Journal for Occultation Astronomy

2011-02

FORMERLY OCCULTATION NEWSLETTER

The wrapped Reichstag in Berlin by Christo and Jeanne-Claude in 1995

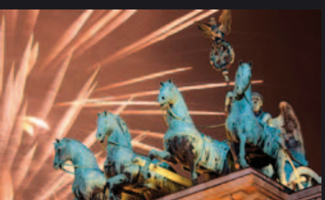
XXX. ESOP Berlin, August 26th to 31st 2011

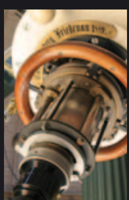
Pluto occultations in May and June

CCD Photometry of Uranian and Saturnian Mutual Events

29th Annual Meeting of the IOTA

The scan drift method





Journal for
Occultation Astronomy

Actual articles and anouncements for future-events allways have the priority for publication. In case your article has not been printed it will be set in the next issue.

Dear Reader,

Thanks for sending us many contributions, but considering the work that has to be done by the editorial team, it would be better to receive it as soon as possible: Do not wait until you have nearly crossed the deadline …

I remember well the beginning of observing minor planet occultations. Very often it was a "va banque"-play to travel to some distant places for recording such events: No precise astrometry and seldom last-minute-predictions existed! Nowadays it is no risk any longer: a result of better astrometry and very often (e.g. important events) actual data have been used for a last-minute-prediction – if possible. Have a look at the PLANOCCULT-list and you will see permanently a lot of positive observation-recordings.

For TNOs it is an equivalent situation: The "RIO-team" is still producing high quality astrometry for these objects and the star that will be occulted. In the meantime several of these far distant dwarf- / minor-planets were successfully recorded when occulting the predicted star. Occultations by TNOs to get more insight in these far distant bodies will be the main challenge for the next decade in occultation astronomy.

There is one thing I am still wondering about: Are there any measurements of the asteroid's lightcurve being done during (or close to) the time of the occultation (in case the occulting body is bright enough)? In this case it could be possible to get an impression of the "3-dimensional-shape" of this object. At least we should know, .whether we recorded the maximum-, minimum or in-between –diameter during the occultation – regardless of the actual orientation of the rotation-axis at that time (remember Kleopatra).

When we realize that an asteroidal occultation has been reasonably well-observed, we inform Brian Warner, **brian@minorplanetobserver.com**, and he notifies other observers of asteroid lightcurves that observations are desirable soon. It's also useful to inform Raoul Behrend, **raoul.behrend@unige.ch**, since like Brian, he makes, and keeps track of, well-observed asteroid lightcurves. In some cases, for important events where many observers are expected, and especially in the case of asteroids like Kleopatra with large-amplitude lightcurves, we seek lightcurve observations in advance, to ascertain the phase that is predicted during the occultation. We also go farther, checking with the DAMIT database of asteroid shapes determined from inversion of lightcurve data, to see what the outline of the asteroid might be at the predicted time of an upcoming occultation. Hans-J. Bode ■

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In this issue:

Writing articles for JOA:

The rules below should be regarded while writing an article; using them will greatly facilitate the production and layout of ON!

If your article does not conform to these rules, please correct it.

There are 3 different possibilities for submitting articles:

- pdf-articles (must be editable – these can be converted)
- unformatted Word *.doc-files containing pictures/graphs or their names (marked red: <figure_01>) at the desired position(s)
- *.txt-files must contain at the desired position the name of each graph/picture

The simplest way to write an article is just use Word as usual and after you have finished writing it, delete all your format-commands by selecting within the push-down-list "STYLE" (in general it's to the left of FONT & FONTSIZE) the command "CLEAR FORMATTING". After having done this you can insert your pictures/graphs or mark the positions of them (marked red: <figure_01>) within the text.

txt-files: Details, that should be regarded

- Format-commands are forbidden
- In case of pictures, mark them within the text like <picture001> where they should be positioned

Name of the author should be written in the 2nd line of the article, right after the title of the article; a contact e-mail address (even if just of the national coordinator) should be given after the author's name.

IMPORTANT:Use only the end-of-line command (press ENTER) if it's really necessary (new paragraph, etc.) and not when you see it's the end of the line!

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Each country / state has a coordinator who will translate your article to English – if necessary.

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Journal for Occultation Astronomy

How to measure occultation timings from star trails obtained by the scan drift method when the star trail is partially registered in a frame? by Claudio Martinez

The scan drift is a method used in asteroidal occultations timings. A detailed description is presented in IOTA's Manual, Chapter 8, Section 8.9.2.

Firstly, it is necessary to consider which part of the trail's shape should be measured, because if done the wrong way, you may introduce important errors.

The shape of the star trail is

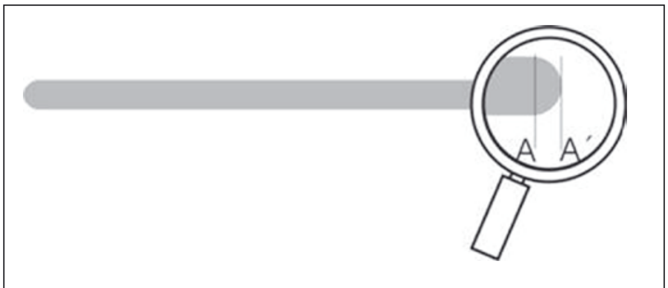

Fig. 1

What about the point to be measured? Should be A or A'? It isn't a minor issue, because in the case of bright stars, the difference may be important, shortening the occultation to an unacceptable value. The three images below are representing occultations of the same length, but for increasingly brighter stars.

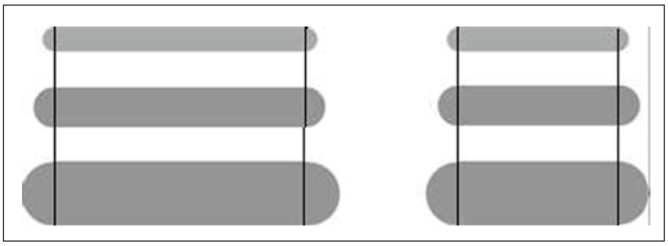

Fig 2

The end to be taken into account is A, because the star is a point of light, and its size is determined only by the brightness of the star. Therefore, when the star disappears behind the asteroid, it is actually in the center of the semicircle of radius AA'.

Consequently, different times and measures have to be considered during an occultation. In the picture below are, above it the measurements in pixels, and below it the seconds of time.

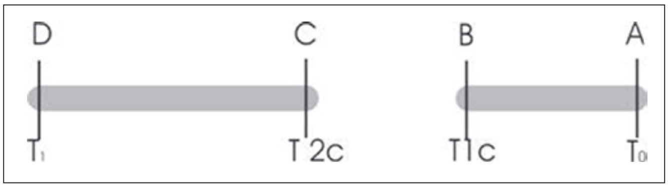

Fig 3

Where: To is the starting time of the exposure, T1c is the time of the first contact, T2c the second contact and T1 the end of the exposure.

Measurements

To determine the contact times, the following values in pixels should be used:

1st contact: A-B or D-B

2nd contact: A-C or D-C

As shown, the values for each contact are determined by two different formulas. It is necessary to use both for averaging and to reduce errors.

a) If the star trail appears complete in the frame.

It is the easiest way. As we have the starting time (T0) and the end (T1), we can deduce the subsequent proportion pixel to time.

Thus:

AD = full length = total exposure time (T1-T0)

The scaling factor E will be

E = AD/(T1-T0) (1) (units: pixels/sec)

Hence

T1c = T0 + AB / E (2) and T1c = T1-DB / E (3)

T2c = T0 + AC / E (4) and T2C = T1-DC / E (5)

We can average (2) and (3) or (4) and (5).

b) If the trail shows only one end (the beginning or the end is missing)

The procedure is similar to the above described, but instead of taking the total length (AD) from the occulted star, we must use another star with a complete trail in the frame, that will be called ìcomparison starî. Apply equation (1). Once the scaling factor is determined, use equations (2) and (4) or (3) and (5), depending on which end of the occulted star trail is visible.

As values can not be averaged, the error is greater than for the previous method.

c) If both ends of the star trail aren't visible.

Here is a little bit harder, but still feasible, to obtain the times of contacts. It is also a method that introduces a greater error.

Now we need to take the scale based on the perpendicular distance between the lines of the comparison (starco) and the occulted star (star).

