UCAC4 337-189531, Discovery of Stellar Duplicity During Asteroidal Occultation by (3130) Hillary

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Abstract: The occultation of the star UCAC4 337-189531 by the asteroid 3130 Hillary on July 23rd, 2019 has shown the duplicity of the star. Three observations carried out from Czech Rep. and Spain enable the determination of the parameters of this double star. A separation of 193.5 ± 18.7 milliarcseconds (mas) and a position angle (PA) of 54.5 ± 18.7 degrees has been calculated. From the magnitude drop in the light curves the estimated magnitudes without filter are 12.6 ± 0.04 and 13.4 ± 0.2. We suggest that this pair be included in the WDS catalog.

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Circumstances

On July 23, 2019 the asteroid (3130) Hillary occulted the star UCAC4 337-189531. This prediction was published in the occultation's feed IBEROC *[6] (Figure 1) and it was observable from the south-east of Spain to the north-east of Europe. UCAC4 337-189531 is a 12.2V magnitude star with the equatorial coordinates RA 19h 30m 57.37s, Dec. -22º 36' 13.26" (J2000.0).

The magnitude of the asteroid (3130) Hillary in the moment of the occultation was 15.5. This value has been obtained in the ephemeris web page of the Minor Planet Center *[3]. Also, star and asteroid magnitudes were in the prediction

Observations

Five separate sites observed this occultation: three with positive results and two negatives. Table 1 gives the geographical coordinates and instrumentation used.

All the stations recording a positive occultation had results that did not match with the predicted ones, specifically the predicted time and the predicted magnitude drop.

Data Analysis

Using the magnitudes of the UCAC4 catalogue and the MPC, the predicted combined magnitude of the target was 12.26V (star UCAC4 [12.312V] plus asteroid MPC [15.5V]) and the predicted drop magnitude was 3.24V.

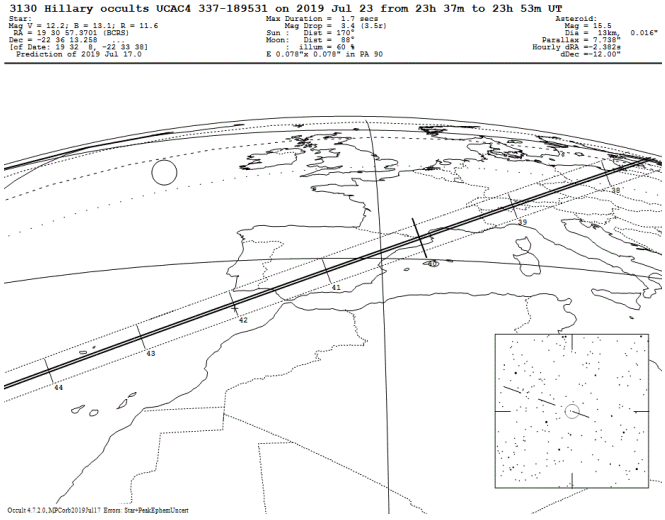

*Figure 1. Prediction map of the occultation computed with Occult *[1].*

The #1 station recorded the occultation 32.9s after the predicted time, and the event had a measured magnitude based in its light flux value of 12.50V ± 0.01 and a magnitude drop of only 0.33V. That's allow us to compute the magnitude of the star not occulted: 12.57V ± 0.04.

The #2 station recorded a delayed disappearance of 53.0s and the event had a measured magnitude based in its light flux value of 13.29V ± 0.01 and a magnitude

#	Station Team	Longitude, Latitude, & Altitude	Telescope	Equipment	Integration used
1	C. Perello & A. Selva	2° 05′ 24.6″ E 41° 33′ 00.2″ N 224 m	Newton 50 cm f/4	TV Camera Watec 910HX & KIWI inserter time	0.08s
2	J. Polak	13° 16' 30.6" E 49° 56' 02.1" N 533 m	Newton 30.3 cm f/4	TV Camera Watec 120N & TIM-10 Inserter time	0.16s
3	T. Janik	14° 02' 25,7" E 0° 40' 59,5" N 378 m	Schmidt-Cassegrain 15.3 cm f/10	TV Camera Watec 120N+ & TIM-10 Inserter time	0.64s
4	M. Rottenborn	13° 15' 37.8" E 49° 50' 09.5" N 427m	Newton 30.3 cm f/4	TV Camera Watec 120N & TIM-10 Inserter time	0.16s
5	B. Kattentidt	12° 12′ 57.3″ E 48° 59′ 23.1″ N 335m	Schmidt-Cassegrain + FR 27.9 cm f/6,3	TV Camera Watec 910HX & DL7USM-2006 V2.0 inserter time	0.16s

