Discovery of Stellar Duplicity of TYC 1326-01111-1 During Asteroidal Occultation by (86) Semele

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Abstract: An occultation of TYC 1326-01111-1 by the asteroid (86) Semele on 2019 October 17 showed this star to be a double star. Both components of the double star were occulted as seen by two observers. The separation of the two components is 0.0046 ± 0.0012 arcseconds at a position angle of 11.7 ± 6.0 degrees. The magnitude of the primary component is estimated to be 12.66(r). The magnitude of the secondary component is estimated to be 12.87(r).

Observation

On 2019 October 17 Jerry Bardecker and Steve Messner observed the asteroid (86) Semele occult the star TYC 1326 01111-1 from two locations in the USA. The observations were made with 30cm (Bardecker) and 20cm (Messner) telescopes, using video with GPS-based time insertion to record the event. Messner's two step event is shown in Figures 1. Bardecker's two step event is shown in Figure 2. The star is of magnitude 12.0 (R). The expected magnitude drop at occultation for the single star was 1.40 magnitudes. Bardecker observed a 0.54 and 0.85 magnitude drop in each of the two events (D1 and D2) – a combined magnitude drop of 1.39 which is very close to the predicted 1.40. Messner observed a 0.52 and a 0.78 magnitude drop in each of the two events (D1 and D2) – a combined magnitude drop of 1.30. All recorded occultation times and data from the observers can be found in archived IOTA records for the event. The observations were made by the observers located at the sites and with the equipment as shown in Table 1.

The star is not listed in the Fourth Interferometric Catalog, nor is it listed in the Washington Double Star catalog.

The predicted observation path is shown in Figure. 4.

Video of the occultation events at both locations was recorded using NTSC video cameras. Analysis of the recorded video and light curve analysis was made using PyMovie 2.5.1 and PyOTE 3.2.5. [1]

Individual Event Times

Times for the disappearance and reappearance of each component of the double star are shown for the two observers 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.

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Site				Telescope				
No.	Observer	Location	State	Telescope Type	Dia (cm)	Method	Chords	Results
1	S Messner	Currie	MN	Newtonian	20	Video+GPS Time Inst	1	Two-step
2	J Bardecker	Gardnerville	NV	SCT	30	Video+GPS Time Inst	1	Two-step

Table 1—Observer(s), site locations, equipment, methods, and results

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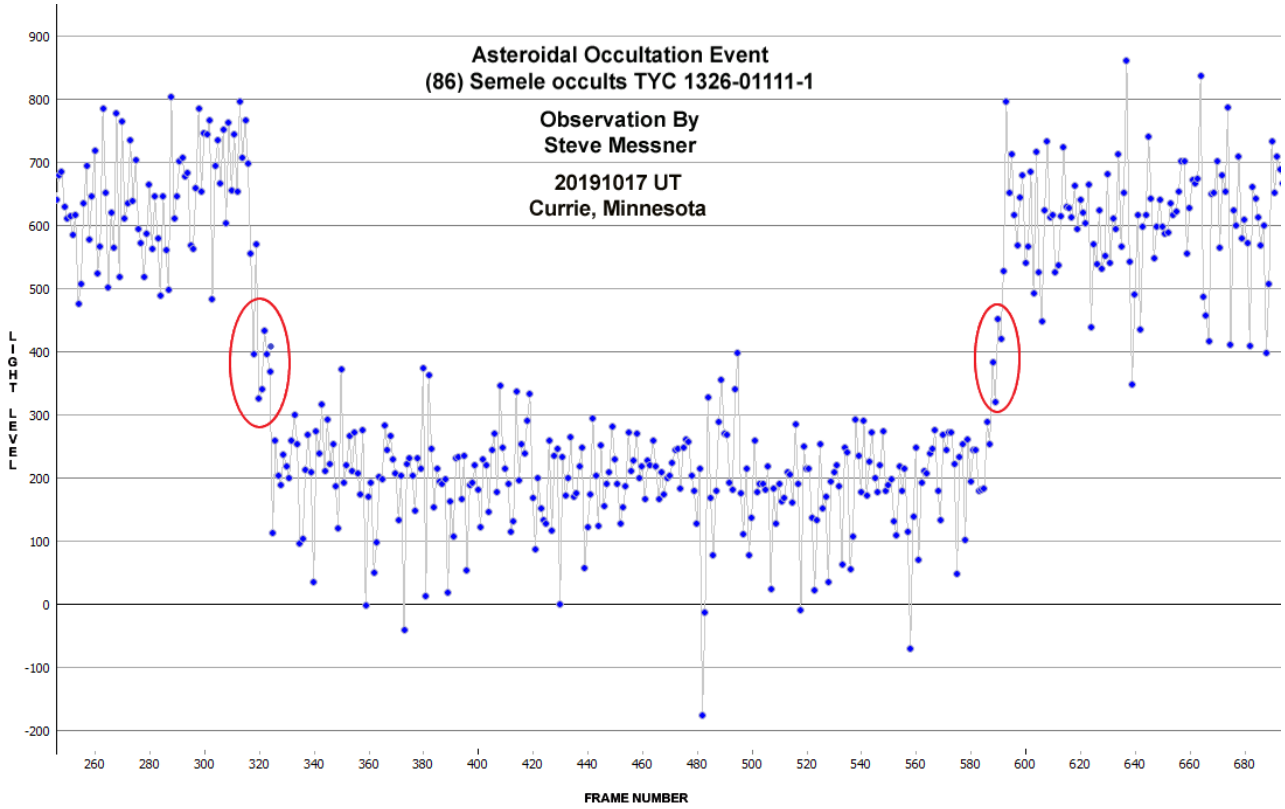

