Double Star Discovery During an Occultation by the Asteroid (676) Melitta

M. Eleftheriou[1], M. Dogrammatzidis[1], A. Karagiannidis[1], C. Weber[2], F. Casarramona[3]
[1] Amateur Astronomy Club Pegasus, Drama, GR, melefth@gmail.com
[2] International Occultation Timing Association/European Section (IOTA/ES), Berlin, DE
[3] Agrupacio Astronomica de Sabadell (AAS), Las Negras - Nijar, ES

Abstract

On 8 April 2023, an occultation of the star UCAC4 402-083153 (Gaia id: 4155332686530844800) by the asteroid (676) Melitta revealed that this star is a previously unknown double star with a separation of 18.0 mas.

1. Observation

The occultation path from Occult4 [1] (Figure 1) ran over the Greek observatory of Nikiforos Drama (obs1). All the parameters of this occultation event can also be taken from Figure 1. For the observation, a Schmidt-Cassegrain telescope with an aperture of 35.5 cm was used. There were no filters in the optical path. The camera was a QHY174GPS, which operated with an exposure time of 500 ms. The recording from this station led to the discovery of the double star.

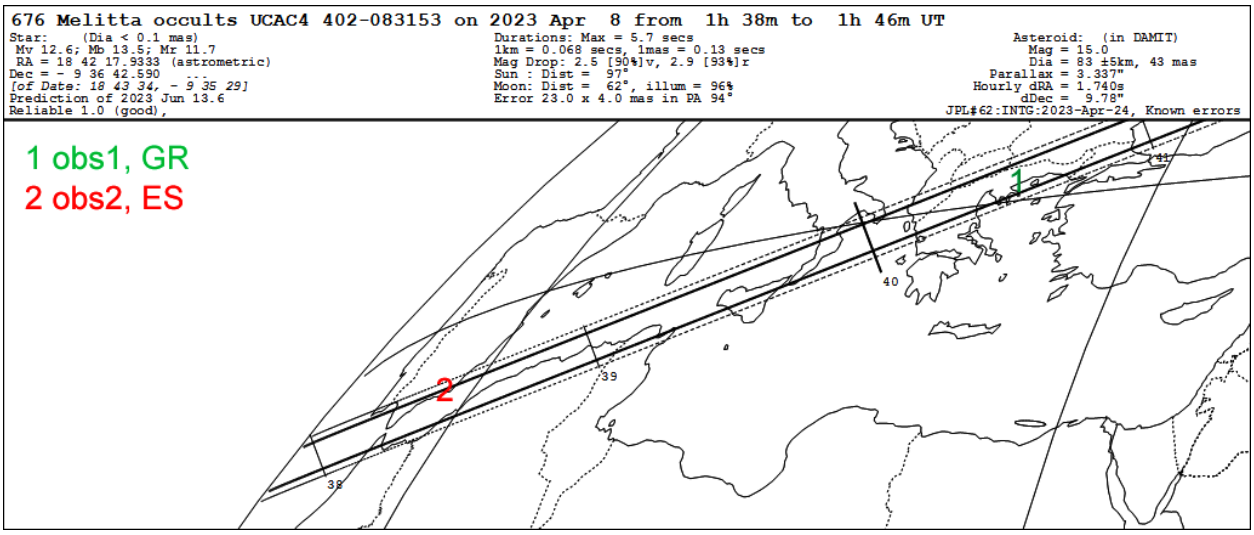

Figure 1: Occult4 prediction of the occultation of UCAC4 402-083153 by Melitta (676)

On the shadow path, there was also a Spanish station (obs2) near Las Negras where a 20 cm Newtonian telescope and a WATEC 910HX-RC camera (exposure time 320 ms, no filters) were used. This station did not register an occultation of the target star; however, with its "near miss" result the ambiguity of the double star solution gotten from the first station's recording could be limited. Both stations used the GPS 1-pps-pulse for precise timing. No other observations of this occultation event are known. The observations of

this stellar occultation event took place within the framework of the International Occultation Timing Association/European Section (IOTA/ES) [2] and the results were recorded with its SODIS portal [3].

2. Data reduction

Figure 2 shows the recording from the Spanish station (obs2), prepared with PyMovie/PyOTE [4].

