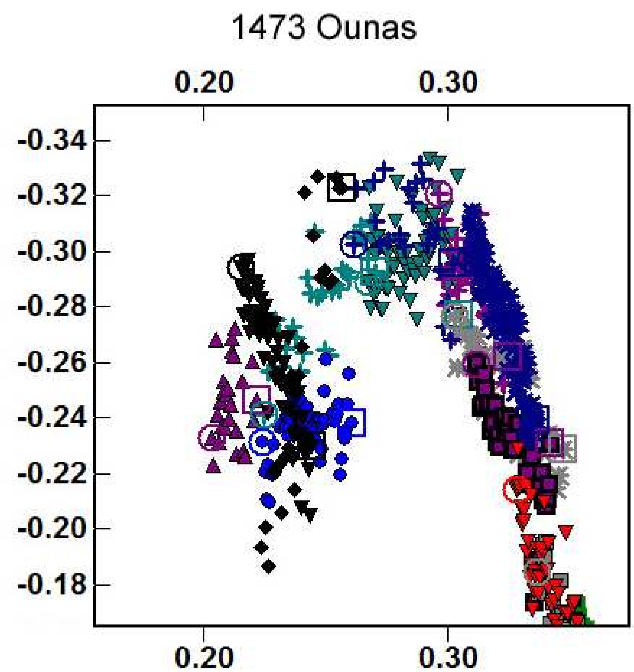

Figure 5. Enlargement of a small section of the lightcurve showing the session of Oct. 1 02:57 UT - 06:59 UT (black triangles) with a slope misfit.

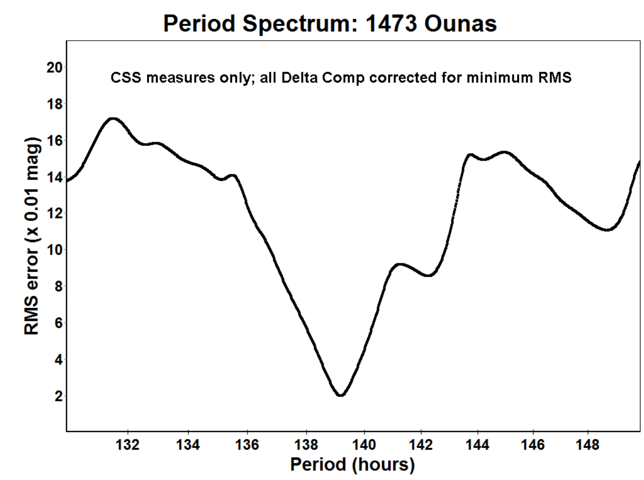

Figure 6. Period spectrum of 1473 Ounas between 130 and 150 hours with magnitudes adjusted as in Fig. 3.

1727 METTE: A NEW HUNGARIA BINARY

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Analysis of CCD photometric observations of the Hungaria asteroid 1727 Mette made in 2013 January shows that the asteroid is a binary system. A bimodal lightcurve for the primary has a period 2.98109 ± 0.00007 h with an amplitude of 0.33 ± 0.01 mag. This makes the primary one of the more elongated objects in the small binary population. The orbital period of the satellite is 20.99 ± 0.02 h. Based on the depth of the mutual events, the satellite-primary diameter ratio is estimated to be $D_s/D_p = 0.21 \pm 0.02$.

The rotation period of the (now known to be) primary of the Hungaria asteroid 1727 Mette had been determined on several previous occasions, e.g., Wisiniewski (1987, 2.63 h), Behrend *et al.* (2003, 2.981 h), Gandolfi (2009), and Warner (2011, 2.981 h). Other observers have reported periods of 2.4-2.6 h over the years. See the references in the asteroid lightcurve database (LCDB; Warner *et al.*, 2009). None of the previous results seemed to indicate signs of the asteroid having a satellite.

As part of the regular observations of the Hungaria asteroids conducted at the Palmer Divide Observatory since 2005, CCD photometric observations of 1727 Mette were started in 2013 January. In this case, the intent was to provide additional dense lightcurves for modeling the asteroid's spin axis and shape. Initial observations showed what appeared to be deviations from a 2.98 hour lightcurve (Figure 1). This prompted additional observations so that the primary curve could be well-determined and then subtracted from the overall data set to determine the period of the satellite events (occultations and/or eclipses), i.e., the orbital period.

The observations at the Palmer Divide Observatory (PDO) were made using a 0.30-m Schmidt-Cassegrain and SBIG ST-9XE CCD camera. Exposures were 120 seconds and unfiltered. Observations at the Center for Solar System Studies (CS3) were made with a 0.35-m Schmidt-Cassegrain and SBIG STL-1001E. Exposures were also unfiltered and 120 seconds. All images were measured in *MPO Canopus*. The dual-period feature in that program, based on the FALC algorithm developed by Harris (Harris *et al.*, 1989) was used to subtract one of the periods from the data set in an iterative process until both periods remained stable. Night-to-night calibration of the data was done using the Comp Star Selector feature in *MPO Canopus*. Catalog magnitudes for the comparison stars were derived from J-K to BVRI formulae developed by Warner (2007) using stars from the 2MASS catalog (Skrutskie *et al.*, 2006). A description of this method was described by Stephens (2008).

