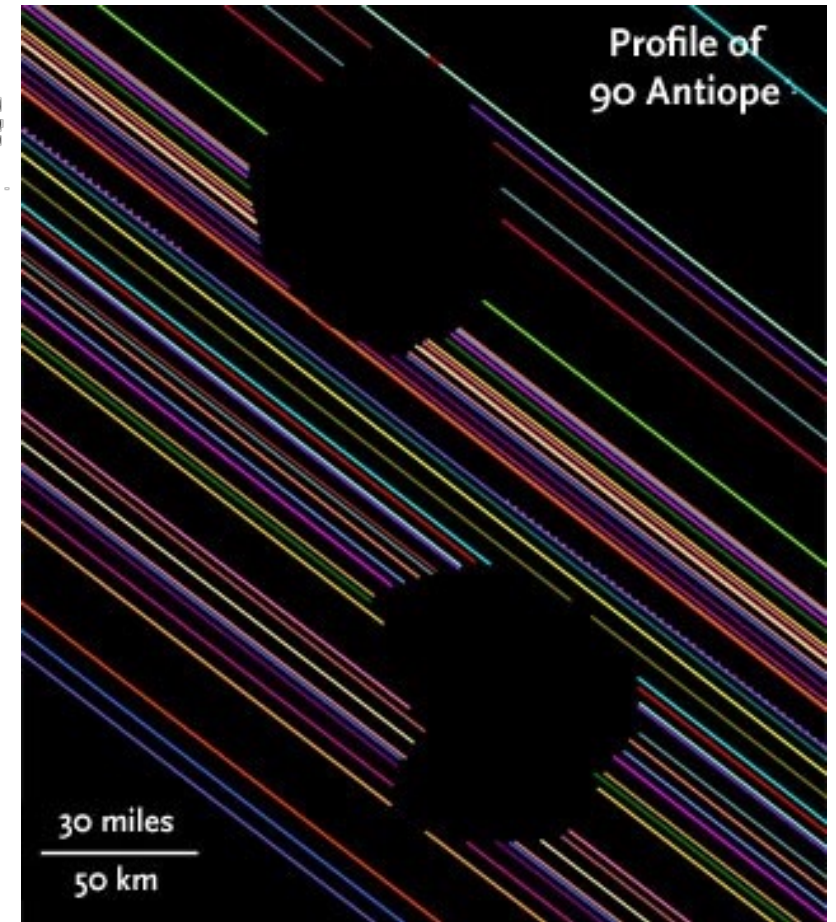


The International Occultation Timing Association (IOTA) and the Development of Occultation Science

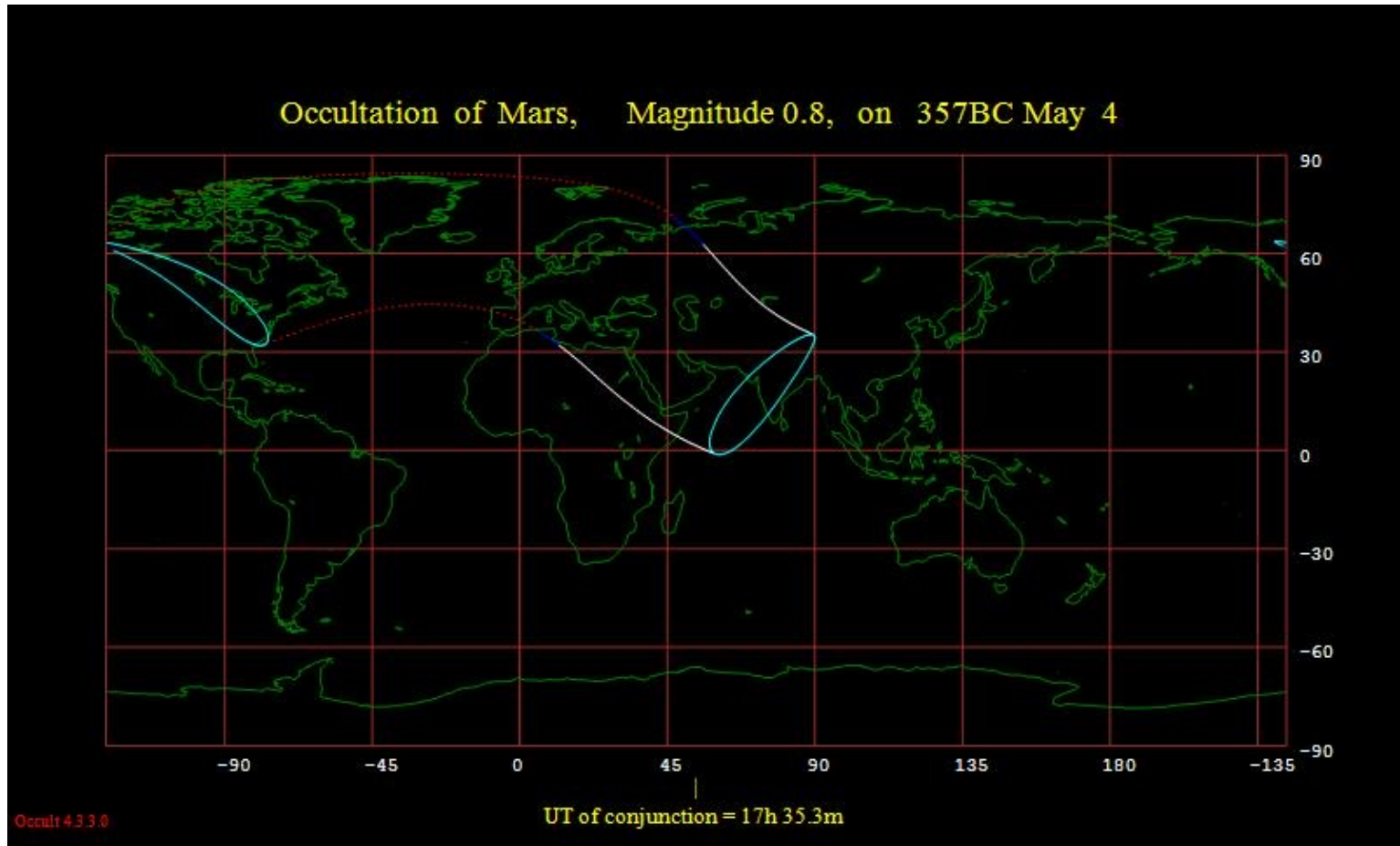


David W. Dunham, dunham (at) starpower (dot) net
IOTA and Intuitive Machines
IOTA – East Asia Section 2026 Meeting
2026 August 30



California & Oregon, 2011 July 19, just after an IOTA meeting at Sierra College, Rocklin, Calif.; the star was 6th-mag. LQ Aquarii, allowing many to set up several mighty mini systems.

Ancient Lunar Occultation Observations



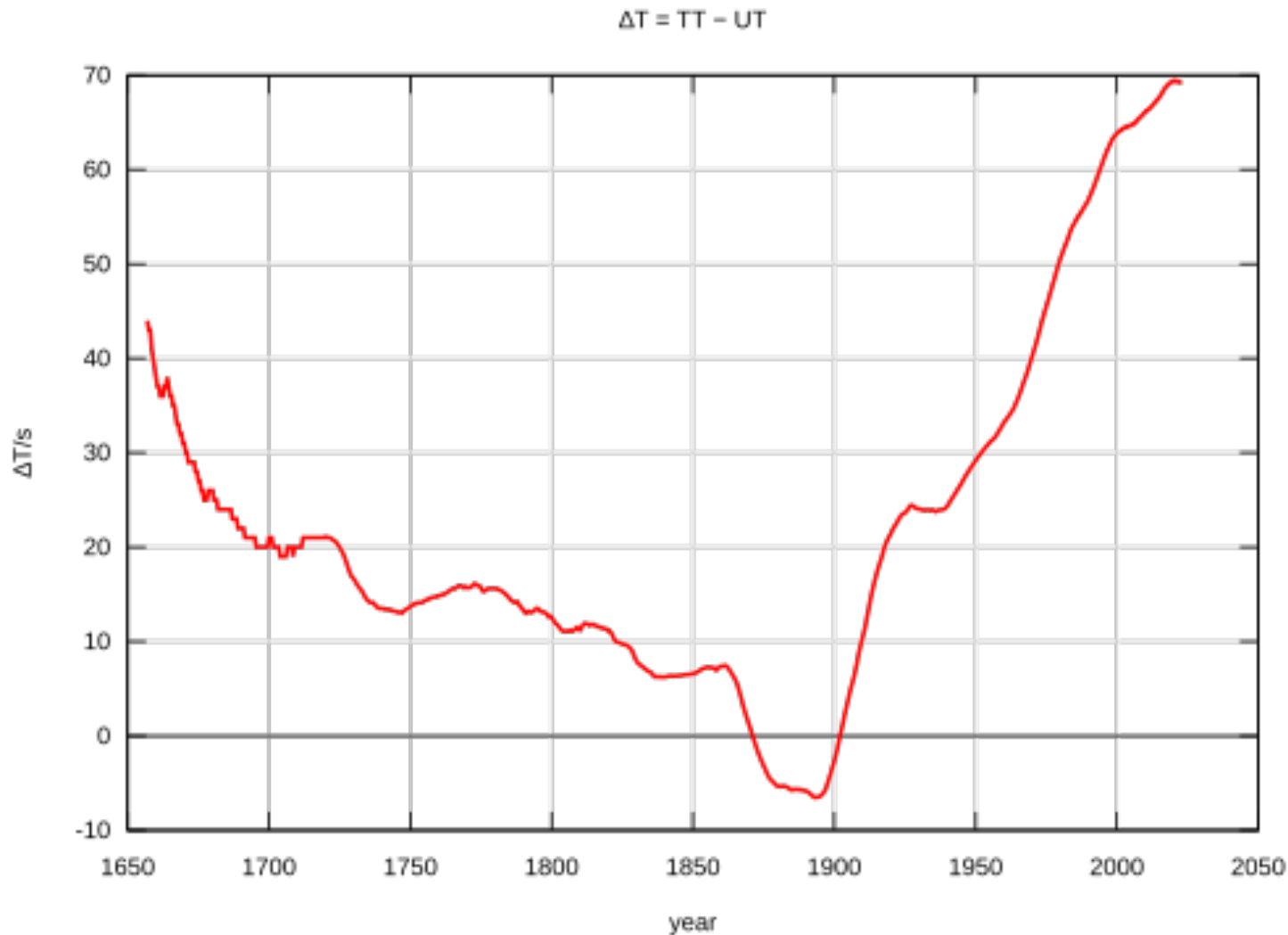
Occult4 Prediction of Aristotle's Occultation

The oldest record of observation of the occultation of a planet (Mars) by the Moon was by Aristotle (384–322 BCE), the Greek philosopher, on 4 May 357 BCE. The observation clearly demonstrated to him that Mars lay further than the Moon.



Telescopic view of a recent occultation of Mars

ΔT – Earth Rotation Variations from Occultations



The oldest usefully timed occultation for this purpose was an occultation of Spica observed at Paris Observatory on 1623 July 5. Comparison with time determined from atomic clocks started in the 1950's. Old solar eclipse observations have been used to determine ΔT with lower precision since around 2000 BCE.

Determination of Geographic Positions

For awhile, lunar occultations were timed for navigation, but phenomena of the Galilean satellites of Jupiter were more useful for determination of longitude at sea, which in turn were superseded by ever more accurate mechanical chronometers.

Some 18th century timings of occultations were used to verify the accuracy of geographical positions of observatories determined from astronomical observations (stellar transit timings, altitude measurements, etc).

Cinemagraphic observations of total and annular solar eclipses were first shown to have promise for linking geodetic datums in the 1920's, and especially at eclipses in 1946 to 1954.

Army Map Service (AMS) Expanded Occultation Program, 1955-1966

In the late 1950's, AMS expanded their program, to try to link the surveying systems of North America, Hawaii, **Japan, and **Taiwan** to determine the positions of many Pacific Islands.**

The program was secret, as this was needed to determine the accuracy of ICBM test launches from the California test range (Vandenberg) to islands like Kwajalein.

The results weren't as good as expected, due to lunar limb uncertainties along the lines, and in the late 1960's they were superseded by better measurements from artificial satellite geodesy.

The project was declassified around 1970, and boxes with project paper chart recordings, calculations, etc. were stored in many boxes at USNO, then our basement, and now at Univ. of Maryland Obs..

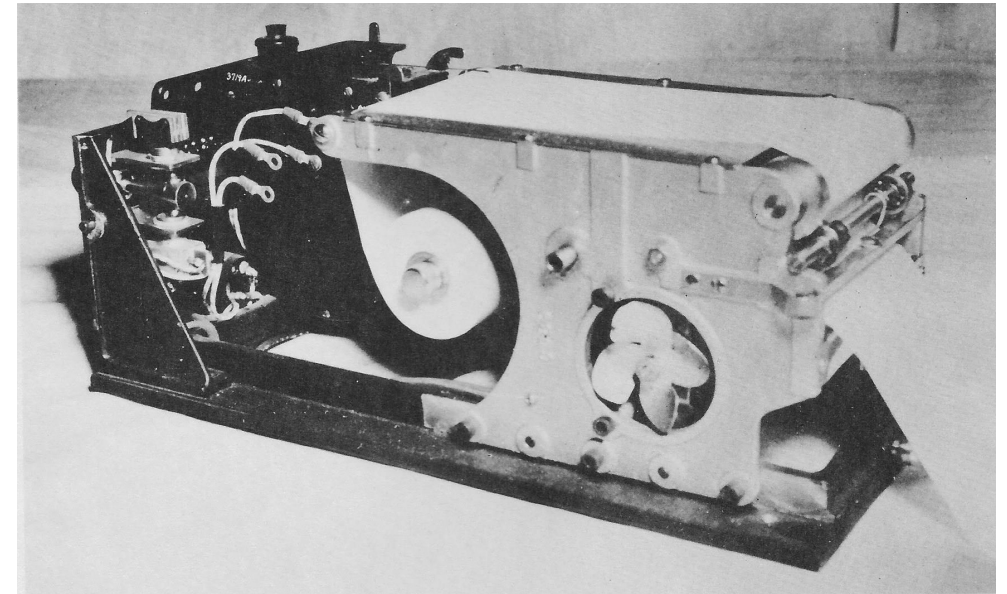
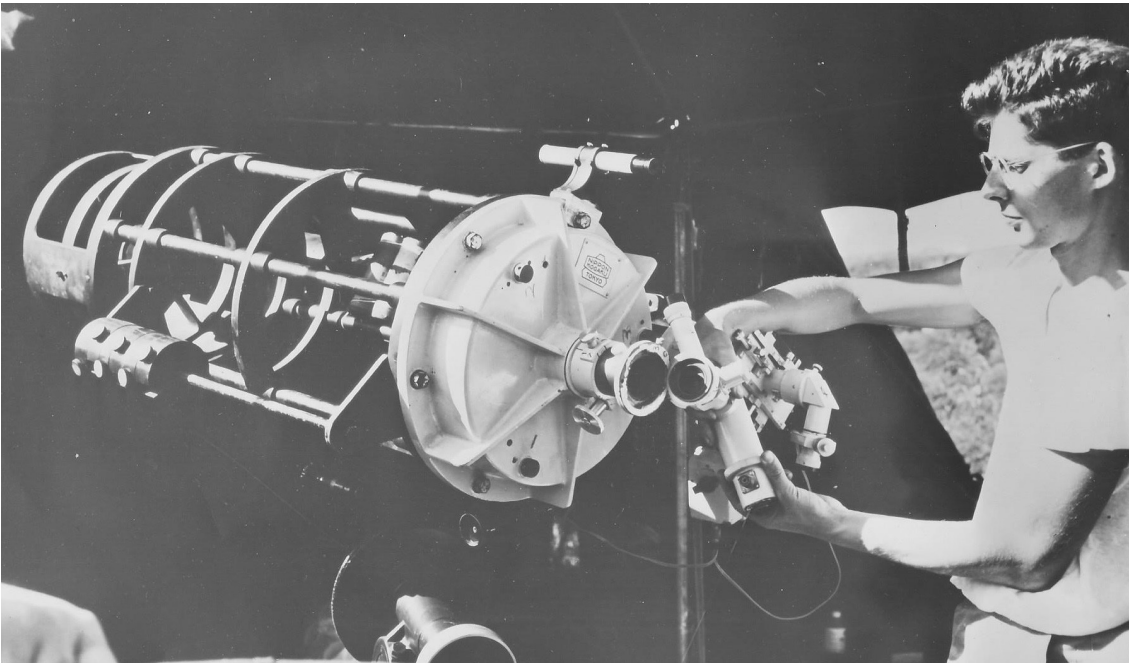


