THE MINOR PLANET BULLETIN

BULLETIN OF THE MINOR PLANETS SECTION OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

VOLUME 36, NUMBER 4, A.D. 2009 OCTOBER-DECEMBER

NEW LIGHTCURVES OF 8 FLORA, 13 EGERIA, 14 IRENE, 25 PHOCAEA, 40 HARMONIA, 74 GALATEA, AND 122 GERDA

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

(Received: 2009 Jun 30 Revised: 2009 Aug 2)

New lightcurves yield synodic rotation periods and amplitudes for: 8 Flora, 12.861 ± 0.001 h, 0.08 ± 0.01 mag; 13 Egeria, 7.0473 ± 0.0001 h, 0.15 ± 0.02 mag in 2007, 0.37 ± 0.02 mag in 2009; 14 Irene, 15.089 ± 0.009 h, 0.03 ± 0.01 mag in 2007, 15.028 ± 0.001 h, 0.16 ± 0.03 mag in 2009; 25 Phocaea, 9.935 ± 0.001 h, 0.11 ± 0.02 mag in 2008, 9.927 ± 0.003 h, 0.06 ± 0.01 mag with one maximum and minimum per cycle in 2009; 40 Harmonia, 8.909 ± 0.001 h, 0.28 ± 0.02 mag; 74 Galatea, 17.268 ± 0.004 h, 0.16 ± 0.03 mag with 4 unequal maxima and minima per cycle; 122 Gerda 10.712 ± 0.010 h, 0.11 ± 0.01 mag.

Observations were made of seven asteroids at the Organ Mesa Observatory where the equipment consists of a Meade 0.35-m LX-200 GPS Schmidt-Cassegrain (SCT) and SBIG STL 1001-E CCD. A red filter was used for the bright asteroids 8, 13, 14, 25, 40, and a clear filter for the fainter asteroids 74 and 122. Exposures were unguided. Image measurement using differential photometry and lightcurve analysis were done with *MPO Canopus*. Due to the large number of data points acquired for each target in this study, the lightcurves have been binned in sets of three data points with a maximum of five minutes between points.

8 Flora. Several different periods have been reported over the years for this asteroid, leaving its true period in doubt. Van Houten-Groeneveld and van Houten (1956) found a period of 13.6 h, but the two minimum that they recorded also supported a period of 12.87 h. Veverka (1971) also recorded two minima that are consistent with a period near 12.9 h. Hollis et. al. (1987) derived a period of 12.790 h. Di Martino (1989) and Harris and Young (1989) also found periods of approximately 12.87 h, as did Piiornen et al. (1998). Torppa et al. (2003) found a sidereal period of 12.79900 h using lightcurve inversion techniques. Several attempts have also been made to determine the spin axis orientation for Flora. Hollis et al. (1987) reported a pole longitude near 148° while Di Martino et al. (1989) found two possible solutions at longitude 140° or 320°. Torppa et al. (2003) found a pole solution of (160°, +16°) and sidereal period of 12.79900 h, similar to (155°, +5°) found by Durech (2009a), both using lightcurve inversion methods. Durech's sidereal period, however, was 12.86667 h.

New observations of the asteroid obtained by the author on 8 nights from 2009 Feb. 21 to Apr. 26 show a synodic period 12.861 ± 0.001 h and amplitude 0.08 ± 0.01 mag. Miles (private communications), one of the authors of the 12.790 h period by Hollis et. al. (1987), states that he considered this period tentative, and that a reinvestigation of the original data shows a much better fit to 12.87 hours. Durech (private communications) has performed lightcurve inversion combining these new observations with the previous ones and states that the expanded data set confirms his period of 12.86667 h, ruling out the shorter period. Since the sidereal-synodic period difference is generally on the order of 0.005 h for this asteroid, all investigations are now consistent with a period of 12.865 ± 0.005 h and this period for Flora can be considered secure.

13 Egeria. Observations were of this asteroid were made by the author during two consecutive apparitions. Data obtained on 3 nights from 2007 Sept. 13-Oct 27 yield a period of 7.047 ± 0.001 h, amplitude 0.15 ± 0.02 mag while those obtained on 5 nights from 2009 Jan. 12-Mar. 8 result in a period of 7.0473 ± 0.0001 h and amplitude 0.37 ± 0.02 mag. These are in agreement with the period adopted in the Asteroid Lightcurve Database (LCDB, Warner et al., 2008).

14 Irene. Periods ranging from 9.47 to 18.71 h have been previously reported (in the LCDB; see Warner et al., 2008). Two new lightcurves were obtained at Organ Mesa in on 2007 Nov. 23 and Dec. 6. This data set is much too sparse to allow an independent period determination; however, they are consistent with a period 15.089 ± 0.009 h, one of the periods in the LCDB. The amplitude at the time was only 0.03 ± 0.01 mag. Observations on 8 nights from 2009 Feb. 28-May 11 show a period of 15.028 ± 0.001 h and amplitude 0.16 ± 0.03 mag. The phases of the individual extrema in the lightcurve remain nearly constant, but their heights vary greatly with changing phase and aspect angle.

IMPORTANT ANNOUNCEMENT

See Announcement Regarding *MPB* Print Subscriptions on page 194.

The determination from the 2007 observations that the pole is near the ecliptic shows that the obliquity in 2009 was near 90 degrees, which in turn indicates the synodic period of 15.028 h is fairly close to the sidereal period. The variations in the shape of the lightcurve will be useful in a future determination of the shape by lightcurve inversion.

25 Phocaea. Groeneveld and Kuiper (1954) obtained lightcurves on 4 nights 1950 Aug. 5-10 and found a period 9.945 h, amplitude 0.18 mag. Buchheim (2007), on the basis of observations on 3 nights from 2006 Oct. 21-23, found the same period with amplitude only 0.03 mag. New observations made on 4 nights from 2008 Jan. 13-Feb. 2 show an irregular lightcurve with period 9.935 ± 0.001 h, amplitude 0.11 ± 0.02 mag. This lightcurve is noisy because the target was traveling through a very dense Milky Way star field. Additional observations obtained from 2009 Apr. 13-21 showed a monomodal lightcurve with period 9.927 ± 0.003 h, amplitude 0.06 ± 0.01 mag. All of these period determinations are compatible with the consideration that the synodic period varies with aspect angle and mean motion.

40 Harmonia. The Asteroid Lightcurve Database (Warner et al., 2008) lists several periods with the most secure being ~8.9 h. New lightcurves obtained on five nights from 2008 Dec. 19-2009 Jan. 14 show a period of 8.909 ± 0.001 h, amplitude 0.28 ± 0.02 mag. This is fully compatible with previous determinations and was obtained to provide data leading to a spin/shape model.

74 Galatea. Harris and Young (1980) obtained lightcurves on two nights that showed an amplitude of ~0.13 mag that were compatible with a 9.0 hour period (and other aliases). Behrend (2009) presents a lightcurve based on data from M. Conjat with a period of 8.628 ± 0.004 h, amplitude 0.09 mag that assumes the usual two maxima and minima per cycle. Pilcher (2008) obtained lightcurves on 11 nights from 2008 Feb. 1-Mar. 23. These showed four unequal maxima and minima per cycle with period 17.270 ± 0.002 h, maximum amplitude 0.08 ± 0.01 mag. New lightcurves on 5 nights from 2009 Mar. 28-Apr. 3 also show four unequal maxima and minima per cycle, a period of 17.268 ± 0.004 h, and amplitude of 0.16 ± 0.03 mag.

122 Gerda. The Asteroid Lightcurve Database (Warner et al., 2008) lists a number of periods of ~10.68 h, with the most secure result being that from Robinson (2009) with P = 10.685 h, A = 0.26 mag. New observations on 3 nights from 2009 Apr. 1-3 show a period 10.712 ± 0.010 h, amplitude 0.11 ± 0.01 mag, with full phase coverage. This is compatible with previous determinations.

References

Behrend, R. (2009). Observatoire de Geneve web site. http://obswww.unige.ch/~behrend/page_cou.html

Bel'skaya, I. N., Dovgopol, A. N., Erikson, A., Lagerkvist, C.-I., and Oja, T. (1993) "Physical studies of asteroids. XXVII. Photoelectric photometry of asteroids 14 Irene, 54 Alexandra, and 56 Melete." *Astron. Astrophys. Suppl. Ser.* **101**, 507-511.

Buchheim, R.K. (2007). "Lightcurves of 25 Phocaea, 468 Lina, 482 Petrina, 551 Ortrud, 741 Botolphia, 834 Burnhamia, 2839 Annette, and 3411 Debetencourt." *Minor Planet Bull.* **34**, 68-71.

Di Martino, M., Zappala, V., Cellino, A. Barucci, M. A., Harris, A.W., Young, J.W., and Zeigler, K. (1989). "The puzzling case of asteroid 8 Flora is solved." *Astron. Astrophys.* **223**, 352-360.

Durech, J. (2009). http://astro.troja.mff.cuni.cz/projects/asteroids/3D

Groeneveld, I. and Kuiper, G.P. (1954). "Photometric Studies of Asteroids. I." *Astrophys. J.* **120**, 200-220.

Harris, A.W. and Young, J.W. (1980). "Asteroid Rotation III. 1978 Observations." *Icarus* **43**, 20-32.

Harris, A.W. and Young, J.W. (1989). "Asteroid Lightcurve Observations from 1979-1981." *Icarus* **81**, 314-364.

Hollis, A.J., Bembrick, C.S., Dumont, M., and Miles, R. (1987). "Photometric properties of the minor planets: observations of (8) Flora in 1984." *J. Brit. Astron. Assoc.* **97**, 220-223.

Piironen, J., Lagerkvist, C.-I., Erikson, A., Oja, T., Magnusson, P., Festin, L., Nathues, A., Gaul, M., and Velichko, F. (1998). "Physical Studies of Asteroids XXXII: Rotation Periods and UBVRI-colors for selected asteroids." *Astron. Astrophys. Suppl. Ser.* **128**, 525-540.

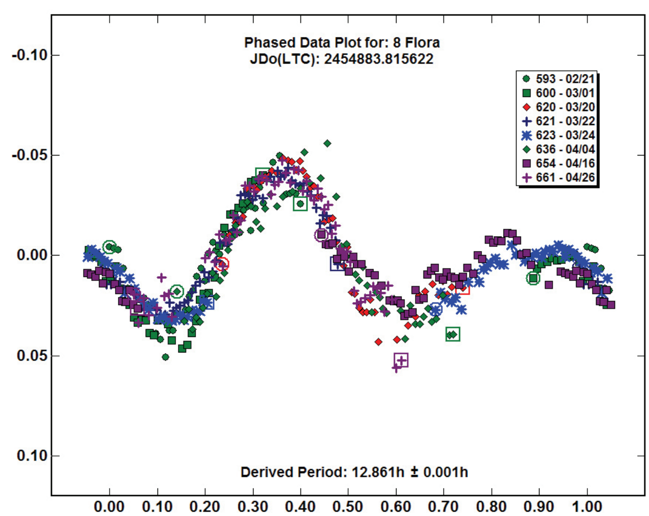
Pilcher, F. (2008). "Period Determinations for 26 Proserpina, 34 Circe, 74 Galatea, 143 Adria, 272 Antonia, 419 Aurelia, and 557 Violetta." *Minor Planet Bul.* **35**, 135-138.

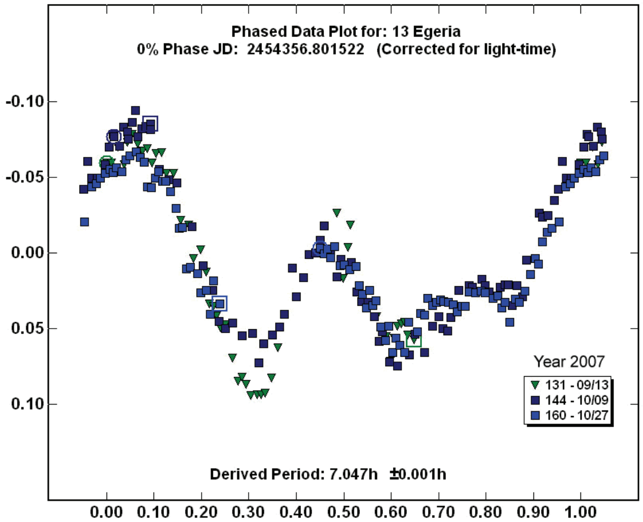
Torppa, J., Kaasalainen, M., Michalowski, T., Kwiatkowski, T., Kryszczynska, A., Denchev, P., and Kowalski, R. (2003). "Shapes and rotational properties of thirty asteroids from photometric data." *Icarus* **164**, 346-383.

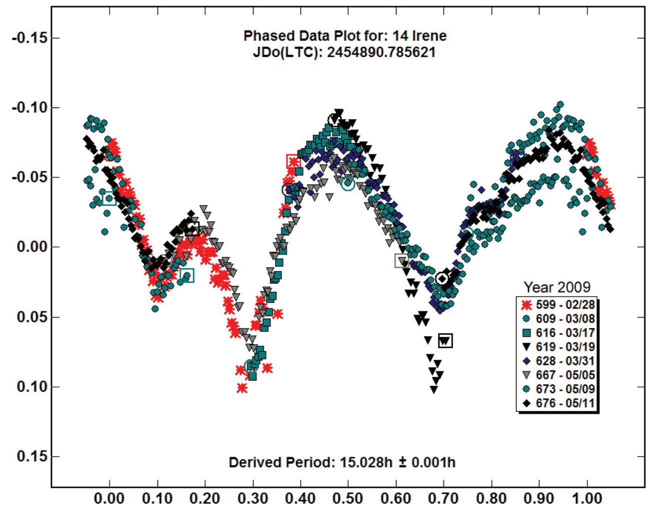
van Houten-Groeneveld, I. and van Houten, C.J. (1958). "Photometric studies of asteroids VII." *Astrophys. J.* **127**, 253-273.

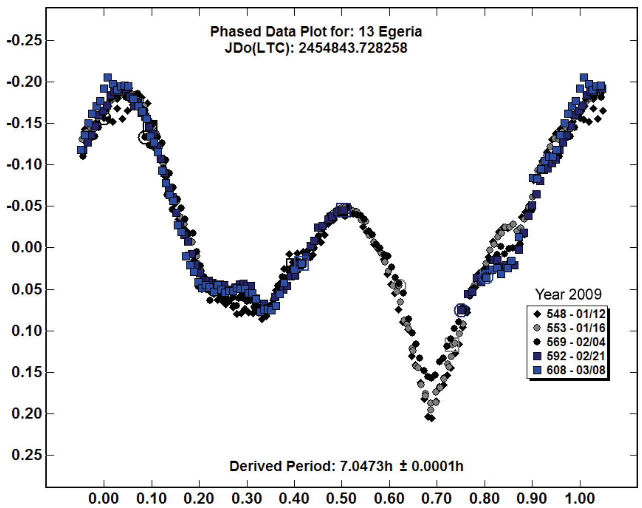
Veverka, J. (1971). "Photopolarimetric Observations of the Minor Planet 8 Flora." *Icarus* **15**, 454-458.

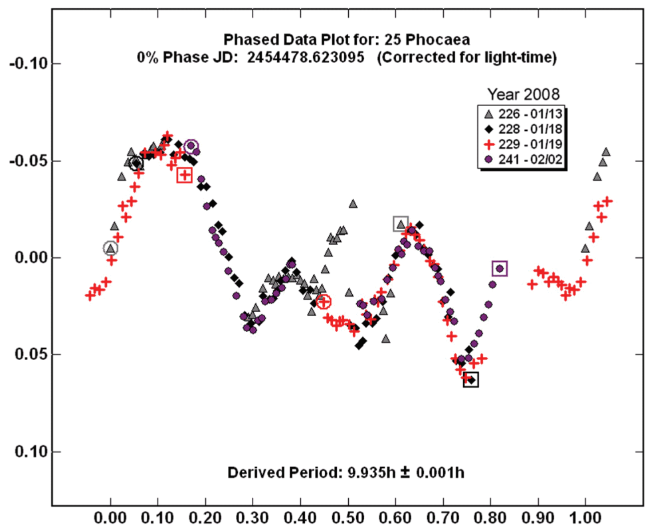
Warner, B.D., Harris, A.W., and Pravec, P. (2008), "Asteroid Lightcurve Data File, Revised Nov. 06, 2008." http://www.MinorPlanetObserver.com/astlc/default.htm.