Draw a perpendicular line as shown in the diagram below, from the end of the comparison star to the point where it crosses the line of the occulted star. (x-x1).

This point (x1) is used as the reference to measure the distance in pixels to contacts 1 and 2.

Knowing the RA and the DEC of the stars, you can determine the difference between stars' RA (dRA). This value can be added up to the differences (d1 and d2) to obtain the contact times. RA and DEC must be used from the present date of the equinox (easily available with any program like Sky map Pro or Guide).

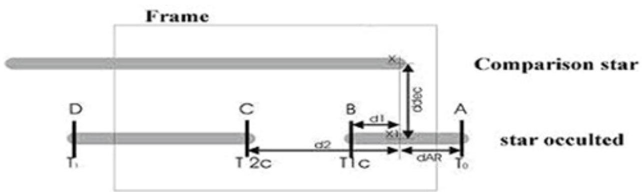

Fig 4

According to the diagram above, (x-x1) pixels are representing the offset in declination - dDEC-).

Then:

dDEC = ||dec (star)| - |dec(starco)||* 3600. (Difference in declination between stars expressed in arcsec)

E = |(x-x1)/DDEC|*15 (Scale of the frame in pixel/second of time)

difRA =|RA(star)-RA(starco)|*3600 (RA difference in seconds of time)

dRA = difRA * cos (dec (star)) * E (RA difference in pixels)

T1c = T0 + (DRA + d1) / E

T2c = T0 + (DRA + d2) / E

Where: dDEC: declination difference between the comparison star and the occulted star.

star = occulted star

Starco = comparison star

d1 = difference between point x and the first contact in pixel

d2 = difference between point x and the second contact in pixel.

Numerical Example:

It is based on a CCD image obtained during the occultation by Desiderata, by JosÈ Luis Sanchez and Luis Alberto Mansilla, Gemini Observatory Austral, Rosario, Santa Fe

The instantaneous coordinates of the occulted star (ie coordinates at the date of the occultation) are:

RA (star): 14hs 48m. 33.412 sec.

Dec (star): -30° 26' 47.12"

And the comparison star:

RA (starco): 14hs 48m. 10.8265 sec.

Dec (starco): -30° 24'51.750"

T0: 23 hs. 19 m. 55 sec.

the image was printed on an A4 sheet, and measured with a ruler. Although the above equations are expressed in pixels, the resulting value is the same because they are all distance units.

-d1: 5,3 mm D2: 38.8 mm x-x1: 41.5 mm

Then:

DDEC: 0.032047221 = 115.37"

E = (41.5 mm / 115.37 ") * 15 = 5.396 mm / sec

difRA = 0.00627375 hs = 22.5855 sec.

DRA = 22.5855 sec x cos (30) x 5.396 mm / sec = 105.54 mm. (Dec. of the occulted star has been rounded)

T1c = 23 hs 19 m 55 sec + (105.54 mm + 5,3 mm / 5.396 mm / sec) = 23 hs 20m 15.54 sec.

T2c = 23 hs 19 m 55 sec + (105.54 mm + 38.8 mm / 5.396 mm / sec) = 23 hs 20 m 21.75 sec.

Despite having used a calculation method affected by a greater error (there are fewer references), the difference to the original measurement obtained by Jose Luis Sanchez and Luis Alberto Mansilla (who had more data for the calculation, ie two ends visible) amounts only a fraction of a second.

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Positive Video Observations of the Occultations by (37) Fides and (1889) Pakhmutova

by Oliver Klös, IOTA-ES · oliverkloes@nexgo.de

Abstract:

After seven years of observing with only one positive observation once per year I was able to record two positive events in two months.

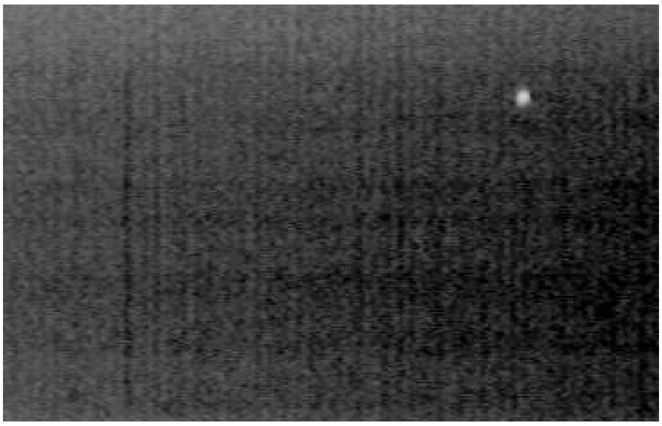
The occultation of (37) Fides proves that a non-integrating video camera can record an occultation with a small light drop of less than 1 magnitude when a software analysis is made of the recorded file.

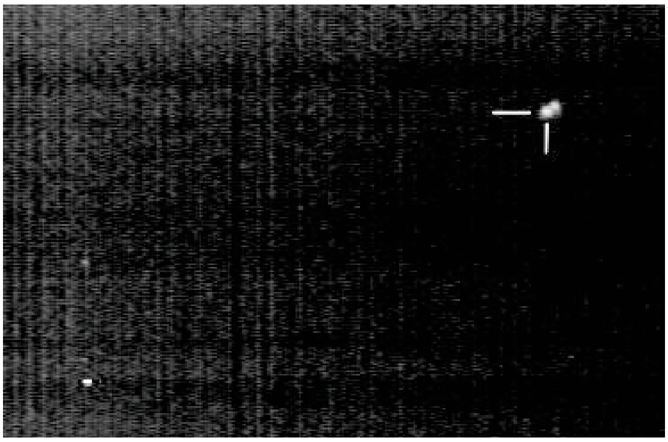
The occultation of (1889) Pakhmutova was the first occultation ever recorded of this asteroid.

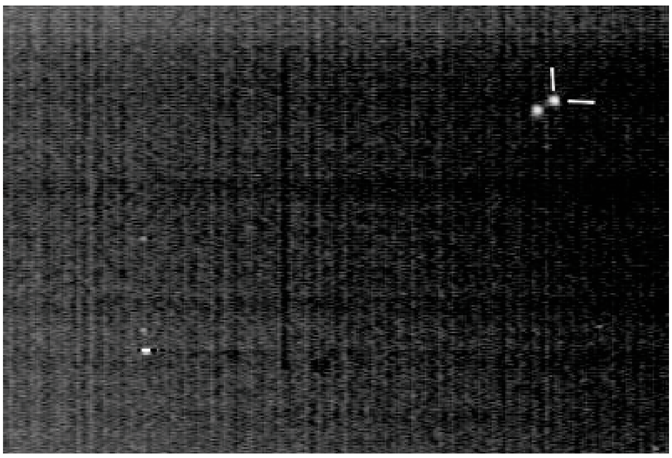
On September 01, 2010 the shadow of (37) Fides passed over Europe in the early morning. The path covered Poland, Germany, France, Spain and Portugal. The star 2UCAC 39795518 (11.2 mag) was predicted to be occulted for about 6 seconds. The expected drop of 0.9 mag was small but the combined light of asteroid and star (10.6 mag) was detectible for my setup (video camera with a ICX255AL and 10" LX200 Classic at ~f5 with a telecompressor, Video timing by video time inserter STVAstro with GPS 35 with 1PPS). The mag limit of my setup is about 11.5 mag depending on altitude and colour index of the star.

I observed from my home station which was located inside the predicted path. The observing conditions were not perfect. The seeing was bad and the last quarter moon was just 3 degrees away from the target area. 15 minutes before the expected occultation time I could see both objects (star and asteroid) approaching on the video screen.

I recognized the beginning of the occultation on my 3" small portable VHS recorder video screen, but I was surprised that I couldn't see the end of the occultation. So I expected a gradual reappearance at the evaluation of the video tape, but could not detect it visually on the screen. 7 Minutes after the occultation both objects were separated again.



