LIGHTCURVES FOR 938 CHLOSINDE AND 3408 SHALAMOV

Dr. Melissa Hayes-Gehrke,
Joseph Benik, Zsombor Kovacs, Sam Knutson, Charles Mills
Department of Astronomy, University of Maryland
College Park, Maryland 20742
mhayesge@umd.edu

(Received: 9 December)

CCD observations yielded lightcurves and synodic periods for two asteroids: 938 Chlosinde, 19.204 ± 0.006 h; and 3408 Shalamov, 10.495 ± 0.001 h.

CCD observations of two asteroids were made at Tzec Maun Foundation's New Mexico Skies observatory, located near Mayhill, New Mexico, in 2010 September and October. A 0.4-m f/9 Ritchey-Chretien with 0.5 arcseconds per pixel resolution was used along with a 0.35-m f/3.8 Maksutov-Newtonian reflector with 1.05 arcseconds per pixel resolution. Both cameras were binned 2x2 and images were acquired through a clear filter. Exposures were 420 seconds at -20°C. All photometric data were analyzed using *SIP* v2.20 (Simonetti, 1999) and *APT* v1.0.6 (Laher, 2010). The SNR was greater than or equal to 100 for 43% of asteroid targets and comparison stars. Differential aperture photometry was used with comparison stars of similar brightness. Two comparison stars were used for each image; however, it was necessary to choose different comparison stars for each evening of observation.

938 Chlosinde. An initial search of the Asteroid Lightcurve Database (LCDB; Warner *et al.* 2009) identified 938 Chlosinde as an asteroid for which no lightcurve data exist. Observations were made from 2010 September 25 through September 28, producing 49 data points in five data sets. Five data points were discarded before doing photometry due to severe vignetting or elongation. Early analysis revealed a tentative rotation period of 6.65 h with an approximate amplitude of 0.15 mag.

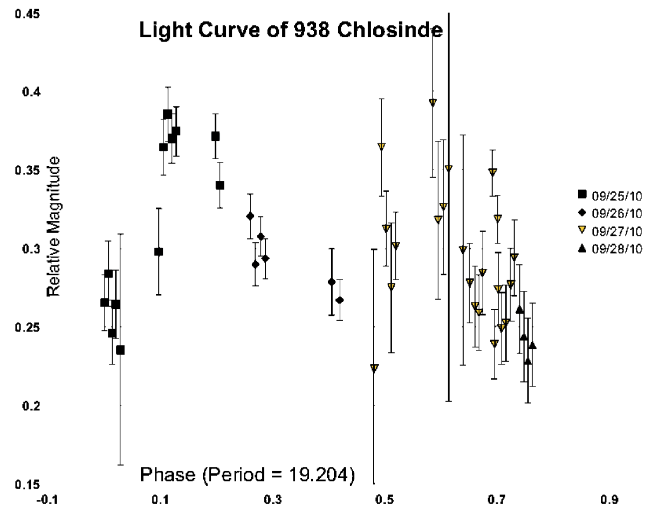
A post-observational search of the LCDB yielded a period of 19.204 ± 0.006 h with an amplitude of 0.16 ± 0.03 as reported by Stephens (2010). Further investigation identified a misspelling of "Chlosinde" in the LCDB that led to our duplicate efforts. Stephens' data are as complete as his lightcurve is convincing. A re-analysis of our observations confirms Stephens's results that he submitted to the CALL website by producing a reasonable lightcurve with $P = 19.204$ h.

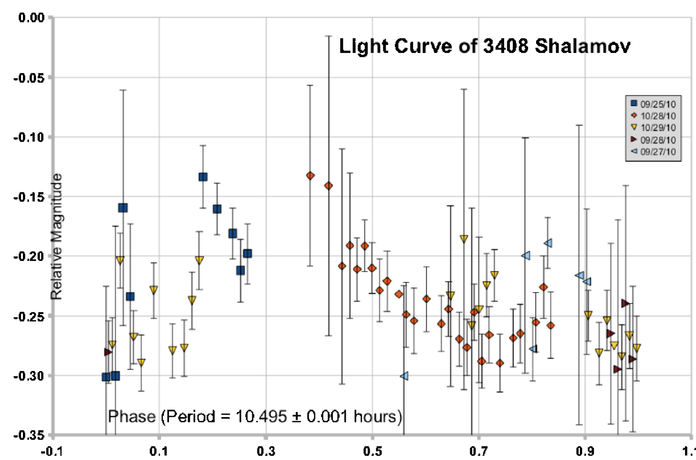
3408 Shalamov. A search of the LCDB does not reveal any reported lightcurve results for 3408 Shalamov. Observations were made from 2010 September 25 through September 28 and from 2010 October 28 through October 30, producing 97 data points in six data sets. Twenty data points were discarded before doing photometry due to severe vignetting or elongation. A rotation period of 10.495 ± 0.001 h was determined with an amplitude of 0.28 ± 0.10 mag. The authors suggest that further observations be done to confirm this result.