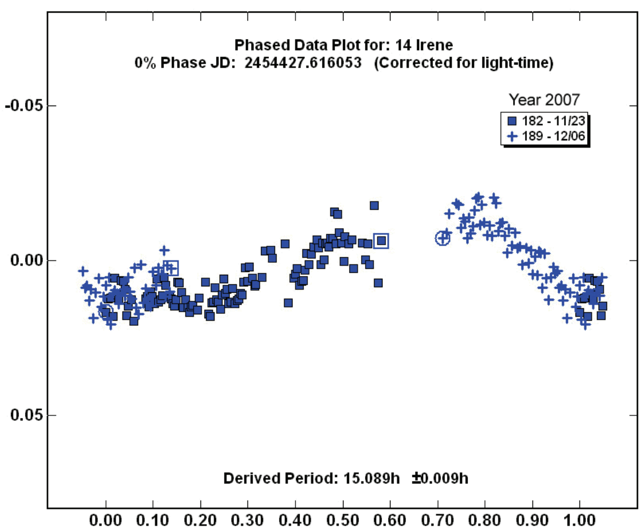


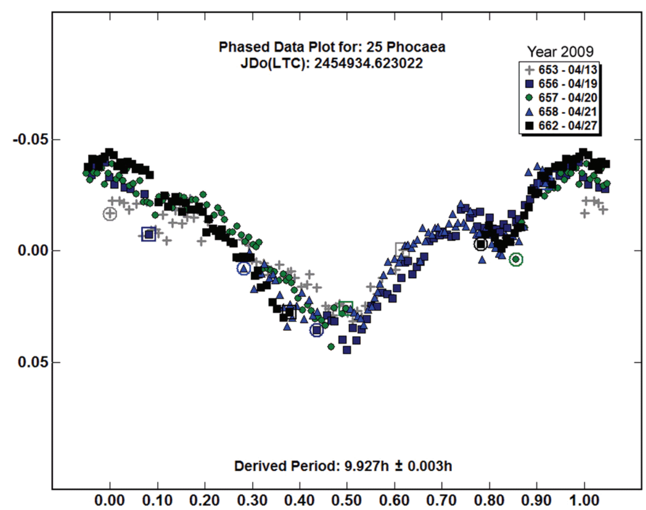

Phased Data Plot for: 13 Egeria
0% Phase JD: 2454356.801522 (Corrected for light-time)
Year 2007
131 - 09/13
144 - 10/09
160 - 10/27
Derived Period: 7.047h ±0.001h

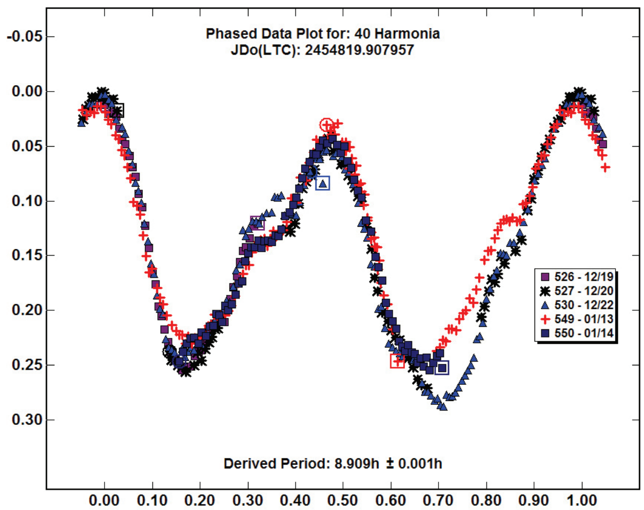

Phased Data Plot for: 14 Irene
JDo(LTC): 2454890.785621
Year 2009
599 - 02/28
609 - 03/08
616 - 03/17
619 - 03/19
628 - 03/31
667 - 05/05
673 - 05/09
676 - 05/11
Derived Period: 15.028h ± 0.001h

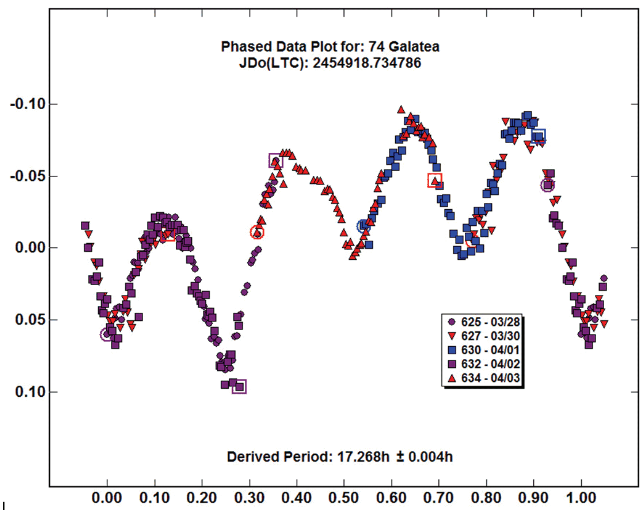

Phased Data Plot for: 13 Egeria
JDo(LTC): 2454843.728258
Year 2009
548 - 01/12
553 - 01/16
569 - 02/04
592 - 02/21
608 - 03/08
Derived Period: 7.0473h ± 0.0001h

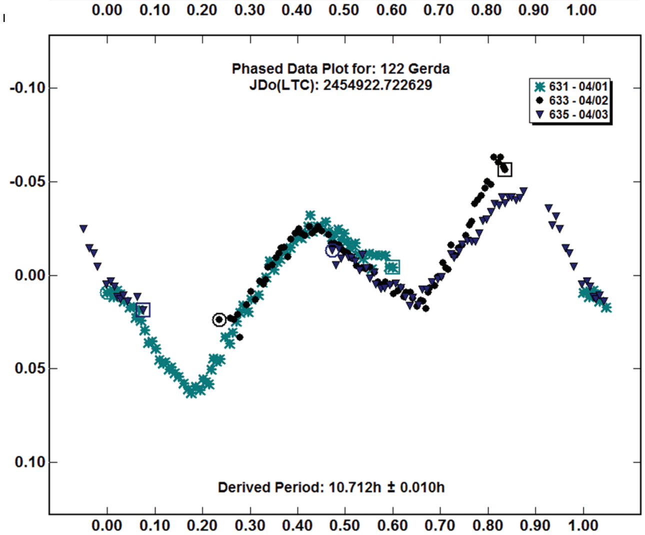

Phased Data Plot for: 25 Phocaea
0% Phase JD: 2454478.623095 (Corrected for light-time)
Year 2008
226 - 01/13
228 - 01/18
229 - 01/19
241 - 02/02
Derived Period: 9.935h ± 0.001h


Phased Data Plot for: 14 Irene
0% Phase JD: 2454427.616053 (Corrected for light-time)
Year 2007
182 - 11/23
189 - 12/06
Derived Period: 15.089h ±0.009h


Phased Data Plot for: 25 Phocaea
JDo(LTC): 2454934.623022
Year 2009
653 - 04/13
656 - 04/19
657 - 04/20
658 - 04/21
662 - 04/27
Derived Period: 9.927h ± 0.003h







LIGHTCURVES AND H-G PARAMETERS FOR 901 BRUNSIA AND 946 POESIA

Gary A. Vander Haagen
Stonegate Observatory, 825 Stonegate Road
Ann Arbor, MI 48103
garyvh2@att.net

(Received: 2009 May 27)

Lightcurves and absolute photometry near opposition revealed photometric results for 901 Brunsia and 946 Poesia. For 901 Bunsia, P=3.1363 ± 0.0002 h, A=0.28 ± 0.02, H=11.93 ± 0.038, G=0.258 ± 0.045. For 946 Poesia, P=73.5 ± 0.02 h, A=0.24 ± 0.05, H=10.54 ± 0.06, G=0.028 ± 0.06.

Target selection for a study to determine the absolute magnitude (*H*) and phase slope parameter (*G*) of asteroids was made from the quarterly lightcurve photometry opportunities article published in *The Minor Planet Bulletin* (Warner et al., 2009a). This is an extremely useful summary of asteroid research opportunities for lightcurves, low phase angle, spin/shape modeling, radar, and other studies. Chosen were upcoming low phase angle asteroids 901 Brunsia and 946 Poesia. They were both at good sky positions for Stonegate Observatory, had V magnitudes in the 13 to 16 range, and oppositions occurring within six weeks of each other.

Observations were made with a 0.36 meter C-14 f/6.6 Schmidt-Cassegrain telescope and SBIG ST-10XME camera. The camera was run at -15°C and binned 2x2. The resultant 1.4 arcsecond/pixel scale was slightly over sampled for the nominal 3-5 arcsecond FWHM seeing. No guiding was necessary. The Michigan winter sky was very poor for photometric work with only one night in ten being useful during some periods. On each night a Landolt reference field was imaged with V, R, and Clear filters at an air mass as close as possible to 2 followed by a Henden field as close as possible to air mass of 1 and, in close proximity to the study asteroid. Exposures ranged from 10 to 120 seconds. The nightly three-color data were reduced using *MPO Canopus/PhotoRed* routines (Bdw Publishing, 2008), computing transforms, extinction, and V-R color indices for the reference stars and object, thus reducing the values to standard magnitudes. For a more complete description of the program to determine H-G parameters, as well of as a discussion of the H-G magnitude system, see Vander Haagen (2009) or contact the author by email for an electronic version of that paper.

901 Brusnia. This asteroid reached zero phase angle on 2008 December 13. The initial direction was to obtain as good as possible photometric data over the phase range of 0° to 20° or greater. During this interval, longer instrumental data were collected to determine the period. The lightcurve for 901 Brunsia is shown in Figure 1. The data were phased using *MPO Canopus* and the synodic period of the lightcurve found to be 3.1363 ± 0.0002 h with an amplitude of 0.28 ± 0.02 mag., which is close to an alternate period given by Wisniewski et al. (1997) and recently adopted in the LCDB (Warner et al., 2009b).

The data from 901 Brunsia were corrected to a mean value such that all data points were effectively at the same part of the lightcurve. The data were then corrected for the (R) Sun-asteroid distance and (r) the Earth-asteroid distance. The H/G Calculator in *MPO Canopus* was used to make these calculations and plot the

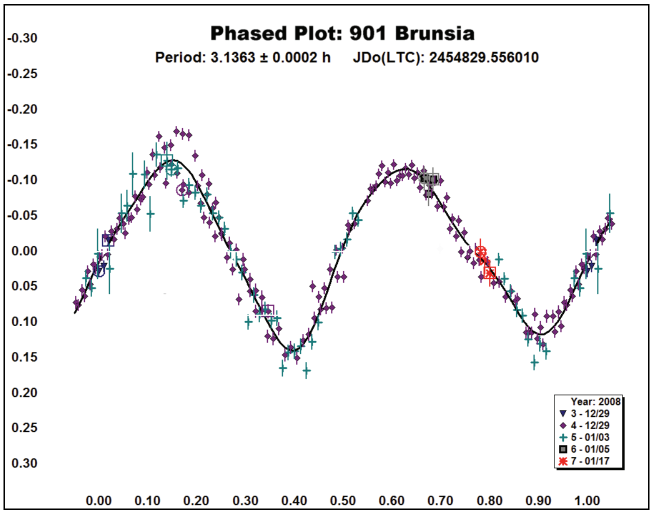


Figure 1. Lightcurve of 901 Brunsia Phased to 3.1363 h.

data (see Figure 2). Based on the derived value of G = 0.258 ± 0.045 and Table 4 in Warner et al. (2009b), 901 Brunsia falls into the range typical for Sq class asteroids (as assigned by SMASS II; summarized in LCDB) with an estimated albedo of p_v = 0.20. Looking up the orbital elements in the MPCORB file and comparing with LCDB class-family grouping supports an S taxonomic classification. Knowing the estimated albedos, p_v = 0.20, and absolute magnitude, H = 11.93, allows calculation of the diameter using the expression (Pravec and Harris, 2007):

$$\log D_{(km)} = 3.1235 - 0.2H - 0.5\log(p_v)$$

This expression yields D = 12.2 km for 901 Brunsia.

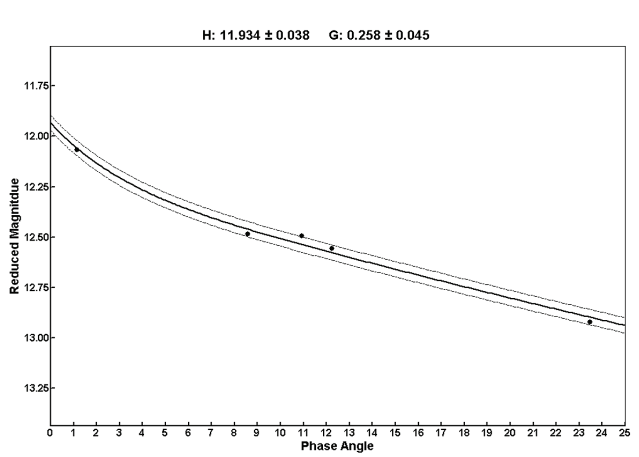


Figure 2. 901 Brunsia H-G parameter phase angle plot

946 Poesia. The same process as described above was used for 946 Poesia. The zero phase angle occurred on 2009 January 16. Photometric data were collected and reduced on 10 nights for use in the H-G parameter determination. Many of these nights were not close to photometric. Long differential photometry runs were also interspersed wherever there was a possible "reasonable" night to determine the asteroids period. The effort was difficult due to the short visibility periods for both seeing and sky position. Even with more than 1100 data points, the period was not determined with certainty. The best solutions are shown in Figures 3 and 4 with periods of 73.5 h and 102.9 h, respectively. The amplitudes for both are 0.24 ± 0.05 mag. Longer nightly runs and successive days would have been useful to resolve the uncertainty.

The adjustments to mean magnitude values and Sun-asteroid and Earth-asteroid corrections were made as described with 901 Brunsia. Both the 73.5 h and 102.9 h periods were used to plot the H-G parameters. The plots are shown in Figures 5 and 6. Figure 5, with means established using the 73.5 h period, yielded the lowest error H-G parameters, which were H = 10.54 ± 0.06 and G = 0.028 ± 0.06. Referring to the SMASS II classifications in the LCDB, the best fit is subclass Ch with a G = 0.094 ± 0.08 and p_v = 0.056. Using an albedo of p_v = 0.056 and absolute magnitude, H = 10.54, the diameter of 946 Poesia is D = 43.7 km.

By collecting photometric data over a range of phase angles on either side of zero we have determined the asteroids period, amplitude, the absolute magnitude (H), the slope parameter (G), the general taxonomic class, the estimated geometric albedo, and estimated diameter. This significantly increases the knowledge for each of these asteroids. The taxonomic class could be verified using spectroscopy as outlined in Bus and Binzel (2002).

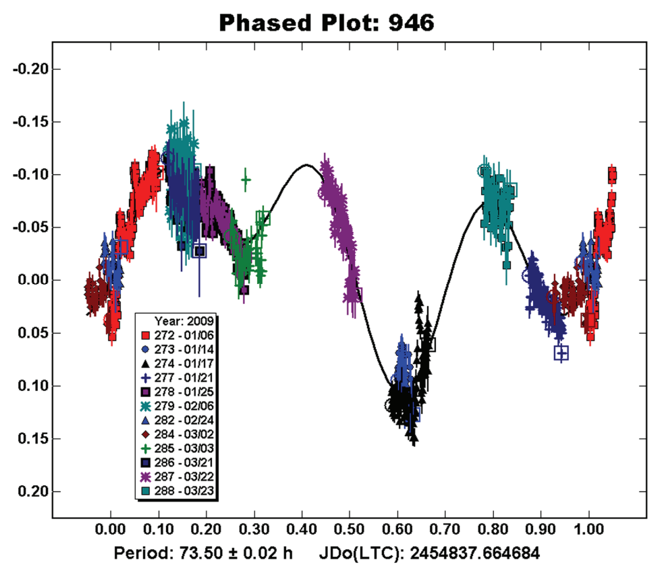


Figure 3. Lightcurve of 946 Poesia Phased to 73.5 h.

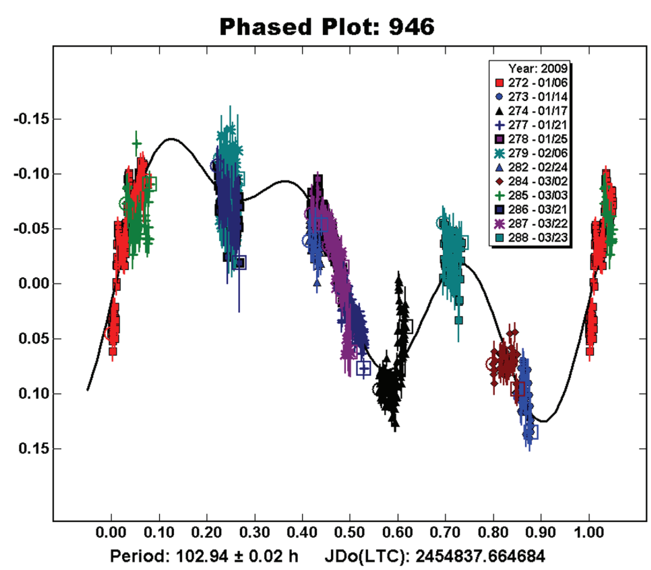


Figure 4. Lightcurve of 946 Poesia Phased to 102.9

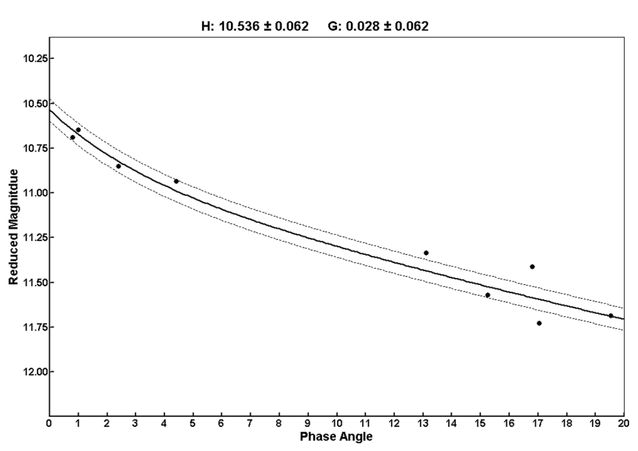


Figure 5. 946 Poesia H-G Parameters using 73.5 h period for finding the mean magnitude.