Table 1. Geographical coordinates and equipment of each station

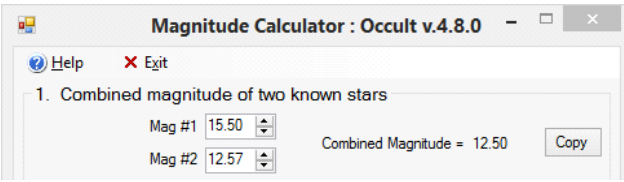

Figure 2. Estimated magnitude of the A component.

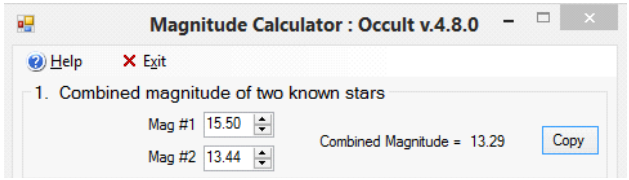

Figure 3. Estimated magnitude of the B component.

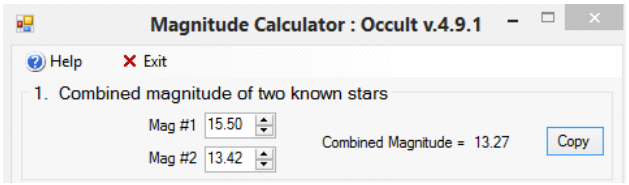

Figure 4. Estimated magnitude of the B component.

drop of only 1,07V. That's allow us to compute the magnitude of the star not occulted: 13.44V ± 0.2.

The #3 station recorded a delayed disappearance of 53.0s (the observer didn't report the delayed time in his report, he only reported a similar delay to station #2) and the event had a measured magnitude based in its light flux value of 13.27V ± 0.01 and a magnitude drop of only 1,08V. That's allow us to compute the magnitude of the star not occulted: 13.42V ± 0.2.

All the results match with the explanation that one component of the system did not be occulted. Based on the signal measured in the recorded videos we think the #1 station recorded the occultation of the B component (the fainter) and the #2 and #3 stations recorded the occultation of the A component (the brighter). The tool used to estimate the magnitude for each star based in the recording was the Magnitude Calculator Tool from Occult *[1] (Figures 2 to 4) assuming the magnitude assigned to the asteroid is 15.5V. These magnitudes are an approximation since there were no photometric filters placed in front of the detectors, and based in the predicted asteroid magnitude and the magnitude drop recorded.

We have also used the same comparison star to estimate the magnitude of the both components: UCAC4 337-189601 with a catalogue magnitude of 11.93V.

All timings obtained with TV-cameras have been corrected following the values obtained by G. Dangl *[4]. See Table 2.

Using the software Occult *[1] we fit the circular shape limits of the asteroid, obtaining a result of ~24.4 km being the negative result of the #4 station a good reference for the shadow limit (see Figure 9) but not enough to be fully reliable about the shape. A separation and position angle of the occulted double star were also obtained and the values are listed in Table 3.

Conclusions

The casual occultation caused by an asteroid of the star UCAC4 337-189531 revealed its duplicity. The number of observers registered was enough to allow us to determine the parameters of this binary system.

(Text continues on page 92)

#	D2	D1	R2	R1
1	23 40 38.47 ± 0.08	-	23 40 41.39 ± 0.04	-
2	-	23:39:24.08 ± 0.16	-	23:39:25.84 ± 0.16
3	-	23:39:19.32 ± 0.32	-	23:39:21.56 ± 0.32

Table 2. Timings of the occultation. D1 and R1 are the disappearance and the reappearance of the brighter component of the double star, while D2 and R2 are, respectively, the disappearance and the reappearance of the secondary component.

