Journal for Occultation Astronomy

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Lunar Occultations of Regulus in 2026

Dear reader,

For the first issue of the Journal for Occultation Astronomy for the year 2026, Eberhard Riedel has once again compiled the best grazing lunar occultations for the coming year. In addition, he provides an overview of lunar occultations of Regulus and the planets. Joachim Siegert has found an interesting article on the evaluation of collected data on lunar occultations. The explanations there on gradual events are intended to provide a basis for discussion.

Tim Haymes reports on a successful observation of a stellar occultation by the minor planet (426) Hippo by observers in Great Britain, with two contributions from continental Europe. Their efforts were rewarded with well-distributed chords across the asteroid's profile.

In the news section, we introduce a new observer network that will offer Web3 and AI applications. Richard Nugent has compiled the many interesting contributions to the IOTA Meeting 2025 in his minutes. The loss of two IOTA members in the US, Tony George and Bob Sandy, leaves a gap that will be difficult to fill.

The JOA editorial team wishes you, dear readers, clear skies with many successful observations in 2026.

Oliver Klös

IOTA/ES, Public Relations

COVER

The image was taken on 2007 October 7 at 04:54 UT, about 30 minutes before Regulus was occulted by the bright limb of the Moon. The event took place at dawn during nautical twilight near Wiesbaden, Germany. The dark side of the Moon is visible, as is SAO 98966 (8.1 mag) near Regulus. Maksutov lens f10/1000 mm, Canon EOS 350D, exposure time 4 s at ISO 400. (O. Klös)

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In this Issue:

Copyright Transfer

Rules for Authors

In order to optimise the publishing process, certain rules for authors have been set up how to write an article for *JOA*. They can be found in "How to Write an Article for *JOA*" published in this *JOA* issue (2018-3) on page 13. They also can be found on our webpage at https://www.iota-es.de/how2write_joa.html .

Journal for
Occultation Astronomy

(426) Hippo Successfully Observed on 2025 September 13

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ABSTRACT: England and parts of Europe were cloud free on the night of 2025 September 13. It was good luck that twelve observers were optimally placed geographically to record this event. All observers reported chords as (426) Hippo passed in front of UCAC4 579-000308 at magnitude r 11.7, with a drop of 1.3 magnitudes.

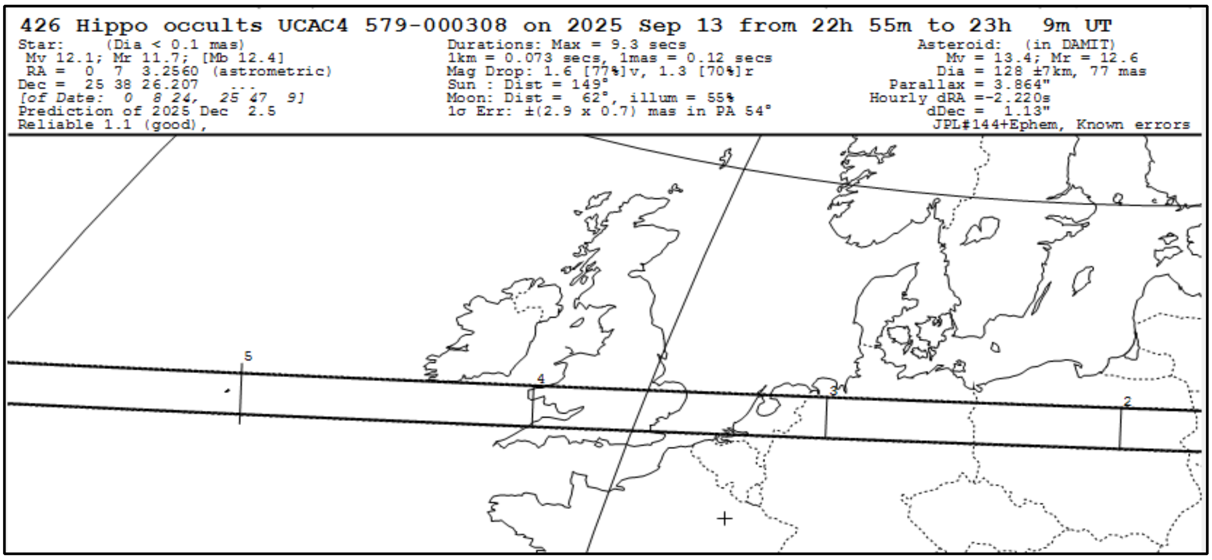

Figure 1. Prediction for the occultation of UCAC4 579-000308 by (426) Hippo on 2025 September 13. (OccultV4)

Observation Results

(426) Hippo, with a diameter of 127 +/- 7 km (weighted diameter NEOWISE/AcuA/IRAS), has been recorded on 19 previous occasions (*Occult* data) [1]. The best by far for number of observers was in Japan on 2021 Dec 27 with 21 reports and 14 chords. So, the observation with 12 chords (no misses) on 2025 Sep 13 with good distribution across the asteroid, is an excellent result. The northernmost chord was obtained by Konrad Guhl our IOTA/ES President, and the southernmost by Malcolm Jennings in South London (Table 1).

Results are now in the SODIS database [2] and were compared with DAMIT 3D models #16297 and #16298 [3]. A perfect fit with the models could not be achieved. The plot from the *Occult* database shows the recorded chords shaping an elliptical shadow profile of 132.1 ± 1.5 km × 115.6 ± 1.0 km (Figure 2). The light curves already submitted and checked are in Figure 4.

Well done to all observers.

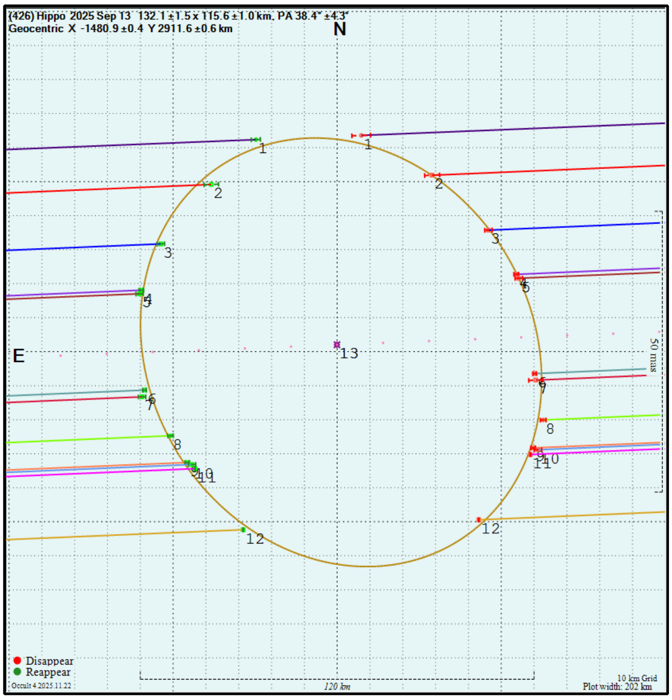

Figure 2. Occult plot with chord fitting. (Occult V4.2025.11.22)

About the author and UK team:

Tim Haymes assist the BAA Asteroids and Remote Planets Section by coordinating the occultation observations and reviewing reports in SODIS. He is chief reviewer of the GB+IE team. Advice is offered though UKoccultations.group.io [4]. When possible we collaborate with ProAm groups, and have occasionally "gone mobile" for events.

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[2] Stellar Occultation Data Input System (SODIS), https://sodis.iota-es.de

[3] Ďurech et al., Database of Asteroid Models from Inversion Techniques (DAMIT), https://damit.cuni.cz/projects/damit/

[4] Asteroid and Lunar Occultations UK, https://ukoccultations.groups.io/g/main

Chord	Observer	Duration	Telescope	Camera	Timing	Exposure
1	Konrad Guhl	2.29 s	30 cm	QHY174-GPS	GPS	0.20 s
2	Luke Broom-Lynne	4.80 s	25 cm Newt.	WAT-910HX	GPS VTI	0.16 s
3	Ken Harrison	7.12 s	20 cm Newt.	NightEagle	GPS VTI	0.16 s
4	Tim Haymes	8.15 s	28 cm SCT	QHY174-GPS	GPS	0.10 s
5	Henk de Groot	8.24 s	35 cm SCT	WAT-120N	GPS VTI	0.08 s
6	John Talbot	8.48 s	30 cm Newt.	WAT-910HX	GPS VTI	0.08 s
7	Derrick Ward	8.56 s	20 cm Newt.	ASI174	NTP/Meinberg	0.15 s
8	Peter Birtwhistle	8.10 s	40 cm SCT	Drift Scan	NTP/Meinberg	25 s
9	Phil Denyer	7.52 s	23 cm SCT	WAT-910HX	GPS VTI	0.08 s
10	Nigel Wakefield	7.52 s	25 cm SCT	WAT-910HX	GPS VTI	0.16 s
11	Peter Tickner	7.29 s	35 cm SCT	ASI432	TIMEBOX	0.065 s
12	Malcolm Jennings	5.12 s	28 cm Newt.	WAT-910HX	GPS VTI	0.08 s

Table 1. Twelve observers who contributed to this success (in chord order, North to South).

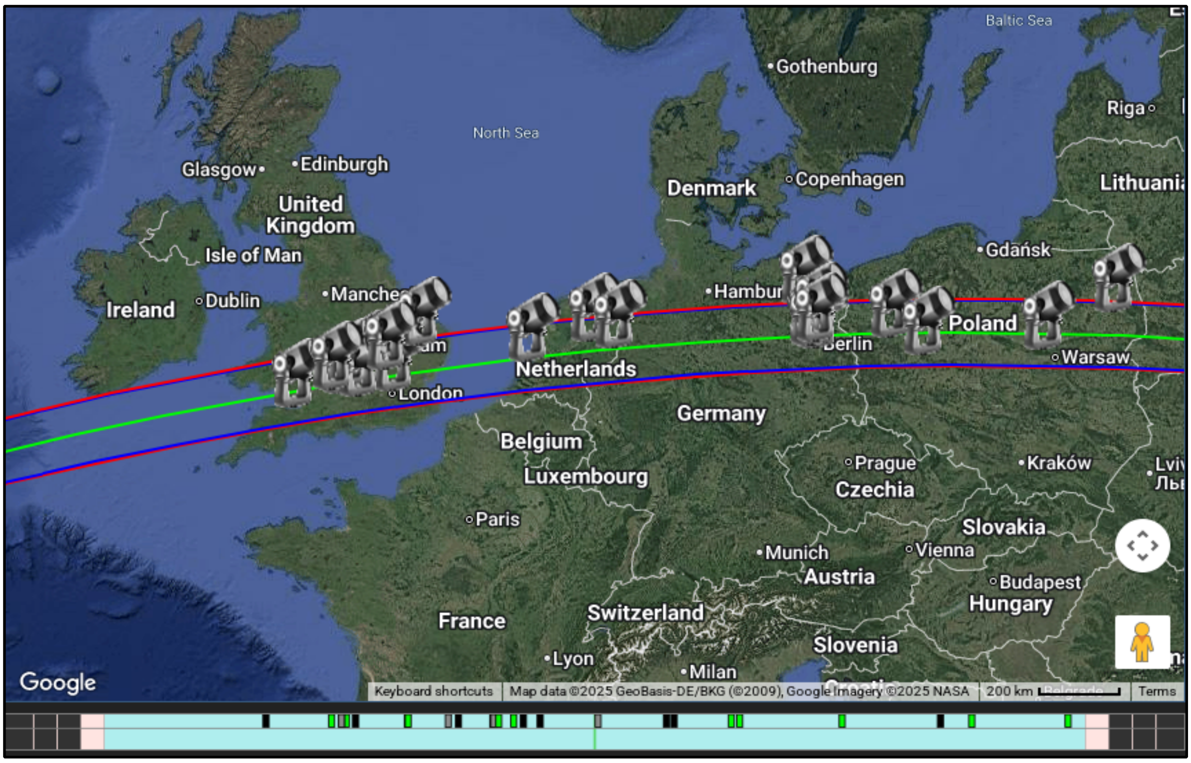

Figure 3. Map of announced stations and the predicted shadow path of the occultation by (426) Hippo on 2025 September 13 from Occult Watcher Cloud. The graphic below the map shows the distribution of the stations perpendicular to the direction of the path. North is on the left. Stations marked in green reported positive observations, stations in grey were clouded out. Stations that didn't report an observation are marked in black. (Google Maps, Meta data ©2025 GeoBasis-DE/ BKG (© 2009), Google Imagery ©2025 NASA)

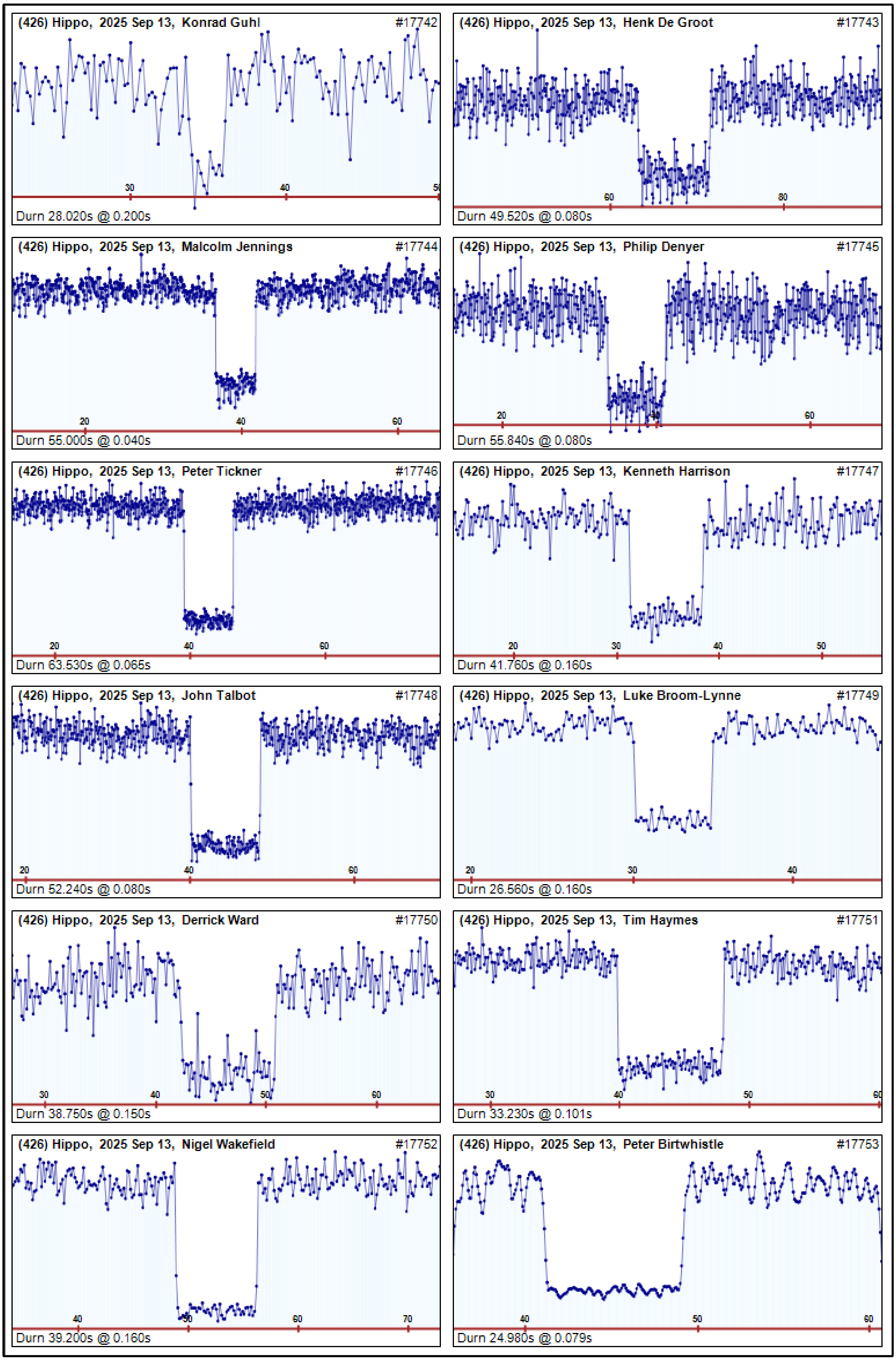

Figure 4. Complete set of reported light curves sorted by entry number in the Occult database.

Some Thoughts Concerning a Publication in Geophysical Research Letters, Volume 52, Issue 8 of 2025 April 28

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ABSTRACT: The following article reviews a publication in the Geophysical Research Letters (GRS article) raising the idea that meteoroidal impacts on the Moon's surface can produce low altitude dust clouds, leading to gradual (long-lasting) star dis- and reappearances during lunar occultations. The data source for this conclusion is the Lunar Occultation Archive (LOA). The main intention of this article is to evaluate the usefulness of LOA as a solid data base for the conclusions of the GRS article. This is not a scientific article in a stricter sense. It is more a discussion about how to evaluate the background of the GRS article and reflects the thoughts of the author about the evaluation results and some considerations aside that evaluation. The GRS article includes the interesting hypothesis about dust possibly being responsible for recent crashes of spacecraft on the Moon and the chances to detect this phenomenon by means of occultations of stars. This hypothesis is not evaluated here but some remarks about it are included.

Introduction and Motivation

Gradual dis- and reappearances of stars during an occultation by the Moon actually are a well-known phenomenon to occultation observers. The explanations heard most often for this type of occultation, described by observers as "star faded", "not instantaneous" or "step event" [1], and others are

- the occulted star is an unresolved double star,
- stars with appreciable angular diameter,
- diffraction effects,
- atmospheric phenomena, or
- observational illusions.

In Geophysical Research Letters, Volume 52, Issue 8 of 2025 April 28, M. L. Khodachenko and O. V. Arkypov (Austrian Academy of Sciences, Space Research Institute, Graz, Austria) proposed an extraordinary interpretation [2] using data from the Lunar Occultation Archive (LOA) [3]. For a certain number of occultations they interpret the gradual fading of the occulted star to be caused by lunar dust raised

- by impacting meteoroids,
- none-impact sources like outgassing due to solar tidal effects and/or solar wind flow.

In a Meta-Analysis, out of the 493,218 events in LOA they extracted 849 events (mainly from the period of 1967–2022) having individual duration data and are not near-pole grazing events (with $\varphi \leq 20°$, where φ is the minimum angle measured along lunar limb, between the polar axis and occultation point).

From these 849 events 419 show a duration of more than 0.1 s and 32 events have disappearance times between 1 s and 8.6 s [2].

Applying statistical analysis on the 419 "abnormal stellar occultation events (ASOEs)", as they call them, the authors conclude that none of the explanations mentioned above is the reason for the gradual dis-(re-)appearance. Instead, they challenged a new explanation for spacecraft accidents happening during attempted Moon landings over the last few years. While the latter scenario is a pure hypothesis at the moment, the ASOEs are real, and we know that there are impacts of meteoroids on the Moon's surface which can be observed as Lunar Impact Flashes [4], [5].

This raises the question whether data from LOA about abnormally long-lasting dis-/reappearance times can be used to find proof of possibly existing meteoroidal dust clouds as a hypothetical cause of spacecraft accidents.

Being an engineer, the author of this article was inspired by the idea of connecting lunar landing failures with meteoroidal impact clouds. Preventing such failures could save hundreds of millions of Euros, if there is a way to minimise such a risk.

The following information was taken into account for an evaluation about the usability of LOA data for dust cloud detections:

- personal communication with the authors,
- personal communications with experienced observers, and
- interpretation of LOA data.

Personal Communication with the Authors

The first step in the process to get more background information was to communicate with the authors of [2]. In an email communication the central questions were:

• Did you compare the dates of the spacecraft accidents with the time ranges of the LOA events respectively is there a relation between the accidents and the observed maxima of ASOEs which was mentioned as a result in [2]?

• Are there model calculations including gravity, electrostatic forces, radiation, and the known special behaviour of regolith?

• What particle parameters have been considered in [2]?

The answers gave a broader insight into the background of the article [6]:

• The GRL article reports just a part of a broader evaluation of the historically observed occultation and light scattering phenomena around the Moon. In focus were the detected phenomenon of low-altitude dust clouds and their possible physical nature.

• The ongoing high rate of accidents and malfunctions of the lunar landing missions was never the driving force or the goal of the authors' research. The estimates of dust cloud density and possible spacecraft impact given in the article are merely indicative figures intended to draw attention to the importance of this phenomenon.

• The search for correlations between mission failures and lunar meteoroid activity has not been done so far.

• The dynamics of dust particles and the development of an individual cloud have not been studied yet. In principle, with an appropriate model of an impact plume and more precise calculation of stellar light scattering in the cloud, a simulation is possible. However, the available resolution of ground-based occultation measurements may not be sufficient for the comparison with such simulations.

• The GRL paper estimates roughly the size of particles in the range between 1-5 micrometers, based on a very simple assumption of a sufficiently high optical depth (~1), that may provide an observable extinction of the starlight during an occultation, and neglecting multiple scattering acts. In other words, sufficiently high optical depth is postulated and the dust concentration (around $10^8/m^3$) is deduced from that.

• The concentrations in the paper are "upper limit" values (because of an oversimplified estimation approach) which also depend on the assumed grain size.

Personal Communications with Experienced Observers

The reactions varied from "interesting idea" to deep scepticism. Hearing some of the argumentation gave the impression that people are not understanding each other or misinterpreting statements. Here two examples to underline this:

Comment by a very experienced occultation observer:
"(…) reflected light will have no effect on the duration of an occultation (…)"
or
"the type of densities being referred to in the paper are so low that the amount of light absorbed will be undetectable"

Replying to a request for a statement concerning the objections, one of the authors of [2] delivered the following answer:

"(…) the light from a stellar source is somehow deflected when passing through the dust cloud during occultation (reflected, scattered, or absorbed), it will not reach the observer, and the occulted stellar light source will become weaker. In view of that I do not understand the statement (…) that "…reflected light will have no effect on the duration of an occultation"

or

"(…) we do not prescribe the amount of dust, but we estimate roughly its concentration, based on a very simple assumption of a sufficiently high optical depth (~1), that may provide an observable extinction of the starlight during occultation, and neglecting multiple scattering acts. At the same time, the size of dust particles is specified in a range (1-5 micrometres)."

From these statements the author of this article concluded a necessity to find a common basis for a discussion.

At this stage of the evaluation a closer look at the Lunar Occultation Archive became necessary.