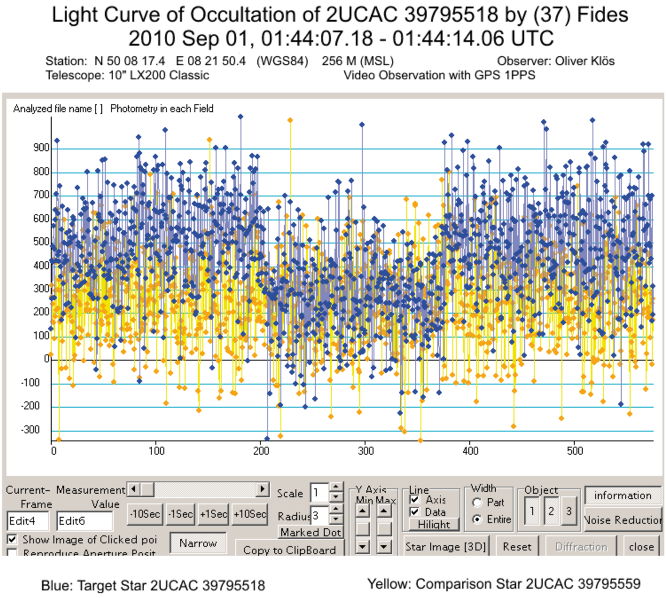




The sequence of images shows the motion of (37) Fides. The images were recorded 15 min before, at time of occultation, and 7 minutes after the occultation. (37) Fides is marked.

The star in the lower left is the reference star. The bright artefact is a hot pixel. Several images were stacked for better contrast.

The evaluation of the video tape was not easy because of the poor S/N ratio. I digitized the analog video signal with a frame grabber and "Virtual Dub" into two files: one with adjustment of brightness and contrast for better contrast between star/asteroid and background and the other without adjustment. I didn't average any fields because I wanted the full time resolution of separate fields (0.02 sec). These files were analyzed with LIMOVIE. The reference star 2UCAC 39795559 (11.1 mag) in the recording field had nearly the same intensity as the combined light of star and asteroid during occultation. This would give a proof of a real occultation rather than a light dropping due to seeing effects. The light curve gives an idea of the very noisy image. But the occultation is clearly visible.



<Light Curve 37.gif>

The LIMOVIE files were checked with OCCULAR V4 to get the times of the beginning and the end of the occultation.

The differences between the measurements of the files (adjusted and unchanged) and methods (symmetric and asymmetric transitions) were only 0.01 sec in duration and 0.02 sec for the D and R times and thus inside the error bars of all measurements. The times calculated by OCCULAR were checked with the real time inserts in the video fields (to avoid misinterpretation due to double or dropped frames at capturing).

The analysis showed that there was no gradual effect at the end of occultation. The increase of light was just hard to see on the small screen.

The times of occultation:

D: 01:44:07.18 UTC +- 0.03
R: 01:44:14.06 UTC +- 0.03
Duration: 6.88 sec +- 0.06
Mid-event: 01:44:10.62 UTC +- 0.06

A report was sent to PLANOCCULT. Three more positive reports were sent in by Jean Lecacheux (France), Wolfgang Rothe and Guido Wortmann & Karsten Walzel (Germany). Unfortunately these chords were very near the one covered by me. Eric Frappa at Euraster.net calculated the diameter of the asteroid to be at least 117 km.

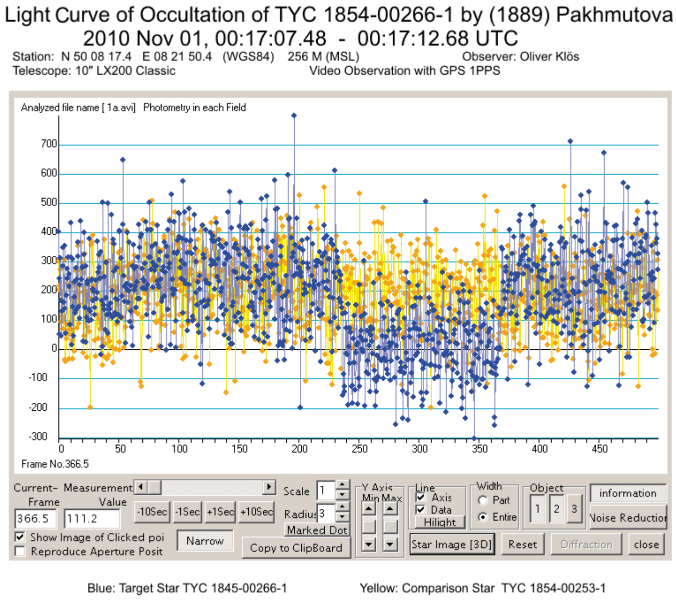
Exactly two month later on November 01, 2010 the asteroid (1889) Pakhmutova occulted the star TYC 1854-00266-1 (10.7 mag) in Taurus. My observing location was at chord +67 inside the 1-sigma limit calculated by Steve Preston. The probability of a positive observation at this chord was only 12 %.

The minor planet with a brightness of 15.6 mag was not visible on the recording.

At the predicted time of occultation nothing happened. 10 seconds later the star disappeared for 5 seconds. This was still inside the uncertainty of time of +/- 13 sec given by Steve Preston in his prediction and could be explained by the large path shift.

Similar to the occultation of (37) Fides the analog video tape was digitized and analyzed with LIMOVIE and OCCULAR V4.

I found TYC 1854-00253-1 (11.2 mag) as a reference star in the recorded field that was very noisy too.



<Light Curve 1889.gif>

The times of occultation:

D: 00:17:07.48 UTC +- 0.02
R: 00:17:12.68 UTC +- 0.02
Duration: 5.20 sec +- 0.03
Mid-event: 00:17:10.08 UTC +- 0.03

A report was sent to PLANOCCULT. I was the only observer with a positive report of this occultation. Gerhard Dangl (Austria) and Tim Haymes (U.K.) were outside the path. Eric Frappa estimates the diameter of the asteroid to be at least 39 km. This was the very first observation at all of an occultation by (1889) Pakhmutova. Future occultation measurements may improve the value of the diameter.

References:

Frappa, Eric euraster.net - 2010 European Asteroidal Occultation Results
http://www.euraster.net/results/2010/index.html

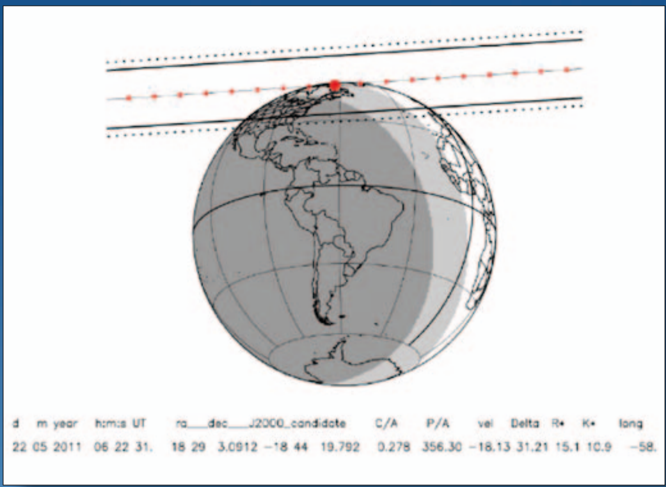
Anderson, Bob and George, Tony: OCCULAR V4
http://www.asteroidoccultation.com/observations/#OccularV4

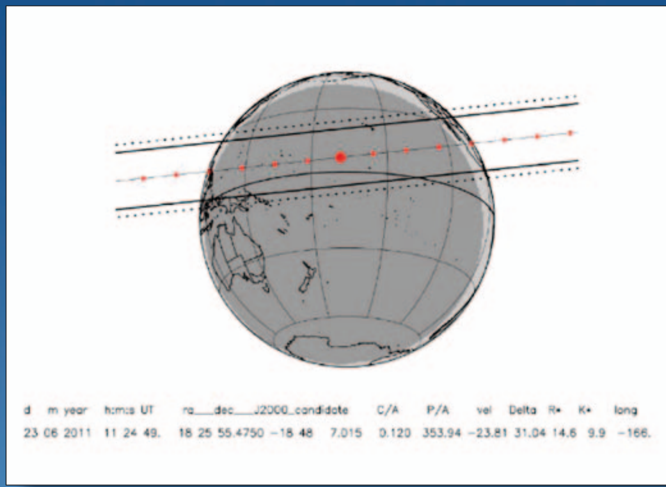
Miyashita, Kazuhisa: LIMOVIE
http://www005.upp.so-net.ne.jp/k_miyash/occ02/limovie_en.html

