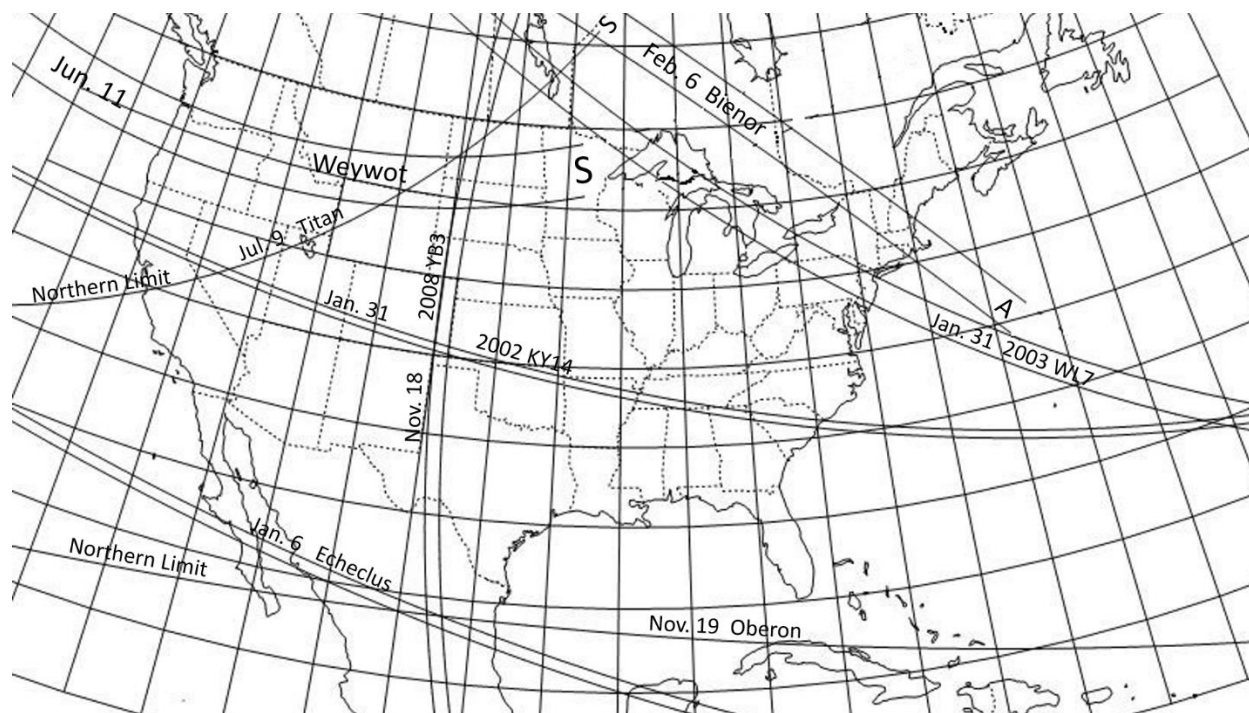


2022 Occultations by Distant Solar System Objects

Of special interest are occultations by distant trans-Neptunian and Centaur objects, many of which have moons and some have rings. These distant objects move slowly, so occultations by them are rare, so fainter stars had to be considered, requiring larger telescopes to observe. The uncertainties of these paths is generally many path-widths, requiring special astrometric observations with large telescopes to predict their location well enough for observing campaigns, and these are accomplished usually only a few weeks before the event. You should find the event on the main IOTA prediction (Steve Preston's) Web site at <https://www.asteroidoccultation.com/> - the 1- σ lines are shown on the Occult-produced map shown there, and better on the interactive Google maps at either <http://www.poyntsource.com/New/Global.htm> or by Occult Watcher (OW; it also shows the 3- σ lines as fainter, outside the 1- σ lines). You can also assess the uncertainties by the event's rank given by Preston and/or OW. On OW's station list, you can also see the formal probability for an occultation at each station. The Lucky Star predictions (see below) often have smaller errors; OW gives their predictions precedence over IOTA's. Many of these events are too faint for most amateur telescopes, but an occultation of a 10th-magnitude star by the Centaur object (60558) Echeclus that occurred over northern Mexico on January 6th is included. Brighter stars are occulted by two outer-planet moons later in 2022.

A good example of a successful campaign for an occultation by a rather large Kuiper Belt Object, (84522) 2002 TC302, took place in November 2021, observed by several in the USA and Europe. It's remarkable that many amateur astronomers with relatively small telescopes could determine the size and shape of an object over 40 AU away, farther than the current distance to Pluto. An account of this event is at <https://occultations.org/publications/rasc/2022/2002TC302Results.pdf>, adopted from an article that was published in the January 2022 issue of *Stardust*, publication of the National Capital Astronomers. We hope to have some further distant-object successes in 2022, with the opportunities portrayed below.