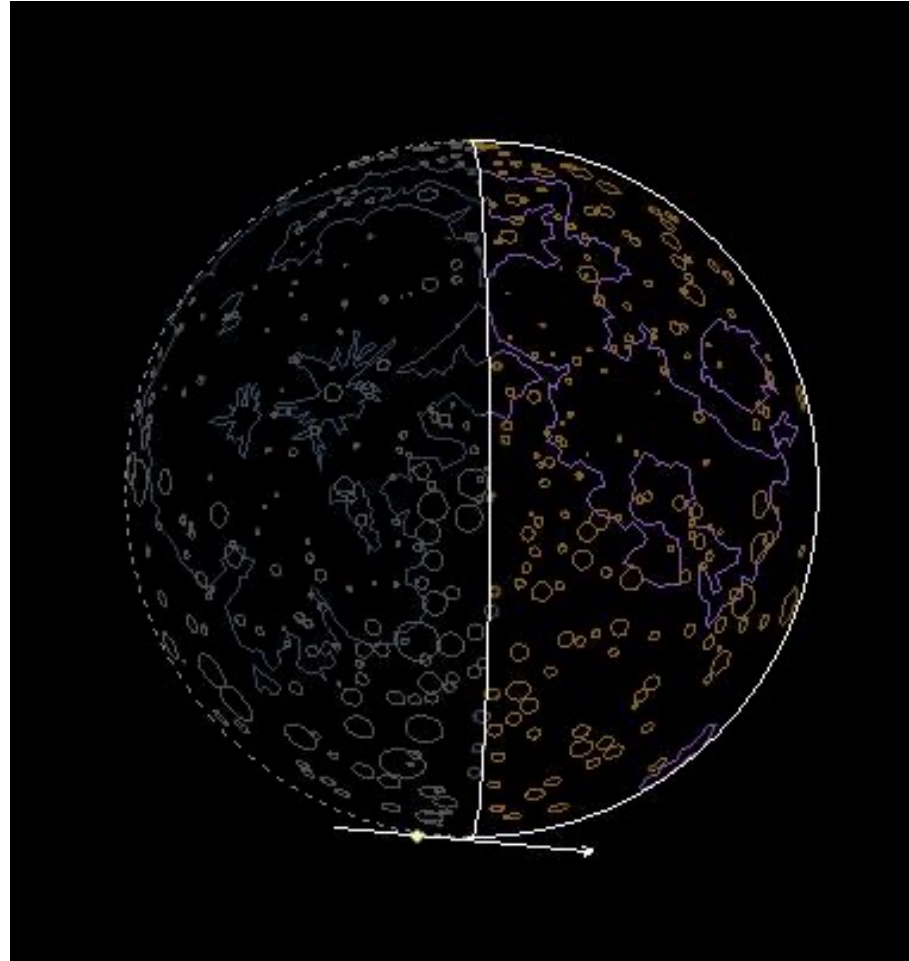
FIGURE 34.—View of oscillograph with cover removed and one pen unit taken out to show connections.

Start of My Interest in Astronomy

I always had a vague interest in astronomy from an early age. In the early 1950's, as a boy scout living in southern California when I was about 10 years old, I remember seeing the Northern Cross on a camping trip to the desert, realizing patterns in the sky.

In 1954 and 1955, I lived in Karachi, Pakistan where my father, a civil engineer, worked on a foreign aid program. Although we lived only 150 km from Mexico, my parents had no interest to go there; consequently, **the first foreign country I visited was Japan, where Yokohama was a stop on our way to Karachi.** I saw partial solar eclipses in June 1954 and June 1955, but my interest was really sparked by seeing a friend's unabridged dictionary, and when I turned to "Stars", I was amazed to see a list of nearly 300 named stars. I decided that **I wanted to find as many of the named stars as I could in the clear desert skies where we lived** on the outskirts of Karachi, in an area with little light pollution at the time. I got some star charts and astronomy books to learn more. As we travelled through different countries of Europe on the way home in December 1955, I saw the same stars and constellations I had self-taught myself, and realized astronomy would be a life-long pursuit.

I expected an occultation of 3.1-mag. β^2 Capricorni after one of β^1 that I saw on 1957 Oct. 29 from our backyard in La Cañada, Calif. But there was only a close approach, with min. distance 5" at 9:47 pm PST. I was amazed at that sight, I could see the Moon's motion, the star looked like a spacecraft flying over the lunar Leibnitz Mountains. It was a real-time view of celestial motion.



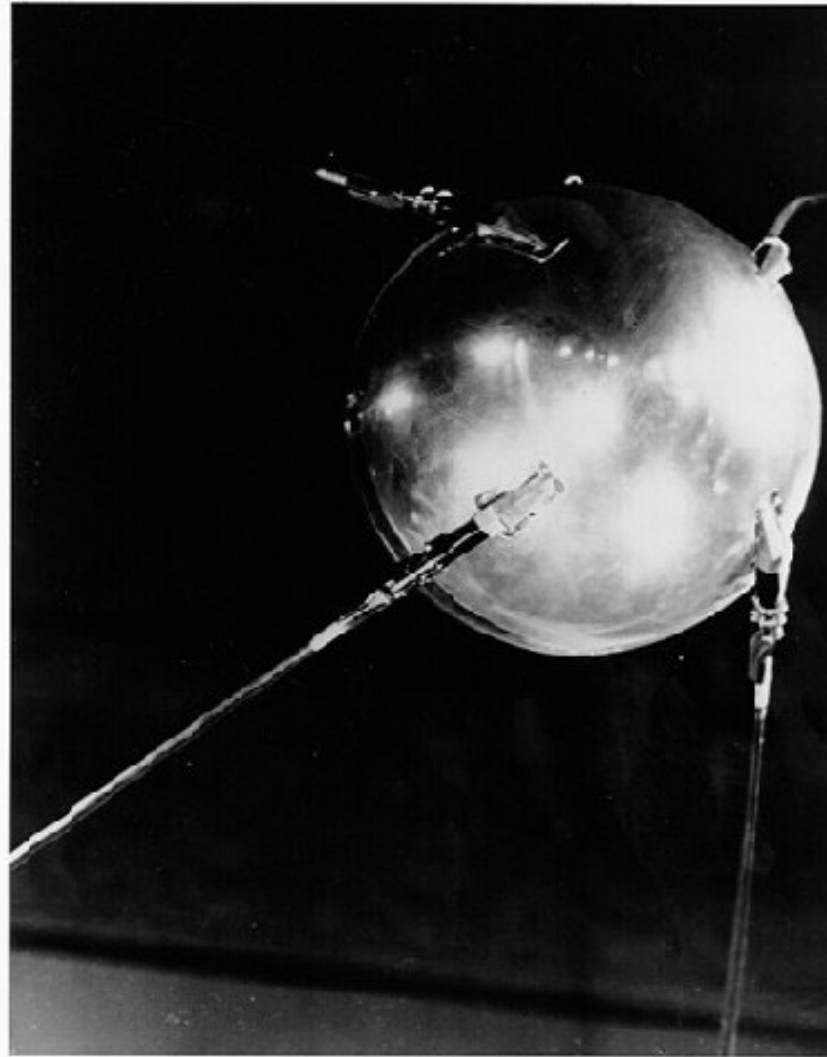
Southern Limit of the β^2 Capricorni

Occultation, 1957 October 29



I was puzzled why I did not have an occultation when one was predicted. I realized that the prediction was for a station 300 km n.w. of me, but no event was given for another station 500 km east of me. I had the idea of a grazing occultation, with multiple events of the star by lunar mountains near the southern limit, which must have been just a few km north of me. I thought it would be great if someone could compute those lines, but I thought I could never do anything that complicated. At that young age, I underestimated my future ability.

Sputnik 1, also October 1957

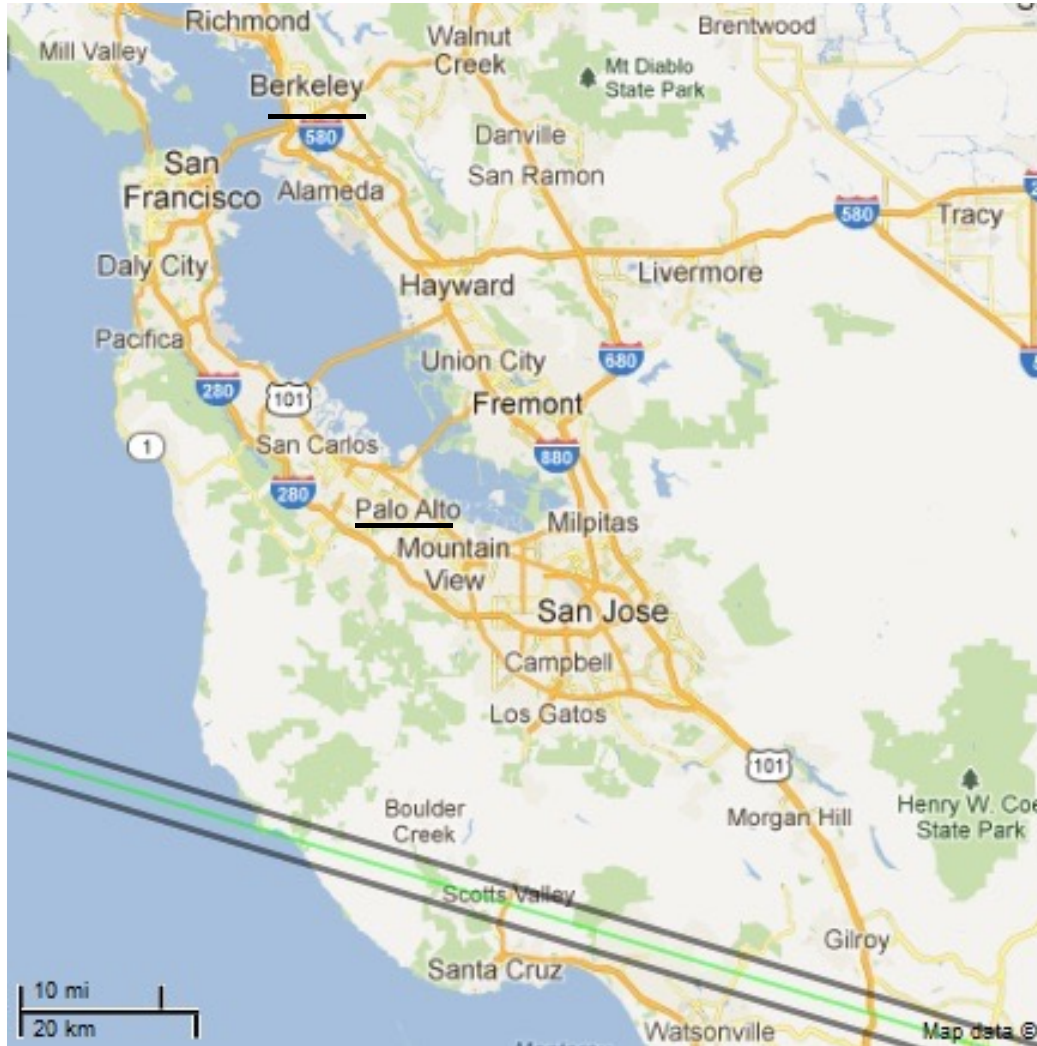


Smithsonian Astrophysical Observatory's Moonwatch Project



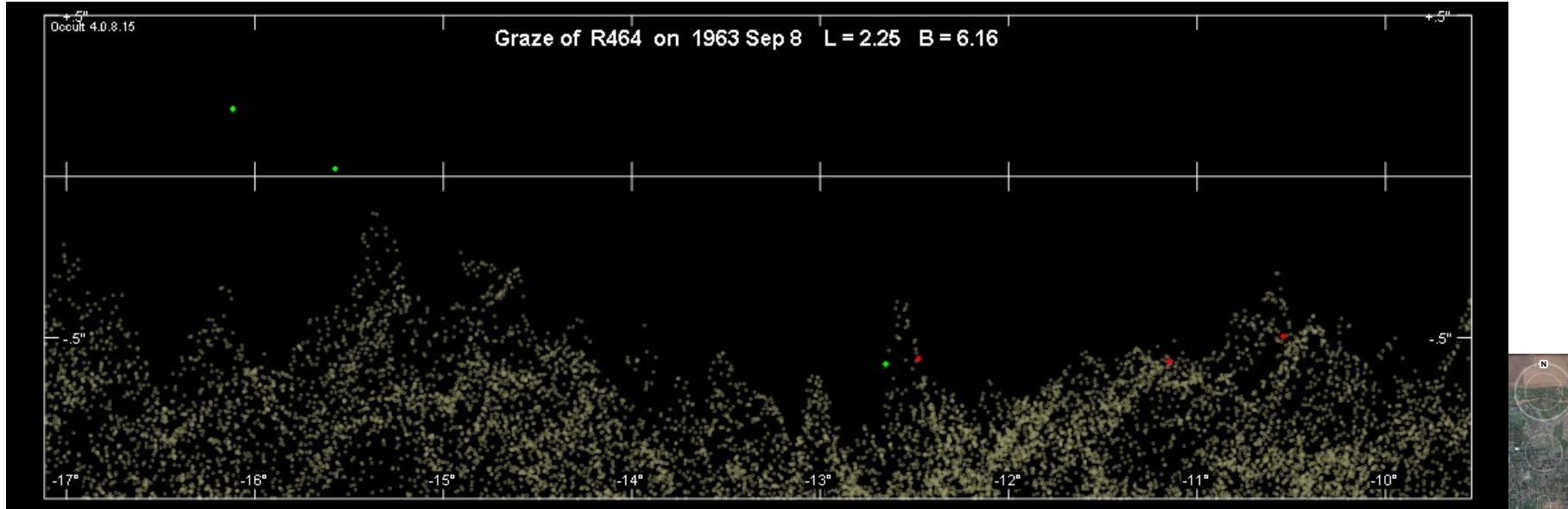
I learned accurate visual timings and the rudimentaries of elliptical orbits with the Sacramento Moonwatch Team (My father had a job with the State of California 1958-1960). This laid the groundwork for my career of computing orbits for novel space missions, including ISEE-3, the first halo orbit mission and later, first to visit a comet, and NEAR, first to orbit and land on an asteroid, 433 Eros.