Interpretation of LOA Data

Covering around 400 years of observations (1623 to 2022) and including almost half a million events LOA is the most complete catalogue of occultations of stars by the Moon known.

Due to limitations of the equipment, especially for amateurs, the duration of the star's first contact with the lunar limb and the complete dis-(re-)appearance was not measurable in the 0.1 s range and below until the second half of the 20^{th} century. Therefore, such duration times in LOA do not appear earlier than 1967. In order to sort and separate the data, the information in LOA format was changed to a spreadsheet readable format. During this process a difference in the numbers of events has been recognised, e.g. 493,085 versus 493,218 in [2]. Compared to the total number of observed occultations the difference is very small (133 events or 0.027%) but it should be mentioned here. Also, the number of ASOEs was slightly different. The reason for this remains unknown: either the limited programming knowledge when bringing the data from LOA to a spreadsheet and/or a misunderstanding in the method in [2] to exclude events to get the ASOEs are possible.

It is well known to occultation observers that not only the length of an event is important for the interpretation of an occultation but also the light curve behaviour must be taken into account.

Unfortunately, light curves are not included in LOA data. A hint led to a Vizier file containing 6902 light curves of occultations by the Moon [7]. A search with some of LOA mentioned observers names was done. By using the date of the event among the LOA events lightcurves were searched. Unfortunately, no light curve of an ASOE event was found in the Vizier file. Therefore, and to reduce search efforts, only 14 registered events from six German observers with duration times larger than 0.1 s were selected to look for light curves. The four still available observers were contacted, so eventually four light curves of LOA events were available for evaluation.

Especially the light curves of the occultation of 35 Leonis on 2006 June 2 (0.42 second event) and HIP 40881 on 2004 March 30 (0.1 second event) showed interesting details. From the LOA data both stars could not be identified to be double or multiple although the first star is listed in the Washington Double Star Catalog, and the second star can be found in the Interferometric Catalog.

The step in the light curve of 35 Leonis can be interpreted as being caused by the occultation of a second component.

In the case of HIP 40881, at first glance, there seems to be no time delay. A more thorough investigation would be necessary with a special look at the data point on the disappearance line. Perhaps the line's slope before and after that point could give more information about the event?

Having no double star flag and being no grazing event it is supposed that both events were part of the data used in [2]. The data was requested, but unfortunately it was not available. Nevertheless, none of the mentioned exclusion criteria in [2] match these events. Thus, it can be assumed that both events were considered in the used data.

This means that in the absence of a light curve of an event a misinterpretation is more likely.

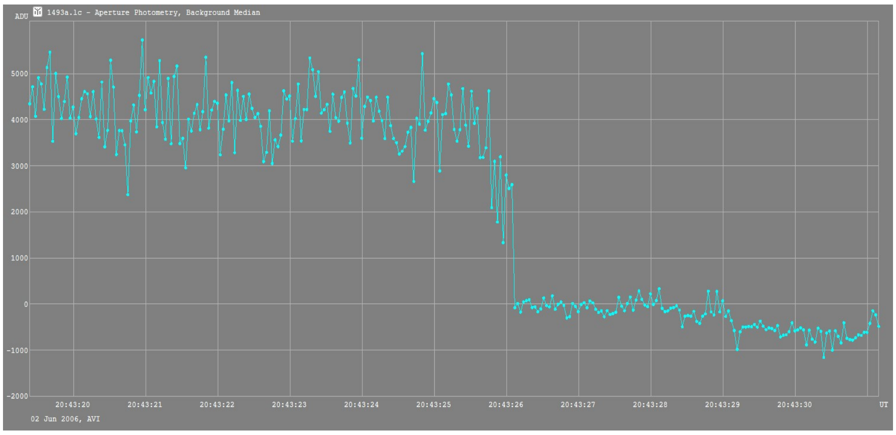

Figure 1. Lightcurve of 35 Leonis occulted by the Moon on 2006 June 2, (with permission of the author Oliver Klös)

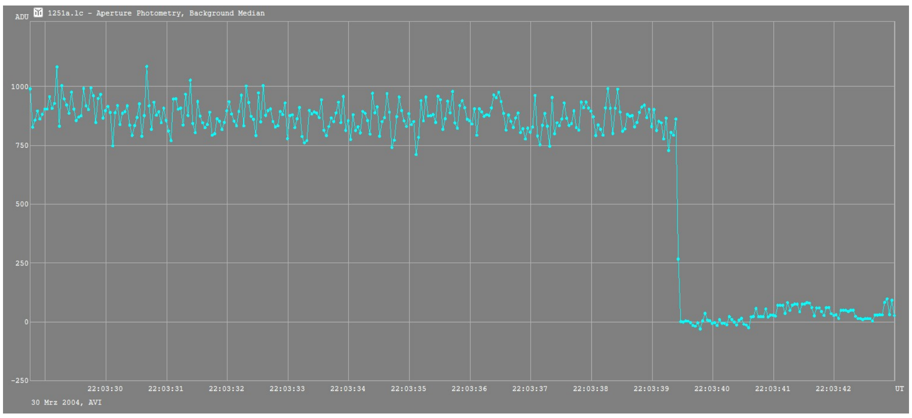

Figure 2. Lightcurve of HIP 40881 occulted by the Moon on 2004 March 30, (with permission of the author Oliver Klös)

Conclusions

Having in mind that this was only a very short evaluation with a database being much too small to be scientific, the following conclusions from an occultation observers' point of view can be drawn:

• The Lunar Occultation Archive should not be used as the single source of data. The LOA data can give a hint to have a closer look at an event but is not sufficient to decide about the nature of a long-duration event. In the above-mentioned example the inclusion of double star catalogues would have excluded at least this ASOE.

• The duration of an event is not the only criterion to evaluate an occultation. Nowadays, light curves should be included to exclude events. For the example above a double star event seems to be more probable than a dust cloud. Why should a dust cloud have the observed step in the light curve?

• Without a list of the events used for the GRS article an evaluation of the database is difficult.

• Whether the resolution of ground-based observations, especially with amateur telescopes, is sufficient to allow a comparison with simulated model data remains a topic which has to be examined.

Further considerations and impressions including data from research areas outside occultations:

• Despite the uncertainty of the GRS article mentioned above, none of the discussed issues rules out the possibility of denser dust clouds caused by meteoroidal impacts.

• LOA events occur on or near the lunar limb. To get a better understanding about meteoroidal impacts on the Moon, more parts of the Moon's surface have to be included. One way to do this is using the Lunar Impact Flash Detection. This part of planetary science has been intensified during the last few years, but is still at its beginning. New software for observation and evaluation has been developed [8], and observation campaigns are organised [9]. A satellite mission is planned for 2028 [10].

• Limited resolution of earthbound occultation observations, especially with amateur means, and the limited area covered by the Moon's limb favour the assumption that the correlation of dust clouds and landing accidents most probably will stay a hypothesis until in situ measurements are made.

• Whether a dust cloud has an influence on a lunar occultation light curve remains unknown at the moment, but should be kept in mind.

And as a final remark: The existence of dust close to the lunar surface possibly influencing occultation observations or even causing accidents of landing spacecrafts would support the necessity to observe lunar occultations at high resolution on one hand. But this phenomenon may on the other hand also turn out to be non-existent after all or at least undetectable with earthbound means, especially by amateurs. The reader may judge for her-himself.

Acknowledgements

The author of this article wants to thank Dave Herald, Dave Gault, Oliver Klös, Nikolai Wünsche, Dietmar Büttner and Konrad Guhl for discussions and hints for evaluation sources. Special thanks for providing their observations and light curves go to Oliver Klös, Nikolai Wünsche, Dietmar Büttner and Konrad Guhl. Maxim Khodachenko, being one of the authors of [2], deserves acknowledgement for his willingness to provide background information in a personal communication concerning [2]. So does the reviewer, whose recommendations helped a lot to make the content of this article more understandable.

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Grazing Occultations of Stars and Planets by the Moon in 2026

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ABSTRACT: The following maps and tables show this year's grazing occultations of the brightest stars and major planets by the Moon in those regions of the world where most of our observers live. The overall limiting magnitude is 5.0. During lunar eclipses stellar magnitudes to 10.0 mag are considered.

Introduction

All regional maps are limited to nighttime events along the dark lunar limb where the limit lines of a grazing occultation are shown in black. Events of stars or planets of mag 1.5 or brighter are highlighted with a bold line. The world map shows all grazes of the major planets without any filters as well as the best grazes of the present Regulus series. Here the events that occur at the sunlit lunar limb at night are given in yellow, whereas all daytime events appear in light blue. Tick marks appear along the limit lines every 10 full minutes of time. The northern limb grazes show tick marks pointing downwards, whereas on the southern limb grazes they point upwards.

All tables and figures in this article were created with the author's *GRAZPREP*-software. Further precise information on the local circumstances of all grazing occultations, also depending on the lunar terrain and the observer's elevation, is provided by this software which can be downloaded and installed via www.grazprep.com (password: IOTA/ES) including prediction files that are needed additionally for different regions of the world. *GRAZPREP* assists in finding and listing individually favourable occultation events and in figuring out the best observing site in advance or even underway by graphically showing the expected apparent stellar path through the lunar limb terrain. The software calculates total occultations as well, also providing a planetarium function.

For all abbreviations in the tables and maps refer to the legend below.

Legend of Tables and Regional Maps

Tables:

No. - Number of event corresponding to the number labels on the map
M D - Month and day of the event referred to UT at the westernmost beginning of the graze limit line
USNO - Identifier in the XZ or ZC catalogue
SAOPPM - Identifier in the SAO or PPM catalogues
D - Double star code from the XZ80Q catalogue
MAG - Vmag of the star/double star system
%SNL - Percentage of sunlit lunar disc, +: waxing Moon, -: waning Moon, E: during lunar eclipse
L. - Limb of the Graze, **N** - northern limb, **S** - southern limb
W. UT - UT at the westernmost beginning of graze limit line
LONG LAT - Position of westernmost beginning of graze limit line
STAR NAME - Name(s) of star or planet
MAG1 MAG2 - Vmag of double star components

Labels on Maps:

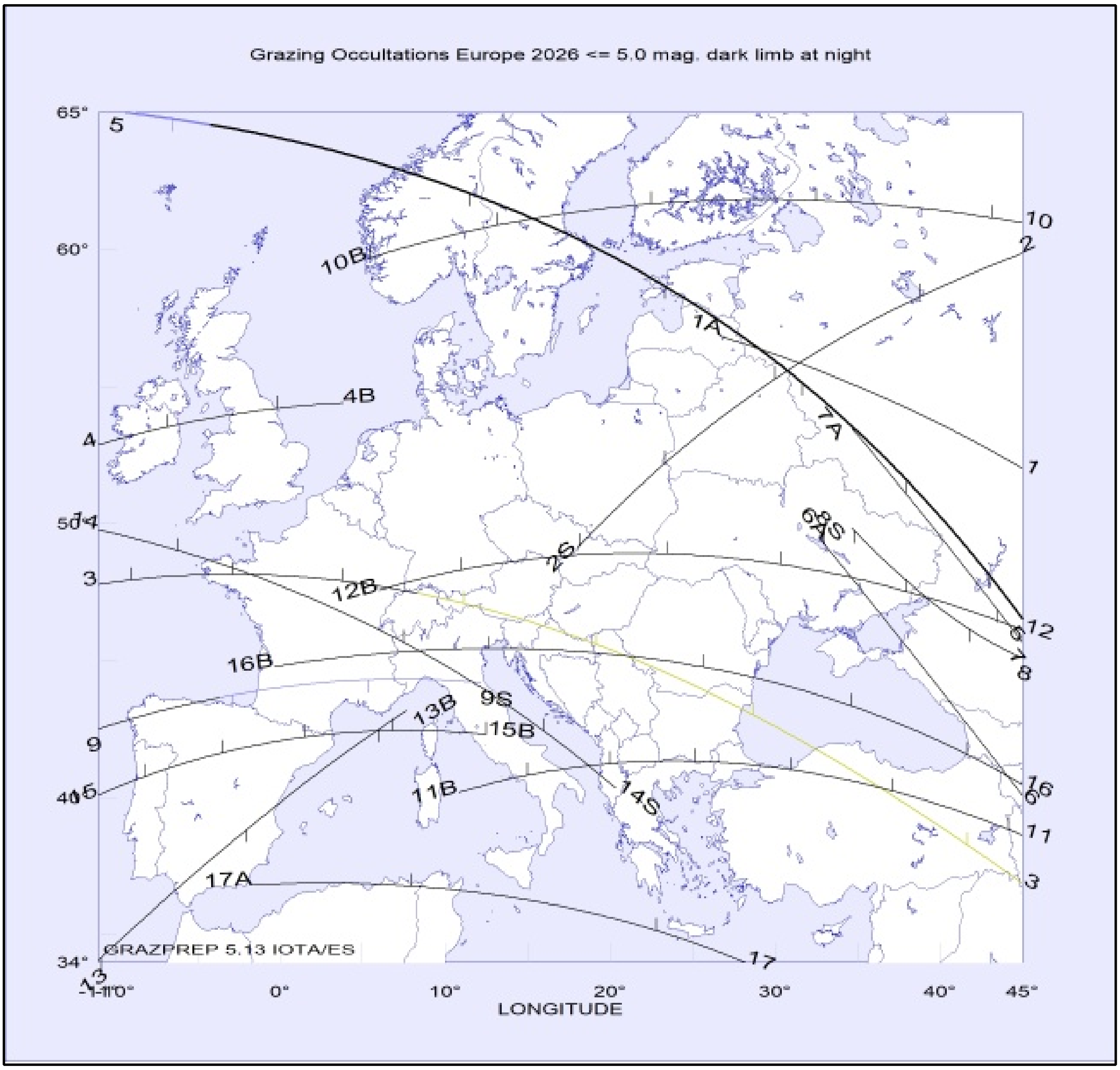
Number - corresponding to the number of the event in the table
Labels at end of graze limit lines:
A - limit line begins or ends due to altitude of Moon/star
B - limit line begins or ends due to brightness of the lunar surface
S - limit line begins or ends due to bright sunlight/sky brightness
U - limit line begins or ends due to edge of umbra

Double Star Codes:

C - double, component in XZ80Q, Separation <1"
c - double, component not in XZ80Q, Separation <1"
D - double, component in XZ80Q, Separation <10"
d - double, component not in XZ80Q, Separation <10"
W - double, component in XZ80Q, Separation >10"
w - double, component not in XZ80Q, Separation >10"
M - multiple system, all components in XZ80Q
S - multiple system, some but not all in XZ80Q

Additional codes were used in the obsolete XZ80N and XZ80P catalogues. Refer to the ReadMe.txt of the XZ80N for details.

Europe



2026	Grazing Occultations Europe 2026 <= 5.0 mag.dark limb at night									GRAZPREP 5.13, IOTA/ES	
No.	**M D**	**USNO**	**SAOPPM D**	**MAG**	**%SNL**	**L.**	**W.UT**	**LONG LAT**	**STAR NAME**	**MAG1**	**MAG2**
1	**Jan 09**	ZC 1815	138892 V	4.7	56 -	S	22 53.4	26 57	chi Virginis	4.8	8.8
2	**Jan 24**	ZC 105	109474 w	4.4	33+	S	15 30.0	18 49	delta Piscium		
3	**Jan 27**	ZC 539	76140 V	4.3	69+	S	21 16.7	-11 48	Taygeta 19 Tauri	4.6	6.1
4	**Jan 29**	ZC 890	77675 V	4.6	88+	S	20 14.0	-11 53	136 Tauri NSV 02696	4.8	6.3
5	**Mar 29**	ZC 1487	98967 S	1.4	89+	N	18 37.7	-62 62	Regulus alpha Leonis		
6	**Apr 06**	ZC 2383	184481	2.8	78 -	S	22 20.3	32 49	Alniyat tau Scorpii		

(Continued on next page)

2026	Grazing Occultations Europe 2026 <= 5.0 mag.dark limb at night											GRAZPREP 5.13, IOTA/ES
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG	LAT	STAR NAME	MAG1	MAG2
7	May 30	ZC 2287	183987W	2.9	100+	N	18 17.5	34	53	pi Scorpii	3.4	4.6
8	Jul 26	ZC 2617	186328 K	4.5	93+	N	17 30.7	34	50		5.1	5.9
9	Sep 07	ZC 1170	79653 A	3.6	18 -	N	5 41.2	-11	43	kappa Geminorum	3.7	8.2
10	Oct 28	ZC 537	76131 U	3.7	95 -	S	0 50.7	5	60	Electra 17 Tauri	3.9	7.0
11	Oct 28	ZC 539	76140 V	4.3	95 -	S	1 11.2	10	40	Taygeta 19 Tauri	4.6	6.1
12	Oct 28	ZC 541	76155 V	3.9	95 -	S	1 21.2	6	48	Maia 20 Tauri	4.4	5.4
13	Oct 29	ZC 890	77675 V	4.6	80 -	N	23 0.6	-11	34	136 Tauri NSV 02696	4.8	6.3
14	Nov 05	ZC 1685	138298 K	4.3	16 -	S	4 47.9	-11	50	upsilon Leonis	4.5	9.0
15	Dec 21	ZC 539	76140 V	4.3	93+	S	22 23.8	-11	40	Taygeta 19 Tauri	4.6	6.1
16	Dec 27	ZC 1486	98964 A	4.4	79 -	S	22 4.1	0	45	31 Leonis A Leonis	4.6	13.6
17	Dec 28	ZC 1599	118610 K	4.8	68 -	S	22 47.1	-1	37	58 Leonis	5.8	5.8

Southern Africa

2026	Grazing Occultations Southern Africa 2026 <= 5.0 mag. dark limb at night											GRAZPREP 5.12, IOTA/ES
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG	LAT	STAR NAME	MAG1	MAG2
1	Jan 07	ZC 1547	118355 M	3.8	83 -	S	6 41.0	10	-26	rho Leonis	4.6	4.6
2	Jan 14	ZC 2268	183896 H	4.5	19 -	S	2 1.7	10	-15	2 Scorpii	5.6	5.6
3	Jan 14	ZC 2287	183987W	2.9	18 -	S	5 9.4	10	-2	pi Scorpii	3.4	4.6
4	Feb 24	ZC 638	76558 A	5.0	52+	S	16 25.7	32	-26	phi Tauri	5.1	8.5
5	Feb 28	ZC 1308	80378 V	4.7	92+	N	22 26.8	15	0	Asellus Borealis Gamma Cancri	5.5	5.5
6	Mar 06	ZC 1853	139033 V	4.8	93 -	S	3 6.1	10	-24	psi Virginis	5.0	8.3
7	Mar 09	ZC 2298	184068	5.0	62 -	S	22 48.6	10	-26			
8	Mar 30	ZC 1600	118615 w	5.0	95+	N	21 47.1	14	0	59 Leonis		
9	Apr 06	ZC 2268	183896 H	4.5	85 -	N	4 23.6	10	-24	2 Scorpii	5.6	5.6
10	Apr 27	ZC 1663	118875 M	5.0	85+	N	16 28.8	21	-8	tau Leonis		
11	May 05	ZC 2617	186328 K	4.5	84 -	S	22 1.2	20	0		5.1	5.9
12	May 26	ZC 1853	139033 V	4.8	82+	N	23 53.6	10	-7	psi Virginis	5.0	8.3
13	Jun 02	ZC 2721	187239 X	3.2	94 -	N	21 48.4	34	-14	phi Sagittarii	4.1	4.1
14	Jun 03	ZC 2864	188337 A	4.6	88 -	N	21 2.6	45	-13	52 Sagittarii	4.7	9.2
15	Jun 22	ZC 1815	138892 V	4.7	59+	N	22 2.4	10	-1	chi Virginis	4.8	8.8
16	Jul 12	ZC 810	77168 Y	1.6	6 -	N	12 38.0	10	0	El Nath beta Tauri	2.6	2.6
17	Aug 20	ZC 2298	184068	5.0	56+	N	16 46.4	14	-24			
18	Aug 24	ZC 2864	188337 A	4.6	89+	N	16 14.6	26	-8	52 Sagittarii	4.7	9.2
19	Aug 28	X 30576	165001	8.6	100 E	S	2 50.4	12	-16			
20	Aug 28	X 30616	146046	9.4	100 E	S	4 23.2	10	-2			