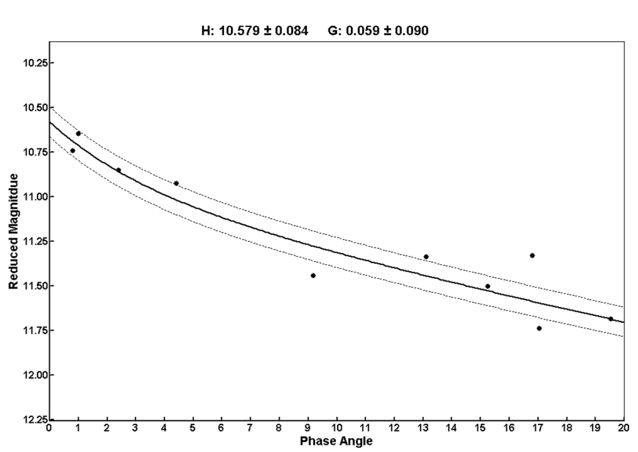


Figure 6. 946 Poesia H-G parameters using 102.9 h period for finding the mean magnitude.

Acknowledgements

The author extends thanks to Brian Warner for the highly useful software tools *Canopus* and *PhotoRed*. Thanks also to Brian for the "gentle push" towards the study of *H-G* Parameters and assistance in sorting out the ambiguous long period of 946 Poesia. Appreciation is also extended to the Society for Astronomical Sciences (SAS) for allowing use of this material as presented at the 2009 Symposium.

References

Bdw Publishing (2008). MPO Software, Canopus version 9.5.0.3. http://minorplanetobserver.com/

Bus, S.J. and Binzel, R.P. (2002). "Phase II of the Small Main-Belt Asteroid Spectroscopic Survey: The Observations". *Icarus* **158**, 106-145.

MPCORB, Orbital Database, Minor Planet Center, http://www.cfa.harvard.edu/iau/MPCORB.html

Pravec, P. and Harris, A.W. (2007). "Binary Asteroid Population 1. Angular Momentum Content". *Icarus* **190**, 250-259.

Warner, B.D. (2009). "Notes from the Acting Editor". *The Minor Planet Bulletin* **36**, 1.

Warner, B.D., Harris, A.W., Pravec, P., Durech, J., and Benner, L.A.M. (2009a). "Lightcurve Photometry Opportunities: January - March 2009". *The Minor Planet Bulletin* **36**, 31-34.

Warner, B.D., Harris, A.W., and Pravec, P. (2009a). "The asteroid lightcurve database". *Icarus* **202**, 134-146.

Vander Haagen, Gary A. (2009) "What is Next in Asteroid Photometry?" In *Proceedings for the 28th Annual Conference of the Society for Astronomical Sciences* (B.D. Warner, J.L. Foote, D. Kenyon, D. Mais, eds.) pp. 85-90. Society for Astronomical Sciences, Rancho Cucamonga, CA.

Wisniewski, W.Z., Michalowski, T.M., and Harris, A.W. (1997). "Photometric Observations of 125 Asteroids." *Icarus* **126**, 395-449.

ON THE PERIOD OF 1506 XOSA

George Stecher, Lyle Ford, and Natalie Bianchi
Department of Physics and Astronomy
University of Wisconsin-Eau Claire
Eau Claire, WI 54702-4004 USA
gstecher@uwec.edu

Brian D. Warner
Palmer Divide Observatory/Space Science Institute
Colorado Springs, CO USA

Larry Robinson
Sunflower Observatory, Olathe, KS USA

(Received: 2009 Jun 1)

Observations from the 2005 opposition of 1506 Xosa combined with re-analyzed data from the 2001 apparition were used to examine the period of 1506 Xosa. The combined data indicate possible periods of 5.9 h and 6.6 h.

The Eau Claire group made R band and I band photometric measurements of 1506 Xosa on 2005 June 16 and 17 using the 0.6-m "Air Force" Telescope located at Hobbs Observatory near Fall Creek, Wisconsin. 60-second exposures were taken with a Photometrics Star I Camera. Images were dark-subtracted and flat-fielded. Instrumental magnitudes were found using *MPO Canopus* version 9.3.1.0 (Warner, 2007a). The asteroid passed near three stars on the night of 16 June, so *Canopus'* StarBGone star removal algorithm was used to eliminate their signals. Images of standard stars from the LONEOS catalog were used to find transforms and first order extinction coefficients, although not all the stars used were Landolt standards. Transforms and first order extinction coefficients were determined using the modified Hardie method as described in Warner (2006). The transforms and extinction coefficient calculations were made by spreadsheet because the unusual color index, R-I, is not supported by the MPO software. The Eau Claire data show possible periods of approximately 4.0 h, 5.9 h (Figure 1), and 6.6 h (Figure 2), with 4.0 h and 5.9 h giving the best fits.

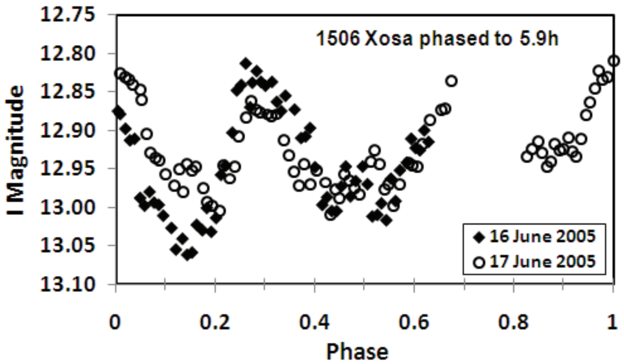


Figure 1. Data for 1506 from 2005 phased to a period of 5.9 h.

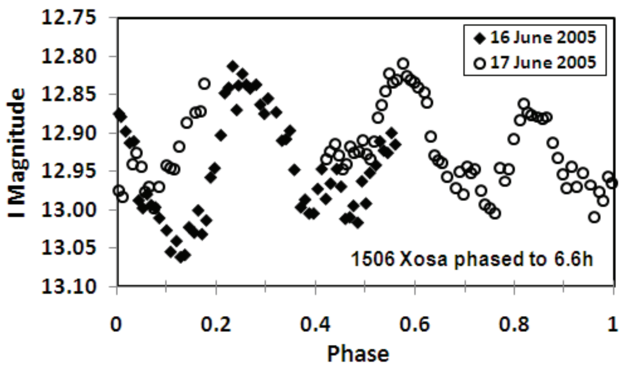


Figure 2. Data for 1506 from 2005 phased to a period of 6.6 h.

Warner re-measured the original 2001 images using the latest version of *MPO Canopus*. Those images were taken mostly by Robinson using a 0.30-m SCT and SBIG ST-9E CCD camera and 60-second exposures. The asteroid was embedded within crowded star fields and so the StarBGone feature of *Canopus* was used to keep as many data points as possible. Night-to-night calibrations were made by using 2MASS to BVRI magnitudes (see Warner, 2007b). Figure 3 shows a best-fit plot of the 2001 data phased to a period of 6.618 ± 0.002 h. Figure 4 shows a period spectrum covering the possible periods mentioned in this paper. From this, the alternate periods of 4.0 h and 5.9 h found by the Eau Claire group are not as likely if one presumes a bimodal curve. However given the low amplitude of the lightcurves at both apparitions, it's possible that a bimodal curve is not a valid assumption even though the phase angle was <15° in both cases. It can also be noted that the phase angle bisector longitudes differed by only 35° between the two apparitions and so the viewing aspect was not significantly different. The final conclusion seems to be that neither data set firmly establishes a period and that observations, preferably with significantly different viewing aspects, be carried out in the future.

The Eau Claire group's data can be obtained from http://www.uwec.edu/physics/asteroid/.

Acknowledgements

The Eau Claire group thanks the Theodore Dunham Fund for Astrophysics and the University of Wisconsin-Eau Claire Office of Research and Sponsored Programs for financial support.

Funding at the Palmer Divide Observatory for the re-analysis of the 2001 data was provided by NASA grant NNX 09AB48G and by National Science Foundation grant AST-0607505.

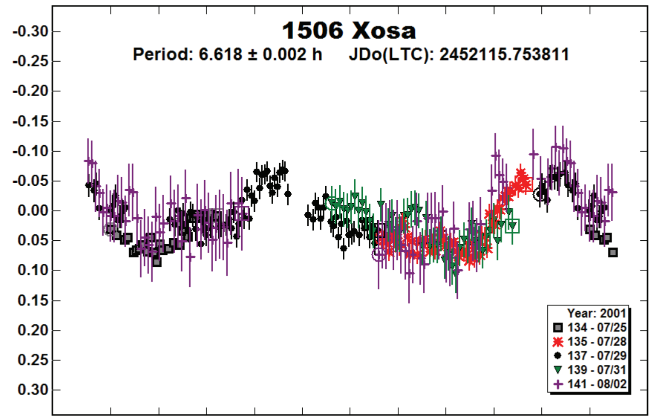


Figure 3. Data for 1506 Xosa from 2001 phased to 6.618 ± 0.002 h.

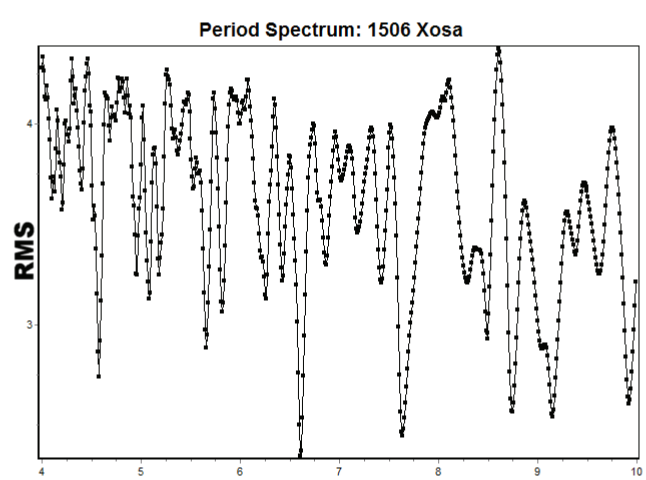


Figure 4. Period spectrum for 1506 Xosa using only 2001 data. The X-axis is the period, in hours, while the Y-axis is the RMS fit.

References

Robinson, L.E. and Warner, B.D. (2002). "A Collaborative Work on Three Asteroid Lightcurves: 506 Marion, 585 Bilkis, 1506 Xosa", *Minor Planet Bulletin* **29**, 6–7.

Warner, B.D. (2006). *A Practical Guide to Lightcurve Photometry and Analysis*. Springer, New York, NY.

Warner, B.D. (2007a). MPO Software, Canopus version 9.3.1.0, Bdw Publishing, http://www.minorplanetobserver.com/

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

SUGGESTED REVISED H VALUES OF SELECTED ASTEROIDS: REPORT NUMBER 4

Gérard Faure
1, Parc de la Châtelière
38760 Varces Allières et Risset FRANCE

Lawrence Garrett
ALPO Minor Planet Section Assistant Coordinator
Fairfax, USA

(Received: 2009 Jun 21)

We report the main results obtained by the "Magnitude Alert Project" (MAP) from 2007 to mid-2009. On 2009 May 31 the MAP Database contained 495 asteroids and 5541 measures. Observations were made of 19 minor planets on at least three oppositions for which visual and CCD measures indicated a significant difference from the predicted value. These discrepancies ranged from 0.2 to 1.7 magnitudes. We suggest a revision of their catalogued H magnitude to permit better predicted magnitudes in the future ephemerides of these objects, notably by the Minor Planet Center.

Since its founding at late 1996, the MAP, begun by Garrett and managed by the ALPO Minor Planet Section, has continuously accumulated numerous visual and CCD measurements of asteroid magnitudes. The total of minor planets observed with a discrepancy of at least 0.3 mag between the predicted and the observed magnitudes increases each year. As of 2009 May 31, the MAP database contained 5541 measures or averaged measures. A total of 495 asteroids were suspected to have a magnitude discrepancy are included. Of those, 91 have been eliminated after finding no significant difference or the difference being explained by a large amplitude lightcurve. The remaining 404 minor planets need follow-up to find the actual H magnitude.

Various analyses of our data show an averaged difference of only 0.1 to 0.2 magnitude between visual and corrected unfiltered CCD measures made with accurate reference stars. Thanks to some analyses on known lightcurves, the impact of the maximum light half-amplitude was found statistically smaller than 0.3 magnitude for nearly 90% of the concerned asteroids. More, they are at the maximum variability just during a short time of their rotation period and not at each opposition. For more information on the MAP methods and results, the reader may go to the various updated MAP Reports at: http://astrosurf.com/map

Since the last report in the MPB (Faure and Lawrence, 2007), two active MAP members, Roger Dymock and Richard Miles, analyzed the Carlsberg Meridian Catalog 14 and tested a new method for a better accuracy of the unfiltered CCD measures. Herbert Raab modified his "Astrometrica" software to permit the use of the CMC14 including 95 million stars. Despite the lack of reference stars in some areas of the sky, mostly far from the ecliptic, this catalog now permits at least an accuracy of ~0.1 magnitude for the observers using a CCD camera that approximates the V band. For CCD cameras closer to the R band, an adjustment based on an assumed V-R = + 0.4 mag permits a better accuracy than when using the USNO catalog. CCD have also used reference stars from the LONEOS or Tycho-2 catalogs, but few measures of this type have been over the 12 years of the project due to difficulties in the methods required to use these much sparser catalogs.

Another improvement is the renewal of the changes of the uncorrected H magnitudes for the numbered asteroids by the Minor Planet Center, since September 2008. As of mid-2009, 20892 asteroids had a corrected H magnitude with 39 of these in the MAP database. The actual residual differences with the MPC are from 0.0 to 0.6 mag for the eight MAP objects seen during at least 3 oppositions (averaged 0.10 magnitude).

This fourth report of MAP results includes 19 new objects for which the measures show a continual difference between observed and predicted magnitudes for at least during 3 oppositions. This consistent offset implies the necessity for the H magnitude to be revised. Our reported offset values are based on the average magnitude discrepancy of all the discrepancies calculated night by night for each asteroid. The various averages reduce statistically the eventual errors. The recent H changes from the MPC are noted under the list of measures for 3 concerned objects included in this fourth MAP Report.

Table I summarizes the results for the 19 asteroids. Table II provides information on the observers of these objects. Table III gives the details on the measures producing the results of these 19 asteroids. With the aim of reducing space in the article, this table only contains the averaged difference of magnitude of all the individual measures made during a same night, from 12H UT to12H UT of the next day.

The evolution of the official H magnitudes follows the record of observations for each asteroid, with the years of the publication of the MPC magnitudes in the *"Ephemerides of Minor Planets"* or the *MPCORBcr* files from the MPC.

Minor Planet	(1)	(2)	**(3)**	(4)	(5)	(6)	(7)
658 Asteria	10.54	-0.3	**10.2**	3	13	3	0.16
870 Manto	13.1	-1.0	**12.1**	3	20	5	>0.15
1002 Olbersia	11.1	-0.2	**10.9**	3	18	6	0.19
1122 Neith	11.1	0.8	**11.9**	3	19	6	0.04
1194 Aletta	10.2	0.3	**10.5**	3	7	3	0.14
1365 Henyey	11.7	0.4	**12.1**	4	12	3	?
1403 Iseldonia	10.6	0.8	**11.4**	3	31	4	0.55
1909 Alekhin	12.3	0.6	**12.9**	4	43	5	?
3198 Wallonia	12.3	0.8	**13.1**	3	6	4	0.29
3873 Roddy	12.0	1.2	**13.1**	5	11	5	0.05
3913 Chemin	12.2	0.4	**12.6**	3	19	6	0.26
4790 Petrpravec	11.8	1.0	**12.8**	3	10	4	?
5222 Ioffe	11.0	0.4	**11.4**	3	11	5	0.14
5231 Verne	11.1	0.8	**11.9**	4	20	6	0.42
5518 Mariobotta	12.8	0.4	**13.2**	5	14	5	?
(5917) 1991 NG	11.3	0.6	**11.9**	3	11	3	0.18
6000 United Nations	11.5	0.6	**12.1**	3	14	5	0.20
6838 Okuda	12.0	0.5	**12.5**	3	17	4	?
6911 Nancygreen	12.4	1.7	**14.1**	3	11	4	0.26

Table I. Summary of results.

M.P: Number and name of the asteroid; (1): H MPC, before changes since September 2008; (2): MAP difference of magnitude; **(3): Recommended revised H value by the MAP**; (4): Total of observed oppositions; (5): Total of MAP measures; (6): Total of observers; (7): Maximum half-amplitude of known light variability.