Distance (mas)	193.5 ± 18.7
PA (degrees)	54.5 ± 18.7
Mag. (A)	12.6V ± 0.04
Mag. (B)	13.4V ± 0.20

Table 3. Parameters of the double star UCAC4 337-189531

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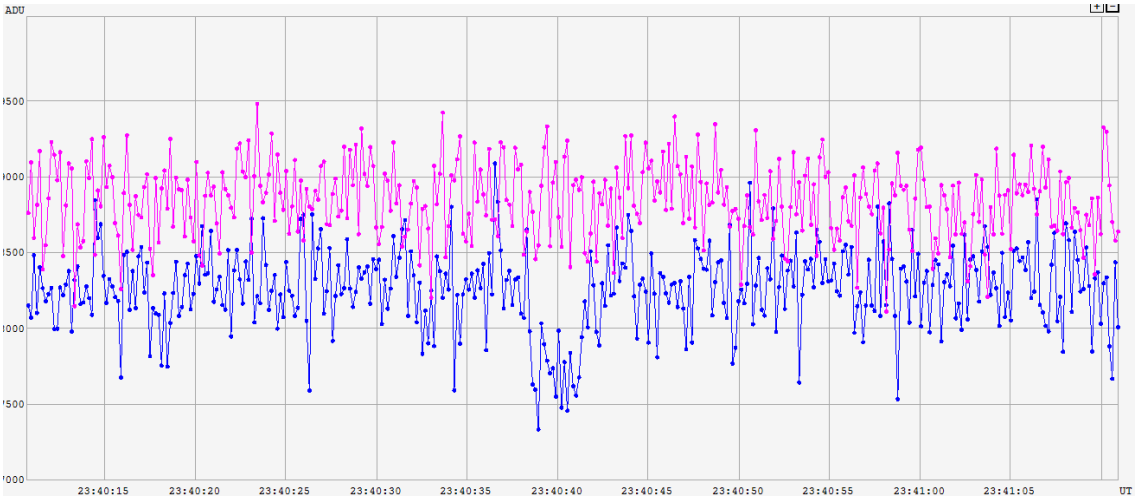