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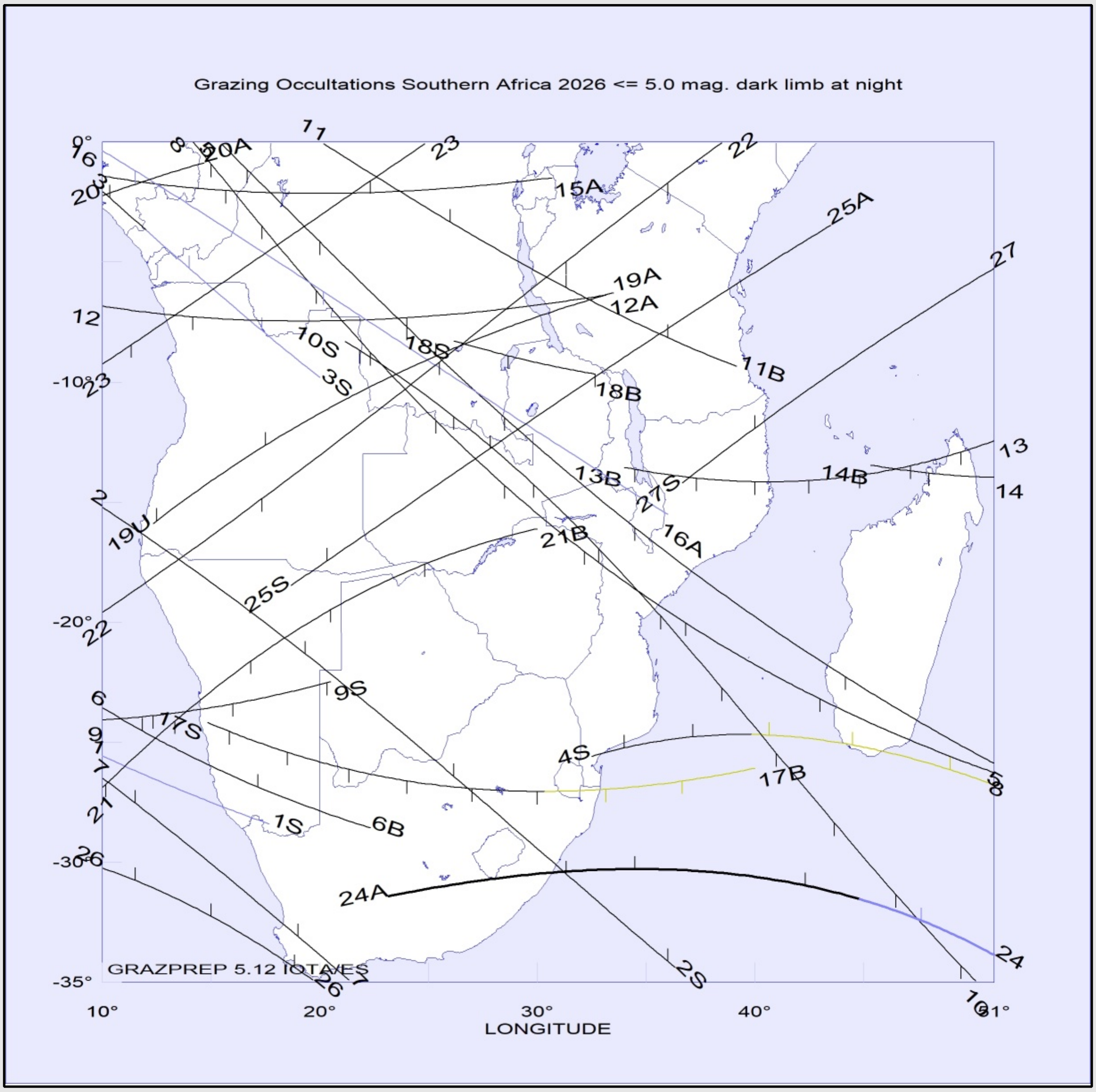
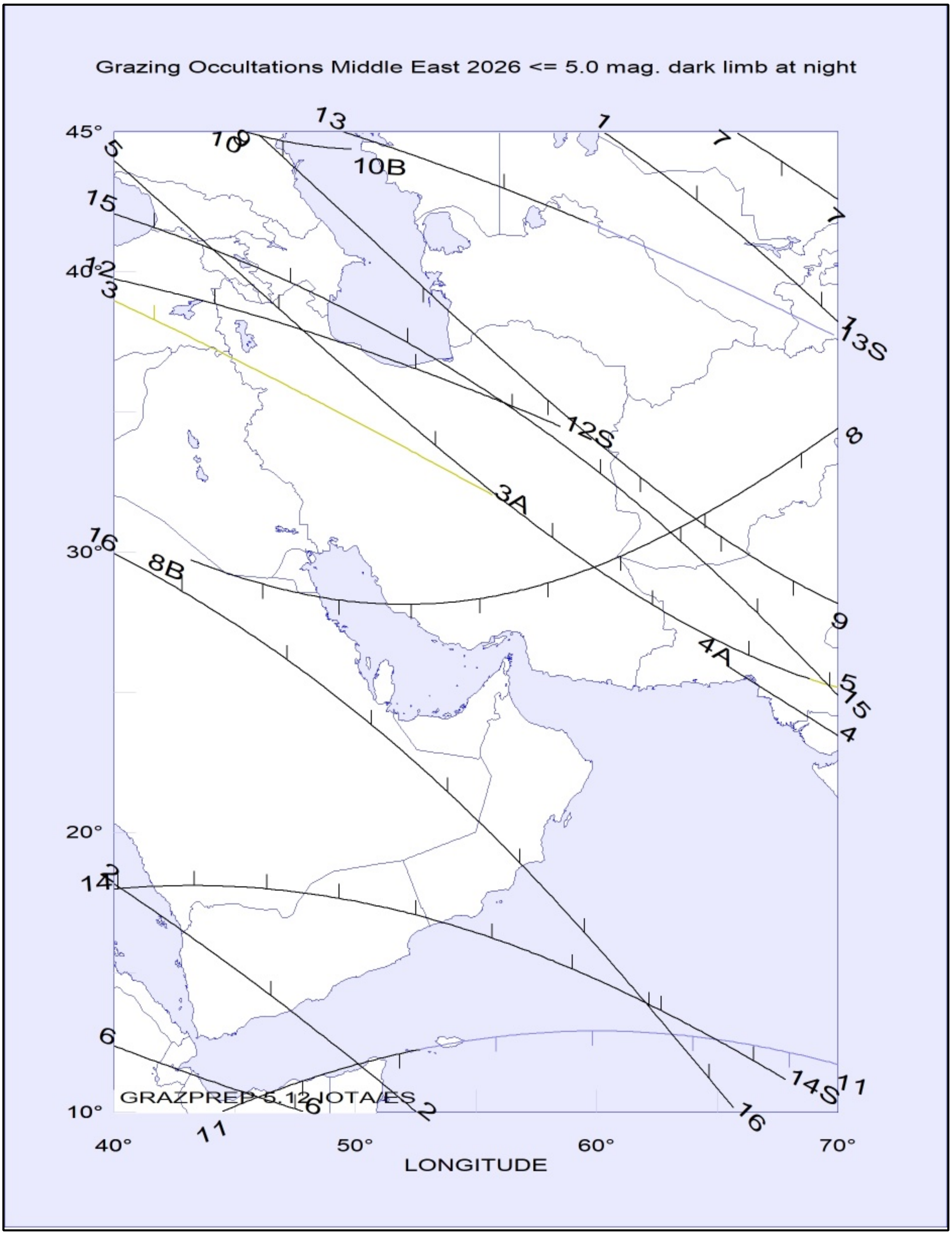


2026	Grazing Occultations Southern Africa 2026 <= 5.0 mag. dark limb at night									GRAZPREP 5.12, IOTA/ES	
No.	**M D**	**USNO**	**SAOPPM D**	**MAG**	**%SNL**	**L.**	**W.UT**	**LONG LAT**	**STAR NAME**	**MAG1**	**MAG2**
21	**Sep 01**	ZC 221	92484 M	3.8	83 -	N	3 9.9	10 -27	Kullat Nunu eta Piscium	3.8	7.5
22	**Sep 04**	ZC 638	76558 A	5.0	52 -	N	0 24.9	10 -20	phi Tauri	5.1	8.5
23	**Sep 05**	ZC 810	77168 Y	1.6	40 -	N	1 9.3	10 -9	El Nath beta Tauri	2.6	2.6
24	**Oct 07**	ZC 1487	98967 S	1.4	13 -	S	2 13.8	23 -31	Regulus alpha Leonis		
25	**Nov 12**	ZC 2554	185755 V	4.5	10+	S	16 57.5	18 -18	X Sagittarii	5.2	5.2
26	**Nov 28**	ZC 1170	79653 A	3.6	83 -	S	1 26.2	10 -30	kappa Geminorum	3.7	8.2
27	**Dec 11**	ZC 2809	187882 Q	4.9	6+	S	15 56.0	36 -14	psi Sagittarii	6.2	6.2

Middle East


Grazing Occultations Middle East 2026 <= 5.0 mag. dark limb at night
45°
40°
30°
20°
10°
40°
50°
60°
70°
LONGITUDE
GRAZPREP 5.12 IOTA/ES
10B
12S
13S
3A
4A
8B
14S

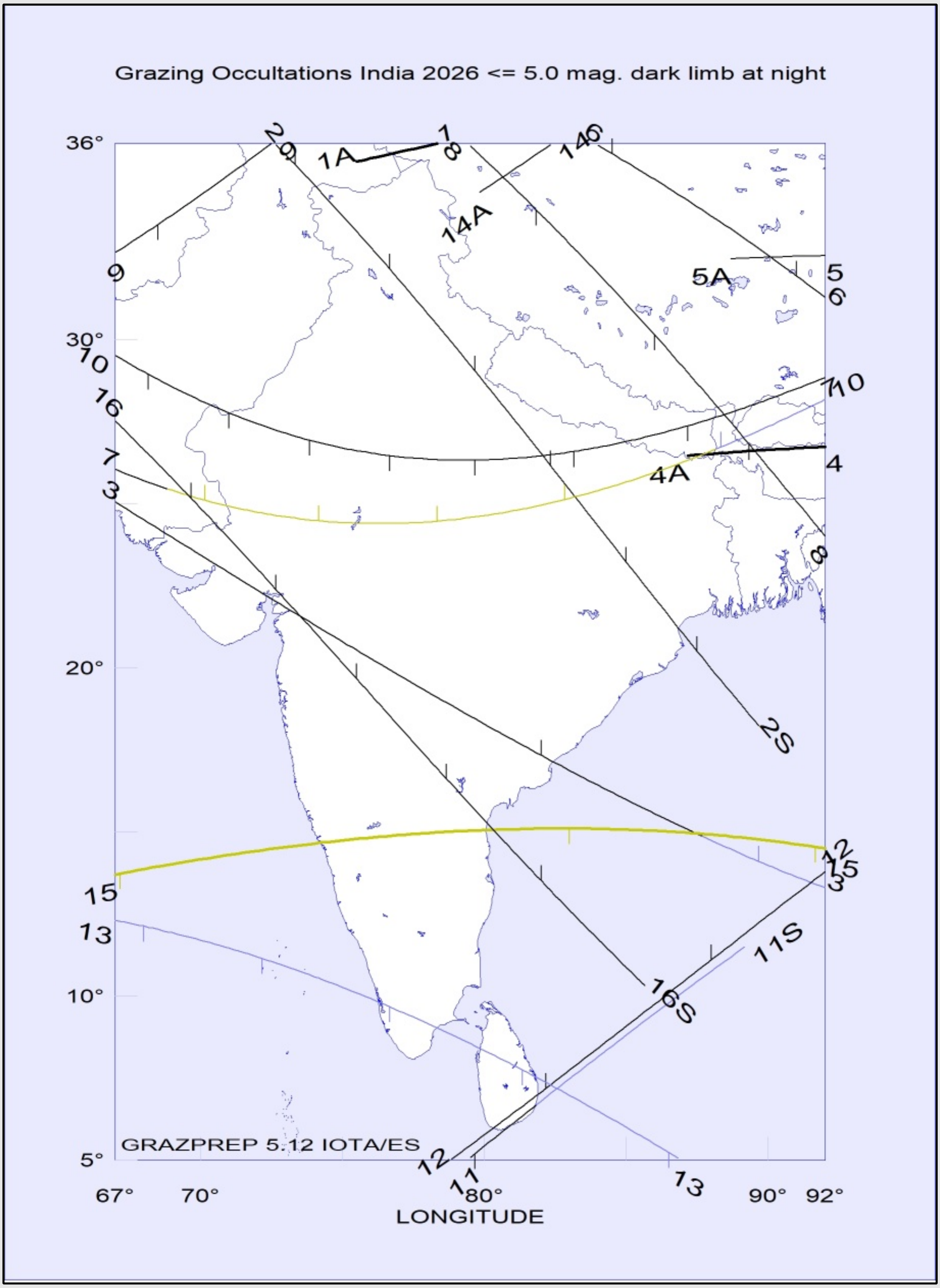
2026 Grazing Occultations Middle East 2026 <= 5.0 mag. dark limb at night GRAZPREP 5.12, IOTA/ES

No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
1	Jan 09	ZC 1815	138892 V	4.7	56 -	S	23 14.3	60 45	chi Virginis	4.8	8.8
2	Jan 14	ZC 2263	183854 V	4.6	19 -	S	0 55.8	40 18	1 Scorpii	5.6	5.6
3	Jan 27	ZC 539	76140 V	4.3	69+	S	22 19.1	40 39	Taygeta 19 Tauri	4.6	6.1
4	Feb 14	ZC 2784	187683 V	3.3	12 -	S	0 21.0	65 26	tau Sagittarii	4.2	4.2
5	Apr 06	ZC 2383	184481	2.8	78 -	S	22 23.4	40 44	Alniyat tau Scorpii		
6	Apr 11	ZC 3078	189986 M	4.9	32 -	S	23 47.6	40 12	Chow eta Capricorni	5.0	7.4
7	Apr 29	ZC 1853	139033 V	4.8	96+	N	15 28.6	66 45	psi Virginis	5.0	8.3
8	May 05	ZC 2617	186328 K	4.5	84 -	N	22 51.4	43 30		5.1	5.9
9	May 30	ZC 2287	183987W	2.9	100+	N	18 21.9	46 45	pi Scorpii	3.4	4.6
10	Jul 26	ZC 2617	186328 K	4.5	93+	N	17 47.2	45 45		5.1	5.9
11	Sep 05	ZC 810	77168 Y	1.6	40 -	N	2 2.2	44 10	El Nath beta Tauri	2.6	2.6
12	Oct 28	ZC 539	76140 V	4.3	95 -	S	2 4.3	40 40	Taygeta 19 Tauri	4.6	6.1
13	Oct 28	ZC 541	76155 V	3.9	95 -	S	2 23.5	49 45	Maia 20 Tauri	4.4	5.4
14	Oct 29	ZC 890	77675 V	4.6	80 -	S	23 59.8	40 18	136 Tauri NSV 02696	4.8	6.3
15	Dec 27	ZC 1486	98964 A	4.4	79 -	S	22 37.5	40 42	31 Leonis A Leonis	4.6	13.6
16	Dec 28	ZC 1599	118610 K	4.8	68 -	S	23 24.1	40 30	58 Leonis	5.8	5.8

India

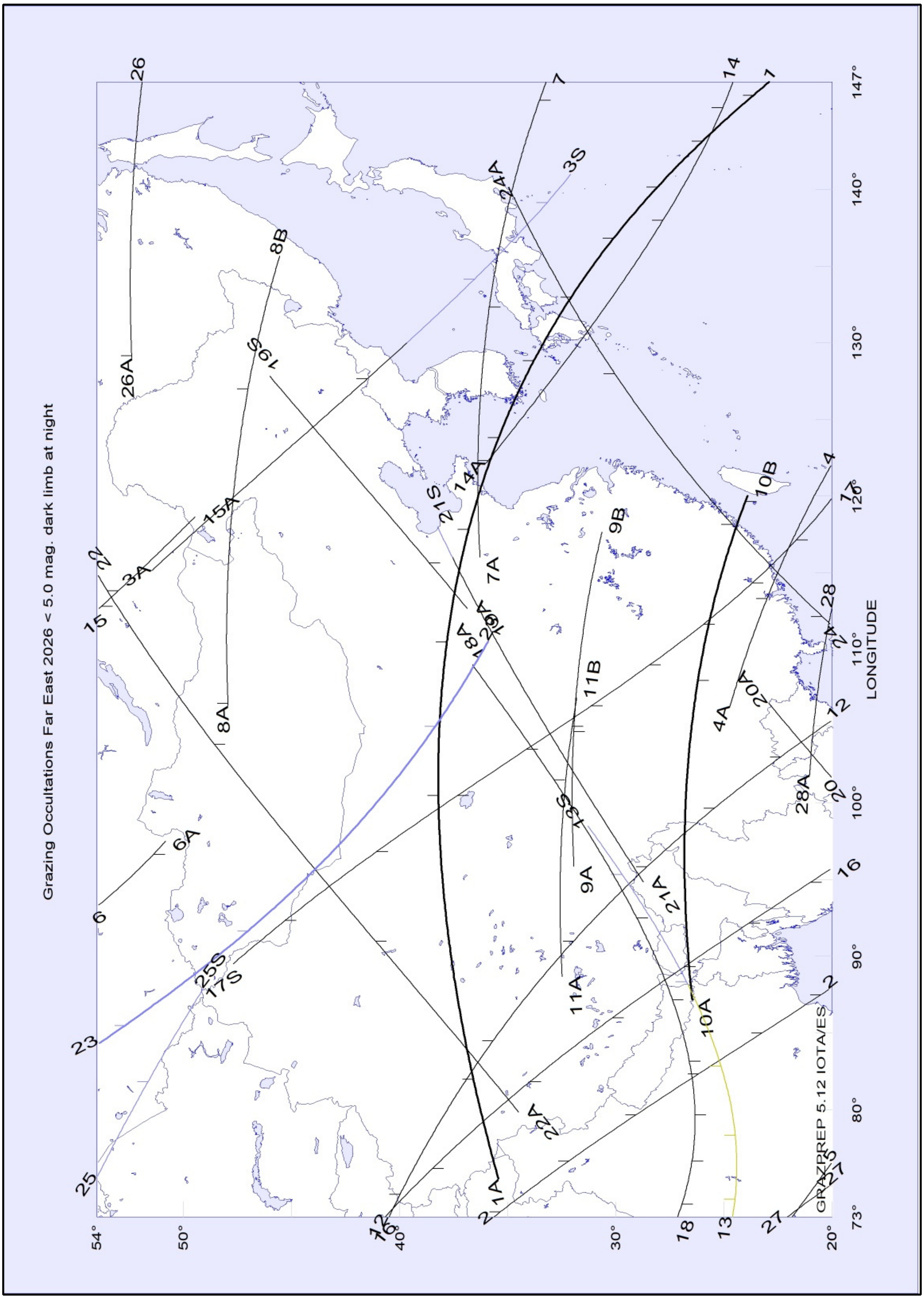
2026 Grazing Occultations India 2026 <= 5.0 mag. dark limb at night GRAZPREP 5.12, IOTA/ES

No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
1	Jan 06	ZC 1487	98967 S	1.4	86 -	S	15 38.7	75 35	Regulus alpha Leonis		
2	Jan 09	ZC 1815	138892 V	4.7	56 -	S	23 38.5	72 36	chi Virginis	4.8	8.8
3	Feb 14	ZC 2784	187683 V	3.3	12 -	S	0 21.2	67 25	tau Sagittarii	4.2	4.2
4	Mar 03	ZC 1600	118615 w	5.0	100 E	N	12 33.8	87 26	59 Leonis		
5	Mar 03	X 16547	118616	8.9	100 E	N	12 44.7	88 32			
6	Mar 05	ZC 1815	138892 V	4.7	94 -	S	17 9.5	84 36	chi Virginis	4.8	8.8
7	Apr 06	ZC 2383	184481	2.8	78 -	S	23 11.9	67 26	Alniyat tau Scorpii		
8	Apr 29	ZC 1853	139033 V	4.8	96+	N	15 45.7	79 36	psi Virginis	5.0	8.3
9	May 06	ZC 2617	186328 K	4.5	84 -	N	0 6.8	67 33		5.1	5.9
10	May 30	ZC 2287	183987W	2.9	100+	N	19 6.3	67 30	pi Scorpii	3.4	4.6
11	Jun 03	ZC 2721	187239 X	3.2	94 -	N	0 20.7	79 5	phi Sagittarii	4.1	4.1
12	Jul 26	ZC 2617	186328 K	4.5	93+	S	19 3.2	78 5		5.1	5.9
13	Sep 05	ZC 810	77168 Y	1.6	40 -	N	2 57.7	67 12	El Nath beta Tauri	2.6	2.6
14	Oct 02	ZC 890	77675 V	4.6	59 -	N	16 46.0	80 34	136 Tauri NSV 02696	4.8	6.3
15	Nov 02			-2.0	37 -	N	21 10.1	67 14	Jupiter		
16	Dec 27	ZC 1486	98964 A	4.4	79 -	S	23 41.3	67 28	31 Leonis A Leonis	4.6	13.6


Grazing Occultations India 2026 <= 5.0 mag. dark limb at night
36°
30°
20°
10°
5°
67°
70°
80°
90°
92°
LONGITUDE
GRAZPREP 5.12 IOTA/ES
1A
14A
5A
4A
2S
16S
11S