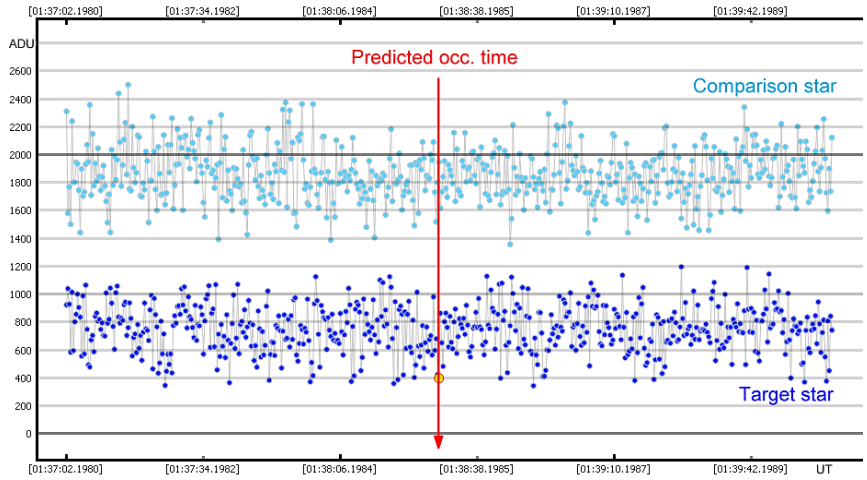

Figure 2: Station obs2 recording - no occultation was detected

For the photometry of the recording of station obs1 (Figure 3), we used the programme Tangra [5].

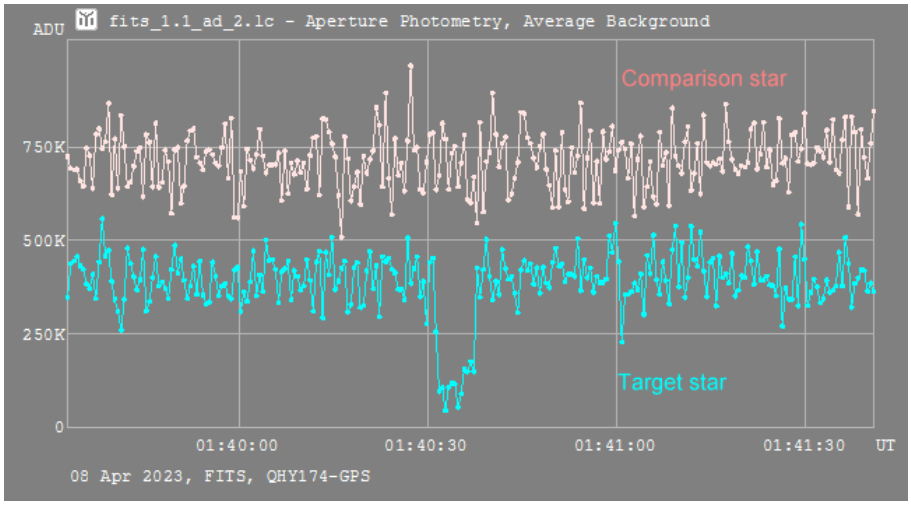

Figure 3: Tangra light curve of the obs1 station recording, showing a clear step on the reappearance from the occultation

In contrast to the station in Spain, this recording shows an occultation with a step-like transition at its end - an indication of the presence of a double star. The star UCAC4 402-083153 is not yet known to be a double star according to the catalogues (WDS, Interferometric Catalog, Gaia). The Occult4 database shows no previous occultations of this star. We used AOTA, part of the Occult4 software package, to extract the obs1 occultation times (Figure 4).

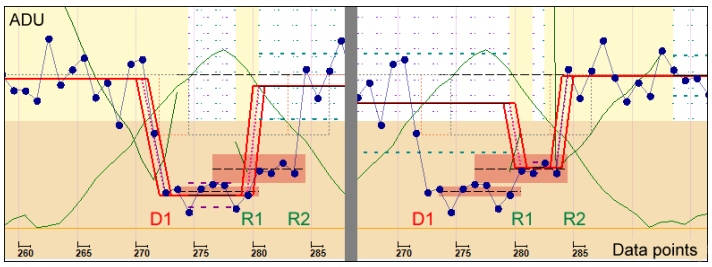

Figure 4: Station obs1 event times extraction with AOTA, for results see Table 1

The derived times are shown in Table 1 as well as the average light levels from the Tangra light curve (Figure 3).

