Abstract Book

European Symposium on Occultation Projects

29. & 30. August 2020

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Web Video Conference ESOP XXXIX

Am Brombeerhag 13, D-30459 Hannover, Germany

Typesetting & graphic design by Oliver Klös, IOTA/ES

Note: Abstracts have not been reviewed *Ver. 2020-08-27*

Programme
Saturday, 29. August 2020

09:00 UT	Welcome to ESOP XXXIX	K. Guhl

Results & Perspectives

W. Beisker - Chairman
K. Guhl - Chatcom

09:05 UT	Occultations and the Size and Density of Asteroids	M. Kretlow
09:30 UT	Asteroidal occultations: Results from 2019	D. Herald
09:55 UT	Latest developments and results at professional observatories	A. Richichi

Coffee Break 10:30 UT

10:45 UT	Modelling and scaling neglected asteroids	A. Marciniak
11:05 UT	Stellar occultations and the Lucky Star project	B. Sicardy
11:30 UT	Occultations by Irregular Satellites of the Giant Planets	A. R. Gomes-Júnior

Lunch Break 12:05 UT

Technology

A. Pratt - Chairman
N. Wünsche - Chatcom

13:00 UT	Experiences from DVTI Camera Beta Tests	C. Weber
13:50 UT	Precise timing with digital cameras	C. Valencia Gallardo

Coffee Break 14:25 UT

Astrometry

M. Kretlow - Chairman
N. Wünsche - Chatcom

14:40 UT	Performance of occultation astrometry with Gaia DR2	J. F. Ferreira
15:05 UT	Improvement of Asteroid Orbits for and with Asteroidal Occultations	D. W. Dunham

Programme
Sunday, 30. August 2020

Predictions & Campaigns

K. Guhl - Chairman
N. Wünsche - Chatcom

09:00 UT	PHEMU 2021: Mutual Phenomena of Jupiter Satellites in 2021	J. Desmars
09:15 UT	Highlights of Stellar Occultations by Asteroids with Moons in 2021 in Europe and Special Events for North America & Australasia	O. Klös

Software

T. Haymes - Chairman
N. Wünsche - Chatcom

09:50 UT	The Cartes du Ciel (Sky Chart) Addin for Occult Watcher	W. Burzyński
10:10 UT	OccultPortal: a web-based platform for data collection and analysis of stellar occultations	Y. Kilic

Coffee Break 10:35 UT

10:50 UT	GOcEcl - a new deep asteroid occultation feed for larger apertures	R. Purvinkis
11:20 UT	QHY174GPS Firmware-Upgrade - Implementation and Benefits	C. Weber

Lunch Break 12:00 UT

Observations

M. Haupt - Chairwoman
S. Andersson - Chatcom

13:00 UT	2 positive asteroidal occultations within 10 minutes	A. Pratt
13:15 UT	Propus graze occultation mystery - the history of one observation	W. Burzyński
13:30 UT	Descending into the Smallest Depth of an Asteroid Occultation	P. D. Maley

Coffee Break 14:00 UT

14:15 UT	The partial and nearly grazing solar eclipse of June 21, 2020 and solar diameter measurements	C. Sigismondi

Next ESOPs & Closing

K. Guhl - Chairman
N. Wünsche - Chatcom

14:45 UT	Announcing ESOP 2021 in Bialystok (Poland)	W. Burzyński
14:55 UT	Announcing ESOP 2022 in Granada (Andalucía/Spain)	P. Santos-Sanz & C. Schnabel
15:05 UT	Closing Remarks	K. Guhl

Occultations and the Size and Density of Asteroids

M. Kretlow [1*]

[1]International Occultation Timing Association, European Section (IOTA/ES); D-27389 Lauenbrück, Germany

1 Introduction

Asteroids are described by dynamical parameters (orbit, dynamical class, families, etc.), by their physical properties, and finally also by their chemical composition. Size, mass, density, and macro porosity are prime physical properties and important for our understanding of the internal structure and morphology of asteroids (Scheeres et al., 2015).

With an increasing amount of size, mass and thus density data, new statistical approaches are possible revealing further structures in the asteroid belt and population, with implication on the description of the current and former state of the Solar System.

However, we yet have density estimates for only some hundred objects, and only about 1/3 of them have a relative accuracy better than 20%. With very few exceptions, bulk densities are calculated from individual size and mass estimates.

We need more data and many of the existing ones should be confirmed and improved in accuracy, where possible. This is a huge and continuous task, covering different (observational and theoretical) domains – and another example of fruitful pro-am collaborations, as many rotational light curve photometry (see CALL website) and occultation oberservations are provided by amateurs.

2 Size and Mass estimates

When the book *Asteroids III* was released in 2002, the chapter on masses and densities by Hilton listed only ~50 individual mass estimates for ~25 different asteroids. The list on individual bulk densities ρ was even smaller. The limiting factor at that time was the availability of asteroid mass estimates, which are systematically much harder to derive than size measurements. Size estimates were already available for almost 2000 asteroids due to IRAS obervations and from stellar occultations. But with increasing accuracy of mass estimates, the uncertainty of the diameter D can now be the limiting factor for the resulting uncertainty in density, because $\Delta\rho/\rho = \sqrt{(\Delta M/M)^2 + 9(\Delta D/D)^2}$.

2.1 Stellar occultations

The number of predicted and successful observed occultations by asteroids has increased significantly in the past two decades due to increasing and better resources and collaboration tools, and a growing community of observers (Figure 1). The Gaia star catalog release boosted that once more. Meanwhile occultations are not only used to derive size and shape of asteroids, but also to get a considerable amount of Gaia level (mas to submas) astrometric positions, even with single chord observations (Ferreira et al., 2020).

