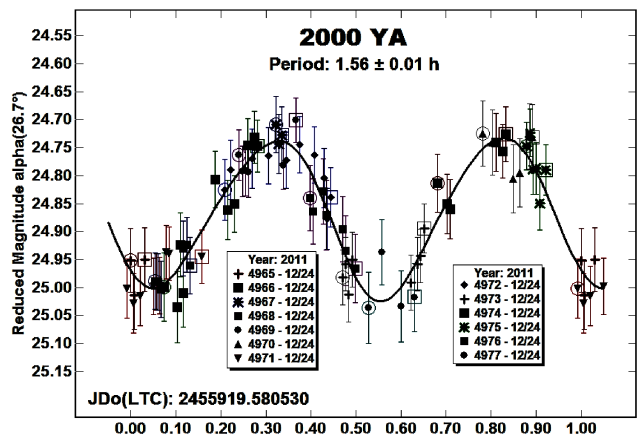




**ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2011 OCTOBER - DECEMBER**

Robert D. Stephens  
Center for Solar System Studies / MoreData! Inc.  
11355 Mount Johnson Court, Rancho Cucamonga, CA 91737  
RStephens@foxandstephens.com

(Received: 10 January)

Lightcurves of six asteroids were obtained from Santana Observatory and Goat Mountain Astronomical Research Station (GMARS): 555 Norma, 1028 Lydina, 1123 Shapleya, 1178 Irmela, 3436 Ibadinov, and 6042 Cheshirecat.

Observations at Santana Observatory (MPC Code 646) were made with a 0.30-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E CCD camera. All images were unguided and unbinned with no filter. Observations at GMARS (MPC Code G79) were made with a 0.4-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. Measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris et al. (1989). The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al. 2011).

The results are summarized in the table below, as are individual plots. Night-to-night calibration of the data (generally  $< \pm 0.05$  mag) was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (Warner 2007 and Stephens 2008).

**555 Norma.** All images were acquired at Santana Observatory. Behrend (Behrend 2011) reported a period of 30.6 h based upon two nights of observations in April 2007 covering about 50 percent of the lightcurve. That lightcurve had an amplitude of about 0.25 mag. when the  $L_{PAB}$  was 187. The amplitude for the current opposition is only 0.06 magnitudes implying that we are viewing Norma nearly pole-on where the lightcurve may not be bimodal and surface features could dominate. The period spectrum shows two competing solutions of 16.60 h and 33.21 h which cannot be entirely eliminated. Observations should be obtained at its next opposition in April 2013.

**1028 Lydina.** All images were acquired at Santana Observatory. Lydina was previously reported to have a period of 15.69 h (Almeida 2003) based upon two nights of observations in November 1998. That period appears to be a 4:3 alias of this result. Behrend (Behrend 2011) reported a period of 48 h based upon three nights of observations in March 2007 covering the maxima.

**1123 Shapleya.** All observations were acquired at Santana Observatory. Wisniewski (Wisniewski 1995) observed Shapleya in January 1989 reporting a period  $> 20$  h. Behrend (Behrend 2011) reported a period of 33.28 h based upon three nights of observations in February 2006, one of which had scatter of almost a magnitude.

**1178 Irmela.** Irmela was observed in 2010 at GMARS and Santana with the resulting period determined to be  $11.989 \pm 0.001$  hr. This newly determined period obtained through data on consecutive nights is a 5/8 alias of the 19.17 h value reported by Binzel (1987) based on sparse sampling over three widely separated (non-consecutive) nights in May 1984.

**3436 Ibadinov.** Ibadinov does not have a previously reported period in the LCDB (Warner et al. 2010). It was a dim target found in the field of view of the primary target, 4138 Kalchas. A raw plot of 4 nights of observations spanning 8 nights suggests a period in excess of 7 days assuming a bimodal lightcurve.

**6042 Cheshirecat.** Observations for this object were completed on New Year's Eve in 2006. However, the results were never published.