Last Aldebaran Graze of 1959 – 1962 series in California occurred on 1962 March 12, my 1st attempt

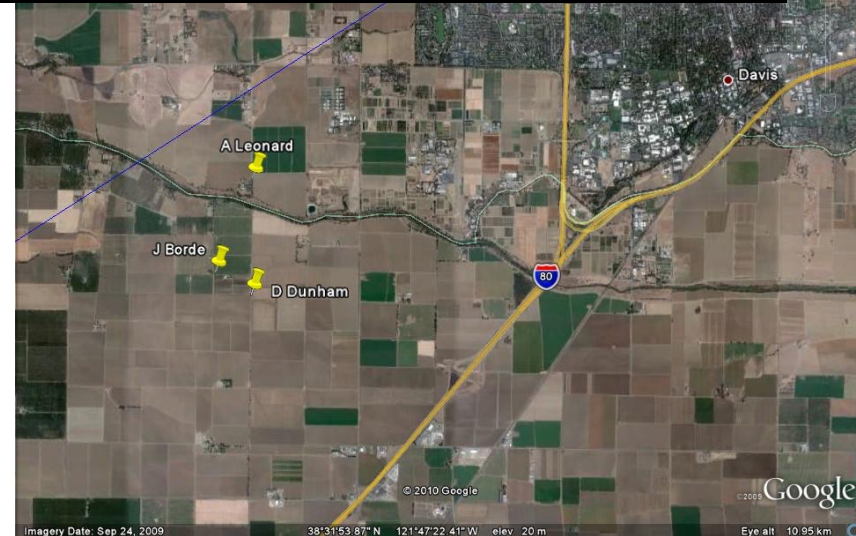


I had completed a course in solid geometry at the Univ. of Calif. at Berkeley shortly before this event, and **I realized, maybe I could compute it.** The hand calculations using trig function tables and a clunky Marchant calculator were harder than expected so I finished only 2h before, with the path near Santa Cruz. I asked a grad student to drive me there since I didn't have a car. **We didn't make it to the limit. At Palo Alto, I quickly set up my 60mm refractor and saw Aldebaran reappear on the bright side, coming out like a drop from a faucet; I realized that was close enough to the limit to see the star's angular diameter!** The chase for grazes was on!

The first successful dark limb graze where the observers travelled to their sites - 1963 Sept. 8 Graze of 6.1-mag. ZC 464, Davis, Calif.

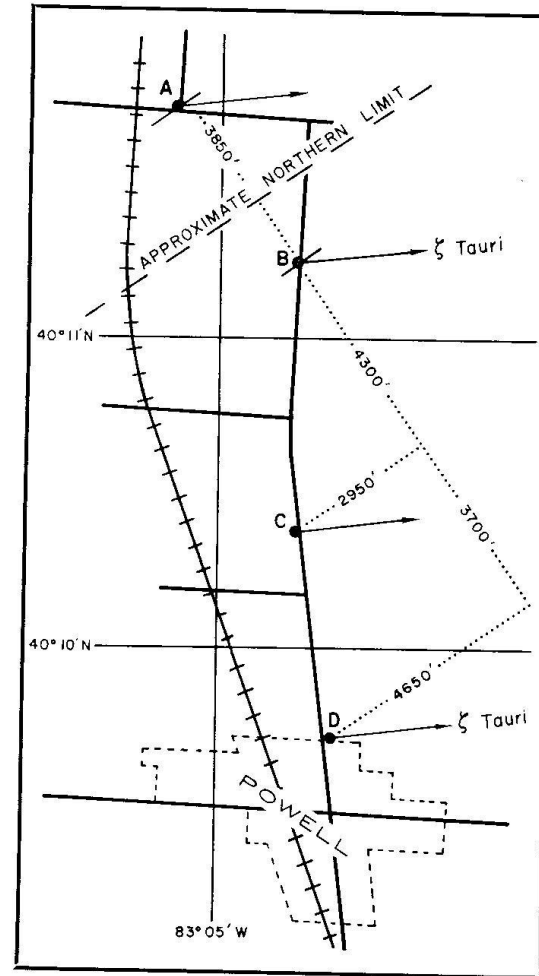


Finally, good timings were made of this graze with cusp angle 15N and Moon 72%- sunlit. This is adopted from Dave Gault's presentation on the current graze archive given at the 2010 IOTA meeting.

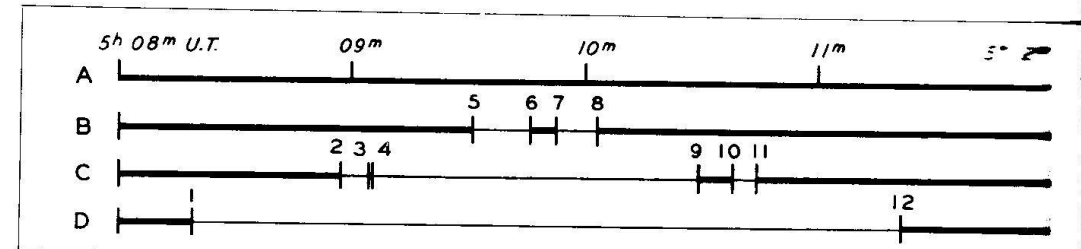


This is the 2nd page (page 370) of the 2-page article about the 1963 October 8th zeta Tauri graze in S&T's Dec. 1963 issue

This early published success encouraged many others across the USA to start observing grazes in their area



near the predicted geographical limit. Early on the evening of October 7th, the following members of the Columbus society gathered with telescopes and other equipment: Barnett Golding, John Kissel,



Charles Legg, Larry Ochs, Mike Peugh, Dan Sagstetter, and Steve Yanocheck. Allen Austin, Butch Hall, and John Morris of the Worthington High School Astronomy Club, and Dan McGrath of Bishop Watterson High School in Columbus, also joined our group.

We observed with a 6-inch refractor and two 6-inch and one 4-inch reflectors. A two-man team recorded CHU time signals on tape, while the other groups had

OBSERVED CONTACT TIMES

Contact (see chart)	Universal time*	Station on Map
1	5 ^h 08 ^m 19 ^s .5	D
2	5 08 57.2	C
3	5 09 04.5	C
4	5 09 05.0	C
5	5 09 31.1	B
6	5 09 45.8	B
7	5 09 52.8	B
8	5 10 03.1	B
9	5 10 29.0	C
10	5 10 38.0	C
11	5 10 44.0	C
12	5 11 21.5	D

*Italics denote disappearances, all others are reappearances.

a timekeeper, observation recorder, and observer.

As the predicted time of contact approached, one observer thought the moon was missing Zeta, for the illuminated portion of its disk had already passed the star, creating the illusion that the dark part was also missing. However, the star had reached the predicted contact position at the angle, and his location eventually proved to be a proper one.

The southernmost station, D, had a simple occultation lasting 3^m 05^s, as shown in the accompanying diagram and table. There was a deep graze at C, where Zeta Tauri was hidden three times for 1^m 47^s. The observer at B, near the northern limit, saw two disappearances in 12 seconds. Zeta was not occulted at A, north of the predicted limit.

Our society has additional information available to interested persons. We would also like to hear from other successful observers of this occultation.

BARNETT GOLDING

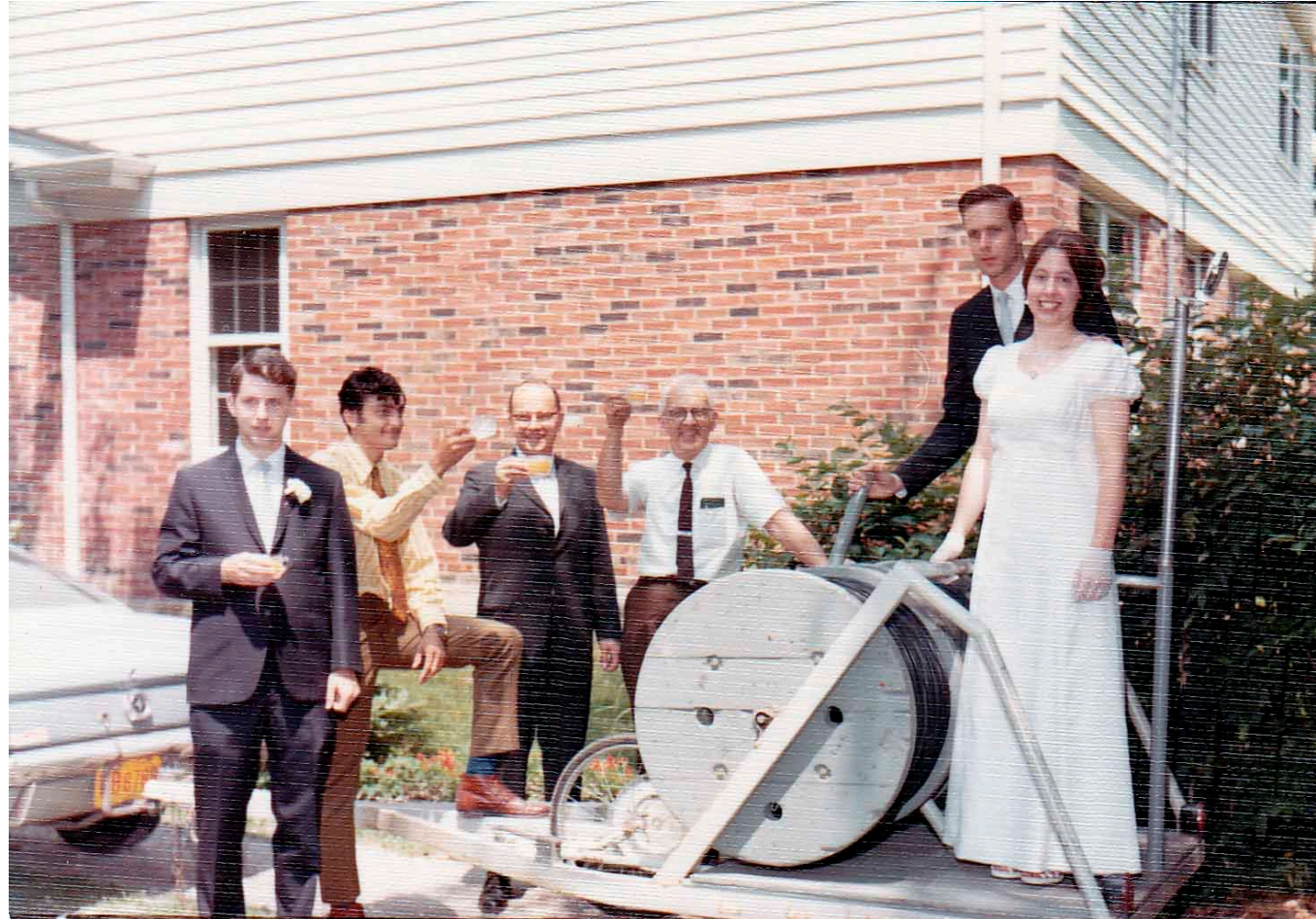
111 Richards
Columbus, Ohio

Starting in 1965, cable systems were developed for observing grazing occultations, first at USNO, then by 3 clubs in California (Riverside, Santa Barbara, and Mount Diablo Astronomical Society), and Milwaukee, Wisconsin



This is a Riverside A.S. expedition to the desert in 1966; I'm wearing a white jacket. Observations were visual, with audio tones recorded at the central station.

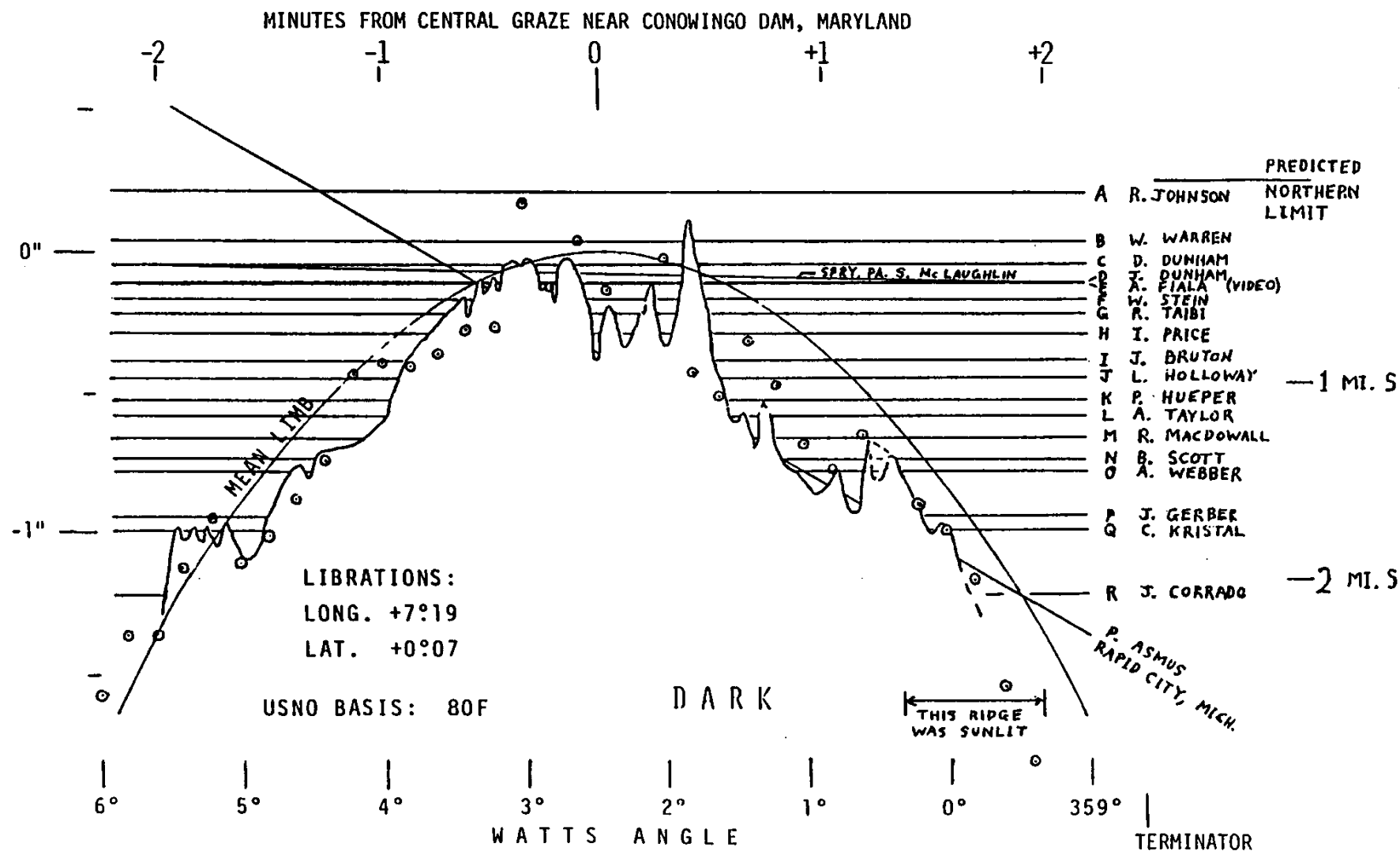
1970 July 11, standing on the Milwaukee cable trailer at our wedding in Highland Park, Illinois



From left to right, Tom Van Flandern, Ronald Abileah, Homer DaBoll, Edward Halbach, David and Joan Dunham. **5 years later, IOTA was founded at this place by H. DaBoll, Buron Stevens, John Phelps and me as a dues-paying organization to support the cost of mailing predictions and Occultation Newsletter.**

Lunar Profile from Graze of delta Cancri – 1981 May 9-10

Alan Fiala, USNO, obtained the first video recording of multiple events during this graze, with 7 D's and 7 R's



Circled dots are Watts' predicted limb corrections

2 years later, IOTA was formally incorporated in Texas and obtained tax-exempt status as a 501c educational and scientific research organization.