Table 1. Station obs1 event times (AOTA) and average light levels (Tangra).

	D1	R1	R2
Time (UTC)	01:40:31.9 ± 0.3 s	01:40:36.3 ± 0.3 s	01:40:38.2 ± 0.3 s
Average light level (kADU)	404 > 90	90 > 163	163 > 404

3. Analysis

For the analysis, we used the appropriate tools of Occult4 in the standard method described by Herald [6]. Figure 5 and Table 2 show the results.

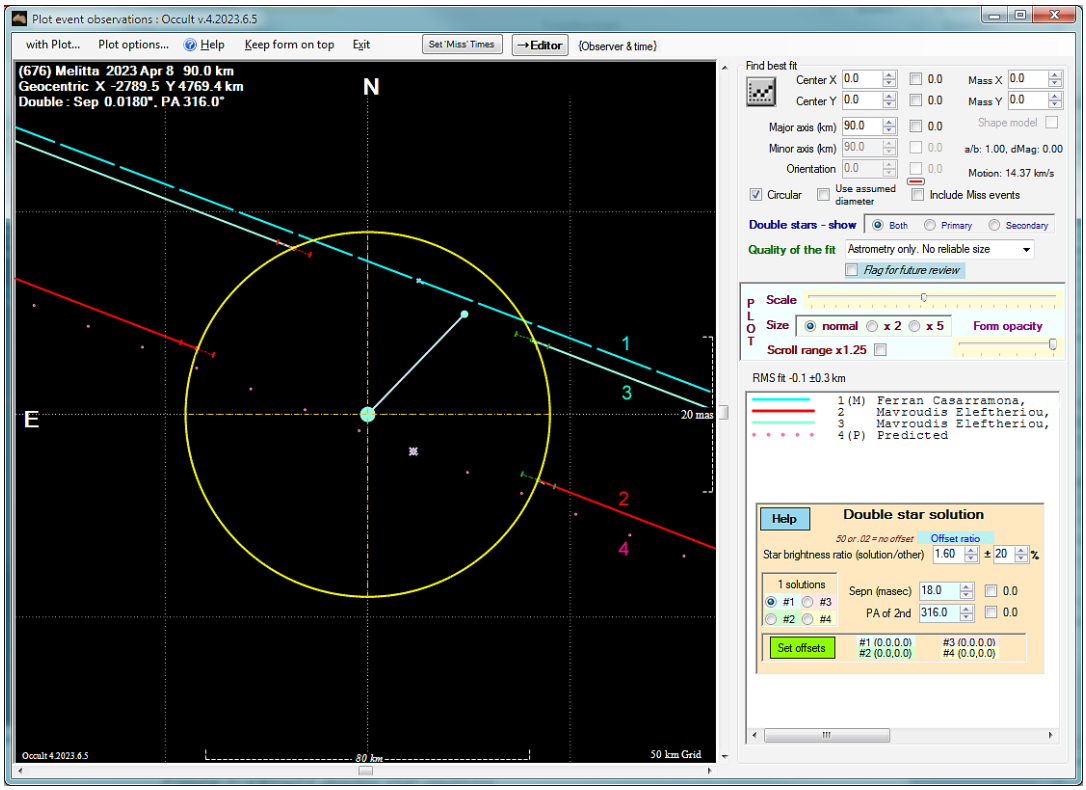

Figure 5: Occult4 double star analysis

The measured chord length of the main event was larger than the predicted diameter of the asteroid (83 ± 5 km). For this reason, we fitted the asteroid with a circle extending over the entire main chord (90 km), see Figure 5. In this way, we could exclude two of the 4 ambiguous double star solutions. Taking the obs2 station non detection recording into account, we can also exclude one of the two remaining solutions (Figure 6).