Stellar occultations play an important role in establishing and extending the list of known densities of asteroids as the number of mass estimates is growing as well. They confirm (or question) existing diameter estimates derived by other methods (e.g. radiometric), and they are very helpful to scale 3D models derived from rotational light curve inversion and thus to provide accurate volumes of irregular bodies.

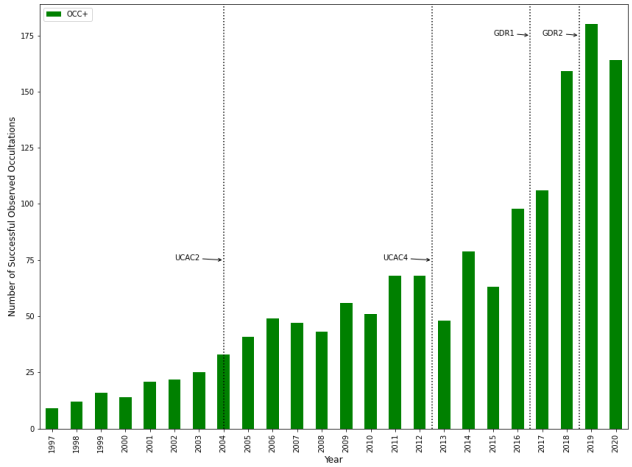

Figure 1: Annual number of successful observed stellar occultations by asteroids in Europe. The release dates of astrometric star catalogs with high impact on occultation predictions are indicated.

3 Web Archive and Portal

Carry (2012) compiled from the literature ~1000 mass and ~1500 size estimates and derived from that mean bulk densities and macro porosities for about 300 asteroids. These data were only available in that publication, not in a machine-readable form. This work is a continuation of that effort. It is an up-to-date and (mostly) complete collection of size and mass estimates, providing researchers with ready to use data. Moreover this web portal also provides some visualization and interactive handling of the data, helping researchers to address certain questions and data science tasks.

References

Carry, B. Density of asteroids. *Planetary and Space Science*, 73(1):98–118, 2012.

Ferreira, J.F., Tanga, P., Machado, P. et al. A survey for occultation astrometry of main belt: expected astrometric performances. *arXiv preprint arXiv:2007.09665*, 2020.

Hilton, J.L. Asteroid masses and densities. *Asteroids III*, 1: 103–112, 2002.

Scheeres, D., Britt, D., Carry, B. et al. Asteroid interiors and morphology. *Asteroids IV*, 745766, 2015.

*Correspondence: mike@kretlow.de

Asteroidal occultations: Results from 2019

Dave Herald, IOTA

I will provide update the statistics about occultation observations from around the world from those I presented at ESOP 38. And I will show the best 11 occultation results of the year.

Latest developments and results at professional observatories

Andrea Richichi (INAF - Arcetri, Italy) and co-authors

Programs for observing occultations are currently in place at a few professional observatories around the world. I will give a brief overview of such efforts at facilities in Germany, India, Italy, Russia. In particular, I will report on exciting new developments and results in the area of spectroscopically dispersed lunar occultations and a recent asteroidal occultation of a binary star leading to the smallest angular diameter ever measured directly.

Modelling and scaling neglected asteroids

Anna Marciniak, IOTA/ES, University of Poznan

In the Astronomical Observatory Institute of Poznan, Poland we are coordinating a worldwide observing campaign of somewhat neglected asteroids. These are small bodies of the main belt with slow rotation and small lightcurve amplitudes. The aim is to improve biased statistics of spin and shape modelled asteroids. We focus mainly on multi-apparition photometric observations, lightcurve inversion modelling, and scaling those models with thermal infrared data. However, many of these asteroids have poor thermal datasets and cannot be precisely scaled this way. This is where good occultation campaigns can greatly help.

Stellar occultations and the Lucky Star project

Bruno Sicardy,
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Jules Janssen, 92195 Meudon, France (bruno.sicardy@obspm.fr)

The European Research Council (ERC) project “Lucky Star" aims at exploring the outer Solar System using stellar occultations and theoretical tools to interpret those observations. It is currently the world-wide leader in its domain. As of April 2020, more than 185 events have been successfully recorded, with more than 70 objects detected, among which about 30 Trans-Neptunian objects, 5 dwarf planets, 6 Centaur objects and more than 20 Trojan asteroids.
Here I review a few highlights of the past year, concerning Triton’s atmosphere, the shape of Varda and the recent densely observed occultation by 2002 MS4 .

Occultations by Irregular Satellites of the Giant Planets

Altair R. Gomes-Júnior (1,2)
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(2) Laboratório Interinstitucional de e-Astronomia - LIneA, Rio de Janeiro-RJ, Brazil

The irregular satellites are objects that orbit the Giant Planets from great distances, with highly inclined, eccentric orbits and mostly retrograde. It is believed that these satellites were captured by their host planets during the Solar System evolution. Thus, studying them may give us hints about their region of origin.

In order to estimate their dimensions with great accuracy, [1] predicted stellar occultations by the 8 largest irregular satellites of Jupiter (Himalia, Elara, Pasiphae, Carme, Lysithea, Leda, Ananke and Sinope) and 1 of Saturn (Phoebe) up to 2020. Due to the passage of the satellites in front of the Galactic Plane in 2018, for Phoebe, and 2019-2020 for the Jovian ones, a large number of events were predicted. Until now, 6 stellar occultations were observed involving Phoebe, 3 with Himalia and 2 with Lysithea.

Since Phoebe already has a known shape from Cassini observations, we used the 3D shape model of [2][1] to fit our chords. This is important because Phoebe is highly cratered so it is likely that the chords may have passed through topographical features.

By comparing the model with the chords of the 2017 event, we notice that both chords could not fit well the 3D shape model. One of the chords was located very far from the projected limb.

However, the chord could fit very well the 3D model if we considered another longitude. This is expected from the error associated with the rotational period of Phoebe. The difference between this result and the expected longitude led us to improve the rotational period of the satellite This work was published in .

