

A Possible New Star: Evidence of a Quaternary Star added to a Tertiary Star System May Have Been Found During the (336) Lacadiera Occultation of 3UC197-115376

Abstract: An occultation of 3UC197-115376 by the asteroid (336) Lacadiera on 2009 April 16 shows evidence of a possible new (quaternary) component of a previously known tertiary star. The new star has a separation of $7.5 (\pm 0.9)$ milliarcseconds (mas) and position angle (pa) of $124.9 (\pm 6.3)$ degrees.

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Observation

On 2009 April 16, six independent IOTA astronomers (Bracken, Cadmus, Carcich, Centala, Modic, and Slauson) observed the asteroid (336) Lacadiera occult the star 3UC197-115376 from six different locations in the USA. See Table 1 and predicted path map Figure 1.

The UCAC3 Catalog was used to identify the stars in this paper as all three stars in the known tertiary star system were already cataloged in UCAC3. The target star 3UC197-115376 is magnitude 10.218 (V). There is a nearby 10.457 (V) secondary (3UC 115373) and a closer 12.187 (V) magnitude tertiary (3UC197-115375). The expected magni-

tude drop at occultation was 3.5 magnitudes based on 3UC197-115376. This star, also identified as TYC 0819-00852-1U, is listed in the Fourth Interferometric Catalog and the Washington Double Star catalog as a triple star system as shown in Table 2.

The light curves obtained by the observers are shown in Figures 2A, 2B, 2C, 2D, 2E and 2F. In some but not all of the light curves a step decrease in brightness is visible in the disappearance part of the light curve. A corresponding step near the top of the reappearance part of the light curve is not readily apparent in any of the light curves due to the low signal-to-noise ratio in the data. Figure 2A is the most definitive evidence of the step event.

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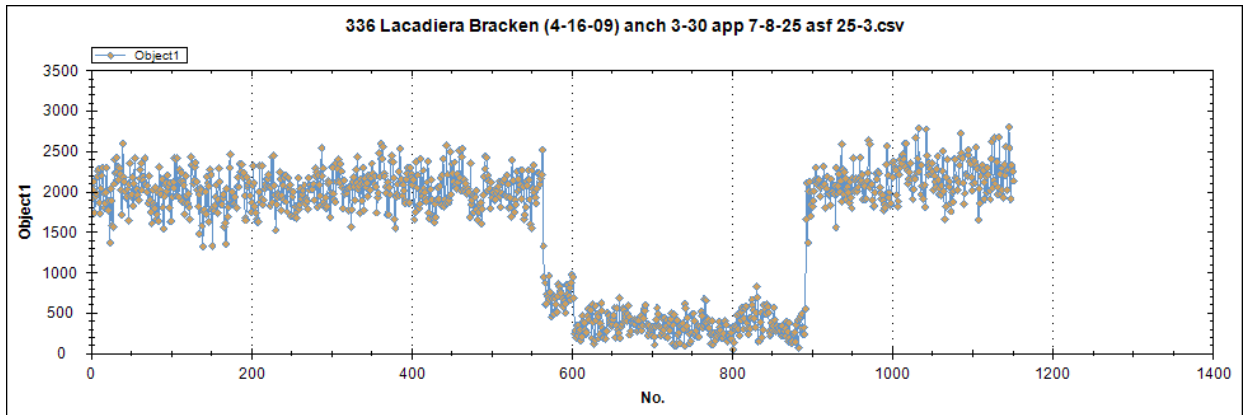