The results of the analysis are shown Figures 1-3. Figure 1 shows the full data set before subtracting the effects of the occultation and/or eclipses caused by the satellite. This shows the nature of the deviations that prompted the additional analysis. Figure 1 also demonstrates the usual nature of these events in *unprocessed* lightcurves: they are not sharp, short-lived, and deep. Instead they extend over a period of an hour or more and somewhat subtle. There are, of course, exceptions, but if an "event" consists of a few data points dropping several tenths of a magnitude and recovering very quickly, it should be viewed with some suspicion and, as always, confirmed with additional observations.

Figure 2 shows the lightcurve after subtracting the mutual events and so represents the rotation of the primary body. The amplitude of 0.33 mag implies a minimum a/b ratio of about 1.4:1 for a simple triaxial ellipsoid, assuming an equatorial view. This makes it one of the more elongated primaries among the small binary population. Usually, primaries tend to be more spheroidal, showing amplitudes in the range of 0.05 to 0.20 mag.

Figure 3 shows the mutual events by subtracting the rotation of the primary from the overall data set. The "dips" at 0.05 and 0.55 rotation phase represent an occultation or eclipse. Using the magnitude drop of the shallower of the two, the estimated secondary-primary size ratio is $D_s/D_p = 0.21 \pm 0.02$. The event at 0.05 appears to be total, so this is probably the actual ratio and not a minimum.

Acknowledgements

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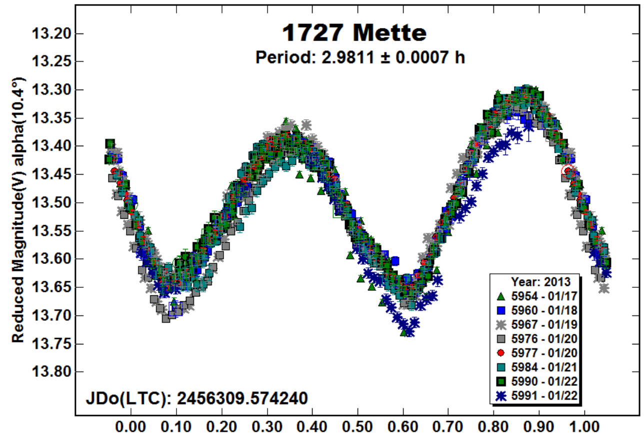

Figure 1. The lightcurve of 1727 Mette without subtracting the effects of the satellite. The deviations from the overall curve are what lead to additional analysis and discovery of the satellite.

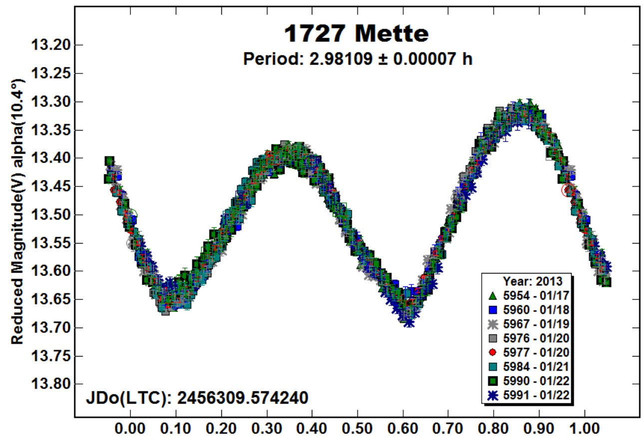

Figure 2. The lightcurve for 1727 Mette showing only the rotation of the primary. The somewhat large amplitude is unusual for the primary of a small binary system. Most primaries have amplitudes in the range of 0.05-0.20 mag.

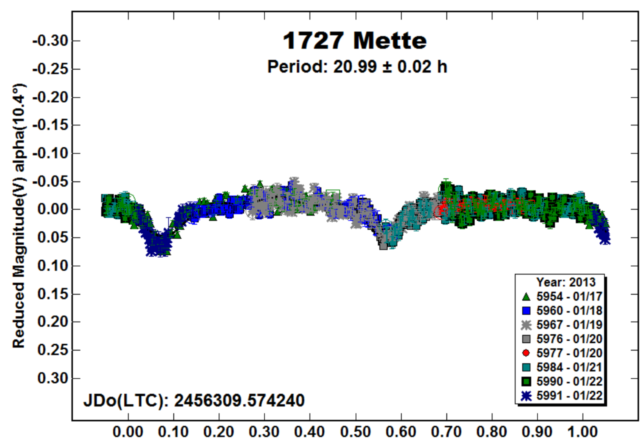

Figure 3. The lightcurve of 1727 Mette after subtracting the primary lightcurve. The "dips" at about 0.05 and 0.55 rotation phase are due to occultations or eclipses involving the satellite. The small upward bowing between the events indicates the satellite is slightly elongated.