Link: <https://vimeo.com/209854850>

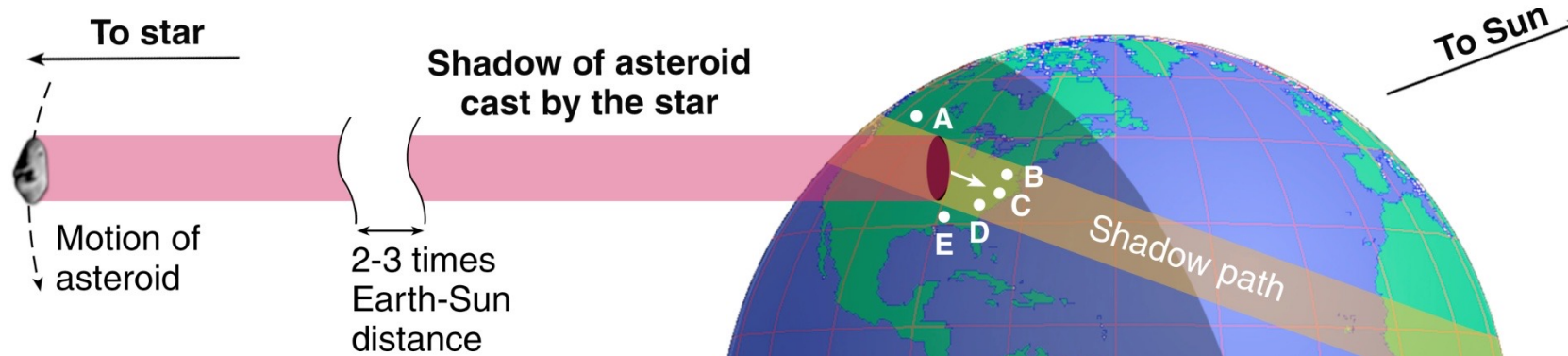
Grazing Occultation of Aldebaran

March 5, 2017 4:16 UT

Remarkable synchronized video from 5 stations
at Mississauga, Ontario, Canada by Andreas Gada



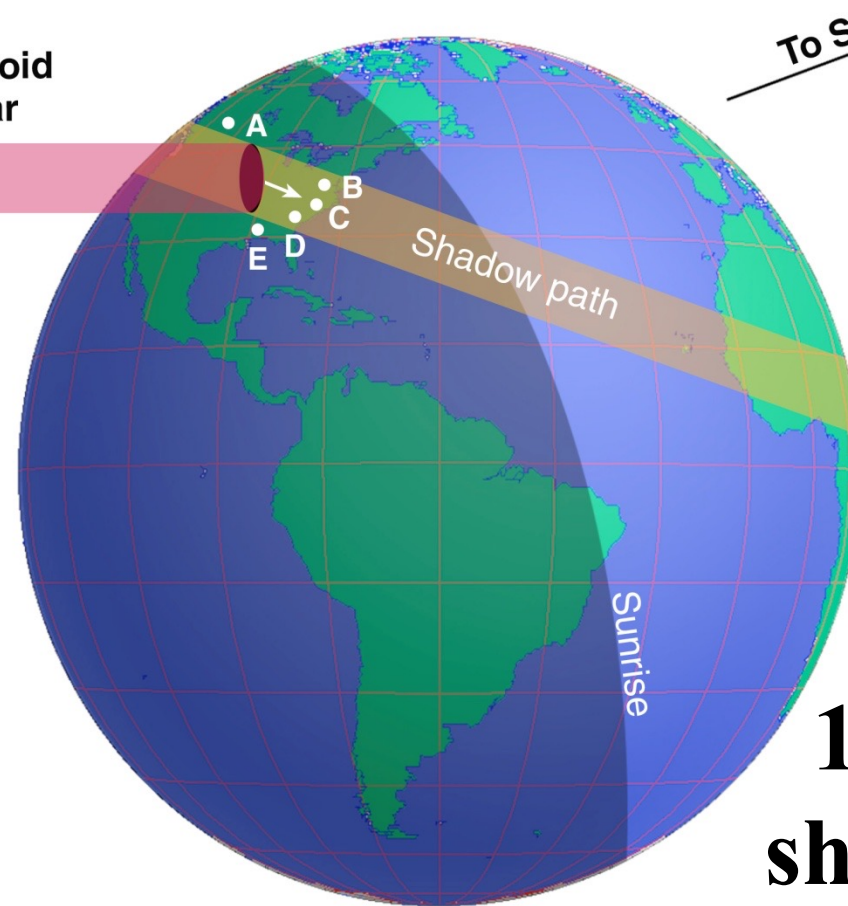
Geometry of an Asteroid Occultation



Observers' View



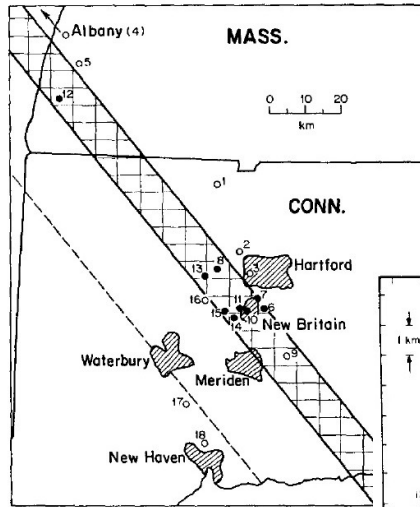
A, E: Negative observations
B, C, D: Positive observations



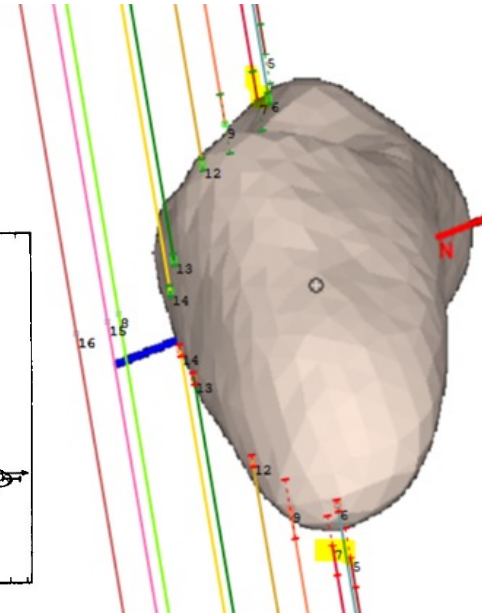
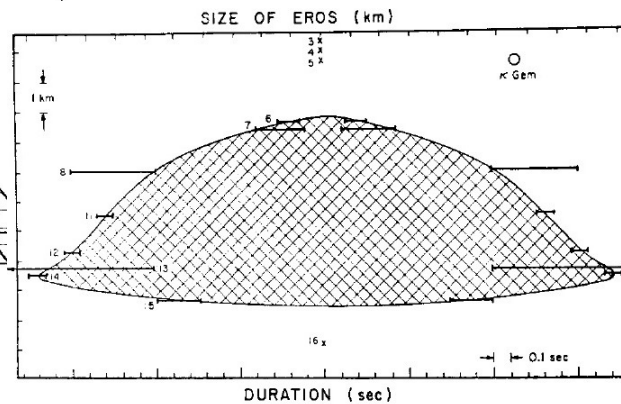
In the late
1970's, IOTA
shifted its focus

more to asteroidal occulta-
tions.

First observed occultation by an NEA, 1975 Jan. 24, κ Gem occulted by Eros



from O'Leary et al.,
Icarus, Vol. 28, pp.
133-146 (1976)



This was the **first successful mobile multi-station asteroidal occultation campaign**, in Connecticut and Massachusetts, USA.

5	M. McGrath, ne
6	R. Gurka, near
7	P. Backus, ne
8 (M)	F. Jettner, ne
9	R. Dragon, ne
12	D. R. Morrisor
13	D. Yard, near
14	Phil Dombrowski
15 (M)	H. Schwartz, r
16 (M)	C. Boccadoro,

Left, map of observers & sky plane plot from the 1976 Icarus paper. Right, modern sky plane plot of the chords fitted to Eros' shape model derived from NEAR-Shoemaker data. This was the first occultation by ANY asteroid that was observed from multiple stations. Especially, the stations deployed by the Pioneer Valley Colleges led by Brian O'Leary was the first successful coordinated effort to observe such an event by mobile observers. A crucial observation, now known to be a false negative, resulted in the wrong squashed shape shown by O'Leary et al. It would be 44 years before an occultation by another NEO would be observed.

The First Multiple Stations were Deployed for Grazing Occultations

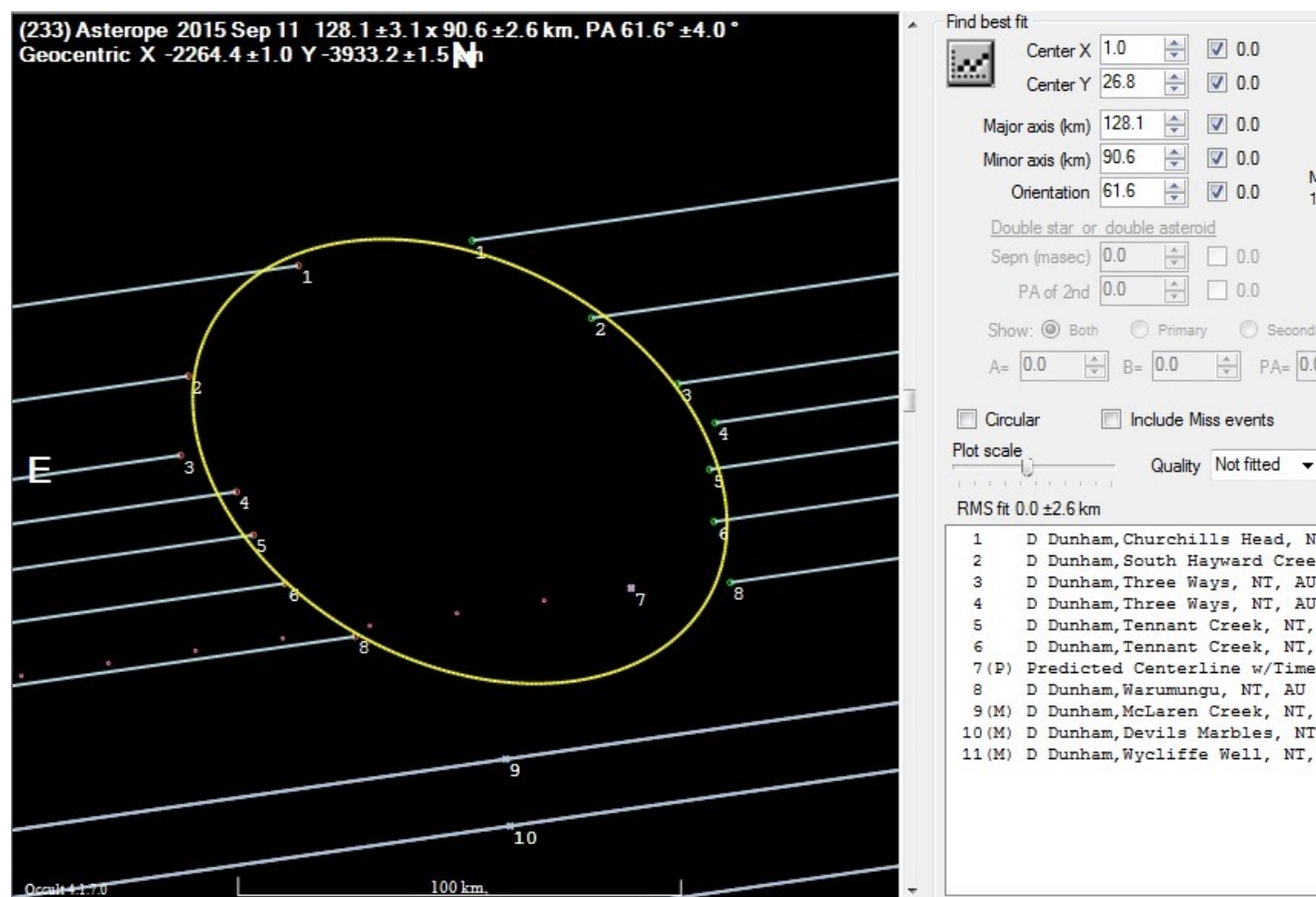
- **In the 1990's, I often thought, the equipment is doing all the work, maybe I should be somewhere else making another observation.**
- For a graze of omicron Leonis the morning of 1998 November 12, I set up a 5-in. clock-driven SCT at Delta, Pennsylvania, near York
- I left a student there after showing him how to make adjustments to keep the star in the field of view, and set up another telescope about 0.5 km away to record the event
- When I came back, he was excited to see the multiple occultations of the star. “Did you make any adjustments?” “No”. “At least, you were there to protect the equipment”.
- “Actually, it was the other way around. Whenever a car drove by, I hid behind the telescope box.”

Remote Stations for Asteroidal Occultations

- **Separation should be many km, much larger than for grazes, so tracking times & errors are too large**
- Unguided is possible since the prediction times are accurate enough, to less than $1 \text{ min.} = \frac{1}{4}^\circ$
- **Point telescope beforehand to same alt. & az. that the target star will have at event time and keep it fixed in that direction**
- Plot line of target star's declination with Guide or C2A
- Can usually find “pre-point stars” that are easier to find than the target
- Find a safe but accessible place for both the attended & remote scopes
- Separation distance limited by travel time & available dark time
- Roger Venable uses VCR's with timed starts, allows larger separation
- Better to have remote sites attended for starting equipment later (allows larger separations) and security
- Paver mounts allow pre-pointing on previous nights

Multistation Efforts

Most are 2 – 4 stations that really help with the astrometry and preliminary size determination. I did the first ones in 1998 (lunar grazes) and 2001 (asteroidal). Our best was this 7 positives event in 2015 Sept. 11 in Australia.



