

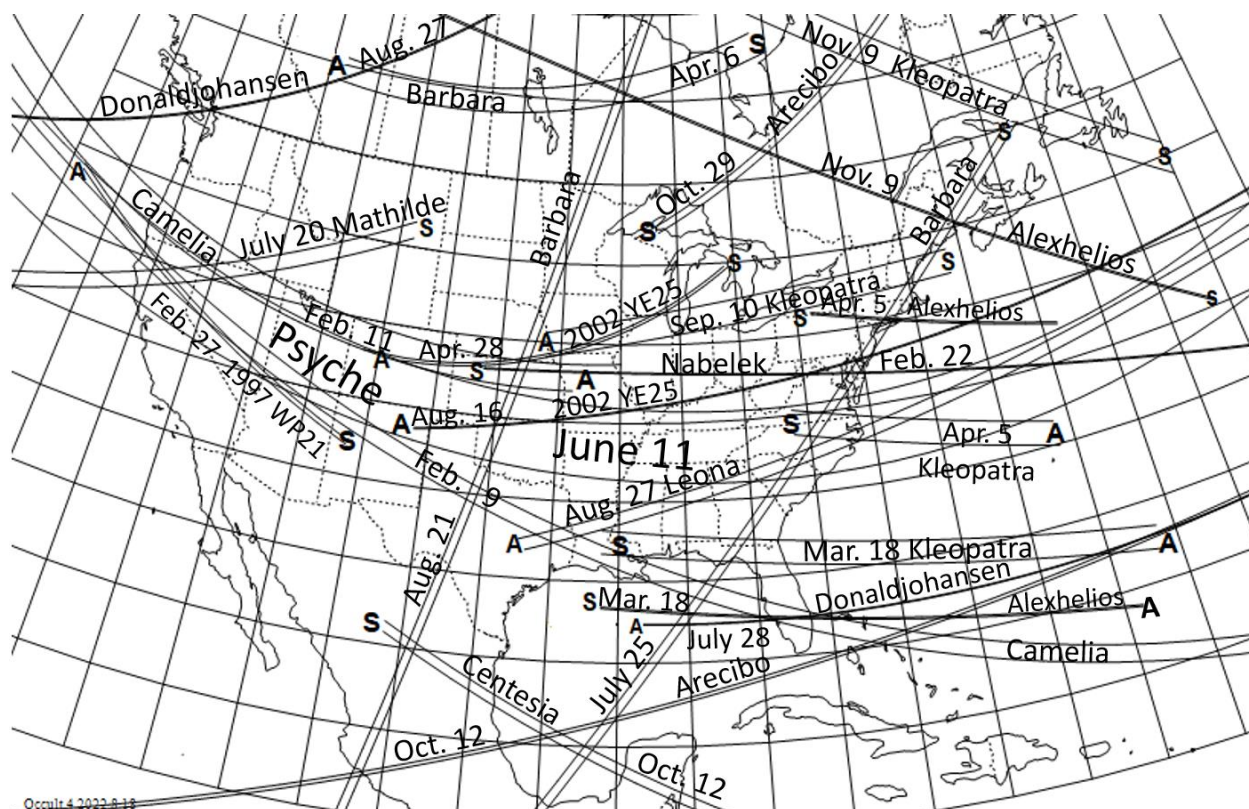
## 2023 Occultations by Special Main-Belt Asteroids

The map, and the corresponding table, similar to those of the previous subsections, shows the paths for occultations of a selected group of Main-Belt asteroids that will be occultated in 2023. 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 2023 at <https://occultations.org/publications/rasc/2023/nam23MBspecialoccs.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/2023/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 2023, 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 now available at the IOTA special Main Belt occultations page at <https://occultations.org/publications/rasc/2023/nam23MBspecialoccs.htm>. With fewer objects than considered in the previous sections, occultations of stars to magnitude 14.0 had to be considered, so these usually require larger telescopes to observe. But three of the stars are brighter than mag. 11.0. 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 2023