Himalia is the largest irregular satellite of Jupiter and it is the main satellite of the group that bears its name. It was the first Jovian irregular satellite ever observed by an occultation, at 12 May 2018 in the USA. This provided two positive chords. The second one happened in 20 May 2018, a week later, observed in Europe and providing six positive chords.

By fitting the 20 May chords with a elliptical shape, we find a size which is larger than those provided by Cassini, with an equatorial radius larger than 100 km. As expected from objects with these dimensions, Himalia must have craters with significant sizes compared to the satellite. By using chords that could be located in craters, the determination of the size could be affected. The preliminary results show a probable cratered shape and a equatorial radius larger than those obtained by Cassini.

Lysithea is from the same orbital family of Himalia. By now, only one-chord occultations have been observed. The results only confirms the size obtained by thermal observations [4].

[1] Gaskell (2013): https://space.frieger.com/asteroids/moons/S9-Phoebe

Stellar occultations of irregular satellites has provided us new informations about these interesting objects. The new rotational period of Phoebe can be used to better fit new occultations. This is important to better constraint the shape of Phoebe if chords close to the north pole of the satellite is observed (region not observed by Cassini).

Acknowledgements

The authors thank the financial support of FAPESP (2016/24561-0, 2018/11239-8), INCT, CAPES/Brazil and CNPq (300371/2018-7 and 380777/2018-5).

References

[1] Gomes-Júnior A. R., et al., MNRAS, 462, 1351–1358, 2016.

[2] Gaskell R. W., NASA Planetary Data System, 207, 2013.

[3] Gomes-Júnior A. R., et al., MNRAS, 492, 770–781, 2020.

[4] Grav T., et al., AJ, 809, 3, 2015.

Experiences from DVTI Camera Beta Tests

Christian Weber, IOTA/ES

There is a Swiss kickstarter project to develop a CMOS camera with integrated GPS time-stamping for occultation work – the “DVTI Camera” (https://groups.io/g/d-vti-cam/). The project has made great strides in recent years. There were several external beta testing phases. One of the beta prototypes was kindly made available to me.

The presentation will not only describe the camera, its handling, performed tests and comparisons to the QHY174GPS and WAT910Hx cameras, but also experiences from real occultation work.

The following points will be included:

- Introduction to the Swiss DVTI project
- Specifications of the prototype provided
- Adaptation to various telescopes
- Hardware requirements and installation
- Presentation of the GUI (Fig. 1) including OW-plugin and plate solving / telescope control