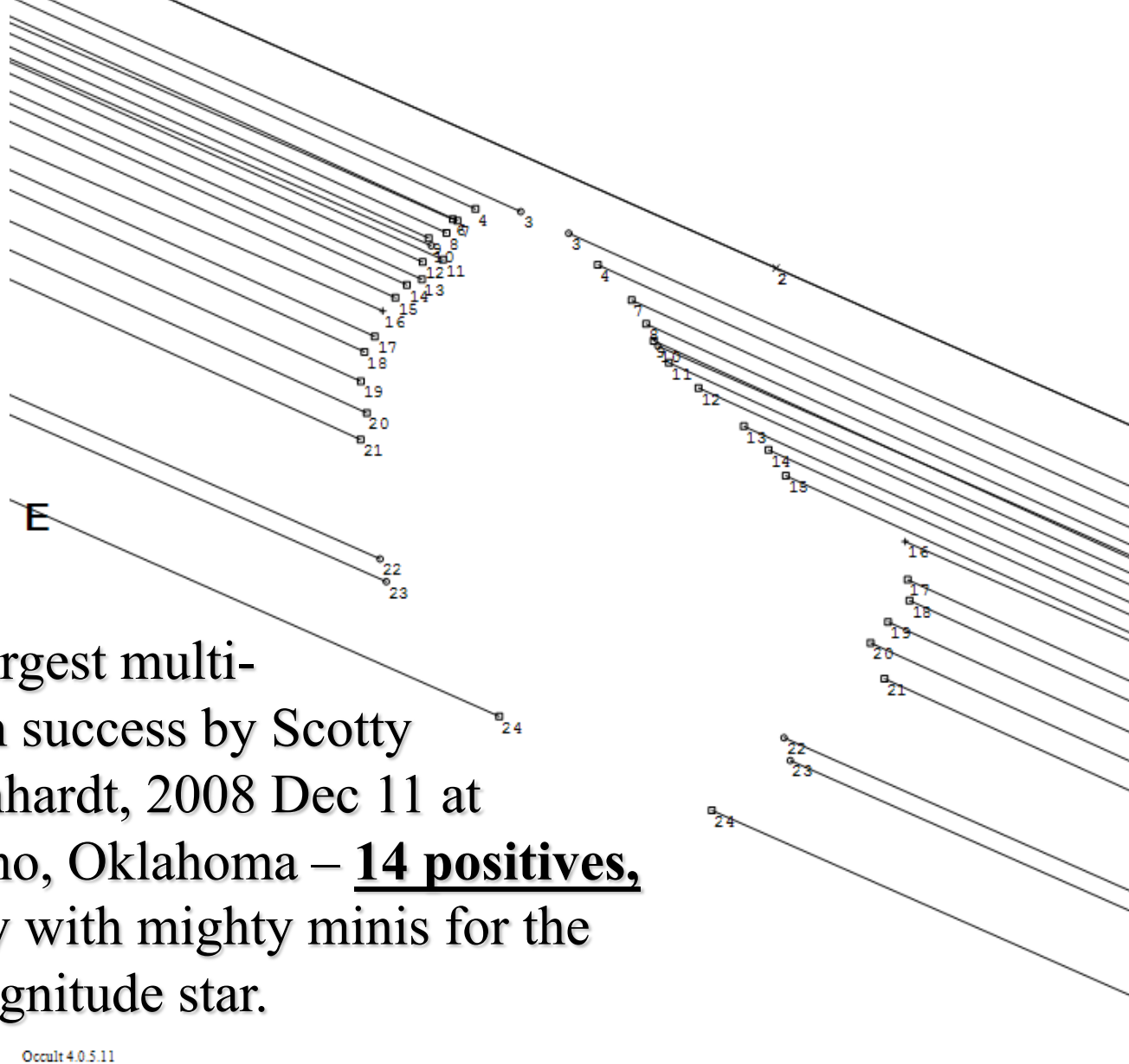
“Mighty Mini” Complete portable occultation timing setup (air carryon)



**Half-50mm-binocular-based
system by
Scotty Degenhardt, bringing
multiple-station campaigns
to a higher level for bright
occultations**

The largest multistation success by one observer

(135) Hertha 2008 Dec 11 $96.5 \pm 2.3 \times 64.3 \pm 2.5$ km, PA 40.6 ± 3.0
Geocentric X 3159.2 ± 0.9 Y 1940.4 ± 1.1 km



Find best fit

Center X ☒ -6.7
Center Y ☒ 3.4

Major axis (km) ☒ 4.3
Minor axis (km) ☒ -6.7
Orientation ☒ 5.0

a/b=1.50
dM=-0.44

Double star
Sepn (masec) ☐ 0.0
PA of 2nd ☐ 0.0

☒ Both ☐ Primary ☐ Secondary

☐ Circular ☐ Include Miss events

Plot scale Quality

RMS fit 1.8 ± 7.5 km

1 (M)	R Stanton, Three Rivers, CA
2 (M)	P Maley, Baker CA
3	G Mroz, Santa Fe, NM
4	S Degenhardt01, Okarche, OK
6	D Dunham, Harvard, CA
7	S Degenhardt02, Okarche, OK
8	S Degenhardt03, Okarche, OK
9	S Degenhardt04, Okarche, OK
10	R Wasson, Barstow, CA
11	S Degenhardt05, El Reno, OK
12	S Degenhardt06, El Reno, OK
13	S Degenhardt07, El Reno, OK
14	S Degenhardt08, El Reno, OK
15	S Degenhardt09, El Reno, OK
16	A Holmes, Goleta, CA
17	S Degenhardt10, El Reno, OK
18	S Degenhardt11, El Reno, OK
19	S Degenhardt12, Union City, OK
20	S Degenhardt15, Union City, OK
21	S Degenhardt14, Minco, OK
22	B Owen/J Young, Wrightwood, CA
23	K Young, Wrightwood, CA
24	G Lyzenga, Altadena, CA

The largest multi-station success by Scotty Degenhardt, 2008 Dec 11 at El Reno, Oklahoma – **14 positives**, mostly with mighty minis for the 8th magnitude star.

The 10-inch 'Suitcase' Telescope



**Designed and Built by John Broughton,
Reedy Creek, Queensland, Australia**

The camera is at prime focus, so the images are reversed (one reflection); it is normally used for pre-pointed occultations of faint stars by asteroids.

Astrid Plate-Solving Imaging and Occultation Camera, by Mark Simpson, Calgary, Canada, 2024

Astrid Case Options



See the “Recommended Equipment” section of the Observing Tab at www.occultations.org.
You can also use your own camera and system, as long as it can record at least a few frames/sec.

With so many, Which Occultations should we Try with mobile efforts?

- **Near-Earth Asteroids, especially Potentially Hazardous ones (PHA's)**
- Those by Trans-Neptunian Objects (TNO's) and Centaurs – Distant Objects
- Trojan Occultations, to support Lucy Mission Science (RECON campaigns)
- Special Main Belt (MB) asteroids, now 2 categories with diff. strategies:
- 1- All Special MB's, to observe from home whenever you can (now 160+)
- **2 - Most Special MB's you should travel to, especially campaign events (110)**
- **These include new moon discoveries with good confirmation chance, and objects with odd shapes that could be contact binaries; those with known close moons need coverage out to at least the moon's probable distance.**
- For the later MB special occs for 2026, I may add a subset of those objects for which we only are interested in the shape, since covering beyond the 1-sigma limit is less important for them.

Discovery and confirmation of the satellite of (4337) Arecibo, 2021

Discovery by Peter Nosworthy & Dave Gault, May 19, west of Sydney, NSW, Australia
Confirmation by Richard Nolthenius and Kirk Bender, June 9, central California, USA

Sky plane plot of the observations; the fitted circle for (4337) Arecibo is 24.4 km in diameter, while that for the satellite is 13.5 km

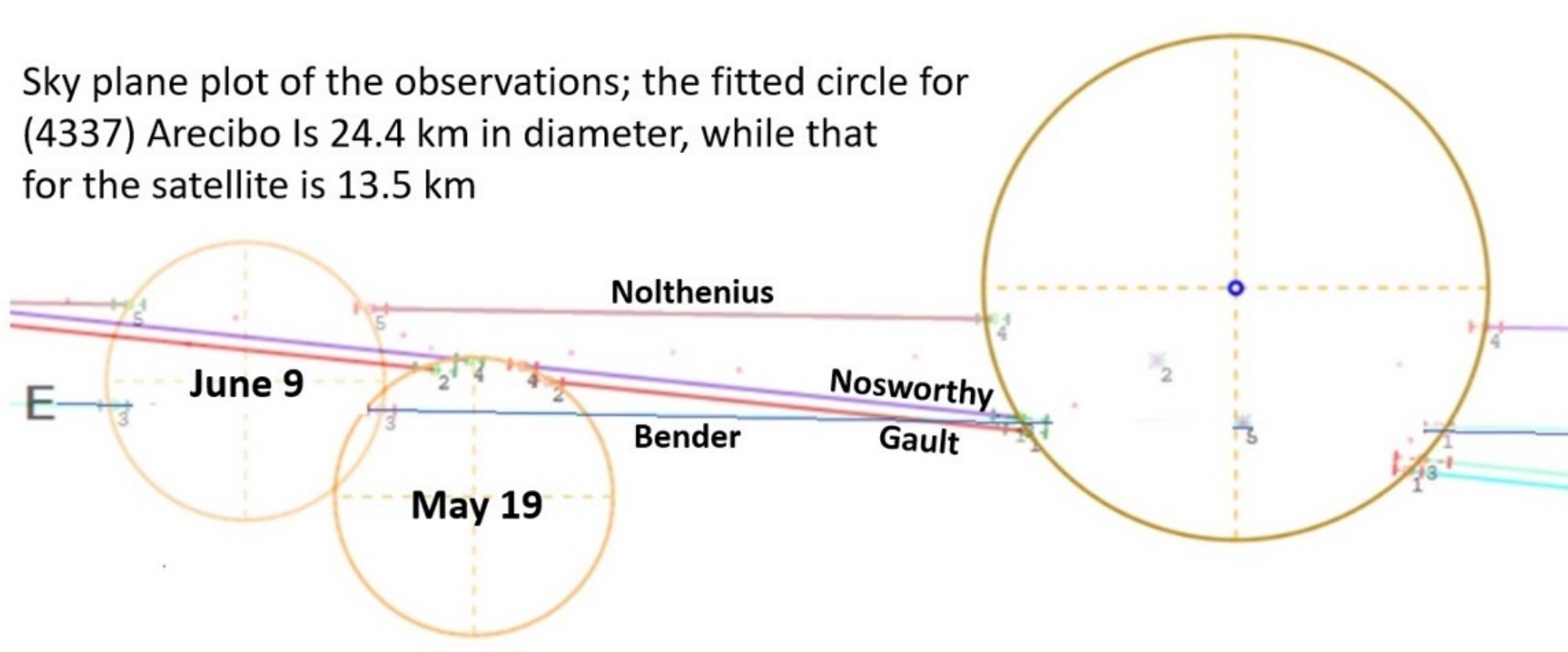
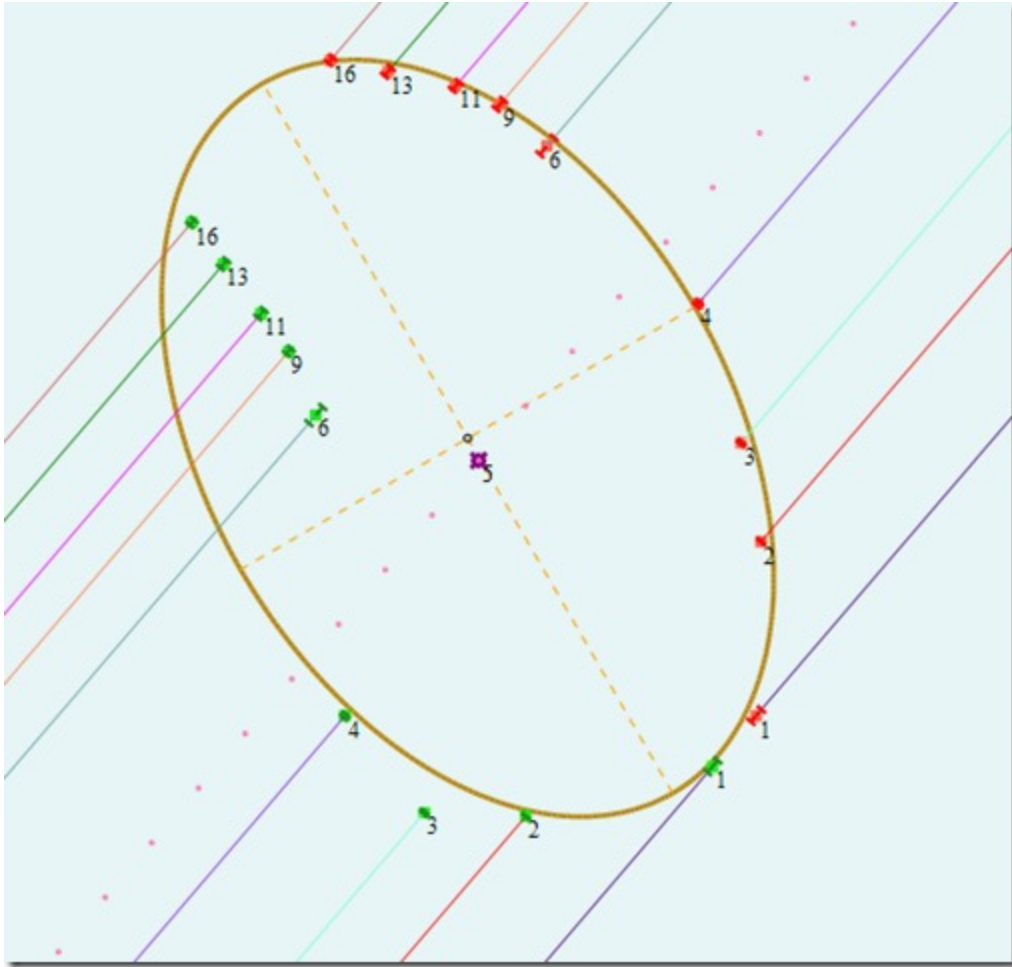


Diagram by Dave Herald using the Occult4 program. For more, including the videos, please visit https://www.youtube.com/watch?v=w_Cc5Or1FFw . Gaia confirmed the duplicity from the small wobble of the center of figure, finding a period of 1.3 days, and the orbit was determined.

2025 April 18 Campaign for (319) Leona – 9.1-mag. star



We need to improve knowledge of the size and shape of Leona, to better analyze the extensive observations of the **2023 Dec. 12th occultation of Betelgeuse by Leona**. This bright event was observed from sites mostly in Missouri. The stations were:

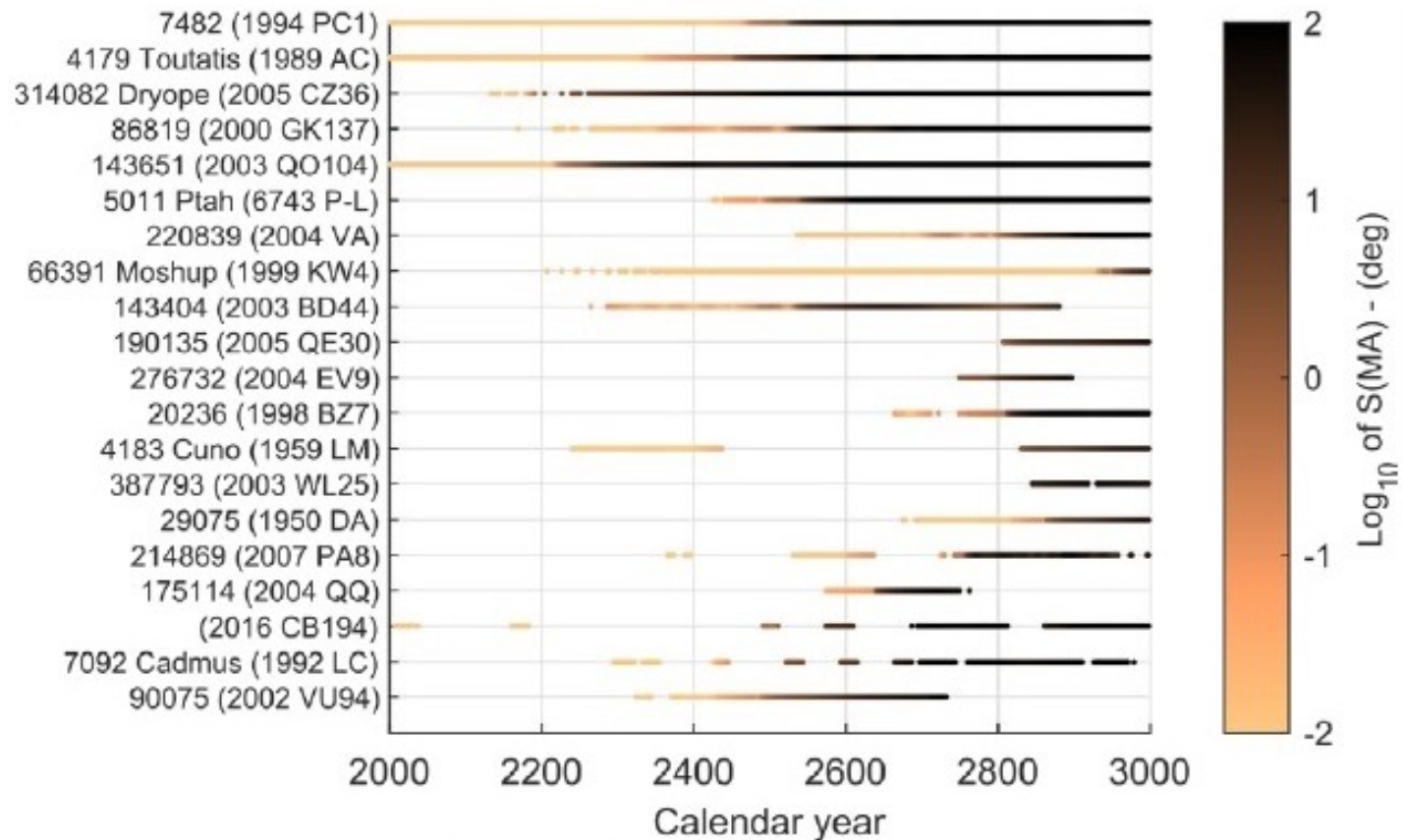
1. David and Joan Dunham
2. Vadim Nikitin
3. Skip Whitehurst
4. John Moore
5. The prediction
6. Andy Howell
7. 9,11,13,&16 – Roger Venable

The occultation light curves show gradual events due to the red star's angular diameter so the event points are at the 50% level. Venable believes the star may also be a very close binary, but Dave Herald, who made the sky-plane plot to the left showing Leona's odd shape departing from the fitted ellipse, is not convinced of stellar duplicity.