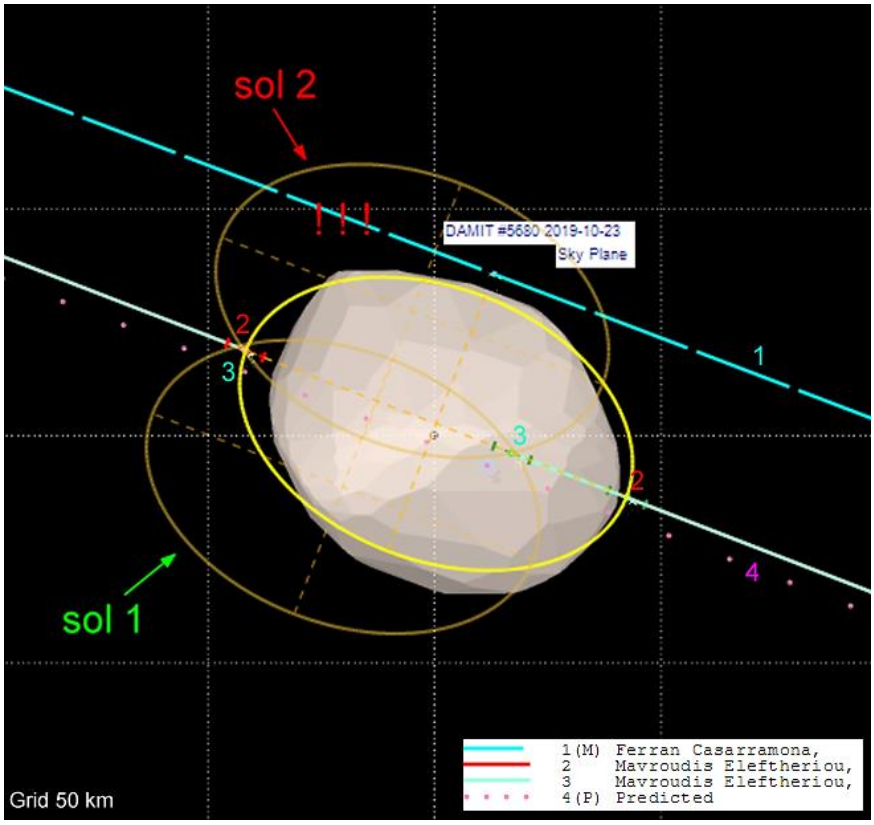

Figure 6: Exclusion of solution sol 2 using Occult4: Station obs2 (chord 1 (M) F. Casarramona) did not record a detection

Assuming a linear camera response of station obs1 recording, we estimated the magnitudes of the double star components using the average light levels given in Table 1. Due to the limited number of data points during the events, the magnitudes given are only rough estimates. Using the Occult4 magnitude calculator, we derived a magnitude of 13.0 for the main component and a magnitude of 13.8 for the fainter component.

4. Results

The derived double star characteristics are shown in Table 2. Further observations are necessary to improve the data.

Table 2. Double star characteristics.

Star	UCAC4	UCAC4 402-083153
	Gaia DR3 ID	4155332686530844800
	GCRS position at epoch 2023.2668	RA 18h 42m 17.933750s, Dec - 9° 36' 42.59475"
	G-mag	12.61
	Estimated diameter (Gaia)	0.04 mas
Double star solution	Separation	18.0 ± 0.1 mas
	Position angle	316.0° ± 0.4°
	Estimated component magnitudes A, B	13.0, 13.8

Acknowledgements

We acknowledge the developers of the software used in this work, especially D. Herald (Occult4), H. Pavlov (Tangra) and B. Anderson (PyMovie, PyOTE). This work has made use of data from the European Space Agency (ESA) mission Gaia (https://www.cosmos.esa.int/gaia), processed by the Gaia Data Processing and Analysis Consortium (DPAC, https://www.cosmos.esa.int/web/gaia/dpac/consortium) Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the Gaia Multilateral Agreement. This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

References

[1] Herald, D., Occult4, http://www.lunar-occultations.com/iota/occult4.htm
[2] International Occultation Timing Association (IOTA)/European Section (IOTA/ES), https://iota-es.de/index.html
[3] IOTA/ES Stellar Occultation Data Input System (SODIS), https://sodis.iota-es.de/
[4] Anderson, B., PyMovie/PyOTE, http://occultations.org/observing/software/pymovie/
[5] Pavlov, H., Tangra, http://www.hristopavlov.net/Tangra3/
[6] Herald, D., et al., 2009, "New double stars from asteroidal occultations, 1971 – 2008", JDSO, 6, 88-96, http://www.jdso.org/volume6/number1/herald.pdf