Figure 2A: Carl Bracken

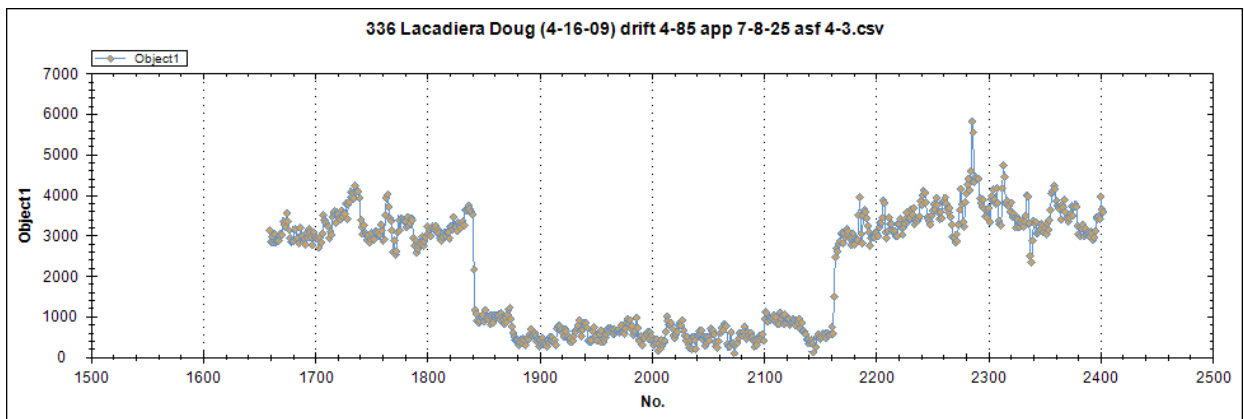


Figure 2B: Doug Slauson

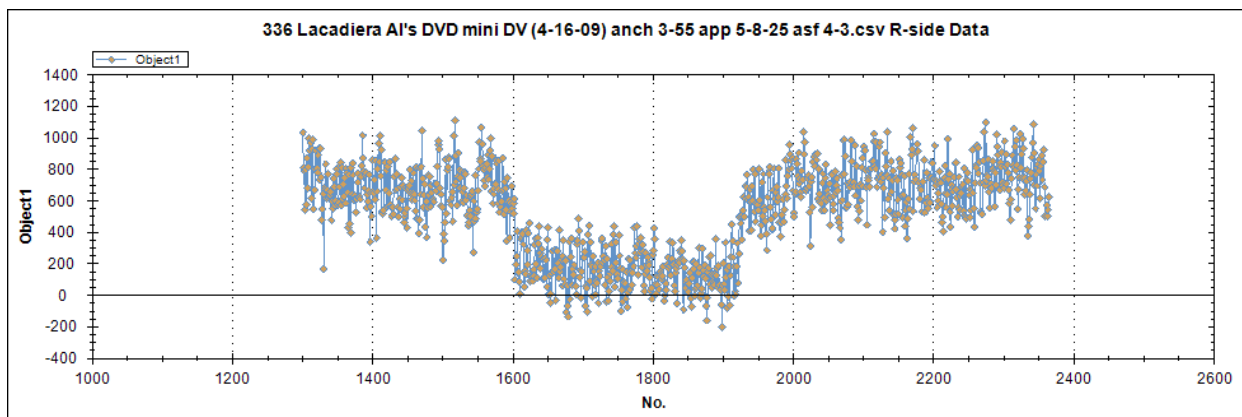


Figure 2C: Al Carcich

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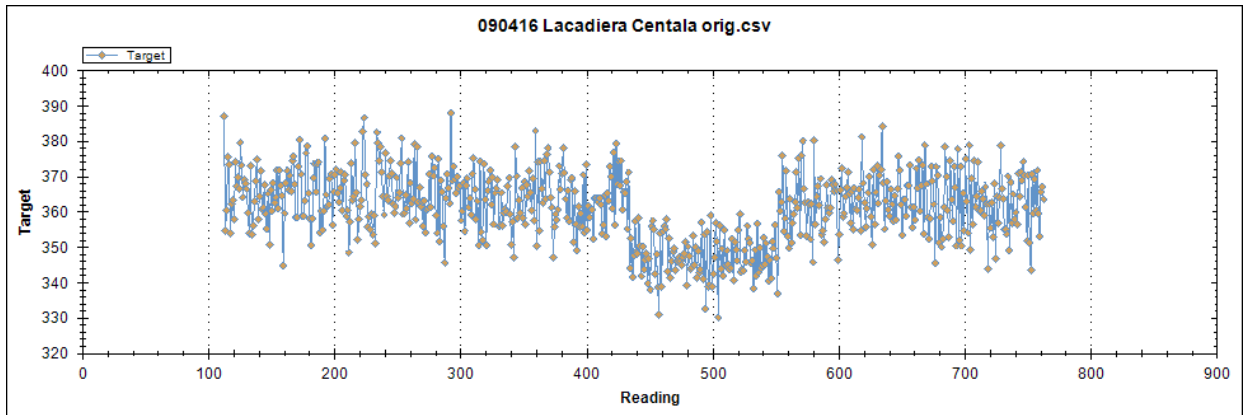


