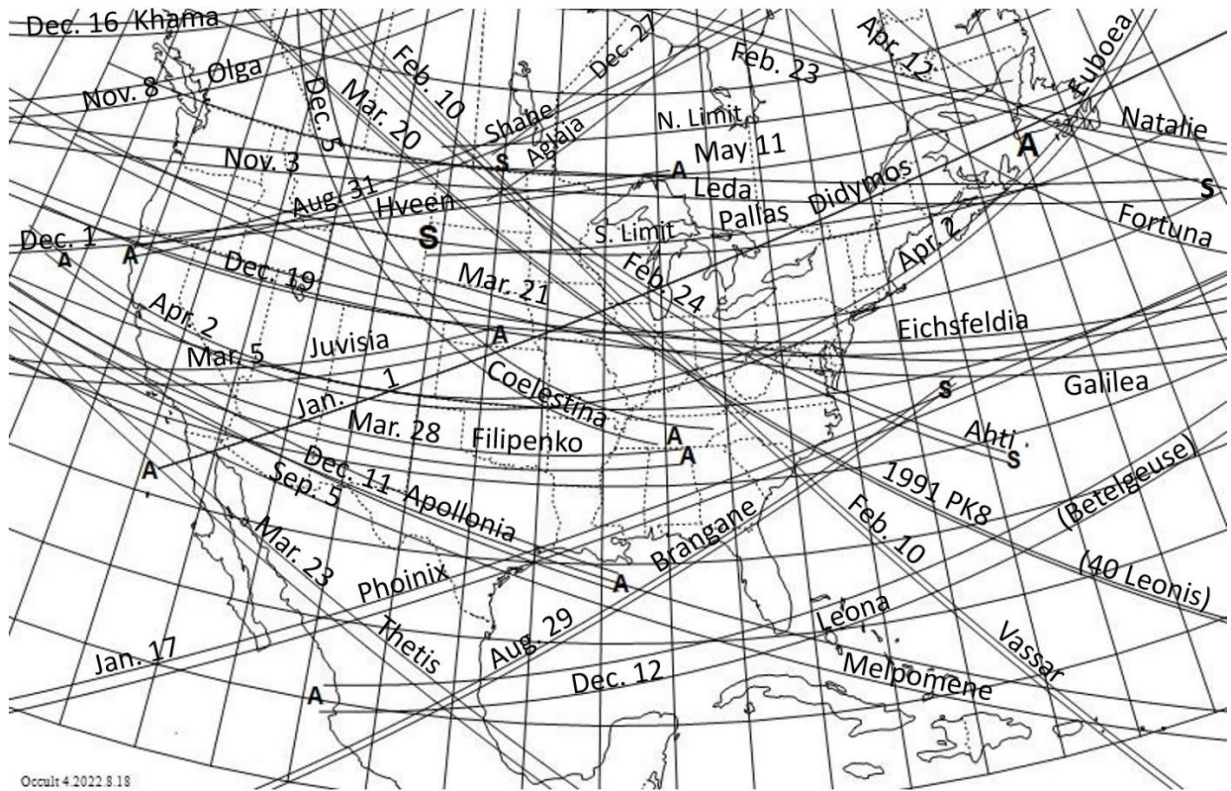


## 2023 Occultations of Stars brighter than mag. 9.1 by Main-Belt Asteroids



Date	UT	Occulting Body	Star	RA (2000)			Dec ° ' "	ΔMag.	Dur. s	Path
				Mag.	h	m s				
Jan. 1	01:41	65803 Didymos	HIP 37693	9.0	07 43 59.0	+29 24 22	7.4	0.2	NL-Baja	
Jan. 17	03:34	4543 Phoenix	TYC 2456-00727-1	8.6	07 28 59.3	+32 40 38	7.9	3.9	NC-Baja	
Feb. 10	07:05	1312 Vassar	HIP 54381	8.7	11 07 35.0	+20 16 17	7.1	2.1	SC-AB	
Feb. 23	02:05	448 Natalie	TYC 2371-00436-1	8.4	04 15 58.7	+31 42 15	7.9	3.6	QC-NL	
Feb. 24	10:25	2826 Ahti	HIP 58521	8.6	12 00 05.7	+17 55 12	7.2	3.5	VA-AB	
Mar. 5	12:16	605 Juvisia	HIP 60711	8.2	12 26 31.8	-13 47 42	7.1	4.7	CA-NE	
Mar. 20	05:38	7585 1991 PK8	HIP 50564	4.7	10 19 43.8	+19 28 10	13	1.5	NC-BC	
Mar. 21	06:11	697 Galilea	HIP 58372	8.7	11 58 09.4	+07 32 46	5.6	4.8	DE-OR	
Mar. 23	06:26	17 Thetis	HIP 66212	7.5	13 34 16.0	-00 18 49	3.4	10.5	Mex-Baja	
Mar. 28	09:59	2892 Filipenko	TYC 4916-00388-1	8.7	10 45 20.2	-03 16 38	6.7	4.8	AL-CA	
Apr. 2	06:37	1119 Euboea	HIP 75879	8.2	15 29 56.7	-14 48 51	6.9	11.2	NL-CA	
Apr. 12	06:57	19 Fortuna	HIP 81844	8.6	16 43 01.4	-21 20 40	3.5	80.1	NL-QC	
May 11	03:07	2 Pallas	HIP 39848	7.3	08 08 27.6	+05 21 59	1.8	16.8	ND-NS	
Aug. 29	09:24	606 Brangane	HIP 26712	6.0	05 40 35.9	+31 21 29	8.9	1.3	Mex-GA	
Aug. 31	08:21	1994 Shane	HIP 28166	5.6	05 57 07.4	+22 50 20	12.1	1.7	CA-QC	
Sep. 5	08:22	18 Melpomene	TYC 0061-01117-1	8.5	03 06 19.9	+05 18 53	1.3	14.7	CA-VI	
Nov. 3	08:59	38 Leda	TYC 1401-02070-1	8.8	09 10 43.9	+17 02 14	4.4	5.1	OR-NS	
Nov. 8	09:45	304 Olga	HIP 12204	8.1	02 37 08.7	-11 11 51	4.6	8.7	SK-BC	
Dec. 1	05:47	1678 Hveen	HIP 113718	7.2	23 01 52.2	-03 51 01	9.7	3.5	CA-ON	
Dec. 5	08:26	237 Coelestina	HIP 8454	7.3	01 49 00.4	+01 19 53	6.5	7.1	TN-AB	
Dec. 11	11:19	358 Apollonia	HIP 19499	8.6	04 10 40.9	+15 14 13	3.9	10.1	TX-CA	
Dec. 12	01:16	319 Leona	HIP 27989	0.5	05 55 10.2	+07 24 25	13.7	11.6	Mex-BS	
Dec. 16	09:58	1357 Khama	HIP 58012	8.9	11 53 56.3	+15 54 30	8.5	3.0	BC-AB	