*Figure 5. A. Selva and C. Perello light curve obtained with Tangra *[2].*

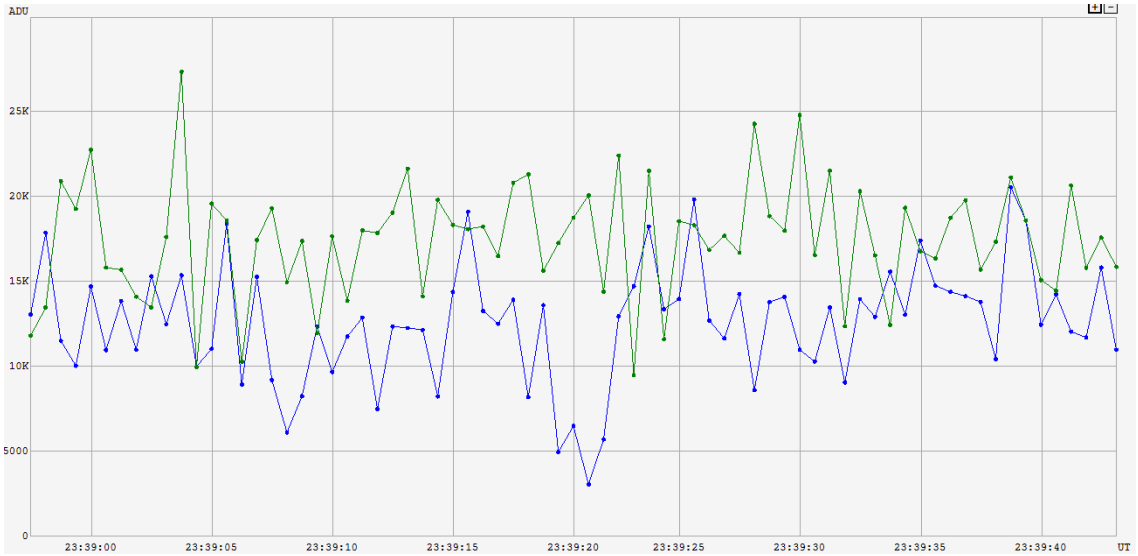

*Figure 6. T.Janik light curve obtained with Tangra *[2].*

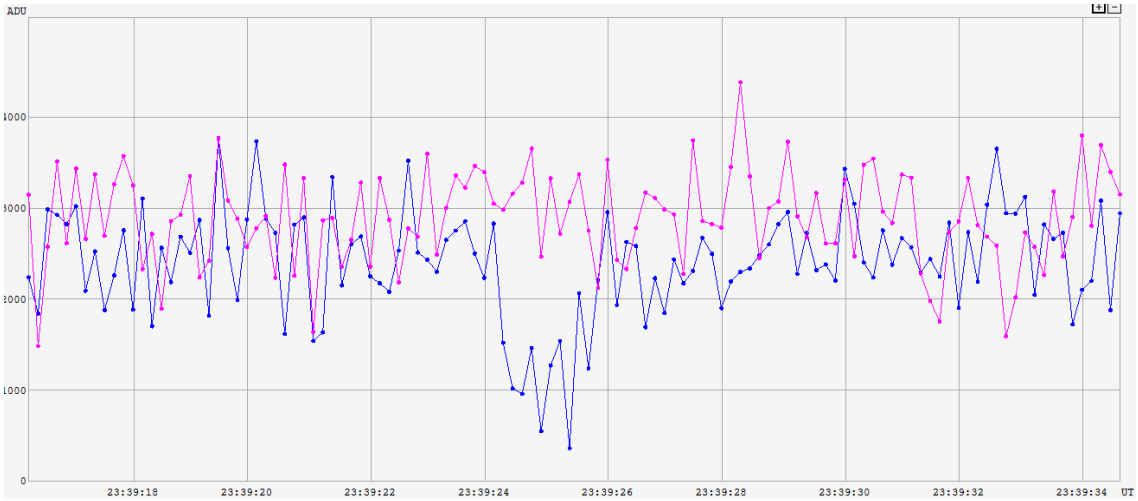

*Figure 7. J. Polak light curve obtained with Tangra *[2].*

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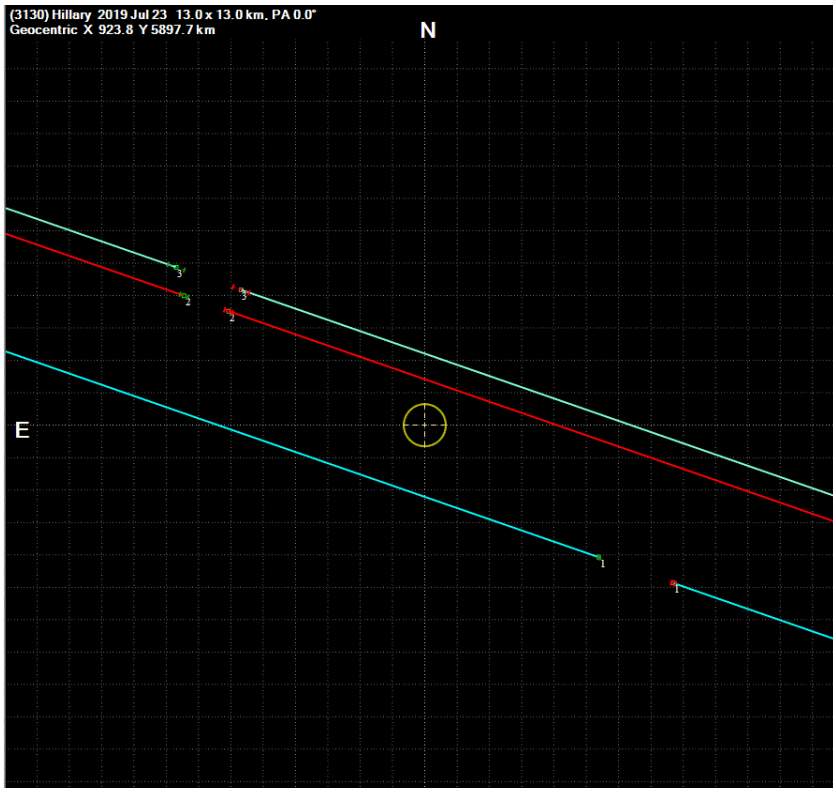