Name Observer	Country	T	Tel	CCD camera
ANTONINI Pierre	France	C	T26cm	Hi-SiS22
BOSCH Jean-Gabriel	Swiss	C	T20cm	Starlight MX 516
BOIVIN Claude	Canada	C	T28cm	Audine Kaf 401E
BOOKAMER Richard	USA	V	T41cm	
BROCHARD Emmanuel	France	C	T20cm	Audine Kaf 401E
CHARDONNENS Bruno	Swiss	C	T20cm	Hi-SiS22
CHASSAGNE Robin	France	C	T21cm	Hi-SiS22
CHRISTOPHE Bernard	France	C	T60cm	Hi-SiS22
DYMOCK Roger	UK	C	T25cm	Starlight MX 516
FAURE Gérard	France	V/C	T20cm	Sbig ST6
GARRETT Lawrence	USA	V	T32cm	
HARVEY Roger	USA	V	T73cm	
KOFF Robert	USA	C	T25cm	Apogee AP-47
LASKOWSKI Tom	USA	V	T28cm	
LLAPASSET Jean-M.	France	C	T28cm	Sbig ST7
MARINELLO Wladimiro	Italy	C	T40cm	CCD type ?
MARTINOLE Philippe	France	C	T25cm	Hi-SiS22
MILES Richard	UK	C	T28cm	Starlight SXV-H9
MORATA Didier	France	C	T30cm	Hi-SiS22
MORATA Stephane	France	C	T30cm	Hi-SiS22
PIZZETTI Gianpaolo	Italia	C	T40cm	CCD type ?
PONCY Raymond	France	C	T20cm	Sbig ST7
ROY René	France	C	T25cm	Hi-SiS22
SALTHOUSE Andrew	USA	V	T44cm	
SPOSETTI Stefano	Swiss	C	T20cm	Hi-SiS22

Table II. List of observers.

T = Observation Type: C = CCD; V = visual

```
Dates Observation date (year-month-day.part of day)
(1)   Magnitude type:
        AMv  Visual magnitude with asteroid comparison
        CMV  Filtered CCD w/CMC14 near V band
        CMr  Unfiltered CCD w/CMC14 near R band
        CMu  Unfiltered CCD w/CMC14 near V band
        GMt  Unfiltered CCD w/GSC corrected by Tycho 2
        GMv  Visual w/GSC corrected by Tycho 2
        LMu  Unfiltered CCD w/LONEOS R comparison
        SMr  Unfiltered CCD w/USNO-SA R comparison
        TMv  Visual w/Tycho 2 (V comparison)
        UMv  Visual w/USNO-SA R comparison
        UMr  Unfiltered CCD w/USNO-A comparison
        UMu= Unfiltered CCD w/USNO-SA comparison
(2)   Predicted V magnitude
(3)   MAP magnitude differences. Averaged by night
        x.xx F =  x.xx magnitude fainter than predicted
        x.xx B = x.xx magnitude brighter than predicted
        Adjustment V-R = 0.4 mag for the CMC14, SMr and
        UMr magnitude
(4)   Number of measures made during the given day
```

Table III. Observations column definitions.

Observations and Results for H magnitudes

658 Asteria (Koronis)

Dates	(1)	(2)	(3)	(4)	Observers
00-02-26.9	AMv	14.5	-0.30B	1	FAURE
07-09-15.0	AMv	14.4	-0.50B	2	FAURE
08-12-06.8	CMu	14.3	-0.14B	2	MILES
08-12-08.0	CMr	14.3	-0.30B	8	FAURE CCD

H MPC = 10.56 (EMP 1988 =>1991)
H = 10.54 (EMP 1992 => 2009)
H DIFF. = 0.31 B   Revised H MAP = 10.2

870 Manto

Dates	(1)	(2)	(3)	(4)	Observers
02-06-13.9	AMv	15.5	-1.05B	2	FAURE
02-06-14.9	AMv	15.6	-1.20B	2	FAURE
02-06-29.1	AMv	15.8	-1.20B	1	GARRETT
02-07-04.8	UMr	15.9	-0.60B	1	PONCY
06-10-13.9	AMv	15.2	-0.40B	2	FAURE
09-04-24.9	AMv	15.8	-1.10B	2	FAURE
09-05-13.1	AMv	15.6	-0.90B	2	SALTHOUSE
09-05-16.1	AMv	15.6	-0.90B	2	SALTHOUSE
09-05-17.0	AMv	15.7	-1.65B	2	FAURE
09-05-19.1	AMv	15.7	-0.90B	1	SALTHOUSE
09-05-29.9	CMr	15.9	-1.42B	3	FAURE CCD

H MPC = 11.8 (EMP 1988 =>1991)
H = 12.1 (EMP 1992 =>1997)
H = 13.1 (EMP 1998 =>2008)
H DIFF. = 1.03 B   Revised H MAP = 12.1
Modified H MPC 01/2009 = 11.6
Diff/H MAP after change MPC = 0.5 F

1002 Olbersia

Dates	(1)	(2)	(3)	(4)	Observers
93-09-20.9	AMv	13.9	-0.40B	1	FAURE
98-09-23.1	SMr	15.2	-0.23B	3	CHASSAGNE
98-11-05.0	SMr	14.6	-0.40B	3	CHASSAGNE
98-11-07.8	UMR	14.6	-0.50B	1	PIZZETTI/MARINELLO
98-11-15.9	SMr	14.7	-0.23B	3	S./D. MORATA
98-11-21.8	SMr	14.9	-0.40B	2	CHRISTOPHE
99-02-13.7	SMr	16.4	-0.10B	2	CHRISTOPHE
07-09-14.1	AMv	14.2	0.20F	1	FAURE
07-09-14.0	AMv	14.1	-0.30B	1	SALTHOUSE
07-09-16.0	AMv	14.1	0.20F	1	SALTHOUSE

H MPC = 10.9 (EMP 1988)
H = 11.1 (EMP 1992 => 2009)
H DIFF. = 0.22 B   Revised H MAP = 10.9

1122 Neith

Dates	(1)	(2)	(3)	(4)	Observers
00-12-25.9	AMv	13.7	0.80F	2	SALTHOUSE
01-02-15.8	UMu	15.0	0.96F	3	ROY
01-02-15.8	UMu	15.0		2	BOSCH
01-02-19.7	UMu	15.1	0.85F	2	BOSCH
04-11-17.9	AMv	13.0	0.90F	1	FAURE
04-12-10.9	AMv	13.3	0.80F	2	FAURE
05-01-02.1	AMv	14.1	0.80F	1	GARRETT
08-10-27.9	CMu	13.4	0.60F	5	MILES
08-12-06.8	CMu	14.4	0.69F	1	MILES

H MPC = 11.6 (EMP 1988 => 1991)
H = 12.2 (EMP 1992 => 1997)
H = 11.1 (EMP 1998 => 2009)
H DIFF. = 0.80 F   Revised H MAP = 11.9

1194 Aletta

Dates	(1)	(2)	(3)	(4)	Observers
00-03-04.1	AMv	13.9	0.20F	2	SALTHOUSE
00-03-06.1	AMv	13.9	0.30F	1	SALTHOUSE
07-09-09.9	AMv	14.8	0.30F	2	FAURE
08-12-06.8	CMu	14.5	0.25F	2	MILES

H MPC = 10.62 (EMP 1988 => 1991)
H = 10.2 (EMP 1992 => 2009)
H DIFF. = 0.26 F   Revised H MAP = 10.5

1365 Henyey (Flora)

Dates	(1)	(2)	(3)	(4)	Observers
98-03-21.9	AMv	14.0	0.55F	2	FAURE
98-03-28.0	AMv	13.8	0.50F	1	FAURE
98-05-15.8	SMr	14.7	0.25F	2	SPOSETTI
01-02-15.9	AMv	14.8	0.35F	2	FAURE
06-11-18.9	AMv	15.2	0.35F	2	FAURE
08-03-08.1	UMv	14.0	0.10F	1	BOOKAMER
08-03-14.0	AMv	14.0	0.40F	2	FAURE

H MPC = 12.23 (EMP 1988 =>1991)
H = 11.7 (EMP 1992 => 2009)
H DIFF. = 0.36 F   Revised H MAP = 12.1

1403 Idelsonia (Chloris)

Dates	(1)	(2)	(3)	(4)	Observers
99-10-06.1	AMv	12.9	0.30F	2	SALTHOUSE
99-10-08.1	AMv	12.9	0.30F	1	SALTHOUSE
99-10-12.1	AMv	12.9	0.60F	1	SALTHOUSE
99-10-16.1	AMv	12.8	0.70F	1	SALTHOUSE
99-11-27.8	AMv	13.7	0.70F	2	FAURE
03-06-30.0	AMv	13.4	0.40F	1	FAURE
08-10-27.9	CMu	13.0	1.23F	21	MILES
08-11-04.0	AMv	13.1	0.70F	1	BOOKAMER
08-12-06.8	CMu	14.0	2.03F	1	MILES

H MPC = 11.29 (EMP 1988 => 1991)
H = 11.3 (EMP 1992 =>1997)
H = 10.6 (EMP 1998 => 2009)
H DIFF. = 0.77 F   Revised H MAP = 11.4

1909 Alekhin

Dates	(1)	(2)	(3)	(4)	Observers
94-05-17.1	AMv	14.5	0.80F	1	HARVEY
98-06-19.9	GMt	13.8	0.59F	1	ANTONINI
98-06-20.0	AMv	13.8		2	FAURE
98-06-28.9	GMt	14.1	0.64F	2	ANTONINI
06-08-31.9	AMv	15.4	0.45F	2	FAURE
09-03-21.1	AMv	14.1	0.60F	2	SALTHOUSE
09-03-23.1	AMv	14.0	0.70F	1	SALTHOUSE
09-03-24.1	AMv	14.0	0.47F	1	SALTHOUSE
09-03-24.3	CMV	14.0	0.43F	5	DYMOCK
09-03-28.3	CMV	14.1	0.71F	4	DYMOCK
09-04-17.2	CMV	14.6	0.43F	10	DYMOCK
09-04-19.2	CMV	14.7	0.78F	10	DYMOCK
09-04-24.8	AMv	14.8	0.65F	2	FAURE

H MPC = 12.3 (EMP 1988 => 2009)
H DIFF. = 0.62 F   Revised H MAP = 12.9

3198 Wallonia (Mars-crosser)

Dates	(1)	(2)	(3)	(4)	Observers
92-04-03.1	AMv	14.7	0.60F	1	HARVEY
97-11-27.?	AMv	13.7	0.60F	1	LASKOWSKI
97-11-28.0	AMv	13.7	0.70F	1	GARRETT
97-12-30.8	AMv	14.2	1.10F	1	FAURE
08-04-05.0	AMv	14.6	1.08F	2	FAURE

H MPC = 13.53 (EMP 1988 => 1991)
H = 12.3 (EMP 1992 =>2009)
H DIFF. = 0.77 F   Revised H MAP = 13.1

3873 Roddy (Hungaria)

Dates	(1)	(2)	(3)	(4)	Observers
92-12-03.1	AMv	14.6	1.20F	1	HARVEY
96-06-11.9	AMv	13.6	1.30F	1	FAURE
97-11-28.0	AMv	13.6	0.90F	1	GARRETT
99-08-29.8	GMt	15.2	1.07F	6	ROY
09-05-30.0	CMr	13.3	1.36F	2	FAURE CCD

H MPC = 13.1 (EMP 1990 => 1991)
H = 11.8 (EMP 1992 => 1997)
H = 12.0 (EMP 1998 => 2009)
H DIFF. = 1.17 F   Revised H MAP = 13.2
Modified H MPC 06/2009 = 12.7
Diff/H MAP after change MPC = 0.5 F

3913 Chemin (Phocaea)

Dates	(1)	(2)	(3)	(4)	Observers
98-02-28.0	AMv	14.2	0.60F	1	FAURE
98-03-28.0	AMv	14.1	0.50F	1	FAURE
98-04-19.8	SMr	14.6	0.60F	3	ANTONINI
98-04-22.0	AMv	14.6	0.50F	1	GARRETT
98-04-23.1	AMv	14.6	0.50F	1	GARRETT
98-05-06.8	SMr	15.0	0.20F	2	LLAPASSET
98-05-18.8	SMr	15.2	0.42F	3	ANTONINI
06-09-01.8	CMr	15.8	0.38F	3	FAURE CCD
09-04-24.0	AMv	14.5	0.45F	2	FAURE

H MPC = 12.0 (EMP 1990 => 1997)
H = 12.2 (EMP 1998 => 2009)
H DIFF. = 0.45 F   Revised H MAP = 12.6

4790 Petrpravec

Dates	(1)	(2)	(3)	(4)	Observers
00-06-02.1	LMu	15.4	0.80F	4	KOFF
04-03-29.0	AMv	15.1	1.00F	1	FAURE
08-02-28.1	AMv	15.1	0.90F	3	HARVEY
08-04-25.9	CMr	16.2	1.18F	2	FAURE CCD

H MPC = 11.8 (EMP 1993 => 2009)
H DIFF. = 0.97 F   Revised H MAP = 12.8

5222 Ioffe (Pallas)

Dates	(1)	(2)	(3)	(4)	Observers
01-05-19.9	AMv	14.4	0.37F	3	FAURE
01-05-22.9	TMu	14.5	0.40F	2	BROCHARD
01-05-25.9	AMv	14.6	0.20F	2	FAURE
01-06-04.8	UMu	14.8	0.70F	1	CHARDONNENS
06-06-11.0	CMr	15.1	0.24F	2	FAURE CCD
08-12-06.8	CMu	15.5	0.30F	1	MILES

H MPC = 10.9 (EMP 1994 => 1997)
H = 11.0 (EMP 1998 => 2009)
H DIFF. = 0.32 F   Revised H MAP = 11.3

5231 Verne (Eunomia)

Dates	(1)	(2)	(3)	(4)	Observers
91-02-05.1	AMv	14.6	0.80F	1	HARVEY
98-10-30.0	AMv	14.1	0.65F	2	FAURE
98-11-05.8	SMr	13.9	1.07F	3	ANTONINI
98-11-07.9	SMr	13.9	1.13F	3	ROY
98-11-23.9	SMr	14.0	1.03F	3	ANTONINI
98-11-29.0	UMR	14.1	0.70F	1	PIZZETTI/MARINELLO
08-02-09.0	AMv	14.6	0.70F	2	FAURE
09-05-29.9	CMr	15.8	0.45F	5	FAURE CCD

H MPC = 11.1 (EMP 1994 => 2009)
H DIFF. = 0.82 F   Revised H MAP = 11.9

5518 Mariobotta

Dates	(1)	(2)	(3)	(4)	Observers
91-07-14.1	AMv	14.5	0.70F	3	HARVEY
98-08-19.9	SMr	14.9	0.70F	1	ANTONINI
98-08-24.0	SMr	14.9	0.40F	3	MARTINOLE
01-05-12.9	AMv	14.6	0.25F	2	FAURE
01-06-04.8	UMu	15.0	0.10F	1	CHARDONNENS
04-03-15.9	AMv	16.1	0.15F	2	FAURE
08-06-28.0	AMv	14.3	0.65F	2	FAURE

```
H = 13.0 => 0.7F for 1989 YF in 1991
H MPC = 12.5 (EMP 1995 => 1997)
H = 12.8 (EMP 1998 => 2009)
H DIFF. = 0.42 F    Revised H MAP = 13.2
```

(5917) 1991 NG (Maria)

Dates	(1)	(2)	(3)	(4)	Observers
00-09-29.1	AMv	14.9	0.60F	2	HARVEY
04-09-09.9	AMv	14.5	0.75F	2	FAURE
08-08-08.1	AMv	14.3	0.50F	2	SALTHOUSE
08-08-09.1	AMv	14.2	0.60F	2	SALTHOUSE
08-08-10.1	AMv	14.2	0.60F	1	SALTHOUSE
08-08-23.9	AMv	14.2	0.70F	2	FAURE

```
H MPC = 11.3 (EMP 1996 => 2009)
H DIFF. = 0.63 F    Revised H MAP = 11.9
```

6000 United Nations (Eunomia)

Dates	(1)	(2)	(3)	(4)	Observers
00-12-04.2	AMv	15.1	0.50F	2	HARVEY
01-02-15.9	UMu	16.0	0.83F	3	ROY
01-02-26.8	UMu	16.2	0.80F	2	BOSCH
04-11-22.0	AMv	14.3	0.60F	1	FAURE
08-10-27.9	CMu	13.9	0.49F	5	MILES
08-12-06.8	CMu	14.9	0.38F	1	MILES

```
H MPC = 11.5 (EMP 1996 => 2009)
H DIFF. = 0.60 F    Revised H MAP = 12.1
```

6838 Okuda

Dates	(1)	(2)	(3)	(4)	Observers
98-07-27.1	UMr	16.5	0.63F	6	BOIVIN
98-08-04.9	GMt	16.6	0.49F	2	CHASSAGNE
04-12-16.2	AMv	15.1	0.60F	2	HARVEY
08-12-06.8	CMu	15.3	0.43F	2	MILES
08-12-08.0	CMr	15.3	0.37F	5	FAURE CCD

```
H MPC = 12.0 (EMP 1998 => 2009)
H DIFF. = 0.51 F    Revised H MAP = 12.5
```

6911 Nancygreen (Hungaria)

Dates	(1)	(2)	(3)	(4)	Observers
00-11-??.?	SMr	13.9	1.80F	1	SPOSETTI
00-11-21.1	AMv	14.1	1.30F	2	HARVEY
05-07-31.9	AMv	14.8	1.60F	2	FAURE
08-10-27.9	CMu	13.5	2.05F	6	MILES

```
H MPC = 12.4 (EMP 1998 => 2008)
H DIFF. = 1.69 F    Revised H MAP = 14.1
Modified H MPC 01/2009 =14.0
Diff/H MAP after change MPC = only 0.1 F
```

References

Carlsberg Meridian Catalog 14: http://www.ast.cam.ac.uk/~dwe/SRF/cmc14.html

Dymock, R., Miles, R. (2009). "A Method for Determining the V Magnitude of Asteroids from CCD Images". *J. Br. Astron. Assoc.* **119**, 149-156.

