Discovery of stellar duplicity of UCAC4 561-133587 during asteroidal occultation by (2363) Cebriones

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Abstract

An occultation of UCAC4 561-133587 by the Jupiter Trojan asteroid (2363) Cebriones on 2022 July 02 showed this star to be a double star. Both components of the double star were occulted as seen by the single observer. The separation of the two components is 9.0 arcseconds at a position angle of 308 degrees. The magnitude of the primary component is estimated to be 15.16(r). The magnitude of the secondary component is estimated to be 15.77(r).

Observation

On 2022 July 02 Jerry Bardecker observed the Jupiter Trojan asteroid (2363) Cebriones occult the star UCAC4 561-133587 from Gardnerville, Nevada in the USA. The observation was made with 30cm telescope, using video with GPS-based time insertion to record the event. The two-step event is shown in Figure 1. The star is of magnitude 14.5(R) as referenced in UCAC4. The expected magnitude drop at occultation for the single star was 1.7 magnitudes. Bardecker observed a 0.84 and 1.12 magnitude drop in each of the two events (D1 and D2) – a combined magnitude drop of 1.96 which is close to the predicted 1.70. The recorded occultation times and data from the observer can be found in archived IOTA records for the event. The observation was made by the observer located at the site and with the equipment as shown in Table 1.

The star is not listed in the Fourth Interferometric Catalogue, nor is it listed in the Washington Double Star catalogue as a possible double star.

Site No.	Observer	Location	State	Telescope Type	Telescope Dia (cm)	Method	Chords	Results
1	J Bardecker	Gardnerville	NV	SCT	30	Video+GPS Time Inst	1	Two-step

Table 1—Observer, site location, equipment, methods, and results

The predicted observation path, as well as the observers location, is shown in Figure. 4.

Video of the occultation event was recorded using NTSC video camera. Due to the relatively low magnitude of the occulted star, field integration was required to properly secure the event with sufficient Signal to noise ratio. The Watec 910-HX video camera used was set at 16X field integration, or 8 frames, with a maximum manual gain setting of 41. Block integration of the video frames results in timeDelta of 0.267 seconds. Analysis of the recorded video and light curve analysis was made using PyMovie 3.4.4 and PyOTE 4.8.5.[1]

