

LIGHTCURVE FOR THE HUNGARIA BINARY 5477 HOLMES

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CCD photometric observations of the known Hungaria binary 5477 Holmes were made in 2012. Analysis of the data confirmed the previously-determined rotation and orbital periods and size ratio of the secondary to primary. The data will be useful for further modeling of the system.

The Hungaria asteroid 5477 Holmes was discovered to be binary in 2005 (Warner *et al.*, 2005; Warner *et al.*, 2011). At that time, a primary period of 2.9943 h and orbital period of 24.42 h were reported. The estimated size ratio, D_s/D_p , was 0.37 ± 0.02 . Additional observations were made in 2007 (Pravec *et al.*, 2012). The combined data set was then used to refine the system parameters, increasing the size of the satellite slightly to $D_s/D_p = 0.39 \pm 0.02$ and finding the pole of the satellite orbit (Pravec *et al.*, 2012).

The asteroid was observed again in 2012 by the authors to add to the data set for modeling. The observations at PDO were made using either a 0.5-m Ritchey-Chretien and FLI-1001E CCD camera or a 0.35-m Schmidt-Cassegrain (SCT) with an SBIG STL-1001E CCD camera. The observations at CS3 used a 0.35-m SCT and SBIG ST-10 CCD or a 0.4-m SCT with STL-1001E CCD. All images were unfiltered. The data were put onto an internal standard system using V magnitudes derived from the 2MASS catalog (Skrutskie *et al.*, 2006; see Warner, 2007; Stephens, 2008). The observations were made over the period of 2012 March 6 to April 18. Almost 700 data points were used in the analysis.

Warner used the dual period search feature in *MPO Canopus* to find the period of the primary ($P_1 = 2.9932 \pm 0.0002$ h, amplitude 0.10 ± 0.01 mag) and the orbital period (24.37 ± 0.01 h). Both of these are in good agreement with the model from Pravec *et al.* (2012). The amplitude of the mutual events varied from about 0.17 to 0.20 mag, with a total eclipse being observed. This gives $D_s/D_p = 0.38 \pm 0.02$, in excellent agreement with the model by Pravec *et al.* (2012).

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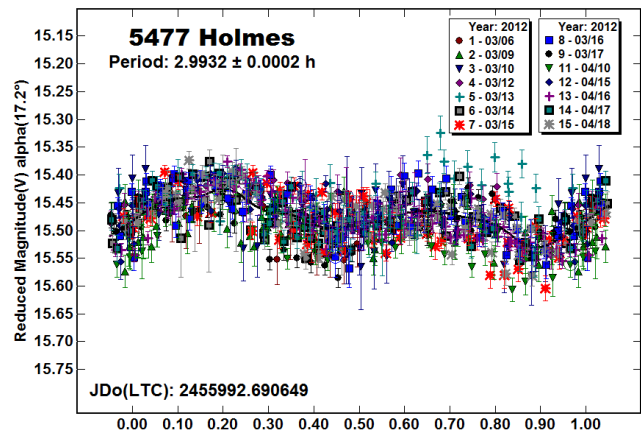


Figure 1. Lightcurve due only to the rotation of the primary in the binary system of 5477 Holmes.

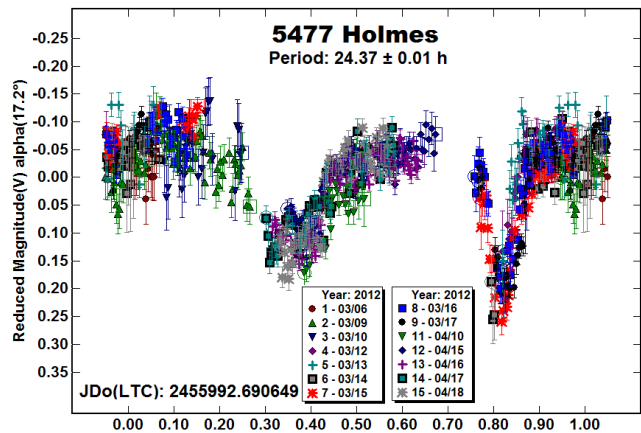


Figure 2. Lightcurve of 5477 Holmes after subtracting the rotation of the primary. The two “dips” at rotation phases ~0.3 and 0.8 are due to occultations/eclipses involving the satellite. The flat portion of the event at 0.3 phase indicates that the event was total. The magnitude drop of this event is used to calculate the size ratio of the two bodies, giving $D_s/D_p = 0.38 \pm 0.02$.

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LIGHTCURVE FOR 1090 SUMIDA

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Analysis of CCD photometric observations of the Phocaea asteroid 1090 Sumida in 2012 showed a low amplitude lightcurve of 0.11 mag. A period of 2.7181 h was determined by Fourier analysis. There were indications of a secondary period with several possible solutions. However, none of them were sufficiently convincing.

The Phocaea asteroid 1090 Sumida was observed by Wisniewski (1991), who reported a period of 2.750 h ($A = 0.22$ mag) and by Behrend *et al.* (2004), who reported a period of 2.7194 h and $A = 0.28$ mag. The period and the estimated size of the object, about 8 km, made it a good candidate for being binary even though neither of two previous observers reported any signs of a satellite.

Observations of the asteroid were started at PDO on 2012 June 9 as a “full moon project”, i.e., it was bright enough to be worked despite the moon’s phase and because there were no program targets among the Hungaria asteroids available at the time. A 0.30-m Schmidt-Cassegrain (SCT) and SBIG ST-9XE were used to obtain the unfiltered images. Analysis of the first night’s data was able to find a period around 2.7 h but there were indications of unusual behavior in the curve, either due to systematic problems or a secondary period. Help was requested from Megna at CS3 to observe the asteroid almost simultaneously, which would help eliminate systematic issues. He used a 0.35-m SCT and SBIG ST-9 CCD camera, also unfiltered.

The data from both locations were put onto an internal standard system using V magnitudes derived from the 2MASS catalog (Skrutskie *et al.*, 2006; see Warner, 2007; Stephens, 2008). Night-to-night calibrations for each observer and between observers were generally within 0.05 mag or less of one another. On at least two nights both observers recorded what appeared to be “unusual

behavior”, i.e., significant deviations from the smoothed curve that appear in the plot. However, an additive dual period search by Warner, one best suited to lightcurve changes due to a satellite, could not find a stable secondary solution, even as more data were added to the analysis. Subtraction of some of the secondary periods does reduce the scatter in the plot, but not to the point of statistical significance.

High-precision observations at future apparitions are strongly encouraged.

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