Faure, G., Garrett, L. (1999). "Suggested Revised H Values of Selected Asteroids." *Minor Planet Bulletin* **26**, 12-13.

Faure, G., Garrett, L. (2001). "Suggested Revised H Values of Selected Asteroids – Report number 2". *Minor Planet Bulletin* **28**, 74-77.

Faure, G., Garrett, L. (2007). "Suggested Revised H Values of Selected Asteroids - Report number 3". *Minor Planet Bulletin* **34**, 95-99.

Faure, G. (2007). "10 Years of Visual and CCD Photometry for the MAP". http://astrosurf.com/map/MAP_REPORT_1996-2006_ENGLISH.htm

Institute of Applied Astronomy - Russia. "*Ephemerides of Minor Planets*" from 1985 to 2006.

MAP Alerts website: http://home.myfairpoint.net/lgasteroid1/map/

MAP Database: http://astrosurf.com/map/index_us.htm

Minor Planet Center, "MPCORBcr" files from 2006 to 2009. ftp://cfa-ftp.harvard.edu/pub/MPCORB/

Pilcher, F. (1977-2009) "General Report of position observations by the ALPO Minor Planet Section for the year". *Minor Planet Bulletin,* **5-36**

Raab, H. (2009). "Astrometrica". http://www.astrometrica.at/

Skiff, B. (2003). "LONEOS star catalog" ftp://ftp.lowell.edu/pub/bas/starcats/loneos.phot

---

LIGHTCURVE ANALYSIS OF 48 DORIS AND 1055 TYNKA

David Higgins
Hunters Hill Observatory
7 Mawalan Street
Ngunnawal ACT 2913 AUSTRALIA
higginsdj@bigpond.com

Frederick Pilcher
Organ Mesa Observatory
Las Cruces, NM 88011 USA

(Received: 2009 Jun 15)

The synodic period and amplitude for minor planet 48 Doris was found to be 11.8906 ± 0.0004 h and 0.36 ± 0.02 mag; for 1055 Tynka, the parameters are 11.893 ± 0.002 h and 0.07 ± 0.01 mag.

Hunters Hill Observatory (HH) is equipped with a Meade 14" LX200 GPS Schmidt-Cassegrain (SCT) fitted with a Meade f/3.3 focal reducer and SBIG ST-8E CCD producing a final focal ratio of f/4. The scale with 1x1 binning was 1.32 arcsec/pixel. The camera was operated at –15°C. All observations were made with a clear filter with guided exposures ranging from 60 to 180 seconds. *MaxIm DL/CCD*, controlled by DC3 Dreams *ACP5*, was used for automated telescope and camera control and image acquisition whilst calibration and image measurement via differential photometry were undertaken with *MPO Canopus* v9. Organ Mesa Observatory is equipped with a Meade 14" LX2000 GPS f/11 SCT and SBIG STL 1001-E CCD. A red filter was used with unguided 60-second exposures. Differential photometry and data sharing were made with *MPO Canopus*.

48 Doris. This asteroid was chosen due to its reported period being very close to 12 hours and the fact that it had not been observed in more than 20 years. Initial observations indicated that the target period was commensurate with 12 or 24 hours and required observations from widely-spaced longitudes. Higgins requested a collaboration via the CALL website (Warner, 2009) and Pilcher responded. The target was previously observed by Debehogne et al. (1982), Harris and Young (1980), and Schober and Schroll (1982) who published periods ranging from 11.88 to 11.90 h. The period derived from our data agree with those results.

1055 Tynka. Initial observations indicated that the target's period was very close to 12 or 24 hours and required observations from widely-separated longitudes. As with 48 Doris, the authors formed a collaboration via the CALL web site. The distinct dip in the lightcurve at phase 0.25 indicates that the period based on the bimodal curve presented here is the one most likely correct.

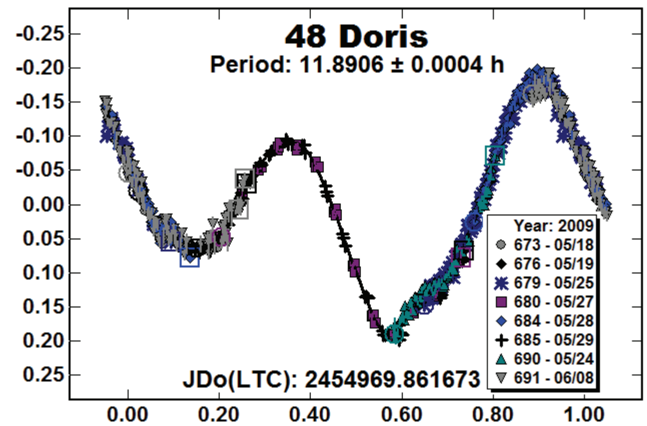
References

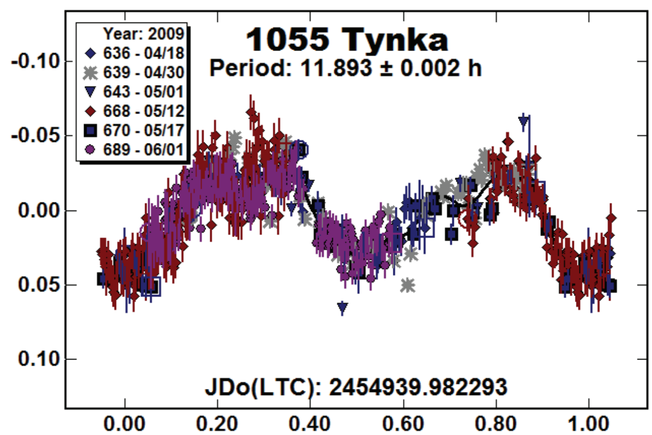
Debehogne, H., Lagerkvist, C.-I., and Zappala, V. (1982). "Physical studies of asteroids VIII. Photoelectric photometry of the asteroids 42, 48, 93, 105, 115, and 245." *Astron. Astrophys. Suppl. Ser.* **50**, 277-281.

Harris, A.W. and Young, J.W. (1980). "Asteroid Rotation III. 1978 Observations." *Icarus* **43**, 20-32.

Schober, H.J. and Schroll, A. (1982). "The Asteroids 36 Atalante and 48 Doris, Rotation, UBV-photometry, and Lightcurves." *Astron. Astrophys.* **107**, 402-405.

Warner, B.D. (2009) "Collaborative Asteroid Lightcurve Link (CALL)" web site.
http://www.MinorPlanetObserver.com/astlc/default.htm





CCD LIGHTCURVE ANALYSIS OF 511 DAVIDA

Kevin B. Alton
UnderOak Observatory
70 Summit Ave
Cedar Knolls, NJ 07927

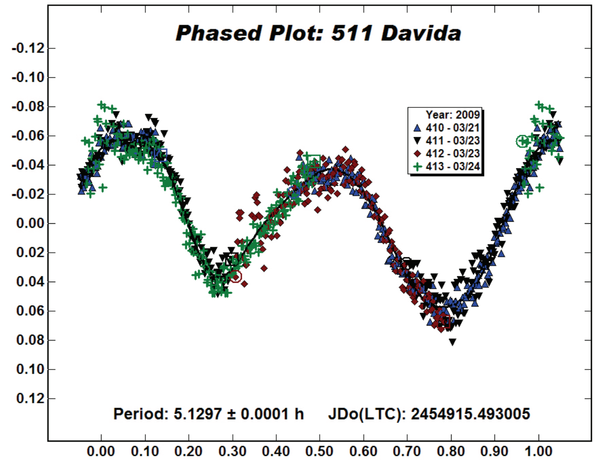
(Received: 2009 Apr 30)

Filtered (Ic) CCD images for 511 Davida were obtained over four sessions in 2009 March. A folded lightcurve was produced and the synodic period estimated by Fourier analysis to be 5.1297 ± 0.0001 h.

First discovered in 1903 by R.S. Dugan, 511 Davida is a C-type main belt asteroid which ranks seventh in mass amongst all minor planets (Michalak, 2001). Recent ground-based investigations on 511 Davida using adaptive optics and infrared imaging (Conrad et al., 2006, 2007) have confirmed a triaxial ellipsoidal shape with a mean diameter of *D* = 289 km.

The equipment for this photometric study included a focal-reduced (f/6.3) 0.2-m Schmidt-Cassegrain telescope with a thermoelectrically cooled (-5°C) SBIG ST-402 ME CCD camera mounted at the Cassegrain focus. Filtered (Ic) imaging was conducted on four nights with exposures automatically taken every 45 seconds. Image acquisition (raw lights, darks, and flats) was performed by *CCDSoft* 5 (SBIG) while calibration and registration were accomplished with *AIP4WIN* (Berry and Burnell, 2006). Further data reduction with *MPO Canopus* (Warner, 2008) used at least two non-varying comparison stars to generate lightcurves by differential aperture photometry. Data were light-time corrected but not reduced to standard magnitudes.

A total of 908 data points was generated over 4 days. Relevant aspect parameters for 511 Davida taken at the mid-point from each session are tabulated below. *MPO Canopus* provided a period solution for the folded data sets using Fourier analysis (Harris, 1989). The calculated synodic period of 5.1297 ± 0.0001 h is in good agreement with the most recent value for 511 Davida reported at the JPL Solar System Dynamics website. Peak amplitude was estimated at 0.11 ± 0.02 mag. Phased data are available by request at http://underoakobservatory.com.



UT Date (2009)	Obs	Phase Angle	L_{PAB}	B_{PAB}
Mar 21	276	14.8	143.1	13.2
Mar 23	239	15.3	143.3	13.2
Mar 24	187	15.5	143.3	13.2
Mar 25	206	15.7	143.4	13.2

Acknowledgement

Special thanks are due to the NASA Astrophysics Data System hosted by the Computation Facility at the Harvard-Smithsonian Center for Astrophysics.

References

Berry, R., Burnell, J. (2006). AIP4WIN version 2.1.10, Willmann-Bell, Inc, Richmond, VA.

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. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261 and 863." *Icarus,* **77**, 171-186.

Conrad, A.R., Dumas, C., Merline, W.J., Campbell, R.D., Goodrich, R.W., Le Mignant, D., Chaffee, F.H., Fusco, T., Kwok, S., and Knight, R. I. (2006). "Rotation and morphology of asteroid 511 Davida." 37th *Lunar and Planetary Science Conference*, abstract 1955.

Conrad, A.R., Dumas, C., Merline, W.J., Drummond, J.D., Campbell, R.D., Goodrich, R.W., Le Mignant, D., Chaffee, F.H., Fusco, T., Kwok, S.H., and Knight, R.I. (2007). "Direct measurement of the size, shape, and pole of 511 Davida with Keck AO in a single night." *Icarus*, **191**, 616-627.

Michalak, G. (2001), "Determination of asteroid masses. II. (6) Hebe, (10) Hygiea, (15) Eunomia, (52) Europa, (88) Thisbe, (444) Gyptis, (511) Davida and (704) Interamnia." *Astron. Astroph.*, **374**, 703-711.

Warner, B.D. (2008), MPO Software, Canopus version 9.5.0.3. Bdw Publishing, Colorado Springs, CO.

JPL Solar System Dynamics website:
(http://ssd.jpl.nasa.gov/sbdb.cgi)

PHOTOMETRIC OBSERVATIONS OF 1998 OR2, 1999 AQ10, AND 2008 TC3

Alberto Silva Betzler[1,2], Alberto Brum Novaes[1]

1- Projeto "Descobrindo o Céu", Departamento de Física da Terra e do Meio Ambiente, Instituto de Física, Universidade Federal da Bahia (IF-UFBA), Salvador, Estado da Bahia, BRASIL

2- Projeto "Astronomia no Campus", Coordenação de Física, Departamento de Ciências Aplicadas, Instituto Federal da Bahia (IFBA), Salvador, Estado da Bahia, BRASIL

(Received: 2009 Jun 14 Revised: 2009 Jul 18)

The near-Earth asteroids 1999 AQ10 and 1998 OR2 were observed by the authors between 2009 February and March to determine their basic physical parameters. The absolute magnitudes are, respectively, H = 20.4 ± 0.5 and 16.1 ± 0.2 using G = 0.15. The lightcurve parameters for 1999 AQ10 are P = 2.79 ± 0.02 h, A = 0.205 ± 0.005 mag and, for 1998 OR2, P = 3.198 ± 0.006 h, A = 0.29 ± 0.01 mag. The linear phase coefficient for 1999 AQ10 is β = 0.034 ± 0.002 mag/deg. For 2008 TC3, we obtain B-V = 0.608 ± 0.002.

The Aten type asteroid, 1999 AQ10, and Amor type, 1998 OR2, were observed in 2009 February and March in Salvador (Brazil), using a 0.3-m LX200 GPS Meade telescope operating at f/3.3, combined with a CCD SBIG ST-7XME detector. Our goal was to determine the lightcurve parameters, linear phase coefficient (β), absolute magnitude (H), slope parameter (G), and diameter (D). Because of the fast sky motion of the two asteroids, exposure times were 30 seconds or less in order to avoid excessive trailing. This resulted in SNR values of 30-50. To reduce the noise in the lightcurves, three consecutive differential instrumental magnitudes in the dataset were binned to form a single data point. All images taken in Salvador were corrected with bias, dark, and flat-field frames. The period search was done using the Fourier analysis algorithm in *MPO Canopus* v. 9.3.10.

Photometric calibration was done using 2MASS stars in the asteroid's field. The 2MASS J-K field star color index were converted to the equivalent V magnitude and B-V index of Johnson-Cousins system using the transformation equations from Warner (2007) and Gary (2008). The T_{B-V} transformation coefficient between the instrumental and Johnson-Cousins photometric system was calculated using definitions by Gary (2006). The B-V color index of the object's field stars were used to calculate this last parameter. The H and G parameters were estimated using the mean V magnitude calculated from photometric data publish in MPEC and the FAZ routine available in *MPO Canopus*. These V magnitudes were used to calculate the object's linear phase coefficient (β), excluding the opposition effect.

1998 OR2. 1998 OR2 was observed on 2009 March 15 and 16 UT with a total of 106 unfiltered images obtained. From our data, we found a synodic rotation period of 3.198 ± 0.006 h and amplitude of 0.29 ± 0.01 mag, assuming a bimodal lightcurve (Fig.1). The absolute magnitude is H = 16.1 ± 0.2 using G = 0.15. When both values are allowed to "float", the results are H = 15.7 ± 0.1 and G = –0.18 ± 0.06 (Fig. 2). These are consistent the value

H = 15.7 ± 0.7 reported on the JPL Small-Body Database Browser. A negative value for G is unusual, though it has been found for C-type main belt asteroids 51 Nemausa and 175 Andromache (Warner, 2007) and in some trans-Neptunian objects (Sheppard and Jewitt, 2002). To test our results, we calculated the object's apparent V magnitude on 2009 March 15 at 04:14 UT using the H-G system (see Bowell et al., 1989). Using H = 15.7 and G = 0.15 we found V = 14.0 ± 0.1; with G = –0.18, V = 14.6 ± 0.2. We then used a method described by Henden (2000) on our clear images to measure V directly. This resulted in V = 14.64 ± 0.06, assuming B-V = 0.6, which fits with a Tholen low albedo class. Assuming that our G value is correct, 1998 OR2 may be of some low-albedo taxonomic type.

1999 AQ10. 1999 AQ10 was classified as a possible S type in SMASS II (Binzel et al., 2004). We observed it on 2009 February 16 for about 4 hours, obtaining 155 clear filter images with 15-second exposures. Our dataset gave lightcurve parameters of P = 2.79 ± 0.02 h and A = 0.205 ± 0.005 mag (Fig. 2). Casulli (2009) reported a similar period of 2.664 ± 0.002 h. We found an absolute magnitude H = 20.4 ± 0.5 using G = 0.15. Assuming typical values for an S type of G = 0.227 and albedo, p_v = 0.184 (Harris, 1989), then H = 20.5 ± 0.4 (Fig. 4) and D = 0.25 ± 0.08 km. We also found a linear phase coefficient of β = 0.034 ± 0.002 mag/deg between phase angles of 25° and 52°.

2008 TC3. 2008 TC3 was observed at Slooh.com Teide Observatory (Canary Islands, Spain) approximately 40 minutes before its collision with Earth by D. Matt, who used a 0.35m f/11 Celestron SCT with SBIG ST-10XME with RGB filters. Exposures were 30s. Using the G and B instrumental magnitudes, we found B-V = 0.608 ± 0.002.

