Asteroids & Remote Planets Section

Stellar occultation by asteroid (130) Elektra successfully observed across Europe

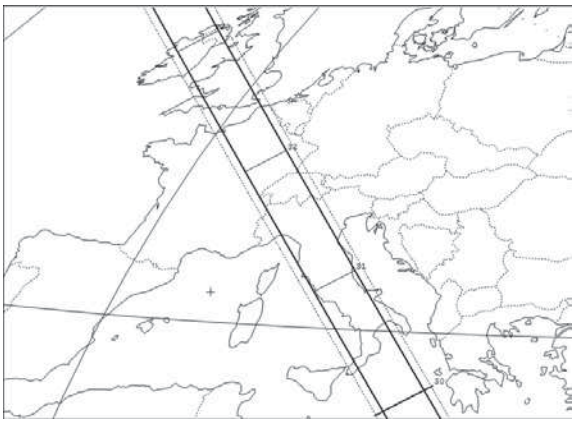


Figure 1. Prediction of the occultation track by Steve Preston, IOTA: **http://www.asteroid occultations.com/2018_04/0421_130_54818.htm**

Astronomers seem to be entering a golden age for occultation astronomy now that star positions and the orbits of small solar system bodies are known to an unprecedented level of precision, largely thanks to the ongoing *Gaia* space observatory mission. By 2022, *Gaia* will have completed its work and the final data release will greatly enhance the accuracy of asteroid orbits.

Detailed predictions of forthcoming asteroidal occultations are issued many months in advance and such was the case ahead of an event involving asteroid (130) Elektra which was forecast to occult TYC-0408-0029, an 11th magnitude star in Ophiuchus, on 2018 April 21. Its shadow track passed over densely populated regions of the UK and Europe as shown in Figure 1.

Occultation observers determine the exact time when a star disappears behind a moving solar system object, followed by its time of reappearance. Each successful measurement made from a different location on Earth represents a line across what is in effect a silhouette of the object. These lines are called occultation chords. In this way, several differently positioned chords provide information about the size and shape of the shadow profile.

In the event, more than 30 stations participated in this, the most successful observation ever of an occultation by (130) Elektra. This asteroid's shadow profile has never before been so accurately measured. At around 00:30 UT on April 21, observers from Italy, Switzerland, France, Belgium and the UK successfully recorded the occultation. Nine timings were made from the UK, by Peter Birtwhistle, Tim Haymes, Philip Denyer, Peter Tickner, Adrian Jones, Simon Kidd, John Talbot, Malcolm Jennings and Mike Collins.

Currently, 35 measured chords define the shadow profile (Figure 2). Eric Frappa (**www.euraster.net**) has determined an elliptical profile of the asteroid with a size of 262×160km from the observational data. The chords are well distributed across virtually the entire profile; only at the eastern edge is there a gap. These successful measurements will also provide a highly accurate astrometric position of (130) Elektra which can be included in future orbit calculations.

In addition to measuring the profile of Elektra, the observing stations also looked out for very brief occultations caused by either of its two satellites, which measure roughly 6km and 2km across. Figure 3 is a near-infrared image depicting this triple system produced using the European Southern Observatory's VLT/SPHERE instrument, a second-generation adaptive optics facility. The approximate shape of Elektra is clearly evident despite the fact that it measured only about 0.1 arcseconds across at the time (see **https://arxiv.org/pdf/1603.04435.pdf**).

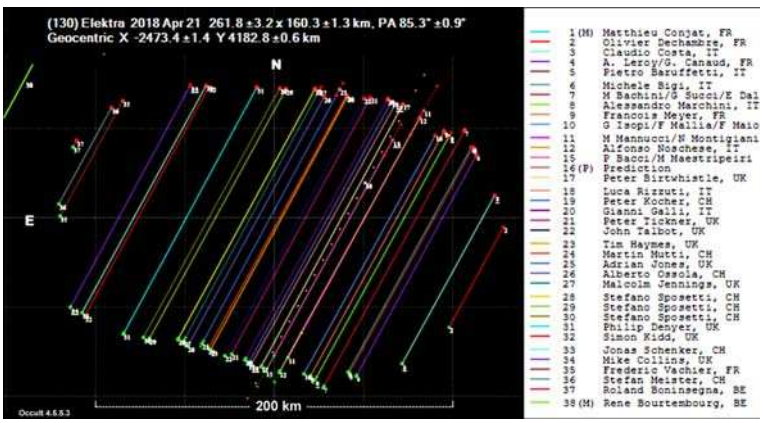


Figure 2. Chords defining the shadow profile of (130) Elektra, from observations made on 2018 April 21. *Eric Frappa, Euraster.net*

Since most observers used video recording, even changes in light lasting a fraction of a second would have been registered; in practice, no such events were recorded.