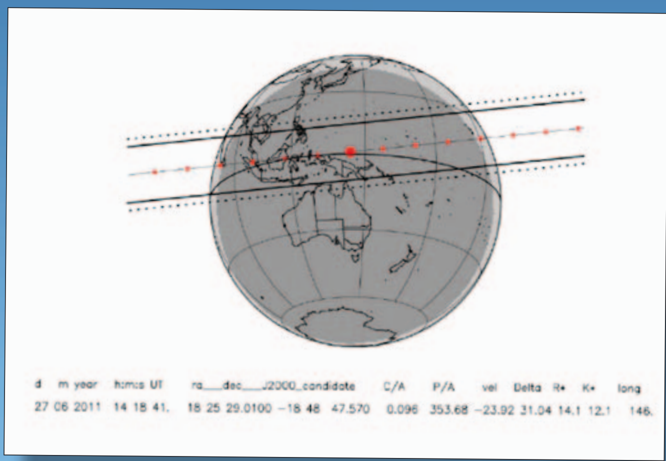
Journal for Occultation Astronomy

Pluto occults 2U24680978 (15.1 mag), 2U24677089 (14.6 mag) and 2U24676603 (14.1 mag) on May 22nd, June 23rd and June 27th

by Hans-J. Bode







Some of the highlights of this year are several occultations of different stars by Pluto best to be seen in eastern North America and the Pacific (Hawaii islands). The stars and Pluto are bright enough to be easily recorded by telescopes with an aperture starting with 12". The only problem might be that they have to be recorded with a (minimum) 12 bits CCD-camera in order to be able to measure details of Pluto's atmosphere undetectable by the 8 bits Mintron- or Watec-cameras. When you plan to work with an 8 bits camera these data can be used for refining Pluto's orbit – which is important too for computing these high precision events for it is still useful to make last-minute astrometry.

Due to the fact that the predictions are based on measurements by the "RIO-team" you can be sure that the computed events will take place in the predicted areas – as it was in the past.

In addition to the two Pluto-events in June you can also record an occultation by Charon (23rd) and perhaps Pluto's moon Hydra (27th) within 1 week!

Are you interested? First take a look to the flight fares to Hawaii: It might be difficult to find an inexpensive one!

Journal for
Occultation Astronomy

CCD Photometry of Uranian and Saturnian Mutual Events in 2007, 2008 and 2009

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Abstract

We present a set of observations of mutual events between satellites of the outer planets Uranus and Saturn. These were made at the Ellinogermaniki Agogi School Observatory (EAO) in Pallini, Greece, using a 40 cm instrument, during the period 2007-2009. Following a successful detection of a mutual occultation between the Uranian satellites Oberon and Umbriel in 2007 (Christou et al, A&A, 2009), we observed and reduced three mutual events between the Saturnian satellites Enceladus, Tethys, Dione and Rhea in late 2008 and in mid 2009.

1. Introduction

The orbits of planetary satellites change over time due to the gravitational attraction between the satellites and between a given satellite and the body of the planet itself. For example, a satellite raises a tidal "bulge" on the planet, which, in turn, affects the motion of that satellite by expanding or contracting its orbit.

This amounts to a very small so-called "tidal" or "secular" acceleration in the satellite's orbital motion that accumulates over time to become observationally detectable over periods of several decades or centuries. Detecting these subtle changes requires not only very accurate satellite astrometry but also regular measurements over long periods of time. The latter requirement generally precludes the use of spacecraft data for this purpose. Accurate timing and photometry of mutual satellite events, on the other hand, is intrinsically a much better estimator of long-term orbital changes.

2. The Mutual Events - IMCCE

In 2008-2010, a series of eclipses and occultations occurred among the satellites of Jupiter and Saturn due to these planets reaching equinox in 2009 (Figure 1). In 2006-2010 a similar series of astronomical events took place between the satellites of the planet Uranus. Systematic observations of this kind were first made in 1973 for Jovian (Aksnes & Franklin, 1976), in 1980 for Saturnian (Aksnes et al, 1984) and in 2007 for Uranian satellites (Christou et al, 2009). The observation of these events provides valuable data to the professional astronomy community.

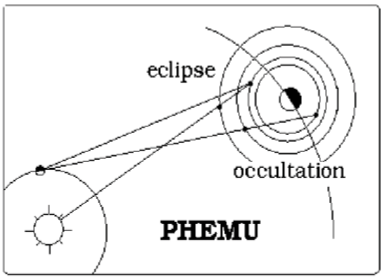

Figure 1: Geometry of the mutual events. Source: PHEMU Tech. Note #1, IMCCE, France.

As there is practically no atmosphere around the satellites, the astrometric accuracy for the satellite positions can be better than 30 mas (milli-arc-seconds) for Jupiter's satellites (Arlot et al, 1997) and better than 5 mas for Saturn's satellites (Noyelles et al, 2003). This translates into 90 km accuracy for the actual position of Jovian satellites in space and just 30 km for Saturnian

Phenomenon	Uranus (2007)	Jupiter (2009)	Saturn (2009)
Opposition	September 9	August 14	March 9
Conjunction with the Sun	March 5	January 24	September 18
Transit of the Sun in the equatorial plane of the planet (equinox)	December 7	June 22	August 12
Transit of the Earth in the equatorial plane of the planet			
(disappearance of the rings)	May 2 & August 16	April 15	September 4
Declination of the planet	-4.1 to 0 deg.	-20 to -13 deg.	0 to 8 deg.

Table 1: Dates of oppositions, conjunctions with the Sun and equinoxes of Uranus (for the year 2007), Jupiter and Saturn for the year 2009.
Source: http://www.imcce.fr/fr/presentation/equipes/GAP/travaux/phemu09/index_en.html, IMCCE.

Date (DD/MM/YY)	Event Type	Obs. Site	Midtime (UT)	Impact Parameter (km)	Albedo Ratio	Relative Speed on Impact Plane (km/sec)	Mean RMS on fit
14/08/07	2O4P	Ellinogermaniki Agogi Obs. Pallini, Greece	01:34:25 ± 28	750 ± 160	0.813 ± 0.1	5.765	0.083

Table 3: Best-fit estimates of the parameters of the mutual event 2O4P for EAO observation (Christou et al, A&A, 2009).

satellites. The Institut de Méchanique Céleste et des Calcul des éphémérides (IMCCE, formerly Bureau des Longitudes) has been organizing observing campaigns of these events since 1973 with the objective of providing the long time series necessary to isolate these tidal effects and use them as proxies for the interior of these bodies, effectively doing geophysics through ground-based photometry. IMMCE has organized the campaigns PHEURA07 for Uranian, PHESAT09 for Saturnian and PHEMU09 for Jovian satellites.

(See: http://www.imcce.fr/en/observateur/campagnes_observation.php). The dates of oppositions, conjunctions with the Sun and equinoxes of Uranus, Jupiter and Saturn are presented in Table 1.

3. Observation of the Uranian mutual events (2007)

Our observations were part of a series of observations organized by one of us (AAC) during the planet's Equinox in 2007. Five different instruments worldwide had taken part in this set of observations, ranging in aperture from 0.4m to 10m. The observations covered specific intervals of time when mutual eclipses and occultations were predicted. Two of these instruments, both of 0.4m aperture, operated in Greece. On August 14th, 2007 we carried out a successful observation of Uranian mutual event 2O4P from Ellinogermaniki Agogi Observatory, in which U2 (Umbriel) partially occulted U4 (Oberon). Later, on September 22nd, 2007, an attempt was made to observe the event 1E5P, in which U1 (Ariel) partially eclipsed U5 (Miranda), from Gerostathopoulion observatory, near Athens. However, the high air mass and poor atmospheric conditions during the observation did not allow the collection of useful data.

3.1 Method & Equipment

Chip	Sony Chip ICX-285 AL
Resolution	1390 x 1040 pixels (1.445.600 pixels)
Chip size	10.2mm x 8.3mm - diagonal 13.15mm
Pixel size	6.45 x 6.45 um
Digitization	16 BIT
Computer Port	USB 1.1 Download time max. 15s
Cooling	Peltier cooling (25° below ambient temp.)
Preview function	Only approx. 1 second download time
Power supply	12V DC - 0.8A power consumption
Protective glass	Optical glass - BK-7

Table 2: CCD specifications.

