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ASE2023 - Baily's Beads and the Solar Radius

Dear reader,

One of the differences between paid and unpaid astronomers is the fact that unpaid astronomers decide for themselves when and what they observe. But when observations are made, the unpaid astronomers should have the entitlement to analyse and publish their observations quickly and correctly. Sometimes this duty is a nuisance. Perhaps the measured values are not so clear after all or the evaluation programmes used are complex and sometimes difficult to use.

The time you spend at the telescope is often more enjoyable than the time you spend at the computer. Nevertheless, the thorough and prompt evaluation is a moral duty. Other observers who have observed the same event want to know what their colleagues have measured. The observations should be available to all astronomers via the world's databases. In our fast-paced world, we should not take much time with this. The fact remains:

Only an observed occultation is a 'good' occultation. Only an analysed observation is a completed observation and only a reported analysis is the end of the work.

Please report quickly and correctly to our reviewer and reduction teams.

Konrad Guhl
President IOTA/ES

COVER

The image on the cover shows a single frame of a high-resolution video file recorded by Jörg Schoppmeyer during the annular solar eclipse on 2023 October 14th south of Durango, Colorado, USA. He used a Baader Travel Companion 95/560 with a Baader Herschel-prism without any additional filtering. The video file was recorded in 4K at 1/4000 s, ISO 100 with a Canon EOS 250D. The full video can be watched on YouTube.

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In this Issue:

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

ASE2023: Eclipse Solar Radius Estimation from a High-Quality Video Recording

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ABSTRACT: A high-resolution, unfiltered, white-light video of the 2023 October 14th annular eclipse (ASE2023), collected very close to the eclipse's northern antumbral path limit, was analysed using the Baily's beads matching method to obtain an estimate of the eclipse solar radius $S_\odot$. By applying the novel idea of the "pivot point" effect and supplementing the analysis by revisiting data collected at the edge of the 2017 February 26th annular eclipse (ASE2017), the following bounds were obtained: 959.90″ ≤ $S_\odot$ ≤ 960.00″ at 1 au.

Introduction

A white-light video of ASE2023 was recorded by one of the authors (J. S.) from a site very close to the shadow's northern path limit in the vicinity of Durango, Colorado, USA. The video documents a very dynamic display of Baily's beads over several minutes and it shows prominences, long chromospheric arcs and tantalising hints of the inner corona. The video lacks time-stamping but its high quality enabled us to analyse the evolving Baily's beads configuration against simulations based on robust eclipse computations, leading to a successful estimate of bounds on the eclipse solar radius.

Observation Site

Figure 1 shows the location of the observing site with respect to the northern limit computed by accounting for the topography of the lunar limb and using different values of the solar radius. $S_\odot$=959.63″ is the "standard" value measured by Auwers [1] in the late 19th century and still used nowadays for eclipse predictions by NASA [2], USNO [3] and IMCCE [4]. $S_\odot$=959.85″, 959.95″ and 960.05″ are representative of the range of eclipse solar radii measured in the last decade with a variety of techniques [5, 6, 7, 8], mainly during total and annular-total eclipses.

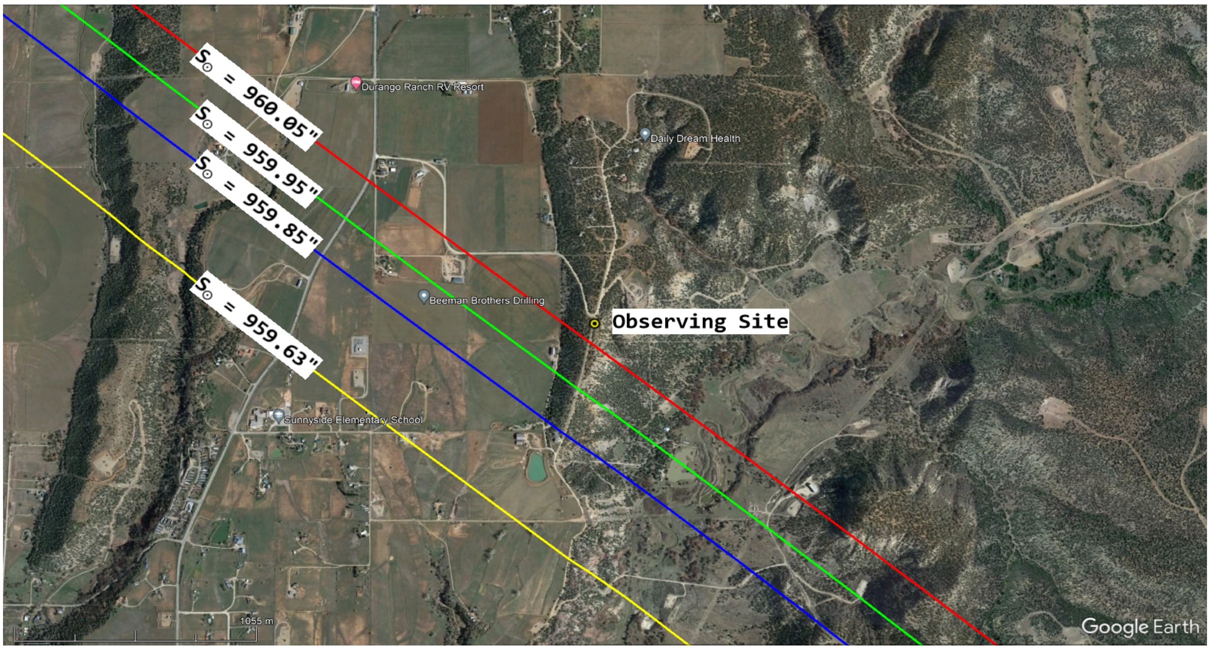


Figure 1. Observing location in relation to the true-limb northern limits computed for $S_\odot$=959.63″ (the standard solar radius) and for a range of more likely values: $S_\odot$=959.85″, 959.95″ and 960.05″. All limit lines account for the elevation, both on the lunar limb and on the Earth's surface. (Map: Google Earth)

The WGS84 geodetic coordinates of the observation site were:

ASE2023	λ	β	h
Observing Site	107° 50′ 50.22″ W	37° 07′ 35.20″ N	1995 m

The inadequacy of the standard solar radius to reproduce observations can be revealed by simply timing, even approximately, the duration of totality as seen from locations very close (0.5 km or less) to the edges of a total eclipse path [8]. Such observations show that photospheric extinction lasts substantially, and detectably, less than durations predicted using the standard solar radius. Nevertheless, determining a precise and reliable value for the eclipse solar radius has been a far more complex task.

Observations

The video recording can be viewed at the following link:

20231014 Annular solar eclipse near the northern limit without solar filter (YouTube)

The video displays in great detail a long-lasting and evolving configuration of Baily's beads, a hallmark of how close to the northern limit the observation site was located. A large prominence can be seen as well as possible hints of the corona. The fact that the video is unfiltered is a key requirement in the measurement of the eclipse solar radius as no light is lost to a solar filter.

The video was recorded using a Baader Travel Companion 95/560 telescope and a Canon EOS 250D camera. The telescope is a genuine fluorite apochromatic instrument with a compact mechanical design, and it is one of the best travel telescopes available on the market. The camera has a great advantage – for 4K videos (3840 x 2160 pixels) only the inner area of the chip (6000 x 4000 pixels) is used, so there are no pixel conversions, and the crop factor is 2.5. This is ideal for the Sun and Moon in combination with the 560 mm focal length; a teleconverter or a Barlow lens is not required. A further advantage of this set-up is that filming takes place directly on the optical axis and therefore no image flattener is required. As a result, there are no internal reflections, and the image sharpness and contrast are unrivalled.

The potential of this optical and camera set-up can be seen in the evident sharpness and high resolution of the following 4K video of the 2023 April 20th annular-total solar eclipse captured by the same author (J.S.) in Exmouth, Western Australia:

2023.04.20 Total solar eclipse in Exmouth, Australia : 4K telescope video (YouTube)

According to several astro-imagers and seasoned eclipse chasers, this is considered one of the best videos of totality ever taken.

Since at least the 1990's there have been images of annularity taken without solar filters, but the lenses were then usually heavily stopped down. For ASE2023, the observer wanted to do something completely new – to record a 4K video without solar filter at full lens aperture. To achieve the goal of reducing the light intensity without using a solar filter, the idea of using a Herschel wedge emerged. A side benefit of using a Herschel wedge is that the relative intensity of the various spectral components of solar light is unchanged. The sharpness and high resolution of the recorded video is a testament to the success of this idea. Perhaps this experimental set-up will become the de facto standard for observing annular eclipses at the edge of the shadow path, enabling observers to gain much higher resolution data than in the past.

Method: Baily's Beads Matching

Due to the absence of time-stamping, the method used to analyse the video and estimate the eclipse solar radius was to simply match recorded Baily's beads configurations with graphical simulations.

This Baily's beads matching technique has been used, amongst others, by Xavier Jubier to study historical images of beaded eclipses occurring during the 20th century (see [9] for an example of the analysis). The technique, even if it is rather intuitive, presents several challenges. The observing location and timing of the images might not be known, and this will introduce uncertainties, possibly large ones. In the case of the ASE2023 video, the position of the observation site was accurately known but not the timing of the images. Moreover, the nature of the light visible in every image is complex and needs to be assessed carefully. The use of a solar filter and the chosen exposure setting can alter what is visible in the images quite dramatically. Our video has the advantage of being unfiltered and well exposed, lessening but not completely eliminating some of these concerns. Baily's beads simulations need to be as precise as possible to reduce the uncertainties.

Nature of the Light Sources in the Video

To study the video, we need to assess the nature of the light sources visible in it. The video shows light coming from the photosphere, the mesosphere, the chromosphere and possibly from the inner corona, albeit very faintly. The mesosphere is the lowermost layer in the solar atmosphere extending approximately up to 500 km above the photosphere. The mid- and higher-chromosphere stretches to approximately 12000 km above the photosphere [10]. Prominences can occasionally swirl much higher than that. A couple of very delicate ones can be seen in the video. The light emitted by the photosphere is of a different nature than the light from the solar atmosphere. The photosphere emits a continuum of light over a very broad range of wavelengths encompassing the visible spectrum. The mesosphere emits a discrete spectrum of light constituting a forest of mainly faint lines, but with some intense ones in between.

Hydrogen, helium, magnesium and sodium emit intense lines, while iron and a host of other elements emit the forest of faint lines. In the mid-chromosphere only the intense emission lines from hydrogen, helium, magnesium and sodium predominate. Higher than ~3000 km above the photosphere, only the hydrogen and helium lines remain visible – helium lines up to ~8000 km and hydrogen lines up to ~12000 km.

The photosphere appears essentially white and shines intensely. The mesosphere also appears white but it shines far less intensely. The mid- and higher-chromosphere emits a fainter glow. Prominences can tower well above the chromosphere and they will appear diffuse and faint. Figure 2 shows how these different sources contribute to the eclipse light seen in one frame of the video. Mid- and higher-chromosphere and prominences are quite easy to separate from the rest. The light from the mesosphere is often rather difficult to distinguish from the photosphere but some guidance comes from comparing its intensity and apparent thickness with its immediate surroundings.

Computation of the Solar-Lunar Limb Dynamics

The topography of the lunar surface creates the complex lunar limb profile of mountains and valleys that is responsible for the prolonged display of Baily's beads and the highly dynamic activity that is visible in the video. Key to the analysis of the video is the ability to simulate these dynamics in the most accurate way possible.

One of the authors (J. I.) has developed a very detailed and precise eclipse computational model. The model relies on the latest ephemerides and accounts in a very precise way for all the complexity of the lunar topography and the orientation of the celestial and terrestrial reference systems via robust algorithms and procedures. Details of the model can be found in [6].

The model produces a detailed lunar limb profile computed from the topocentric perspective of the observer, together with

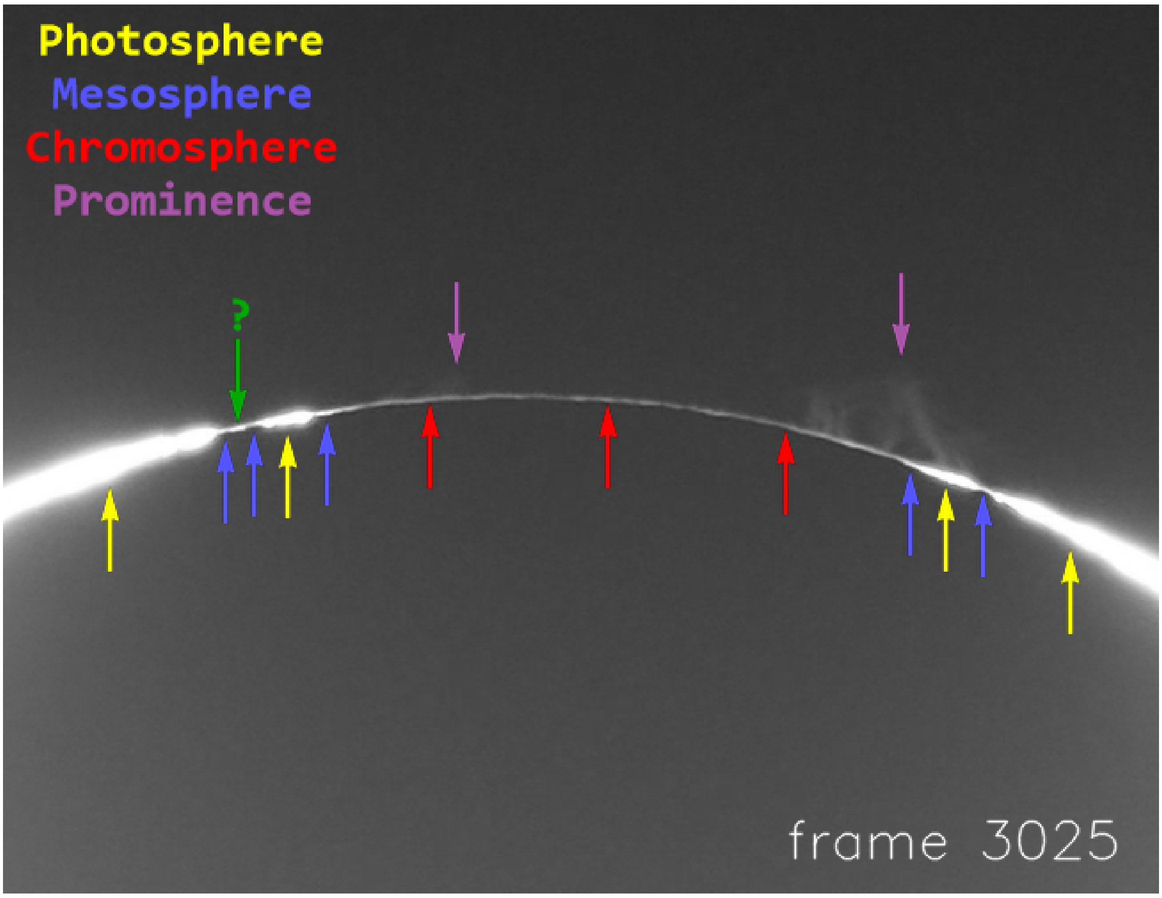


Figure 2. An example frame from the video indicating the appearance of photospheric, mesospheric and chromospheric light. The photosphere is very intense and tends to "bloom" due to overexposure. The mesosphere appears brilliant but somewhat subdued compared to the photosphere. The chromosphere is usually much fainter. The green arrow indicates light of uncertain source – the light is definitely of mesospheric origin, but it cannot be conclusively ruled out that it might contain traces of photosphere in the form of a very small Baily's bead.

polynomials describing how the Sun moves with respect to the Moon and how the topocentric solar and lunar semidiameters vary with time. The lunar limb profile is shown in Figure 3 and the polynomials coefficients are given in Table 1.