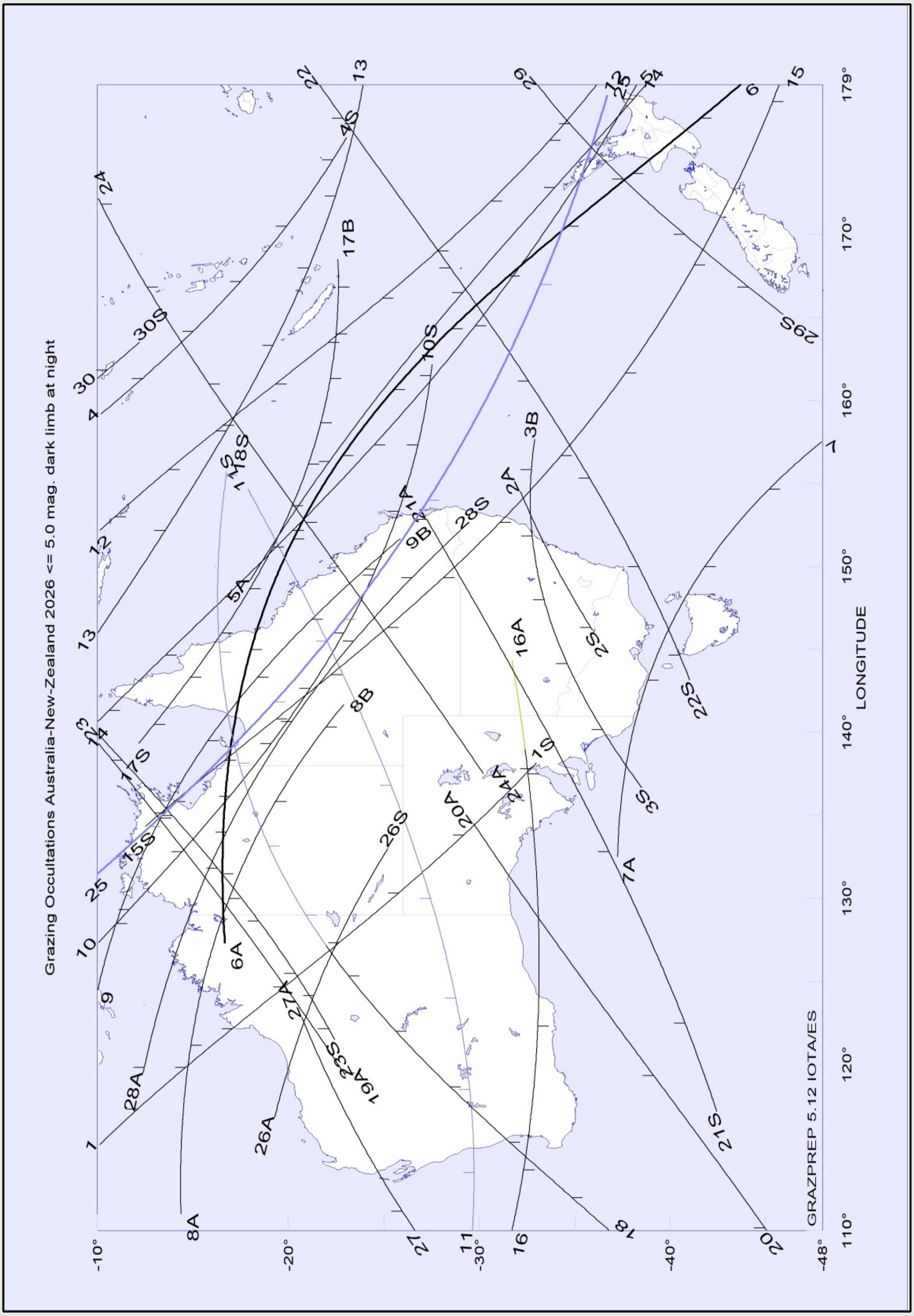
Far East

2026	Grazing Occultations Far East 2026 < 5.0 mag. dark limb at night											GRAZPREP 5.12, IOTA/ES
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG	LAT	STAR NAME	MAG1	MAG2
1	Jan 06	ZC 1487	98967 S	1.4	86 -	S	15 38.7	75	35	Regulus alpha Leonis		
2	Jan 09	ZC 1815	138892 V	4.7	56 -	S	23 39.4	73	36	chi Virginis	4.8	8.8
3	Jan 14	ZC 2383	184481	2.8	13 -	S	22 31.5	115	51	Alniyat tau Scorpii		
4	Feb 06	ZC 1853	139033 V	4.8	76 -	S	15 17.4	106	25	psi Virginis	5.0	8.3
5	Feb 14	ZC 2784	187683 V	3.3	12 -	S	0 23.2	73	22	tau Sagittarii	4.2	4.2
6	Feb 27	ZC 1170	79653 A	3.6	85+	N	22 38.4	93	54	kappa Geminorum	3.7	8.2
7	Mar 03	X 16455	P157364	9.9	100 E	N	10 54.6	116	36			
8	Mar 03	X 16443	118582	9.0	100 E	S	11 30.2	106	48			
9	Mar 03	X 16528	118607	9.6	100 E	N	12 17.9	96	32			
10	Mar 03	ZC 1600	118615 w	5.0	100 E	N	12 33.8	87	26	59 Leonis		
11	Mar 03	X 16547	118616	8.9	100 E	N	12 44.7	88	32			
12	Mar 05	ZC 1815	138892 V	4.7	94 -	S	16 59.0	73	40	chi Virginis	4.8	8.8
13	Apr 06	ZC 2383	184481	2.8	78 -	S	23 27.4	73	25	Alniyat tau Scorpii		
14	Apr 09	ZC 2784	187683 V	3.3	54 -	S	17 30.8	122	36	tau Sagittarii	4.2	4.2
15	Apr 21	ZC 890	77675 V	4.6	23+	N	16 0.7	112	54	136 Tauri NSV 02696	4.8	6.3
16	Apr 29	ZC 1853	139033 V	4.8	96+	N	15 35.7	73	41	psi Virginis	5.0	8.3
17	May 26	ZC 1815	138892 V	4.7	81+	N	13 45.0	89	48	chi Virginis	4.8	8.8
18	May 30	ZC 2287	183987W	2.9	100+	N	19 27.5	73	27	pi Scorpii	3.4	4.6
19	Jul 12	ZC 890	77675 V	4.6	4 -	N	19 49.4	112	37	136 Tauri NSV 02696	4.8	6.3
20	Jul 26	ZC 2617	186328 K	4.5	93+	S	19 33.0	101	20		5.1	5.9
21	Aug 10	ZC 1170	79653 A	3.6	4 -	N	21 24.5	94	29	kappa Geminorum	3.7	8.2
22	Oct 02	ZC 890	77675 V	4.6	59 -	N	16 46.0	80	34	136 Tauri NSV 02696	4.8	6.3
23	Oct 05			1.1	31 -	S	6 47.7	84	54	Mars		
24	Oct 20	ZC 3126	164346	4.3	69+	S	14 39.2	111	20	Tae iota Capricorni		
25	Oct 28	ZC 537	76131 U	3.7	95 -	S	1 56.3	75	54	Electra 17 Tauri	3.9	7.0
26	Dec 01	ZC 1599	118610 K	4.8	45 -	S	15 50.2	129	52	58 Leonis	5.8	5.8
27	Dec 28	ZC 1486	98964 A	4.4	79 -	S	0 1.6	73	22	31 Leonis A Leonis	4.6	13.6
28	Dec 29	ZC 1685	138298 K	4.3	61 -	S	16 33.3	102	21	upsilon Leonis	4.5	9.0


Grazing Occultations Far East 2026 < 5.0 mag. dark limb at night
LONGITUDE
GRAZPREP 5.12 IOTA/ES

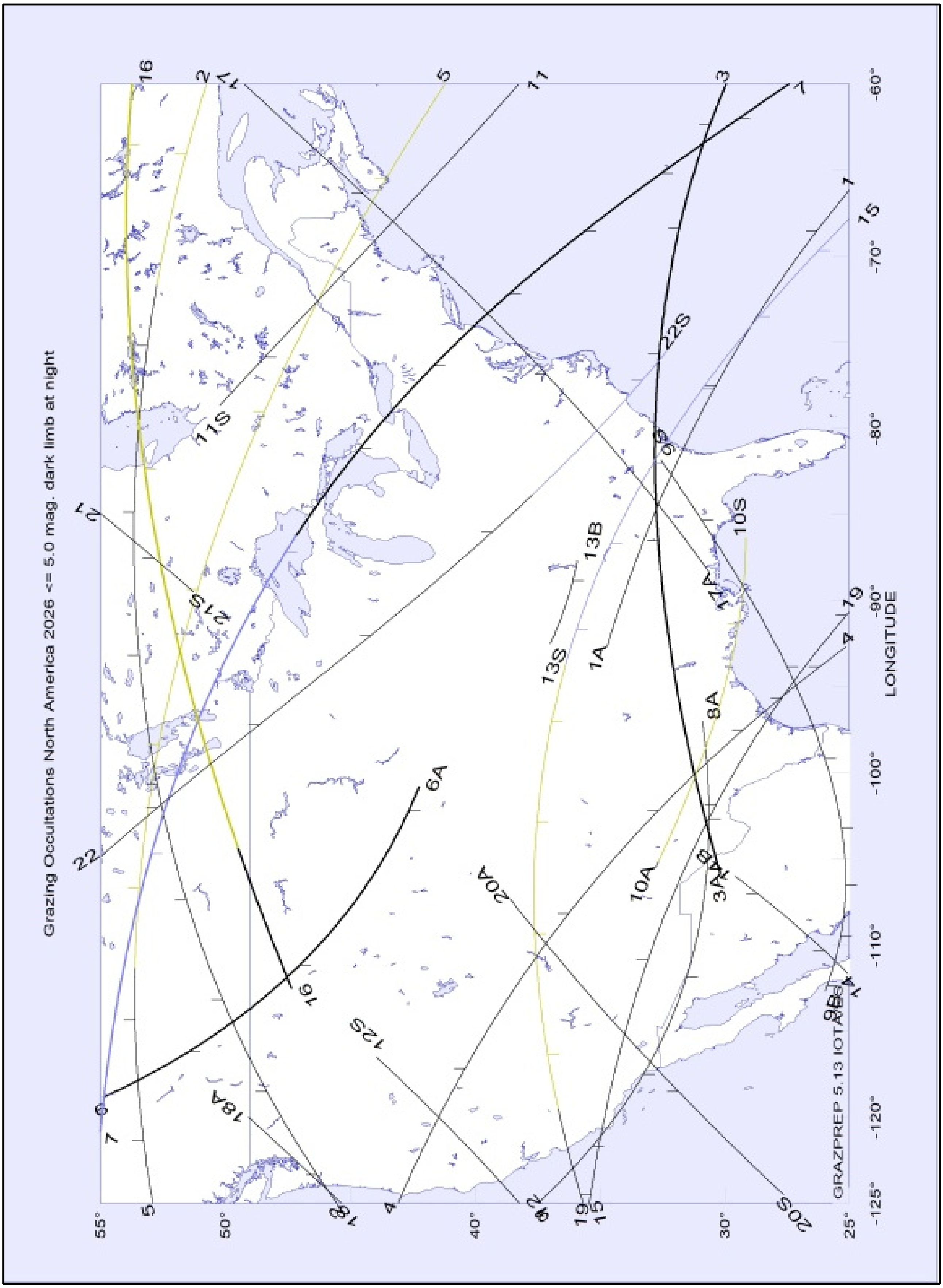
Australia & New Zealand

2026 Grazing Occultations Australia-New-Zealand 2026 <= 5.0 mag. dark limb at night											
No.	**M D**	**USNO**	**SAOPPM D**	**MAG**	**%SNL**	**L.**	**W.UT**	**LONG LAT**	**STAR NAME**	**MAG1**	**MAG2**
1	**Jan 07**	ZC 1600	118615 w	5.0	77 -	S	18 31.4	115 -10	59 Leonis		
2	**Jan 20**	ZC 3126	164346	4.3	3+	S	9 29.9	146 -36	Tae iota Capricorni		
3	**Jan 28**	ZC 638	76558 A	5.0	75+	S	10 12.3	136 -39	phi Tauri	5.1	8.5
4	**Feb 06**	ZC 1853	139033 V	4.8	76 -	S	17 11.6	159 -10	psi Virginis	5.0	8.3
5	**Feb 10**	ZC 2298	184068	5.0	40 -	S	14 27.0	149 -18			
6	**Mar 03**	X 16431	118578	7.4	100 E	N	10 19.0	127 -17			
7	**Mar 03**	X 16420	118575	8.3	100 E	N	10 22.1	132 -37			
8	**Mar 03**	X 16509	118600	9.9	100 E	N	11 34.8	111 -14			
9	**Mar 03**	X 16511	118602	8.4	100 E	N	11 45.4	124 -10			
10	**Mar 09**	ZC 2263	183854 V	4.6	65 -	S	17 34.7	127 -10	1 Scorpii	5.6	5.6
11	**Mar 09**	ZC 2287	183987W	2.9	63 -	S	22 52.7	110 -30	pi Scorpii	3.4	4.6
12	**Mar 31**	ZC 1663	118875 M	5.0	97+	N	10 57.3	152 -10	tau Leonis		
13	**Apr 08**	ZC 2617	186328 K	4.5	65 -	S	14 52.0	146 -10		5.1	5.9
14	**Apr 24**	ZC 1308	80378 V	4.7	54+	N	9 48.1	140 -10	Asellus Borealis Gamma Cancri	5.5	5.5
15	**May 24**	ZC 1600	118615 w	5.0	60+	N	8 44.7	134 -12	59 Leonis		
16	**Jul 20**	ZC 1853	139033 V	4.8	41+	N	13 4.6	110 -32	psi Virginis	5.0	8.3
17	**Jul 24**	ZC 2298	184068	5.0	77+	N	8 36.7	139 -12			
18	**Aug 04**	ZC 221	92484 M	3.8	63 -	N	21 15.0	110 -37	Kullat Nunu eta Piscium	3.8	7.5
19	**Aug 07**	ZC 638	76558 A	5.0	31 -	N	18 30.1	119 -23	phi Tauri	5.1	8.5
20	**Aug 22**	ZC 2554	185755 V	4.5	74+	S	17 19.8	110 -45	X Sagittarii	5.2	5.2
21	**Oct 14**	ZC 2298	184068	5.0	14+	S	10 33.9	117 -42			
22	**Oct 16**	ZC 2554	185755 V	4.5	29+	S	8 47.4	143 -41	X Sagittarii	5.2	5.2
23	**Oct 18**	ZC 2864	188337 A	4.6	48+	S	9 58.5	121 -22	52 Sagittarii	4.7	9.2
24	**Oct 29**	ZC 810	77168 Y	1.6	84 -	N	13 12.5	137 -30	El Nath beta Tauri	2.6	2.6
25	**Nov 02**			-2.0	37 -	N	23 21.0	131 -10	Jupiter		
26	**Nov 06**	ZC 1853	139033 V	4.8	6 -	S	20 6.6	116 -19	psi Virginis	5.0	8.3
27	**Nov 16**	ZC 3079	164132	4.1	42+	S	15 18.9	110 -27	Tsin theta Capricorni		
28	**Dec 03**	ZC 1815	138892 V	4.7	25 -	S	17 59.9	119 -12	chi Virginis	4.8	8.8
29	**Dec 17**	ZC 3494	128336	4.5	52+	S	8 44.9	165 -46	lambda Piscium		
30	**Dec 29**	ZC 1685	138298 K	4.3	61 -	S	18 38.7	161 -10	upsilon Leonis	4.5	9.0


Grazing Occultations Australia-New-Zealand 2026 <= 5.0 mag. dark limb at night
GRAZPREP 5.12 IOTA/ES
LONGITUDE
110°
120°
130°
140°
150°
160°
170°
179°
-10°
-20°
-30°
-40°
-48°

North America

2026	Grazing Occultations North America 2026 <= 5.0 mag. dark limb at night									GRAZPREP 5.13, IOTA/ES	
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
1	Jan 10	ZC 1853	139033 V	4.8	54 -	S	6 32.4	-92 35	psi Virginis	5.0	8.3
2	Jan 27	ZC 440	75673 M	4.7	60+	S	2 6.5	-125 46	epsilon Arietis	5.2	5.6
3	Feb 03	ZC 1487	98967 S	1.4	98 -	S	2 1.9	-106 30	Regulus alpha Leonis		
4	Feb 06	ZC 1815	138892 V	4.7	79 -	S	7 44.7	-125 43	chi Virginis	4.8	8.8
5	Feb 24	ZC 539	76140 V	4.3	45+	S	2 44.6	-125 53	Taygeta 19 Tauri	4.6	6.1
6	Mar 03	X 16391	118571 V	7.4	100 E	N	12 12.5	-118 55	NSV 05015	8.0	8.8
7	Apr 25	ZC 1487	98967 S	1.4	70+	N	23 57.5	-162 52	Regulus alpha Leonis		
8	Apr 29	ZC 1815	138892 V	4.7	95+	N	9 21.3	-125 37	chi Virginis	4.8	8.8
9	May 03	ZC 2263	183854 V	4.6	97 -	N	9 39.2	-112 26	1 Scorpii	5.6	5.6
10	May 09	ZC 3078	189986 M	4.9	56 -	S	8 12.6	-105 33	Chow eta Capricorni	5.0	7.4
11	May 19	ZC 890	77675 V	4.6	7+	N	0 57.5	-78 50	136 Tauri NSV 02696	4.8	6.3
12	Jun 13	ZC 539	76140 V	4.3	4 -	N	12 2.0	-125 38	Taygeta 19 Tauri	4.6	6.1
13	Aug 23	ZC 2617	186328 K	4.5	76+	N	0 50.9	-92 37		5.1	5.9
14	Aug 28	X 30724	165111 M	8.7	100 E	S	5 6.8	-111 25		8.8	11.4
15	Oct 04	ZC 1170	79653 A	3.6	40 -	N	11 29.5	-125 36	kappa Geminorum	3.7	8.2
16	Oct 06			-1.9	20 -	N	8 54.1	-112 47	Jupiter		
17	Oct 28	ZC 552	76199 K	2.9	95 -	S	0 26.2	-88 31	Alcyone eta Tauri	3.0	4.6
18	Nov 13	ZC 2617	186328 K	4.5	12+	S	1 31.8	-125 45		5.1	5.9
19	Dec 02	ZC 1685	138298 K	4.3	38 -	S	10 1.3	-125 35	upsilon Leonis	4.5	9.0
21	Dec 21	ZC 545	76172	4.1	93+	S	21 47.7	-89 51	Merope 23 Tauri		
22	Dec 26	ZC 1310	98087 S	3.9	91 -	S	12 14.3	-104 55	Asellus Australis Delta Cancri		

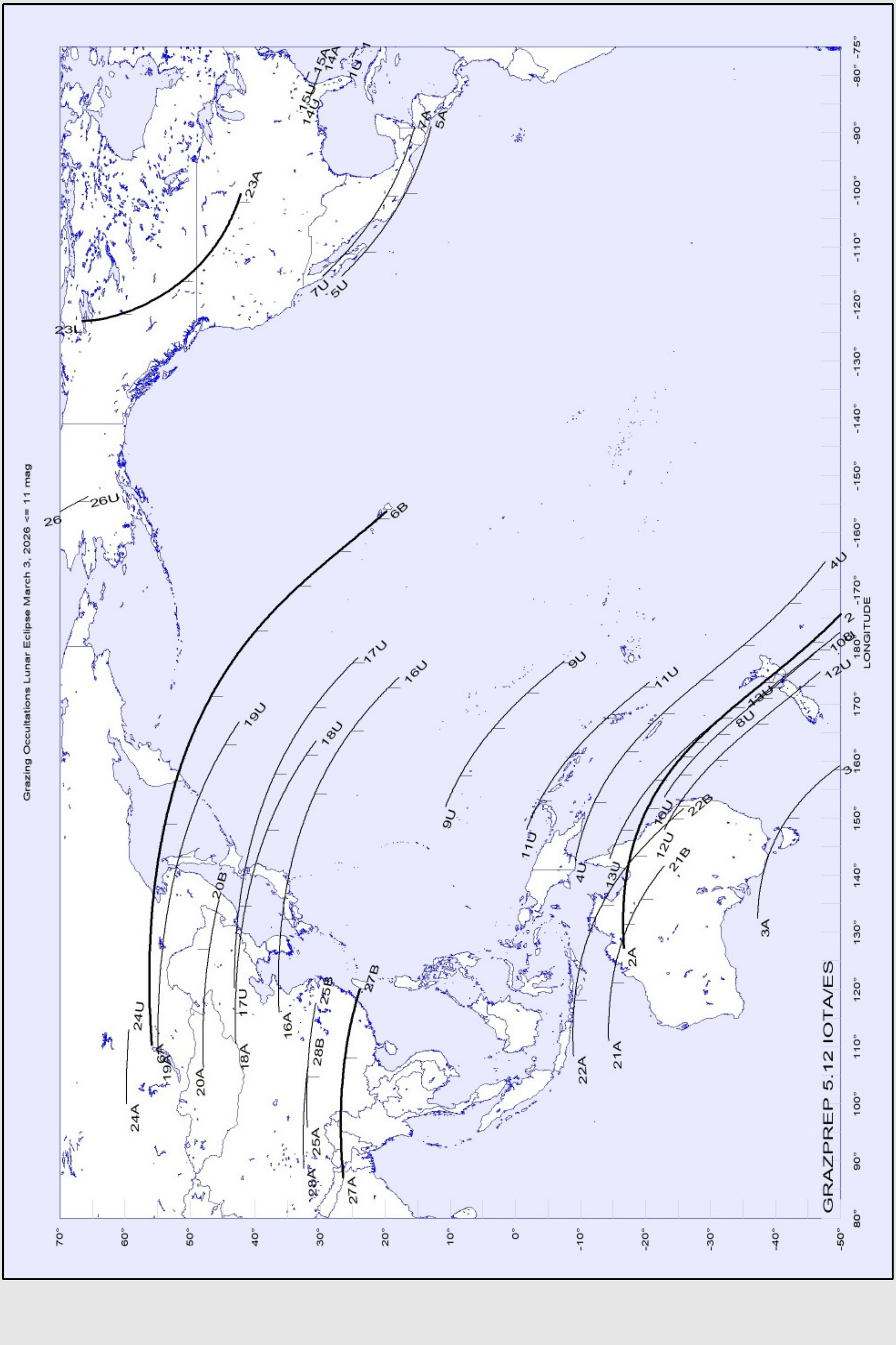


Grazing Occultations North America 2026 <= 5.0 mag. dark limb at night
LONGITUDE
GRAZPREP 5.13 IOTA/ES
-125° -120° -110° -100° -90° -80° -70° -60°
25° 30° 40° 50° 55°

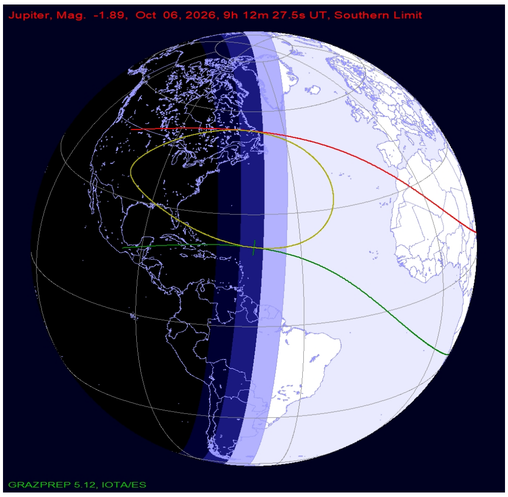
Total Lunar Eclipse, 2026 March 3

2026 Grazing Occultations Lunar Eclipse March 3, 2026 <= 11 mag GRAZPREP 5.12, IOTA/ES

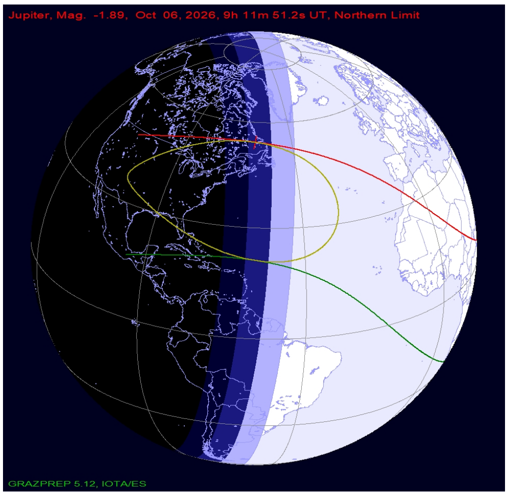
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
1	**Mar 03**	X 16237	118517 K	8.6	100 E	N	10 12.1	-76 25		8.9	9.5
2	**Mar 03**	X 16431	118578	7.4	100 E	N	10 19.0	127 -17			
3	**Mar 03**	X 16420	118575	8.3	100 E	N	10 22.1	132 -37			
4	**Mar 03**	X 16434	118580	9.2	100 E	N	10 26.5	142 -9			
5	**Mar 03**	X 16310	P157278 D	10.6	100 E	N	10 49.2	-115 27			
6	**Mar 03**	ZC 1589	118576	5.9	100 E	N	10 49.3	110 56	56 Leonis VY Leonis	5.9	6.0
7	**Mar 03**	X119618	P0	10.4	100 E	N	10 49.7	-115 30			
8	**Mar 03**	X119824	P0	10.6	100 E	N	10 50.3	169 -36			
9	**Mar 03**	X119884	P0	10.2	100 E	N	10 51.0	152 11			
10	**Mar 03**	X 16435	P157352	10.5	100 E	N	10 51.2	153 -23			
11	**Mar 03**	X119896	P0	10.9	100 E	N	10 51.5	148 -2			
12	**Mar 03**	X 16446	P157360	10.5	100 E	N	10 51.9	148 -23			
13	**Mar 03**	X119899	P0	10.9	100 E	N	10 52.3	142 -14			
14	**Mar 03**	X 16283	P157258	10.1	100 E	N	10 52.5	-83 32			
15	**Mar 03**	X119587	P0	10.9	100 E	N	10 52.8	-81 32			
16	**Mar 03**	X 16455	P157364	9.9	100 E	N	10 54.6	116 36			
17	**Mar 03**	X 16442	P157357	10.2	100 E	N	10 54.9	120 43			
18	**Mar 03**	X119928	P0	10.2	100 E	N	11 19.0	110 43			
19	**Mar 03**	X119910	P0	10.1	100 E	N	11 27.5	108 55			
20	**Mar 03**	X 16443	118582	9.0	100 E	S	11 30.2	106 48			
21	**Mar 03**	X 16509	118600	9.9	100 E	N	11 34.8	111 -14			
22	**Mar 03**	X 16511	118602	8.4	100 E	N	11 36.1	108 -9			
23	**Mar 03**	X 16391	118571 V	7.4	100 E	N	11 50.4	-123 67	NSV 05015	8.0	8.8
24	**Mar 03**	X119968	P0	10.5	100 E	N	12 9.8	100 60			
25	**Mar 03**	X 16528	118607	9.6	100 E	N	12 17.9	96 32			
26	**Mar 03**	X 16443	118582	9.0	100 E	N	12 30.0	-159 75			
27	**Mar 03**	ZC 1600	118615 w	5.0	100 E	N	12 33.8	87 26	59 Leonis		
28	**Mar 03**	X 16547	118616	8.9	100 E	N	12 44.7	88 32			