The observation of the event 2O4P was carried out with Ellinogermaniki Agogi Observatory's (EAO) Meade LX-200R Schmidt – Cassegrain 16" (40 cm) telescope, which is located in a 5 meter dome in the area of Pallini, southeast of the city of Athens. For CCD imaging we used an AtiK 16-HR camera, set at 1x1 binning mode (see Table 2 for camera specs). Image scale was 0.31 arcsec/pixel. Exposure time was 30 sec. We took 34 CCD frames with a Bessell (s) to mitigate against the glare from the planet. Timing information was provided by an Oregon Scientific RMB 899P DCF77 radio clock. UT time of first exposure was 01:09:39 and UT time of last exposure was 01:46:14. Following modeling and subtraction of the planetary source from these frames, differential aperture photometry was carried out on the satellite pair Umbriel & Oberon, involved in the event. Nearby bright satellite Titania was used as the reference source.

3.2 Results

The light curve was model-fitted to yield best estimates of the time of maximum flux drop and the impact parameter. Time of mid-event was estimated to be UT 01:34:25 ± 28 sec. The impact parameter was estimated as 750 km ± 160 km (see Table 3).

4. Strategy for observing the Saturnian mutual events (2008 and 2009)

On the IMCCE web page there are interactive tools where one can input values for parameters (filters) e.g.: site coordinates, minimum distance of satellite from the planet, minimum planet elevation, maximum sun elevation, minimum flux drop, etc, in order to create a table of events visible from his observing site and observable according to his equipment capabilities.

(See: http://www.imcce.fr/page.php?nav=en/observateur/campagnes_obs/phesat09/prog_interactif.php)

For Athens, Greece, the number of all the theoretically visible events was 19. Many of these events were practically impossible to observe, as they occurred during bright twilight. After careful examination of this list, we selected two events to observe in 2008 and one in 2009. These are: event 4O5P (occultation of S5 Rhea by S4 Dione on December 19th, 2008), event 3O2P (occultation of S2 Enceladus by S3 Tethys on December 24th, 2008 and event 3E4P (eclipse of S4 Dione by S3 Tethys on July 7th, 2009).

Journal for Occultation Astronomy

4.1 Observation Method and Equipment

We used again EAO's Meade LX-200R telescope, AtiK model CCD camera and Oregon Scientific radio clock employed for the uranian satellite observations. Our previous observational experience of imaging that event suggested that we should make the observations with a Bessel I(s) filter in order to minimize the glare from the bright planet. This proved to be particularly useful for the observation of the first two events, 4O5P and 3O2P. However, the predicted circumstances for the third event, (large magnitude drop, relatively large distance of target satellites from the planet) allowed us to observe the event 3E4P with a Bessell V filter. 3x3 binning was used. The combination of the specific telescope and CCD imager resulted in a pixel scale of 0.93 arcsec/pixel and a FOV of 6,68 x 5,37 arcmin for each frame. For the event 4O5P we acquired 63 frames of 30 sec exposure time between UT 01:51:20 and UT 2:25:26 (19 Dec 08) and for the event 3O2P we acquired 51 frames of 6 sec exposure time between UT 01:57:12 and UT 02:04:42 (24 Dec 08). During the event 3E4P, we acquired 140 4-sec exposures between 19:00:34 UT and 19:12:52 UT (07 July 09).

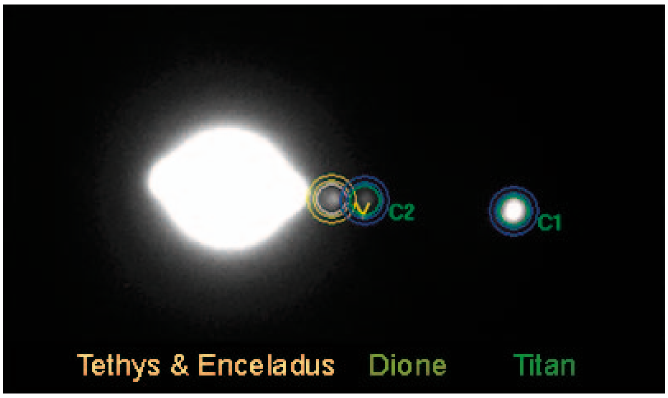

Figure 2: Differential photometry with AIP4WINV2. Left: Event 4O5P. The variable light source (V) is the satellite pair Dione+Rhea and the comparison light source (C1) is Titan. Right: Event 3O2P. The variable light source (V) is the satellite pair Tethys+Enceladus and the comparison light source (C1) is Titan. The check light source is satellite Dione (C2).

4.2 Image Processing with AIP4WIN V2

We derived lightcurves of the target satellite or pair of satellites with respect to a reference source by means of differential photometry. For the first two events in December 2008 (Figure 2), the reference source was satellite S6 (Titan), while Rhea was used for the third event. In the case of 3O2P in particular, we used satellite Dione as a check source. For the event 4O5P we set the radii of the photometric apertures to 9 pixels for the inner ring (the annulus containing all of the star's light), 12 pixels for the middle ring (the inner boundary of the region containing the sky background) and 16 pixels for the outer ring (the outer boundary of the region containing the sky background). For the event 3O2P, due to the close proximity of the target to the planet Saturn and, after some trial and error, we finally set the radii of the photometric apertures to 5 pixels for the inner, 6 pixels for the middle and 8 pixels for the outer ring, in order to get reasonable results.

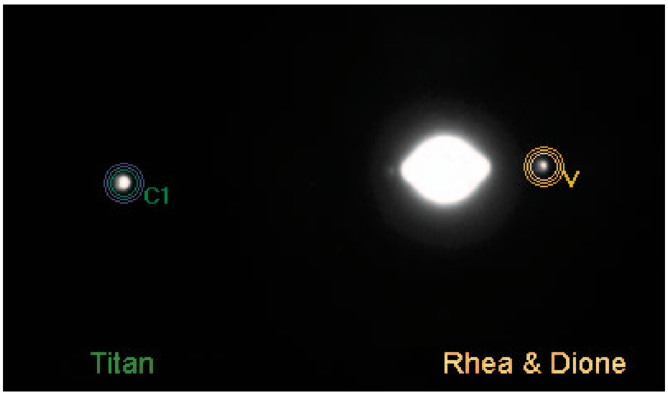

Figure 3: This diagram explains the geometry of the events. The blue disc of a satellite is occulting the brown disc of another satellite. The blue disc is larger than the brown satellite in this example, but it could be smaller. For each event there is an uncertainty Delta b in the impact parameter b (b affects how large the light drop is), and in the time of mid-event tmin (Delta tmin). Indeed the fact that there is an a priori uncertainty in these quantities is the reason why it is valuable to do the observations.

4.3 Processing of photometric points with IDL software

One of us (AAC) used Interactive Data Language (IDL) for the model fitting of the observed light curves. We estimated the time of minimum tmin and the impact parameter b (see Figure 3) for each event by processing and fitting the light curves produced with AIP4WIN V2.

4.4 Results

The results are presented in Table 5 and can be compared to the predicted values of the main prediction models, TASS and D93, given in Table 4. Figures 4, 5 and 6 present the best-fit model vs. observations.

In the case of the event 4O5P the time of minimum is in a better agreement with the TASS prediction, while in the case of 3O2P there is agreement with both predictions, given that the 4 second error (12 seconds at the 3-sigma level) is comparable to the time difference between the

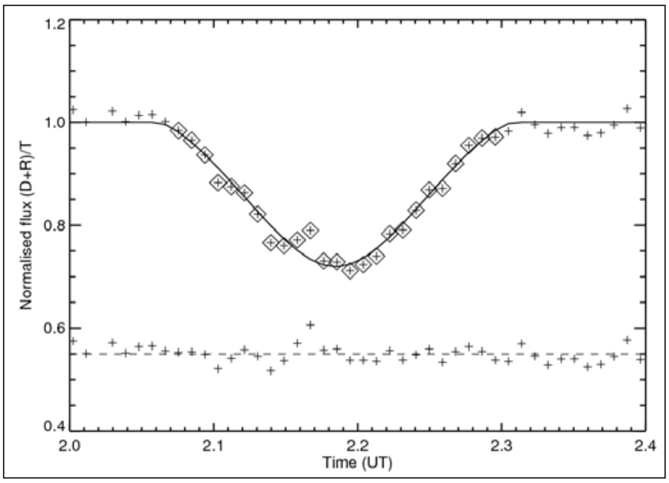

Figure 4: Best-fit model (continuous line) for the event 4O5P vs. observations (+ signs). The diamonds (<> signs) indicate the observations, which were used for the fit. The + signs below and above the dashed line indicate the residuals after the fit.