The best occultations of stars by Distant Solar System Objects in North America during 2022



Date	UT	Occulting Body	Star	Mag.	RA (2000)			Dec			Dur.		Path
					h	m	s	°	'	"	ΔMag.	s	
Jan 6	08:35	60558 Echeclus	TYC 1332-00942-1	9.9	06	29	43.6	+18	39	07	9.7	2.8	Mex-Baja
Jan 31	03:45	250112 2002 KY14	UCAC4 474-035230	13.1	07	38	35.0	+04	44	07	8.2	1.7	SC-CA
Jan 31	09:33	136204 2003 WL7	UCAC4 553-047150	14	10	00	06.4	+20	27	56	7.1	5.4	NJ-AB
Feb 6	08:52	54598 Bienor	UCAC4 670-035234	12.7	05	12	37.6	+43	50	00	6.6	14.6	MA-SK
Jun 11	09:05	Weywot	UCAC4 375-120303	14.4	18	26	06.7	-15	07	47	4.4	6.0	MN-OR
Jul 9	09:22	Titan	HIP 107569	8.7	21	47	10.8	-14	40	59	0.6	326.6	MB-CA
Nov18	01:58	342842 2008 YB3	UCAC4 651-078239	14.7	19	47	10.1	+40	09	12	6.6	2.2	MB-Mex
Nov19	08:56	Oberon	HIP 13601	7.2	02	55	17.7	+16	18	32	6.8	75.3	Cuba-BajaN

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 2022*, shows the paths for occultations of some of the better distant-object occultations during 2022. The version of the table in the printed Handbook has an extraneous "J" in front of "Jan" in the line for the first event that has been whited out here. Also, ignore the "N" after "Baja" at the end of the last entry of the table. 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.

Details of most of these events will be given on the Paris Observatory's Lucky Star Project's web site at <https://lesia.obspm.fr/lucky-star/predictions.php>, while some will also be described at <https://www.boulder.swri.edu/~buie/recon/reconlist.html>, the prediction Website of the Research and Education Collaborative Occultation Network (RECON), the network of observatories in the western USA and Canada dedicated to observation of distant-object occultations. Echeclus, Bienor, and the three unnamed objects are all Centaur asteroids in orbits between Jupiter and Neptune. The other objects are described below:

Weywot, with an occultation on June 11, is a 140-km moon of the large TNO (trans-Neptunian object) (50000) Quaoar.

Titan, the 8th-mag. largest moon of Saturn with a thick atmosphere, will occult a star of the same brightness on July 9. The occultation will be visible from much of North America, south of the northern limit shown on the map; the southern limit crosses northwestern South America. Titan will be 3 arc-minutes east of Saturn when the occultation occurs. Local circumstance predictions (U.T. of central occultation, and altitudes of the star and Sun) will be posted for hundreds of North American cities on this Web site before the July 9th occultation.

Oberon, also known as Uranus IV, is 1520 km across. The northern limit of the Nov. 19th occultation brushes the northern coast of Cuba and crosses Mexico just south of Texas (see the map), while the southern limit is over Venezuela, northern Colombia, and Panama. The bright occultation will be visible across the Caribbean, but low as seen from the eastern islands. Oberon will be about 45 arc-seconds south of Uranus during the occultation.

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.

Zoomable Aladin star charts centered on the target, interactive Google maps and other details for most of these events, and other event details are given for most of these occultations at the Lucky Star prediction Web site at <https://lesia.obspm.fr/lucky-star/predictions.php>. It's worth checking these Web sites a week or two before an occultation that you might observe, since Lucky Star updates their predictions with the help of earlier occultation observations which can shift the paths substantially from what we show on the map,

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. Instructions are at <http://www.lunar-occultations.com/iota/2022iotapredictions.pdf>. This describes a prediction input file for planetary and asteroidal occultations 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. But note that these generally don't have good error information; you should consult the Web sites given near the top of this document for better and current errors.

2022NA-DistantFinal.xml – This is the input for the 8 distant Solar System objects occultations for North America shown on the main (top) map above.

2022WorldDistant.xml – This is the input for 388 occultations worldwide by selected Centaurs and Kuiper-Belt Objects of stars to mag. 16.

2022WorldPlutoAndMoons.xml – This is the input for 4 occultations worldwide by Pluto and by its moons 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 **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.

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