Figure 2D: John Centala

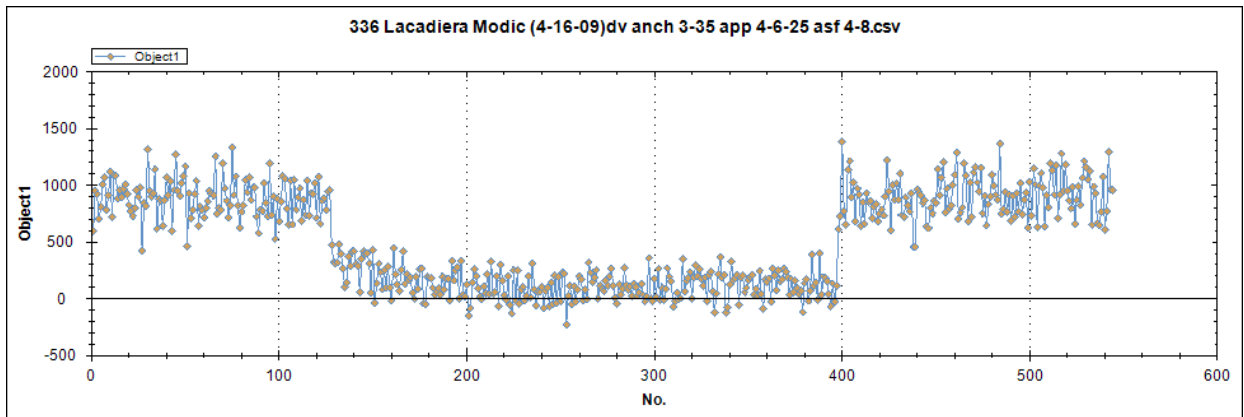


Figure 2E: Robert Modic

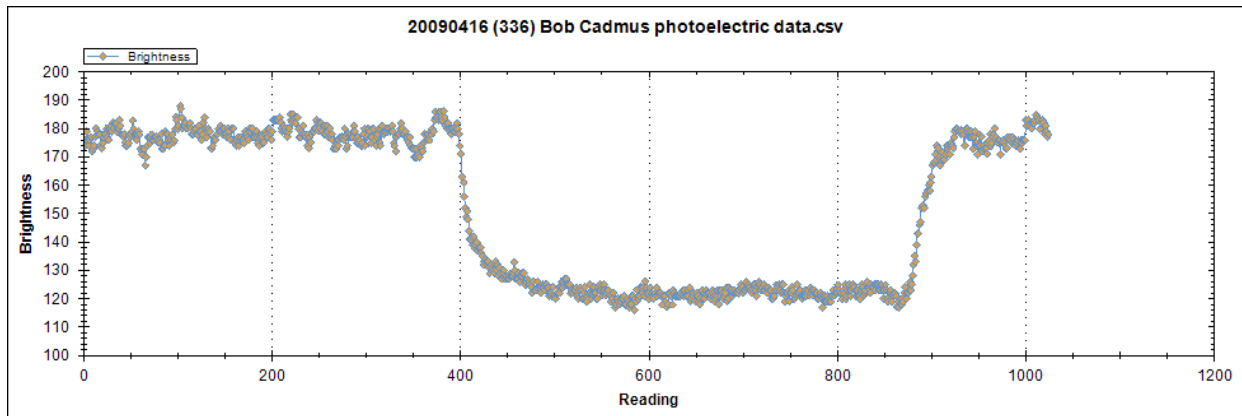


Figure 2F: Robert Cadmus

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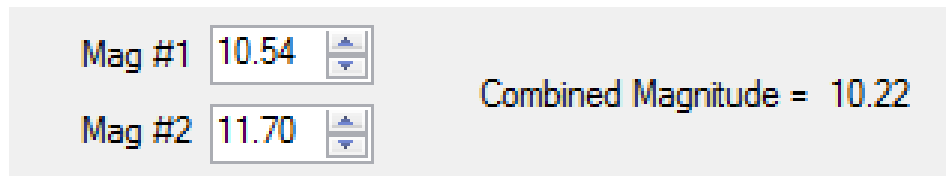


Figure 3: Documentation of calculated component magnitudes (from Occult4).

Table 3 – Double Star Identification and Properties

Star	3UC197-115375 UCAC2 34650672 TYC 0819-00852-1U Nomad 0982-0010277 PPMXL 4051009846414370790 PPMX 091647.1+081417
Coordinates (J2000)	09:16:47.12 +08:14:17.7
Mag A	10.218 (V) 3UC 10.54 (V) from occ. obs
Mag B	11.7 +/- 0.1 (V)
Separation	7.5 mas ± 0.9 mas
Position Angle	124.9° ± 6.3°
Epoch	2009.288

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Timing of the event disappearance and reappearance was obtained through either:

1. GPS time inserted in each frame,
2. GPS time inserted at the start and end of video and then inserted by frame based on frame count
3. WWV or WWVB time recording/ simultaneous video recording with frame times interpolated from WWV or WWVB time tones.

A detailed discussion of these timing techniques is given in Nugent [1].

The observations from all six chords were analysed in the standard manner described by Herald [2]. Assuming the asteroid had an elliptical profile, the double star characteristics are shown in Table 3.

The magnitude for each component was determined separately. See Figure 3 for documentation of the primary and quaternary component magnitudes. The magnitudes of the two stars are estimated to be

10.54 (V) and 11.7 (V).

The pair might be detectable through interferometry. Due to the uncertainty of the quaternary star, further interferometric analysis is recommended. The solution for the double star is shown in Figures 3 and 4. The solution for the entire quaternary system is summarized in Figure 5.

Acknowledgements:

The authors would like to acknowledge Dave Herald, Murrumbateman, Australia for his help in resolving the component profile issues and establishing disappearance and reappearance weighting factor for each chord used in the profile plot. We would also like to thank David W. Dunham, Greenbelt, MD USA for his review comments.

This research has made use of VizieR and Aladin.

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(336) Lacadiena 2009 Apr 16 76.6 ± 14.9 × 60.2 ± 1.9 km, PA -30.6° ± 12.2°
 Geocentric X 3908.3 ± 1.7 Y 3810.8 ± 4.4 km
 Double : Sep 0.0075 ± 0.0009", PA 124.9° ± 6.3"