The data for each of these asteroids was uploaded to the ALCDEF database (see Warner et al., 2011) on the Minor Planet Center's web site (MPC 2011).

**References**

Behrend, R. (2011). Observatoire de Geneve web site, [http://obswww.unige.ch/~behrend/page\\_cou.html](http://obswww.unige.ch/~behrend/page_cou.html).  
Binzel, R.P. (1987). "A Photoelectric Survey of 130 Asteroids." *Icarus* **72**, 135-208.

| #    | Name        | mm/dd 2011/12           | Data Pts | $\alpha$      | $L_{PAB}$ | $B_{PAB}$ | Per (h) | PE      | Amp (mag) | AE   |
|------|-------------|-------------------------|----------|---------------|-----------|-----------|---------|---------|-----------|------|
| 555  | Norma       | 12/15 - 01/05           | 1,712    | 10.4, 1.9     | 108       | -1        | 19.55   | 0.01    | 0.06      | 0.02 |
| 1028 | Lydina      | 11/22 - 12/08           | 1,063    | 3.9, 0.5, 2.3 | 70        | 1         | 11.680  | 0.005   | 0.22      | 0.03 |
| 1123 | Shapleya    | 10/17 - 11/18           | 2,351    | 6.0, 19.6     | 23        | -8        | 52.92   | 0.01    | 0.38      | 0.03 |
| 1178 | Irmela      | 2010/03/11 - 2010/03/14 | 591      | 1.9, 3.6      | 167       | 0         | 11.989  | 0.001   | 0.40      | 0.02 |
| 3436 | Ibadinov    | 11/20 - 11/27           | 210      | 16.3, 15.0    | 107       | -2        | $> 170$ | $> 1.0$ |           |      |
| 6042 | Cheshirecat | 2006/12/20 - 2006/12/31 | 656      | 3.1, 9.0      | 83        | -1        | 10.050  | 0.002   | 0.40      | 0.3  |

Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

Minor Planet Center (2011). Lightcurve Database, [http://minorplanetcenter.net/light\\_curve](http://minorplanetcenter.net/light_curve).

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 31-32.