The coordinates of the Sun's centre are expressed in a Cartesian reference system with the origin at the centre of the Moon and with the *y*-axis pointing in the direction of the Moon's north pole projected on to the observer's plane-of-sky. The solar semidiameter corresponds to an eclipse solar radius S⊙=959.95″ at 1 au, while the lunar semidiameter corresponds to a radius of 1738.091 km.

Changing the eclipse solar radius is achieved by scaling the solar semidiameter polynomial by a factor of S⊙/959.95″. The reference time T_0 for the polynomials is 2023 Oct 14th 16:34:10 UTC and the polynomial variable t = (T – T_0) is expressed in minutes. The polynomials are valid over the interval t = ±2 minutes.

Comparing Video Frames and Simulations

The video does not come with time-stamping, so comparing video frames with simulations is initially a little tricky. The approximate UTC timing of the frames was nevertheless recovered by trying to match details in the Baily's beads in a series of 6 frames separated by 20 s and then attempting to get an approximate agreement between the observed beading and the simulation over a reasonably wide time span.

(arcsec)	t^0	t^1	t^2	t^3
SSD	962.353464	0.000278150	-2.443328 10^{-7}	-2.757316 10^{-10}
MSD	910.792324	0.033064676	-8.492474 10^{-5}	-9.481430 10^{-8}
SCX	-18.700870	20.068860792	-1.415462 10^{-2}	2.445535 10^{-5}
SCY	47.386622	7.870597786	2.752270 10^{-3}	-1.412925 10^{-5}

Table 1. Coefficients of the third-degree polynomials describing the temporal variation of the topocentric solar and lunar semidiameters (SSD & MSD) and the x- and y-coordinates of the centre of the Sun with respect to the centre of the Moon (SCX & SCY). Time t is expressed in minutes from the reference time T_0 = 2023 Oct 14th 16:34:10 UTC.

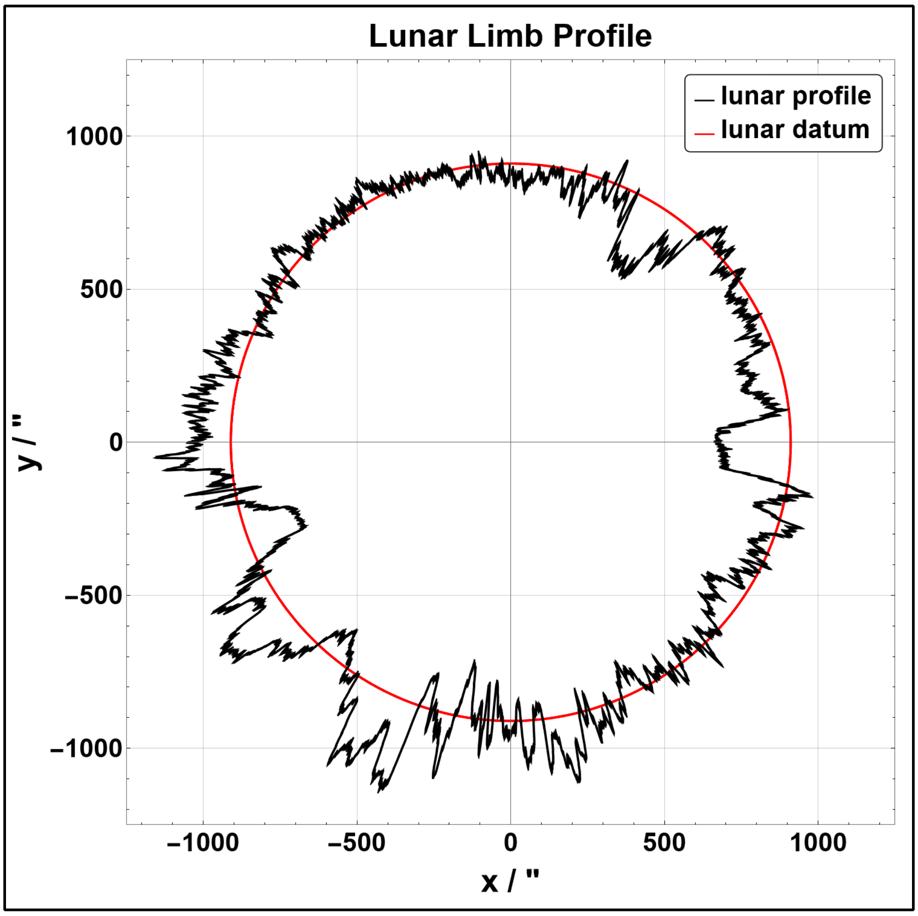


Figure 3. Plot of the topography of the lunar limb as seen from the observation site. In red is the reference lunar datum. To emphasise the changing elevation, the deviation between the limb and the lunar datum is magnified by a factor of 100. For topocentric libration: L = -3.1071°, B = -0.1226°, R = 393622.299 km, and a profile resolution of 0.02°.

From this approximately recovered timing, Figures 4, 5a, and 5b show side-by-side comparisons of video frames and simulations. The simulations show the lunar limb and a series of lines related to the solar limb. The solar limb corresponding to $S_\odot$=959.95″ is depicted in red, very closely surrounded by two blue lines corresponding to 959.85″ (lower one) and 960.05″ (upper one). These lines allow us to assess the impact of changing the eclipse solar radius on the Baily's beads simulations.

Two other lines are also depicted in green and orange. The green line lies 500 km above the edge of the photosphere while the orange line is 3000 km above the edge (computed with $S_\odot$=959.95″). These two lines provide some guidance on where the mesosphere and where the mid-chromosphere end.

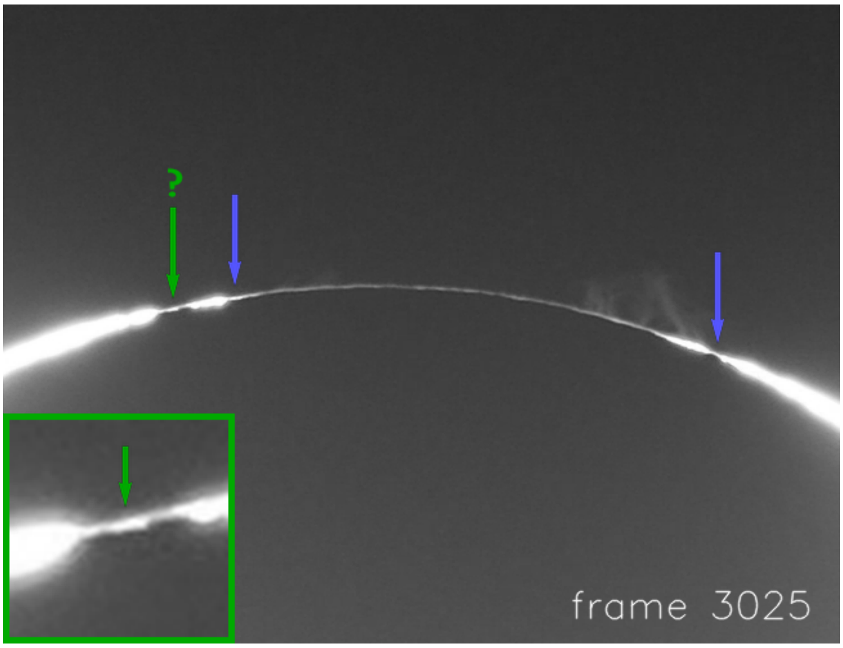
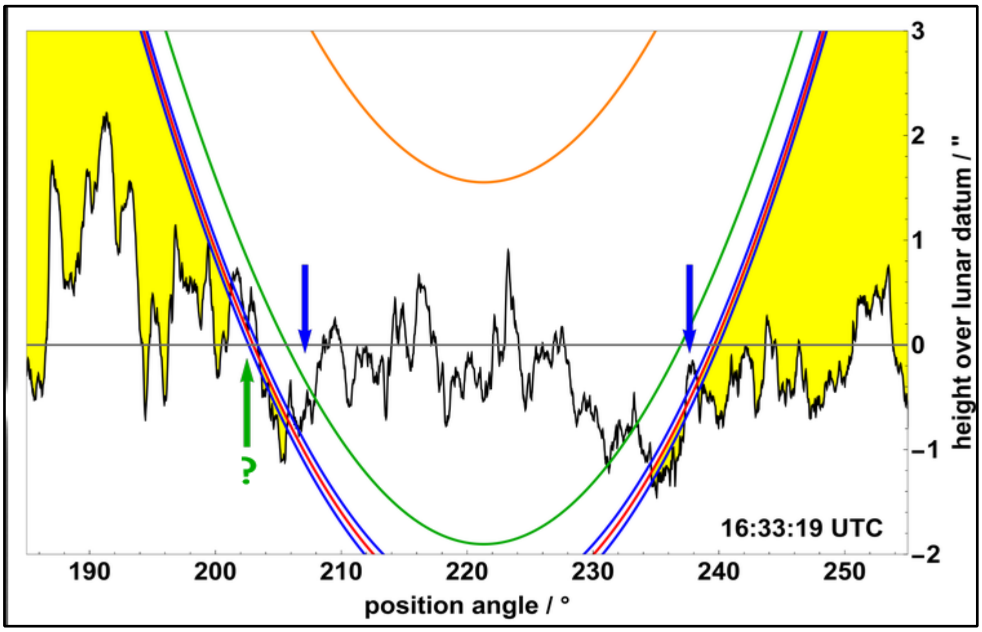


Figure 4. Comparison between a video frame (top, same as Figure 2) and simulations (below). See text for explanations on the meaning of the lines in the simulation pane.



We can now revisit the light source attributions in Figure 2. Figure 4 shows the same video frame alongside the corresponding simulation. The blue arrows indicate examples of light coming from the mesosphere. How can we be certain that the light is of mesospheric origin and not photospheric? If we examine the simulation, we will notice that for all three values of the eclipse solar radius, at the location of the blue arrows, the limb of the photosphere is below the lunar limb, so the photosphere is totally occulted, even if barely, by the Moon. But the mesosphere, the approximate upper edge of which is indicated by the green outline in the simulation, is entirely uncovered at those locations, generating the light we see in the frame. If we now investigate the location indicated by the green arrow (the one of uncertain attribution), we realise that the limb of the photosphere is tangential to the bottom of a lunar valley if $S_\odot$=959.95″, just below it if $S_\odot$=959.85″, and just above it if $S_\odot$=960.05″. There will definitely be mesospheric light at that location but, in the first two cases, there should be no photospheric light visible, and in the third case there should be an incredibly small Baily's bead present. There does not seem to be a small bead of brighter light in the midst of the more subdued mesospheric light, but the case is far too close to be certain.

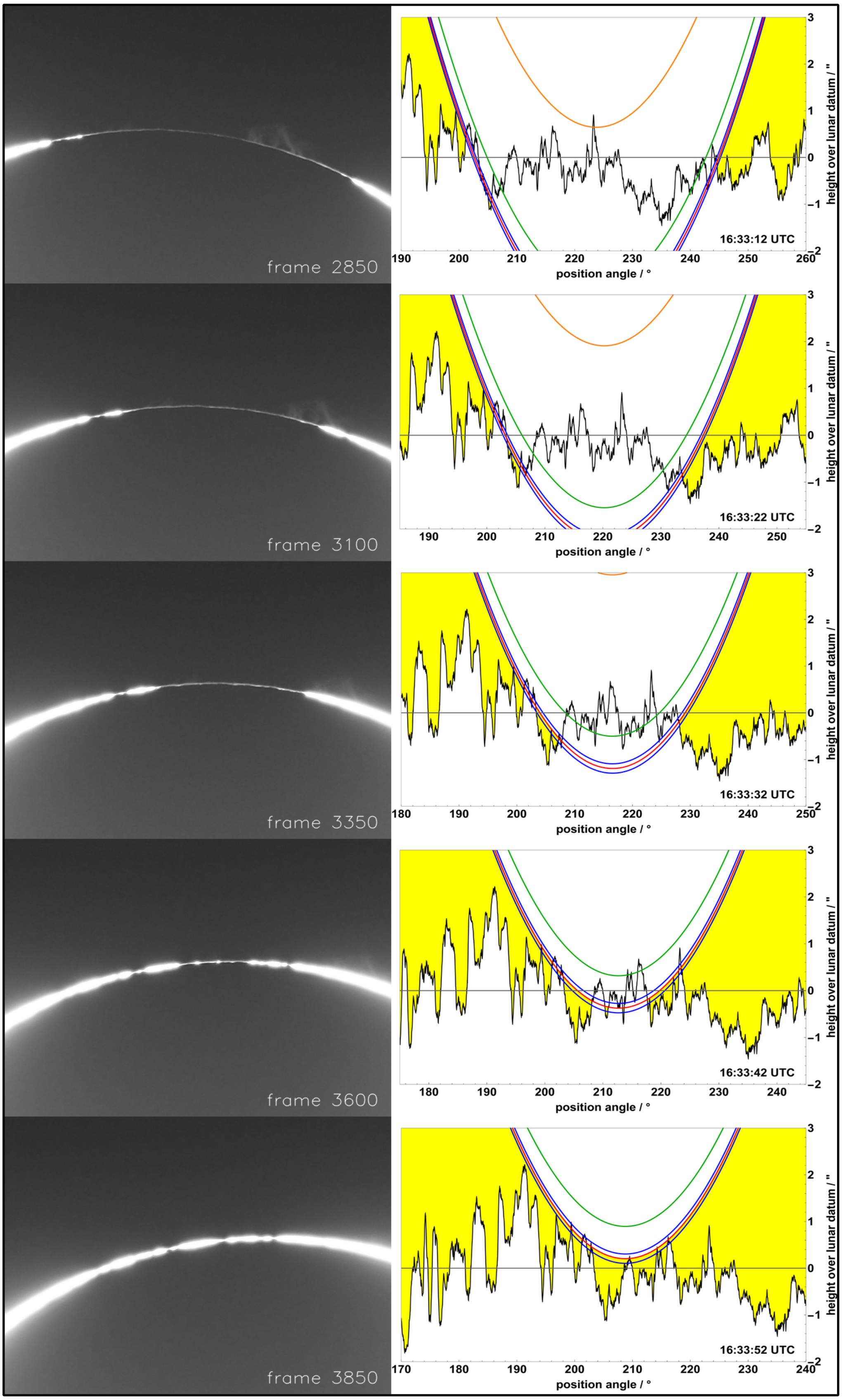


Figure 5a. Comparison between a series of video frames and simulations. See text for explanations on the meaning of the lines in the simulation pane.