The path prediction was generated on 2018 Feb 27 by Steve Preston of the International Occultation Timing Association, USA (IOTA). This prediction proved to be very accurate in that there was only a slight path shift to the east, and the occultation occurred about four seconds later than predicted. This result is graphic evidence of the enormous improvements in prediction accuracy for occultations in recent years, and bodes well for increased participation amongst amateur astronomers in this type of study in future.

This is the twelfth occultation by main-belt asteroid (130) Elektra that has been observed worldwide. The previously most successful observation took place on 2010 Feb 20. On that occasion, the undersigned together with Andrew Elliott, Martin Cole, Peter Birtwhistle and Robert & Edward Simonson from the UK obtained seven timing chords, six of which were used to determine the asteroid's profile. The result was an ellipse with dimensions of 255×155km. The present work has significantly refined our knowledge of the object's shape as shown in Figure 4.

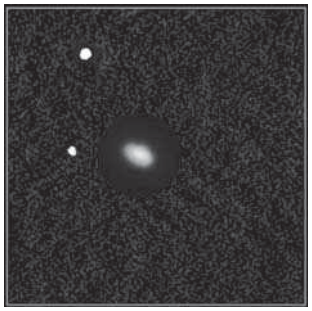


Figure 3. Near-infrared image of the Elektra system produced by the Very Large Telescope of the European Southern Observatory. *ESO*

A further significant stellar occultation involving Elektra occurred on 2018 May 01 when its shadow first crossed South Africa before passing over Liberia and Sierra Leone. After traversing the Atlantic, it left the Earth in the eastern USA, where it was visible at a relatively low altitude above the horizon. At the time of writing, the results have yet to be fully analysed.

Acknowledgments

This report is based on an International Occultation Timing Association – European Section (IOTA-ES) press release issued by public relations officer, Oliver Klös (**PR@iota-es.de**) on 2018 April 25, translated by Alex Pratt. We also wish to thank Eric Frappa of Euraster, Josef Durech of the Astronomical Institute of Charles

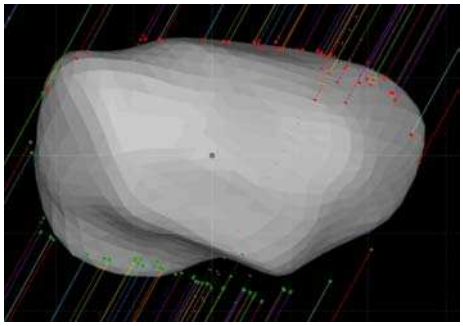


Figure 4. The shape of (103) Elektra as derived from stellar occultation observations.

Solar Section

2018 February

Sunspot activity followed the trend of the previous three months maintaining a low count. The southern hemisphere marginally out-performed the north due to the presence of a substantial sunspot group mid-month. As a consequence the Relative sunspot number (R) was the highest recorded since 2017 October. Most observers reported spotless counts between Feb 1 & 4 and also 17 to 25.

AR2698 S03°/194° made a brief appearance on Feb 2 & 3 near the SE limb, type Axx.

AR2699 S07°/166° was first reported on Feb 5 as an Hsx sunspot over the SE limb. By the following day a small follower penumbral spot made the group type Dso. On Feb7 the follower had increased in size and several pores were seen within the group. The whole active region seemed to be surrounded by a slightly lighter shade of granulation. The follower continued to grow on Feb8 making the leader and follower of comparable size, the total area of the group being around 200 millionths.

On Feb 9 both main components showed complex umbrae and multiple cores with pores visible between the main elements but especially towards the following end. By Feb 11 the group had just passed the CM, of type Dai with the leading sunspot sporting a clearly visible light bridge. Some of the spots between the two main components had strengthened to give a more mature appearance to the group. The following day the group had increased its size to 240 millionths but by Feb 15 all the follower penumbral sunspots had disappeared to leave a Cso type group of 110 millionths in area. With the group nearing the limb on Feb 16, only an Hsx sunspot was observed and was seen the following day. The group was reported as visible to the protected naked eye on Feb 11 only.

AR2700 N06°/328° was first reported on Feb 26 in the NW quadrant but it soon faded being type Axx on Feb 28.

17 observers reported a Quality number of Q= 1.63 for February.

H-alpha

Prominences

19 observers reported a Prominence MDF of 1.87 for February. There were few prominences of note during the month.