This research was done as part of an undergraduate class, taught by Dr. Hayes-Gehrke, at the University of Maryland. The purpose of this class was to teach the concepts and applications of aperture photometry and lightcurve analysis, as well as to contribute to our knowledge of asteroid rotation periods.

Acknowledgements

We would like to thank Robert Stephens for his correspondence in sharing the results of his submission to the *Minor Planet Bulletin* regarding 938 Chlosinde as well as the Tzec Maun Foundation for the use of their New Mexico Skies observatory in New Mexico, USA. We would also like to thank Brian D. Warner for his correspondence in aiding us with the preparation of this paper.





References

Laher, R. (2007-2010). *APT*, Aperture Photometry Tool software, version 1.0.6. Spitzer Science Center, California Institute of Technology, Pasadena, CA. *http://spider.ipac.caltech.edu/staff/laher/apt/*

Simonetti, J. (1999). *SIP*, Sky Image Processor software. *http://www.phys.vt.edu/~jhs/SIP/*

Stephens, Robert D. (2010). Posting on CALL website. *http://www.minorplanetobserver.com/astlc/default.htm*

Warner, B.D., Harris, A.W., and Pravec (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updates available at: *http://www.MinorPlanetObserver.com/astlc/default.htm*

ROTATION PERIOD DETERMINATIONS FOR 25 PHOCAEA, 140 SIWA, 149 MEDUSA, 186 CELUTA, 475 OCLLO, 574 REGINHILD, AND 603 TIMANDRA

Frederick Pilcher
4438 Organ Mesa Loop
Las Cruces, NM 88011-8403 USA
pilcher@ic.edu

(Received: 1 January)

Synodic rotation periods and amplitudes are found for: 25 Phocaea 9.9341 ± 0.0002 h, 0.26 – 0.16 mag; 140 Siwa 34.407 ± 0.002 h, 0.05 ± 0.01 mag; 149 Medusa 26.038 ± 0.002 h, 0.56 ± 0.03 mag; 186 Celuta 19.842 ± 0.001 h, 0.54 ± 0.02 mag; 475 Ocllo 7.3151 ± 0.0002 h, 0.66 ± 0.04 mag; 574 Reginhild 14.339 ± 0.001 h, 0.17 ± 0.02 mag with 3 maxima and minima per cycle; 603 Timandra 41.79 ± 0.02 h, 0.10 ± 0.02 mag.

All observations reported here were made at the Organ Mesa Observatory. Equipment consists of a 35 cm Meade LX200GPS S-C, SBIG STL-1001E CCD, R filter for 25 Phocaea and 186 Celuta, clear filter for other fainter objects, unguided, instrumental magnitudes only. Due the large number of data points acquired the lightcurves have been binned in sets of three data points with maximum of 5 minutes between points, except for 603 Timandra in which the binning is in sets of 5 data points with maximum of 10 minutes between points.

25 Phocaea. Previous period determinations are: Groeneveld and Kuiper (1954), 9.945 h; Buchheim (2007), 9.945 h; Pilcher (2009), 9.935 h in 2008 and 9.927 h in 2009. These show irregular lightcurves with shapes varying greatly with longitude of observations and amplitudes 0.03 – 0.16 magnitude. All of these periods are compatible with each other and with the new results reported here. New observations on 7 nights 2010 Sept. 25 – Dec. 10 show a period 9.9341 ± 0.0002 hours. An amplitude change occurred in the deepest minimum near phase 0.40 which correlates positively with phase angle, from 0.26 mag at phase angle 21 degrees, the largest yet observed, to 0.16 mag at phase angle 4 degrees. This is caused by shadowing of irregularities and will be useful in spin/shape modeling. Otherwise the lightcurve was very stable throughout the apparition.