Figure 1 -- Messner event – note stepped events circled.

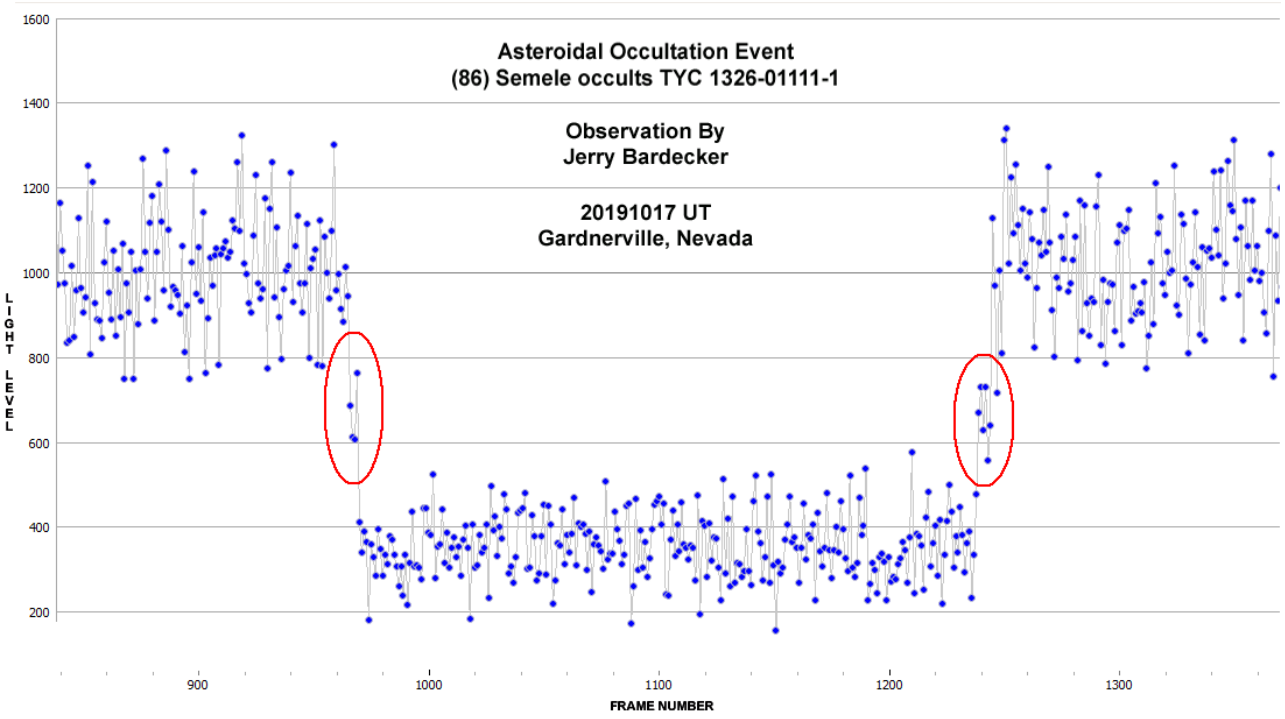

Figure 2 -- Bardecker event– note stepped events circled

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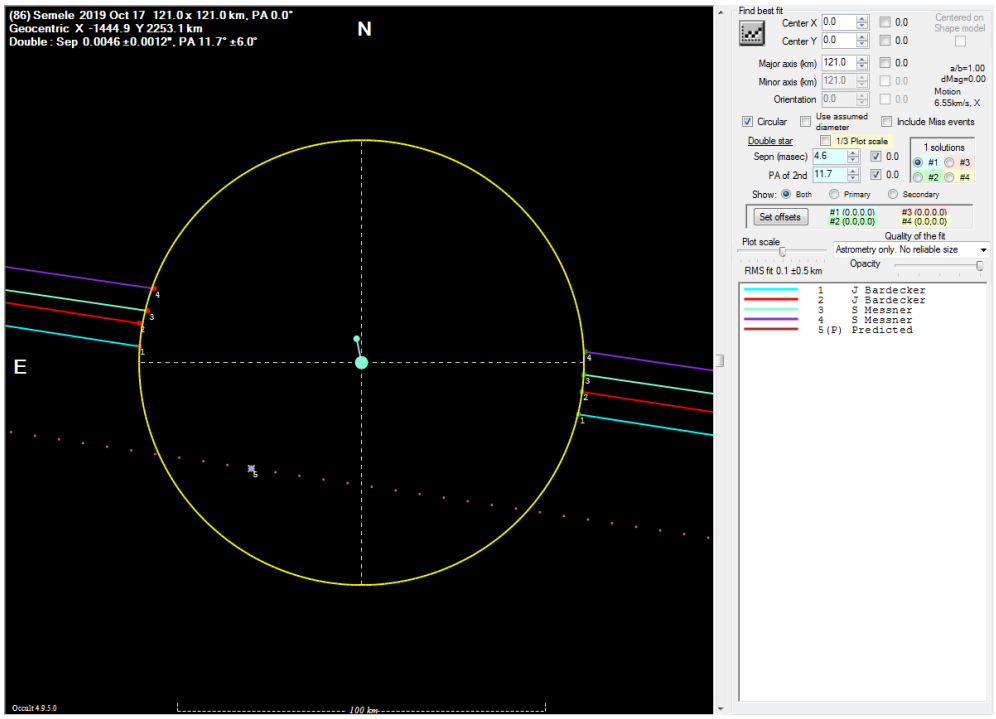