M-class (216) Kleopatra has an odd very elongated dumbbell shape, an extreme contact binary object with 2 small moons.

Defending Earth from Potentially Hazardous Asteroids (PHA's)

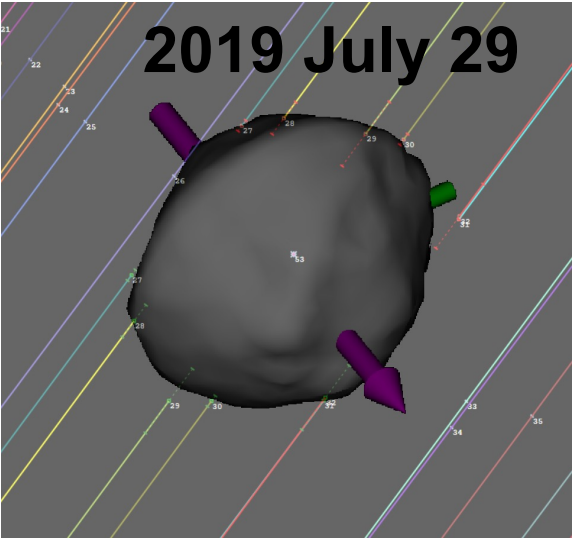
- Well-known is (99924) Apophis with multiple Earth-returns that amplify errors
- 500m (101955) Bennu has about 0.04% chance of Earth impact in 2880 Sep 24
- 1.4km (29075) 1950 DA has a 0.003% chance to impact Earth in 2880 Mar. 16.



It is one of 20 PHA's for which occultation observations are sought as their orbits are not now known well-enough to exclude impact during the next 1000 years, and also are 1 km or larger so they are capable of causing severe worldwide problems.

Above, O. Fuentes-Muñoz et al, ACM2023

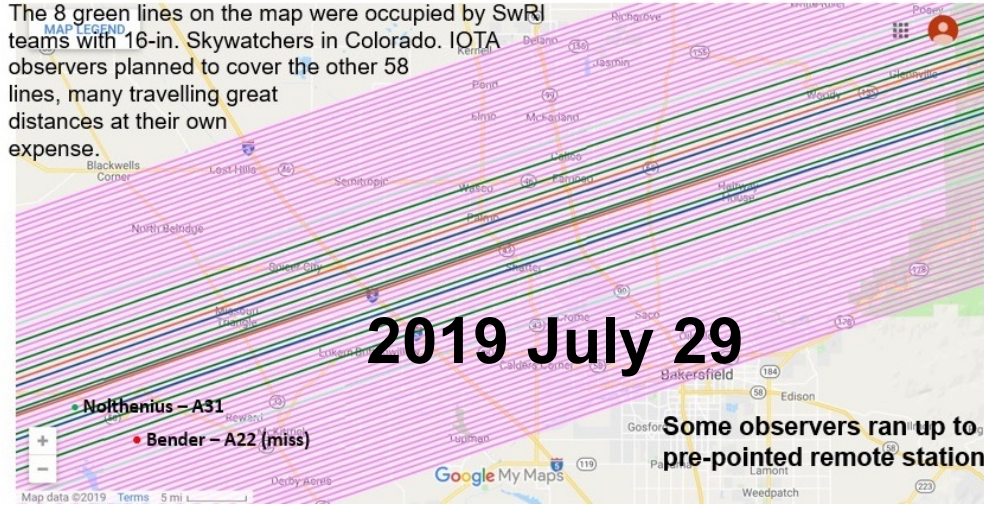
The First Occultations by (3200) Phaethon were described at PDC 2021



Left: Sky-Plane plot of central timings fitted to Sean Marshall's Phaethon shape model.

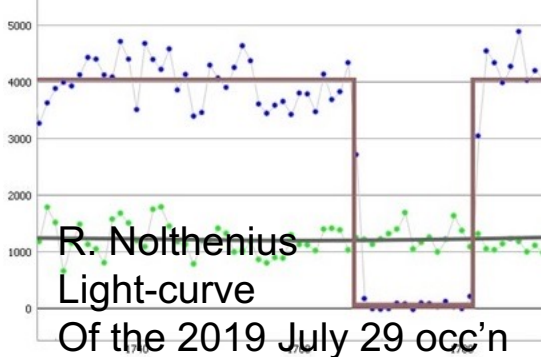
Right: Map showing planned observer lines, central California.

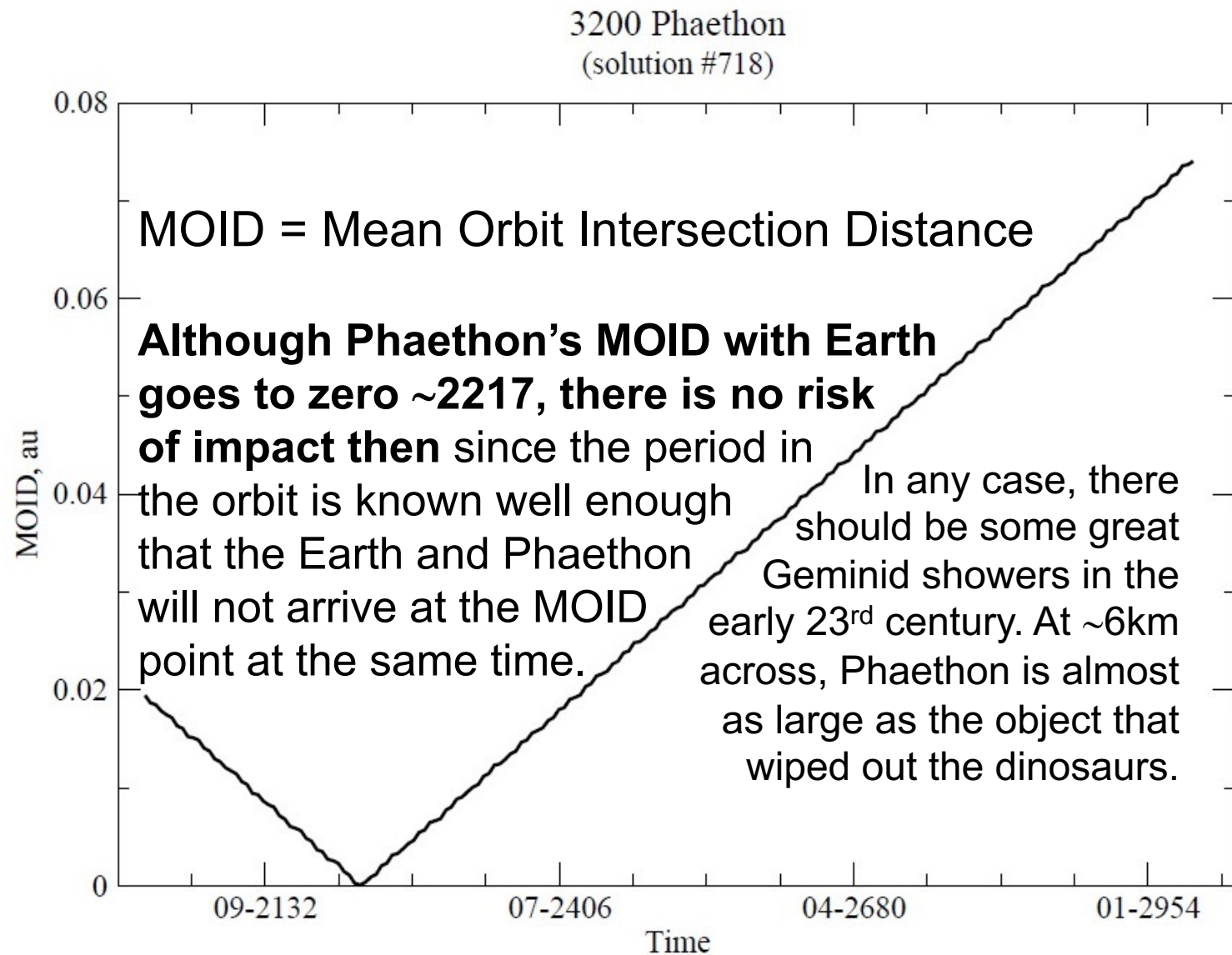
Most stations were n. of Las Vegas; others were n. of Ridgecrest and near Pueblo, Colo.



The 1st occultation, of 7.3-mag. SAO 40261 whose path crossed the southwestern USA on 2019 July 29, was found by Isao Sato in Japan. The orbit was refined by the planetary ephemeris team at JPL that provided a prediction that was much more accurate than expected. Almost 70 telescopes were set up, 8 by SwRI and the rest by IOTA, to record the event from a span of 45 km, with the 6 central stations recording the event. The scopes at ~20 unattended stations were pre-pointed to the alt/az of the occultation using Guide star charts with the “pre-point line of declination” plotted. We hope that new plate-solving techniques will enable more to make these multi-station deployments; we seek help in finding solutions that work with simple video systems in the field. **Five more Phaethon occultations were observed in late 2019 and one in 2020** that resulted in a 3-times reduction of the error of the determination of the A2 non-gravitational parameter of Phaethon's orbit, with a table of the observed events on the lower left.

Date	Star mag.	# stations positive/all	Locations(s)	Remarks
2019 July 29	7.3	6/52	s.w. USA	8 SwRI 16in., 44 IOTA stations
2019 Sept. 29	12.0	3/4	s. California	2 pre-pointed 10in. scopes, 2 8in. SCTs
2019 Oct. 12	11.3	2/2	Virginia	UVA expedition with 14in. SCTs
2019 Oct. 15, 17h	11.5	2/2	Japan	Clouds at more stations that tried
2019 Oct. 15, 19h	11.1	3/3	DE, FR, Algeria	In FR, a 1m portable scope was used
2019 Oct. 25	11.3	3/3	Italy, Algeria	2 nd Phaethon occ'n for D. Baba Aissa
2020 Oct. 5	11.2	1/4	s. Mississippi	R. Venable, pre-pointed 11 & 14in SCTs

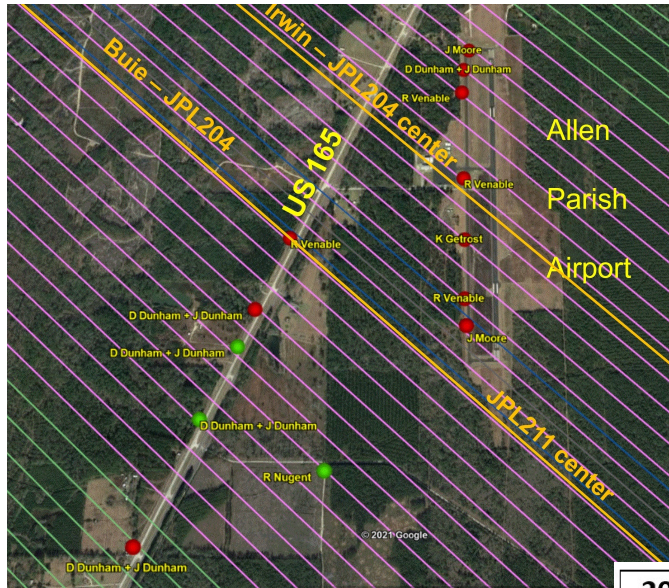




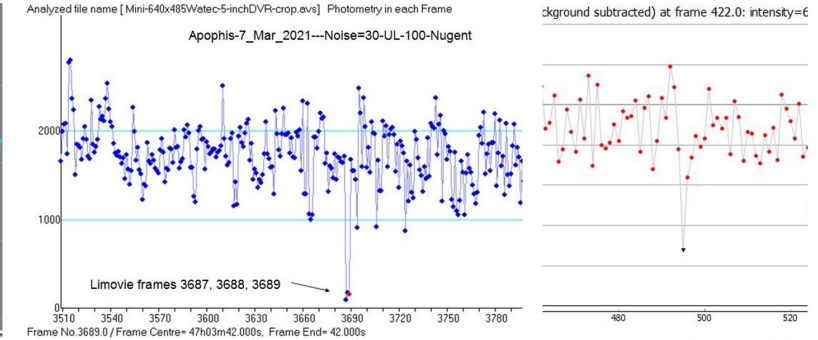
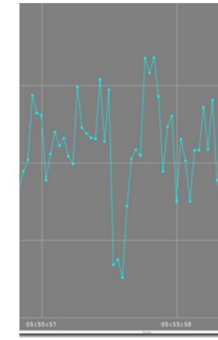
We should keep close tabs on Phaethon since its A2 term could change; its rubble pile structure could change with the severe thermal shocks it suffers, so such a change might alter the orbit period, maybe enough to be a concern in 200 years??

2021 Occultations by (99942) Apophis

The 1st observed event on March 7th benefitted from a JPL prediction based on radar data from Mar. 4-6; the star was 8.4-mag. NY Hydrae, an eclipsing binary with high Gaia RUWE.



Above, the 2 pre-pointed 8cm Dunham unattended systems that recorded positives; 3 others they deployed had misses.



Above, the 3 positive light curves for the March 7th occultation.

Left: Stations near Oakdale, Louisiana with the planned lines; Green dots mark positive sites, red dots mark sites that had no occultation (negatives).