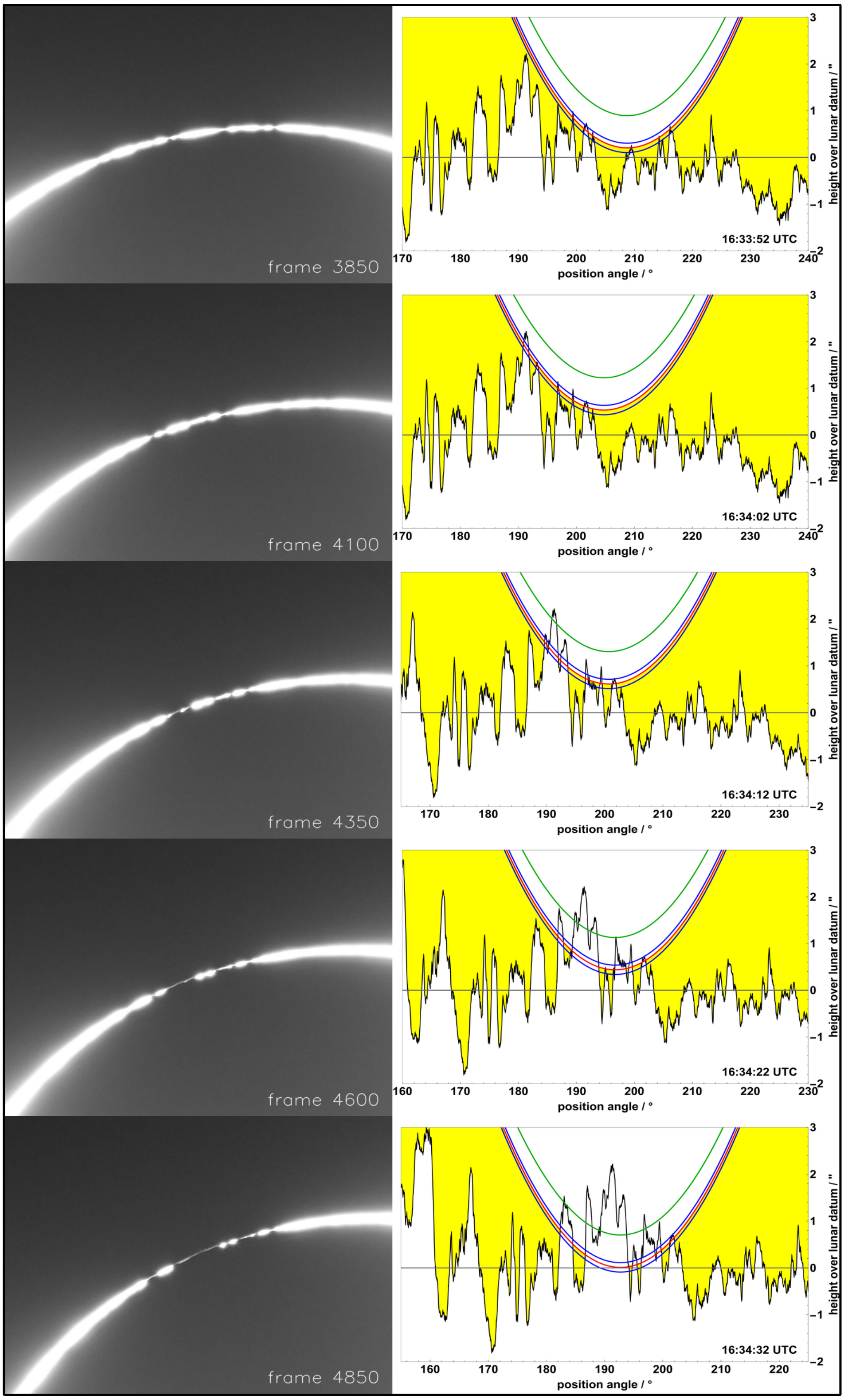


Figure 5b. Comparison between a series of video frames and simulations. See text for explanations on the meaning of the lines in the simulation pane.

A series of examples of Baily's beads matching is presented in Figures 5a and 5b. Given the observations on the nature of the light visible in the images and the reference lines in the simulations, the reader can try to make a judgement on the estimated value of the eclipse solar radius. An initial simple consideration is to determine, by carefully watching the video, if pure annularity was ever seen from the observation site. Our assessment suggests not. This sets an upper bound on the eclipse solar radius of S⊙≤ 960.09″ (the radius required for the true-limb path limit to pass through the observation site). Determining a more accurate value, by trying to match images and a Baily's beads simulation, is a far more complex task. It is admittedly a qualitative judgement by looking at the finer details of the Baily's beads configurations captured in the video, but it seems that S⊙=959.85″ is a bit too small and S⊙=960.05″ is a bit too large to reproduce the appearance of the faintest beads. We have carefully studied far more video frames than the ones depicted in Figures 5a and 5b and conclude that 959.85″ ≤ S⊙ ≤ 960.05″.

The Pivot Point: A Novel Variation of Baily's Beads Matching

We can potentially narrow the bounds on the eclipse solar radius estimate by looking at what we have called the "pivot point". If we look at simulations of the relative position of the solar and lunar limbs in the interval between T_0 – 20 s and T_0 + 20 s (as shown in Figures 6 and 7 for two values of the eclipse solar radius) we notice that there is one point where all solar limbs come together. As the limbs move, the distance of this pivot point from the lunar limb remains constant over the whole duration of the chosen time span.

The video is not time-stamped and the absolute timing of the video frames was only recovered approximately ex post facto. Because the position of the pivot point with respect to the lunar limb remains unchanged through time, the pivot point is largely insensitive to inaccuracies in the time-stamping. The appearance of Baily's beads in the vicinity of the pivot point will remain largely unchanged for tens of seconds.

Close examination of Figures 6 and 7 will show that the pivot point is almost exactly at the top of a lunar peak for S⊙=960.05″ and about 0.1-0.2″ below it for S⊙=959.95″. In the first case, we would expect to see the photosphere on either side of the lunar peak to basically touch, and possibly to "bloom" on either side of the peak and merge. In the second case, the lunar peak should create a visible break in the photosphere. Remembering that the mesosphere is just above this peak, we should then see a filament of slightly fainter light joining the photosphere on each side of the peak.

Figure 8 shows video frame close-ups over 41 s in the region where the pivot point is located. We distinctly see a filament in all frames. If the filament was of photospheric origin, it would "bloom" like the surrounding photosphere. But this is not the case. We cannot exactly estimate a best estimate for the eclipse solar radius, but the presence of this filament supports a radius closer to 959.95″ than to 960.05″. We can then approximately refine the bounds previously found to 959.85″ ≤ S⊙ ≤ 960.00″.

ASE2017: Revisiting an Earlier Edge Observation

During ASE2017 one of the authors (J.S.) collected a sequence of unfiltered images of the annular eclipse from near Sarmiento, in Argentina. The WGS84 geodetic coordinates of the observation site were:

ASE2017	λ	β	h
Observing Site	69° 01' 29.74" W	45° 28' 15.32" S	284 m

This location was very close to the antumbral shadow's southern limit. The images were recorded using a Canon EOS 650 at a focal length of 400 mm (f6.3 at f-stop 32) and can be viewed at the following link:

2017 Annular Solar Eclipse in Sarmiento Argentina (YouTube)

These images seem to support the fact that the eclipse did briefly become annular. There are at least a couple of frames in the sequence where a complete ring of bright light is visible. Of course, we should always bear in mind that the exposure setting might have overexposed the photosphere, and the consequent "blooming" could have masked tiny gaps that might have broken the apparent full ring of photospheric light.

However, to have the true-limb southern limit pass through the observing location and create zero seconds of annularity, the eclipse solar radius needs to be equal to 959.90″. If we assume that the eclipse was seen as fully annular at the observation site (albeit fleetingly) then we can conclude that S⊙≥ 959.90″.

Other Edge Observations during ASE2023

Several other observations were performed near the northern and southern path limits of ASE2023, which are summarised below.

A group of experienced eclipse chasers congregated near the northern limit at the Vista Grande Overlook Observation Site, north-east of Santa Fe in New Mexico. Amongst them were the eclipse meteorologist Jay Anderson [11] and the eclipse computers Michael Zeiler [12], Xavier Jubier and Ernie Wright. Unfiltered observations taken by several of these eclipse chasers show that the eclipse was never fully annular at this location. Accounting for the lunar topography and the altitude of the observation site, we have determined that an eclipse solar radius of 960.19″ is required for the true-limb northern limit to go through the site and produce a zero-second eclipse. Due to the failure to observe true annularity from there, we can deduce that S⊙≤ 960.19″.

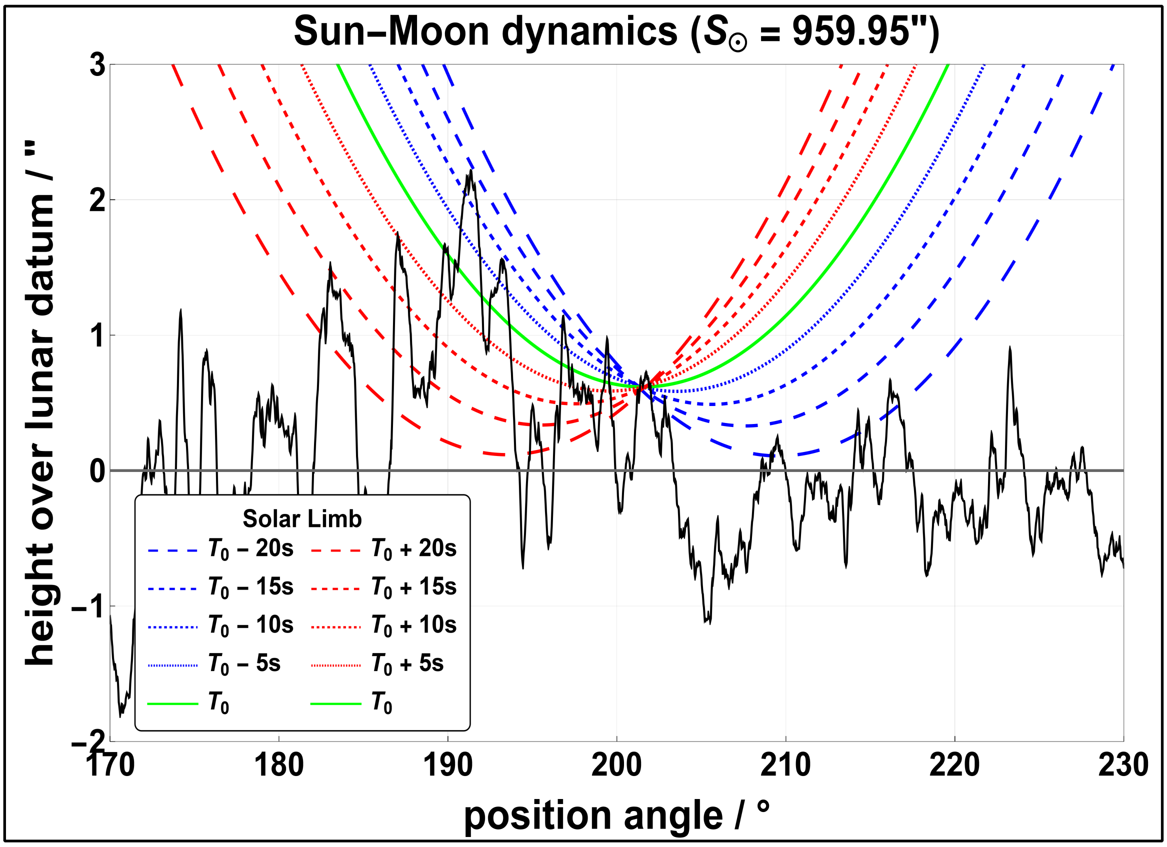


Figure 6. Relative motion of the solar limb with respect to the edge of the Moon for S⊙=959.95".

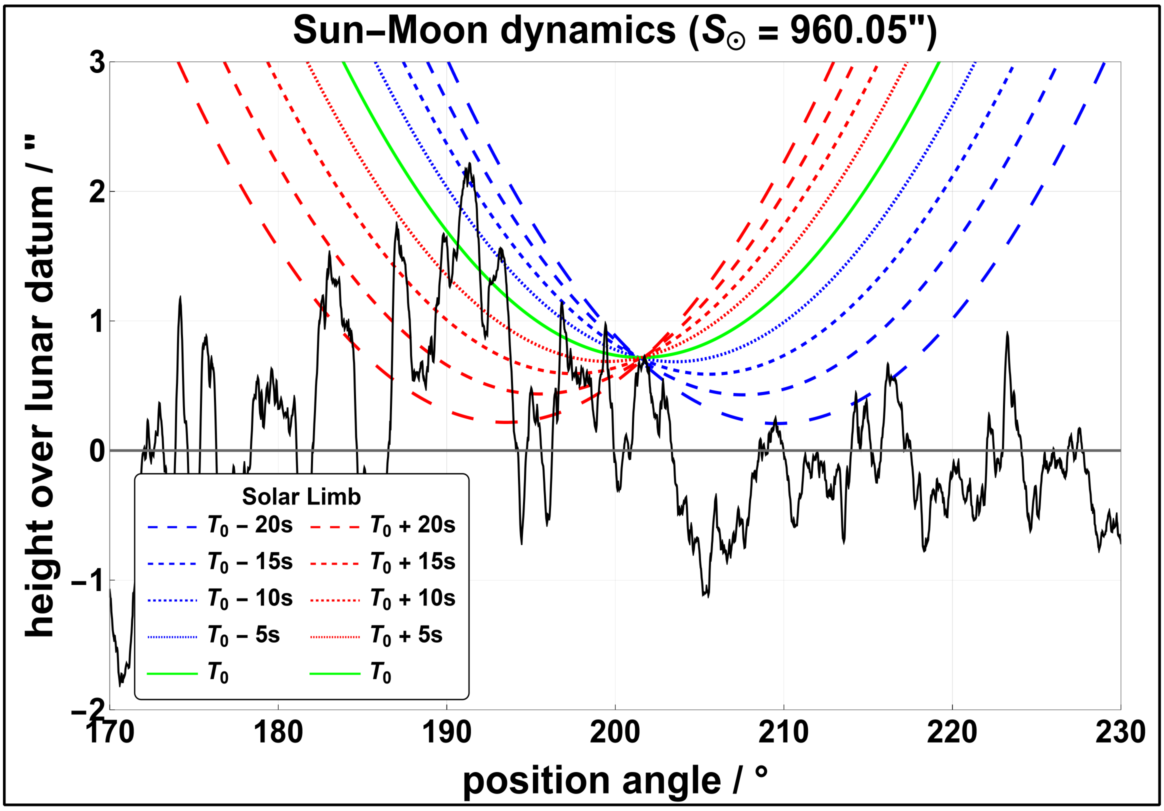


Figure 7. Relative motion of the solar limb with respect to the edge of the Moon for S⊙=960.05".