Grazing Occultations Lunar Eclipse March 3, 2026 <= 11 mag
GRAZPREP 5.12 IOTA/ES
LONGITUDE

Planet Grazes Worldwide



Event No. 10

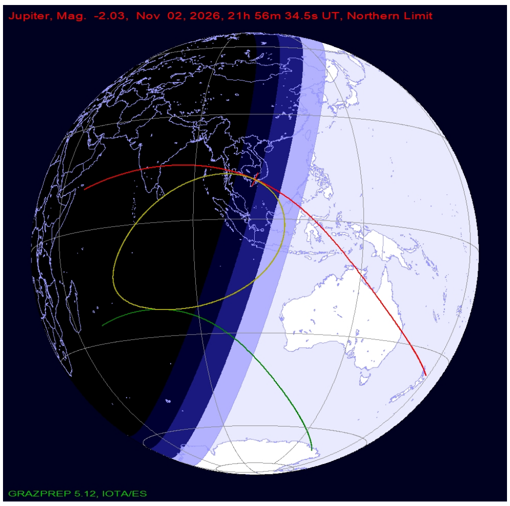


Event No. 11

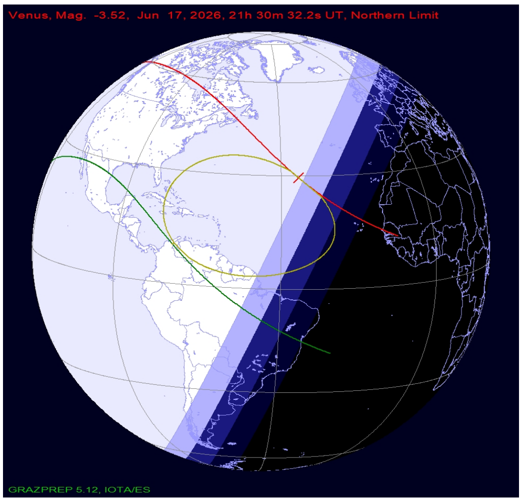
Grazing Occultations Planets 2026 GRAZPREP 5.12, IOTA/ES

No.	M D	MAG	%SNL	L.	W.UT	LONG LAT		STAR NAME
1	**Feb 16**	1.2	1 -	N	16 36.6	176	-50	Mars
2	**Feb 18**	-0.7	2+	N	21 19.0	149	-19	Mercury
3	**Feb 18**	-0.7	2+	S	21 29.0	143	-51	Mercury
4	**Jun 17**	-3.5	10+	S	18 38.7	-154	18	Venus
5	**Jun 17**	-3.5	10+	N	19 4.4	-178	47	Venus
6	**Sep 08**	-1.8	7 -	S	17 14.3	140	50	Jupiter
7	**Sep 14**	-4.3	13+	S	9 51.9	-10	35	Venus
8	**Sep 14**	-4.3	13+	N	10 24.4	16	67	Venus
9	**Oct 05**	1.1	31 -	S	5 12.8	-110	66	Mars
10	**Oct 06**	-1.9	20 -	S	8 38.3	-96	17	Jupiter
11	**Oct 06**	-1.9	20 -	N	8 54.1	-112	47	Jupiter
12	**Nov 02**	0.9	43 -	N	12 28.9	-170	-22	Mars
13	**Nov 02**	-2.0	37 -	N	21 8.6	55	11	Jupiter
14	**Nov 02**	-2.0	37 -	S	21 38.3	57	-25	Jupiter
15	**Nov 07**	-3.9	4 -	N	9 34.0	-84	-23	Venus
16	**Nov 30**	-2.2	61 -	N	7 26.4	-114	-28	Jupiter

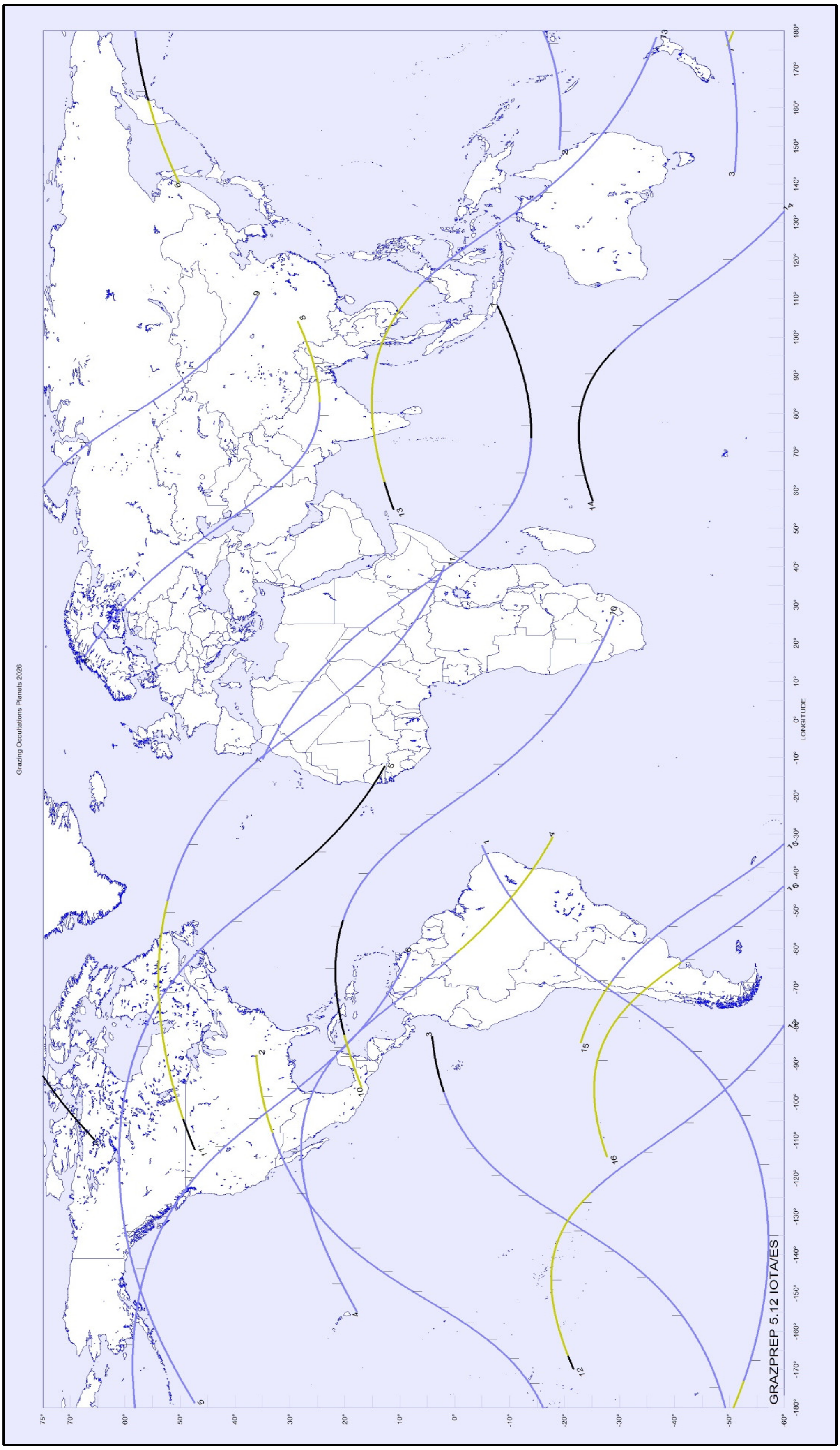
Detailed maps of grazing occultations of Jupiter (left) and Venus (below). The event numbers refer to the line in the table above. The maps show the shadow of the Moon (yellow) at the time given on the map. Southern graze lines are plotted in green and northern limit lines are red. A marker is set where the Moon grazes the planet at the given time.



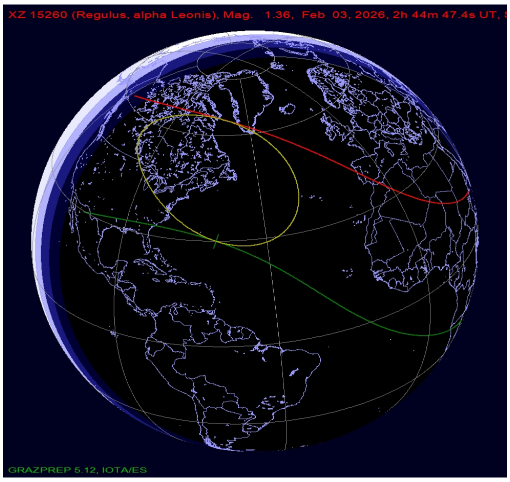
Event No. 13



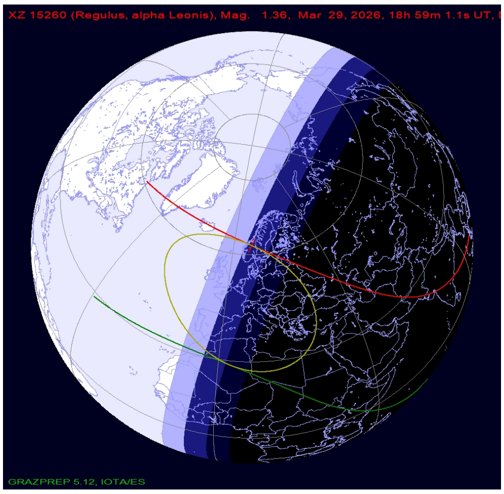
Event No. 5


Grazing Occultations Planets 2026
GRAZPREP 5.12 IOTA/ES
LONGITUDE

Regulus Grazes Worldwide

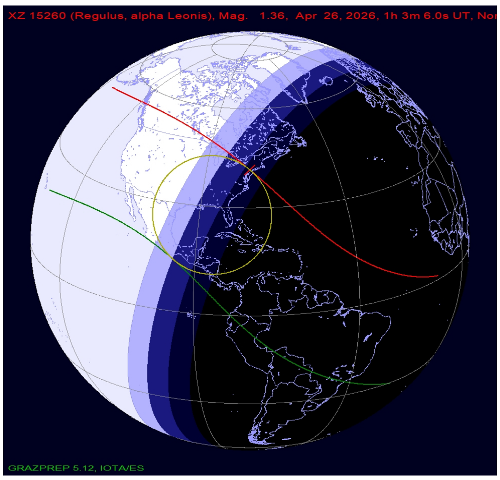


Event No. 3, 4 *North America No. 3*



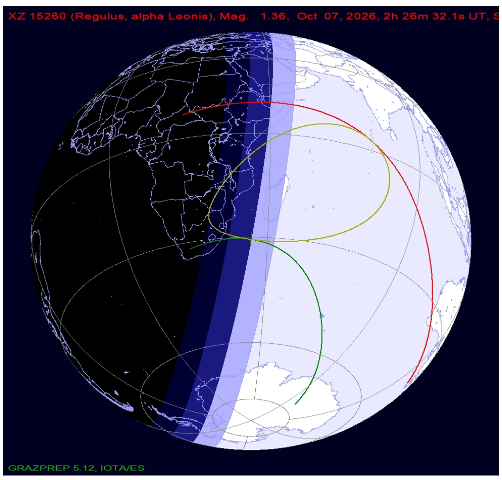
Event No. 7, 8 *Europe No. 5*

2026	Grazing Occultations Regulus 2026						GRAZPREP 5.12, IOTA/ES		
No.	**M D**	**USNO**	**SAOPPM D**	**MAG**	**%SNL**	**L.**	**W.UT**	**LONG**	**LAT**
1	**Jan 06**	ZC 1487	98967 S	1.4	86 -	S	15 38.7	75	35
2	**Jan 06**	ZC 1487	98967 S	1.4	86 -	N	16 12.3	46	69
3	**Feb 03**	ZC 1487	98967 S	1.4	98 -	S	2 1.9	-106	30
4	**Feb 03**	ZC 1487	98967 S	1.4	98 -	N	2 27.9	-127	63
5	**Mar 02**	ZC 1487	98967 S	1.4	99+	S	11 14.3	89	31
6	**Mar 02**	ZC 1487	98967 S	1.4	99+	N	11 40.8	67	63
7	**Mar 29**	ZC 1487	98967 S	1.4	89+	S	18 12.6	-42	29
8	**Mar 29**	ZC 1487	98967 S	1.4	89+	N	18 37.7	-62	62
9	**Apr 25**	ZC 1487	98967 S	1.4	70+	S	23 41.9	-149	21
10	**Apr 25**	ZC 1487	98967 S	1.4	70+	N	23 57.5	-162	52
11	**May 23**	ZC 1487	98967 S	1.4	49+	S	5 38.3	98	6
12	**May 23**	ZC 1487	98967 S	1.4	49+	N	5 38.9	90	37
13	**Jun 19**	ZC 1487	98967 S	1.4	27+	N	13 15.4	-47	23
14	**Jun 19**	ZC 1487	98967 S	1.4	27+	S	13 30.7	-43	-10
15	**Jul 16**	ZC 1487	98967 S	1.4	9+	S	23 14.1	146	-21
16	**Oct 07**	ZC 1487	98967 S	1.4	13 -	N	1 33.8	23	8
17	**Oct 07**	ZC 1487	98967 S	1.4	13 -	S	2 13.8	23	-31
18	**Nov 03**	ZC 1487	98967 S	1.4	34 -	N	7 16.0	-86	-4

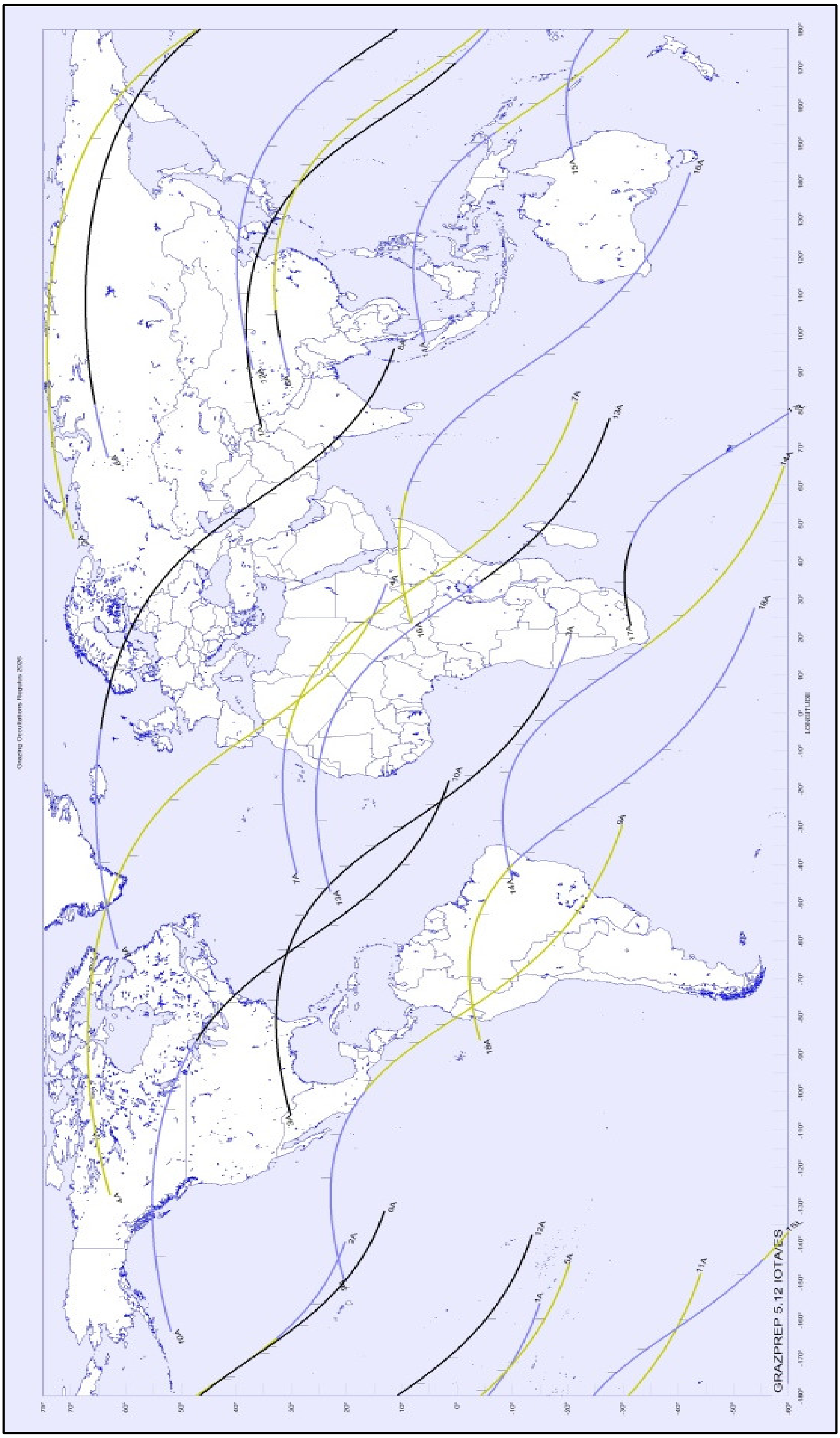


Event No. 9, 10 *North America No. 7*

The numbers in the captions of the maps refer to the lines in the table above and in blue to the lines in the relevant tables of the regions.



Event No. 16, 17 *Southern Africa No. 14*


GRAZPREP 5.12 IOTA/ES
LONGITUDE

Beyond Jupiter

The World of Distant Minor Planets

Since the downgrading of Pluto in 2006 by the IAU, the planet Neptune marks the end of the zone of planets. Beyond Neptune, the world of icy large and small bodies, with and without an atmosphere (called Trans-Neptunian Objects or TNOs) starts. This zone between Jupiter and Neptune is also host to mysterious objects, namely the Centaurs and the Neptune Trojans. All of these groups are summarised as "distant minor planets". Occultation observers investigate these members of our solar system, without ever using a spacecraft. The sheer number of these minor planets is huge. As of 2025 December 13, the *Minor Planet Center* listed 2026 Centaurs and 3799 TNOs.
In the coming years, JOA wants to portray a member of this world in every issue; needless to say not all of them will get an article here. The table shows you where to find the objects presented in former JOA issues. (KG)

In this Issue: (121725) Aphidas

Konrad Guhl · IOTA/ES · Berlin · Germany · kguhl@astw.de

ABSTRACT: The inactive Centaur object (121725) Aphidas was discovered in 1999 not far from aphelion orbiting the Sun every 76 years. The elliptical orbit has its perihelion inside the orbit of Saturn and aphelion just inside the orbit of Neptune. Its diameter is around 50 to 110 km. Since discovery, the object has remained very distant and is not yet expected to exhibit cometary activity, nor have any satellites been found.

No.	Name	Author	Link to Issue
944	Hidalgo	Oliver Klös	JOA 1 2019
2060	Chiron	Mike Kretlow	JOA 2 2020
5145	Pholus	Konrad Guhl	JOA 2 2016
5335	Damocles	Oliver Klös	JOA 2 2023
7066	Nessus	Konrad Guhl	JOA 1 2024
8405	Asbolus	Oliver Klös	JOA 3 2016
10370	Hylonome	Konrad Guhl	JOA 3 2021
10199	Chariklo	Mike Kretlow	JOA 1 2017
15760	Albion	Nikolai Wünsche	JOA 4 2019
15810	Awran	Konrad Guhl	JOA 4 2021
20000	Varuna	Andre Knöfel	JOA 2 2017
28728	Ixion	Nikolai Wünsche	JOA 2 2018
31824	Elatus	Konrad Guhl	JOA 2 2025
32532	Thereus	Konrad Guhl	JOA 1 2023
38628	Huya	Christian Weber	JOA 2 2021
47171	Lempo	Oliver Klös	JOA 4 2020
49036	Pelion	Joachim Siegert	JOA 4 2025
50000	Quaoar	Mike Kretlow	JOA 1 2020
53311	Deucalion	Konrad Guhl	JOA 2 2024
54598	Bienor	Konrad Guhl	JOA 3 2018

No.	Name	Author	Link to Issue
55576	Amycus	Konrad Guhl	JOA 1 2021
58534	Logos & Zoe	Konrad Guhl	JOA 4 2023
60558	Echeclus	Oliver Klös	JOA 4 2017
65489	Ceto and Phorcys	Konrad Guhl	JOA 1 2025
90377	Sedna	Mike Kretlow	JOA 3 2020
90482	Orcus	Konrad Guhl	JOA 3 2017
120347	Salacia	Andrea Guhl	JOA 4 2016
134340	Pluto	Andre Knöfel	JOA 2 2019
136108	Haumea	Mike Kretlow	JOA 3 2019
136199	Eris	Andre Knöfel	JOA 1 2018
136472	Makemake	Christoph Bittner	JOA 4 2018
174567	Varda	Christian Weber	JOA 2 2022
208996	2003 AZ_8	Sven Andersson	JOA 3 2022
229762	G!kún‖'hòmdímà	Konrad Guhl	JOA 3 2025
341520	Mors-Somnus	Konrad Guhl	JOA 4 2022
471143	Dziewanna	Wojciech Burzyński	JOA 3 2024
486958	Arrokoth	Julia Perła	JOA 3 2023
-	2004 XR_{190}	Carles Schnabel	JOA 1 2022
541132	Leleākūhonua	Konrad Guhl	JOA 4 2024

The Discovery

The object was discovered on 1999 December 13 at the *Mount Hopkins Observatory* (now called the *Fred Lawrence Whipple Observatory* (FLWO)) in southern Arizona, USA (IAU Obs. Code 696) [1]. For the discovery, the 1.2 m f/8 telescope was used (Figure 1). Unusually, Carl Hergenrother is listed as the official discoverer although Matthew Holman and C. Ernst were also listed as observers in the Minor Planet Circulars of 2000 Jan 24 [2]. Its provisional designation was 1999 XX_{143}.