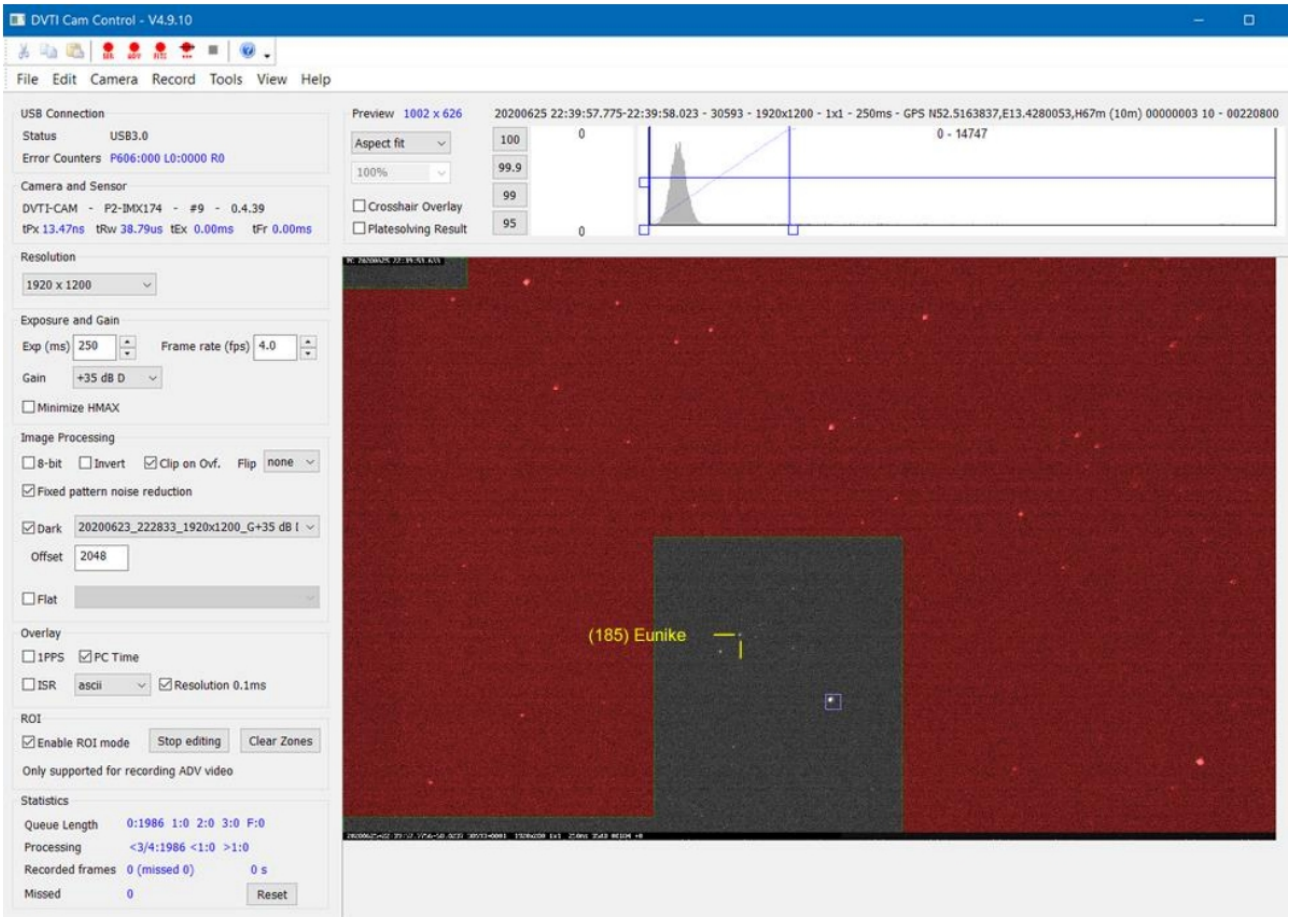

Fig. 1: Example of the GUI

Performed tests

Comparison to QHY174GPS and WAT910HX

Software recognizing the DVTI's output

Observing / observed occultations (Fig. 2) with the DVTI

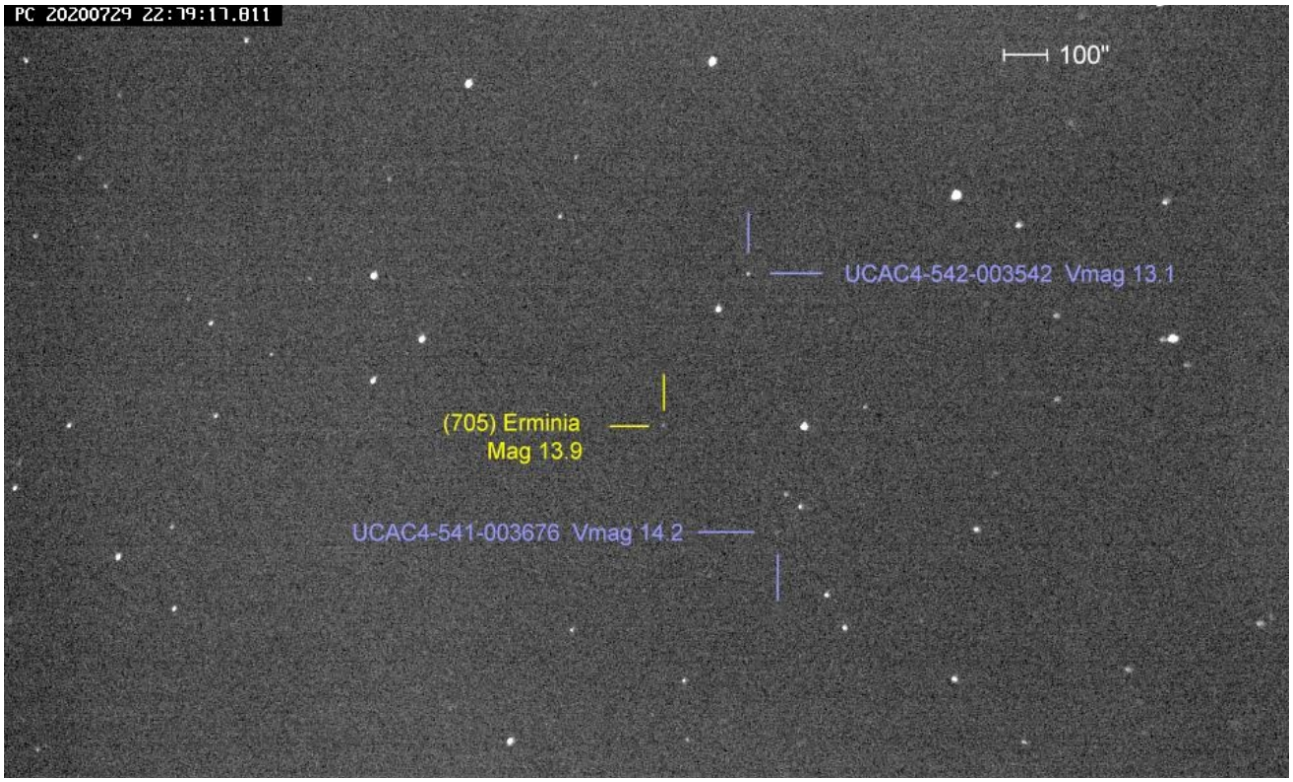

Fig. 2: (705) Erminia occults UCAC4-542-003553 - single frame

Outlook / project's next steps

Precise timing with digital cameras

Cesar Valencia Gallardo, TimeBox UTC

The Shelyak TimeBox has just been released as a multi-mode, accurate, modular and portable solution for UTC timing using digital video cameras in a Windows environment. The goal of this presentation is to show the results of the independent testing of the Shelyak TimeBox using described methods (SEXTA and OccuRec) that measure the accuracy of UTC timestamped recordings for both computer synchronization and trigger modes, and to assess the accuracy of the timestamping when using different cameras and acquisition software.

Performance of occultation astrometry with Gaia DR2

João F. Ferreira (1, 2), Federica Spoto (3), Paolo Tanga (1) and Pedro Machado (2)
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Stellar occultations provide an instantaneous relative astrometric measurement, as the position of the asteroid center of mass, at the mid-time of the event, is very close to the that of the occulted star. If this target star has an independently measured, accurate position, then the asteroid astrometry can be determined at a similar level of uncertainty. This fact is being routinely exploited, for instance, to improve the orbit of distant Trans-Neptunian Objects after a positive detection of an occultation, thus enhancing the probability of observing subsequent events. However, the same approach can be applied more extensively to the whole available data set of stellar occultations, mainly involving Main Belt asteroids (~5 000 events, for ~1 200 asteroids). We present the results obtained so far in this domain.

The exploitation of stellar astrometry from the Data Release 1 of Gaia has already shown the strong potential for such an approach. However, recent advances have made possible to reach a new level of accuracy.

The first innovation involves a more refined data reduction for occultation astrometry, taking into account differential relativistic effects. The new procedure also provides a more realistic error model, that takes into account both the reported measurement uncertainty, derived from each light curve of an event, and the errors on the position of the occultation chord relative to the asteroid center of mass.