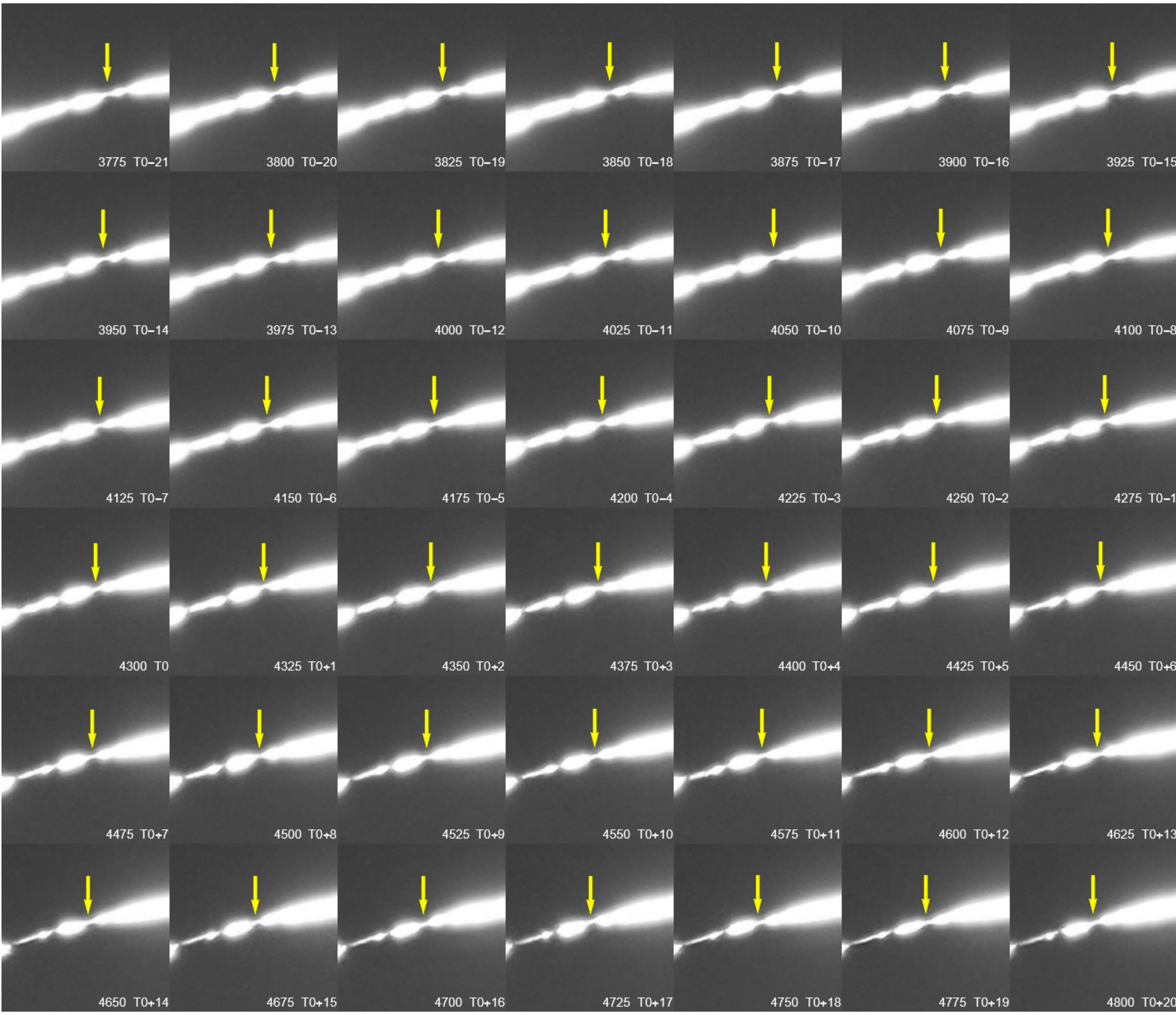


Figure 8. Close-ups every second from 20 s before to 20 s after the reference time T_0 of the region around the pivot point. The arrows point to the persistent filament at the exact location of the pivot point. The configuration of Baily's beads changes around the filament but the filament remains essentially unchanged.

Kirk Wines and others also observed from near the northern limit, north-east of Big Spring, Texas [13]. They collected a filtered video of Baily's beads showing a great deal of activity around the limb of the Moon. Again, the video does not show true annularity, from which we can deduce that $S_\odot \leq 960.26''$ for this site.

Joan and David Dunham observed from the southern limit near the township of Mentmore in New Mexico [14]. They collected a filtered time-stamped video of a very dynamic display of Baily's beads. The observers estimated ~21 s of annularity from the video. We determined that this duration corresponds to an eclipse solar radius $S_\odot=959.92''$, taking into account the site elevation and the topography of the lunar limb.

Another observation near the southern limit was carried out by a team led by Richard Nolthenius at Yahoo Canyon, near the township of Eureka in Nevada [15]. Baily's beads data were collected but we are not aware of any estimated eclipse solar radius that this observation yielded.

Discussion

For over almost 50 years IOTA has been engaged in the recording of time-stamped videos of Baily's beads observed from near the edges of total, annular and annular-total eclipse paths, with the primary aim of estimating the eclipse solar radius [16]. Where possible, efforts were made to observe near both limits of the same eclipse. Historical results show quite a bit of variability and in general smaller estimated values for the eclipse solar radius than in the present and other researches. This is probably due to using different equipment, with different sensitivity and using different exposure levels to record Baily's beads.

In the present work, from a careful analysis of an unfiltered, high-resolution, video of ASE2023, observed from just outside the northern path limit, we have estimated bounds on the eclipse solar radius to be 959.85″ ≤ $S_\odot$ ≤ 960.00″. Also, by revisiting observations collected from near the ASE2017 southern path limit, we have estimated a (likely) bound on the eclipse solar radius of $S_\odot$ ≥ 959.90″. Combining these bounds, we obtain an overall estimate of 959.90″ ≤ $S_\odot$ ≤ 960.00″.

It is instructive to compare this result with estimates obtained from other, more recent, eclipse observations. We highlight the following measurements:

• $S_\odot$ = (959.99 ± 0.06)″: By recording with photodiodes the variation of the ambient light level during total and annular-total eclipses in 2010, 2012, 2013 and 2015 [5].

• $S_\odot$ = (959.95 ± 0.05)″: By analysing a video of the flash spectrum of the 2017 August 21st total eclipse (TSE2017), recorded from just inside the southern path limit near Vale, Oregon, USA [6].

• $S_\odot$ = (960.01 ± 0.12)″: By timing Baily's beads during ATSE2023 in Exmouth, Western Australia, close to the northern path limit [7]. An independent analysis of these timings by one of the authors (J.I.) found $S_\odot$= (959.93 ± 0.06)″ by eliminating two anomalous data points and by treating the disappearing and reappearing beads separately as they showed distinctly different levels of scatter.

• 959.90″ ≤ $S_\odot$ ≤ 960.02″: By manually recording the UTC times of second and third contact through diffraction grating spectacles at the 2023 April 20th annular-total eclipse (ATSE2023) in Exmouth, Western Australia, marginally inside the northern path limit [8].

• 960.15″ ≤ $S_\odot$ ≤ 960.35″: By recording with photodiodes the variation of the ambient light level during ATSE2023 in Exmouth, Western Australia, just inside the northern path limit [8]. Several considerations lead us to seriously doubt the validity of this result due to the presence of an extra component of ambient light not directly related to the photosphere.

We can also mention again the analysis of historical beaded eclipses [9] and of TSE2017 by Xavier Jubier who has estimated $S_\odot$=(959.98 ± 0.02)″. This result is quoted only once [17], apparently based on both historical beaded eclipses and TSE2017, but no further details are given on the way it was derived. We suspect the error bar to be in the region of 0.10″ or more, considering that some of the historical observations studied lacked accurate observation site coordinates, and the image quality was often limited.

It still appears that further work is needed to get a better estimate of the eclipse solar radius, but the authors feel that we are reaching a point where various, modern, eclipse-based methods are converging on a value of the eclipse solar radius somewhere in the interval 959.90″ ≤ $S_\odot$ ≤ 960.00″.

The Baily's beads matching analysis of the ASE2023 video is subject to uncertainty because we cannot, with absolute certainty, disentangle the light from the photosphere and mesosphere. And matching Baily's beads configurations to simulations cannot be quantitatively formalised, so it partly remains in the qualitative domain. This type of uncertainty is an inherent feature of this method. Studying the "pivot point" phenomenon might, in some lucky cases like ours, improve on the method.

Finally, we would like to stress that the eclipse solar radius $S_\odot$ is the parameter that goes into precise eclipse computations that attempt to reproduce visual observations as best as possible. All eclipse observations are looking at the physical Sun but the interface between photosphere and mesosphere is very likely not at all sharp and very likely involves a narrow transition region, probably turbulent.

Therefore, the eclipse solar radius should not be thought of as a measure of a physical radius. It has been remarked several times that we would need to define an inflection point or agree on a reference isophote to attempt to do that. Instead, it is better to view $S_\odot$ as a parameter for precise eclipse computations. As such, $S_\odot$ will never be determined with an accuracy of 0.01″, that would be unrealistic, but it will always have some degree of uncertainty. Moreover, as we remarked in [6], true-limb contact times are better considered as very brief transitions than as sharp times, despite access to very accurate ephemerides and very accurate determinations of the lunar topography. We have all made good progress and things will improve, but we need to acknowledge that there will always be a sizeable lower limit on the error bar of the eclipse solar radius. We doubt that we can know it better than around 0.02-0.03″.

Conclusion

Bounds on the value of the eclipse solar radius were estimated by analysing a high-resolution video of ASE2023 collected from just outside the eclipse's true-limb northern limit, initially by employing Baily's beads matching, and then refining them by introducing the novel idea of studying the "pivot point". By integrating an edge observation collected during ASE2017, we have estimated the eclipse solar radius $S_\odot$ to be:

$$959.90'' \leq S_\odot \leq 960.00''$$

This radius is compatible with several other recent measurements during total, annular-total and annular eclipses. The standard eclipse solar radius of 959.63" has been shown repeatedly to be incompatible with observations and we advocate for all future eclipse computations to use a solar radius in this range, as well as to use the most recent lunar topography determinations to compute reliable true-limb path limits and true-limb contact times.

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Journal for
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Two Occultations by (344) Desiderata on 2024 January 27 - An Observer's Report

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ABSTRACT: Main-belt asteroid (344) Desiderata occulted two stars across Europe on 2024 January 27. Both events were observed successfully from the same site. The first one was a single chord observation, the second one was observed by five additional stations with positive chords. A shadow profile of 123 × 100 km was measured during the second occultation.

Introduction

Asteroid (344) Desiderata has a diameter of approximately 128 km [1] and belongs to the main-belt between Mars and Jupiter. Stellar occultations by this object were observed 16 times from 2004 to 2023. The best observation to date was recorded on 2016 February 8 with four positive and one negative chords from stations maintained by Joan & David Dunham [2]. Another occultation by this asteroid was successfully observed in Spain on 2024 January 25 with three positive chords, measured by Deborah Smith (two chords) and Ferran Casarramona [3].

Just two days after the observation in Spain, on the evening of January 27th, there was the great opportunity to observe two occultations by this asteroid from the same site with a time span of about 218 minutes between the two events (Figures 1, 2). Predictions using data from Gaia and JPL Horizons showed the author's home site within the paths. However, due to the faintness of the target stars and in particular the faint drop in magnitude during the first event, these would be challenges.

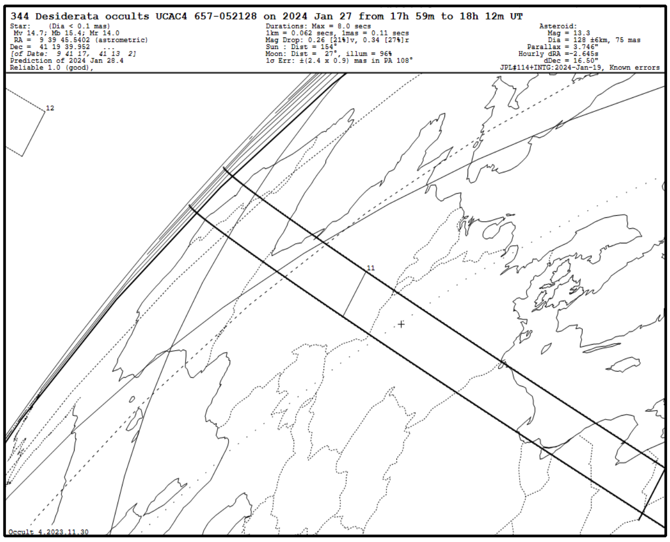

Figure 1. Path prediction for the first event, based on data from Gaia EDR3 and JPL Horizons. The cross marks the position of the observing site close to the centre line. (Occult V4.2023.11.30)

The First Event

It was the first observation in about three months. Bad weather had cancelled all observation attempts for weeks. The weather forecast for this evening was stable so the 10" LX200 Classic was set up and the recording of the first event was prepared with a QHY174M-GPS camera. *SharpCap* [4] on a notebook with a SSD was used for recording FITS files with a region of interest of 800 × 600 pixels with 2 × 2 binning. The focal length of the telescope was reduced to approximately 1600 mm with an Alan-Gee-Telecompressor.