Dec. 19	02:13	442 Eichsfeldia	HIP 15099	7.6	03 14 47.9	+08 58 41	6.3	9.5	NJ-CA	
Dec. 27	23:40	47 Aglaja	HIP 113379	8.4	22 57 43.7	-06 35 10	5.1	4.8	ND-ON	

Like 2022, we are presenting a map of the brightest occultations by main-belt asteroids in North America on the first page; 25 events involving stars brighter than mag. 9.1 are included. This is not ALL of the occultations of bright stars by asteroids with good-enough orbits to predict them well. As the orbits of more smaller asteroids are improved with the ever-growing numbers of astrometric observations of them (especially high-accuracy data from occultation observations), more bright events are found that didn't have good-enough orbits when we generated the predictions for 2023 several months ago to meet the RASC Handbook publication deadline. For example, on Feb. 3, several minutes before 8h UT, the asteroid (1936) Lugano will occult 7.0-mag. SAO 181576 in a narrow path crossing central New York, eastern Penn., and central N.J.; details for it can be found at <https://cloud.occultwatcher.net/event/763-1936-189039-646586-H65149> . You can find events like this, and many others visible from or near your location using IOTA's free Occult Watcher software, described near the end of this document. After the map is a table, similar to our tables given in the 2021 and earlier Handbooks, but without the long path descriptions we had before, since the path locations can easily be seen on the map. The predictions were generated by Edwin Goffin, Scott Donnell, Steve Preston, Derek Breit, and David Herald. Preston assisted Dunham in the selection for the map, and he prepared the basic tables. The maps were produced with IOTA's free *Occult* software; see <http://www.lunar-occultations.com/iota/occult4.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 *Occult*. At the bottom of the first page is the shortened version of the table given in the *Handbook*. Below is the full original version of the table of the 25 events:

2023	U.T.	Occulting Body	Diameter		Star	Star R.A. (J2000)	Dec.	dmag.	Dur.	Elongation	Moon	Path	
Month	day hr:min	Number Name	Mag	km	" "	Mag h m s	" ' "		s	Sun,*	Moon,*	%sl	
Jan	1 01:41	65803 Didymos	16.4	0.8	0.004 HIP 37693	9.0 07 43 59.0	+29 24 22	7.4	0.2	165	80	70	NL-Baja
Jan	17 03:34	4543 Phoinix	16.5	65.4	0.023 TYC 2456-00727-1	8.6 07 28 59.3	+32 40 38	7.9	3.9	167	123	28	NC-Baja
Feb	10 07:05	1312 Vassar	15.8	33.9	0.019 HIP 54381	8.7 11 07 35.0	+20 16 17	7.1	2.1	157	32	82	SC-AB
Feb	23 02:05	448 Natalie	16.2	48.1	0.022 TYC 2371-00436-1	8.4 04 15 58.7	+31 42 15	7.9	3.6	94	57	11	QC-NL
Feb	24 10:25	2826 Ahti	15.8	40.2	0.026 HIP 58521	8.6 12 00 05.7	+17 55 12	7.2	3.5	156	139	22	VA-AB
Mar	5 12:16	605 Juvisia	15.3	65.6	0.036 HIP 60711	8.2 12 26 31.8	-13 47 42	7.1	4.7	151	51	96	CA-NE
Mar	20 05:38	7585 1991 PK8	17.7	17.0	0.009 HIP 50564	4.7 10 19 43.8	+19 28 10	13.0	1.5	150	170	3	NC-BC
Mar	21 06:11	697 Galilea	14.3	76.0	0.045 HIP 58372	8.7 11 58 09.4	+07 32 46	5.6	4.8	172	176	0	DE-OR
Mar	23 06:26	17 Thetis	10.9	83.9	0.085 HIP 66212	7.5 13 34 16.0	-00 18 49	3.4	10.5	158	172	3	Mex-Baja
Mar	28 09:59	2892 Filipenko	15.4	59.1	0.035 TYC 4916-00388-1	8.7 10 45 20.2	-03 16 38	6.7	4.8	155	75	44	AL-CA
Apr	2 06:37	1119 Euboea	15.1	31.3	0.027 HIP 75879	8.2 15 29 56.7	-14 48 51	6.9	11.2	138	87	85	NL-CA
Apr	12 06:57	19 Fortuna	12.0	201.1	0.136 HIP 81844	8.6 16 43 01.4	-21 20 40	3.5	80.1	130	25	63	NL-QC
May	11 03:07	2 Pallas	8.8	532.0	0.331 HIP 39848	7.3 08 08 27.6	+05 21 59	1.8	16.8	74	160	66	ND-NS
Aug	29 09:24	606 Brangane	14.9	35.4	0.022 HIP 26712	6.0 05 40 35.9	+31 21 29	8.9	1.3	70	135	96	Mex-GA
Aug	31 08:21	1994 Shane	17.7	21.3	0.011 HIP 28166	5.6 05 57 07.4	+22 50 20	12.1	1.7	68	109	100	CA-QC
Sep	5 08:22	18 Melpomene	9.3	142.2	0.177 TYC 0061-01117-1	8.5 03 06 19.9	+05 18 53	1.3	14.7	116	16	67	CA-VI
Nov	3 08:59	38 Leda	13.2	105.4	0.066 TYC 1401-02070-1	8.8 09 10 43.9	+17 02 14	4.4	5.1	85	28	69	OR-NS
Nov	8 09:45	304 Olga	12.7	68.9	0.080 HIP 12204	8.1 02 37 08.7	-11 11 51	4.6	8.7	152	132	23	SK-BC
Dec	1 05:47	1678 Hveen	16.9	40.9	0.019 HIP 113718	7.2 23 01 52.2	-03 51 01	9.7	3.5	97	128	85	CA-ON
Dec	5 08:26	237 Coelestina	13.9	43.4	0.029 HIP 8454	7.3 01 49 00.4	+01 19 53	6.5	7.1	132	137	49	TN-AB
Dec	11 11:19	358 Apollonia	12.5	88.2	0.082 HIP 19499	8.6 04 10 40.9	+15 14 13	3.9	10.1	164	170	3	TX-CA
Dec	12 01:16	319 Leona	14.2	60.8	0.046 HIP 27989	0.5 05 55 10.2	+07 24 25	13.7	11.6	162	152	1	Mex-BS
Dec	16 09:58	1357 Khama	17.3	43.8	0.018 HIP 58012	8.9 11 53 56.3	+15 54 30	8.5	3.0	92	138	16	BC-AB
Dec	19 02:13	442 Eichsfeldia	13.9	64.8	0.054 HIP 15099	7.6 03 14 47.9	+08 58 41	6.3	9.5	141	62	42	NJ-CA
Dec	27 23:40	47 Aglaja	13.5	144.2	0.071 HIP 113379	8.4 22 57 43.7	-06 35 10	5.1	4.8	68	124	99	ND-ON