In 2006 the planet was assigned the number 121725 [3] and in 2017 its final name [4]. Eleven years after discovery it reached aphelion and is now on its long journey back to perihelion in 2049. It only recently moved closer to the Sun than when it was first discovered in 1999. No 'precovery' astrometry has been reported to the MPC despite the fact it can reach 18th magnitude when near perihelion.

The Name

Small solar system bodies called 'centaurs' are named after the centaurs of Greek mythology, which are imagined beasts having characteristics that are a mixture of humans and horses. This name was chosen because astronomical centaurs are a class of celestial body that is gravitationally confined between the large gas planets (straying no closer than Jupiter and no further than Neptune) and where their orbit is unstable over the long term. As such, they represent a 'mixture' of different objects: the more distant bodies tend to be more like an asteroid whilst the ones that approach nearer the Sun are often active and sometimes form a coma like a comet.

The centaurs were the arch enemies of the Lapiths and were driven out by them when, 'heated by wine,' they made advances towards the Lapith women at the wedding of Peirithoos, king of the Lapiths. This battle, known as the 'Centaur-Machia', is a popular theme among Renaissance artists. Figure 2 shows the battle on an ancient Roman sarcophagus in the Museo Ostiense (Ostia Antica).

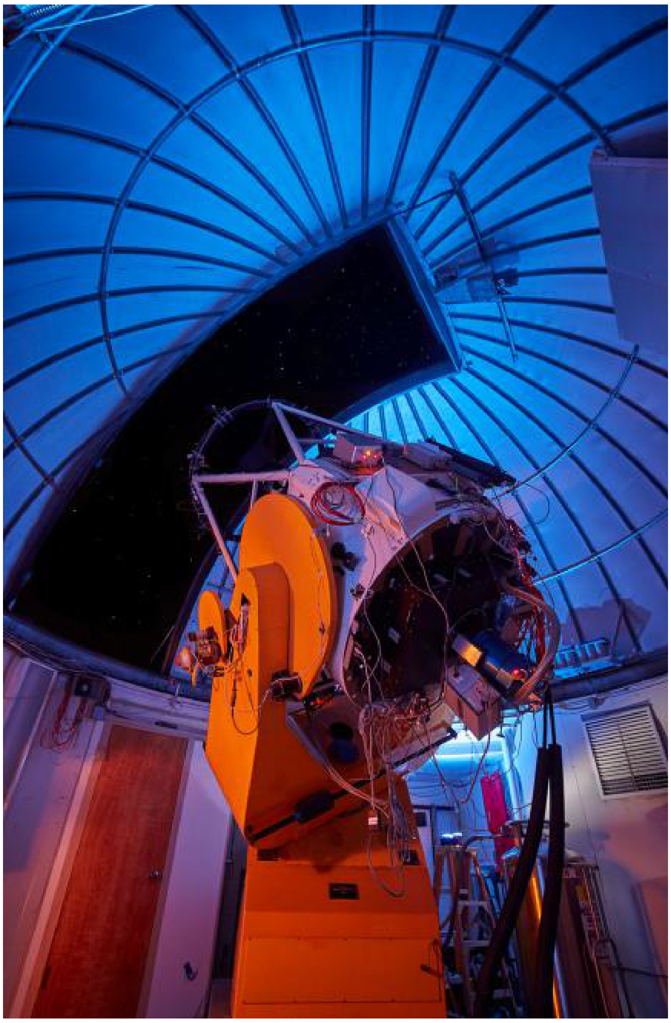


Figure 1. The 1.2 m/f8 reflecting telescope at the Fred Lawrence Whipple Observatory. (Credit: CfA/Rick Peterson)

The centaur Aphidas was nowhere to be seen when trouble broke out, being drunk on wine during the battle and was killed in his sleep by a spear thrown by the Lapith, Phorbas.

Figure 2. Relief from an ancient Roman sarcophagus depicting a Centauromachy. Image: Sailko – (Source: Own work, CC BY 3.0, Bas)

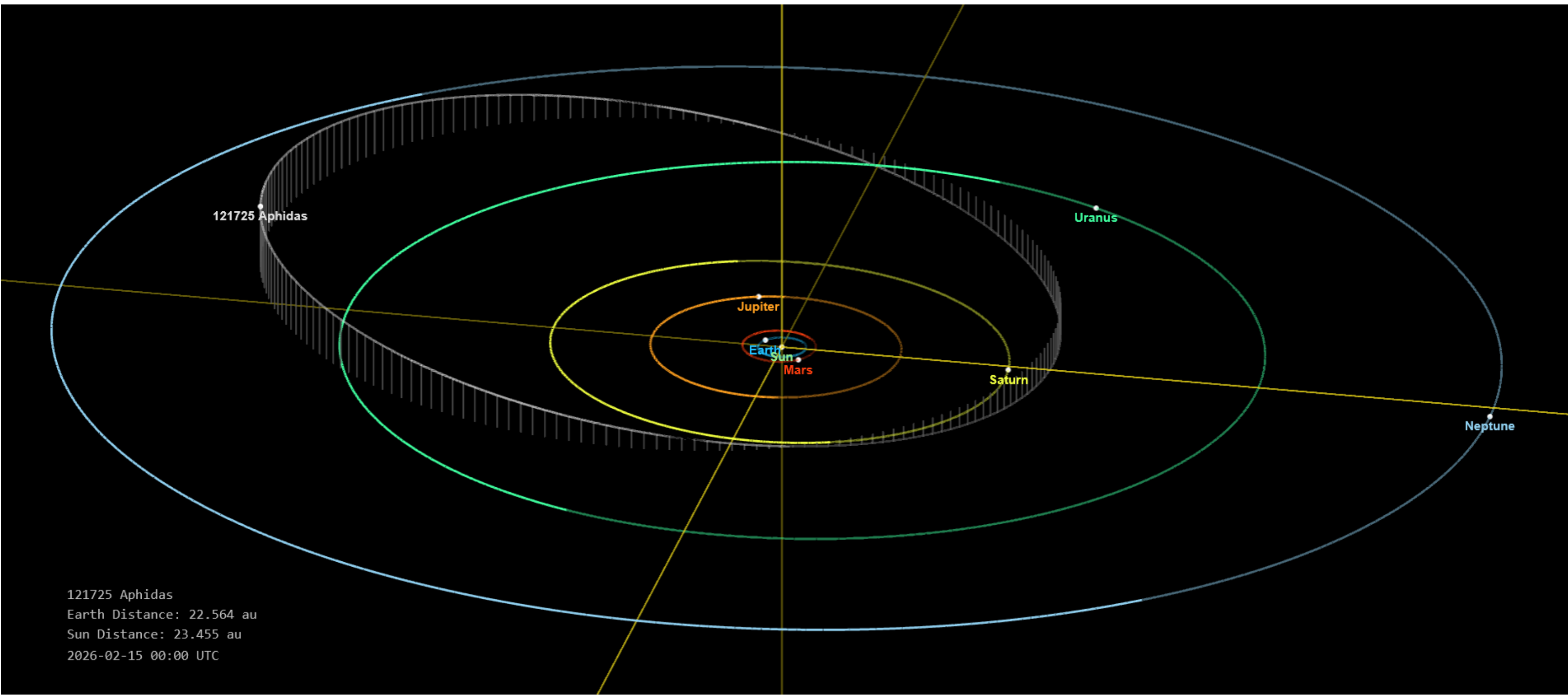


Figure 3. Orbit diagram and position of (121725) Aphidas on 2026 February 15.
(Source: https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html#/?sstr=121725&view=VOP)

The Orbit

The orbit has a strong eccentricity of 0.46 and is inclined to the ecliptic by 6.8° (Figure 3). With a semi-major axis of 17.94 au, the object's distance from the Sun currently varies between 9.66 au (close to Saturn) to 26.23 au and is therefore classified as a Centaur. Saturn orbits the Sun between 9.03 and 10.05 au and so the perihelion distance overlaps Saturn's orbit but gravitationally it cannot collide with the planet, its closest distance being approximately 1 au. The next close approach is calculated to occur in 2194.

The current distance from the Sun (Epoch 2026.0) is 23.50 au.

Physical Characteristics

The JPL Small Body Database [5] reports an absolute magnitude [H] = 8.88. The calculated diameter is approximately 50 to 110 km. For more exact information on its size we need an occultation event or photometry from a closer distance. In Reference [6], the object is identified as Class-c: Cold Classical Disk object. (121725) Aphidas was one of nine centaur objects investigated in 2017, it having been included as an example of a dormant Centaur [7]. (121725) Aphidas, and one other object, were the two most distant Centaurs observed, both being found by the authors to be redder than the others they examined (B–V ≈ +1.0, V–R ≈ +0.7). Currently, (121725) Aphidas remains dormant but may become active as it approaches closer to the Sun.

Future Occultations

To date, no occultation by this body has been successfully observed. Using Dave Herald's *Occult* software [8], we find a prediction for a stellar occultation event in 2028 (Figure 4).

Currently, the predicted event is some time off and so we need more astrometry to improve the accuracy of this prediction especially because of the gap in coverage in recent years with only 3 epochs of astrometry reported since 2020 March. Hopefully, large survey telescopes such as the *Vera C. Rubin Observatory* will provide high-SNR astrometry of this 22nd magnitude object making for more accurate predictions in future.

Fortunately, (121725) Aphidas is travelling towards perihelion and so will be brightening reaching 19th magnitude and traversing the Milky Way in Sagittarius in 20 years' time, when its apparent velocity will be greater than now and it will occult many more stars. Also, perhaps in a few years' time, more observers will be running easy-to-use citizen science instruments like *eVscope* to follow occultation events such as this one in Africa and others in relatively remote locations.

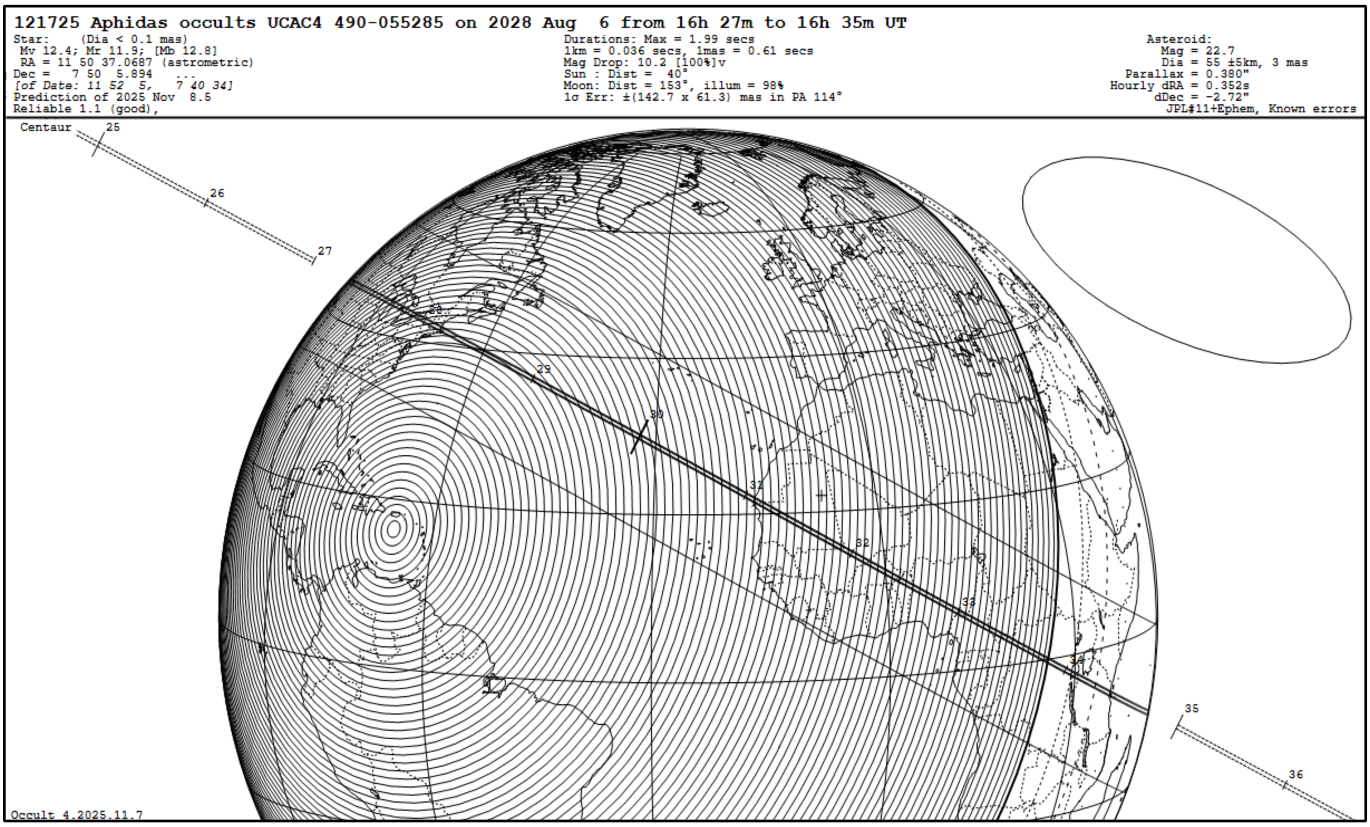


Figure 4. Map of the predicted path of the occultation on 2028 August 06. (Occult V4.2025.11.7)

References

[1] Minor Planet Electronic Circular MPEC 1999-Y19
https://www.minorplanetcenter.net/mpec/J99/J99Y19.html

[2] Minor Planet Circulars M.P.C., MPC 37426
https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2000/MPC_20000124.pdf

[3] Minor Planet Circulars M.P.C., MPC 56182
https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2006/MPC_20060314.pdf

[4] Minor Planet Circulars M.P.C., MPC 106503
https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2017/MPC_20171005.pdf

[5] JPL Small-Body Database
https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html#/?sstr=121725&view=VOP

[6] Hainaut, O. R., Boehnhardt, H. & Protopapa, S. (2012): "Colours of Minor Bodies in the Outer Solar System", Astronomy & Astrophysics 546, L115, https://www.eso.org/~ohainaut/MBOSS/index.html

[7] Wong, I., Mishra, A. & Brown, M. E., (2019): "Photometry of active Centaurs: Colors of dormant active Centaur nuclei". *Astronomical Journal*, 157, 225
https://www.doi.org/10.3847/1538-3881/ab1b22

[8] Herald, D. (2023): Occult v4.2025.11.7 software tool
http://www.lunar-occultations.com/iota/occult4.htm

News

SETI Institute and SkyMapper Create a Network for Mapping the Entire Sky, Around the Clock

On 2025 June 17, the SETI Institute announced in a press release a strategic collaboration with SkyMapper, the world's leading decentralised network for astronomy and space exploration. The goal: to provide scientists, educators and the citizen science community worldwide with real-time astronomical data.

https://skymapper.io/

Telescope users can receive real-time observation requests from experts and feed their data back into a secure, globally accessible network. One of the advantages of round-the-clock global monitoring via a robust telescope network is the avoidance of observation failures caused, for example, by cloudy skies.

The plug-and-play hardware tool SkyBridge is essential for participation in the network and was introduced for beta testing in August 2025 with 14 global testers. With SkyBridge, users receive observation requests. The hardware is capable of controlling the telescope's automatic functions and can transmit observation data with blockchain security, ensuring transparency and trust in the scientific data. SkyBridge is still in development and can be pre-ordered for US $349. Currently, only Unistellar telescopes are supported by SkyBridge, but broader support is in the works, such as ASCOM-ALPACA compatibility (December 2025).

Further developments of the hardware and requirements for telescopes can be found on the website:

https://skymapper.io/products/skybridge-telescope-requirements

SkyBridge uses the SkyViewer interface, which converts raw astronomical data into an interactive window to the universe. With this interface, observations from around the world can be followed live. With a SkyBridge-connected telescope, users can observe remotely through other SkyBridge-enabled telescopes, transforming cloudy skies on their location into clear views on other sites.

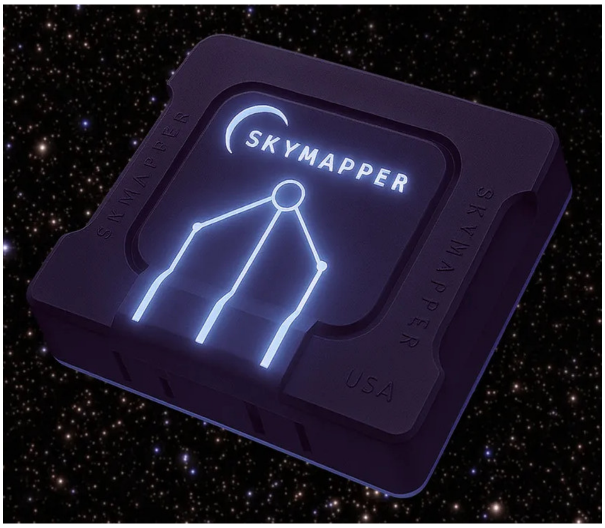


Figure 1. SkyBridge hardware. (Source: SkyMapper webpage)

Franck Marchis, senior astronomer and Director of Citizen Science at the SETI Institute, gave a comprehensive overview of the project on 2025 December 5 in a SETI Live podcast on YouTube. The recording of the session is available here:

https://www.youtube.com/watch?v=zbDWsEFhpSg

Franck Marchis wrote about the features for occultation work on the IOTAoccultations mailing list on 2025 Dec 10:

"We have developed an AI-based algorithm to quickly derive if an occultation is positive or negative [1]. ODNet has been improved recently by our colleagues (Peter Pokorny and Josef Hanuš) and will be tested on our decentralized network. The ultimate goal is to perform the AI compute on the SkyBridge. It will be then almost live just after the acquisition so we send to the data repository (maintained by AKAVE) only the frames with positive occultation for a more accurate analysis. We could also imagine a system (edge AI) which adjust then the timing of an occultation as the stations located 10-40 min ahead detected it."

[1] Cazeneuve, D. et al., ODNet: A Convolutional Neural Network for Asteroid Occultation Detection, 2023 AJ 165 11, https://www.doi.org/10.3847/1538-3881/ac9c69

(O. Klös)

The International Occultation Timing Association's 43rd Annual Meeting, 2025 September 6-7

Richard Nugent · IOTA · Dripping Springs, Texas · USA · RNugent@wt.net

ABSTRACT: IOTA's 2025 Annual Meeting was held online via Zoom on 2025 September 6-7. Numerous presentations were made by members of the worldwide IOTA community. More than 50 attendees participated in the meeting.

The 43rd annual meeting of the International Occultation Timing Association was held on Saturday and Sunday 2024 September 6-7 online via Zoom.

Saturday 6th September 2025 - Day 1

Vice President Roger Venable welcomed everyone to the meeting. Attendees: The meeting started with a total of 47 participants, rose to 57 and this number fluctuated throughout the session.

Business Meeting

Treasurer Joan Dunham presented IOTA's financials and membership status. A full report of the business meeting is available [1].

Elections

Executive Secretary Richard Nugent presented the results of the 2025 election. IOTA's revised its By-laws in 2022. The new Bylaws stated that IOTA Officers will be chosen by Board members. Board members (minimum of 3 and up to 9) are to be elected by the general paid membership.

The election results were unanimous for the following persons:

Elected in 2024 (in a special election):

Board Member: Aart Olsen
Board Member: Greg Lyzenga

Elected/re-elected in 2025:

Executive Secretary: Greg Lysenga
V.P. for Grazing Occultation Services: Mitsuru Soma
V.P. for Lunar Occultation Services: Walt "Rob" Robinson
V.P. for Planetary Occultation Services: Norm Carlson
Board Member: Michael Skrutskie

Awards

Richard Nugent next presented IOTA's *Homer F. Daboll* and *David E. Laird Awards*. The *Homer F. DaBoll Award* is given to recognise significant contributions to the field of occultation science and to the work of IOTA. This year's recipient of the *Homer F. Daboll Award* is **Ted Blank**. Since 2010, Ted set up over 190 stations, many of them multiple stations. Ted runs and operates the IOTA Store, assembling kits for the RunCam cameras,the IOTA VTI and Astrid camera. He has participated in several SwRI expeditions for the KBO 2014 MU_{69} occultation, (discovered by Marc Buie) including Cape Town, Columbia, Argentina and Darwin, Australia. The SwRi expeditions obtained valuable data for these special occultations as well as providing good liaison between them and IOTA.

Figure 1. The certificate given to Ted Blank.

Upon notification of the award, Ted sent the following e-mail:

I am very humbled and honored to receive this award from my colleagues here in IOTA, and very sorry I cannot be with you today. Chasing shadows has been a source of great enjoyment for me since meeting David and Joan Dunham at the Cambridge, Mass. IOTA meeting in (I think) 2010. Occultation recording is an accessible way for an amateur astronomer to make a significant contribution to Solar System science. While variable star observing is another interesting and useful approach, some of us enjoy the "chase" as well. As a software guy I have to especially thank Tony George for patiently teaching me how to use LiMovie, R-OTE and PyOTE/PyMOVIE, along with the developers of those packages and all the rest of the wonderful software we depend upon. Clear skies everyone!