The transparency of the sky was variable. The western sky was quite clear, in the east a lot of haze and some thin clouds blocked the view to the sky. Only a few bright stars could be used for the alignment in AltAz-mode of the telescope. So Aldebaran and Betelgeuse were selected. However, due to the small distance between the two stars on the sky plane, this was not a perfect pair for alignment. Even with LX200's High-Precision-Pointing mode, some misalignment was to be expected. The first attempt didn't work. The alignment was too far off. The sky cleared a little more

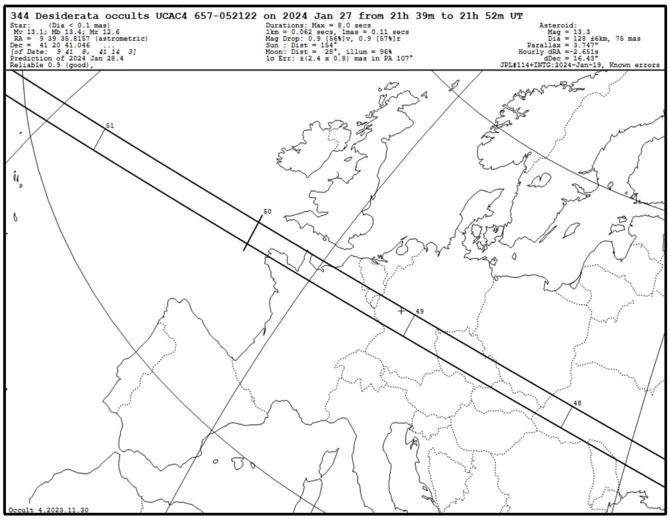

Figure 2. Prediction for the second event. The cross shows that the position of the observing site is now closer to the northern path limit compared to the first event. (Occult V4.2023.11.30)

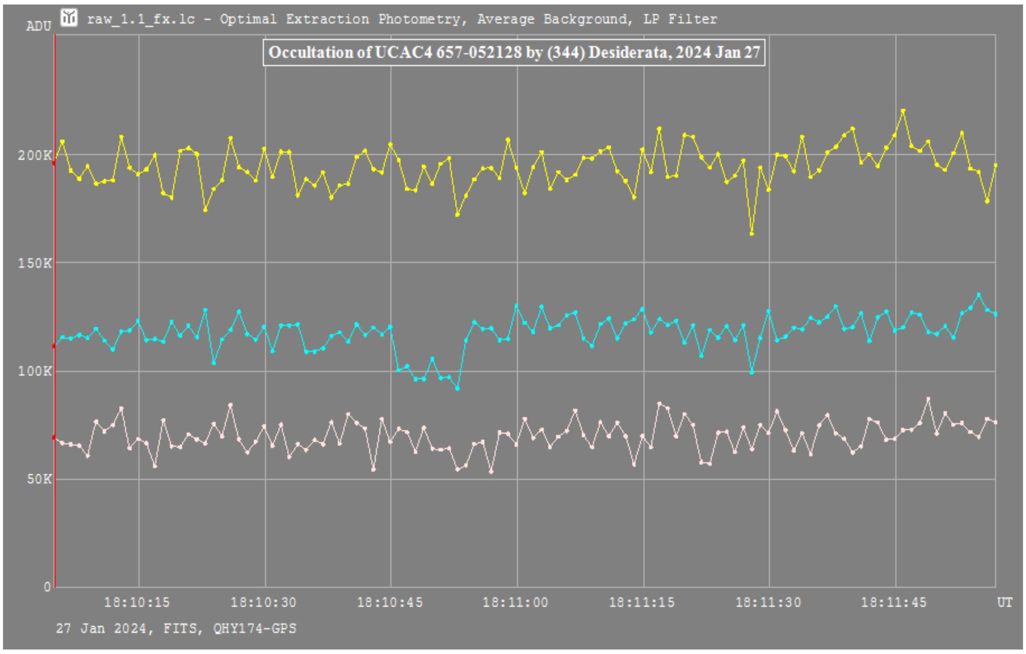

Figure 3. Light curve of the first event (blue), analysed with Tangra 3.7.5 by Christian Weber. Light curves of two comparison/guiding stars are added: UCAC4 657-052123 (Vmag 12.6, yellow) and UCAC4 657-052121 (Vmag 13.7, pink).

in the east and Betelgeuse was replaced by Procycon as one of the alignment stars. This time the LX200 slewed very close to the target area, so that only some minor corrections were necessary. The exposure was set to 1 s, gain to 340 and a duration of 120 s for the measurement, just in time for the first event.

An analysis was carried out after the recording with *Tangra* [5]. The dip in the light curve was visible (Figure 3). The much harder to observe occultation of the two events – smaller mag drop, fainter target star – was successfully recorded. The occultation near to the centre line lasted 8.0 seconds with an error of ± 0.5 s [6]. The measured duration was in good agreement with the predicted maximum duration. After the occultation, a sky brightness of 19.3 mag/arcsec^2 was measured at the zenith using a Sky Quality Meter (SQM-L) [7]. A typical value for the site located 18 kilometres in a straight line from the international airport of Frankfurt am Main, Germany.

The Second Event

The sky transparency improved as the temperature dropped about two degrees in the more than two hours between the two events (Figure 4). After the successful first occultation, it was fairly certain that the second event would also be positive. Only technical problems or the weather could spoil the observation.

Figure 4. Waiting for the second occultation. The almost full Moon illuminates the haze at the observing site in Eppstein-Bremthal. The GPS antenna of the QHY174M-GPS on a pole is visible just to the right of the 10" LX200 Classic.

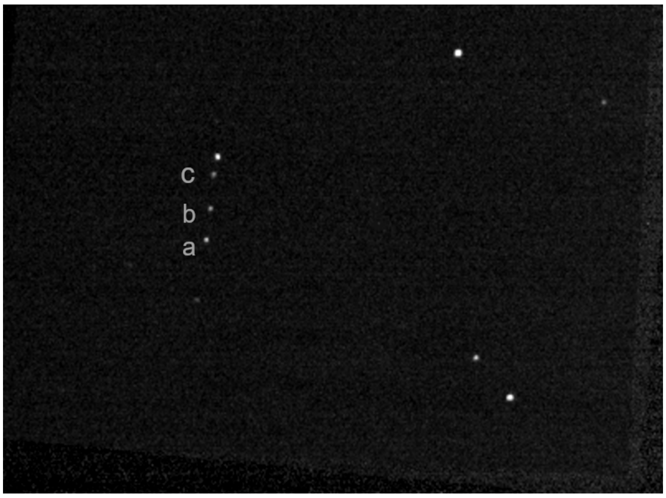

Figure 5. The path of (344) Desiderata between the two target stars was tracked with short sequences of 1-s-exposures. The positions of the asteroid are shown at 19:43 (a), 20:30 (b) and 21:21 (c), respectively. A single frame of each sequence was aligned, derotated and stacked to the final image. Times in UT.

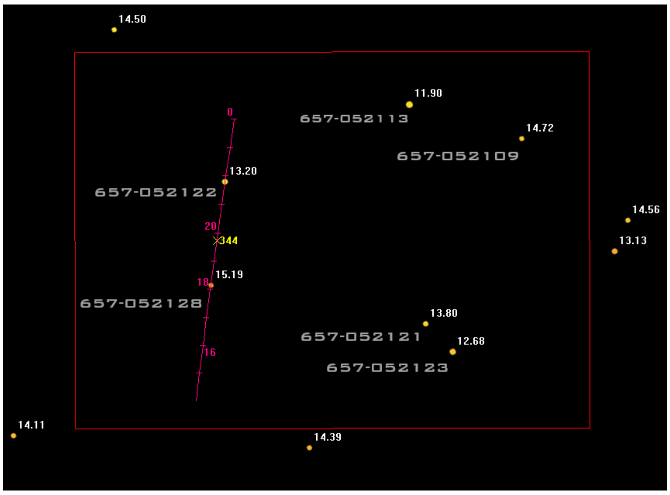

Figure 6. Map of the field of view of the camera (rectangle) with both target stars within the field. Star identifiers are from UCAC4 [8]. The V-magnitudes are based on data from APASS [9]. The path of (344) Desiderata between 14:00 and 24:00 UT is shown with markers for each hour. The cross marks the position of the asteroid at 19:43 UT (see Figure 5). (Map made with Guide 9.1 [10])

While waiting for the event, several short image sequences were recorded to track the path of the asteroid between the first and second target star (Figures 5, 6). A much shorter exposure time of 0.4 s and a lower gain of 323 were used for the second measurement due to the brighter target star at a higher altitude in the sky. The almost full Moon increased the sky brightness at the zenith to 18.6 mag/arcsec². The second occultation went smoothly and was easy to follow "live" on the notebook screen and lasted 3.8 seconds ± 0.2 s [11], (Figure 7).

Figure 7. Light curve of the second event (blue), analysed with Tangra 3.7.5.
Comparison/guiding stars: UCAC4_657-052113 (Vmag 11.9, green) and UCAC4 657-052123 (Vmag 12.6, yellow).

Analysis

All recordings were analysed the next day and sent to the Stellar Occultation Data Input System (SODIS) [12] for review. It was a little disappointing that the first event ended up as a single chord observation. Although another station was announced on *Occult Watcher* [13], it was reported as "no observation". However, more positive reports came in for the second (344) Desiderata occultation. Finally, six positive chords were measured of this occultation.

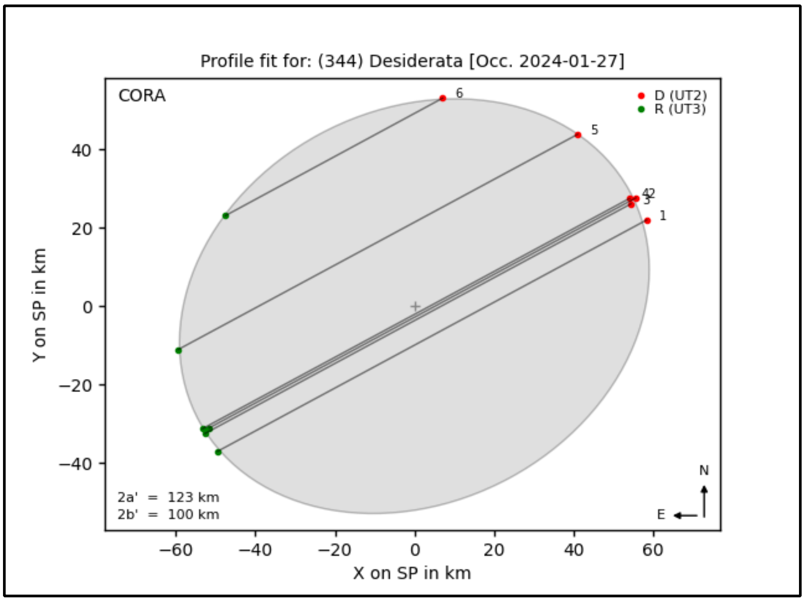

Figure 8. Preliminary shadow profile from the six positive observations of the stellar occultation of UCAC4 657-052122 by (344) Desiderata on 2024 Jan 27. Chords: Jiří Polak (1), Jiří Kubanek (2), Miroslav Polacek (3), Karel Halíř (4), Jan Mánek (5), and Oliver Klös (6).
(Collaborative Occultation Resources and Archive - CORA)

Conclusion

The second occultation by (344) Desiderata yielded a shadow profile of 123 × 100 km with a mean diameter of 111 km [10], (Figure 8), but the first occultation yielded only a single chord. Such single chords of large asteroids cannot even provide a good astrometric position.

My personal conclusion: *Nevertheless, this single positive observation is significant in my personal archive. The double occultation by (344) Desiderata was a special event for me. While I have been observing asteroidal occultations for more than 20 years, this was the first time I observed two occultations by the same asteroid from the same location on the same night. Sometimes the fun of observing surpasses the science.*

Acknowledgements

The author wants to thank Karel Halíř, Jiří Kubanek, Jan Mánek, Miroslav Polacek and Jiří Polak for measuring the second occultation by (344) Desiderata and of the SODIS team Gregor Krannich and Christian Weber for reviewing the reports.

These observations have made use of data from JPL Horizons provided by the Solar System Dynamics Group of the Jet Propulsion Laboratory and of data from the European Space Agency (ESA) mission Gaia (https://www.cosmos.esa.int/gaia), processed by the Gaia Data Processing and Analysis Consortium (DPAC, https://www.cosmos.esa.int/web/gaia/dpac/consortium). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement.

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Encouraging Young Students to Practice Stellar Occultations

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ABSTRACT: The occultation caused by the main-belt asteroid (738) Alagasta on 2024 February 5 presented a great opportunity for the Minor Bodies Group of our Astronomical Society. The ground shadow was passing over our territory, and we wanted to conduct a significant measurement involving some young students from the Bellinzona High School. The excellent weather conditions and a favourable event time on the evening allowed for a successful outcome.

Call for Observations

We are a small group of enthusiastic observers of asteroidal occultations distributed over a small portion of southern Switzerland. We have fixed instrumentation and observe occultations when the asteroidal shadows pass over our observation sites.

The (738) Alagasta occultation (Figure 1) provided a good opportunity to promote this particular observation activity to others, including friends and young people. We made appeals through messages on our network and personally contacted other potential observers to follow the event.