On Feb 1 a lace-like prominence hearth was seen near the equator on the E limb, with the southern element being quite intense with a tangled magnetic field that appeared to be associated with a less intense arch prominence. A fan shaped prominence measuring around 35,000km in height was on the SE limb on Feb 4 as was a platform arch type prominence with a height of around 30,000km and a width of 40,000km.

A tall pillar prominence was on the NW limb on Feb 16 whilst on Feb 22 another pillar was observed on the SE limb. On Feb 23 three low pillar prominences were on the NE limb. A large spire prominence was on the NE limb at 35° on Feb 24 and persisted the next day as a broken pyramid.

Bi-polar magnetic regions, filaments & plage

16 observers reported a filament MDF of 0.99 for February. Substantial filaments were few in number during the month.

A long filament measuring some 260,000km in length was seen in the NE quadrant on Feb 1.

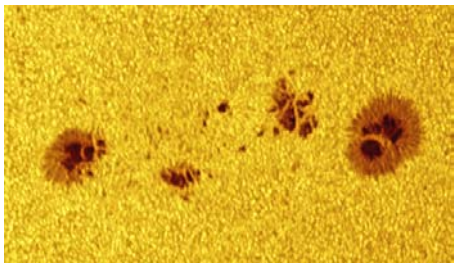
On Feb 5 plage was seen with new sunspot group AR2699 and on Feb 7 a line of bright plage was seen just forward of the following sunspot of the group. The active region was within a modest bipolar magnetic region.

Plage was seen with AR2699 on Feb 9 and on Feb 11 the chromospheric network surrounding AR2699 was showing an increasingly complex bi-polar magnetic region. A small filament was seen just south of the leading sunspot in the group and another filament was quite close to and following the curvature of the SE limb.

On Feb 15 plage was seen with AR2699 as it neared the W limb.

On Feb 26 a filament orientated NE to SW was seen in the NE quadrant measuring around 210,000km in length. The eastern end appeared almost oval in shape and symmetrical along the NE–SW line. Plage was also seen mid-disk which appeared as AR2700 in white light.

On Feb 28, the same filament was reported in the NE quadrant with a length of 100,000km.



AR 2699 imaged in white light by Dave Tyler, 2018 Feb 12 at 10:50 UT.

North & south MDF of active areas g

	MDFNg	*MDFSg*
February	0.10 (36)	0.37 (36)
March	0.03 (42)	0.04 (42)

g = active areas (AAs)
MDF = mean daily frequency
R = relative sunspot number
The no. of observers is given in brackets.

BAA sunspot data, 2018 February–March

	February		*March*	
Day	*g*	*R*	*g*	*R*
1	0	0	1	8
2	0	0	0	3
3	0	0	0	0
4	0	4	0	0
5	1	12	0	0
6	1	15	0	0
7	1	17	0	0
8	1	21	0	0
9	1	23	0	1
10	1	21	0	0
11	1	26	0	0
12	1	22	0	0
13	1	21	0	0
14	1	19	0	0
15	1	15	0	0
16	1	8	0	1
17	0	0	0	5
18	0	0	1	5
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	1	12	0	0
27	1	12	0	0
28	1	9	0	0
29			0	0
30			1	7
31			1	8
MDFg	0.51 (47)		0.08 (50)	
Mean R	9.21 (42)		1.09 (46)	

University, Prague, for shadow profiles and modelling via the Database of Asteroid Models from Inversion Techniques (DAMIT), and Dave Herald for use of his *Occult* software.

Richard Miles/Alex Pratt/Tim Haymes,
Occultations subsection, ARPS

Useful websites

http://www.iota-es.de/elektra2018.html
http://www.euraster.net/results/2018/index.html#0421-130
http://www.euraster.net/results/2018/20180421-Elektra_cbf.gif
http://www.euraster.net/results/2018/20180421-Elektra_cbf+DAMIT1856.gif
http://call4obs.iota-es.de/
http://call4obs.iota-es.de/wp-content/uploads/2015/03/2018_04_21-130-Elektra.gif
http://www.euraster.net/results/2010/index.html#0220-130

About IOTA/ES:

IOTA/ES e.V. (International Occultation Timing Association – European Section) is a registered association in Germany with over 70 members in 15 countries. For over 30 years, the work of its members has included the observation of occultation phenomena, the publishing of predictions and the worldwide coordination of observers. IOTA/ES also supports observers in publishing observational results and gives guidance on the technical requirements for scientifically useful observations. IOTA/ES publishes the *Journal for Occultation Astronomy* and organises the annual ESOP conference (European Symposium on Occultation Projects) – the next meeting (ESOP 37) takes place in Rokycany, Czech Republic, on 2018 August 24–29. The association also functions as a specialist occultations group in the German 'Verein der Sternfreunde e.V' (VdS).