IMPACT PARAMETER				
DATE OF MINIMUM YYYY/MM/DD	EVENT	TIME OF MINIMUM (UT) TASS D93	FLUX DROP TASS D93	(KM) TASS D93
(V-band)				
2008/12/19	4OCC5P	02:11:10 - 02:11:44	0.271 - 0.311	530 - 278
2008/12/24	3OCC2P	02:00:47 - 02:00:57	0.130 - 0.063	483 - 583
2009/07/07	3ECL4P	19:06:29 - 19:06:46	0.869 - 0.535	298 - 318

Table 4: The predictions of TASS D93 for the time of minimum (UTC), the light flux drop in the V-band and the impact parameter for the three events. The value for light flux drop is given for the V-band.

EVENT	TIME OF MINIMUM (UT)	FLUX DROP	IMPACT PARAMETER (KM)
4 OCC 5 P	02:11:08 ± 13 sec	0.28 (I-band)	430 ± 400
3 OCC 2 P	02:00:55 ± 04 sec	0.16 (I-band)	455 ± 200
3 ECL 4 P	19:06:35.6 ± 03 sec	0.19 (V-band)	420 ± 80

Table 5: The result of the observation of the three events. The observed flux drop is measured in the I-band for the first two events and in the V-band for the third event. The impact parameter is given in kilometers.

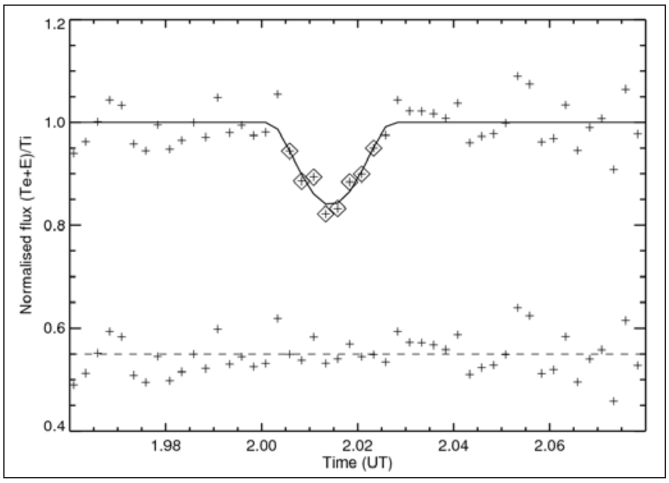

Figure 5: Best-fit model (continuous line) for the the event 3O2P vs. observations (+ signs). The diamonds (<> signs) indicate the observations which were used for the fit. The + signs below and above the dashed line indicate residuals after the fit.

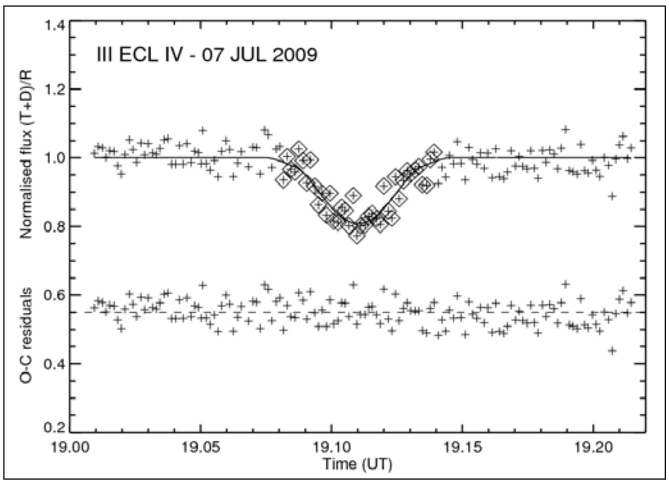

Figure 6: Best-fit model (continuous line) for the event 3E4P vs. observations (+ signs). The diamonds indicate the observations, which were used for the fit. The + signs below and above the dashed line indicate the residuals after the fit.

predicted times of the two models (12 seconds). As for the value of the impact parameter, there is a fairly better agreement with the TASS prediction, for both events. For the event 3E4P, the estimated mid-eclipse time is slightly better in agreement with TASS, but the two models predict essentially the same impact parameter, smaller than what we observe. Note that the measured flux drop is much lower than predicted. This is due to the fact that the photometric aperture also contained the satellite Tethys due to its proximity to Dione.

5. Conclusions

Our general conclusion is that the more recent TASS Ephemeris represents the differential positions of the satellites of Saturn with a better accuracy than the D93 Ephemeris. We hope that the comparison of these two 2008 events, as well as of others to follow in 2009, with the past events of 1980 and 1995 will more precisely define limits to values of tidal acceleration of the Saturnian satellites, mainly of the inner quartet Mimas, Enceladus, Tethys and Dione.

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Andrew John Elliott – an English Gentleman passed away.

It must have been roughly 30 years ago that we got in touch for the very first time by standard mail. At that time IOTA/ES was computing and distributing occultation predictions of stars by the moon, planets and asteroids. From the very beginning he introduced himself as an experienced stellar occultation observer always working with state of the art instruments and equipment – proving this by his results.

Over the years he was a frequent and most curious participant of IOTA/ES's European Symposium on Occultation Projects (ESOP), always letting others share his many skills and advices in his calm, friendly, and unique humorous manner. In 1997 Andrew invited the European Occultation Community to come to Cambridge where he had taken the effort to organise ESOP XVI.

The participants of ESOP XVI kept in mind the special scientific quality of the sessions, also being given the chance to listen to one of the "veterans" of lunar occultation work, Gordon Taylor from HMNAO, Greenwich. None of us will ever forget the once in a lifetime privilege to see the stone circles of Stonehenge and to walk through them in just a small group!

Andrew was the one giving us these rare opportunities and organising all this and much more. He even helped out personally with some financial problems of one of the participants: he readily took the expenses, not telling anyone, not even the board of IOTA/ES!

Yet this year Andrew and his colleagues organised EXOP XXIX at York-University and again he secretly sponsored some funding for the symposium in his generous way. We were very sad already then that he was no longer able to be with us.

We will miss him. Farewell Andrew!
IOTA/ES and the board

Dear All,

I have been asked by Andrew Elliott's mother, Edna, to pass on the following remarks. Specifically Edna makes the following comments:

"I would like to thank all Andrew's friends for the wonderful tributes which have been pouring in. It is a great comfort to me to know how much both his friendship and Astronomical work have been valued."

I can also report that at the Christmas meeting of the British Astronomical Association which took place at Burlington House, Piccadilly, London last Saturday (December 11), we held a minute's silence at the start of the meeting in memory of our dear friend Andrew.

Richard Miles

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Light Curve of the 1978 August 26th Lunar Graze Occultation of Aldebaran in Scotland Obtained from Cine Film.

By Tim Haymes

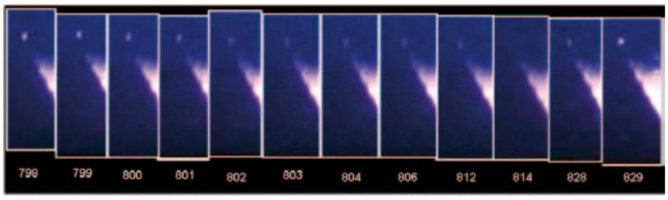
Summary

Super-8 cine film of the graze was copied onto digital tape and transferred to PC.

Limovie was used to produce a light curve. Some events are non-instantaneous.

The Story

This graze occultation of Aldebaran was found in the historical lunar occultation facility within Occult (Ref-1). It was of particular interest to the author because he recorded the graze with a super-8 cine camera attached to the eyepiece of a 15cm F/8 Alt-Az reflector, guided with an 80 mm refractor. The film was recently digitised and shows a significant fade event (at 0226:41 UT) which had been reported previously (Ref-2). The digital reproduction (AVI) was analysed with Limovie (Ref-3). The long fade was apparently not reported to ILOC because the star was dimly seen in the eyepiece by both observers. (Gavine and Haymes). The film recorded it as having disappeared. The fade is estimated to be about two magnitudes. Several of the events were non-instantaneous in nature. A curious phenomenon caused by the diameter of the star now well understood, but was of observational interest at the time.