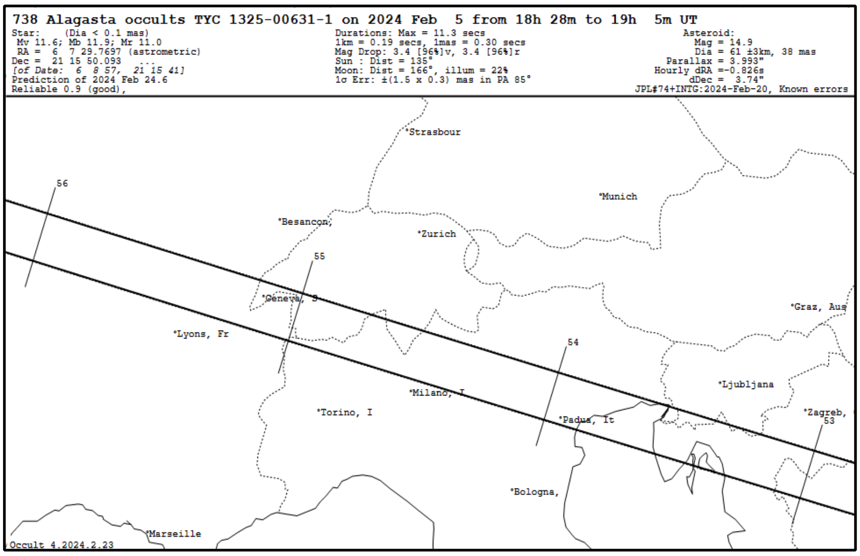
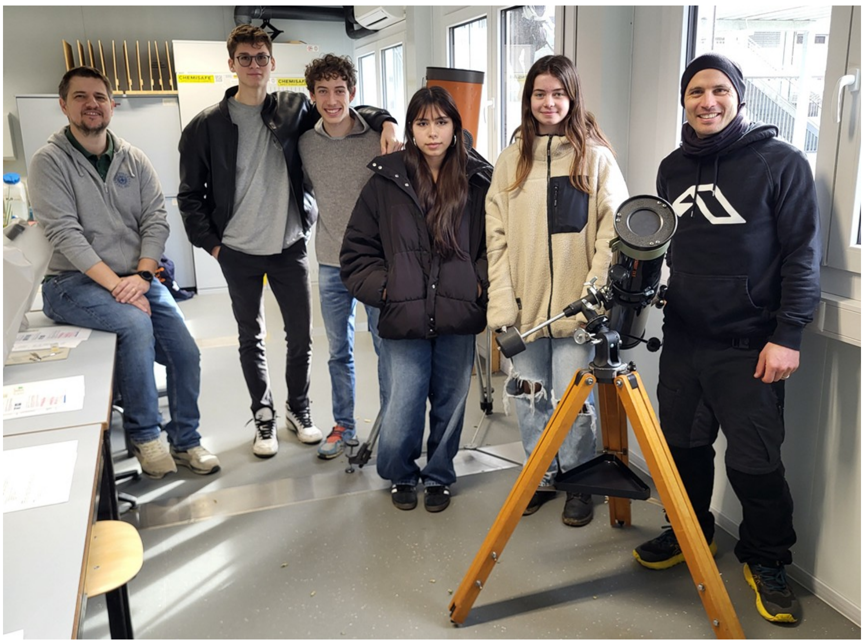


Figure 1. The predicted shadow path of the occultation by asteroid (738) Alagasta across the southwest of Switzerland on 2024 February 5. (Occult 4.2024.2.23.)



It seemed important to involve some students from the nearby Bellinzona High School, so we contacted some teachers, informing and preparing them for the event registration. The brightness of the star of 11.6 mag did not require large aperture instruments. They had a 20-cm telescope at the High School.

Figure 2. Some students with teachers Ivan Zivko (far left), Davide Speziga (far right).

The Observation

We provided some equipment: a video camera, a grabber, a time inserter, and a focal reducer. The high school group observed independently, pointing the star field with the "prepoint track" mode and their stationary telescope (Figures 2, 3).

Unfortunately, a second group located elsewhere, also attempting their first asteroidal occultation observation, encountered technical issues. Other individual observers with more experience observed autonomously.

Figure 3. The Bellinzona team is observing.

The Result

In the end, the group's contribution resulted in six chords (Figure 4), all positive, clean, and precise. The dimensions of (738) Alagasta determined from the observations confirmed the literature data, and the asteroid's profile proved to be very interesting. The ground shadow appeared slightly shifted compared to the predicted track.

We are pleased to have made a small contribution to improving the understanding of the asteroid (738) Alagasta.

Acknowledgements

The author wishes to thank the observers L. Berti, C. Gualdoni, A. Manna and A. Ossola.

Reference

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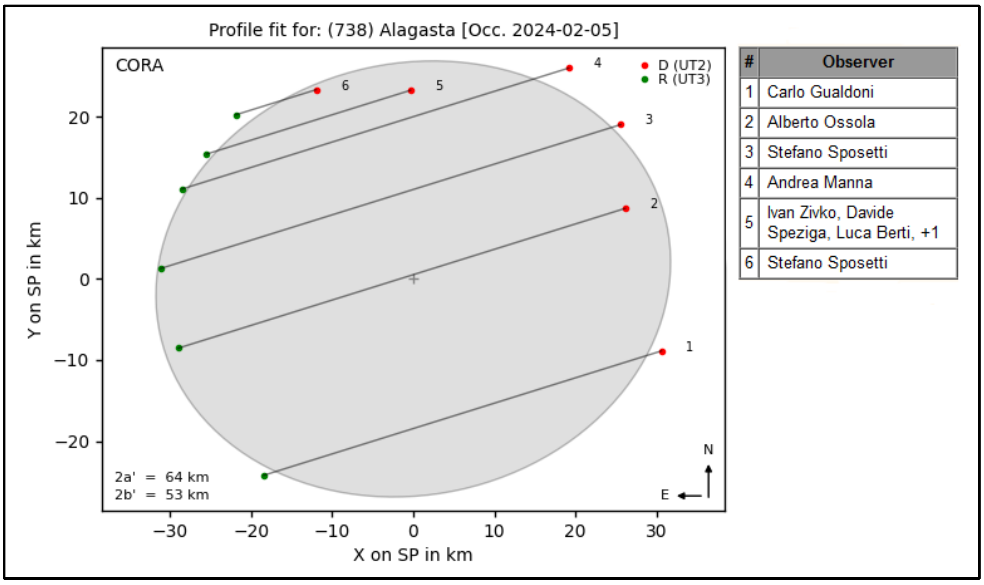

Figure 4. The six positive chords measured during the occultation on 2024 Feb 5 and the ellipse profile of (738) Alagasta [1].
The group from the Bellinzona High School recorded chord no. 5.

Journal for
Occultation Astronomy

SODIS - Looking Back at the First Year

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ABSTRACT: Since January 2023, observations of stellar occultations by minor planets have been collected and reported by IOTA/ES using the SODIS system. After one year of operation, a short report on the operation of SODIS will be given here.

Introduction

Since the launch of SODIS [1, 2], observations have been reported by observers using a clearly structured form. The form can be completed in various ways.

Many entries (telescope, position) can be pre-filled. Several report forms can be created for different observation locations.

- Have *Occult Watcher* [3] fill in the form.
  After the observation, only the observation results and the observation conditions need to be entered.

- Have the form filled in by a Python Script in *SharpCap* [4].

- Have the form filled in by the DVTI+CAM [5] program.

- Fill in the form manually.
  Copy the star and asteroid number etc. from *OW Cloud* [6] here.

The purely manual entry in SODIS is not recommended, as typing errors can easily occur here.

The form is read into SODIS and the required files are uploaded. The required data can be seen in Figure 1. The report of an observation should be reported by the observer to SODIS after 14 days at the latest. The reviewers can then examine the observation, ask the observer questions if necessary and then mark it as completed. This process should not take longer than 14 days.

All observations of an event are later exported as an XML file and read into *Occult4* [7], fitted and sent to Dave Herald. The export is carried out approximately one month after the occultation event. The data flow in SODIS is shown in Figure 2.

The data from SODIS is automatically exported to the Collaborative Occultation Resources and Archive (CORA) [8] and can be viewed there.

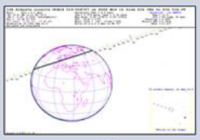
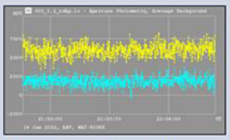
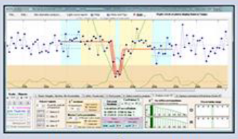
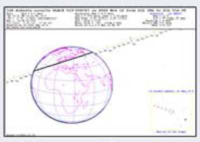
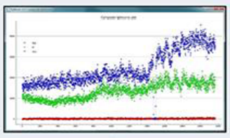
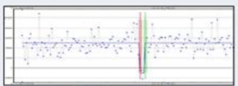
Pipeline	Event	Overview	Reduction	Log	csv File
Tangra, AOTA	 PNG-Image from Occult-Watcher: „Open Event in Occult“	 PNG-Image from Tangra: „Export lc / Save as Image File“	 PNG-Image from AOTA: „tab 5“	 Textfile („… AOTA_Report.txt“) from AOTA „tab 6“: „Save Report“	csv file from Tangra: „Export lc / Save as csv File“
Py-Movie, PyOTE	 PNG-Image from Occult-Watcher: „Open Event in Occult“	 PNG-Image from PyMovie: „Plot“ („Composite Lightcurve Plot“)	 Image from PyOTE: („… PYOTE.png“)  Image from PyOTE: („… noise_induce_event _pyote.png“)	 Textf. („… PYOTE.log“) from PyOTE	PyMovie csv file (Result of PyMovie photometry)
Other (SORA, Li-movie, …)	Please provide similar information as described above.				

Figure 1. Data to be submitted by the observer in the case of an event detection - positive observation. For non-detection observations only the "Event" and "Overview" images and the csv-file are required. (Source: C. Weber)

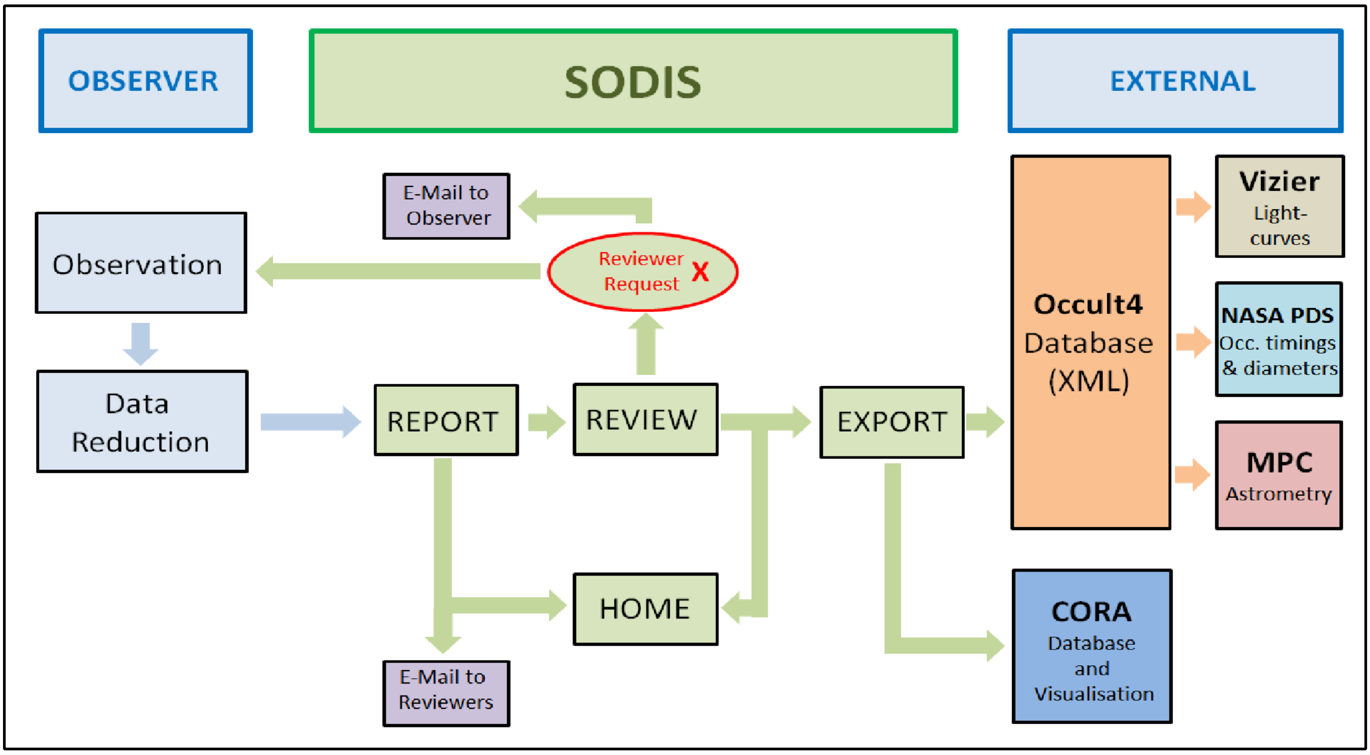


Figure 2. Data flow in SODIS (Source: C. Weber).

Statistics and Results

After one year of SODIS operation, it is time for some statistics. The following numbers of observations were reported and processed:

- Positive observations 921
- Negative observations 1838
- Ratio Pos/Neg 0.5

Observations were reported by 263 observers from 24 countries. An overview about the number of observations per month (Figure 3), per country (Figure 5), and per observation method (Figure 6) are given on the following pages.

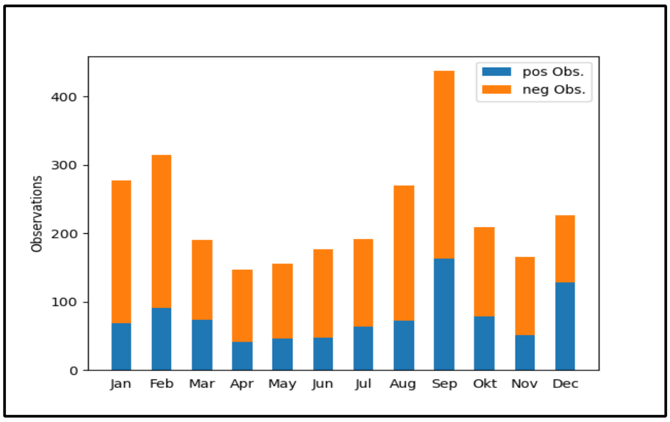


Figure 3. Distribution of observations per month in 2023.

Figure 4. Countries from which observations were reported.

