

LIGHTCURVES FOR 938 CHLOSINDE, 1342 BRABANTIA, 2715 MIELIKKI, AND 3252 JOHNNY

Larry E. Owings
Barnes Ridge Observatory
23220 Barnes Lane
Colfax, CA 95713 USA
lowings@foothill.net

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Lightcurve observations have yielded period determinations for the following asteroids: 938 Chlosinde, 13.702 ± 0.003 h; 1342 Brabantia, 4.175 ± 0.001 h; 2715 Mielikki, 33.6205 ± 0.0006 h; and 3252 Johnny, 3.5467 ± 0.0006 h.

Photometric data on four asteroids were collected in 2010 and 2011 at Barnes Ridge Observatory located in northern California at an altitude of 762 meters. The equipment included a 0.43-m PlaneWave f/6.8 corrected Dall-Kirkham astrograph and Apogee U9 camera. The camera was cooled to -25°C and binned 2×2 , which resulted in an image scale of 1.26 arcsec/pixel. All exposures were 210 seconds and taken through a photometric V filter. The data were obtained with *MaxIm DL V5* driven by *ACP v5* and analyzed using *MPO Canopus v10.0* (Bdw Publishing, 2010). All comparison stars and asteroid targets used had SNR at least 200.

938 Chlosinde. Data were collected from 2010 September 01-14 resulting in 11 data sets totaling 612 data points. 938 Chlosinde was tracked through 22.76 revolutions based on the derived period of 13.702 ± 0.003 h. The peak-to-peak amplitude of was 0.12 mag.

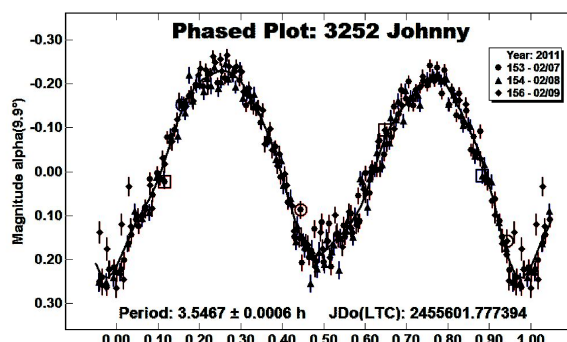
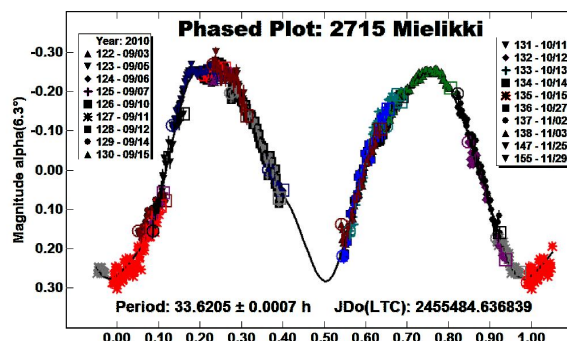
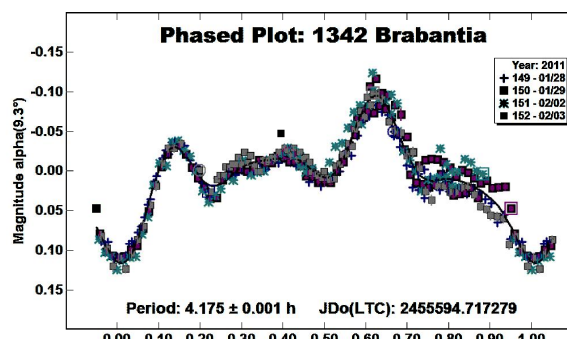
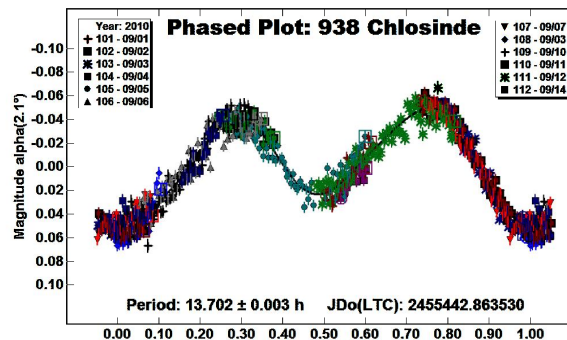
1342 Brabantia. Data were collected from 2011 January 28 through February 03 resulting in 4 data sets totaling 341 data points. A period of 4.175 ± 0.001 h was determined with a peak-to-peak amplitude of 0.21 mag. Based on the period, the asteroid was tracked through 35.95 revolutions.

2715 Mielikki. Data were collected from 2010 September 09 through November 29 resulting in 19 data sets totaling 840 data points. A period of 33.6205 ± 0.0007 h was determined with a peak-to-peak amplitude of 0.54 mag. Given the period, the total span of the observations covered 61.94 revolutions.

3252 Johnny. Data were collected from 2011 February 07-09 resulting in 3 data sets totaling 291 data points. A period of 3.5467 ± 0.0006 h was determined (observation span = 15.20 revolutions). The peak-to-peak amplitude was 0.47 mag.

References

Warner, B.D. (2010). *MPO Canopus* software. Bdw Publishing, Colorado Springs, CO.



ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2010 DECEMBER – 2011 MARCH

Brian D. Warner
Palmer Divide Observatory
17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA
brian@MinorPlanetObserver.com

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Lightcurves for 34 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2010 December through 2011 March: 434 Hungaria, 1019 Strackea, 2035 Stearns, 2047 Smetana, 3266 Bernardus, 3447 Burckhalter, 3511 Tsvetaeva, 4490 Bambery, 6384 Kervin, 6493 Cathybennett, 7187 Isobe, (7579) 1990 TN1, 7781 Townsend, (10779) 1991 LW, (12265) 1990 FG, (13578) 1993 MK, 13822 Stevedodson, (16562) 1992 AV1, (19131) 1988 CY3, (20936) 4835 T-1, (21056) 1991 CA1, (22696) 1998 QT105, (23336) 2579 P-L, (42612) 1998 EL3, (46784) 1998 HK117, (46803) 1998 KL33, (48470) 1991 TC2, (61461) 2000 QA31, (65739) 1993 SG13, (89550) 2001 XU97, (101771) 1999 FB58, (113567) 2002 TV36, 2001 GU8, and 2006 WH2. Previous results by the author for 7187 Isobe and (13578) 1993 MK are reviewed. The data obtained in 2010-11 for 3447 Burckhalter reveal that it is a “tumbler” (non-principal axis rotation), which explains previous, apparently contradictory results.

CCD photometric observations of 34 asteroids were made at the Palmer Divide Observatory (PDO) from 2010 December through March. See the introduction in Warner (2010a) for a discussion of equipment, analysis software and methods, and overview of the plot scaling. The “Reduced Magnitude” in the plots uses Cousins R magnitudes corrected to unity distance by applying $-5 \log(R_r)$ with R and r being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle given in parentheses, e.g., $\alpha(6.5^\circ)$, using $G = 0.15$ unless otherwise stated.

On “Targets of Opportunity” and Half-Period Analysis

A number of the lightcurves presented here are based on one night of observations as a result of the asteroid being in the same field of view as a planned target. The basic philosophy at PDO is “no asteroid left behind”, meaning that if at all possible, sufficient data are obtained for any *planned* target to determine the rotation period to a reasonable certainty. This is not usually possible for the occasional asteroid that crosses the field. Regardless, each object in the field that has sufficient SNR to give hope of finding a lightcurve that is not completely dominated by noise is measured. In some cases, this leads to the unplanned target becoming a planned target and being followed to completion.

Since the data for these targets of opportunity are from only one observing session, it’s very common that a complete cycle (assuming a bimodal curve) is not covered. However, if the data extend through at least half of the estimated cycle, period analysis is concentrated on finding the half-period. This can be done with some assuredness if the amplitude of the lightcurve is >0.2 mag, and more so as the amplitude increases. This is because, at lower phase angles and larger amplitudes, physical requirements dictate

that the object be an elongated body that produces a double-peaked (bimodal) lightcurve. If the amplitude is <0.2 mag, more so if it’s <0.1 mag, this assumption cannot be made. Under those circumstances, one can try to find a period with a monomodal solution and, if one is found, note that the double-period may be possible. In some of cases below, the plot is for the bimodal (double-period) solution based on a search for the half-period that produced a monomodal lightcurve. For some, because of the combination of the period and available data, it made better sense to show the monomodal solution since it provided some overlap and allowed more confidence in the proposed solution.

Finally, it should be noted that when searching for a half-period a smaller number of harmonic orders should be used, e.g., 2 instead of the usual 4, when seeking the full period. This has to do with the way the Fourier analysis works. For example, when doubling the period, the second order harmonic of the half-period becomes the fourth order of the doubled period, and so on.

434 Hungaria. This is the largest remnant of the Hungaria family/group. Its lightcurve parameters have been reported several times, e.g., Harris and Young (1983) and Warner (2010a). The period reported here, $P = 26.502$ h, agrees with those earlier results.

1019 Strackea. Behrend (2011) and Warner (2009) previously reported periods of $P \sim 4.05$ h.

2035 Stearns. Wisniewski *et al.* (1997) reported only that the period was “long.” Shevchenko *et al.* (2003) found a period of 85 h with an amplitude of 0.70 mag. The Shevchenko curve is not unconvincing at first look. However, there are significant gaps between some observing runs and adjustments of zero points of >0.1 mag for V observations and >0.6 mag for one session in R. Analysis of the PDO data resulted in $P = 51.89$ h and $A = 0.20$ mag. The PDO data do not fit the longer period. The only certainty here is that additional, well-calibrated data of sufficient density are needed in the future to help determine the correct period.

2047 Smetana. The previous work by the author (Warner, 2006c) found a period, $P = 2.4969$ h, which is slightly longer than the $P = 2.4801$ h found in 2011. The period spectrum for the 2011 data does show a solution near 2.497 h, though slightly weaker. A period search based on code provided by Josef Ďurech for lightcurve inversion work and that used both data sets in combination with sparse data from USNO-Flagstaff and the Catalina Sky Survey favors the longer period.

3266 Bernardus. The results reported here are in agreement with earlier work by the author (Warner, 2009). The amplitude in 2011 was about 0.25 mag less, which is not unexpected since the viewing aspects (phase angle bisector longitude) differed by about 110° .

3477 Burckhalter. This Hungaria asteroid has been a conundrum for some time. Warner (2002) first reported a period of 22.8 h, but with a poor data set obtained in 2002 October. Behrend (2011), using data from about the same time, found a period of 22 h. Warner and Bembrick (2005) combined new data sets and found a period of 60.0 h. The author reviewed the 2001 data (Warner, 2011), re-measuring the images with updated software, and found a period of 51 h. The last work was in press when it was realized that an upcoming apparition had been overlooked. An observing campaign to “settle things once and for all” was started in 2010 mid-December and completed in 2011 late January. A period of 59.8 h was strongly favored but the data did not all fit. On the