The 35th European Symposium on Occultation Projects (ESOP XXXV)

held at the University of Surrey, Guildford, UK on 2016 August 19–21

Amateur astronomers travelled from the Czech Republic, Germany, Netherlands, Poland, Spain and within the UK to attend this annual European 'workshop'. The event is held in a different country each year. This is the third occasion the UK has hosted the event.[1]

Thirty eight delegates attended presentations over two days, of which seventeen were given by UK presenters. It was an ideal opportunity for observers to meet and discuss ideas, observing techniques and new developments. We were also fortunate this year to have keynote contributions from Dave Herald (Murrumbateman, Australia) who presented on *Gaia* (via Skype) and Dr Toni Santana–Ros (University Adam Mickiewicz in Poznan, Poland) on the *Gaia*–GOSA interactive service.

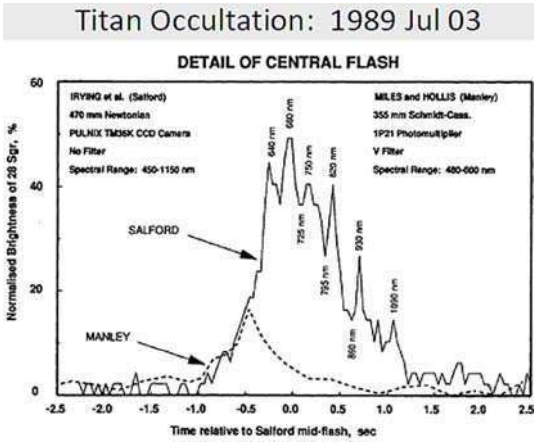
We gathered in the University Wates Bar for a buffet reception on Friday evening, followed at 8pm by a visit to the AstroPhysics department Observatory. We were guided expertly by PhD student Kearn Grisdale. The dome, by Sirius Observatories, houses an Orion Optics (UK) 16" [406mm] ODK on Paramount ME. Students are trained in telescope control, acquiring CCD data, measurement and reduction methods.

A summary of selected presentations

Occultations and the BAA – past, present and future

Dr Richard Miles (BAA ARPS) summarised major past successes by BAA observers in a talk entitled 'UK occultation studies pre-2010'. The BAA *Journal* from 1940 to 1990 has almost 100 references to this subject. An occultation of Epsilon Geminorum by Mars on 1976 April 8 had been predicted by Gordon E. Taylor working at Herstmonceux, using the FK4 position and proper motion of the star, and a (then) recent ephemeris for Mars (supplied by the Jet Propulsion Laboratory) using the adopted radius of 3394 km. This led to a predicted event that was widely observed. G. E. Taylor was President of the Association 1968–1970, and Director of the Computing Section 1974–2009.

On 1989 July 3 an occultation of the mag 5.8 star 28 Sgr by Titan (predicted by Commission 20 of the IAU) was recorded by many observers using visual, video and photoelectric photometry, with the central flash being recorded in some detail. The UK was blessed with clear conditions. A joint paper in the *Journal* was written by Dr Miles, and the late Dr A. J. Hollis.[2]



Occultation of 28 Sgr by Titan, 1989 Jul 3.[2] Details of the central flash recorded by Irving *et al.* (Salford) and Miles & Hollis (Manley, Cheshire).

Lunar and asteroidal occultations in the period were coordinated by the late Andrew Elliott, who used an image-intensifier, and then some of the first ultra-high-sensitivity WATEC cameras. His observations are recorded in the *Occultation Newsletter*,[3] compiled by David Dunham *et al.* of the International Occultation Timing Association (IOTA).

Asteroidal occultations of stars became a reality when the speaker recorded the first UK positive after 38 nights of being more or less clouded out. Using *Asteroid Pro* DOS software, the next scheduled observation was (892) Seeligeria on 1997 Nov 8/9. The occultation of this 10.9 mag star was observed visually with a 20cm SCT (duration 5.2 sec) and reported in ref. 4.

Tim Haymes (UK) continued the presentation with recent BAA successes from 2010 to the present, notably the lunar graze occultation of SAO-145938 observed by Loughton AS on 2014 Nov 1.[5] This was followed by a summary of the results from (130) Elektra which occulted TYC 0747-01779-1 on 2010 Feb 20. Seven UK observers obtained chords ranging from 6.4s to 13.5s duration.[6] The most extensive UK coverage of an asteroid was achieved on 2015 Sept 30, when 21 reports were received for the (275) Sapientia / HIP 14977 occultation.[7,8,9]

Lunar occultations – revisiting the graze of 44 Cap

Alex Pratt (UK) described the investigation he made into a rare lunar graze during a total lunar eclipse on 1989 Aug 17. While examining historical records in the *Occult 4* database (compiled by Dave Herald) he noticed a timing by Andrew Elliott that seemed to be uncharacteristically in error. The original written records by the observer were retrieved, and the report corrected. The talk was illustrated with detailed plots obtained from the *Occult* software and video footage. In summary, it is wise to keep all observations and log books.