## 2023 OCCULTATIONS BY SPECIAL MAIN-BELT ASTEROIDS

Date	UT	Occulting Body	Star	Mag.	RA (2000)			Dec		Dur. s	Path
					h	m	s	°	'		
Feb. 9	06:08	957 Camelia	UCAC4 425-048350	13.3	08 39	41.6	-05 05	33	1.2	6.5	BS-CA
Feb. 11	10:40	957 Camelia	UCAC4 426-047968	13.7	08 37	57.0	-04 56	29	0.9	6.6	IL-OR
Feb. 22	01:30	4552 Nabelek	TYC 1247-00212-1	12.8	03 36	01.0	+21 44	22	5.8	0.3	KS-DE
Feb. 27	12:44	33074 1997 WP21	UCAC4 340-175407	12.6	18 55	07.6	-22 08	29	6.4	0.6	CA-NM
Mar. 18	01:00	Alexhelios	TYC 0634-00190-1	10.7	02 19	49.1	+10 35	22	1.5	0.20	FL-BS
Mar. 18	01:00	216 Kleopatra	TYC 0634-00190-1	10.7	02 19	49.1	+10 35	22	1.5	2.9	LA-FL
Apr. 5	00:48	216 Kleopatra	UCAC4 514-004708	12.4	02 57	59.8	+12 41	49	0.5	2.7	VA-NC
Apr. 5	00:48	Alexhelios	UCAC4 514-004708	12.4	02 57	59.8	+12 41	49	0.5	0.19	NY-LI
Apr. 6	09:11	234 Barbara	UCAC4 415-122294	13.9	19 19	54.0	-07 00	60	0.6	2.0	AB-ON
Apr. 28	09:17	172376 2002 YE25	UCAC4 432-115773	12.1	22 14	10.4	-03 41	46	8.8	0.12	CO-MI
Jun. 11	05:53	16 Psyche	UCAC4 391-062150	13.6	14 50	37.7	-11 56	48	0.1	28.3	NC-OR
Jul. 20	10:04	253 Mathilde	UCAC4 531-006629	13.1	03 35	31.9	+16 08	10	2.1	1.8	CA-MT
Jul. 25	07:00	234 Barbara	UCAC4 416-141013	11.9	20 14	26.2	-06 57	13	0.3	5.6	NB-Mex
Jul. 28	02:52	52246 Donaldjohanson	TYC 5234-00643-1	11.5	22 48	20.6	-01 08	58	8.3	0.6	DZ-FL
Aug. 16	02:49	172376 2002 YE25	UCAC4 488-143179	13.0	22 39	09.8	+07 32	19	6.5	0.3	NJ-NM
Aug. 21	05:16	234 Barbara	TYC 5750-00865-1	10.7	19 58	20.0	-14 41	46	0.9	5.9	ON-Mex
Aug. 27	06:23	52246 Donaldjohanson	UCAC4 438-122513	12.3	22 25	23.5	-02 35	50	6.7	0.3	SK-BC
Aug. 27	07:01	319 Leona	UCAC4 525-012493	13.8	05 21	37.5	+14 51	37	2.0	2.2	TX-NC
Sep. 10	08:59	216 Kleopatra	UCAC4 497-050188	13.1	08 21	04.9	+09 15	05	0.4	3.2	IA-ME
Oct. 12	01:09	513 Centesima	TYC 5749-00630-1	8.2	20 21	10.9	-11 45	55	6.6	4.8	Mex
Oct. 12	07:20	4337 Arecibo	UCAC4 537-005401	12.6	03 05	18.8	+17 22	48	5.3	1.7	BS-Mex
Oct. 29	23:51	4337 Arecibo	UCAC4 534-004986	11.7	02 53	22.8	+16 40	34	5.8	1.3	QC-MI
Nov. 9	08:59	Alexhelios	UCAC4 451-048971	12.7	09 38	44.5	+00 07	14	0.6	0.4	SK-NS
Nov. 9	08:59	216 Kleopatra	UCAC4 451-048971	12.7	09 38	44.5	+00 07	14	0.6	5.9	QC-NL

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 2023*, shows the paths for occultations of some of the better distant-object occultations during 2023. 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.

The special main belt asteroids that we have selected are (some others have no events for N.Am. in 2023):  
**(16) Psyche:** The largest M-class (metallic) asteroid and target of a NASA mission. The occultation by it on June 11 will be difficult since Psyche is much 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 small magnitude change.  
**(90) Antiope:** A binary asteroid, but no events of stars brighter than mag. 14 in N. America during 2023.  
**(216) Kleopatra:** This is the "Dog-bone" asteroid, the 2<sup>nd</sup>-largest M-class (metallic) asteroid, and has two

small moons. Separate predictions are given for the paths of the larger one, **Alexhelios**.

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

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

**(253) Mathilde:** NEAR imaged half the asteroid in 1997; occultations could probe the other half.

**(319) Leona:** We want to improve knowledge of the size, shape, and orbit for the Dec. 12<sup>th</sup> occultation of Betelgeuse (see the bright Main-Belt events for more about that unique occultation).

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

**(957) Camelia:** 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>. [of course, this was unknown when the Handbook was issued, so no paths are on the map; see the MB special occ'ns page]. There will be no Repsolda occultations during the rest of 2023 visible from North America.

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

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

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

**(52246) Donaldjohanson:** This is a Lucy-mission main-belt asteroid 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.

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 at IOTA's main asteroidal occultation prediction Web site at <https://www.asteroidoccultation.com/>.

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, have come to light in subsequent months; some may be included in the predictions for 2024, including (398) Admete, (885) Ulrike, (1721) Wells, (14758) 6519 P-L, and (243267) 2008 AM10. We'll also 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 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/2022iotapredictions.pdf>. This describes a prediction input file for planetary and asteroidal files called **All2002.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:

**2023namMBspecialFinal.xml** – This is the input for the 24 special main-belt occultations for North America shown on the map at the bottom of the 1<sup>st</sup> page.

**2023worldMBspecial.xml** – This is the input for 620 occultations worldwide by the selected special main-belt asteroids of stars to mag. 14.

**2023restClementinaWorldToMag14.xml** – This is the input for occultations worldwide by (252) Clementina of stars to mag. 14 for the rest of 2023.

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 **All2002.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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