Acknowledgments

Thanks to the Vitae Foundation, MCT, IFBA and the Institute of Physics of UFBA (IF-UFBA) for supporting the "Discovering the Sky" and "Astronomy in the Campus" projects. This work used CCD images that were kindly made available by Slooh.com observatories.

References

Binzel, R. P., Rivkin, A. S., Stuart, J. S., Harris, A. W., Bus, S. J., Burbine, T. H. (2004). "Observed spectral properties of near-Earth objects: results for population distribution, source regions, and space weathering processes." *Icarus* **170**, 259-294.

Bowell, E., Hapke, B., Domingue, D., Lumme, K., Peltoniemi, J., Harris, A. W. (1989). "Application of photometric models to asteroids." In *Asteroids II* (R. P. Binzel, T. Gehrels, M. S. Matthews, eds.) pp. 524-556. University of Arizona Press, Tucson.

Casulli, S. (2009). "1999 AQ10". http://obswww.unige.ch/~behrend/r99a10qa.png

Gary, B. L. (2006). "CCD Transformation Equations for use with Single Image (Differential) Photometry." http://reductionism.net.seanic.net/CCD_TE/cte.html

Gary, B. L. (2008). "J and K to BVRcIc: Method #0." http://brucegary.net/dummies/method0.html

Harris, A. H. (1989). "The H-G Asteroid Magnitude System: Mean Slope Parameters." *LPI* **20**, 375.

Henden, A. A. (2000). "The M67 Unfiltered Photometry Experiment." *JAVSO* **29**, 35-43.

Sheppard, S. S., Jewitt, D. C. (2002). "The shapes, densities, and phase functions of trans-Neptunian objects." In *Proceedings of Asteroids, Comets, Meteors (ACM 2002). International Conference, 29 July - 2 August 2002, Berlin, Germany* (Barbara Warmbein, ed.) pp 21-24. ESA SP-500. Noordwijk, Netherlands.

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

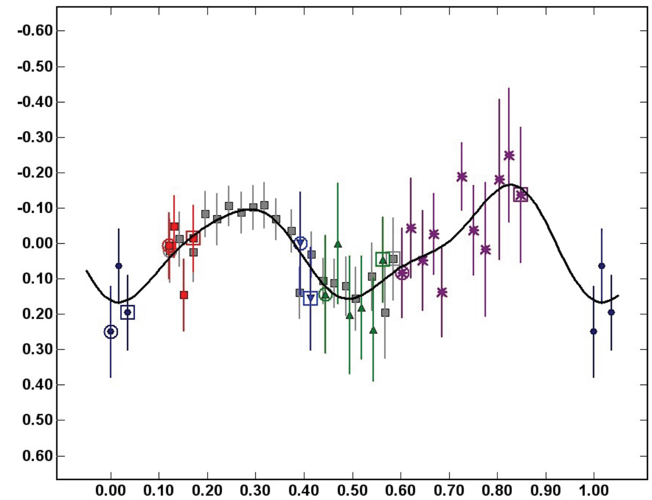


Figure 1. 1998 OR2 lightcurve phased to a period of 3.198 ± 0.006 h. Zero phase corresponds to JDo (LTC) 2454905.619916. The black solid line is the best fit to a 4th harmonic Fourier series.

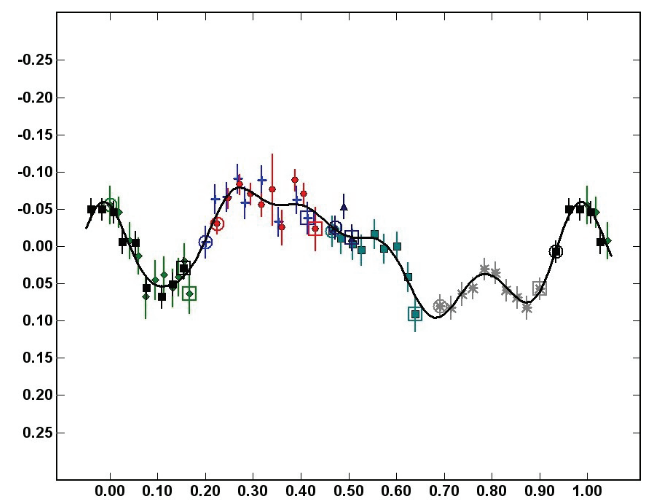


Figure 2. 1999 AQ10 lightcurve adjusted phased to a period of 2.79 ± 0.02 h. Zero phase corresponds to JDo (LTC) 2454878.557014. The black solid line is the best fit to an 8th harmonic Fourier series.

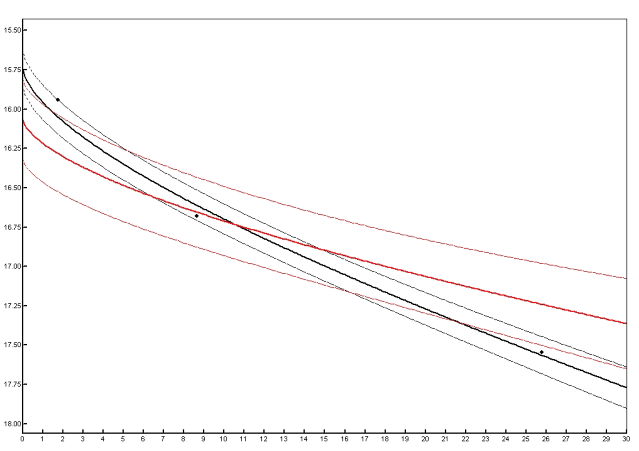


Figure 3. Plot of the reduced magnitude of 1998 OR2 versus the phase angle. The solid black line is corresponding to a curve with $G = -0.18 \pm 0.06$ and the red line to $G = 0.2(0.15) \pm 0.2$. The reduced magnitudes have ~0.01 mag of error.

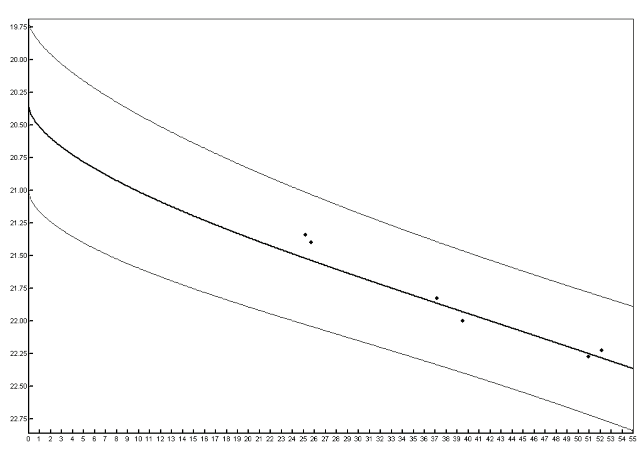


Figure 4. Plot of the reduced magnitude of 1999 AQ10 versus the phase angle. The solid black line corresponds to a curve with $G = 0.2(0.15) \pm 0.2$. The reduced magnitudes have ~0.01 mag of error.

ASTEROID LIGHTCURVE ANALYSIS AT RICKY OBSERVATORY

Craig Bennefeld
Physics Dept., Imagine Renaissance Academy
414 Wallace
Kansas City, MO 64125
craig.bennefeld@imagineschools.com

Science Department Students
Stephen Bass, Ricco Blair, Kendrick Cunningham, Da'Quia Hill, Michael McHenry, Lerone Maxwell

(Received: 2009 Jun 26)

Lightcurves for five asteroids were obtained at Ricky Observatory from 2007 October through 2008 December: 1160 Illyria, 4797 Ako, 5132 Maynard, 6000 United Nations, and (27851) 1994 VG2.

Observations of five asteroids were carried out at Bennefeld's Observatory (MPC H46), which is equipped with a 0.35-m Meade LX200 GPS telescope operating at f/6.3 coupled to a SBIG ST7-XME CCD camera, resulting in a resolution of ~1.7 arcsec/pixel (binned 2x2). Unfiltered exposure times varied between 30-60 s.

The asteroids under observation were selected from the list of asteroid lightcurve photometry opportunities which is posted on the Collaborative Asteroid Lightcurve Link website (CALL; Warner, 2007a). Lightcurve measurements were made using Brian Warner's *MPO Canopus*, which employs differential aperture photometry to produce the raw data (Warner, 2007b). Period analysis of the raw data was also done using *Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris et al., 1989). As well as reporting the synodic rotational period, amplitude, and phase angle of the asteroids, every attempt was made to expand on the knowledge base of the asteroids by, where appropriate, reporting the minimum axial ratio a/b of an elliptical asteroid and the Phase Angle Bisector longitude and latitude, PAB_L and PAB_B, respectively.

1160 Illyria. The main-belt asteroid was sampled 258 times over 2 nights. Analysis of the data revealed a synodic rotation period of 4.104 ± 0.001 h. The absolute value of the peak-to-peak magnitude differential (Δm) of 0.58 mag for the lightcurve implies an axial ratio (a/b) of 1.70, assuming an equatorial viewing aspect. No other lightcurves for this asteroid are known to exist.

4797 Ako. The main-belt asteroid was sampled 156 times over 1 night. The derived synodic period was 4.085 ± 0.001 h. The absolute value of the peak-to-peak magnitude differential (Δm) of 0.70 mag implies an axial ratio (a/b) of 1.95. No other lightcurves for this asteroid are known to exist.

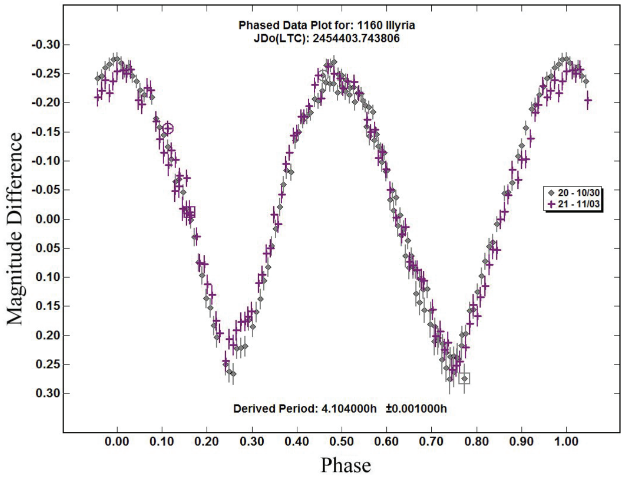
5132 Maynard. The main-belt asteroid was sampled 390 times over 4 nights, yielding a synodic rotation period of 3.902 ± 0.001 h. The absolute value of the peak-to-peak magnitude differential is 0.58 mag, implying an axial ratio (a/b) of 1.70. No other lightcurves for this asteroid are known to exist.

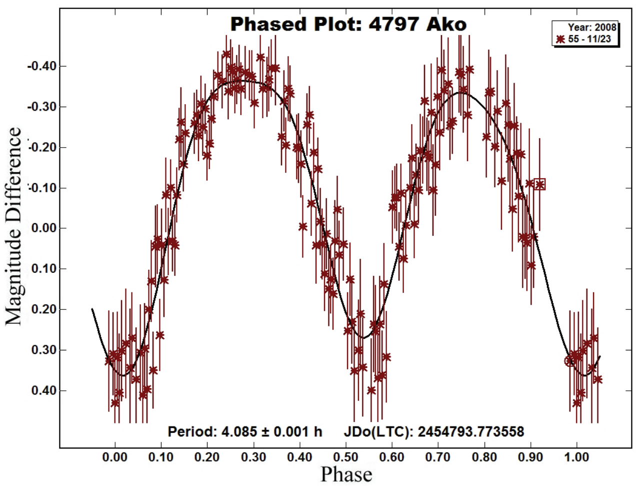
6000 United Nations. This main-belt asteroid was sampled 365 times over a 3 night period to yield a synodic rotation period of 3.262 ± 0.001 h. The absolute value of the peak-to-peak

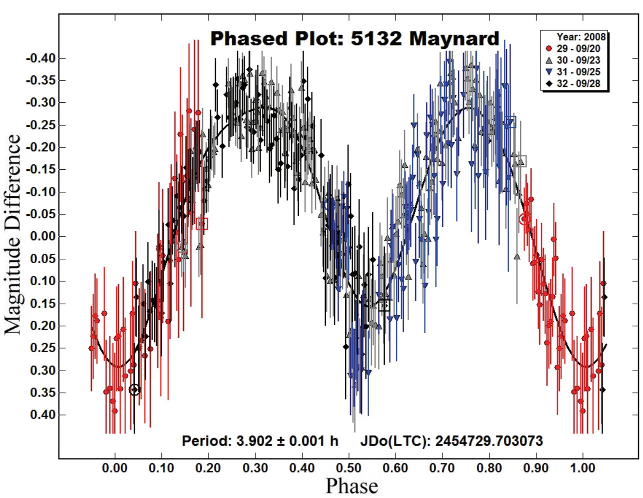
# Name	Date Range (mm/dd)	Data Pts	Phase	PAB_L	PAB_B	Per (h)	PE	Amp	AE
1160 Illyria	10/30-11/03/2007	258	6.50	33.4	10.7	4.104	0.001	0.56	0.02
4797 Ako	11/23/2008	156	10.20	76.9	2.4	4.085	0.001	0.90	0.03
5132 Maynard	09/20-28/2008	390	11.43	339.0	-0.68	3.902	0.001	0.80	0.02
6000 United Nations	11/01-04/2008	365	3.70	36.9	-5.2	3.262	0.001	0.45	0.03
(27851) 1994 VG2	11/27-12/04/2008	183	19.63	37.3	-2.5	7.733	0.002	1.00	0.05

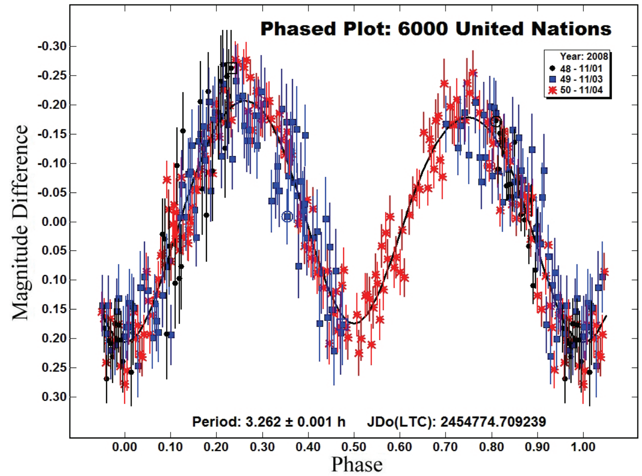
magnitude differential is 0.40 mag, implying an axial ratio (a/b) of 1.44. No other lightcurves for this asteroid are known to exist.

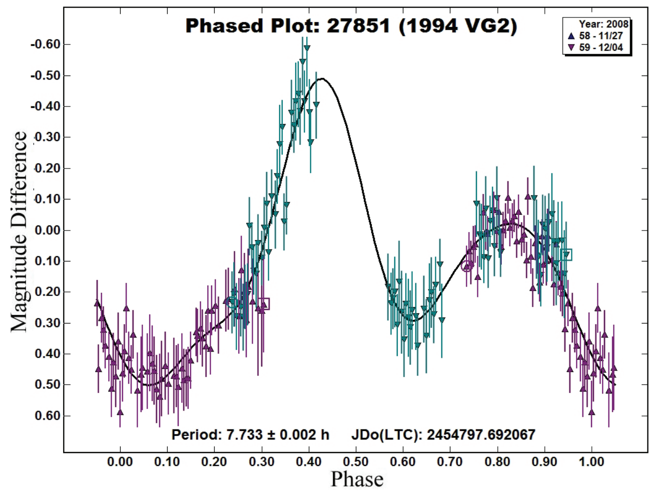
(27851) 1994 VG2. The main-belt asteroid was sampled 183 times over a 2 night period. We found a synodic rotation period of 7.733 ± 0.002 h. Due to an incomplete lightcurve the axial ratio was not computed. No other lightcurves for this asteroid are known to exist.











Acknowledgements

The students would like to thank the entire staff at Imagine Renaissance Academy (Wallace Campus) including Mrs. Debbie Jones-Fowler, Head of Schools, Mr. Geoffrey Alderman, Assistant Director, and Mr. Greg McGhee, Activities Director, for striving to provide us with a project-based learning environment second to none. Thanks also go out to Mr. Bennefeld, our physics and astronomy teacher.

References

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.

Warner, B.D. (2007a). "Collaborative Asteroid Lightcurve Link." http://www.minorplanetobserver.com/astlc/default.htm.

Warner, B.D. (2007b). MPO Software, Canopus version 9.4.0.3. Bdw Publishing, Colorado Springs, CO.