- Ted

The *David E. Laird Award* is given to recognise those who, more than 15 years ago, made significant contributions to occultation science and to the work of the IOTA. This year's *David E. Laird Award* recipient is **John Phelps, Jr**. from Orland Park, Illinois. John Phelps helped create IOTA in 1975, serving as the first Vice President and Publications Chairman for IOTA for three years. For another five years, until 1983, he served as IOTA's Secretary-Treasurer, assuming the important role as the point of contact for IOTA. In 1983, he worked with Paul Maley to formally incorporate IOTA in Texas and apply for tax-exempt status as a scientific research organisation. John helped set up IOTA's current structure still in use today.

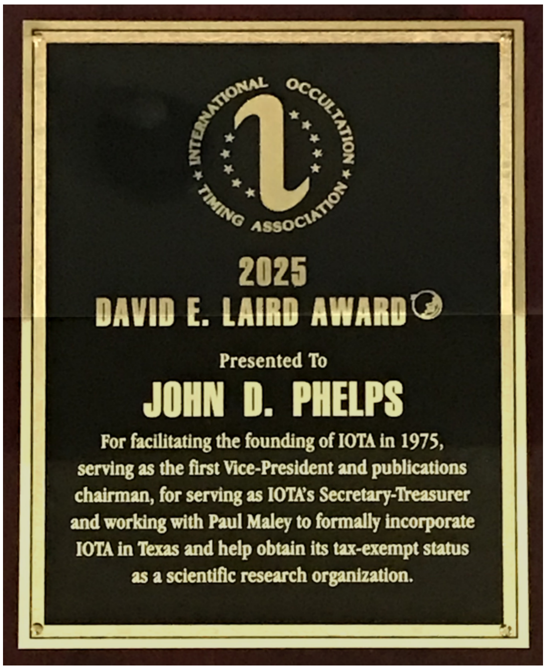


Figure 2. The certificate for John D. Phelps.

Upon notification of the award, John sent the following e-mail:

Hi Richard,

Your phone call was sure a bolt from the past! I occasionally still think about my time chasing grazes. PBS recently had a program about an asteroid graze viewed from, I believe, the MiddleEast or Africa. Unfortunately, my computer died shortly after I received your message. I did find a picture of Homer. It is not to recent since it is from the 1970 eclipse. This was my first total eclipse which I had been looking forward to since I discovered the Canon of Solar Eclipses in 1963. I came home on leave from the Navy and my Mother met me in Norfolk. We drove down to North Carolina where we met up with Homer DaBoll and his wife Audrey. The next day, we went to a carefully preselected site nearby to watch the eclipse. Homer was participating in an observation program to measure motion of the corona using photos taken at a string sites along the eclipse track thru special film that had a broad range of sensitivity using a surplus aerial camera lens mounted on an wood frame equatorial mount. I tried to photograph, not to well, thru a homebuilt 3-inch reflector while watching visually thru a small elbow telescope. My Mother photographed, on slide film, the activity and changing light levels using a simple Instamatic camera. She got one of Homer standing near his rig and facing the camera near the beginning of the partial phase leading up to totality. If you are interested, I can try to get a print made from the slide and mail it to you. Insidently, last year I completed what I call a Grand Saros, By observing the April 17th eclipse in southern Indiana.

John

The IOTA Board of Directors awarded the *W. J. Merline Award for Discovery of an Asteroid Moon by Occultation* (MADAMO) to **Dave Gault** and **Peter Nosworthy** for the discovery of the satellite of asteroid (4337) Arecibo on 2021 May 19 and to Université Côte

Figure 3. Dave Gault (left) and Peter Nosworthy.

d'Azur, CNRS for independent confirmation. This was the first time ever that a satellite of an asteroid was detected by occultation measurements. Dave and Peter produced two separate light-curves, each showing the primary and secondary. The discovery was reported to the IAU on 2021 June 20 in CBET 4981.

Technical Sessions

Paul Maley discussed the history and motivation of the *W.J. Merline Asteroid Satellite Award* (MADAMO) which was introduced in 2013. Paul discussed his history with IOTA starting in 1969 when he began organising grazes. The catalyst for the MADAMO award was his personal visual observation of a possible satellite of (6) Hebe in 1977 which unfortunately has yet to be confirmed. Paul then talked more of his occultation history and observations worldwide and recently in the Arizona area. Paul has made an astounding 963 positive observations to date of asteroid occultations in his 50+ year career.

Bill Merline, retired staff scientist from the Southwest Research Institute, discussed the MADAMO award and its creation by Paul Maley. It is a $4,000 cash award to the first amateur (not professional) astronomer that discovers an asteroid satellite by the occultation method. Specifically, the award requirements can be found in [2].

Bill then showed the qualification steps which included reporting the discovery to IAU, plus confirmation and validation by independent methods (not by occultation) and teams. He then showed the light curves from the (4337) Arecibo occultation on 2021 May 19 made by Dave Gault and Peter Nosworthy from Australia. Just three weeks later, observers Richard Nolthenius and Kirk Bender also detected (4337) Arecibo's possible satellite from an occultation in California, again from light curves.

An independent team, led by Paolo Tanga (Université Côte d'Azur), allowed decisive confirmation to be made by using astrometric data from the *Gaia* mission. Their independent analysis of the asteroid's duplicity, using a combination of Gaia data and the prior occultation data, allowed a preliminary orbit determination and indicated that the occultation detections were of the same object tracked by *Gaia*. The results are published by Tanga et al. in [3]. A 3rd independent team (required for the award) validated these results using extensive additional *Gaia* data and improved the orbit [4].

Bill mentioned his background in building and testing instruments for searching for exoplanets in his Doctoral work and how it eventually led him to look for companions of asteroids. Bill was on one of the imaging teams for the *Galileo* discovery of the satellite of (243) Ida named Dactyl. He then talked about the history he had using some of the largest telescopes in the world in searching for asteroid satellites including getting 16 half nights on the Hawaii Keck telescopes looking at Pluto's moons.

Ted Swift presented his experience in May 2025 of discovering that (33956) 2000 NN_3 may have a moon. He outlined his mobile observation planning, the observation itself, the discovery of a suspected moon during video analysis, the careful confirmation steps taken, and the CBET publishing process. He also discussed some of the resources available to everyone to learn more about binary asteroids, and the scientific usefulness of observing binary asteroids. From analysis of his light curves, the presumed size of the satellite was estimated to be 2.8 km. He showed the sky plane plot of the asteroid and suspected moon. It was estimated that the separation of the objects to be about 14.3 km and this was likely a lower limit since only one chord was obtained. The skyplane plot of the system is shown in Figure 4.

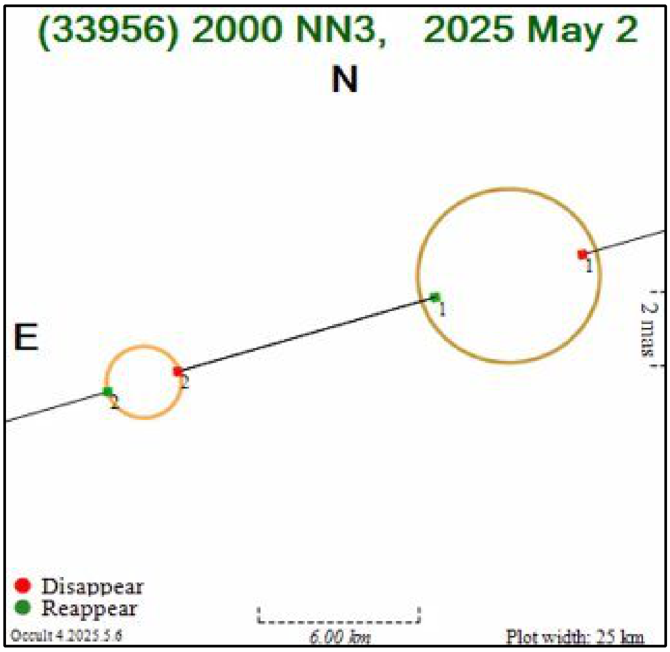


Figure 4. The chord of the occultation by (33956) 2000 NN_3 on 2025 May 2 measured by Ted Swift. (Occult V4.2025.5.6)

Jean-François Goût (Jeff) discussed using photometry on asteroids. Photometry can determine the rotation period of asteroids from light curves. Typical rotation periods of asteroids are 2-20 hours and this usually requires observations over several nights. Light curves can also infer the shape of asteroids and to date there are over 10,000 shape models determined. Jeff then showed light curves of binary asteroids and how they differ from single object light curves. Binary asteroids typically show a rapid short secondary drop in brightness due to the typical small size of the satellites. He mentioned the *TESS* satellite and the hundreds of asteroid photometry data sets in its archives. He showed a table of binary asteroid discoveries to date. Photometric light curves lead the way in such discoveries. Photometry has discovered several binary asteroids in recent years and it can be used as a follow up to help determine the physical parameters of these systems. Parameters such as orbital period, mass, separation and size of the components. He showed the asteroid occultation coming up on 2025 September 10 of (33476) Gilanareiss over the USA and that this asteroid's photometry shows a possible satellite.

Ted Swift commented that knowing the orbital parameters of binary systems and their masses could lead to densities of these asteroids.

Vice President for Planetary Occultation Services Norm Carlson discussed some of the interesting asteroid events of 2024-2025. For 2025 he projected that there will be 1140 North American events observed. This is slightly down from 2024. Norm also discussed the status of the review process of events and how reports and skyplane plots are uploaded to the North American asteroid website.

Norm is working on getting a training coordinator for new reviewers. The review team needs more help. Contact Norm at reports@asteroidoccultation.com.

Norm showed sky plane plots of a satellite discovery for (3927) Feliciaplatt on 2024 December 22 by Vince Sempronio (Figure 5). A confirmation just 10 days later on 2025 January 1 was made by Roger Venable and Kai Getrost (Figure 6). Another satellite discovery by Steve Conard and Greg Lyzenga with multiple stations (132221) 1998 QT_2 was made on 2024 October 12 (Figure 7).

Norm next talked about the review process for North American asteroid occultations. Observers send in their log, report file, CSV file and light curves. Then all files are sent out to a reviewer. First the report form is reviewed. Reviewers have seen errors in just about every report filed. Reviewers process the CSV files typically with PyMovie to compare with the observer's results. The Coordinator then sends the results and light curves to Dave Herald and Dave Gault for final review and eventual uploading to the MPC. Light curves are sent to the ViZier database. The North American review team is looking at a more automated system, like SODIS. Currently the review team consists of 13 people: Jerry Bardecker, Johnny Barton, Steve Conard, Bob Dunford, Joan Dunham, Kevin Green, Ernie Iverson, Robert Jones, Steve Messner, John Moore "Coordinator Emeritus," George Viscome, Dave Eisfeldt - Tangra support, Tony George - difficult observations. Dave Gault and Dave Herald make the final reviews

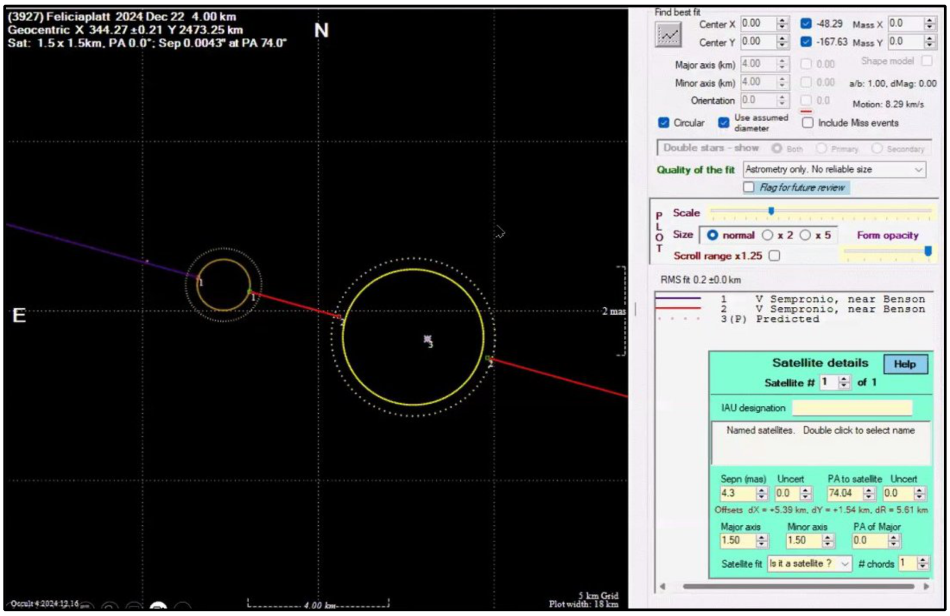


Figure 5 (top). The single chord discovery of the satellite of (3927) Feliciaplatt by Vince Sempronio on 2024 December 22. (Occult V4.2024.12.16)

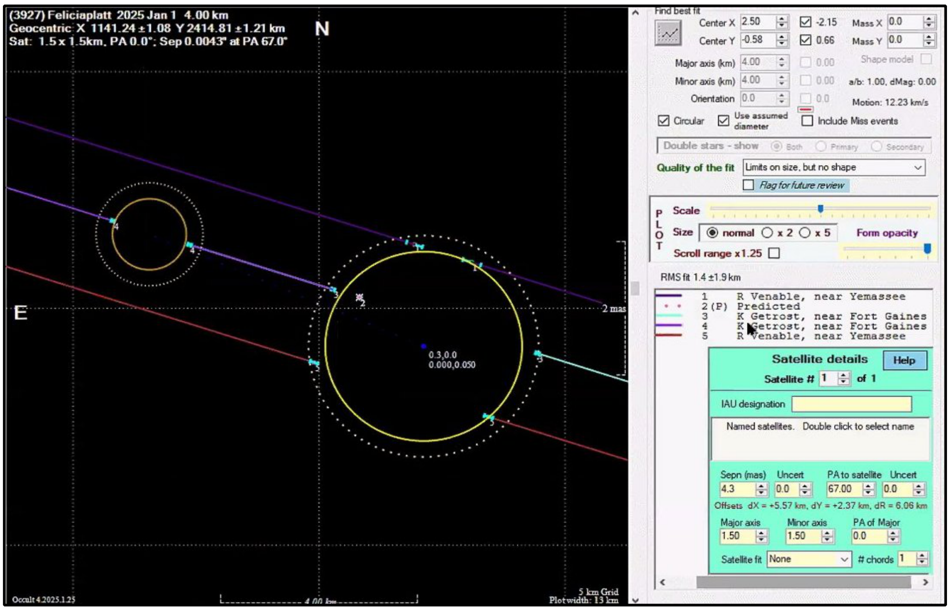
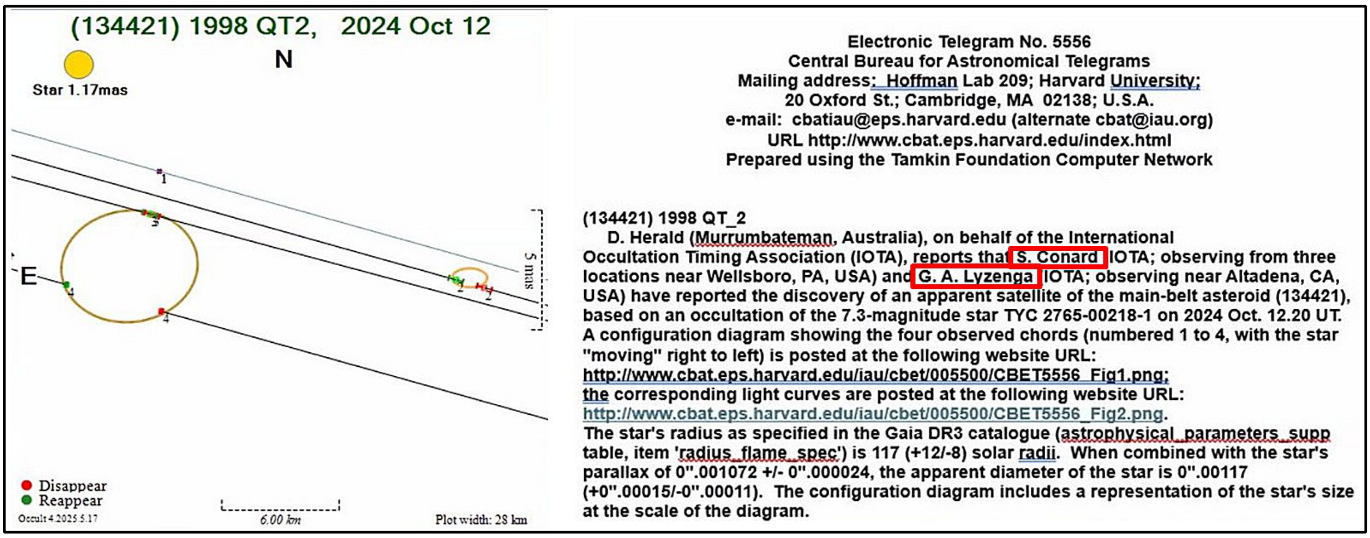


Figure 6 (bottom). Four chords by Roger Venable and Kai Getrost confirmed the discovery on 2025 January 1. (Occult V4.2025.1.25)



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e-mail: cbatiau@eps.harvard.edu (alternate cbat@iau.org)
URL http://www.cbat.eps.harvard.edu/index.html
Prepared using the Tamkin Foundation Computer Network

(134421) 1998 QT_2
D. Herald (Murrumbateman, Australia), on behalf of the International Occultation Timing Association (IOTA), reports that S. Conard (IOTA; observing from three locations near Wellsboro, PA, USA) and G. A. Lyzenga (IOTA; observing near Altadena, CA, USA) have reported the discovery of an apparent satellite of the main-belt asteroid (134421), based on an occultation of the 7.3-magnitude star TYC 2765-00218-1 on 2024 Oct. 12.20 UT. A configuration diagram showing the four observed chords (numbered 1 to 4, with the star "moving" right to left) is posted at the following website URL: http://www.cbat.eps.harvard.edu/iau/cbet/005500/CBET5556_Fig1.png; the corresponding light curves are posted at the following website URL: http://www.cbat.eps.harvard.edu/iau/cbet/005500/CBET5556_Fig2.png. The star's radius as specified in the Gaia DR3 catalogue (astrophysical_parameters_supp table, item 'radius_flame_spec') is 117 (+12/-8) solar radii. When combined with the star's parallax of 0".001072 +/- 0".000024, the apparent diameter of the star is 0".00117 (+0".00015/-0".00011). The configuration diagram includes a representation of the star's size at the scale of the diagram.

Figure 7. A satellite discovery by Steve Conrad and Greg Lyzenga. CBET No. 5556 announced the discovery of a satellite of asteroid (134421) 1998 QT2 to the astronomical community. (Occult V4.2025.5.17, screenshot from presentation)

Hristo Pavlov then talked about recent updates to *Occult-Watcher* (OW) software and how to use it. Hristo authored OW 15 years ago and the latest version is OW 5.5. OW allows observers to coordinate online with each other for multiple chord events by announcing their planned location to avoid duplication. Hristo's talk was a live demonstration of OW's new features he has implemented. A few of new the updates are:

- The estimated asteroid shadow (size) across the bottom of the screen so observers know where on the ground the asteroid shadow will pass. Asteroid sizes and shapes vary, Hristo plans to list the errors in the size in future OW updates
- Cloud prediction (% of cloud cover) and weather conditions for locations.
- Announcing your observation after the event has passed. For those doing these after the fact events, you must file and list your report: miss or positive.
- When choosing an event, OW will list how many previous events for that asteroid have been observed.
- OW 5.5 is faster.

Kazuhisa Miyashita next talked about a data collection system for asteroid occultation reporting currently being used/tested in Japan. For a long time, Japanese observers sent in their observations and reports by e-mail which made it difficult for the coordinator as there was no set format for reporting. He showed the Reconstruction of Observation Reports via e-mail Text (ROREM) and how it was the second step toward efficiency. Previous reports were done by e-mail and had common mistakes such as precise location. The coordinator had to manually decipher the data and finalise for submission to the world coordinator. He also showed how the data received allowed prediction of diffraction patterns on light curves.

Observers create their reports by clicking on a button "Make Report" from the *Limovie* light curve. This creates a file that includes the D and R times of the event along with the uncertainties and S/N ratio. The observer's name, GPS coordinates, telescope, aperture and time keeping method are entered. The Report making function is shown in Figure 8.

By clicking on "Make Report", ROREM makes a file which includes observer information and D and R times. A report email is generated from this data The observer then selects "Copy for Test Report" and this creates the details of the event ready to email to the coordinator.

The new collection sytem ROREM does the following:

- Provides a system that collects the report emails with minimal effort.
- Transcribes the e-mail report to OBS.XML files automatically.
- Collect the observation files: camera configuration, GPS log, light curve CSV, light curve graphic image.
- ROREM stores the various data and makes it available to anyone. It makes an HTML file from the database automatically and creates the webpage with the following information: Date/ Time of event, Asteroid name/#, observer, result (plot), light curve analysis, star mag, predicted mag drop, telescope used, camera and settings, video format (AVI), Time and GPS location and O-C differences.