20220702 (2363) Light Curve

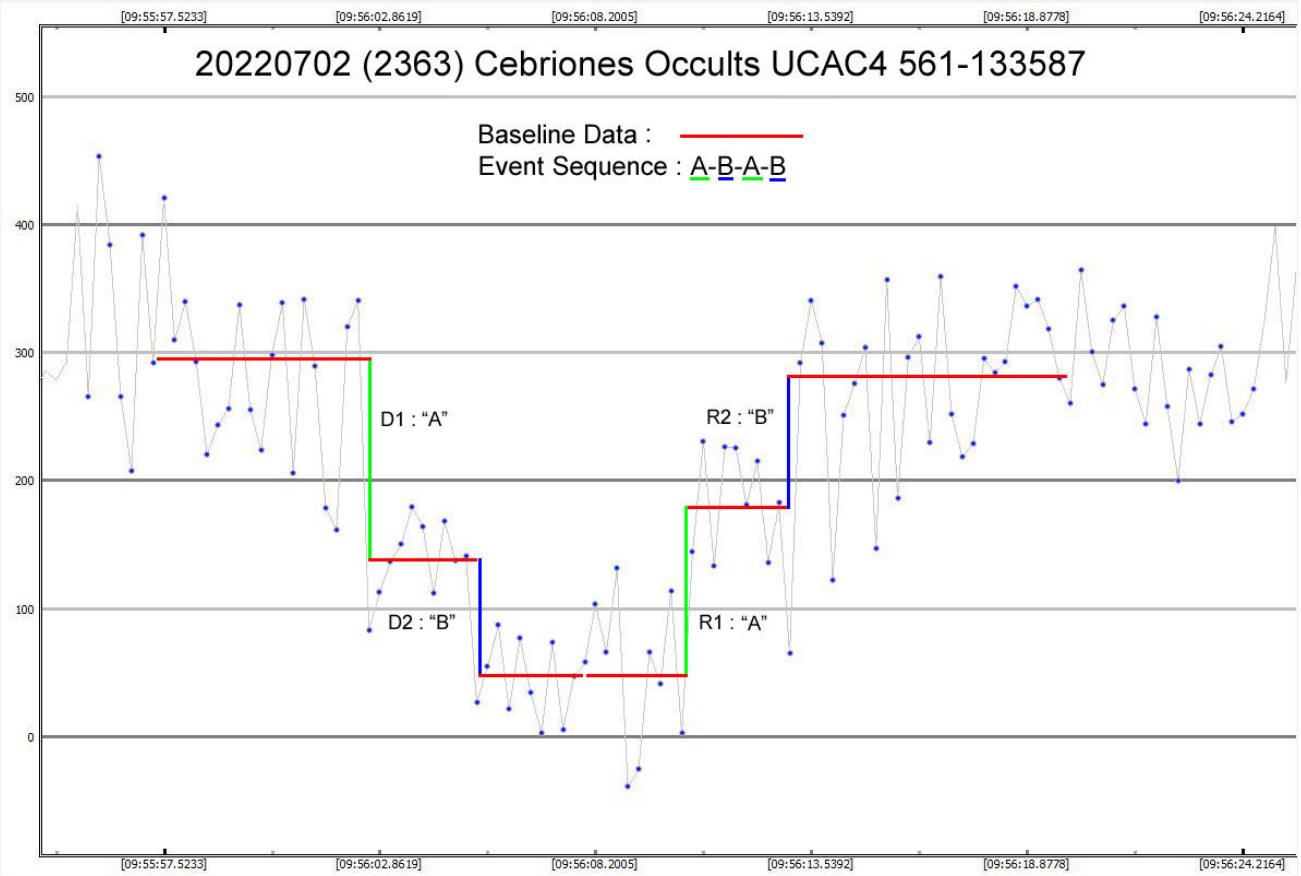


Figure 1 -- Bardecker event– note stepped events (Each data point represents 0.267 seconds)

Individual Event Times

Times for the disappearance and reappearance of each component of the double star are shown in Table 2. These times are corrected for camera and VTI time delays. They are also the reported times that represent the Occult4 double star plot solution shown in Figure 3.

Event	Time UT
D1	10:27:07.774 +/- 0.287
R1	10:27:25.992 +/- 0.298
D2	10:27:07.974 +/- 0.298
R2	10:27:26.326 +/- 0.708

Table 2 – Event times (corrected)

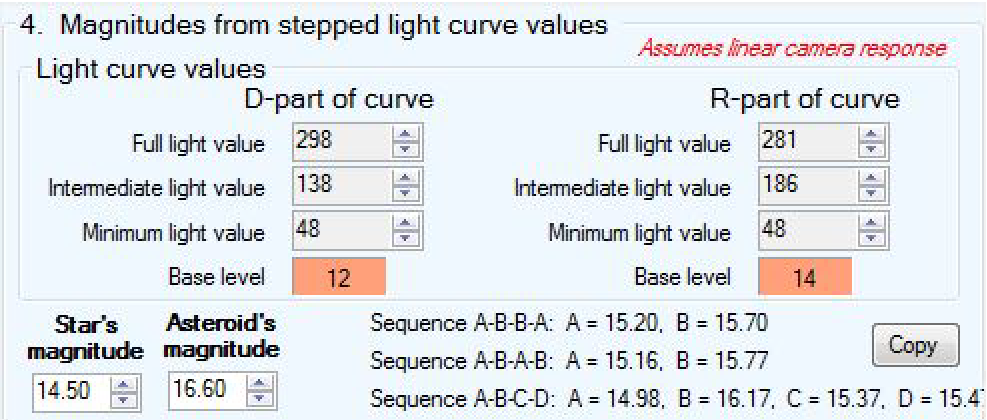
Primary and Secondary Magnitude Estimates

Magnitude estimates for each component were then made using the brightness measurements derived by PyOTE 4.8.5.

Mean Photometric values were extracted from the observer light curves for the D2 and R1 events (the stepped events). These values, along with the baseline and event bottom values from the PyOTE analysis were used to calculate the primary and secondary star magnitudes.

The Magnitude Calculator routine in Occult4 [2] (Method 4 – Magnitudes from stepped light curve values) were used for this analysis.

Light levels for the observation:
* Light levels at D of 298 => 138 => 048
* Light levels at R of 048 => 186 => 281



Calculated star magnitudes for the observation:
* Assuming a Star magnitude of 14.50 and Asteroid magnitude of 16.60.
Magnitudes for sequence A-B-A-B: **Mag A** = 15.16, **Mag B** = 15.77

As seen in Figure 1, the depth of events of D1 and R1 are sufficiently comparable, as are the events of D2 and R2, to establish a probable event sequence. Therefore A-B-A-B event sequence is the most likely for this observation. Note: In this context: B = the secondary (dimmer) star and A = the primary (brighter) star.