Front : Mike Kretlow, Andrea Turner, Bernd Gährken, Oliver Klös, Alex Pratt, Martina Haupt, Jan Manek, Carles Schnabel, Konrad Guhl, Wolfgang Beisker
Middle : Frank Schaffer, Nick Turner, Astrid Teuscher-Faragó, Carsten Faragó, Adrian Jones, Sven Andersson, Vaclav Priban, Henk de Groot, Andreas Eberle, John Sussenbach, Richard Miles, Eberhard Riedel, Eberhard Bredner, Christoph Bittner
Back : Derrick Ward, Tim Haymes, John Talbot, Phil Berry, Brian Mills, Martin Burger, Nick Quinn, Niko Wünsche Len Entwisle, Phil Denyer, Jan-Maarten Winkel, David Briggs, Toni Santana-Ros.

Group photograph of the participants in ESOP XXXV at Guildford, Surrey. *Photo by Janice McClean.*

Analysis of a Hyades double star occultation

Tim Haymes explained how he used the software *LiMovie* to obtain the duration of a step disappearance and to estimate other parameters of the known double star 70 Tau. The occultation was recorded for the BAA Lunar Section *Project Fade* on 2016 Jan 19, using a WATEC 910HX video camera at 50 frames per second. Step-by-step operation of the *LiMovie* software illustrated how lunar occultations can be used to study double stars, some of which are suspected doubles observed previously and requiring confirmation.

Global observations of double star occultations are analysed by Brian Loader (Darfield, New Zealand). *LiMovie* (writ-

ten by Kazuhisa Miyashita) is not the easiest software for use by a novice; the speaker thanked Brian Loader, Jan Manek and Alex Pratt who gave freely of their knowledge.

Hyades occultations first light

Vaclav Priban (CZ) described how he re-roofed his parents' cottage to include an integral observatory. Mr Priban has observed more than 500 lunar occultations since he started with a small telescope. He now observes with the Dablice Observatory, Prague, but his new home equipment is a Newtonian with a video camera at the true prime focus, *i.e.* mounted where the secondary mirror would normally be held. The complete telescope is home made, apart from the optics. The first observations with the instrument were of the Hyades reappearance on 2015 Sept 5. Videos of reappearances at the dark limb were projected.

High resolution imaging of mutual events of the Jupiter moons

Dr John Sussenbach (NL) presented remarkably detailed images of the 2014/2015 occultations and transits of Jupiter's moons compiled by himself and co-author Willem Kivitz, who sadly passed away in February. See the 2016 October *JBAA* for Dr Sussenbach's paper reporting these observations.[10]

The impact of the Gaia satellite on asteroidal occultation prediction

Dave Herald (Murrumbateman, AU) presented via Skype. *Gaia* is delivering star positions and proper motions of unprecedented accuracy. In the very near future these catalogues will transform the prediction of asteroidal, planetary and TNO occultations.

The first release is a five-parameter astrometric solution – positions, parallaxes, and proper motions – for stars in common between the *Tycho-2* catalogue and *Gaia*. (The *Tycho–Gaia* solution). This contains proper motions and parallaxes for stars brighter than ~11.5. Details on this and other topics can be found on the Yahoo! discussion groups, *e.g.* **https://groups.yahoo.com/neo/groups/occult-software/conversations/messages**

On the uncertainty of asteroidal occultation predictions in the Gaia era

Mike Kretlow (DE): The number of positive occultations observed in Europe since 1997 has increased from 10 to 70 per year, which is a consequence of an increased number of predictions being observed, the effective use of mobile equipment, and to some extent, improvement in availability of suitable instrumentation and cameras. Detailed statistics were presented of recent European occultation observations.

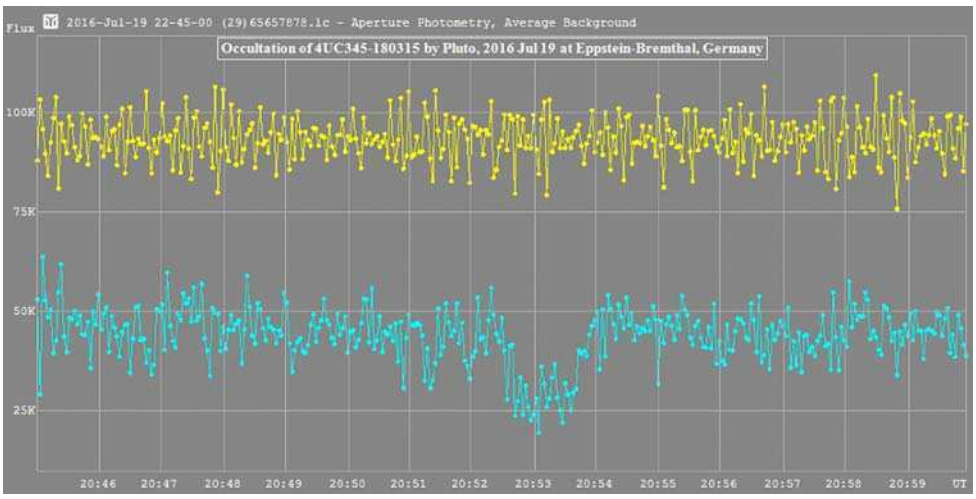
Gaia–GOSA interactive service for asteroid follow-up observations