Frame sequence from 0226:41 to 0226:42 UT (approx) (18fps cine copied at 25fps) · Film: High Speed Ektachrome

Team-one which included the author, observed from the top of the 650m long dam at Loch Cluanie power station. When we got there the gate was locked, so we climbed the fencing and passed our equipment over carefully. It was a beautiful warm clear night. The 6" with A-focal cine camera was a dual station with D Gavine. There were two minutes of run time on the film but the author didn't know how long the graze would be, so the camera was started when his co-observer shouted "IN". Thus the first disappearance was not filmed. The light curve commences with a reappearance. Events were recorded on audio tape with radio time pips from MSF (60 KHz)

The observing team (List from Ref-4) consisted of R McNaught (Dundee, 10x50s), D Gavine (Fort Augustus, 79mm OG), D Taylor (Dundee, 112mm refl), M Fodor (Dundee and St Andrews 79mm OG), T Haymes (Maidenhead, 150mm refl and 80mm OG) and P Furguson (Reading, 112mm refl). A second team observed from a different location: J Righton and S King (254mm refl), N Fisher (152mm refl), R Easto (152mm refl), B Mills (152mm refl) all of Croydon AS and C Clayton(Bath, 152mm refl).

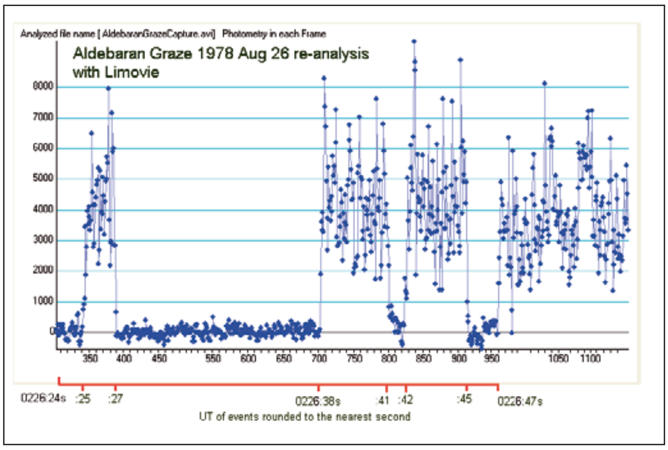
Reappearance of Aldebaran Cine camera attached to 6" Alt-Az (practice mode)

In Summary, I am pleased to have the opportunity to contribute to the JOA. Publishing this cine film record to a wider audience is overdue, and I hope it will be of historical interest. There are many excellent video recordings of grazes on YouTube, but relatively few with Cine. The application of Limovie to this old format may be novel.

Ref-1 V 4.0.9 by David Herald
Ref-2 BAA Lunar Section meeting in Bristol (UK), 1978 November 11.
Ref-3 Limovie version 0.9.29b by Kazuhisa Miyashita of Japan.
Ref-4 Reported in the BAA Lunar Section Circular, December 1978 Vol13, No 12

Tim Haymes, Hill Rise, Knowl Hill Common, Knowl Hill, Reading RG10 9YD. UK, eMail: occultation@baalunarsection.org.uk

2011 March 19



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Portable Meter-Class Astronomy

Developmental and Observational Programs

International Hawaii Conference January 20-22, 2012Canada-France-Hawaii Telescope Headquarters, Waimea, Hawaii

Volcanoes National Park tour January 18th, Mauna Kea insider's tour January 19th

Mauna Kea observing session evening of January 21st

Conference web site: www.AltAzInitiative.org

Co-Chairs: Russell Genet (russMGenet@aol.com), and Bruce Holenstein (bHolenstein@gravic.com)

This conference is devoted to a specialty branch of astronomy—the development and use of portable meter-class telescopes. These telescopes trace their origins to John Dobson and his innovative ideas for making relatively large aperture alt-az telescopes from low cost materials with ordinary tools. Amateur telescope makers have continued to refine these alt-az telescopes which, not surprisingly, have come to ever more closely resemble their huge mountaintop cousins. Heavy, enclosed Sonotubes have been replaced with lightweight, open trusses. Mirrors have become thinner and significantly larger in diameter—supported by increasingly sophisticated whiffletrees. Computer controlled slewing and tracking have been added. Temperature compensated focusers and instrument rotators facilitate long-exposure astro-imaging.

Note: Sessions of special interest to IOTA members include High Speed Photometry (which has many applications) and Occultation Astronomy.

The Alt-Az Initiative was founded in June 2007 with the express purpose of facilitating the evolution of portable, lightweight, low cost, meter-class alt-az telescopes. The Initiative, from its inception, aimed at achieving much larger aperture portable telescopes than currently existed. Initiative members quickly realized that it would pay to closely examine the technologies already developed for modern mountaintop telescopes, so they initiated a purposeful "tech transfer" program that would, at low cost, innovatively emulate appropriate technologies such as direct drives, thin active primary mirrors, deformable secondary mirrors, multiple mirrors, etc.

The primary application of portable meter-class telescopes has been, and will likely continue to be, visual observations. Portability allows telescopes to be safely stored at homes and schools in light polluted cities, yet operated just hours away under dark skies. Large apertures allow faint objects to be observed, while low costs inable widespread ownership and use. Thanks to computer-controlled slewing, tracking, and instrument rotation, portable meter-class telescopes are beginning to be used for astro-imaging and, increasingly, in various areas of instrumented scientific research.

Mirrors, especially low cost, lightweight mirrors, are the key ingredient required for the continued evolution of meter-class portable telescopes. Active efforts are underway to further develop meniscus, sandwich, foam glass composite, spin-cast epoxy, and layered mirrors. Forces are just beginning to be applied to adjust the figures of lightweight thin meniscus primary mirrors in meter-class telescopes in a manner somewhat similar to their large mountaintop relatives. Similarly, work has just begun on low cost active secondary mirrors which can be "warped" to counteract distortions in lightweight primary mirrors. Such active mirrors can also be tip/tilted to reduce the effects of the wind gusts on portable telescopes. Finally—also similar to the largest mountaintop telescopes—we anticipate that the largest meter-class telescopes will employ multiple mirrors to reduce weight and facilitate their manufacture and handling.

Recreational visual astronomers are interested in everything they have a chance to see, so the exciting advantage of a high optical quality, one person set-up, meter-class telescope is that there is so much more to observe. Visual observers marvel at seeing the real photons from objects. Some are excited by being able to barely detect the faintest possible objects such as distant galaxy clusters, quasars, and gravitational arcs. Astro-imaging can also benefit from larger apertures and portability.

Scientific research programs, as is the case with visual and astro-imaging programs, can benefit from larger apertures and the dark sky opportunities that portability creates. In addition to greater program object fluxes, scintillation noise decreases with telescope aperture, so meter-class telescopes have superior program object signal-to-noise ratios for a given integration time.

There are instances where scientific observations actually require portability. For example, the size and shape (and hence albedos) of asteroids and trans-Neptunian objects (TNOs) can be determined from occultations observations as they pass in front of a star, casting a narrow shadow that races across the Earth. Since such narrow shadows rarely pass over fixed location observatories, they must be observed with portable telescopes. With larger, meter-class telescopes, many more occultations can be observed than would otherwise be possible.

Telescopes may also need to be moved to a location not because of some astronomical event, but because the local observing conditions are advantageous in some way. For example, near infrared photometry (especially Ks band) benefits from high altitudes and dry skies. A number of mountaintop observatories, blessed with good roads to the summit, would not mind sharing their skies with portable meter-class telescopes.

The era of portable meter-class astronomy has been underway now for several decades – ever since large aperture alt-az Dobsonian telescopes first made their first appearance. Visual observations through Dobs have endeared an entire generation of the public to observational astronomy. We hope and expect that the use of portable meter-class telescopes will increasingly be extended beyond visual observation, not only to recreational astro-imaging, but also to a wide variety of scientific research projects. The dark skies beckon the ever increasing numbers of portable meter-class telescopes of all types.

We maintain that portability doesn't have to be restricted to "smaller" apertures. The only limits should be our ingenuity and what can be legally towed down the road. There is no reason we shouldn't see portable 2 meter telescopes in the near future, starting first with on-axis light buckets and then spreading to imaging telescopes. There will be many problems to overcome on the way to 2-meter portability, but working together we'll solve them all—one at a time.

29th Annual Meeting of the International Occultation Timing Association

David Dunham, Greenbelt, Maryland, USA, dunham@starpower.net

You are invited to attend the 29th annual meeting of IOTA that will convene July 16-18, 2011, at Sierra College in Rocklin, California, the same venue where IOTA met for their 21st meeting in July 2003. We will meet informally for dinner Friday, July 15th; the location has not yet been selected, but will be announced on our Web site for the meeting at http://www.asteroidoccultation.com/observations/NA/2011Meeting/index.htm .