A profile plot of the observational chords along with the calculated position angle and separation of the double star are represented in Figure 3.

Based on the data presented in this report, the double star characteristics are:

Star	UCAC4 560-025472 Gaia 1791081626782628608 2UC 225-165393 2MASS 811675734 spectral type not known to authors
Coordinates (J2000)	RA 21° 26m 04.5268s DEC +22° 01’ 02.102”
Mag A	15.16
Mag B	15.77
Separation	9.0
Position Angle	308

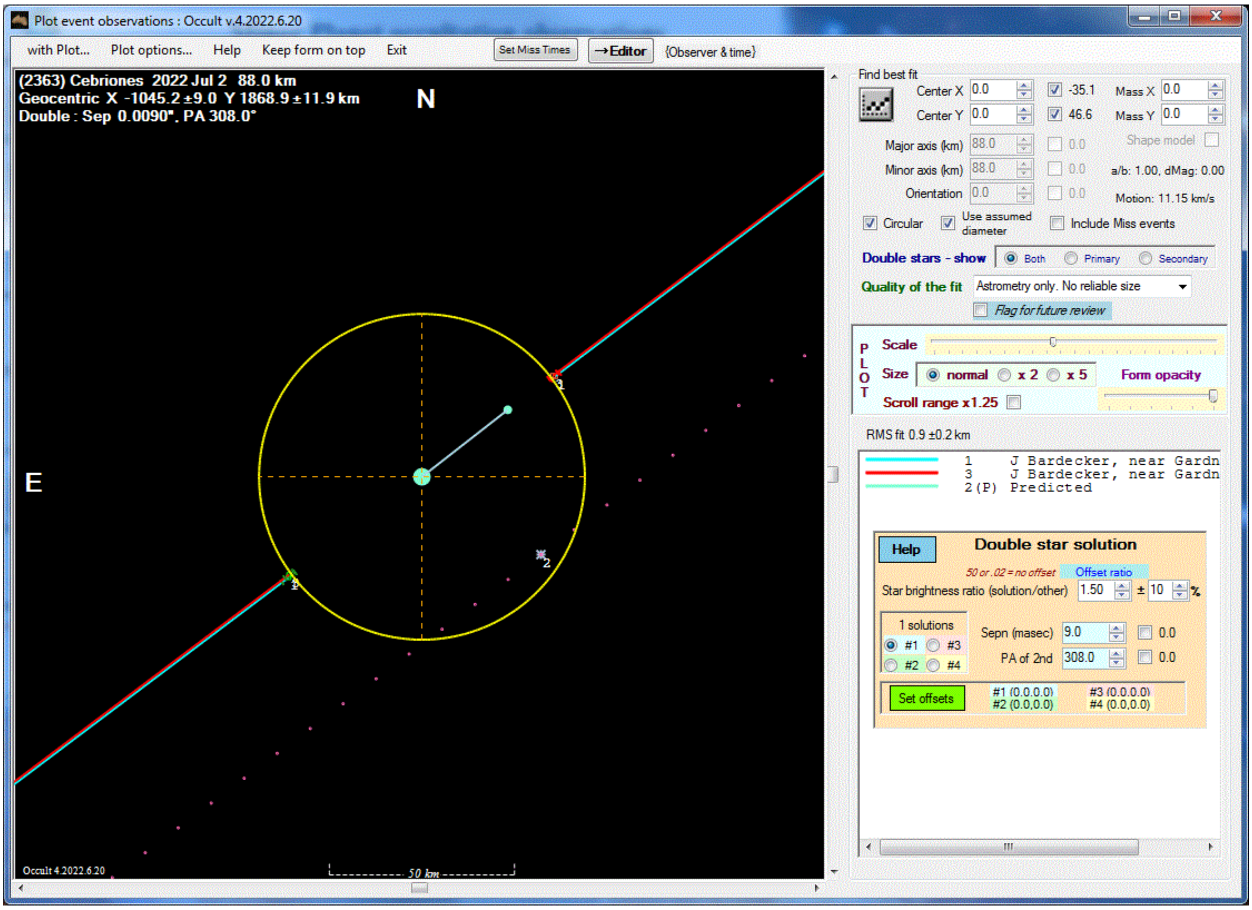


Figure 3: Occultation (2363) Cebriones occultation of UCAC4 561-133587 profile plot

NOTE: The Occult4 Double star solution tool was used to established a possible separation and position angle for the observation. As both the observed chords lengths were approximately equal to assumed diameter of the asteroid, both chords must therefore pass through the centre of the asteroid to ascertain a plot solution. In this somewhat unusual case, this results in only a single solution for this observation.