2021 Date	mag. [1]	Loc. [2]	Total #	# pos.	$\Delta\alpha$ [3]	$\Delta\delta$ [3]	Δt [3]	RUWE [4]
March 7	8.4	LA,OK,CO,BC	29	3	-11.0	+1.2	+0.17	1.45 [5]
March 22	10.0	FL,AL,IL	9	1	+0.4	-0.5	-0.02	1.15
April 4	11.0	NM	8	3	+0.3	-0.1	-0.01	0.90
April 10	12.6	Japan	2	1?	marginal detection, not used			
April 11	10.1	NM	3	3	+0.5	-0.5	-0.03	0.85

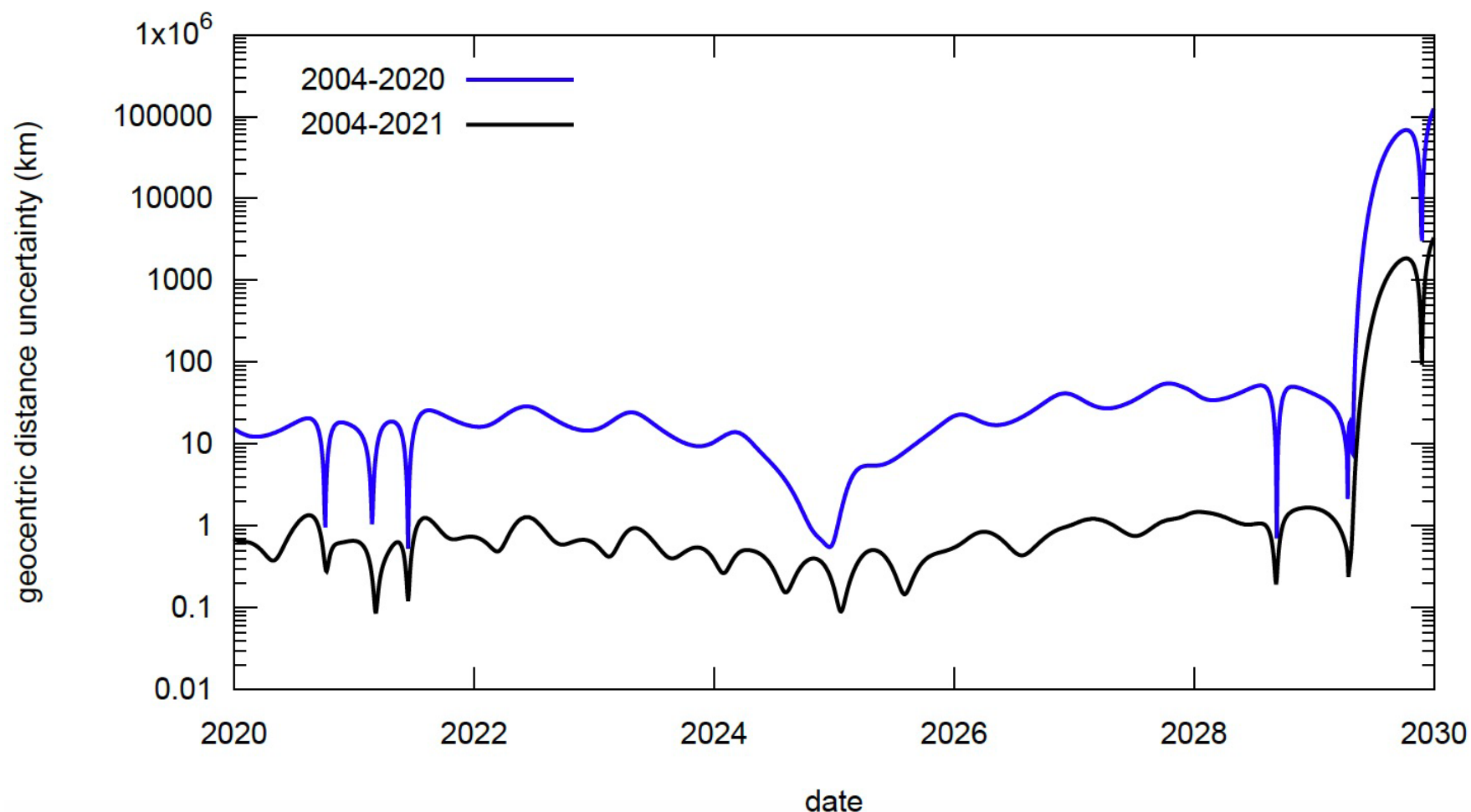
Right: Residuals from the first 5 Apophis occultations from the JPL 214a orbit that gave 0 weight to Mar. 7 since the star's Gaia RUWE was high. The high-precision orbit, with radar & occultations, retired the risk of impact with Earth for at least a century.

- [1] This is the Gaia g magnitude of the occulted star.
- [2] For location, the country is given, or 2-letter US State/Canadian Province codes.
- [3] The O-C residuals are relative to JPL orbit 214a, in mas, but in seconds for Δt .
- [4] The RUWE is for the Gaia 3rd Early Data Release (EDR3); values >1.40 indicate stars that are likely to have positional errors larger than the formal errors from the Gaia astrometric solution.
- [5] The star is NY Hydrae, an eclipsing variable with a 4.8-day period.

Analog video, optimized for 30 fps, are still among the best systems for recording short NEA occultations.

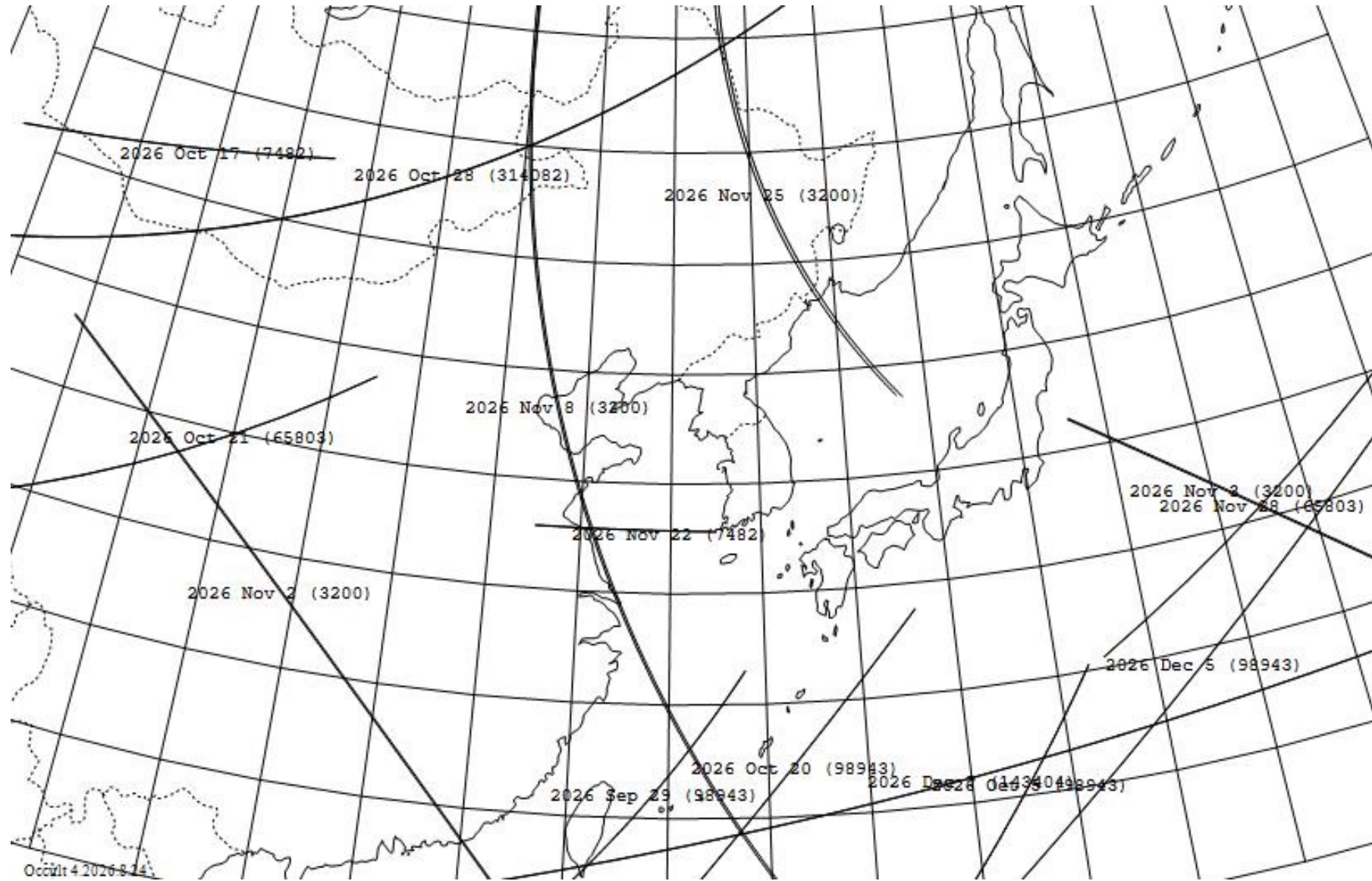
Much information about past observed Apophis occultations is at <http://iota.jhuapl.edu/Apophis2021.htm>.

Improvement of the orbit of Apophis by adding the 2021 Occultation Observations



Presented by D. Souami, ACROSS, at the Asteroids, Comets, Meteors Convention, Flagstaff, AZ in June 2023. The errors, in blue, from previous astrometry and 2021 radar already retired the risk of Apophis impact for the next 100 years, but **adding the occultations, black curve, decreased them another order of magnitude**. We can **observe Apophis occultations again in 2028**, through the 2029 April Earth flyby.

E. Asian Selected NEA Occultations to mag. 12 to end of 2026

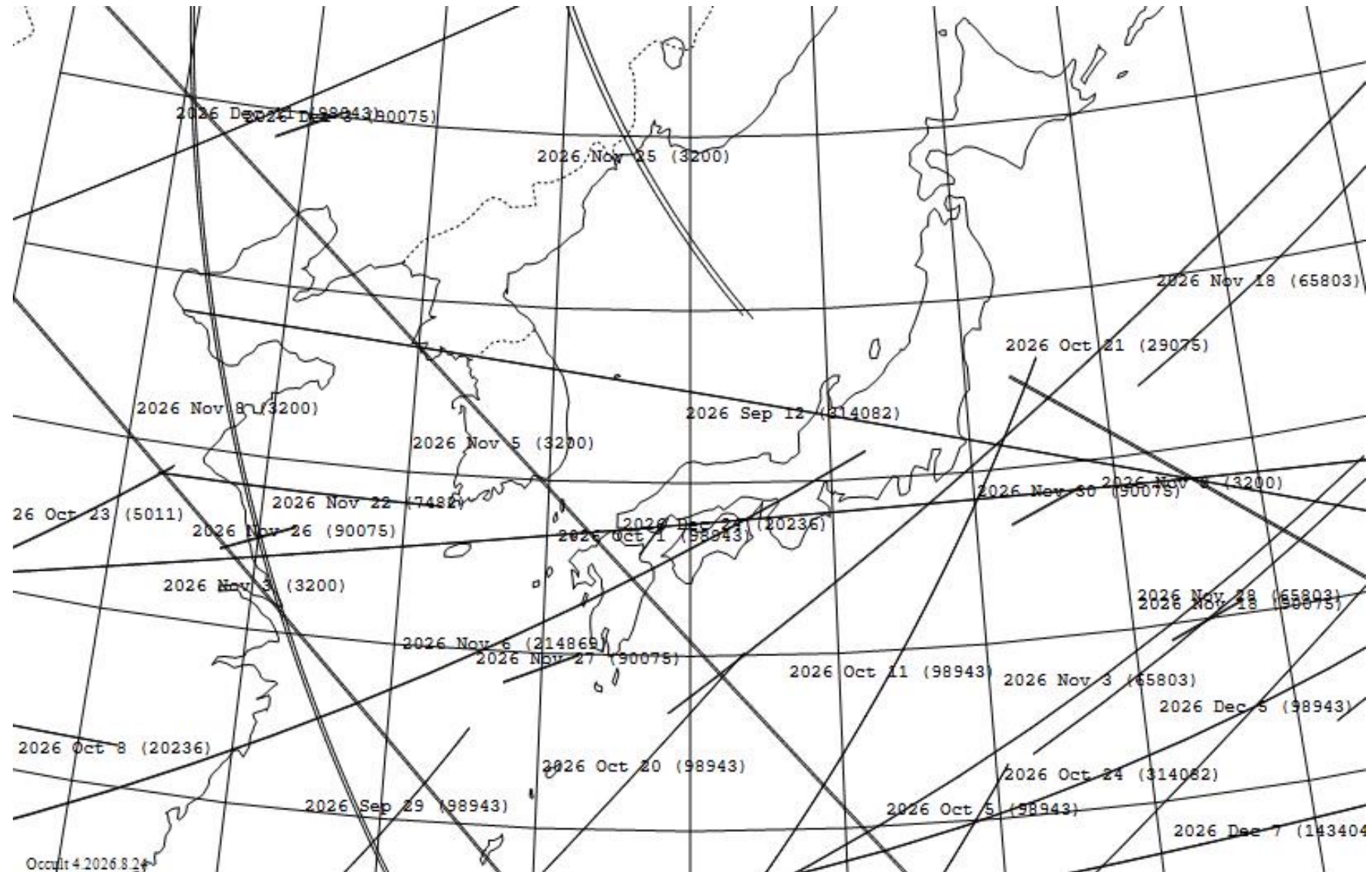


E. Asian Selected NEA Occultations to mag. 12 to end of 2026

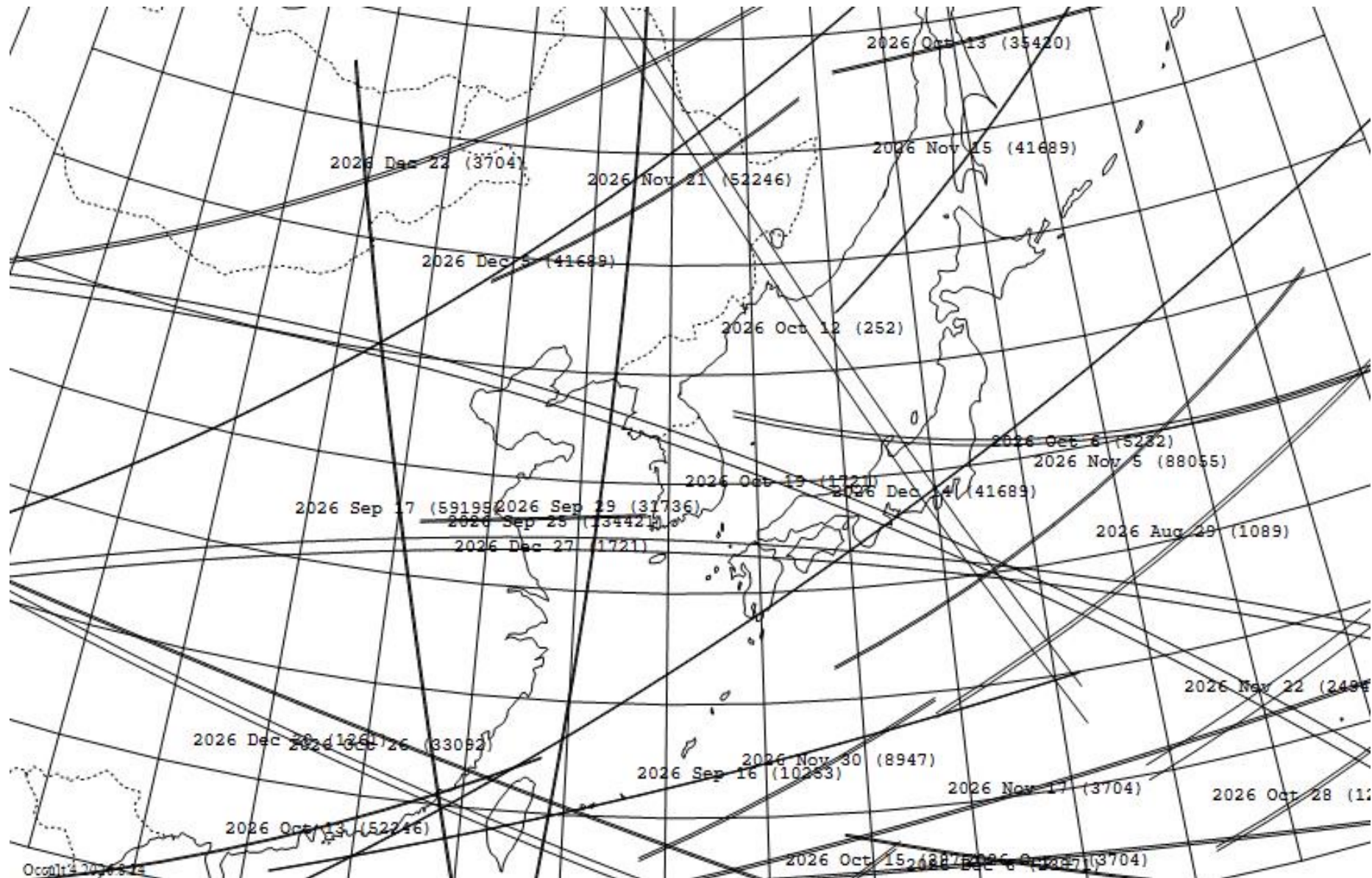
Event Summary for selected NEA's for eastern Asia region to mag. 12 - sorted by Date