**Full Table (above) Description:** The successive columns in the table list: (1) the date and map central time [UT] of the event; (2) the number and name of the occulting body; (3) its magnitude; (4) its diameter, in km and then in arc seconds; (5) the catalogue and number of the occulted star; (6) the star's apparent visual magnitude; (7) the star's right ascension and (8) declination; (9) the expected magnitude change from the combined brightness; (10) the predicted maximum duration of the occultation in seconds; (11) the elongation of the star from the Sun and (12) the Moon; (13) the percent of the Moon's disc that is sunlit; and, (14) 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. “LI” is used for Long Island (NY); “Baja” is Baja California, either Norte or Sur, while “Mex” denotes the rest of Mexico. DR is the Dominican Republic, and BS is the Bahamas. Due to uncertainties mainly in the ephemerides of the minor planets from which these predictions are derived (most star positions are now accurately determined from the European Space Agency’s Gaia mission), the region of visibility of an occultation is uncertain, but now by only a few tenths of a path-width for most of these events. Errors remain, so those near but outside the paths should try to observe. It’s also useful, especially for the brighter stars that produce high signal-to-noise recordings, to observe even if you are located up to about 10 path-widths from the predicted path, to check for the possibility of an occultation by a previously-unknown satellite of the asteroid.

We can only portray the brightest events here. Our searches have found many other occultations, including 152 visible from North America of stars brighter than mag. 11.1. Tables and interactive maps of them are available at [http://www.poyntsource.com/New/RASC\\_Events.htm](http://www.poyntsource.com/New/RASC_Events.htm).

The “short” table in the Handbook, at the bottom of the first page of this document, doesn’t have as much information as the “long” version on the previous page; although the order of the columns that are there in the short version is the same. The “short” version does not include the “long” version columns 3, 4, 11, 12, and 13 that are described on the previous page.

Note that the times are for a point near the center of the path shown on the map; for any specific location in North America, the event time can be a few minutes earlier or later. A few weeks before each event, improved predictions and the latest path maps, as well as finder charts of different scales to locate the stars, may be obtained from Steve Preston’s minor planet occultation website: [www.asteroidoccultation.com](http://www.asteroidoccultation.com). Much other useful information, including interactive maps to zoom in on the path, circumstances for dozens of stations in and near the path, and lists of stars that can be used to pre-point telescopes to the target stars are at <http://www.poyntsource.com/New/Global.htm>. “Occult Watcher (OW)” is highly recommended as it will list all of the asteroidal occultations, filtered to a magnitude limit that you specify, visible from your site or region during the next two months; it is a free download from <http://www.hristopavlov.net/OccultWatcher/publish.htm>. Since OW, and its companion OW Cloud, works from an interactive Web site, IOTA uses it to coordinate minor planet occultation observation plans. It is a valuable tool that all serious observers of these events should use.