Figure 3: Occultation (86) Semele occultation of TYC 1326-0111-1 profile plot

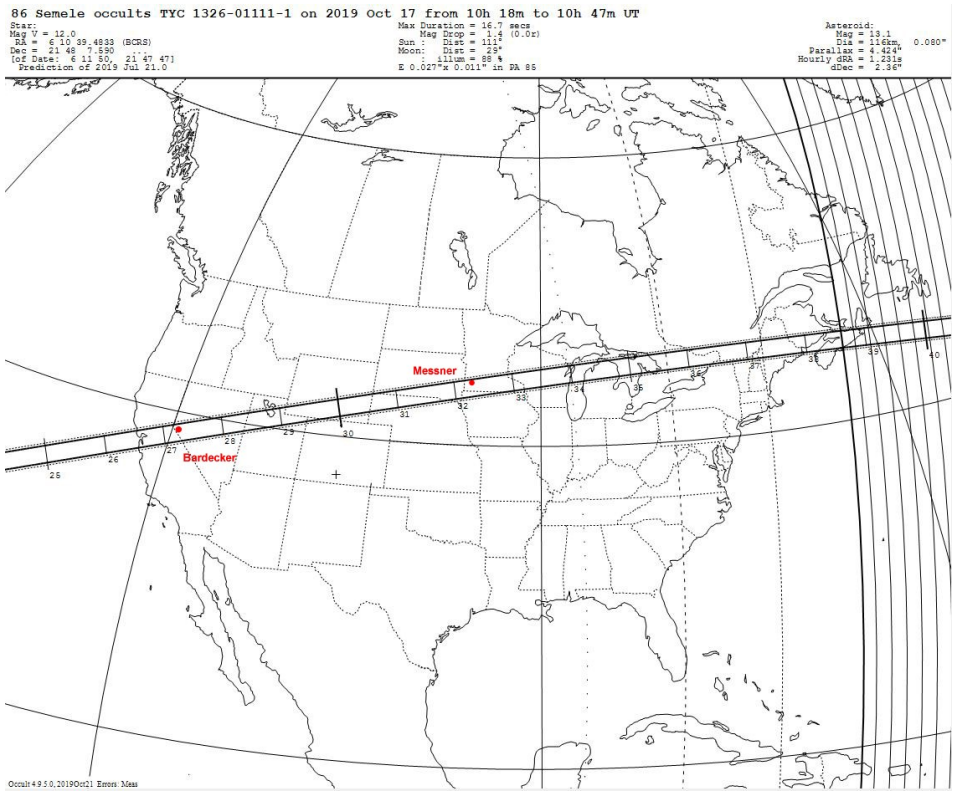

Figure 4 – Predicted Occultation Path

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Event	Bardecker Time UT	Messner Time UT
D1	10:27:07.774	10:32:14.600
R1	10:27:25.992	10:32:32.751
D2	10:27:07.974	10:32:15.076
R2	10:27:26.326	10:32:33.018

Table 2. Event times (corrected)

Event	Bardecker Magnitude Change	Messner Magnitude Change
D1	0.54	0.52
R1	0.84	0.78
D2	0.85	0.78
R2	0.57	0.53

Table 3 – Calculated Magnitude Drops

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Individual Event Magnitude Analysis

Each of the individual D and R events for both observers were then analysed using PyOTE 3.2.5. The estimated magnitude change for each event (D1, D2, R1, and R2) is shown in the Table 3.

Primary and Secondary Magnitude Estimates

Magnitude estimates for each component were then made using the brightness measurements derived by PyOTE 3.2.5.

Mean Photometric values were extracted from each observers 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 (Method 3 – Magnitudes from light curve values) was used for this analysis.

Light levels for the Messner observation:
* Light levels at D of 602 => 404 => 198
* Light levels at R of 198 => 394 => 602

Calculated star magnitudes for the Messner observation:
* Assuming a combined magnitude of 12.00
Magnitudes for sequence A-B-B-A: Mag A = 12.75, Mag B = 12.76
Magnitudes for sequence B-A-A-B: Mag A = 12.76, Mag B = 12.75

Light levels for the Bardecker observation:
* Light levels at D of 929 => 668 => 272
* Light levels at R of 272 => 660 => 929

Calculated star magnitudes for the Bardecker observation:
* Assuming a combined magnitude of 12.00
Magnitudes for sequence A-B-B-A: Mag A = 12.99, Mag B = 12.56
Magnitudes for sequence B-A-A-B: Mag A = 12.56, Mag B = 12.99

Although the calculated magnitudes of the primary (P) and secondary (S) components are somewhat similar, there is sufficient difference to establish a probable event sequence. Based on these values, a SPPS (or BAAB) event sequence is the most likely for this set of observations. Note: In this context: B=the secondary (dimmer) star and A=the primary (brighter) star.

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

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

Star	TYC 560-1111-1 UCAC4 560-025472 3UC 224-053300 NOMAD 1118-0119007 PPMX 061039.4+214807 spectral type not known to authors
Coord (J2000)	RA 06h10m39.5s DEC +21°48'07.519"
Mag A	12.56-12.76
Mag B	12.75-12.99
Separation	0.0046 (± 0.0012 arcseconds)
Position Angle	11.7 (± 6.0 degrees)

Acknowledgements

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References

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

[2] Occult v4.1.0. Occultation prediction software by David Herald. http://www.lunar-occultations.com/iota/occult4.htm