THE VERY LONG SIDEREAL PERIOD OF 1807 SLOVAKIA

Adrián Galád
Modra Observatory,
Department of Astronomy, Physics of the Earth, and Meteorology
FMFI UK, 842 48 Bratislava, SLOVAKIA
and
Astronomical Institute AS CR, 251 65 Ondřejov,
CZECH REPUBLIC
galad@fmph.uniba.sk

Leonard Kornoš
Modra Observatory,
Department of Astronomy, Physics of the Earth, and Meteorology
FMFI UK, 842 48 Bratislava, SLOVAKIA

Marek Husárik
Skalnaté Pleso Observatory,
Astronomical Institute of the Slovak Academy of Sciences
059 60 Tatranská Lomnica, SLOVAKIA

(Received: 2009 Jun 22)

A long synodic rotation period of about 308 h was found for asteroid 1807 Slovakia in its 2008/2009 apparition based on a combination of data from Modra and the Minor Planet Center (MPC). Asteroid brightness estimates found in the MPC data covering several previous apparitions not only confirmed the synodic period and large amplitude of the lightcurve of ~1.0 mag, but also led to absolute magnitude (*H*) and sidereal period determinations, those being $H = 12.6 \pm 0.1$ and $P_{sidereal} = 311.75 \pm 0.09$ h. The sense of rotation is retrograde.

Several initial photometric observations of 1807 Slovakia were obtained using a 0.6-m telescope with ST8 CCD camera at Modra in 2001 and 2003. With only relative data available at the time, we could not determine if the rotation period was long or the amplitude of the lightcurve was very small. Parts of sessions indicated that the former was more likely. Similarly, according to Behrend (2009), observations from other observers also indicated a long period.

An Apogee AP8 CCD camera was subsequently installed at Modra that provided a larger field of view, and so it became possible to link sessions of main belt asteroids observed on consecutive nights to an internal, though not necessarily standard, system. We tried again to get data for the asteroid in 2008, but the weather didn't allow getting a long streak of consecutive nights. Regardless, our new observations indicated a possible solution of ~261 h with an amplitude of ~1 mag. The lightcurve was not smooth, but slow rotators are sometimes tumblers, having two periods.

To try to supplement our data, we checked the astrometric data stored at the Minor Planet Center (MPC) to see if some of those also contained photometric observations. Generally, such data are of much lower quality and have mostly only one-digit precision. However, there was still hope since a method had been successfully tested using MPC data for another target with a long period and large amplitude (Galád, 2009). For best results, the object should be observed with a standard filter, preferably several times with the same telescope/filter combination. We were able to find some useable data and added them to our data set. This resulted in a new, preferred, solution with a slightly longer period. We also noticed that the MPC data contained brightness estimates from previous apparitions and so we tried to get more lightcurves based on the additional data. The most useful were those from U.S. Naval Observatory, Flagstaff (MPC 689), which provided V data to two digit precision. Similar long periods were found based on the MPC data from each apparition, confirming our solution of the synodic period for the asteroid.

Apparition Details

1998/1999 and 2000. All sessions (17 in each apparition) were obtained at USNO. Two sessions by Lowell Observatory (LONEOS, MPC 699) in R band in 2000 were not included since they did not significantly change the solution after they were shifted by ~ 0.5 mag.

2001. This apparition provided the largest number of observations with 31 sessions obtained by 689 alone. Only those data were used for the lightcurve analysis. Data from other stations were available, but there was no need to include them and, besides, they were of questionable use because they were in the R band, duplicated coverage, or had too large of scatter. For an asteroid the size of Slovakia (~10 km) with such a long period, tumbling (in non-principal axis rotation) is not unlikely. However, there was no clear sign of tumbling in the form of deviations from the smooth lightcurve.

2003. The lightcurve presented consists of 16 observations by 689 and 4 by 699 in R band shifted by 0.5 mag.

2004. We used only 13 observations by 689. Some observations in the R band were available from other stations but they were not used.

2005/2006. In addition to 7 sessions by 689 and 7 sessions in R

Dates yyyy mm/dd	Phases deg	LPAB deg	BPAB deg	Period [h]	Amp [mag]	H	H/G	n
1998 10/29-1999 03/10	02.0-27.4	88-105	-1 - -4	308 ± 1	0.9	12.53	12.66/0.29	3
2000 02/27-06/08	01.8-19.5	210-213	-2 - -1	307 ± 1	1.1	12.66	12.75/0.25	3
2001 08/06-12/17	05.4-30.0	5-32	1 - 4	308.6 ± 0.4	1.1	12.55	12.55/0.15	4
2003 01/13-06/23	01.8-22.8	177-189	-2 - -4	310 ± 1	1.1	12.57	12.61/0.20	2
2004 06/05-09/26	07.9-28.7	295-309	3 - 5	307 ± 2	0.8	12.48	12.41/0.10	2
2005 10/22-2006 05/26	02.4-25.6	128-158	-3 - -5	310.7 ± 0.8	1.0	12.58	12.51/0.07	2
2007 01/31-08/07	02.9-24.8	233-256	-1 - 2	307 ± 1	1.1	12.77	12.84/0.25	2
2008 07/29-2009 01/15	02.5-30.4	56-101	1 - -4	308.0 ± 0.3	1.1	12.61	12.73/0.29	4

Table I. Asteroid 1807 Slovakia with observation dates, minimum and maximum solar phase angles, phase angle bisector values, derived synodic rotation periods with uncertainties, and lightcurve amplitudes. *H* is the absolute magnitude for the slope parameter G = 0.15. Formally, the best *H* and *G* values are also mentioned for a particular Fourier order n.

band by 699 (shifted by 0.5 mag), we also used 11 sessions by 703 (LINEAR), which were in the V band and shifted by 0.3 mag.

2007. Just 4 sessions were available from 689, only one from 703 (which we shifted by 0.3 mag) and none from 699. We used 6 sessions from E12 (Siding Spring), which were in the V band and were shifted by 0.6 mag. A single data point each was used from Reedy Creek (428, V band), Lulin Observatory (D35, R band), and Purple Mountain Observatory, XuYi Station (D29, R band).

2008/2009. We obtained two sets of linked data and two sets of relative data at Modra. Added to these were two sessions from 689, which indicated for the first time the right period in the range of 306 to 311 h. Data from Steward Observatory (691) and LINEAR (703) also supported the solution.

Assuming the V band used in 689 was a standard filter, while data from other observatories were shifted to V, it was possible to derive the absolute magnitude (*H*). Table 1 shows the data from all 8 apparitions. We first used a default value for the slope parameter (*G*) of 0.15 and then tried to derive *H* and *G* values so that the RMS of the residuals was as low as possible. Despite calibrated observations that covered various solar phase angles, there was a low degree of freedom to derive *G* reliably due to lack of data and the low quality. Using the data from 689, we found $H = 12.6 \pm 0.1$, which is lower than that given by the MPC, $H = 12.1$ (assuming $G = 0.15$). Changing the value for *G* had no significant effect on the period or amplitude of the lightcurves.

Available data are too crude to derive the reliable shape of asteroid and its pole position. However, the data set is more than enough to derive the sidereal period. Using software provided by Ďurech (2009), we found $P_{sidereal} = 311.75 \pm 0.09$ h and that the asteroid is in retrograde rotation. Based on the lightcurves, the shape of the asteroid elongated and the pole position is probably not close to the plane of asteroid orbit.

Acknowledgements

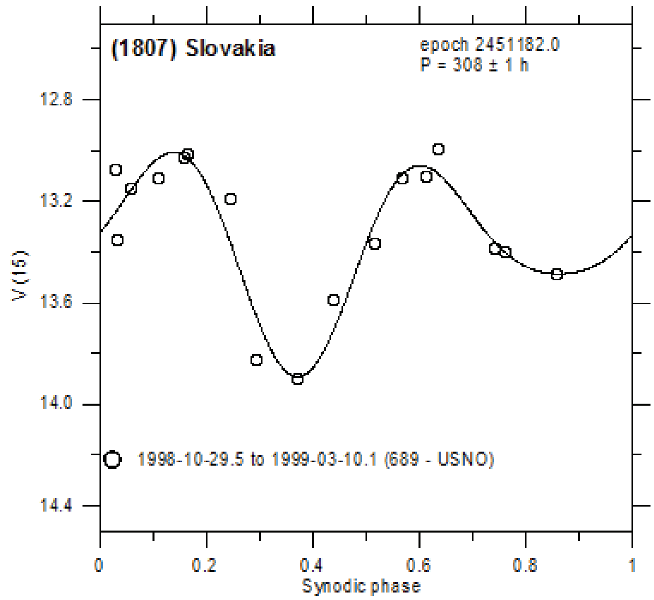
We are grateful to Petr Pravec, Ondřejov Observatory, Czech Republic, for his ALC software used in data analysis. The work was supported by the Slovak Grant Agency for Science VEGA, Grants 2/0016/09, 1/0636/09, 2/7009/27, as well as the Grant Agency of the Czech Republic, Grant 205/09/1107.

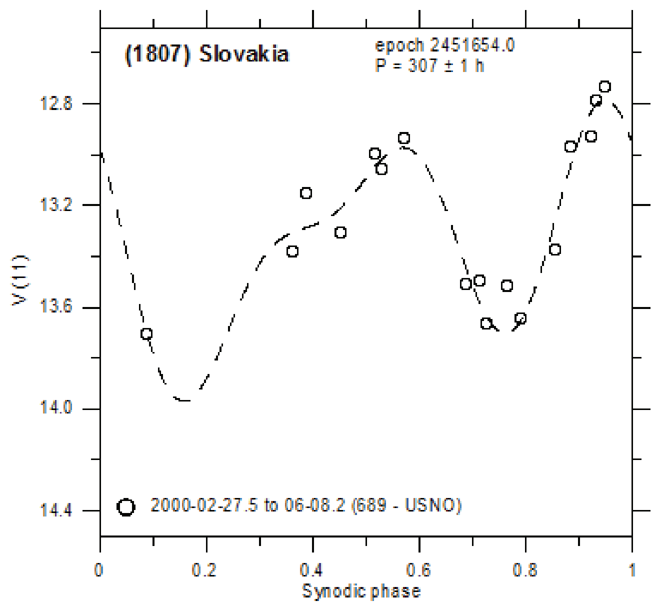
References

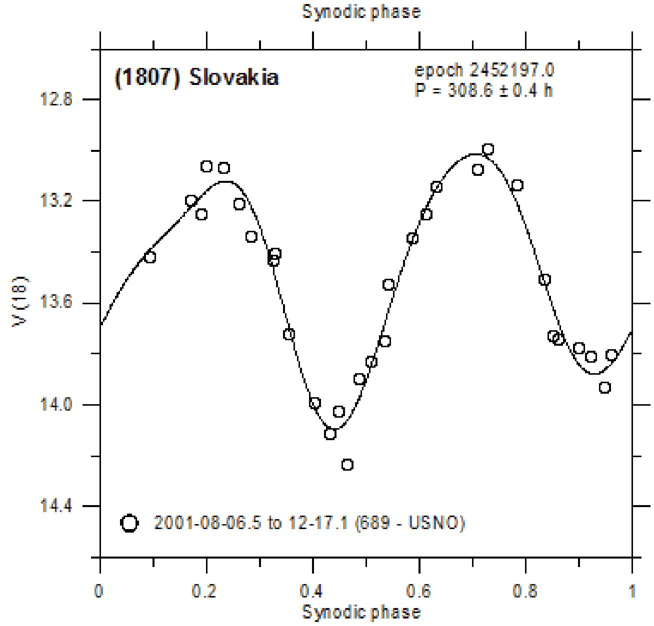
Behrend, R. (2009). "Courbes de rotation d´astéroïdes et de comètes, CdR." http://obswww.unige.ch/~behrend/page_cou.html

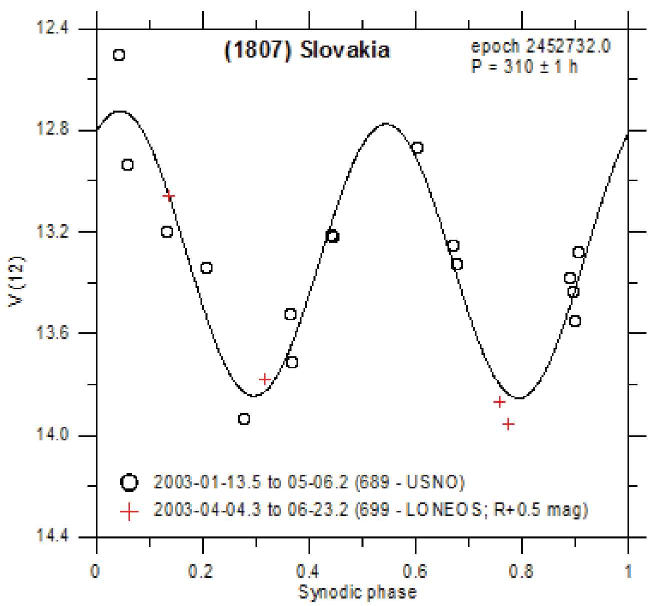
Ďurech, J. (2009). "Database of Asteroid Models from Inversion Techniques."
http://astro.troja.mff.cuni.cz/projects/asteroids3D/web.php

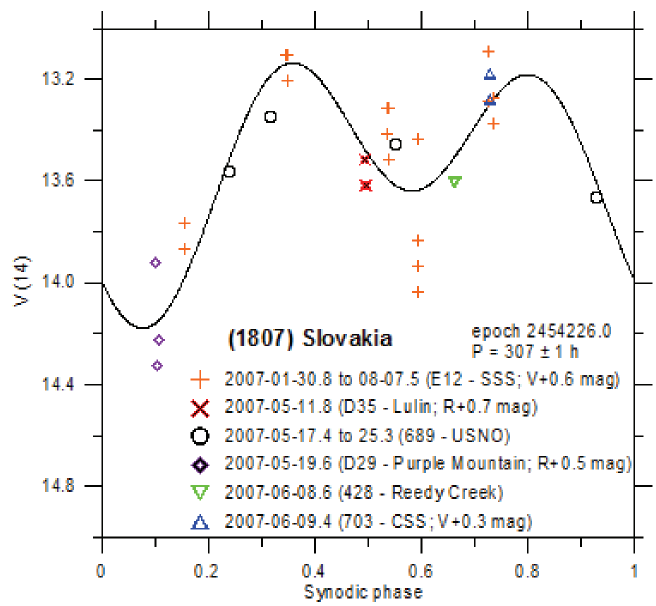
Galád, A. (2009). "Digest of ten lightcurves from Modra." *Minor Planet Bulletin* **36**, 42-44.

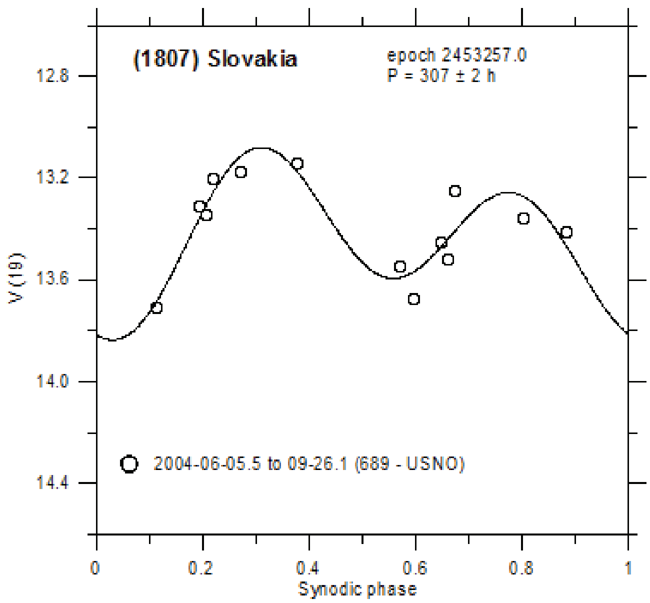


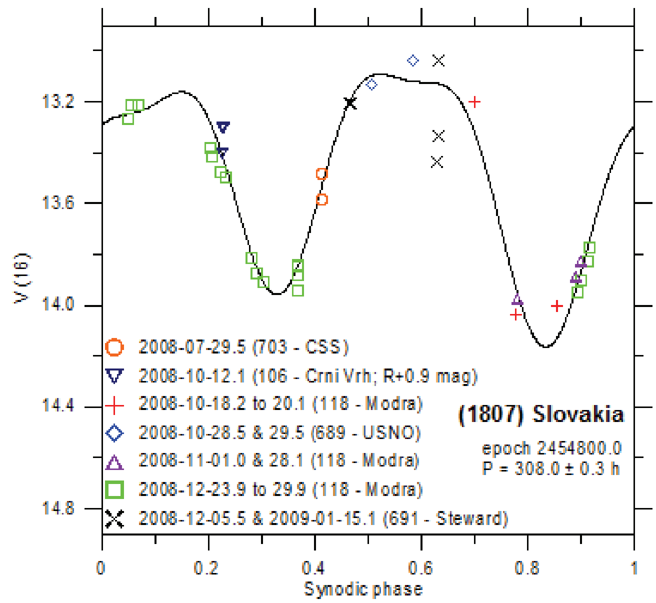


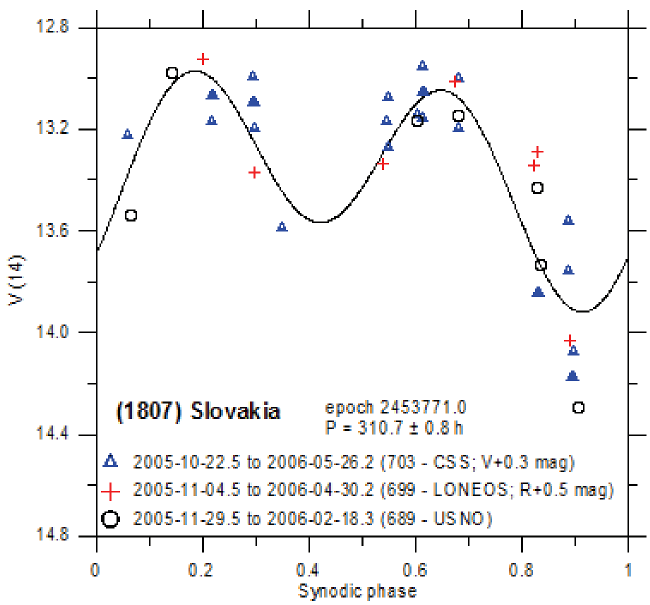


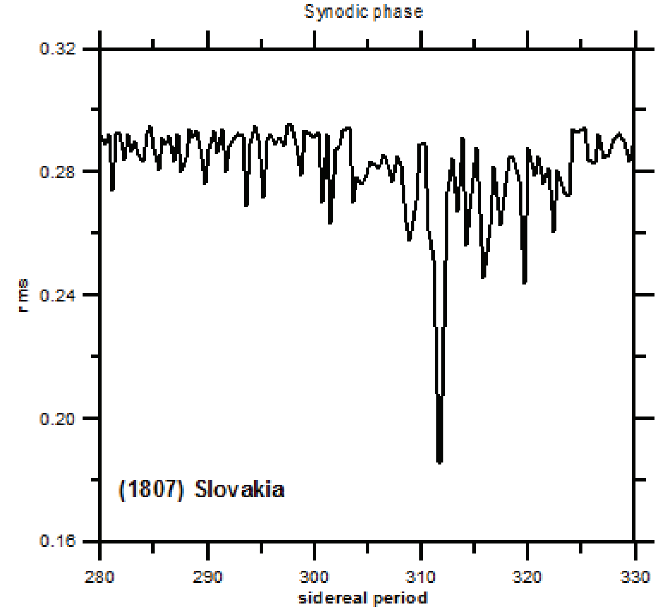

(1807) Slovakia
epoch 2452732.0
P = 310 ± 1 h
2003-01-13.5 to 05-06.2 (689 - USNO)
2003-04-04.3 to 06-23.2 (699 - LONEOS; R+0.5 mag)
V (12)
Synodic phase