*Figure 8. Chart obtained with Occult *[1] before double star settings applied. The line is present if the star is visible.*

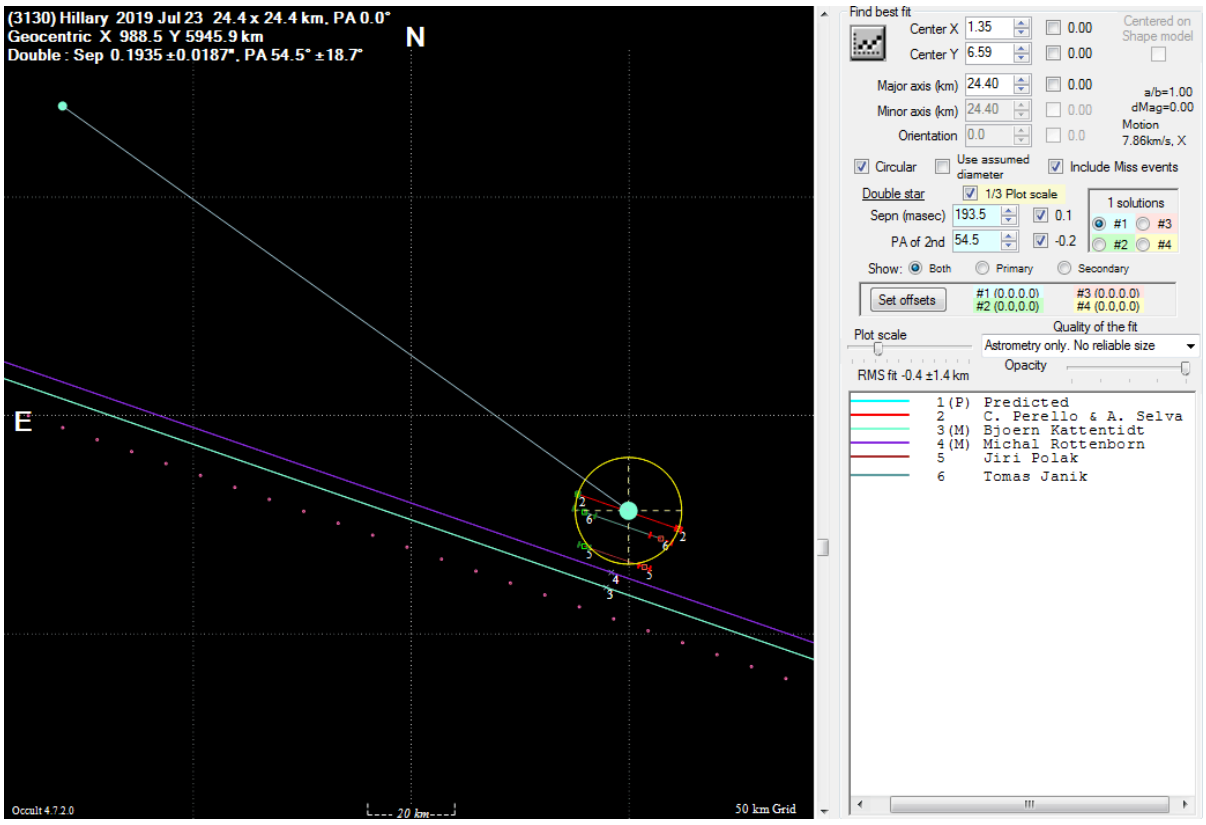

*Figure 9. Double star solution obtained by Eric Frappa with Occult *[1]. See *[5] for more information. The chords in the circle are the time that the star is occulted by the asteroid for the different observer's station. The continuous line below are the two negative chords (star always visible) and the dotted line is the predicted path.*

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*References

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IBEROC Occultation Feed for Occult Watcher, maintained by Carles Perelló and available at http://ocultacions.astrosabadell.org/IBEROC/