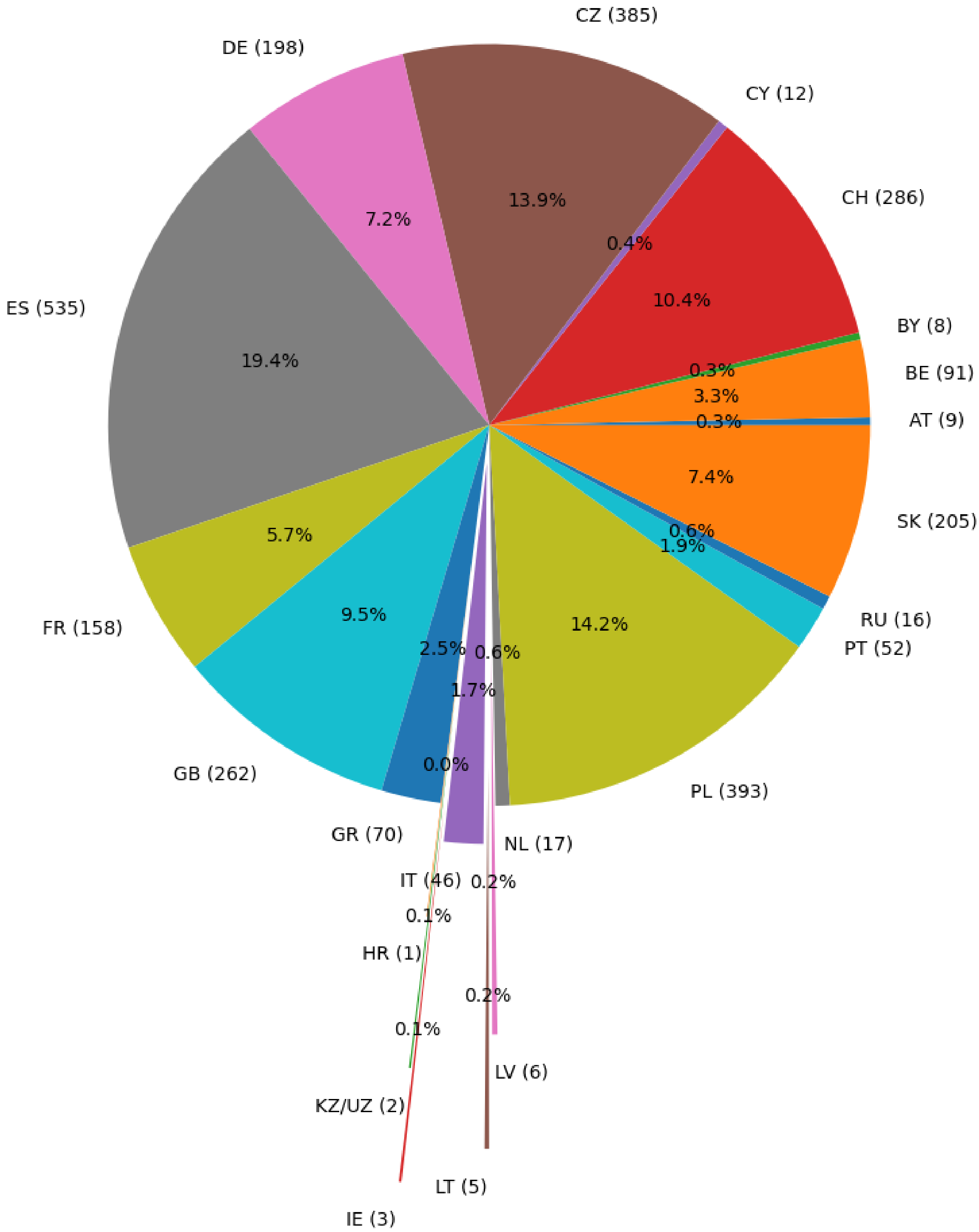


Figure 5. Countries from which observations were reported. The statistics does not represent a rating, as the number of observers in the respective country and weather conditions etc. were not taken into account here.

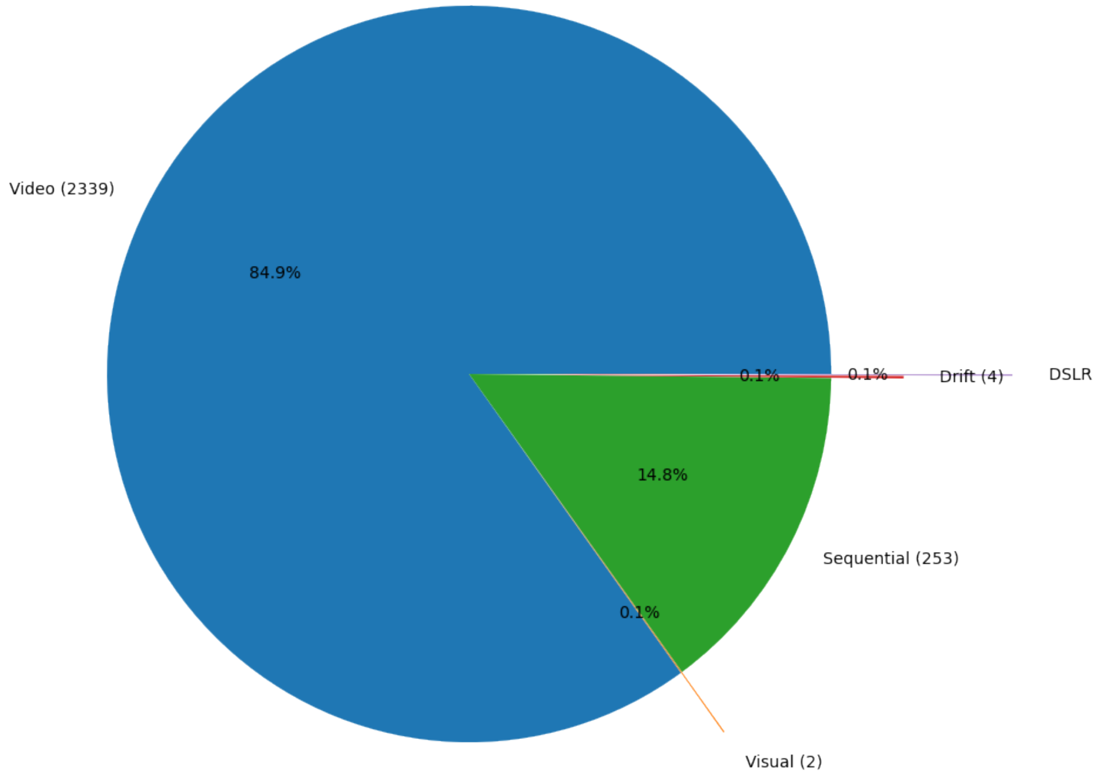


Figure 6. Observation method.The majority of observations used video technology (analogue/digital), followed by the recording of sequential images. DSLR, drift scan and visual observations are the exception.

Help and Support

An observer can get help and support from the SODIS team at any time. It is important to read the manual [9] carefully, then most questions will be solved. The next step is to search the forum [10] and/or ask questions. As many questions arise frequently, the observer will quickly find what they are looking for there. If this does not help either, the e-mail address sodis@iota-es.de can be used for questions. We have organised several online meetings for the observers and reviewers and will continue to do so if necessary.

Acknowledgements

A big thank you goes to the SODIS team, without whom this successful work would not be possible. The SODIS team consists of the administrators, the reviewers and the exporters. Some also have several functions.

Special thanks go to Erik Tunsch, the SODIS programmer, who is always quick to help with problems and makes small enhancements.

At this point, we must also mention Christian Weber, who takes care of the difficult cases as a "special reviewer".

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[9] Weber, C., SODIS Observer Documentation, https://www.iota-es.de/sodis/sodis_docu.html
[10] SODIS forum, https://forum.iota-es.de/

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 2024 March 12, the *Minor Planet Center* listed 1571 Centaurs and 3222 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:

(53311) Deucalion

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

ABSTRACT: Since 2016, JOA regularly publishes portraits of objects beyond Jupiter's orbit. This short communication on the trans-Neptunian object known as (53311) Deucalion tells the story of its discovery, the meaning behind its name and the nature of its orbit. The sizes and physical properties are derived from data published up to 2023.

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
32532	Thereus	Konrad Guhl	JOA 1 2023
38628	Huya	Christian Weber	JOA 2 2021
47171	Lempo	Oliver Klös	JOA 4 2020
50000	Quaoar	Mike Kretlow	JOA 1 2020
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
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_{84}	Sven Andersson	JOA 3 2022
341520	Mors-Somnus	Konrad Guhl	JOA 4 2022
486958	Arrokoth	Julia Perła	JOA 3 2023
-	2004 XR_{190}	Carles Schnabel	JOA 1 2022

The Discovery

The discovery of Deucalion was a result of the “Deep Ecliptic Survey” (DES), a project of the University of Arizona. This project ran from 1998 till 2003 and covered 550 square degrees for objects down to mag. 22.5. As a result, nine new minor planets were discovered and new formal definitions for objects in the family of Kuiper belt objects were introduced [1].

The object in focus of this "Beyond Jupiter" was discovered on 1999 April 18 at the *Kitt Peak National Observatory* in Arizona, United States. It received the provisional designation, 1999 HU_{11} [2]. The object was numbered 53311 on 2003 Feb 16 [3], whilst its official name was assigned on 2003 Jun 14 for the son of Prometheus, Deucalion [4].

The Name

In Greek mythology, Deucalion (ancient Greek Δευκαλίων Deukalíōn, Latin Deucalion) is the son of the Titan god of fire, Prometheus and his Okeanid-nymph wife, Pronoia. As in the Bible, Greek mythology also tells of a great flood. Deucalion is the equivalent of Noah here. Like Noah, he receives a warning and builds a boat in which he saves the creatures of the Earth. He receives an oracle to "repopulate" the world: He was advised to "throw his mother's bones over his shoulder". Initially horrified by this sacrilege, they then understood the "mother" to be Gaia ("Mother Earth") and the "bones" to be rocks. Thus, Deucalion and his wife Pyrrha threw stones over their shoulders. They became human beings, a new humanity. Pyrrha's stones became women and Deucalion's became men.

In the 16th century, Guillaume Rouillé (who lived around 1518 – 1589) drew portraits of all the historical figures of the western world in [5]. His depiction of Deucalion is shown in Figure 1.

Figure 1. Deucalion in [5].

The Orbit

The eccentricity of the orbit is 0.061, which is less than that of the orbit of Mars [6]. With an orbital inclination of 0.37°, the planet moves in the plane of the ecliptic. With a large semi-major axis of 43.9 au, its distance from the Sun is between 41.2 au and 46.5 au. The orbital period is approximately 290.4 years. There is no orbital resonance with the outer planets. So, the object belongs to the cold classical Kuiper Belt group also known as Cubewanos moving on almost circular orbits, unperturbed by Neptune.

Physical Characteristics

As of today, no spectral type nor rotational light curve has been obtained from spectroscopic and photometric observations. The rotation period, pole and shape remain unknown. The lack of knowledge about its physical characteristics is partly a consequence of the object remaining around 23rd magnitude, given its near-

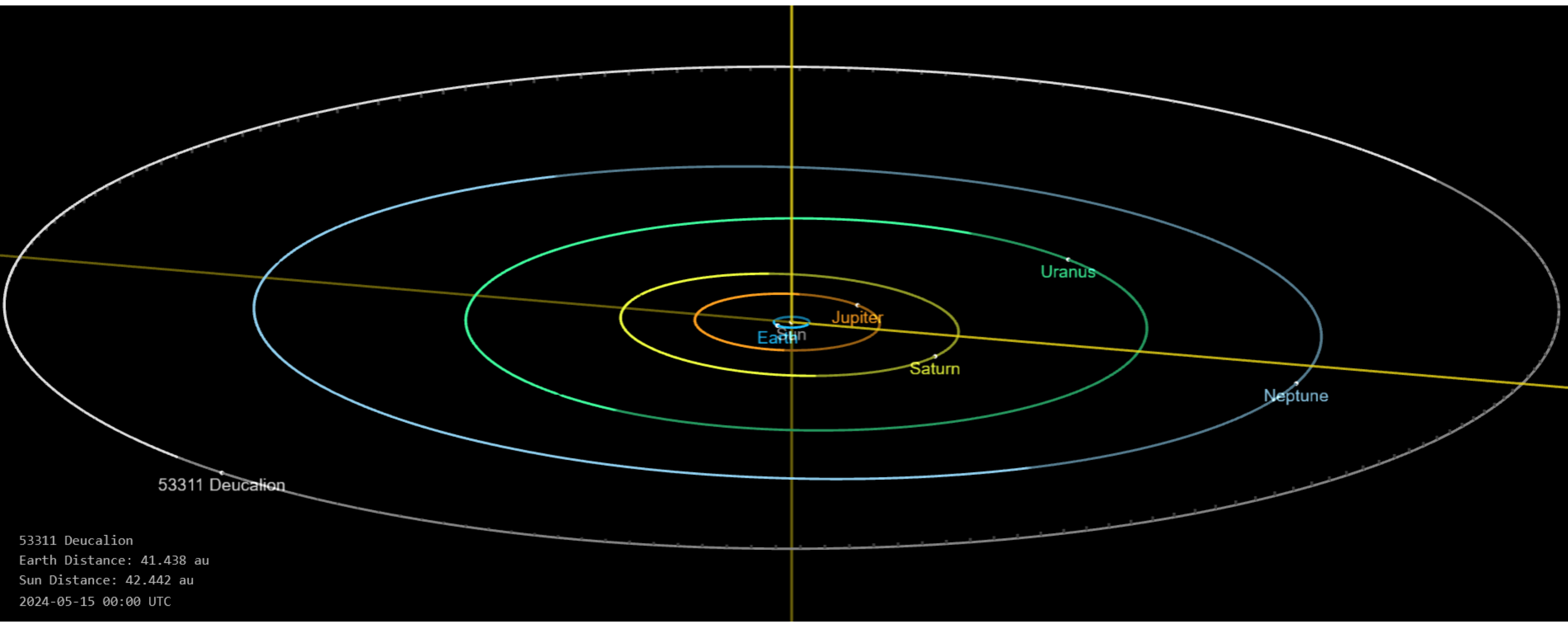

Figure 2. Orbit diagram and position of (53311) Deucalion on 2024 May 15.
(Source: NASA/JPL Small-body database lookup, https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html#/?sstr=53311)

circular orbit. Also, no satellites have yet been detected. In [7] the absolute magnitude is reported as [H]=6.71. There are two calculated diameters published: In [8] the value is 134 km, in [9] the size is 151 km. In [8] the assumed albedo is 20%, in [9] the assumed albedo is 16%. The B-R value is reported in [9] as +2.03, i.e. much redder than the solar value of +1.03 and one of the reddest TNOs known.

Future Occultations

Using [10] we find a possible occultation for 2024 May 18. As we know, the uncertainties with such a calculation are huge and this is just a first announcement. All observers should watch out for last-minute updates here. The team of the ERC Lucky Star project has added this object to their NIMA ephemerides [11] and calculated a prediction for the event [12], (Figure 3).