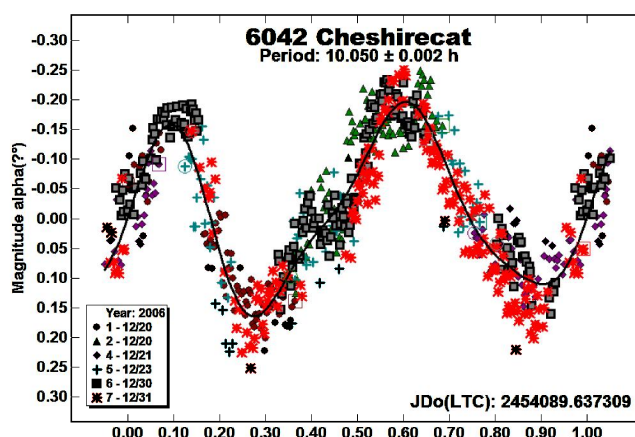
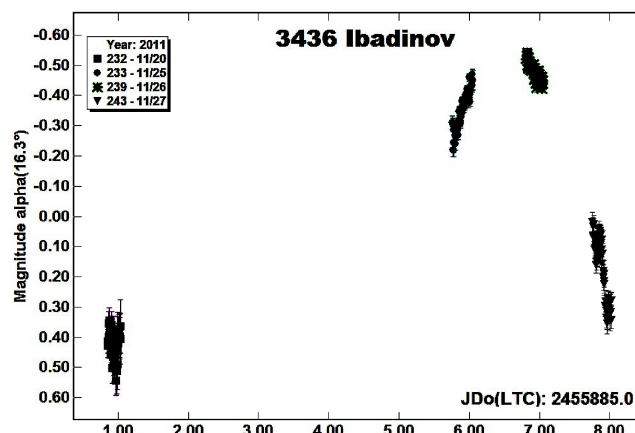
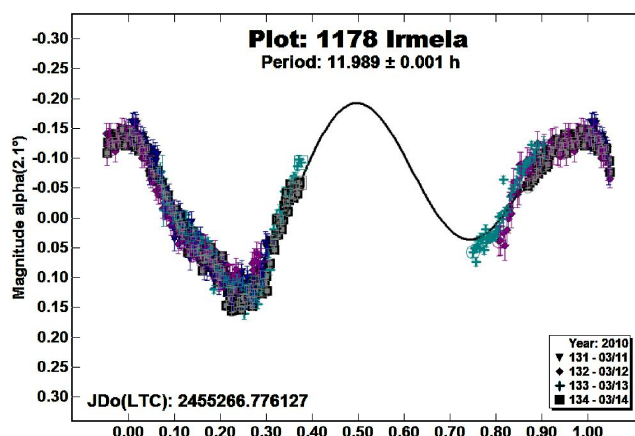
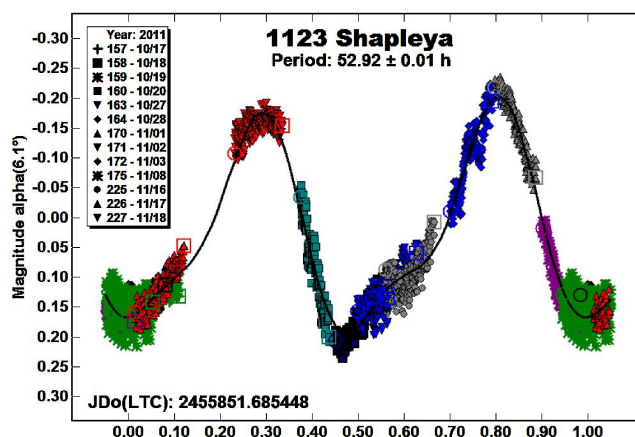
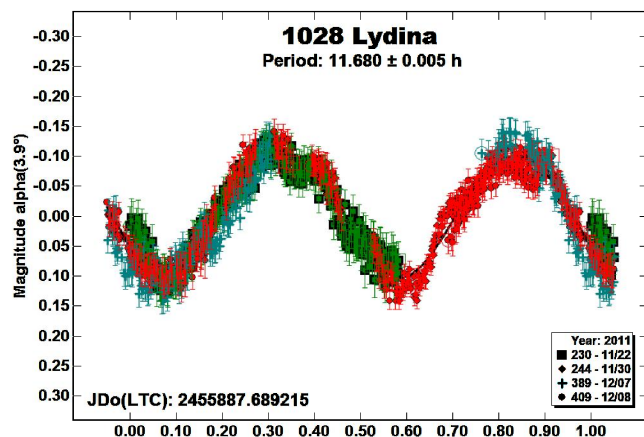
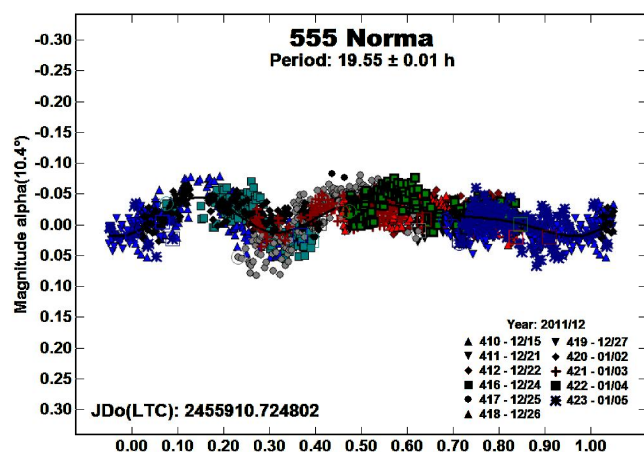
Warner, B.D. (2007). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

Warner, B.D., Harris, A.W., and Pravec, P. (2011) Lightcurve Database. <http://www.minorplanet.info/lightcurvedatabase.html>.