Date			U.T.		Diameter		Durn	Rate	Star	Mag-Drop		Elon	%	Star	d Rely	Planet	Min	Moon		☾	R.A. (J2000)			Dec.				
y	m	d	h	m	km	"	sec/m	km/s	mag	V	R	*	o	No.	<1.4	No	Name	D	Error	Dist	ill	h	m	s	o	'	'	
2026	Sep	3	10	29.7	0.50	0.003	0.04s	12.5	11.8	7.7	7.4	63		UCAC4 292-074301	s 1.20	98943	Torifune	0.96	±0.00	160	60	14	14	44.382	-31	39	2	
2026	Sep	29	11	39.5	0.50	0.003	0.04s	12.5	9.1	9.3	9.0	89		UCAC4 221-167507	s 1.10	98943	Torifune	0.80	±0.00	127	90	18	23	34.656	-45	58	6	
2026	Oct	5	11	36.4	0.50	0.003	0.04s	12.5	10.8	7.6	7.3	94		UCAC4 232-168562	0.85	98943	Torifune	0.63	±0.00	152	29	19	25	4.730	-43	46	11	
2026	Oct	17	22	16.0	1.10	0.001	0.02s	55.0	10.8	8.2	7.6	34		TYC 0857-00145-1	s 1.00	7482	1994 PC1	0.61	±0.00	116	43	11	37	4.990	9	19	47	
2026	Oct	20	13	40.4	0.50	0.002	0.04s	12.5	10.7	7.9	7.1	103		TYC 7476-00767-1	0.95	98943	Torifune	0.26	±0.00	17	68	21	14	26.378	-33	36	45	
2026	Oct	21	12	21.6	0.80	0.001	0.03s	26.7	8.2	12.8	12.1	65		UCAC4 319-146318	0.80	65803	Didymos	0.76	±0.00	57	76	18	12	4.812	-26	23	51.	
2026	Oct	28	15	31.8	1.00	0.001	0.09s	11.1	9.5	13.4	13.5	140		TYC 0092-01038-1	s 1.05	314082	Dryope	0.82	±0.01	23	91	4	47	37.680	4	7	52	
2026	Nov	2	11	33.4	5.0	0.011	0.22s	22.7	11.7	4.0	3.7	110		TYC 2716-01293-1	1.05	3200	Phaethon	0.07	±0.00	128	43	21	27	1.225	36	18	55	
2026	Nov	3	8	18.5	5.0	0.011	0.22s	22.7	10.3	5.4	5.2	110		TYC 2712-00109-1	s 0.95	3200	Phaethon	0.10	±0.00	132	34	21	30	55.736	35	36	15	
2026	Nov	8	15	33.0	5.0	0.010	0.24s	20.8	11.6	4.4	4.0	111		TYC 2718-01088-1	1.20	3200	Phaethon	0.79	±0.00	119	1	21	51	25.983	31	45	32	
2026	Nov	9	22	22.1	0.80	0.003	0.07s	11.4	10.2	10.1	10.0	34		TYC 7256-00542-1	s 0.95	152637	1997 NC1	0.65	±0.00	35	1	12	49	33.972	-35	0	5	
2026	Nov	22	21	16.0	1.10	0.001	0.02s	55.0	11.9	7.0	6.8	31		UCAC4 465-051139	s 1.05	7482	1994 PC1	0.38	±0.00	158	96	14	29	1.454	2	56	28	
2026	Nov	25	8	38.4	1.50	0.001	0.05s	30.0	11.8	10.1	10.5	38		UCAC4 308-250190	s 0.75	5011	Ptah	0.85	±0.01	153	99	18	48	40.527	-28	34	9	
2026	Nov	25	15	43.9	5.0	0.007	0.28s	17.9	11.4	5.5	5.5	105		UCAC4 570-127261	s 1.10	3200	Phaethon	0.93	±0.00	85	98	22	36	5.376	23	55	45	
2026	Nov	28	8	23.8	0.80	0.001	0.03s	26.7	9.6	11.1	10.9	56		TYC 6906-00214-1	s 2.55	65803	Didymos	0.60	±0.00	177	81	20	18	5.381	-22	37	35.	
2026	Nov	30	7	52.6	2.20	0.002	0.04s	55.0	11.3	6.7	7.0	31		UCAC4 360-161623	s 0.75	90075	2002 VU94	0.78	±0.00	132	60	18	34	26.367	-18	1	10	
2026	Dec	5	10	33.0	0.50	0.001	0.05s	10.0	8.6	11.3	10.8	100		UCAC4 414-144223	s 0.80	98943	Torifune	0.25	±0.00	139	12	23	43	42.711	-	7	20	16
2026	Dec	7	8	50.7	0.90	0.001	0.02s	45.0	11.2	11.4	11.1	25		TYC 6288-02040-1	0.60	162173	Ryugu	0.56	±0.00	43	3	18	40	45.101	-20	28	41	
2026	Dec	7	14	25.0	1.30	0.001	0.08s	16.3	11.1	10.4	10.6	165		UCAC4 549-020978	s 1.20	143404	2003 BD44	0.12	±0.00	149	2	5	56	36.920	19	37	1	

Japan Selected NEA Occultations to mag. 13 to end of 2026



E. Asia MB Most Special Occultations to mag. 12 to end of 2026



E. Asia Main Belt Most Special Occultations to mag. 12 to end of 2026

MB most special Summary for East Asia region to Mag 12.0 - sorted by Date

Date	U.T.	Diameter	Durn	Rate	Star	Mag-Drop	Elon	%	Star	d Rely	Planet	Min	Moon	\$ ●	R.A. (J2000)	Dec.
y m d	h m	km "	sec/m	km/s	mag	V	R *	o Ill	No.	<1.4	No Name	D Error	Dist ill	€	h m s	o ' "
2026 Aug 29	15 28.2	13 0.010	0.55s	24.0	10.8	5.1	5.5	79	UCAC4 556-012602	v 0.90	1089 Tama	0.52 ±0.00	83 98	\$€	5 2 0.903	21 4 10.
2026 Sep 1	10 3.1	11 0.012	1.03s	10.2	10.2	5.2	4.3	113	TYC 6843-02366-1	0.70	1216 Askania	0.54 ±0.00	119 81		18 8 49.764	-23 25 46.
2026 Sep 16	19 25.9	2.20 0.001	0.06s	36.7	10.1	9.8	9.5	51	TYC 1386-00674-1	s 2.00	10253 Westerwald	0.10 ±0.00	119 31		8 19 39.683	19 47 38.
2026 Sep 17	11 47.7	6.3 0.003	0.44s	14.3	9.2	11.1	10.5	111	TYC 0466-01182-1	0.85	59195 1999 BG2	0.20 ±0.00	48 37		19 5 2.685	2 34 23.
2026 Sep 25	20 35.3	7.5 0.003	0.18s	41.7	10.7	9.8	9.4	30	UCAC4 513-051837	0.75	134421 1998 QT2	0.03 ±0.00	160 99	€	10 19 37.010	12 30 23.
2026 Sep 29	12 12.5	5.1 0.004	0.91s	5.6	11.8	6.8	6.5	134	UCAC4 415-142469	0.95	31736 1999 JR73	0.15 ±0.00	81 90	€	21 22 57.523	- 7 7 11.
2026 Oct 1	18 11.6	9.9 0.006	0.97s	10.2	11.8	5.5	5.7	101	UCAC4 561-020218	s 1.30	3704 Gaoshiqi	0.05 ±0.00	14 70		5 46 9.942	22 8 41.
2026 Oct 6	9 51.8	12 0.007	0.51s	22.9	12.0	5.2	5.5	83	UCAC4 379-105802	s 0.85	5232 Jordaens	0.82 ±0.00	134 20	\$€	18 22 48.716	-14 12 0.
2026 Oct 12	19 30.0	67 0.036	10.0s	6.6	10.5	4.6	4.3	113	UCAC4 523-015625	s 1.00	252 Clementina	0.29 ±0.00	137 5	\$	5 43 11.061	14 32 0.
2026 Oct 13	13 16.4	3.90 0.002	0.18s	21.7	11.8	9.5	8.9	77	TYC 6278-01689-1	0.95	52246 Donaldjohanson	0.49 ±0.00	43 9		18 28 36.141	-20 50 30.
2026 Oct 13	17 29.6	6.6 0.003	0.21s	31.4	9.2	10.3	9.8	55	TYC 0821-01676-1	s 1.80	35420 1998 AG6	0.52 ±0.00	91 10	\$G	9 42 0.326	8 7 33.
2026 Oct 14	12 5.5	56 0.033	1.59s	35.3	10.4	4.0	3.5	62	TYC 6243-00190-1	s 0.65	269 Justitia	0.47 ±0.00	20 14	\$	17 30 39.193	-19 39 21.
2026 Oct 15	10 33.9	9.9 0.004	0.30s	33.0	10.2	8.0	7.8	56	TYC 6823-00093-1	s 0.75	2875 Lagerkvist	0.54 ±0.00	2 21	\$	17 2 28.161	-29 59 44.
2026 Oct 19	15 11.3	45 0.027	8.0s	5.6	9.7	6.3	5.6	125	TYC 2906-01953-1	5.25	1721 Wells	0.50 ±0.00	129 59		4 55 49.738	43 10 30.
2026 Oct 23	13 1.6	10 0.008	0.42s	25.0	10.4	5.9	5.6	82	TYC 6893-00030-1	s 0.95	1216 Askania	0.31 ±0.01	65 91		19 35 31.738	-24 30 21.
2026 Oct 26	20 1.4	7.5 0.003	0.25s	30.0	11.9	7.9	7.5	66	TYC 0239-00958-1	1.65	33092 1997 YR1	0.02 ±0.00	105 99		9 44 38.278	4 1 0.
2026 Oct 28	8 20.5	10 0.008	0.40s	26.2	10.3	6.1	5.9	79	UCAC4 329-190916	s 0.90	1216 Askania	0.67 ±0.01	131 93		19 45 14.101	-24 17 7.
2026 Nov 5	9 13.0	5.4 0.003	0.19s	28.4	11.1	9.7	9.6	67	UCAC4 328-191496	s 0.90	88055 Ghaf	0.72 ±0.00	112 15		19 26 20.881	-24 32 9.
2026 Nov 15	10 4.4	2.60 0.002	0.34s	7.6	11.5	7.5	7.0	146	TYC 2404-00270-1	2.50	41689 2000 UW18	0.68 ±0.00	145 31		5 39 12.320	31 8 27.
2026 Nov 17	18 13.6	9.9 0.008	1.18s	8.4	11.8	4.7	4.2	148	UCAC4 551-018751	1.90	3704 Gaoshiqi	0.02 ±0.00	119 53		5 47 28.834	20 3 20.
2026 Nov 21	9 31.4	3.90 0.002	0.13s	30.0	8.5	12.9	12.7	50	UCAC4 352-169221	s 1.00	52246 Donaldjohanson	0.79 ±0.00	87 86		19 18 48.930	-19 43 25.
2026 Nov 22	8 21.9	50 0.021	1.78s	27.9	11.5	5.2	4.8	68	UCAC4 393-127304	1.10	2494 Inge	0.45 ±0.00	81 93	\$	20 30 40.146	-11 34 11.
2026 Nov 30	9 40.7	8.6 0.004	0.21s	41.0	11.6	7.7	7.5	39	UCAC4 335-199828	0.90	8947 Mizutani	0.53 ±0.00	140 59		19 13 35.286	-23 0 18.
2026 Dec 5	12 7.1	2.60 0.003	0.23s	11.3	11.8	6.8	6.2	169	TYC 2390-01216-1	1.25	41689 2000 UW18	0.53 ±0.00	133 12		5 17 17.492	30 40 2.
2026 Dec 6	19 4.3	6.3 0.003	0.15s	42.0	11.2	8.8	8.4	44	TYC 5553-01590-1	1.05	23871 Ousha	0.14 ±0.00	21 5		13 55 33.186	- 8 55 58.
2026 Dec 14	11 46.1	2.60 0.003	0.23s	11.3	11.3	7.2	7.2	172	UCAC4 601-016899	s 1.05	41689 2000 UW18	0.29 ±0.00	116 24		5 5 45.821	30 8 22.
2026 Dec 15	22 27.5	19 0.007	0.43s	44.9	10.9	7.3	7.3	23	TYC 6199-00082-1	s 1.10	4337 Arecibo	0.54 ±0.00	98 37	\$€	15 53 51.374	-20 38 44.
2026 Dec 22	11 51.9	9.9 0.009	0.88s	11.2	10.2	5.8	6.0	168	TYC 1287-00637-1	s 0.95	3704 Gaoshiqi	0.66 ±0.00	14 96		5 13 42.365	18 14 13.
2026 Dec 24	9 2.8	11 0.004	0.30s	35.3	7.4	12.3	12.4	22	TYC 6303-00912-1	s 1.05	39249 2000 YR88	0.71 ±0.00	162 100		19 40 15.607	-17 53 28.
2026 Dec 27	17 12.5	45 0.029	4.0s	11.1	11.8	3.9	3.7	145	TYC 2868-01080-1	1.10	1721 Wells	0.44 ±0.00	82 81		3 58 52.223	41 7 6.
2026 Dec 30	17 60.0	32 0.023	2.6s	12.4	12.0	3.3	2.7†	173	UCAC4 576-024486	w 0.95	1261 Legia	0.08 ±0.00	97 50		6 7 50.243	25 4 39.

RASC Observer's Handbook and IOTA special events Web Sites with **Worldwide Occult input files to find events in your area**

2026 Prediction Links, for North America and worldwide data

<https://occultations.org/publications/rasc/2026/nam26MBoccs.htm> - Main Belt, the brighter events, with links also to worldwide **Occult input files for NEAs, Trojans, and special main-belt objects. It includes a link to a .pdf that describes the reasons why many of the objects deserve special efforts.**

Instructions for using Occult4 to compute local and regional predictions:

<http://www.lunar-occultations.com/iota/2026iotapredictions.pdf>

Similar sites for 2027 will be set up during November and December.

For Lunar occultations of double stars, Europe has a good project for them, see https://astro-oled.es/oled/oled_SEPTIEMBRE25.html . Dave Herald suggested that they expand beyond Europe, to other continents.