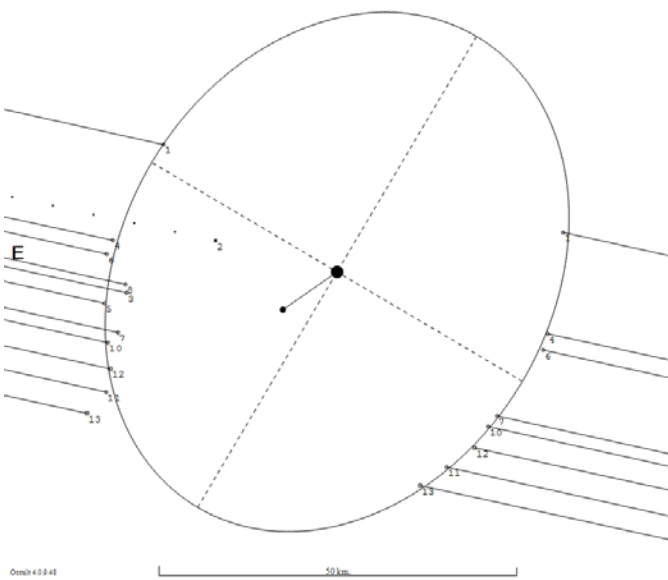


Figure 4A: Asteroid profile plot – primary and secondary stars aligned

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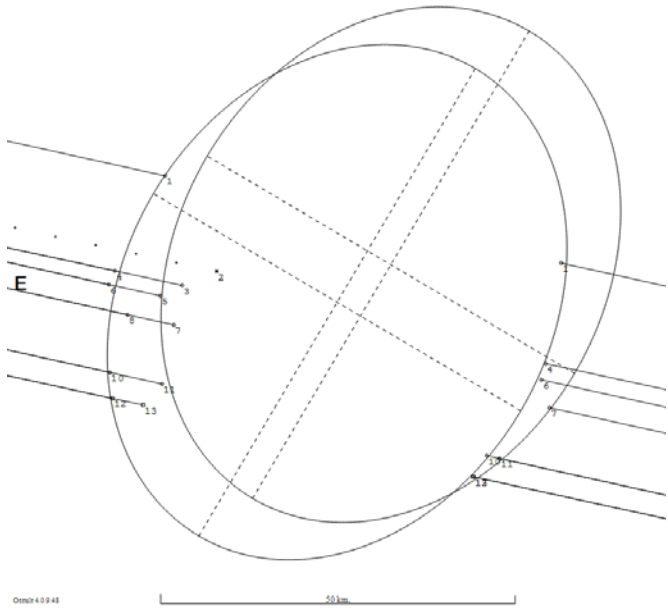


Figure 4B: Asteroid profile plot – primary and secondary stars separate

Key to Observer Chord Numbers

- 1 J Centala, Marion, IA
- 2(P) Predicted Centerline w/Time
- 3 A Carcich, Slate Hill, NY
- 4 A Carcich, Slate Hill, NY
- 5 C Bracken, EIOLC., IA
- 6 C Bracken, EIOLC., IA
- 7 D Slauson, Swisher, IA
- 8 D Slauson, Swisher, IA
- 10 R Cadmus, Grinnell, IA
- 11 R Cadmus, Grinnell, IA
- 12 R Modic, Richmond Hts., OH
- 13 R Modic, Richmond Hts., OH

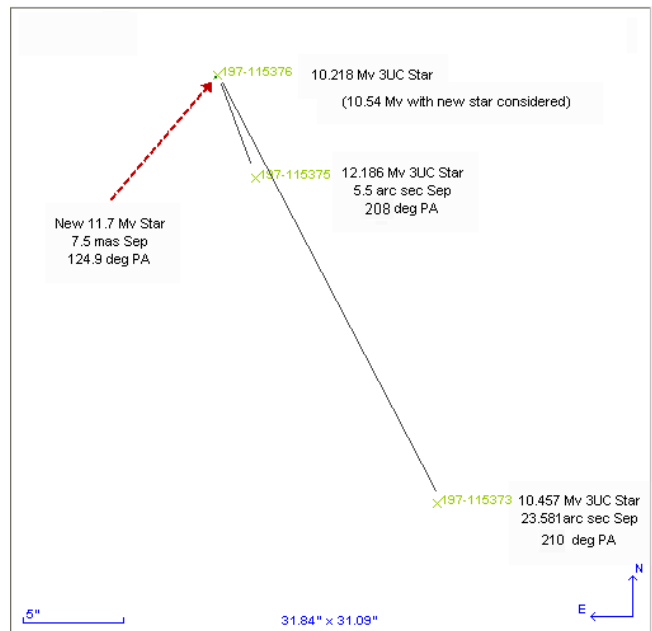


Figure 5: Relative positions and magnitudes of quaternary star system

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References

1. "Chasing The Shadow: The IOTA Occultation Observer's Manual, The Complete Guide to Observing Lunar, Grazing, and Asteroid Occultations", Richard Nugent, April 2007.
2. Herald, D. et al., "New Double Stars from Asteroidal Occultations, 1971 - 2008", JDSO Vol. 6, No. 1, pp. 88-96, January 2010

