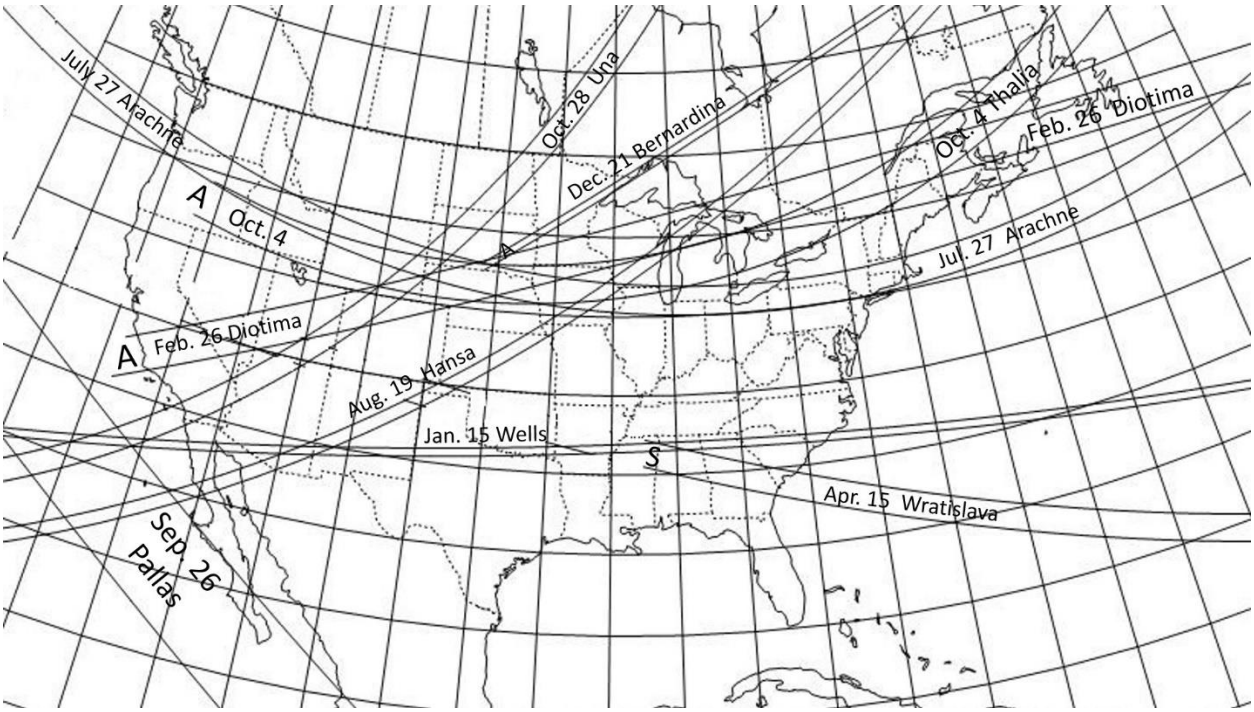
Occultations by Main-Belt Asteroids



					Diameter						R.A. (J2000)	Dec.		Dur.	Elongation		Moon	
Date		UT	Occulting	Body	Mag.	km	″	Star	Mag.	h m s	° ′ ″	ΔMag.	s	Sun, °	Moon, °	%sl	Path
Jan.	15	07:06	1721	Wells	15.3	45	0.030	HIP 41760	7.8	08 30 56.0	+26 01 22	7.4	3.3	169	39	93	NC-Baja
Feb.	26	01:31	423	Diotima	11.9	201	0.129	HIP 53615	7.4	10 58 09.0	+24 22 32	4.5	15.1	164	120	26	NL-CA
Apr.	15	00:29	690	Wratislavia	14.0	140	0.055	HIP 22486	8.1	04 50 15.4	+19 55 24	5.9	3.8	49	108	96	MS-SC
Jul.	27	05:35	407	Arachne	12.5	94	0.084	TYC 5779-01576-1	11.2	21 10 22.5	-12 32 09	1.6	9.2	167	151	2	OR-MA
Aug.	19	02:53	480	Hansa	12.5	59	0.045	TYC 1099-01683-1	11.2	20 30 45.8	+14 42 38	1.6	5.2	146	99	50	Baja-NL
Sep.	26	11:01	2	Pallas	8.9	532	0.339	TYC 5376-00624-1	8.6	06 28 54.9	-13 22 48	0.9	20.0	85	93	0	Baja-MX
Oct.	4	02:37	23	Thalia	11.1	104	0.079	HIP 4031	6.7	00 51 37.4	-08 49 06	4.4	7.9	167	74	62	OR-NL
Oct.	28	01:50	160	Una	14.1	82	0.049	TYC 6351-01171-1	8.7	21 17 44.1	-18 10 22	5.5	7.4	102	68	9	CA-ON
Dec.	21	00:12	629	Bernardina	13.9	37	0.030	TYC 1913-02265-1	7.6	07 21 39.7	+25 51 44	6.3	3.7	160	128	8	SD-QC

In previous years, we published a two-page table of about 70 of the brighter and/or more valuable or interesting occultations by major and minor planets during the year. We believe that few readers go to the effort to read through those lists, to try to figure out events they might be able to observe. Instead, we are presenting a map of nine of the brightest occultations by main-belt asteroids above. After it is a table, similar to our previously-published tables, but without the long path descriptions we had before, since the path locations can easily be seen on the map; that allows us to add five more columns of data. 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 table. 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*.

Table Description: The successive columns in the table list: (1) the date and 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. "Baja" is Baja California, either Norte or Sur, while "Mex" denotes the rest of Mexico. DR is the Dominican Republic. 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 113 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** .

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. 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. 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; we provide more information about it at **https://occultations.org/publications/rasc/2022/OccultWatcher.htm** .