The second major progress is the publication of the new data release by Gaia (DR2) in April 2018, providing nearly the full astrometric performance of the mission, providing proper motions and parallaxes for a large fraction of the stars.

Nevertheless, the exploitation of these data requires some additional care to be effective.

First of all, to exploit asteroid astrometry referred to Gaia DR2, a de-biasing (correction of local systematic errors) must be run on ground based astrometry, when this was reduced by pre-DR2 catalogues. We have recently completed the de-biasing procedure for all 14 099 asteroids present in DR2, and for all the asteroids that produced occultations in the past.

The second critical aspect are the subtle corrections to be applied to the DR2 catalogue to mitigate the impact of a reference frame rotation found in the catalogue (Lindegren 2020).

With this approach, we attempted to improve the asteroid orbits with all archival astrometry included, and with occultations only, for what can be considered to be the best possible exploitation of occultation astrometry to date. We illustrate the obtained performance, and the limitations of the methods for observed events with a small number of observed chords.

With the expected improvement in asteroid orbits brought by Gaia DR2 (and DR3 to come) a large number of smaller asteroids will provide reliable predictions and contribute more systematically to accurate astrometry, to the advantage of the detection of subtle dynamical effects (such as Yarkovsky) directly in the Main Belt.

Improvement of Asteroid Orbits for and with Asteroidal Occultations

David W. Dunham, IOTA
Tony George, IOTA
Bob Jones, IOTA

In JOA 2018-4, pages 6-10, I published a paper, “Improving Asteroidal Occultation Predictions using Recent Past Occultations by the Same Object”. At the end of that article, I mentioned efforts to improve the orbital elements of a given asteroid using past observed occultations by that asteroid. In principle, this is possible since Gaia Data Release 2 (Gaia DR2) gives almost perfect astrometric data for most of the occulted stars, such that the accuracy of the astrometric points are limited only by the analysis of the occultation observations, resulting in astrometric positions that are much more accurate than other Earth-based observations.

On 2019 July 29th, the 5-km near-Earth asteroid (3200) Phaethon occulted a 7th-magnitude star across the southwestern USA. A large campaign, aided by the Horizons team at the Jet Propulsion Laboratory (JPL) that used Gaia and 2017 radar observations of Phaethon to improve the orbit, resulted in the successful observation of the rate event. Adding the July 29th occultation allowed observation of a much fainter occultation two months later, and that in turn allowed a further improvement that precisely predicted four more occultations in 2019 October.

Steve Preston and I worked with Davide Farnocchia and Jon Giorgini at JPL to continue this work for selected main-belt asteroids that resulted in notable successes during early 2020 that I will describe. These asteroids now have considerably better orbits than are available via traditional orbital updates, but there are some pitfalls that I will describe; Dave Herald discusses some of them in a paper about asteroidal occultations that he is currently preparing. Among the problems are that many of the brighter stars in Gaia DR2 have “duplicated source” and “high RUWE” flags that show that the actual astrometric errors are likely larger than the formal errors. Observers should watch for these flags, given in Steve Preston’s predictions, especially for mobile observers, but fixed-site observers farther from the path than usual have a chance for a positive in these cases.

It should be possible to generate better orbits for many asteroids that have a good history of past-observed occultations, but proper weighting of the observations, when only one, two, or three usually poorly-distributed chords are available, have prevented a general solution to this problem so far. The Lucky Star Project has used similar techniques to accurately predict occultations by Pluto and by a few other TNO’s and Centaurs. These efforts can aid our observational efforts by providing more accurate predictions until even better asteroid orbits become available from Gaia DR3.

PHEMU 2021: Mutual Phenomena of Jupiter Satellites in 2021

J.Desmars, V.Robert, J.E.Arlot, V.Lainey

IMCCE, Paris Observatory, France

As every 6 years, Jupiter is crossing the ecliptic plane in 2021 allowing the observation of mutual occultations and eclipses between the Galilean satellites. The so called PHEMU events are now well observed by amateur astronomers providing a very accurate astrometry of Galilean satellites. PHEMU are still important for astrometry as Galilean are not observed by Gaia and in the perspective of future missions to Jupiter system: JUICE, CLIPPER, IVO.
In this presentation, we will present results of previous campaigns, scientific interests of PHEMU and favorable PHEMU events observable from Europe in 2021.

Highlights of Stellar Occultations by Asteroids with Moons in 2021 in Europe and Special Events for North America & Australasia

Oliver Klös, IOTA/ES

Observing stellar occultations of asteroid with moons is a very exciting task for the community of occultation observers worldwide. Today, accurate astrometric data gives the opportunity to predict stellar occultations of the asteroidal moons. This was proved by the successful observations of (87) Sylvia and their moons Romulus & Remus in October 2019 in Europe.
Stellar occultation measurements will provide new determinations of the diameters and shapes for the main bodies as for the satellites as well. The recorded data will help to improve the orbital elements for the moons. A dence network of observing stations is nessecary to chase the shadows of these small bodies.
This lecture will present predictions of the best events of stellar occultations by asteroids with moons in 2021 in Europe. The focus will be on (22) Kalliope, (45) Eugenia, (87) Sylvia, (239) Emma and (617) Patroclus.
Additional, very promising events by (22) Kalliope and its moon Linus for North America will be shown. We will have a look on stellar occultations by (31) Euphrosyne and its moon in Australia and New Zealand in 2021.
Special calls for observation for the presented events should be made by the local associations.

The presented predictions were calculated with *Occult V4* by Dave Herald with data from Miriade (IMCCE) and JPL *Horizons*.

