.4	0.6	Baja-Mex
Oct. 7	11:17	Deimos	TYC 1909-00533-1	9.8	07	17	36.4	+22	55	57	4.4	0.6	CA-IL
Nov. 7	23:38	1016 Anitra	UCAC4 309-164338	11.9	18	05	35.6	-28	12	43	5.2	0.3	Cuba-BS
Nov. 13	11:06	578 Happelia	UCAC4 599-026750	11.9	05	58	11.2	+29	44	42	2.7	7.1	ON-MB
Dec. 6	02:53	513 Centesima	UCAC4 476-004159	11.9	02	47	26.8	+05	00	10	2.1	6.3	NJ-Baja
Dec. 6	04:32	513 Centesima	TYC 0053-01328-1	11.9	02	47	24.8	+05	00	02	2.1	6.3	ON-OR
Dec. 31	10:30	906 Repsolda	TYC 6192-00868-1	12.0	15	31	28.8	-19	22	47	3.4	1.8	QC-MA

The map, and the corresponding table, similar to those for main-belt and other types of occultations published in the *RASC Observer's Handbook for 2024*, and for bright main-belt occultations described in <https://occultations.org/publications/rasc/2024/nam24MBoccs.pdf>, shows the paths for occultations of some of the better distant-object occultations during 2024. The successive columns in the table list: (1) the date and central time of the event; (2) the name of the occulting body; (3) the catalogue and number of the occulted star; (4) the star's apparent visual magnitude; (5) the star's right ascension and (6) declination; (7) the expected magnitude change from the combined brightness; (8) the predicted maximum duration of the occultation in seconds; and, (9) the path location specified by the lands crossed by the eastern and western ends of the path shown on the map. The two-letter abbreviations for the US States and Canadian Provinces are given, with the order indicating the direction of motion of the shadow. "Baja" is Baja California, either Norte or Sur, while "Mex" denotes the rest of Mexico. Note that the times are for the geocentric time of closest approach; for any specific location in North America, the event time can be several minutes earlier or later. They are shown if occultations by them of stars brighter than magnitude 12.1 will occur in North America during 2024. Note that the table in the printed handbook has two errors (corrected in our table above): The Deimos occultation listed on Sept. 23 will actually be on Oct. 7, and the Anitra occultation given as Oct. 7 will actually be on Nov. 7. Also, the 4 tables in the Planetary Occultations section of the printed USA edition have no column headings; pages to correct that error are on the RASC 2024 corrections Web page at <https://rasc.ca/2024-edition-updates>.

For 2024, we selected the 29 asteroids described below for our special MB asteroids; in the descriptions below, an "-x" follows the object's name, if no occultations by it of stars brighter than mag. 12.1 will occur in North America during 2024. For those asteroids, occultations by fainter stars, yet observable by many, may occur, and relatively bright events will occur in other parts of the world.

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(16) Psyche: The largest M-class (metallic) asteroid and target of a NASA mission. The occultation by it on July 17 will be difficult since Psyche is brighter than the star; defocus slightly or take other steps to avoid

saturation of the combined image of the objects so you can detect the 0.3 magnitude change. On the map, the Psyche path is very wide, accentuated with thicker lines to avoid confusion of it with 4 other paths it envelops.

(90) Antiope-x: This is a binary asteroid with equal large (~90km) components 171 km apart. Special procedures given at <http://iota.jhuapl.edu/PlottingPathsForAntiopeOccultations.pdf> are needed to show paths of occultations by the separate components, which is crucial for these events; often only a miss by both components will occur at the central line of an uncorrected prediction.

(121) Hermione-x: has an 8-km moon 770 km away, discovered by adaptive optics.

(165) Loreley-x: May have a moon about 5% of Loreley's size, from a 2020 July 21st occultation.

(216) Kleopatra-x: This is the "Dog-bone" asteroid, the 2nd-largest M-class (metallic) asteroid, and has two small moons. Separate predictions are given for the paths of the larger one, **Alexhelios**.

(234) Barbara-x: This may be a contact binary; past occultation observations reveal two lobes.

(252) Clementina-x: Probable unusual shape; see JOA 2023_1, p. 9.

(253) Mathilde: NEAR imaged half the asteroid in 1997; occultations could probe the other half. The star, El Tauri, occulted on Apr. 29, is a Mira variable, spectral type S, with range 10.4 - >15 with a 389d period. Since its maximum is expected on May 15, only 17 days after the occultation, it should be near maximum. Its Gaia # is G054656.5+175431.

(276) Adelheid-x: May have small moon, with K. Green's obs. of 2022 Aug. 31 event, 9 km ~500 km away.

(269) Justitia-x: This very red object may have originated in the Kuiper belt. It is a target of the UAE's Main Belt asteroids mission planned to launch in 2028 and will orbit Justitia and land on it in 2034.

(317) Roxane: This has a 5km moon, Olympias, with separation 245 km.

(319) Leona-x: We want to improve knowledge of the size and shape of this occultation, to better analyze observations of the 2023 Dec. 12th occultation of Betelgeuse by Leona.

(379) Huena-x: An 8-km moon 3000 km away was discovered with adaptive optics at Keck in 2003.

(412) Elisabetha-x: May have a 4km moon 3 diameters away, based on a 2016 Mar. 17 event in Slovakia.