We attempted to limit the map and table above to stars of magnitude 9.0 or brighter. The magnitudes are Gaia "g" magnitudes that are usually close to visual magnitudes, but not always. We had to check the designations of the stars occulted on July 27 and August 19, and in the process, discovered a large discrepancy in their magnitudes relative to other star catalogues. The V magnitudes given by the AAVSO's APASS catalog generally are among closest to visual magnitudes, and for the stars for these two events, it gave V as 11.2, which was confirmed by the Tycho catalog. This is much fainter than our intended 9.0 limit (which was the Gaia g mag. for both stars), but still bright enough to observe with most telescopes used by amateur astronomers. Consequently, we didn't go to the considerable effort that would be needed to find other events for the map at that point, and so we kept them, but have used the APASS magnitudes rather than the Gaia magnitudes. The July 27th star has a large B-V of 1.3 so it may be a red variable star, but that's not the case for the August 19th star.

Now that the prediction accuracy as 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.

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 the bright stars in the table above, some other designations are available:
Jan. 15, (1721) Wells: The star is SAO 80222, spectral type K5.
Feb. 26, (423) Diotima: The star is SAO 81601, spectral type K0.
Apr. 15, (690) Wratislavia: The star is SAO 94154, spectral type K0.
Sep. 26, (2) Pallas: The star is PPM 712736.
Oct. 4, (23) Thalia: The star is SAO 128993, spectral type K0.
Oct. 28, (160) Una: The star is SAO 164284, spectral type K0.
Dec. 21, (629) Bernardina: The star is SAO 79319, spectral type K2.

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 "2022 Predictions" section. Near the top of that, click on the line "Concerning 2022 IOTA Predictions Must Read (pdf format)". In that, it 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 map and in the short table above:

2022NA-BrighterThanMag11p1.xml – This is the input for 113 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 .

2022-events-NA.xml – This is the input file for all 543 North American asteroidal occultations in Steve Preston's predictions for 2022 given at https://www.asteroidoccultation.com/ including stars to 12th magnitude, and a few fainter. As the year progresses, Preston adds more events, to 13th 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 **All2002.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/2022/nam22NEAoccs.htm

David Dunham, dunham@starpower.net, 2021 January 23