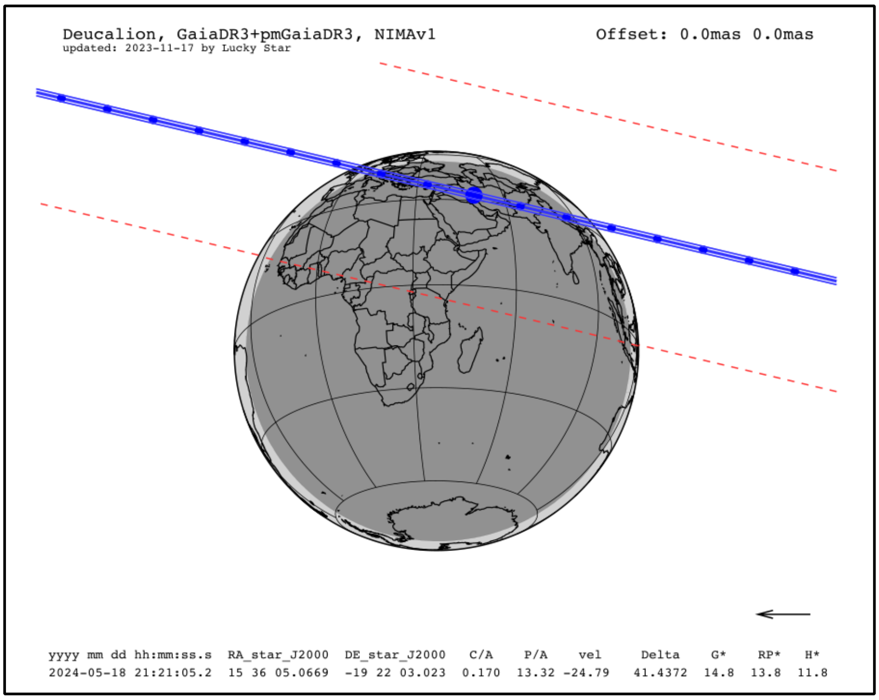

Figure 3. Prediction by the ERC Lucky Star project for the stellar occultation of UCAC4 354-072942 (Mv 14.5) by (53311) Deucalion on 2024 May 18. A maximum duration of 8.6 s with a mag drop of 8.4 is predicted. Map: ERC Lucky Star project

References

[1] Elliot, J.L. et al., "THE DEEP ECLIPTIC SURVEY: A SEARCH FOR KUIPER BELT OBJECTS AND CENTAURS. II. DYNAMICAL CLASSIFICATION, THE KUIPER BELT PLANE, AND THE CORE POPULATION", Astronomical Journal, 129:1117–1162, 2005 February,
https://iopscience.iop.org/article/10.1086/427395/pdf

[2] MPC Circular 34709, https://www.minorplanetcenter.net/iau/ECS/MPCArchive/1999/MPC_19990622.pdf

[3] MPC Circular 47740, https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2003/MPC_20030216.pdf

[4] MPC Circular 49102, https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2003/MPC_20030614.pdf

[5] Rouillé, G. : "Prima pars Promptuarii iconum insigniorum à seculo hominum, subjectis eorum vitis, per compendium ex probatissimis autoribus desumptis: et Promptuarii iconum pars secunda incipit a Christo nato, perpetuam ducens feriem ad usque christianissimus francorum regem Henricum hoc nomine secundum, hodie ...", apud Gulielmum Rovillium, 1553

[6] JPL Small-Body Database,
https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html#/?sstr=53311

[7] MPO 692495, https://www.minorplanetcenter.net/iau/ECS/MPCArchive/2022/MPO_20220520.pdf

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https://web.gps.caltech.edu/~mbrown/dps.html

[9] Johnston, Wm. Robert: "List of Known Trans-Neptunian Objects". Johnston's Archive. Updated 2023 July 23
https://www.johnstonsarchive.net/astro/tnoslist.html

[10] Herald, D., Occult V4
https://occultations.org/observing/software/occult/

[11] NIMA ephemerides of the ERC Lucky Star project, 2023 Nov 17,
https://lesia.obspm.fr/lucky-star/obj.php?p=1157

[12] Prediction by ERC Lucky Star project for 2024 May 18,
https://lesia.obspm.fr/lucky-star/occ.php?p=131615

Useful Links

About objects like TNOs and Centaurs:

NASA/JPL Small-Body Database Lookup
https://ssd.jpl.nasa.gov/tools/sbdb_lookup.html#/
Spacewatch, Lunar and Planetary Laboratory, University of Arizona
https://spacewatch.lpl.arizona.edu
Minor Planet Center
https://minorplanetcenter.net/
Deep Ecliptic Survey
https://web.archive.org/web/20040612003417/http://www.lowell.edu/Research/DES/

Zeiss-Dome of Stuttgart Observatory.

We invite you to attend the 43rd European Symposium on Occultation Projects (ESOP), held in Stuttgart, Germany, on the last weekend in August 2024.

Stuttgart Observatory is one of the oldest public observatories in Germany and has a long tradition in doing occultation work.

25 years ago - Group photo of ESOP 1999 in Stuttgart.

Consequently this will be already the second time that the ESOP stops over in Stuttgart.

Since our observatory can offer a great history and some beautiful telescopes, but can't offer lots of space, only the Welcome Reception on Friday evening Aug, 23rd will take place directly at *Stuttgart Observatory* (with an additional possibility to visit on Sunday evening). The lecture programme on the weekend is hosted by *Stuttgart Planetarium*. This offers of course the possibility to visit the planetarium itself with its modern projection system. A separate programme for accompanying persons uninterested in the ESOP-lectures will be provided on demand.

For the social dinner on Saturday evening we have prepared something special. We will visit the world's first television tower (also part of this year's ESOP-logo) and have a wonderful dinner next to it.

Details and registration here:
www.sternwarte.de/esop43

Lecture hall at Stuttgart Planetarium.

Mercedes-Benz Museum. Credits: Julian Herzog (https://commons.wikimedia.org/wiki/File:Mercedes-Benz_Museum_201312_07_blue_hour.jpg), https://creativecommons.org/licenses/by/4.0/legalcode

But besides its television tower, what's Stuttgart even more famous for? Of course – its cars. Hence a visit to the great Mercedes-Benz Museum is a "must have" for every Stuttgart tourist and will be part of our Excursion Programme on Tuesday.

Kepler-Monument on the market place in Weil der Stadt Credits: Memorino (https://commons.wikimedia.org/wiki/File: Keplerdenkmal_Weil_der_Stadt.jpg), „Keplerdenkmal Weil der Stadt", https://creativecommons.org/licenses/bysa/3.0/legalcode

Time keeping devices at Stuttgart Observatory for the registration of occultations (approx. 1950).

Other destinations for the Excursion Programme on Monday and Tuesday is a stopover at Solitude Palace and the remains of Zavelstein castle with view to the Black Forest and a short tour to the important monastery at Hirsau. Major stops will be done in Esslingen with its medieval town centre and Weil der Stadt with its museum dedicated to the famous astronomer Johannes Kepler who was born there.

We are looking forward to meeting you in Stuttgart.

Andreas Eberle
President
Stuttgart Observatory

News

Eighteenth Trans-Tasman Symposium on Occultations (TTSO18) on 2024 April 1st

Trans-Tasman Occultation Alliance (TTOA) is holding its Eighteenth Trans-Tasman Symposium on Occultations (TTSO18) on Monday the 1st of April (Easter Monday). For the first time since 2019, this will be a physical meeting held in Parkes, New South Wales, Australia in conjunction with NACAA (National Australian Convention of Amateur Astronomers).

Steve Kerr, Trans-Tasman Occultation Alliance Director, has announced that the meeting will be shared on *Zoom* for those who can't attend including several of the presenters.

The meeting will run from 09:00 Australian Eastern Daylight Time (22:00 UTC on the 31st of March) to 17:00 Australian Eastern Daylight Time (06:00 UTC on the 1st of April).

On-site attendees should register through the NACAA website (it is not an obligation to attend the rest of NACAA) at https://nacaa.org.au/2024/register.

Anyone wanting to attend via *Zoom* are asked to e-mail Steve Kerr and Murray Forbes at director@occultations.nz.org. They will acknowledge your interest and closer to the date, will e-mail out the log in details.

Check for latest updates:

https://occultations.org.nz/meetings/TTSO18/TTSO18.htm

(OK)

UTC	Duration	Speaker	Title	Description
Sun 2024/03/31	min			
22:00:00	0:10:00	S. Kerr	Welcome and Introduction	
22:10:00	0:30:00	T. Haymes	SODIS	An introduction to the SODIS observation reporting structure.
22:40:00	0:40:00	S. Kerr	Round Up of TTOA Observing	Reviewing the results of observations by TTOA through 2023 with summary and statistics.
23:20:00	0:30:00	Morning Break		
23:50:00	0:30:00	M. Forbes	Occultations by Global Meteor Network	This presentation shows my preliminary investigation into the possibility of using the GMN system for observing occultations.
Mon 2024/04/01				
0:20:00	0:30:00	D. Gault	Short Event Processing	A cooks tour of the planetary occultation processing pipeline.
0:50:00	0:30:00	D. Herald	World Wide Result Roundup	Interesting observations and statistics from around the world.
1:20:00	1:00:00	Lunch		
2:20:00	0:30:00	M. Camilleri	GPS Flash Timing	Cheap and accurate GPS timing without DIY.
2:50:00	0:30:00	D. Herald	Validation of Asteroid Satellites by Occultation	A review of the challenges of detecting asteroid satellites.
3:20:00	0:30:00	W. Hanna	2023 Observation Roundup	A summary of results from Bill's observatory.
3:50:00	0:30:00	Afternoon Break		
4:20:00	0:30:00	T. Holt	2024 Didymos Campaign	A overview of the ACROSS Didymos campaign across Australia and New Zealand.
4:50:00	0:30:00	S. Kerr	Upcoming TTOA Occultations and Campaigns	A round up of interesting upcoming occultations for Australia and New Zealand.
5:20:00	0:30:00	S. Kerr	Wrap Up	
5:50:00	0:10:00			

Table 1. Schedule for the Eighteenth Trans-Tasman Symposium on Occultations. (Status: 2024 March 21)

New URL for the Euraster.net Archive

Eric Frappa has taken care of analysing and collecting observations of stellar occultations by asteroids measured by European observers in the years 1997 to 2022. Eric has now moved this valuable archive to a new URL.

https://euraster.ericfrappa.com/

Be aware that direct links to reports on euraster.net published in past issues of JOA will not work anymore. *(OK)*

News

North America Lunar Doubles Feed for Occult Watcher Is Back

For many years observers benefitted from the work of the late Brad Timerson who published lunar double star predictions for North America in *Occult Watcher*. Now his work is continued by Ted Blank (IOTA).

He has begun generating monthly lunar double star predictions for North America and uploading the file to IOTA's webpage https://occultations.org for anyone who wishes to observe these interesting and still scientifically useful events. The procedure used is to generate predictions for twelve US cities spread "corner to corner" across the country, combine the predictions and eliminate duplicates. *Occult Watcher* will then compute the event time for your own location. The cities used near the US borders should cover Canadian and Mexican observers, but if there are observers in northern Canada or southern Mexico who are not seeing events, please contact Ted to add more cities.

To add this feed to *Occult Watcher* on your computer, you will simply need to install the "Lunar Occultations for Occult Watcher" Add-In for *Occult Watcher* desktop (scroll down to find it). Once you restart *Occult Watcher* you should enable this feed. Then you can configure the Add-In by pointing it to the following URL for the online file:

https://www.occultations.org/data/NADoubles.txt

(Note: this text string must be copied exactly, the capitalisation is important).

A detailed description of how to configure the feed in *Occult Watcher* can be found in Journal for Occultation Astronomy Vol. 8, No. 1, page 9-10.

This feed will be updated every month to contain the predictions for the upcoming lunation cycle. If it does not slow down synchronisation too much, Ted plans to increase the coverage to cover two cycles, current and next.

Once the feed is active and you sync *Occult Watcher*, you should see entries for upcoming lunar occultations of suspected double stars. The entries will be interspersed with your asteroid predictions, and should look similar to this:

326 D Wed., 14 Feb, 20:01   15 Feb, 03:01:43   5.7   etc...

Prediction values are described in *Occult* help text. Only D, d, R and r events are shown. Grazes and misses are excluded.

- D - disappearance
- d - disappearance, but star is less than 1 mag brighter than the predicted visibility limit.
- R - reappearance
- r - reappearance, but star is less than 1 mag brighter than the predicted visibility limit.

Double-clicking on the entry in *Occult Watcher* will bring up the usual Moon map in *Occult* showing the location on the lunar limb where the event will occur.

If you have questions you can contact Ted Blank:

tedblank@gmail.com

(OK)

Sun Sketchers - Measuring the Solar Diameter during the Solar Eclipse on 2024 April 8

The citizen science project »Sun Sketchers« calls for volunteers to use their smartphones during the upcoming solar eclipse to measure the shape of the Sun. A special »SunSketcher App« was created for *iOS* and *Android* devices and is available in the app stores.

Check their webpage for details, download links, and social media networks: https://sunsketcher.org/

The project is featured by »Get Involved with NASA« :

https://science.nasa.gov/get-involved/citizen-science/become-a-sunsketcher-and-help-measure-the-shape-of-the-sun/

(OK)

Russ McCormick †

Russ McCormick, IOTA member and author of "IOTA Video Capture" (IOTAVC), passed away 2023 December 15 after a valiant battle with pancreatic cancer.

Russ was a relatively new member of the IOTA/NA community. He did not have any previous experience with occultations prior to attending IOTA's Annual Meeting in Las Vegas in October 2015. However, having recently retired from his coding job, he was looking for a project that would be helpful to others. After some discussion, Russ agreed to research the idea of writing a *Windows* based video capture application which would be optimised for occultation work.

This eventually led to his development of *IOTAVC* [1]. He released an alpha version of *IOTAVC* in January 2016, and beta testing started in June 2016. The first broad release happened in late summer of 2016. *IOTAVC* became the workhorse capture program for many subsequent observations by many observers. Russ continued to make improvements to *IOTAVC* based on feedback and suggestions from observers. Even after his diagnosis, he continued his development work during his cancer treatment, sending out new releases until the end of October 2023. In 2023, IOTA gave Russ the *Homer F. DaBoll Award* in recognition of his contributions.

Those of us who spent some time with Russ know that in addition to being an accomplished and collaborative colleague, he was a caring and fun person. I spent time with him at multiple IOTA meetings and at NEAF. During the time I knew him, Russ and his wife Florence completed their quest to see a baseball game in all 30 major league stadiums. This quest included a Seattle Mariners game which we attended together.

Russ will be missed by many people in the occultation community.

Steve Preston
President IOTA

[1] IOTA Video Capture 2.4, https://occultations.org/observing/software/

Journal for
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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.

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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If necessary for any reason JOA can shorten an article but without changing its meaning or scientific contents.

JOA will always try to produce an article as soon as possible based to date & time of other articles it received – but actual announcements have the priority!

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