Warner, B.D., Harris, A.W., and Pravec, P. (2011) Lightcurve Targets. <http://www.minorplanet.info/call.html>.

Warner, B.D., Stephens, R.D., and Harris, A.W. (2011). "Save the Lightcurves." *Minor Planet Bul.* **38**, 3.

Winiewski, W.Z., Michalowski, T.M., Harris, A.W., and McMillan, R.S. (1995). "Photoelectric Observations of 125 Asteroids." *Abstracts of the Lunar and Planetary Science Conference*. **26**, 1511.



## THE ENIGMATIC HUNGARIA ASTEROID 4868 KNUSHEVIA

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

David Higgins  
Hunters Hill Observatory  
Gunnawal, Canberra 2913  
AUSTRALIA

Petr Pravec  
Astronomical Institute, Academy of Sciences  
Ondřejov, CZECH REPUBLIC

Alan W. Harris  
MoreData!, La Cañada, CA USA

(Received: 12 January)

CCD photometry observations of the Hungaria asteroid 4868 Knushevia were made at the Palmer Divide Observatory and Hunters Hill Observatory in 2011 October. Period analysis favored two possible solutions, 3.143 h and 4.716 h, the latter being slightly favored despite having a more complex lightcurve. Attempts to fit data from two previous apparitions to either period failed.

CCD photometry observations of the Hungaria asteroid 4868 Knushevia were made from 2011 October 22–31 at the Palmer Divide Observatory (PDO) and Hunters Hill Observatory (HHO). The asteroid had been previously observed by Warner (2009, 2010). Analysis of the data obtained in 2008 found a period of 4.45 h while that of the 2010 data found a period of 4.54 h. The 2011 campaign was run to try to find a definitive period. Instead, it only extended the ambiguities.

PDO observations by Warner were made with a 0.35-m Schmidt-Cassegrain (SCT) and FLI ProLine 1001E CCD camera. Exposures were unfiltered and 300 s. All frames were dark and flat field corrected. HHO observations by Higgins used 0.35-m SCT and SBIG STL-1001E CCD camera. Exposures were unfiltered and 240 s. All frames were dark and flat field corrected. *MPO Canopus* was used to measure all images and then do the period analysis. The entire data set was calibrated to a single internal system using J-K to BVRI conversions (Warner, 2007) on the comparison stars for each night to where merging the data from the two observatories required no zero point adjustment.

Initial analysis using only the PDO data could not find a unique solution, favoring a bimodal lightcurve of about 3.1 h or a trimodal, non-symmetric lightcurve of about 4.7 h, or almost exactly 1.5x the shorter solution. The addition of the HHO data refined the solutions but did not make one stand out over the other. The period spectrum (RMS fit versus period) shows that the two solutions are almost exactly equal. A review by Pravec with a more sophisticated set of analysis tools did not resolve the problem, although it precluded the presence of a second period, e.g., due to tumbling or an undetected satellite. Furthermore, attempts to fit the data from the previous apparitions to either of those found in 2011 either failed or were inconclusive.

This asteroid has oppositions just more than 18 months apart and so the oppositions in 2008 September and 2010 March were almost exactly 180° apart in viewing aspect (phase angle bisector longitude,  $PAB_L$ ). Both showed lower amplitude than in 2011 October. The next opposition, 2013 April 28, is about six weeks later than the 2010 opposition and is hoped to be closer to an equatorial viewing aspect. The 2014 December 14 opposition is almost exactly 90° in  $PAB_L$  from the 2008 opposition, when the amplitude was lowest. This may be the best opportunity to determine the period once and for all, assuming observations and analysis during the 2013 apparition fail to do so.