The Cartes du Ciel (Sky Chart) Addin for Occult Watcher

Wojciech Burzyński, IOTA/ES

We all know how helpful it is to connect Occult Watcher with a good sky mapping software using an addin. Creating another addin for the OW makes observation process faster and easier.
So far, there have been two addins connecting OW with most useful planetarium type programs - C2A and Guide. The new addin connecting Cartes du Ciel (Sky Charts) to OW filled the existing gap. At my request, the plugin was immediately written by Grzegorz Czepiczek, Poland.
The CdC itself is very often (even weekly) updated, and the CdC author responds positively and quickly to any suggestions from users. What is important for us, it supports for the latest and most accurate astrometric catalogs such as UCAC4 or Gaia DR2.
Meanwhile, in the CdC software, you can personalize display settings so that it visually suits you best. After learning how to use this program, you may stop using C2A and Guide with Occult Watcher, what I did.

OccultPortal: a web-based platform for data collection and analysis of stellar occultations

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(1)TÜBİTAK National Observatory, Antalya, Turkey
(2) Department of Space Sciences and Technologies, Akdeniz University, Antalya, Turkey
(3) Federal University of Technology-Paraná (UTFPR / DAFIS), Curitiba, Brazil
(4) Observatório Nacional/MCTIC, Rio de Janeiro, Brazil

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The stellar occultation technique is a unique and reliable method to investigate the size, shape, and environment around Solar System objects. One of the indispensables of this technique is multi-chord observations. The more observers there are on the predicted line, the more detailed and accurate information about the object of interest can be revealed. On the other hand, as the number of observers increases in multi-chord campaign observations, access to raw observational data becomes more challenging for researchers. Besides, collecting observational data and equipment details from each observer affects prolonged research time.

For this reason, it is aimed to create a common online platform where the needed data will be collected and analyzed (producing light curves/photometry) on a single center for ongoing campaign observations. Such a platform has been developed on a high-performance server of TÜBİTAK National Observatory and is currently working for testing purposes (http:// occultation.tug.tubitak.gov.tr).

The Django framework is preferred thanks to the support of python, which enables the rapid development of the platform's software base. IRAF/PyRAF and sep packages are used to make a photometric analysis of all station data collected with this platform. For now, FITS images are supported, but other image extensions and video format is under implementation. On the developed online web platform, stellar occultation predictions are gathered from the Lucky Star website or can be manually introduced. These predictions are listed on a calendar; thus, any observer who wants to provide data to the announced campaign can upload it to the server. After that, the data can be analyzed by the researchers on the platform. In this presentation, we will show the platform and its use.

Keywords. techniques: stellar occultations, image processing, photometry, asteroids.

GOcEcl - a new deep asteroid occultation feed for larger apertures

Robert Purvinskis, IOTA/ES

The author proposes a new set of asteroid occultation predictions aimed at amateur observers with larger telescopes. The aim is to use parts of the Gaia star catalog (DR2) around the ecliptic down to magnitude 17. The aim of this prediction feed is not to replace other prediction sets but to supplement them. Careful down-selection and fine-tuning of the asteroid set used can also decrease the search time for events.

Some features of the prediction feed include:

Exclusively uses Gaia DR2 catalog in selected fields along the ecliptic

Brighter stars are not included (G magnitude range 14 to 17)

Each field (‘Box’) is searched separately. This allows to avoid moonlight periods, for instance. The first star catalog used also avoids star-dense regions of the Milky Way.

Alimited subset of asteroids are used. Very small (< 7km diameter) or large asteroids above 50 km diameter are not included. Only main belt asteroids are used.

QHY174GPS Firmware-Upgrade - Implementation and Benefits

Christian Weber, IOTA/ES

The QHY174GPS camera is so far the only one comercial CMOS camera with integrated GPS timestamping. This camera is applied by IOTA in Europe as well in the US. For minor body occultation observations the camera was first used by Marc Buie at SWRI within the 2014 MU69 campaign (https://www.boulder.swri.edu/MU69_occ/).

Using SharpCap, the QHY174GPS cameras provide GPS data. However, until now the QHY delivered QHY174GPS cameras came with a limited GPS data output, e.g. there are no GPS status messages and also no GPS_ALT output. Marc Buie and Robin Glover, developer of SharCap, kindly made a firmware upgrade available which allows the output of an enhanced GPS data set (https://forums.sharpcap.co.uk/viewtopic.php?f=28&t=2802).

The upgrade was performed by me with a QHY174GPS camera. The poster describes how to implement this upgrade.

Prerequisites and setup (Fig. 1)