Dr Toni Santana–Ros (PL) and his team from University Adam Mickiewicz in Poznan work mainly on asteroid modelling using photometry, radar, and stellar occultations. Occultations are used to scale 3D asteroid models, reject wrong spin solutions and, in some cases, to confirm large concavities in the shape. Observers were invited to contribute time-series CCD frames of asteroids selected by the *Gaia*–GOSA project team using a web based planning tool which identifies the asteroids currently being investigated. Contributors upload the frames following a straightforward procedure explained on the website.[11] Analysis is undertaken by the team and the contributor can collaborate with other imagers to obtain data that produce a full lightcurve at the same time as *Gaia* is obtaining accurate photometry. From this it is possible to build 3D models of the asteroid. This presentation can be found at this link,[12] and the *Gaia*–GOSA home page is ref.11.

The 2016 Pluto campaign

Dr Wolfgang Beisker (IOTA-ES).[13] A dozen or so observers across Europe responded to a call to record the occultation of a 14th mag star by Pluto on 2016 July 13/14, referred to as the 'pathfinder'. This was in preparation for a second occultation (16.0 mag, 4UC 345-180315), where it was planned that the pathfinder would provide a precise location for the shadow and hence an observation of Pluto's atmosphere on 2016 July 19/20. Events were predicted by Bruno Sicardy, Paris. Several observers were successful, and one positive observation was recorded by Oliver Klös (Eppstein, Germany) using a WAT-910HX ×128 integration (2.56 sec) and 25cm LX200 in good conditions.

Following the *New Horizons* mission, the thickness of Pluto's atmosphere now needs to be monitored. This is being achieved by photometry of occulted stars.



Pluto occults 4UC 345-180315, 2016 July 19. Oliver Klös: 25cm LX200 and WAT 910HX (2.56s integration). Yellow= comparison star, Blue= Pluto + occulted star. Duration from 20:52:37 to 20:53:50 ± 6s.

Conclusion

More presentations from the Symposium and full details of the above are available on the ESOP35 website.[14]

A tentative plan to observe an occultation by (922) Schlutia on Sunday evening Aug 22 was unfortunately rained off. An informal software demonstration on Saturday evening allowed the use of *OccuRec* to be demonstrated. This is a video acquisition program written by Hristo Pavlov specifically for integrated video.

Post-symposium excursions were arranged on Monday and Tuesday. The Monday trip started with a tour of the Hampshire Astronomical Group (Clanfield) Observatories (IAU code J69). This was followed by a visit to Stonehenge and finally Salisbury Cathedral. The Tuesday excursion was to the Equatorial Group at Herstmonceux, where the twin astrograph was previously used by the RGO for asteroid astrometry.

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References

1 History of ESOP: **http://www.iota-es.eu/ESOP/index.htm**
2 'The occultation of 28 Sgr by Titan': R. Miles & A. J. Hollis, *J. Brit. Astron. Assoc.*, **104**(2), 61–76 (1994)
3 *Occultation Newsletter*: **http://occultations.org/publications/newsletters/**
4 '(892) Seeligeria occultation observed': R. Miles, *J. Brit. Astron. Assoc.*, **107**(1), 49 (1997)
5 Lunar graze observed by Loughton AS: T. Haymes, *ibid.*, **125**(1), 9 (2015)
6 Elektra chords: **http://www.euraster.net/results/2010/index.html#0220-130**
7 '(275) Sapientia occultation well seen from the UK': R. Miles & T. Haymes, *ibid.*, **125**(6), 331–332 (2015)
8 Sapientia chords: **http://www.euraster.net/results/2015/index.html#0930-275**
9 Sapienta *YouTube* video: **https://youtu.be/j0lpfz_S5Js**
10 Jovian satellite mutual events at high resolution: J. Sussenbach & W. Kivits, *J. Brit. Astron. Assoc.*, **126**(5), 290–296 (2016)
11 *Gaia*–GOSA home page: **http://www.gaiagosa.eu/**
12 *Gaia*–GOSA ESOP presentation: **https://prezi.com/x0okn9o4hxrv/esop35/**
13 Pluto, 2016 July 19/20: **http://www.iota-es.de/pluto-19072016.html**
14 All ESOP XXXV presentations: **https://britastro.org/ESOP35**