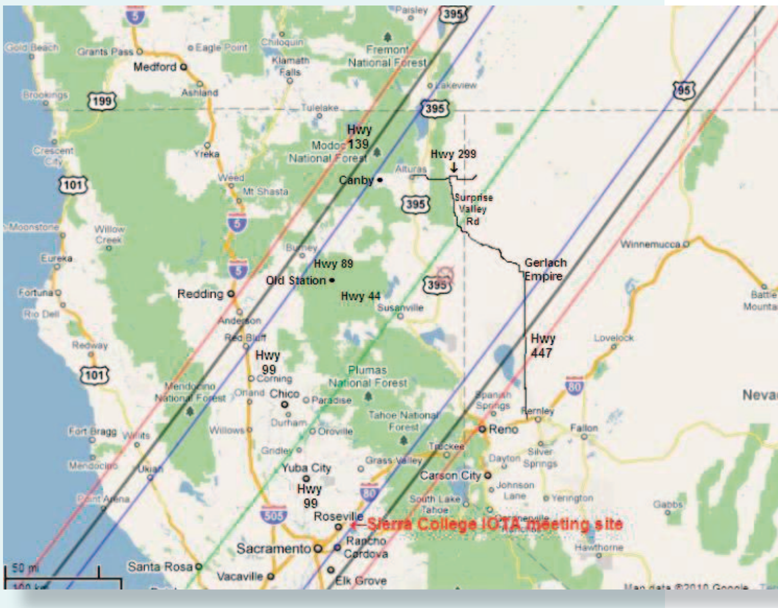
We plan to broadcast the meeting via the free EVO webcasting system, as we have done during the past few IOTA meetings, to allow attendance, even giving presentations, by those around the world who can't physically attend the meeting. Information about the EVO webcasting will be given at the above Web site during the days before the meeting. If you would like to give a presentation at the IOTA meeting, please contact me at dunham@starpower.net . A preliminary schedule will be posted on the meeting Web site in April or May.

If weather conditions permit (the probability for clear skies is very high), we plan to observe the occultation of 6.7-mag. ZC 3339 (= SAO 165285 = HIP 112420) by the large binary asteroid (90) Antiope that is predicted to pass over much of northern California Tuesday morning, July 19th. The components of Antiope are each about 90 km in diameter; their centers are about 170 km apart, with a circular orbital period of 16.5 hours. The line joining the centers of the two objects will be about 45° from the direction of motion of Antiope, so one component or the other will occult the star in a path about 200 km wide (taking into account projection on the Earth's surface). Most stations will have an occultation by one of the objects. For a short distance near the actual central line, either there will be no occultation by either component, or a short occultation by both components; we can't be sure. By spreading many stations across the total range and the 1-sigma uncertainty zone, we plan to map the profiles of both objects in detail. Path maps and other information about this interesting occultation, and about the IOTA meeting (maps showing Sierra College), are in a 0.5-megabyte Power Point file at

http://www.asteroidoccultation.com/observations/NA/2010Meeting/Presentations/July19_Occultation%20by%20Antiope.ppt

The figure below is from the Power Point file.

Predicted path of the occultation of ZC 3339 by (90) Antiope across northern California, 2011 July 19



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Occultation Astronomy

IOTA External Publications

David Dunham, Greenbelt, MD, USA, dunham@starpower.net and
Wolfgang Beisker, Garching, Germany, wbeisker@iota-es.de

It is important for members of IOTA to publish in external publications, to inform the wider astronomical community of the important results that we are obtaining, and the research that we are performing. Below is a list of publications that have been published from 2009 to the present. If we have missed an external publication about occultations for which you are a co-author, please let us know so that it can be included in a similar list in the next issue. First we list publications that have been published, then articles that have been submitted for publication.

Published Papers

B. Sicardy, G. Bolt, J. Broughton, T. Dobosz, D. Gault, S. Kerr, F. B′nard, E. Frappa, J. Lecacheux, A. Peyrot, J.-P. Teng-Chuen-Yu, W. Beisker, Y. Boissel, D. Buckley, F. Colas, C. de Witt, A. Doressoundiram, F. Roques, T. Widemann, C. Gruhn, V. Batista, J. Biggs, S. Dieters, J. Greenhill, R. Groom, D. Herald, B. Lade, S. Mathers, M. Assafin, J. I. B. Camarge, R. Vieira-Martins, A. H. Andrei, D. N. da Silva Neto, F. Braga-Ribas, and R. Behrend,

"Constraints on Charon's orbital elements from the double stellar occultation of 2008 June 22", **The Astronomical Journal**, Vol. 141, pp. 67-83, 2011 February.

M. Assafin, J. I. B. Camargo, R. Vieira Martins, A. H. Andrei, Bruno Sicardy, Leslie Young, D. N. da Silva Neto, and F. Braga-Ribas, "Precise predictions of stellar occultations by Pluto, Charon, Nix, and Hydra for 2008-2015", **Astronomy and Astrophysics**, Vol. 515, p. A32, 2010, doi: 10.1051/0004-6361/200913690

John Talbot, "Recent Successful Asteroidal Occultations in Our Region in the Past Two Years", **Southern Stars,** Vol. 49, No. 4, pp. 16-22, 2010 December. This presents a selection of interesting results from Pluto and asteroidal occultations observed from Australia and New Zealand during 2008 and 2009. The paper was presented at the fourth Trans-Tasman Occultation Symposium in Canberra on 2010 April 5.

David Dunham and Eberhard Riedel, "Occultations by the Moon", **Observer's Handbook 2011** of the Royal Astronomical Society of Canada (also serves astronomers in the USA), 2010, pp 166-181. This includes predictions of lunar total and grazing occultations for southern Canada, the USA, and northern Mexico for 2011. Similar data for 2010 were published on pages 164-179 of the **Handbook** for 2010 published in late 2009. The predictions for grazing occultations, including for other parts of the world, are at http://iota.jhuapl.edu/grazemap.htm .

David Dunham and Jim Stamm, "Planetary and Asteroidal Occultations", **Observer's Handbook 2011** of the Royal Astronomical Society of Canada (also serves astronomers in the USA), 2010, pp 253-257. This includes predictions of asteroidal occultations for North America and Hawaii for 2011. Similar data for 2010 were published on pages 247-250 of the **Handbook** for 2010 published in late 2009.

Brad Timerson, Josef Durech, Fred Pilcher, Jim Albers, Tom Beard, Berger Berger, B. Berman, Derek Breit,

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XXX.

European Symposium on Occultation Projects (ESOP)

Berlin, August 26th to 31st 2011

We are pleased to invite you to the 30th European Symposium on Occultation Projects in Berlin, Germany. In 2011 the annual conference of IOTA/ES will be held at the Archenhold-Observatory, the oldest and largest public observatory in Germany.

ESOP starts in the afternoon of 26. August 2011 with a welcome barbecue. If the weather is favorable observations with the observatorys telescopes will be offered after sunset. The lectures will be held on Saturday and Sunday (27-28. August 2011). For accompanying persons a special programme is offered. From Monday to Wednesday (29-31. August 2011) additional group trips are will give the opportunity for further discussions, to socialise and to visit places with astronomic and/or historical background in and around Berlin.

For more detailed information and online registration visit the ESOP XXX website: www.astw.de/esop. In case of any questions please do not hesitate to contact the local orgnising comitte via the email esop@astw.de

We are looking forward for seeing you in Berlin.

The European symposium of occultation projects (ESOP) is the yearly conference of the international occultation and timing association www.iota-es.de. This event give the possibility to go in touch with professionals and amateurs about occultation observations and calculations from many European countries. Due to the international character of the symposium all lectures are given in English language. You will find a friendly atmosphere and many interesting people. Lectures, discussion and astronomical smalltalks are typically for ESOP since 30 years.

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The longest moveable refracting telescope on Earth is 21 meters long and is still today the main highlight of attraction at the Archenhold Observatory. With its lens diameter of 68 centimetres, it is nevertheless still at 8th place of the world ranking list of large refracting telescopes. Therefore, it has been correctly called the Treptow Giant Telescope since its installation in the year 1896.

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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.

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IOTA Lunar Occultations, Eclipses, and Asteroidal and Planetary Occultations Site:
http://asteroidoccultation.com/iota/

This site contains information on lunar occultations, eclipses, and asteroidal and planetary occultations and the latest information on upcoming events. It also includes information explaining what occultations are and how to report them.

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