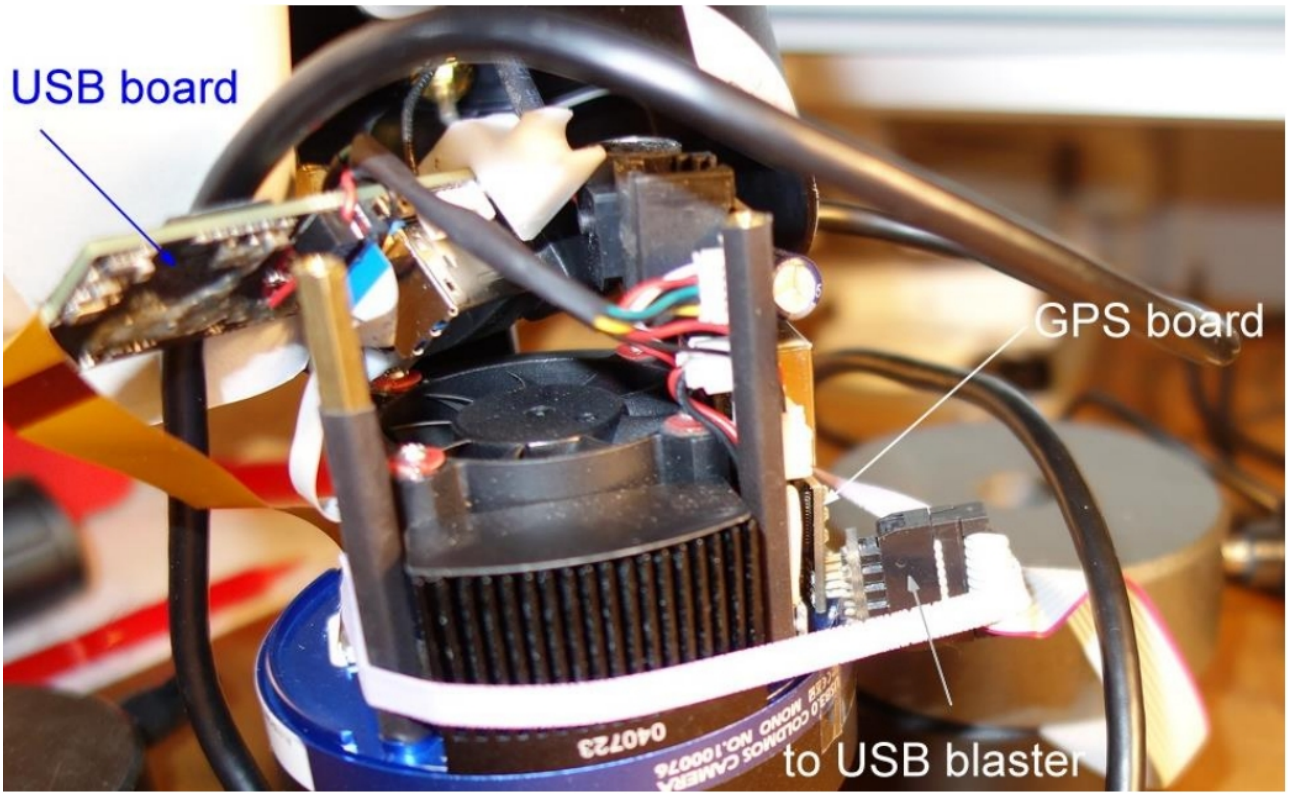

Fig. 1: QHY174GPS firmware upgrade setup

Upgrade implementation and test (Fig. 2)

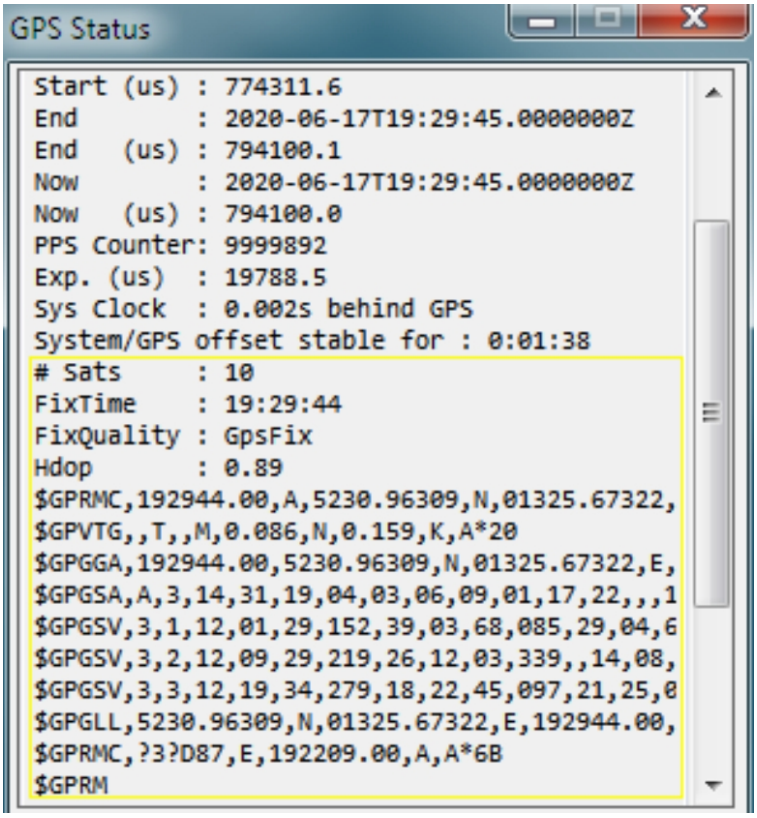

Fig. 2: Additional GPS data (yellow marked) after upgrade

Benefits of the upgrade

Interpretation of the GPS status messages

In addition, results from several tests will be presented (Fig.3)