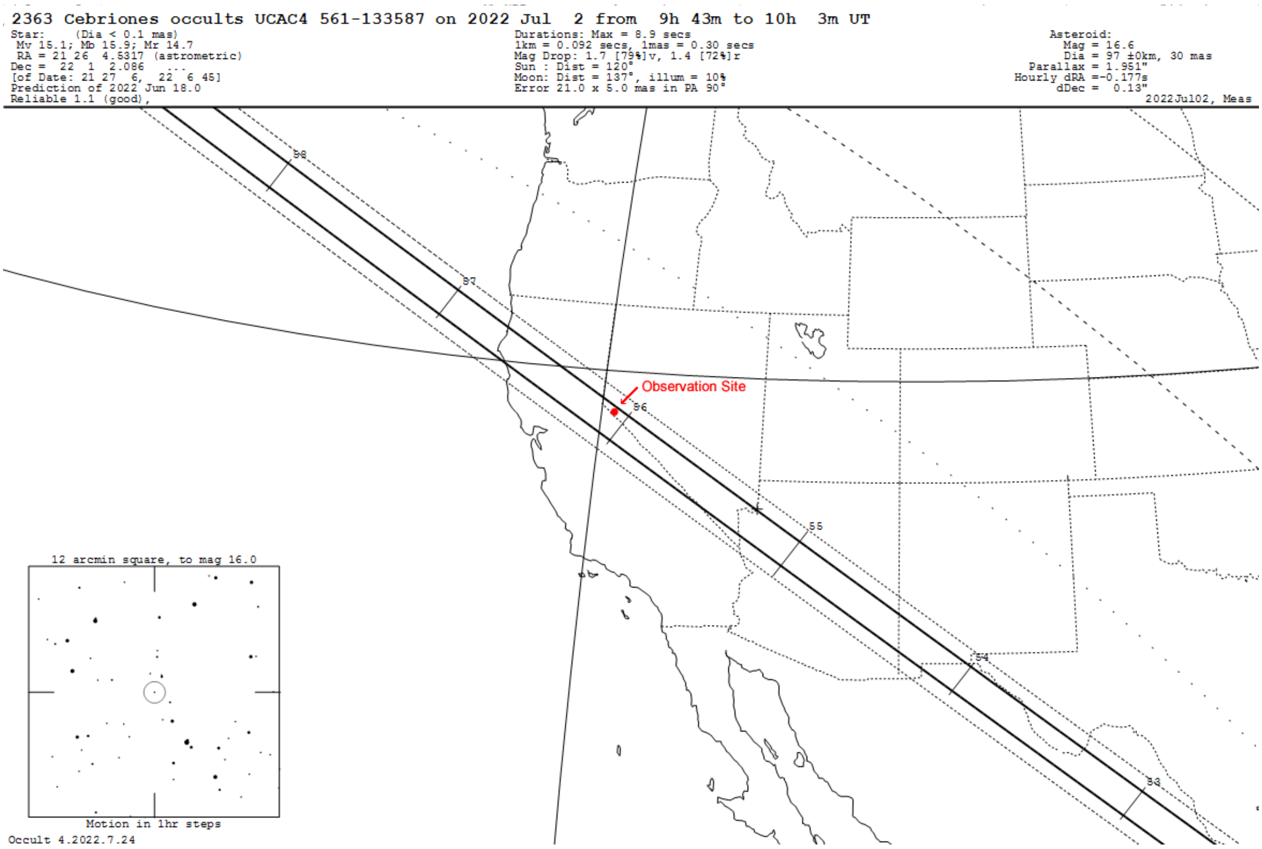


Figure 4 – Predicted Occultation Path and Observing Site

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[1] PyMovie and PyOTE – Bob Anderson
PyMovie: http://occultations.org/observing/software/pymovie/
PyOTE : http://occultations.org/observing/software/ote/

[2] Occult 4.20222.7.24. Occultation prediction software by David Herald. http://www.lunar-occultations.com/iota/occult4.htm