Now that the prediction accuracy has improved for most asteroids, thanks to the Gaia mission, we give maps and tables in the next subsections for selected fainter but more scientifically valuable occultations that could be observed by many amateur astronomers; you are encouraged to visit those subsections, to try some of those events and contribute to occultation science.

### **Some other star designations**

The star designations given in our table above, and in all of our predictions, are those from the version of the Gaia EDR3 catalog that Dave Herald generated for the Occult program. These include HIP and Tycho2 catalog numbers for the brighter stars, and UCAC4 numbers for most of the rest. The stellar data in the catalog are the best available, from Gaia EDR3, but the other star catalog numbers are used for identification since the Gaia designations are so long and cumbersome. For some of the bright stars in the table above, some other designations are given below:

Mar. 5, (605) Juvia: The star is SAO 157287, spectral type F2.

Mar. 20, (7585) 1991 PK8: The star 40 Leonis = SAO 99065, spectral type F5.

Mar. 23, (17) Thetis: The star is SAO 139416, spectral type K0.

May 11, (2) Pallas: The star is SAO 116388, spectral type K0.

Aug. 29, (606) Brangane: The star is SAO 58319, spectral type B8.

Aug. 31, (1994) Shane: The star is BQ Orionis = SAO 77756, spectral type M5III.

Dec. 1, (1678) Hveen: The star is SAO 146456, spectral type K0.

Dec. 5, (237) Coelestina: The star is SAO 110145, spectral type A3.

Dec. 12, (319) Leona: The occulted star is the bright red giant Betelgeuse =  $\alpha$  Orionis, whose angular size is a little greater than that of Leona, so only a deep annular occultation is likely. Leona's rotational light curve suggests an elongated shape, and Betelgeuse, famously variable, has a changing pattern of dark material obscuring parts of its surface, so a complex variation of the star will occur over about 10 seconds. If we can learn more about Leona's size and shape from occultations by it or other stars, we should be able to learn more about Betelgeuse from recordings of the occultation. In any case, it should be a remarkable naked-eye event that many might observe. Besides southern Florida, the occultation will also be visible from parts of Mexico, the Bahamas, Iberia, Italy, Greece, and Turkey.

### Occult Input Files

You can download and use IOTA's free Occult program 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/iotandx.htm> - on the right side of that page, under the "IOTA GOALS AND OBJECTIVES" section, is a "2023 Predictions" section. Near the top of that, click on the line "Concerning 2023 IOTA Predictions Must Read (pdf format)". In that, it describes a prediction input file for planetary and asteroidal files called **All2023.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 map and in the short table above:

**2023NA-MBtoMag11.xml** – This is the input for 152 occultations of stars of mag. 11.0 and brighter visible from North America, the same ones that are on Derek Breit's RASC events page at [http://www.poyntsource.com/New/RASC\\_Events.htm](http://www.poyntsource.com/New/RASC_Events.htm) .

**2023-events-NA.xml** – This is the input file for all 453 North American asteroidal occultations in Steve Preston's predictions for 2023 given at <https://www.asteroidoccultation.com/> including stars to 12<sup>th</sup> magnitude, and a few fainter. As the year progresses, Preston adds more events, to 13<sup>th</sup> magnitude, and some fainter, that won't be in this file. You can get them from the link at the bottom of Preston's prediction page, directly at <https://www.asteroidoccultation.com/future.dat> - it has worldwide input, but only for occultations through the next two months.

For worldwide occultations for the whole year, use the **All2023.xml** file noted above, but even more occultations can be found with Occult Watcher (it is also limited to the next two months); links to it are given above.

For occultations by Near-Earth Asteroids (NEA's), see <https://occultations.org/publications/rasc/2023/nam23NEAoccs.htm>

For occultations by special Main-Belt asteroids, see <https://occultations.org/publications/rasc/2023/nam23MBspecialoccs.htm>

For occultations by Trojan asteroids, see <https://occultations.org/publications/rasc/2023/nam23Trojanoccs.htm>

For occultations by distant objects (SW1, Centaurs, and TNO's), see [but won't be ready until February] <https://occultations.org/publications/rasc/2023/nam23distantoccs.htm>

David Dunham, [dunham@starpower.net](mailto:dunham@starpower.net), 2023 January 3