(513) Centesima: This asteroid has an unusual shape.

(578) Happelia: May have a 3km moon a diameter away, based on a 2017 Feb. 24 in seen in Texas.

(595) Polyxena: May have a 23km moon about 3 diameters away, based on a 2008 Feb. 3 occultation.

(623) Chimaera: This is a 44km 2nd flyby target of the UAE Main-Belt asteroids mission.

(705) Erminia-x: May have an 8km moon about 400 km away, from a 2014 Dec. 8th occultation; see https://www.occultations.org.nz/planet/2014/results/20141208_705_Erminia_4UC_315_245088_Rep.htm .

(957) Camelia-x: This asteroid has an unusual shape.

(906) Repsolda: This may have a ~10km moon ~240km away, according to a 2023 Jan. 25 event in Calif.; see <https://www.dr-ricknolthenius.com/events/20230124Repsolda/index.html> .

(1016) Anitra: May have a 4-km moon, based on rotational light-curve observations.

(4337) Arecibo: Binariness discovered during 2021 occultations and confirmed by Gaia to have a 1.3d period.

(4552) Nabelek-x: This was thought to be 6 km across, but a recent paper argues that it is about 20 km.

(5457) Queen's-x: This has a small moon, discovered on 2023 Sep. 4th occ in Switzerland and confirmed during a second occultation 16 days later, observed in Greece, see <https://www.iota-es.de/queen.html> .

(7165) Pendleton-x: Analysis of the rotational lightcurve shows this may be a close binary.

(33074) 1997 WP21-x: This object, 18 km across, may have a 9 km moon with events recorded in 2021.

(52246) Donaldjohanson-x: This is a Lucy-mission 2025 main-belt target on its way to the Jupiter Trojans.

(172376) 2002 YE25: This is likely a binary asteroid, a small version of Antiope, from 2022 May observations of an occultation by P. Nosworthy and D. Gault.

Some relatively bright occultations by Phobos and Deimos, the small moons of Mars, as well as the northern limits of two occultations by Mars, are also shown here, although their Occult input is with the major planet and their moons events for North America for 2024 Web page at

<https://occultations.org/publications/rasc/2024/nam24Planetoccs.htm> .

The orbital elements are all from the NASA JPL Horizons Web site at <https://ssd.jpl.nasa.gov/horizons.cgi> and the stellar data are from the Early third release (EDR3) of the European Space Agency's Gaia mission, as implemented with UCAC4, Tycho, and Hipparcos catalog identifiers with IOTA's free *Occult* software. Since the orbits are often updated, for any event noted here, you should check to see if there is a more recent and more accurate prediction for the event on Occult Watcher Cloud.

The above objects were the ones we decided upon in August last year when we computed the predictions. But other unusually-shaped asteroids, mostly apparently peanut-shaped objects that produced two occultations for some observers, may be included in the predictions for 2025, including (398) Admete, (885) Ulrike, (1721) Wells, (14758) 6519 P-L, and (243267) 2008 AM10. These are of interest since we initially thought this was the case for **(5457) Queen's**, but then 16 days later, observation of another occultation by it clearly showed two well-separated objects, rather than just one elongated object. Later, we might add (3825) Nürnberg, (3819) Robinson, and (21976) 1999 XV2, which, like (4552) Nabelek, are expected to be larger than the standard thermal IR models predict, according to "Probabilistic Modeling of Asteroid Diameters from Gaia DR2 Errors" in Research Notes of the AAS, Aug. 2021, DOI: 10.3847/2515-5172/ac205e, by Rafael S. de Souza et al. Let us know of any other asteroids that you think should be added to the Main-Belt special asteroids list.

The **European Section of IOTA** has their own priority events with calls for observations on their Web page at <https://call4obs.iota-es.de/> and especially for slow-rotating asteroids at https://www.iota-es.de/neglected_asteroids.html – European observers should consult it, since it includes several events that are not in my lists. I consult it to find some of the asteroids for our selection here.

The maps were produced with IOTA's free *Occult* software; see <http://www.lunar-occultations.com/iota/occult4.htm> . You can download and use this software and use it to compute your own local lists and information about these and many other occultations. The information for doing this is at <http://www.lunar-occultations.com/iota/2024iotapredictions.pdf> . This describes a prediction input file for planetary and asteroidal files called **All2024.xml**. You can use that file to generate local predictions, but you can replace it with the other files listed below to generate predictions for more occultations, mainly of fainter stars than shown on the maps, or for other parts of the world:

Nam24MBspecialFinal.xml – This is the input for the 16 special main-belt occultations for North America shown on the map at the bottom of the 1st page.

Nam24MBspecialToMag14.xml – This is the input for 118 occultations across North America by the selected special main-belt asteroids of stars to mag. 14.

2024worldMBspecial.xml – This is the input for 1907 occultations worldwide by the selected special main-belt asteroids of stars to mag. 14.

For worldwide occultations by major and all types of minor planets (mainly main-belt) worldwide for the whole year, fairly comprehensive only to about mag. 12.5, use the **All2024.xml** file noted above, but even more occultations can be found with Occult Watcher (it is limited to the next two months); it is a free download from <http://www.occultwatcher.net/> .

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