140 Siwa. Harris and Young (1980) and Schober and Stanzel (1979) independently obtained single night 7 hour lightcurves separated by 32 hours which looked similar and surmised a 32 hour period, or perhaps 22 hours. Lagerkvist et al. (1992) on the basis of 4 consecutive nights claimed a period of 18.5 hours. Le Bras et al. (2001) found a period of 18.495 hours with a shape very similar to that published by Lagerkvist et. al. (1992). Riccioli et al. obtained a period of 14.654 hours. Behrend (2010) shows a period of 17.16 hours represented by a lightcurve of amplitude 0.15 magnitudes, the largest reported, and one maximum and minimum per cycle. New observations on 10 nights 2010 Oct. 23 – Dec. 25 show a period 34.407 ± 0.002 hours, amplitude 0.05 ± 0.01 mag. Trial lightcurves phased to all local minima in the period spectrum between 15 and 80 hours were drawn. Those at periods 34.407 and 68.817 hours had the lowest and nearly the same rms residuals, and were the only ones which did not show significant misfits between data on different nights. Phase coverage for the double period 68.817 hours was only 90% complete, but the sections of the lightcurve separated by ½ cycle looked identical to each other and to the 34.407 hour lightcurve. A shape model sufficiently irregular to produce the 34.407 hour lightcurve yet invariant over a 180 degree rotation is highly unlikely. Therefore I claim the 34.407 hour period is the correct one. This period may be consistent with Behrend (2010) if one assumes Behrend missed the second maximum and minimum, and perhaps also with the very sparse data of Harris and Young (1980) and Schober and Stanzel (1979), but not consistent with any of the other reported periods. The next opposition of 140 Siwa is 2012 Mar. 9, at almost the same location in the sky in which Behrend's 0.15 magnitude amplitude was observed. It is recommended that Siwa be observed again in early 2012 with special attention to full phase coverage for an alleged 34.4 hour period and an expected bimodal lightcurve with sufficient asymmetry between the two halves to rule out all aliases.

149 Medusa. The only previous period determination is by Harris et al. (1992) of 26 hours based on less than 50% lightcurve coverage on 2 consecutive nights. New observations on 9 nights 2010 Oct. 1 – Nov. 23 improve the earlier period determination to 26.038 ± 0.002 hours and amplitude 0.56 ± 0.03 mag.

186 Celuta. Bailey (1913) with visual photometry found a period 17.5 h. Lagerkvist (1978) with photographic photometry on one night established a period >12 h. Lagerkvist and Pettersson (1978) used photoelectric photometry on four well separated nights to obtain a period consistent with 19.6 hours, although other periods could not be ruled out. New observations on 7 nights 2010 Oct. 15 – Nov. 27 show a period 19.842 ± 0.001 hours, amplitude 0.54 ± 0.02 mag. This is consistent with, and improves upon, the period by Lagerkvist and Pettersson (1978).

475 Ocllo. This writer (unpublished) observed 475 Ocllo visually with a Celestron 14 in 1985, finding a large amplitude short period brightness variation. He timed two minima with accuracy ± 20 minutes 1985 Nov. 17 7:30 UT and Nov. 23 6:30 UT (JD 2446386.81 and 2446392.77, respectively). These data were insufficient to find a unique period. They are now shown to be consistent with the newly determined 7.3151 hour rotation period, implying 19.55 ± 0.05 cycles between observed minima. These crude observations are published here because they may help to resolve sidereal period ambiguities in future spin/shape modeling. Behrend (2010) states a period of 7.6461 hours. New observations on 4 nights 2010 Nov. 2 – Dec. 1 show a period 7.3151 ± 0.0002 hours, amplitude 0.66 ± 0.04 mag, and rule out Behrend's period.

574 Reginhild. Harris et al. (2010) show no previous observations. New observations on 6 nights 2010 Oct. 11 – Nov. 30 show a period 14.339 ± 0.001 hours, amplitude 0.17 ± 0.02 mag with 3 unequal maxima and minima per cycle. J. Tieman, Chicago, Illinois, USA, has kindly sent unpublished observations of 574 Reginhild which are fully consistent with those presented here.

603 Timandra. Harris et al. (2010) show no previous observations. Due to this object being fainter than magnitude 15 throughout the apparition the lightcurve shows a scatter of about 0.05 magnitudes. The first night's observations showed a long period and fairly small amplitude, and it required 7 sessions for a period near 41.8 hours to appear. This is almost exactly 7/4 of the Earth's sidereal rotation period. Hence different segments of the lightcurve are observed on 7 consecutive nights, after which an identical sequence repeats. With 10 to 11 hour sessions attainable at a declination near +34 degrees in the northern hemisphere in November and December, there is a 4 to 5 hour overlap between adjacent segments of the lightcurve. On 12 nights 2010 Nov. 13 – Dec. 24 all seven segments were observed with five of them