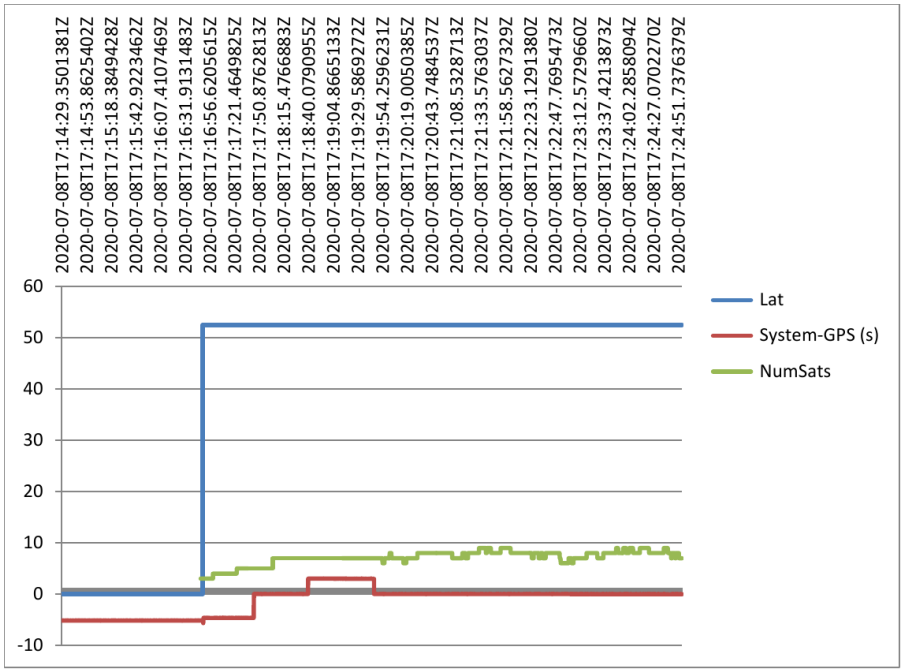

Fig. 3: Temporal behavior of the GPS system from its start

2 positive asteroidal occultations within 10 minutes

Alex Pratt
IOTA/ES
British Astronomical Association Leeds, England

The various prediction feeds to OccultWatcher can offer us several events in a single night. On the evening of 2020 May 11 I monitored asteroid (32215) 2000 OG16 which was predicted to occult a mag. 12 star for 1 second (probability 5%), followed by (786) Bredichina predicted to occult a mag. 11 star for 3 seconds (54% probability). Both observations were successful, recording 2 positive events within less than 10 minutes, although it was a race against time to switch between their star fields and obtain useful recordings of both.
This talk describes the preparations for the night's observing, including the challenges of setting up in bright twilight and locating a target star at low elevation. It also discusses the problems of confirming a positive short-duration event from analysis of the light curve and how future Gaia Data Releases could give us more of these brief events. High-quality predictions will require us to carefully plan and select our observing targets.

Propus graze occultation mystery - the history of one observation

Wojciech Burzyński, IOTA/ES

On August 15, a bright star (4.3 mag) ZC916 = 1Gem = Propus grazing occultation has been organized in Poland.

We had 2 independent observer groups - 2 stations in central Poland led by M. Zawilski and 5 in NE Poland led by W. Burzynski. Additionally, the event was broadcast on-line by the famous Polish astronomy promoter - Karol Wójcicki. We have been waiting for this lunar graze for months, because it was the best of the year for us! Unfortunately, it turned out that there was an unexpected MASSIVE shift of the Moon (ca 0.64"= 1.91 km on the ground) to the south, so that some of the observers in both places had a miss instead of the expected several spectacular events! We knew about duplicity of the star, we saw several partial events going on, but this was not the reason of this huge shift. The graze prediction was also checked by the Grazprep program, which gave results similar to the Occult in the range of 70 m in the field.

Descending into the Smallest Depth of an Asteroid Occultation

Paul D. Maley[1,2], Tony George[1], Robert Jones[1]
1 IOTA
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We discuss being able to capture a minor planet occultation of a 12.8 magnitude star where the magnitude drop at central occultation was only 0.06 from two stations in the USA. Both chords agree within required bounds thus confirming the reality of this detection. This shows that observers should not be deterred by future asteroid occultations where the dM is a small fraction of a magnitude given a proper set of conditions.

The partial and nearly grazing solar eclipse of June 21, 2020 and solar diameter measurements

Costantino Sigismondi (ICRA/Sapienza, IIS Caffè, Rome, AAVSO) Claudia Caldarella, Elisa Cicillini (Sapienza Università di Roma)

The measurement of the solar diameter using central eclipses is a well-established technique exploiting the ON-OFF timing of Baily's beads. We investigate the role of diffraction convoluted with the limb darkening function in the case of a partial and almost grazing solar eclipse: the one of 21st June 2020 from Rome, lasted only 28 minutes with 2.4% of photosphere's occultation.
The O-C timing results -22.8 s and + 22.7 s from selected photograms of the video, 5 after t1, and 5 before t2. This indicate a symmetric effect on either sides, of 1.2 arcsec, of diffraction's nature. Rayleigh diffraction is expected to be 2 arcsec for a 64 mm aperture Newton telescope with obstruction factor 0.2. 1.2 arcsec instead of 2 arcsec is due to the convolution with the limb darkening function which is not a step function as in the Rayleigh solution. This extra-diameter therefore is not physical, but optical, and has to be considered to calibrate transit measurements. The maximum phase of the eclipse is identified with OC 2.6 s, or 0.1 arcsec of angular precision, well beyond diffraction limit (like 1 meter-size solar telescope), by using 11 selected photograms among the full length of the video, with good seeing conditions.
The application of this method to the solar diameter measurement has the advantage of the very good knowledge of the ephemerides of Sun and Moon, and it is independent of the marginal details of the lunar limb, washed out by the seeing and changing from first to last contact at different position angle.

Keywords solar eclipse, partial eclipse, Baily's beads, diffraction, limb darkening function, step function, convolution, solar diameter, ephemerides, lunar limb atlas.

Announcing ESOP 2021 in Bialystok (Poland)

Wojciech Burzyński - XL ESOP LOC Team Leader, IOTA/ES

For the fifth time, European occultation observers will meet at the ESOP symposium in Poland.
The previous ones took place in 1986, 1994, 2000 and 2009.
The last meeting was organized by the unforgettable Pawel Maksym in Niepolomice near Cracow.
This time we will meet in Bialystok, a city with 300,000 inhabitants in the north-eastern part of the country. It is a strong academic center, and the Faculty of Physics of the local University of Bialystok, to which we will be guests, has just completed the construction of a modern astronomical observatory and planetarium.
As part of the optional trips, we will visit the most beautiful parts of this region, including the spectacular Bialowieza Primeval Forest.
Together with my colleagues from the Occultation Section of the Polish Amateur Astronomers Society,I cordially invite you all to visit this part of Poland.

Announcing ESOP 2022 in Granada (Andalucía/Spain)

Pablo Santos-Sanz (IAA-CSIC) / Carles Schnabel (IOTA/ES)

ESOP XLI will be held in Granada, the city where the Instituto de Andalucía de Astrofísica (Andalusian Institute of Astrophysics) is based. The communication will present the possible spaces in which the symposium will take place as well as locations of cultural and astronomical interest that can be visited in the former Andalusian capital and its surroundings.

ESOP XL

See You Next Year in Bialystok, Poland