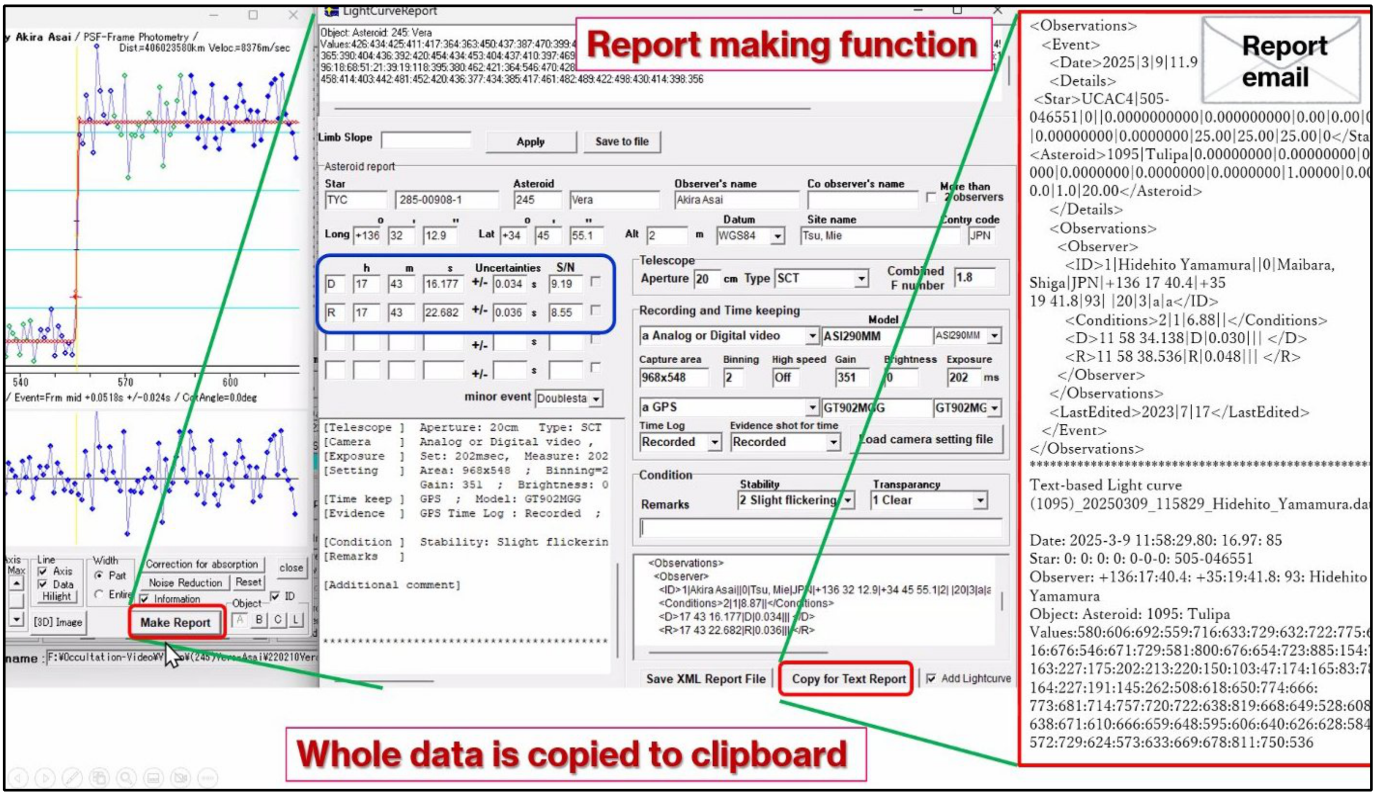

Figure 8. The Report making function. (Screenshot from presentation)

- Makes and sends the regional report to the IOTA Center automatically and this includes: OBS.XML files for each event, .dat light curve files for each observation.

The coordinator can combine multiple observations into a single XML file for reduction using *Occult4*. The ROREM collection system allows monthly reports and is made automatically.

Kazuhisa mentioned the asteroid (99942) Apophis is an additional flyby target of the Japan/German *DESTINY+* mission scheduled to be launched in 2028. Some 60 opportunities are available for occultation events of (99942) Apophis with 7 visible from Japan.

Steve Messner talked about the North American low magnitude feed that he maintains (NA Low Mag Feed). Steve started out with an 18" newtonian 'scope and began using *Occult* to search for fainter events than were posted on Steve Preston's asteroid page. He thus created the NA feed for these fainter events. Now, with *Gaia* data, the feed has had much better predictions. He now has been listing several hundred events/month. Starting in September 2025, he'll change the search criteria for these faint events as follows:

- List events to m = 14.6, with >1 second duration with >0.6 mag drop
- As faint as 13.6, >0.7 sec duration with >0.4 mag drop
- As faint as 12.6, > 0.5 sec duration, > 0.4 mag drop
- As faint as 11.6, > 0.4 sec duration, > 0.5 mag drop

Starting in November 2025, he'll add events as faint as 11th mag, with > 0.3 sec duration.

December 2025: he'll list events down to 15th mag stars.

And all events listed will have a solar elongation > 25 deg. Steve mentioned he can change the filters for events especially avoiding those with short durations and a low rank.

Sunday 7th September 2025 - Day 2

Technical Sessions

David Dunham presented a talk about the most important and special asteroid occultation events for the remainder of 2025 and the coming year 2026, particularly special main belt objects, NEAs, Trojans to support the *Lucy* mission (RECON campaigns), new asteroid moon discoveries and 2026 Lunar grazing events. Many events are on David's webpage [5].

David mentioned the successful 2025 April 18 occultation in Missouri by (319) Leona. This event increased the knowledge of the size and shape of (319) Leona. This will help with the 2023 December 12 Betelgeuse occultation analysis. Another event was the potentially hazardous 3.5 km size asteroid (PHA) (16960) 1998 QS$_{52}$ which occulted the 9.9 mag star PPM 203111 on 2025 June 22 across the southern USA. This is one of the larger PHAs whose impact would result in worldwide devastation, however there's no risk in the next 1,000 years. A sky plane profile of this asteroid (16960) 1998 QS_{52} is shown in Figure 9.

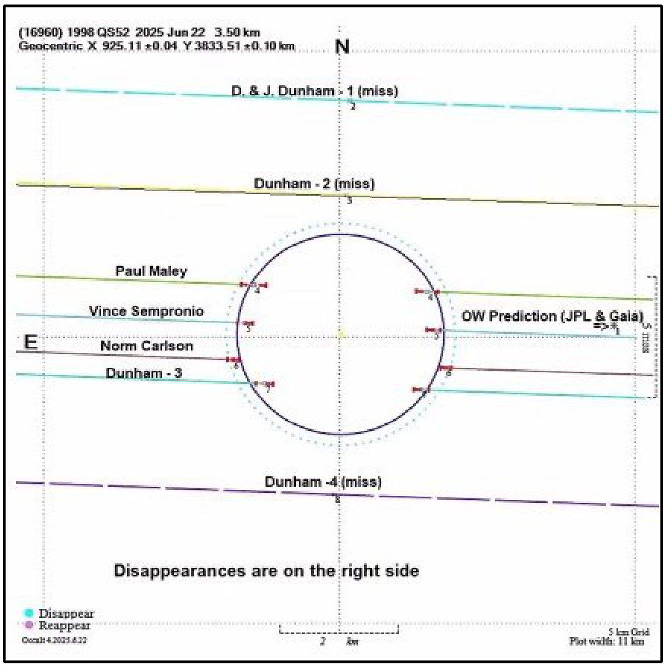

Figure 9. Plot of the observed chords of asteroid (16960) 1998 QS_{52} on 2025 Jun 22. (Occult V4.2025.8.22)

David showed more occultations and their paths:

- 2025 Bright Occultations for the RASC Observer's Handbook
- 2025 NEA Occultations
- 2025 Special Main Belt Asteroidal Occultations
- 2025 Trojan Occultations incl. (617) Menoetius, 2025 Nov 15
- 2026 Lunar Grazing Occultations incl. Regulus on 2026 Feb 5

David finished with RASC Observer's Handbook lists of lunar grazing occultations for 2025. He showed path maps and dates/times for the events.

Jean-François Pittet next talked about several scripts for *SharpCap Pro* to help prepare and observe an event. *SharpCap* does not have star catalogues, rather they are from *SharpSolve* and can be shown by the Deep Sky Animation tool. For UCAC4 stars, the script shows the stars on the live view following a plate solve. The *SharpCap* script uses an external C-compiled software for the star search from the UCAC4 catalog. Jean showed real time views of how this script works.

Script 2 is for QHY174-GPS LED camera calibration. Manual LED calibration can be tedious and has to be repeated after changing settings such as exposure, USB traffic, ROI height and camera's colour space. Jean showed how this script simplifies the calibrations of these cameras. Scripts can be downloaded from the forum *SharpCap* [6].

Script 3 - For occultations and preparation with *Occult Watcher* Addin. For use with OW, select an event and generate an observation file with the Addin. Jean then demonstrated this procedure and how to use it with GOTO telescopes: Target images can be captured automatically or manually. The script allows setting up an observation hours in advance (assuming a good polar alignment) to start and stop the recording of an occultation. Following the capture, saved information is the start/end time of the observation, exposure time and even weather conditions. Jean showed an example event he observed using the scripts for (468861) $2013LU_{28}$ observed on 2025 January 30.

Bob Anderson presented a new analysis software for Fresnel diffraction fitting for light curves. This new tool is a joint project with Dave Herald currently being developed. He programmed it with *Slint*. *Slint* is an open-source, declarative graphical user interface (GUI) toolkit primarily written in Rust. It allows the user to draw the asteroid and light curve to generate a shadow of the sky plane view. The shadow light curve includes: Fresnel diffraction (always present), graze angle, star diameter, magnitude drop, camera exposure and asteroid shadow speed. Bob demonstrated how the program works using a point source star and a small asteroid. Bob showed several examples: An observation path in the centre of the asteroid shadow showing Fresnel diffraction showing nearly equal vertical height on both sides of the light curve, a graze situation with the resultant light curve, and the light curve with a finite size star (Figure 10).

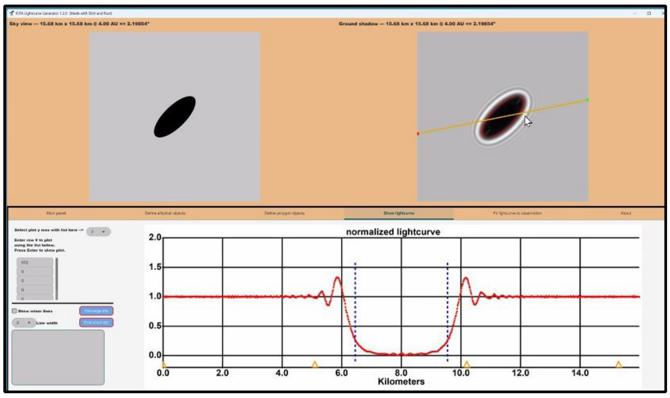

Figure 10. Screenshot of the analysis software for Fresnel diffraction fitting for light curves by Bob Anderson.

Dave Herald continued the presentation with this new software showing several example light curves from real observations. Using this tool requires some experimentation with the shadow/asteroid size parameters for fitting to light curves. Dave demonstrated the rather tedious process of filling out the form for creating the shadow and matching the light curve. This was from 2 chords for the asteroid (9203) Myrtus and its satellite from an observation on 2025 Feb 22 from Japan. Dave is curently writing documentation for this program.

Dave next talked about double star occultations. This talk was dedicated to Brian and Pauline Loader, both who have very recently passed. Historically, Brian Loader handled double star discoveries from both lunar and asteroid occultations. Double star discoveries from occultations are usually published in the Journal of Double Star Observations (JDSO). There were 3 double star discoveries in 2010. By 2024, there were 23 discoveries, and in 2025 to date 17 discoveries. In 2025 through July there have been 26 single-component discoveries. In order for double star discoveries to be included in the published Washington Double Star Catalog (WDS), Brian Mason of the USNO needs at least a minimum separation. For inclusion in the WDS, the double star discovery must be published in a journal, preferably the JDSO which is one of several journals monitored by the USNO.

A recent single component observation has been matched to a known double star component. This observation of TYC 2453-01773-1 was made by Steve Messner on 2024 Feb 21 with the separation determined as > 3.3 mas. From the separation history of this double star, a question arises: Is the orbit of this system highly eccentric? The separation has varied from 0.522″ in 1982 to 0.070″ in 1994 to 0.276 in 2008. Such varying separations could mean a nearly edge-on viewed orbit of a binary star (position angles staying constant) or a highly eccentric orbit viewed face on.

Dave showed a light curve of a recent observation currently being investigated which appears to be a discovery of a triple star. Dave then presented the best-observed world-wide asteroid occultations since last year. Dave showed the number of events by asteroid size and chords from the various IOTA regions. Europe and N. America have the most observations approaching 1,000 for each region. The numbers show that 77% of all observations are single chord events. For 2024 there are 2032 single chord events, 496 with two or three chords, 79 with four up to nine chords and only four events with more than ten chords.

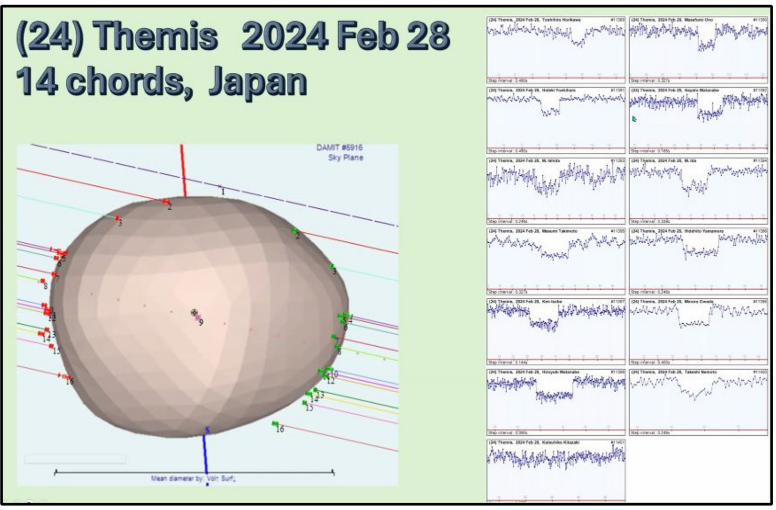

Figure 11. Lightcurves and cords of the occultation by (24) Themis on 2024 February 28. (Screenshot from D. Herald's presentation)

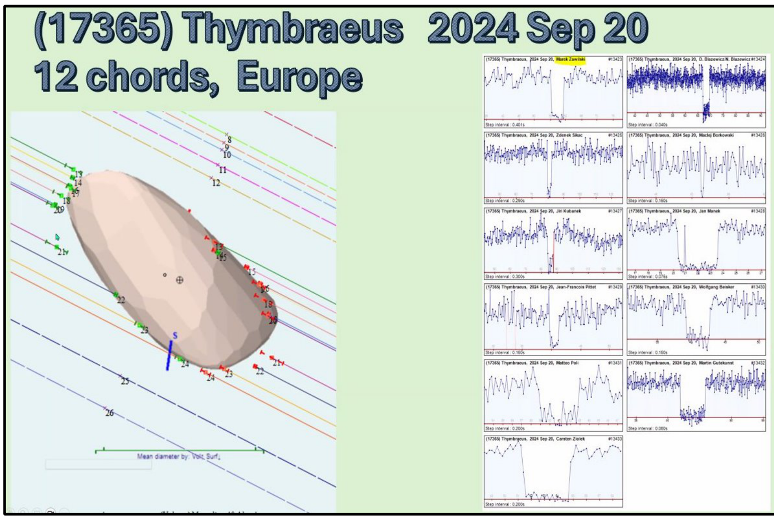

Figure 12. Lightcurves and chords of the occultation by (17365) Thymbraeus on 2024 September 20. (Screenshot from D. Herald's presentation)

The total # of events since 2000 from all regions = 13,889. The huge increase of observed events recently is largely due to *Gaia*'s accurate positions of asteroids which in turn allows highly accurate updated orbits. Satellite discoveries are on the rise also. In 2024: 3 discoveries, 2025 (to date): 7 discoveries and pending: 4 discoveries. Dave showed several selected events from 2024 with multi-chords, e.g. (24) Themis on 2024 February 28, observed in Japan (Figure 11) and (17365) Thymbraeus on 2024 September 20 across Europe (Figure 12).

Several questions were asked about light curve specifics. A question was asked if observers' names who discover double stars are included in the catalog lists. Dave said they are and showed an example. In the WDS catalog, double stars have a 1-line entry. One column of these entries is a 3-letter designation shown for the discoverer. These are discoverers that have made anywhere from one to thousands of double star discoveries in their lifetimes.

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Anthony "Tony" Joseph George Jr.

1947 – 2025

Tony George.

Anthony "Tony" Joseph George Jr. died on 2025 October 2 at home in Scottsdale, Arizona, after a courageous nine-month battle with glioblastoma, an aggressive form of brain cancer.

Tony was born on 1947 January 2 in San José, California. He spent his early years in Campbell, California, before moving to a family farm in Cheshire, Oregon, at age 13.

Tony initially studied architecture at University of Oregon before transferring to Oregon State University, where he graduated with a bachelor's degree in Civil Engineering in 1971. He went on to become licensed in Oregon as a Civil and Acoustical Engineer in 1979.

A passionate outdoors-man, Tony explored the mountains and forests of the Pacific Northwest with joy — rain or shine, hot or cold. One of Tony's signature conservation efforts spanned 20 years as he advocated for protection of what came to be known as the Opal Creek Wilderness and Scenic Recreation Area. His knowledge of the mountains, charismatic charm and strategic thinking became critically important to the successful protection of the 20,000-acre region. For generations to come, hikers and explorers will remember Tony, applauding his work to preserve this special place.

After retiring from Oregon Department of Transportation (ODOT), he went on to teach astronomy for about 10 years at Columbia Basin Community College in Pasco, Washington. He also travelled the globe to witness seven eclipses: Oregon (1979), Mazatlán (1990), Libya (2006), China (2008), Tahiti (2010), Oregon (2017) and Texas (2024).

With his friend Bob Anderson, Tony helped design several software programs that allow International Occultation Timing Association (IOTA) observers to analyse and understand their recordings of occultations. Knowledge gained from these events helps characterise the size, shape and orbit of the asteroids — information that gives insight into the history of the solar system that could not otherwise be obtained without the huge expense of a space mission.

Anderson recalls: "In 2007 Tony and I traveled to Florida to view the launch of space shuttle STS-117. On the way, I was exposed to his 'Tom Sawyer' approach to leadership. During the long plane trip, Tony described the difficulties of processing videos he and others had taken through a telescope of an asteroid passing in front of a star. When such an event occurs, the star 'blinks,' and the start and stop time of that blink are important data for determining asteroid orbits. But such recordings are notoriously noisy, and determining good start and stop times for the blink was problematic, and there was no software package available to do that specialised task. I mentioned to Tony that I had been exposed to methods used in extracting signals from noise in one of my classes and that maybe I could help or advise. Tony said, that's great, let me know when you have the program done and I'll help test it. And so, I picked up my brush and started to paint the fence that Tony had just placed before me."

Tony observed hundreds of occultations, many from home and some after travelling thousands of miles to "chase the shadow" of an asteroid. During one trip to Kansas, he was fortunate to make a recording that resulted in the discovery of a small "moon" or satellite of an asteroid — one of the few discovered by this technique.

I want to add, that Tony was not only a wonderful friend and fellow observer, but also a patient mentor. He used his teaching skills — honed over many years of teaching college astronomy courses — to share his knowledge and techniques with observers all over the world so that we could independently obtain results that met his own high standards.

Tony received IOTA's distinguished 2023 *Homer F. DaBoll Award* in recognition of his lifetime support of the occultation community in reviewing observations, helping with difficult analyses and always being available to answer questions from newbies and experienced observers alike. Asteroid (10194) Tonygeorge is named in his honour and will always be in the sky, keeping his memory and name alive.

Ted Blank
IOTA

Robert Lawrence Sandy 1939 – 2025

I enjoyed working with Bob since I met him in 1964; we collaborated on building up the world-wide network of grazing occultation observers in those early years to form what would become the International Occultation Timing Association 11 years later.

I was glad that we travelled to Missouri last April, to observe with Bob one last time in a practice session at a reservoir parking lot a few km from his home, his favourite observing location. It was the night before an occultation of a 10th-mag. star by (319) Leona. Bob did not observe because a friend of his died the next day, before the occultation. The friend had no relatives or other friends in the Kansas City area, so Bob selflessly helped take care of things for the friend's family in Maine.

Bob not only organised over 150 lunar grazing occultation expeditions, he also manually drew reduction profiles of the observations using Watts charts. He prepared these for several expeditions conducted by others around the world, in addition to those that he led. Many of these are posted on Bob Sandy's Web page set up by Walter Robinson [1]; also there is a good biography that Bob wrote around 1996. Bob timed over 2,000 total lunar occultations. He observed his first asteroidal occultation (visually) in 1995, and 6 more with video.

In addition to his occultation work, Bob also was a good astrophotographer. His striking image of Venus and the crescent Moon taken shortly after the planet reappeared during an occultation on 1978 December 26 was adopted as part of the logo of the large Astronomical Society of Kansas City and was used on their club t-shirt that Bob wore when he was presented the *David E. Laird Award.*

The Moon and Venus on 1978 December 26. (Bob Sandy)

Robert Lawrence Sandy in 2015 with graze profiles in the background.

Other good photos include the Moon in the Pleiades in August 1969, and the total solar eclipse from Acadia National Park in Maine in 1963 July 20; some of these will be posted on his web page.

For his sustained efforts to promote, observe, and analyse occultations, he was presented with IOTA's *David E. Laird Award* in 2015. Asteroid (128027) Bobsandy was named for him in mid 2025 by John Broughton.

Logo of the Astronomical Society of Kansas City.

During 2024 and early this year, Bob double-checked his observations in the *Occult4* databases, uncovering some errors that have been corrected. During the first half of this year, Bob cleaned up years of his occultation records, discarding many of the paper records after he verified the events were in the *Occult* archives. He organised the graze reduction profiles and some of his other records and deposited them in Kansas City's famous Linda Hall Library, where Bob had often consulted U. S. Geological Survey maps for his early grazing occultation efforts. Bob was depressed by this work and suffered a mental breakdown in June. During his last months, his daughter, Karen Reid, took care of Bob at her home much of the time, and prepared Bob's memorial page, including several pictures and testimonials, some from IOTA observers [2].

Bob, we enjoyed your work with occultations over the years, and your many jokes, often corny but always funny and never off-colour; R.I.P.

David Dunham
IOTA

[1] http://www.lunar-occultations.com/bobgraze/index.html
[2] https://www.dignitymemorial.com/obituaries/kansas-city-mo/robert-sandy-12553245

Journal for
Occultation
Astronomy

IOTA's Mission

The International Occultation Timing Association, Inc was established to encourage and facilitate the observation of occultations and eclipses It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made.

The Journal for Occultation Astronomy (JOA) is published on behalf of IOTA, IOTA/ES and RASNZ and for the worldwide occultation astronomy community.

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IOTA maintains the following web sites for your information and rapid notification of events:

www.occultations.org
www.iota-es.de
www.occultations.org.nz

These sites contain information about the organisation known as IOTA and provide information about joining.

The main page of occultations.org provides links to IOTA's major technical sites, as well as to the major IOTA sections, including those in Europe, East Asia, Middle East, Australia/New Zealand, and South America.

The technical sites hold definitions and information about all issues of occultation methods. It contains also results for all different phenomena. Occultations by the Moon, by planets, asteroids and TNOs are presented. Solar eclipses as a special kind of occultation can be found there as well results of other timely phenomena such as mutual events of satellites and lunar meteor impact flashes.

IOTA and IOTA/ES have an on-line archive of all issues of Occultation Newsletter, IOTA'S predecessor to JOA.

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