(1807) Slovakia
epoch 2454226.0
P = 307 ± 1 h
2007-01-30.8 to 08-07.5 (E12 - SSS; V+0.6 mag)
2007-05-11.8 (D35 - Lulin; R+0.7 mag)
2007-05-17.4 to 25.3 (689 - USNO)
2007-05-19.6 (D29 - Purple Mountain; R+0.5 mag)
2007-06-08.6 (428 - Reedy Creek)
2007-06-09.4 (703 - CSS; V+0.3 mag)
V (14)
Synodic phase


(1807) Slovakia
epoch 2453257.0
P = 307 ± 2 h
2004-06-05.5 to 09-26.1 (689 - USNO)
V (19)
Synodic phase


2008-07-29.5 (703 - CSS)
2008-10-12.1 (106 - Crni Vrh; R+0.9 mag)
2008-10-18.2 to 20.1 (118 - Modra)
2008-10-28.5 & 29.5 (689 - USNO)
2008-11-01.0 & 28.1 (118 - Modra)
2008-12-23.9 to 29.9 (118 - Modra)
2008-12-05.5 & 2009-01-15.1 (691 - Steward)
(1807) Slovakia
epoch 2454800.0
P = 308.0 ± 0.3 h
V (16)
Synodic phase


(1807) Slovakia
epoch 2453771.0
P = 310.7 ± 0.8 h
2005-10-22.5 to 2006-05-26.2 (703 - CSS; V+0.3 mag)
2005-11-04.5 to 2006-04-30.2 (699 - LONEOS; R+0.5 mag)
2005-11-29.5 to 2006-02-18.3 (689 - USNO)
V (14)
Synodic phase


(1807) Slovakia
rms
sidereal period

ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY SOUTHERN SKY OBSERVATORY: 2008 OCTOBER THRU 2009 MARCH

Landry Carbo, Dawson Green, Katherine Kragh, Jonathan Krotz, Andrew Meiers, Bernadette Patino, Zachary Pligge, Nelson Shaffer, Richard Ditteon
Rose-Hulman Institute of Technology CM 171
5500 Wabash Ave., Terre Haute, IN 47803
ditteon@rose-hulman.edu

(Received: 2009 Jun 23)

Photometric data for 39 asteroids were collected over 37 nights of observing during 2008 October thru 2009 March at the Oakley Southern Sky Observatory. The asteroids were: 239 Adrastea, 875 Nymphe, 1051 Merope, 1167 Dubiago, 1574 Meyer, 1590 Tsiolkovskaja, 1845 Helewalda, 2294 Andronikov, 2303 Retsina, 2345 Fucik, 2666 Gramme, 2679 Kittisvaara, 3062 Wren, 3162 Nostalgia, 3259 Brownlee, 3376 Armandhammer, 3453 Dostoevsky, 3527 McCord, 3560 Chengian, 3614 Tumilty, 3713 Pieters, 4164 Shilov, 4542 Mossotti, 5133 Phillipadams, 5236 Yoko, 5619 Shair, 5875 Kruga, 6071 Sakitama, 6400 Georgealexander, 6821 Ranevskaya, 6976 Kanatsu, 7087 Lewotsky, (7569) 1989 BK, (7949) 1992 SU, 9780 Bandersnatch, (16182) 2000 AH137, 17770 Baume, 18434 Mikesandras, and (34036) 2000 OX27.

Thirty-nine asteroids were observed from the Oakley Southern Sky Observatory in New South Wales, Australia, on the nights of 2008 October 21-25, November 20, 22, 27, 29-30, December 1-3, 2009 January 24, 26-31, February 1-2, and March 4-8, 15-18, 21, 25, 27-29. From the data, we were able to find lightcurves for 32 asteroids. Out of those 32, 20 were previously unrecorded results, 10 were reasonably close to previously published periods, and 2 were inconsistent with previously published results. The 7 remaining asteroids produced no repeatable data.

Selection of asteroids was based on their sky position about one hour after sunset. Asteroids without previously published lightcurves were given higher priority than asteroids with known periods, but asteroids with uncertain periods were also selected with the hopes that we would be able to improve previous results. A 20-inch Ritchey-Chretien optical tube assembly mounted on a Paramount ME was used with a Santa Barbara Instrument Group STL-1001E CCD camera and a clear filter. The image scale was 1.2 arcseconds per pixel at f/8.4. Exposure times varied between 90 and 240 seconds. Calibration of the images was done using master twilight flats, darks, and bias frames. All calibration frames were created using *CCDSoft*. *MPO Canopus* was used to measure the processed images.

As far as we are aware, these are the first reported observations for the period of the following asteroids: 1574 Meyer, 1845 Helewalda, 2303 Retsina, 2666 Gramme, 3162 Nostalgia, 3614 Tumilty, 3713 Pieters, 4542 Mossotti, 5236 Yoko, 5619 Shair, 5875 Kruga, 6071 Sakitama, 6821 Ranevskaya, 6976 Kanatsu, (7569) 1989 BK, (7949) 1992 SU, 9780 Bandersnatch, 17770 Baume, 18434 Mikesandras, (34036) 2000 OX27. No repeatable pattern was found for the following asteroids: 1167 Dubiago, 3527 McCord, 3560 Chengian, 4164 Shilov, 6400 Georgealexander, 7087 Lewotsky, and (16182) 2000 AH137. Our data for these asteroids were too noisy for us to determine periods or we didn't have enough data, so we are reporting the magnitude variations only. Results from all of the asteroids are listed in the table below. Additional comments have been included as needed.

239 Adrastea. Our data are reasonably close to the period of 18.347 ± 0.003 h found by Uzpen (2003).

875 Nymphe. Our data are reasonably close to the period of 12.638 ± 0.0045 h found by Behrend (2009).

1051 Merope. Our data are inconsistent with the period of 32 h found by Behrend (2009).

1590 Tsiolkovskaja. Our data are consistent with the period of 6.737 ± 0.004 h found by Warner (2008).

2294 Andonikov. Our data are consistent with the period of 3.1529 ± 0.0003 h found by Polishook (2009).

2345 Fucik. Our data are reasonably close to the period of 17.12 ± 0.01 h found by Brinsfield (2008).

2679 Kittisvaara. Our data are reasonably close to the period of 10.123 h found by Brinsfield (2008).

3062 Wren. Our data are reasonably close to the period of 6.9672 ± 0.0072 h found by Behrend (2009).

3259 Brownlee. Our data are consistent with the period of 9.24 ± 0.01 h found by De Sanctis (1994).

3376 Armandhammer. Our data can be fit with the period of 7.9184 ± 0.0009 h found by Pravec (2009), but our data fit our shorter period better.

3453 Dostoevsky. Our data are inconsistent with the period of 3.20 ± 0.04 h found by Polishook (2009).

4164 Shilov. We didn't get enough data to determine a period, but our data cannot be fit to the period of 18.35 h found by Angeli (1996).

5133 Phillipadams. Our data are consistent with the period of 6.66447 ± 0.00004 h found by Behrend (2009).

Acknowledgement

Construction of the Oakley Southern Sky Observatory was funded with a grant from the Oakley Foundation and by a generous donation from Niles Noblitt. This research was partially supported by a grant from NASA administered by the American Astronomical Society.

References

Behrend, R. (2009). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html

Brinsfield, J.W. (2009). *Minor Planet Bul.* **36**, 64-66.

De Sanctis, M.C., Barucci, M.A., Angeli, C.A., Fulchignoni, M., et al. (1994). *Planet. Space Sci.* **42**, 859-864.

Gil-Hutton, R., Canada, M. (2003). *Revista Mexicana de Astronomica y Astrofisica* **39**, 69-76.

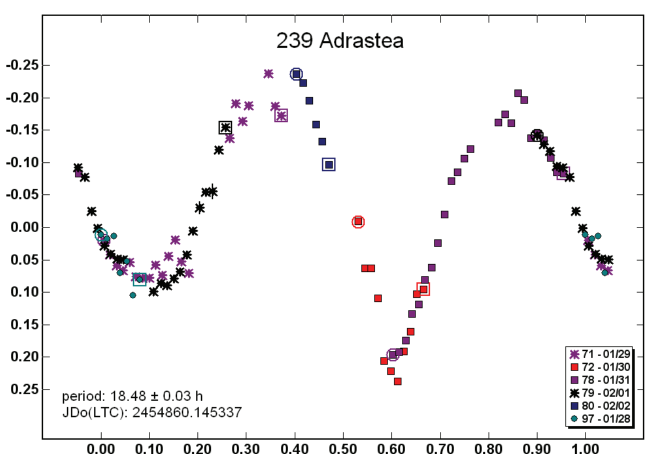
Polishook, D. (2009). *Minor Planet Bul.* **36**, 104-107.

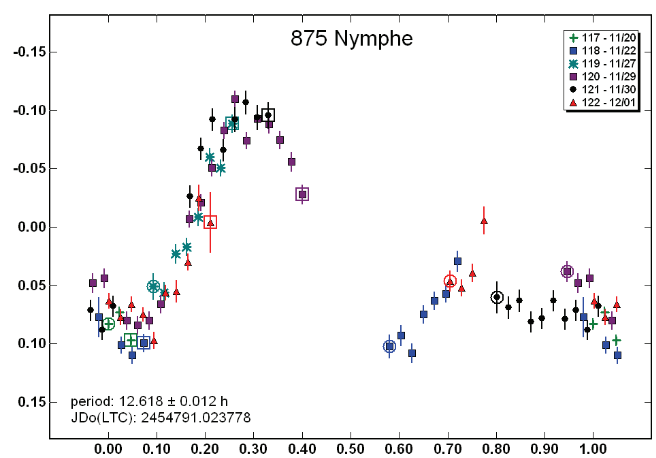
Pravec, P., Wolf, M., Sarounova, L. (2009). http://www.asu.cas.cz/~ppravec/neo.htm

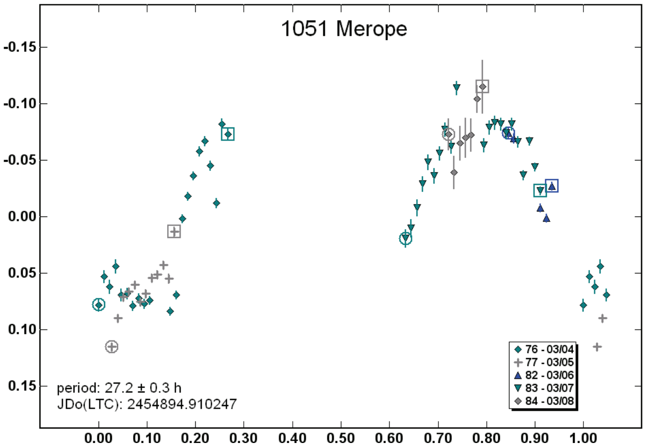
Uzpen, B., Kipp, S. (2003) Minor Planet Bul. 30, 59-61.

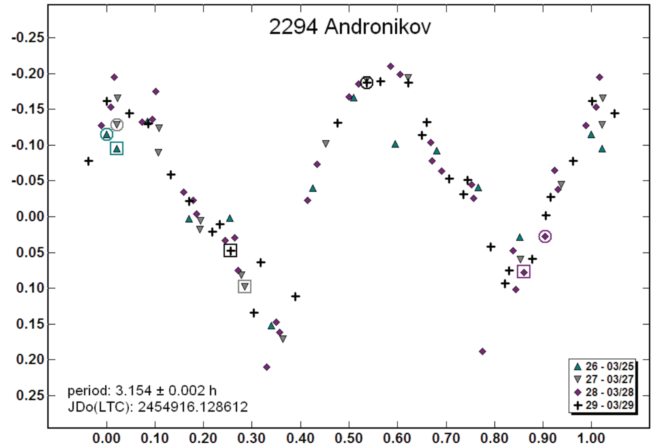
Warner, B.D. (2008) Minor Planet Bul. 35, 67-71.

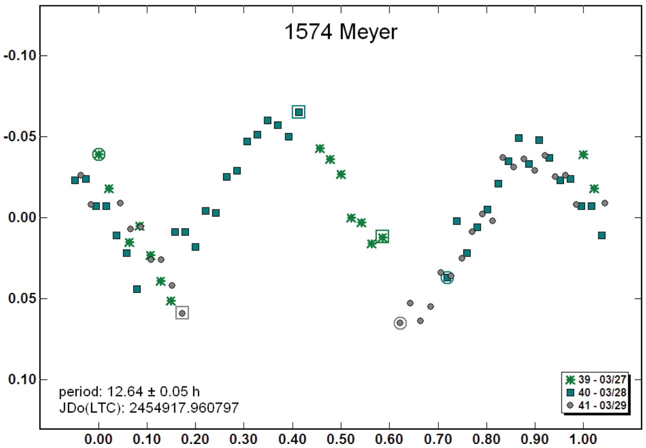
Number	Name	Dates 2008 and 2009 mm/dd	Data Points	Period (h)	P.E (h)	Amp (mag)	A.E. (mag)
239	Adrastea	1/28-2/02	93	18.48	0.03	0.45	0.05
875	Nymphe	11/20, 22, 27, 11/29-12/1	72	12.618	0.012	0.20	0.03
1051	Merope	3/4-8	66	27.2	0.3	0.20	0.04
1167	Dubiago	1/24, 26-27	45	-	-	0.26	0.01
1574	Meyer	3/27-29	70	12.64	0.05	0.12	0.02
1590	Tsiolkovskaja	3/15-18, 21	96	6.731	0.002	0.25	0.03
1845	Helewalda	11/22, 11/27, 11/29-12/1	75	7.399	0.004	0.20	0.03
2294	Andronikov	3/25, 3/27-29	86	3.154	0.002	0.35	0.05
2303	Retsina	11/20, 22, 27, 11/29-12/1	86	10.82	0.01	0.4	0.1
2345	Fucik	3/27-29	79	17.35	0.09	0.2	0.1
2666	Gramme	12/2-3	36	14.12	0.04	0.45	0.05
2679	Kittisvaara	3/15-18, 3/21	80	10.121	0.008	0.25	0.04
3062	Wren	11/22, 11/27, 11/29-30	63	7.097	0.003	0.25	0.03
3162	Nostalgia	1/28-2/2	83	6.412	0.002	0.75	0.05
3259	Brownlee	1/28-29, 1/31-2/2	90	9.25	0.02	0.40	0.05
3376	Armandhammer	1/28-2/2	95	6.82	0.02	0.03	0.02
3453	Dostoevsky	3/15-18, 3/21	84	3.16	0.01	0.10	0.03
3527	McCord	2/28-3/1, 3/4-8	82	-	-	0.10	0.03
3560	Chengian	3/15-18, 3/21	73	-	-	0.08	0.02
3614	Tumilty	3/4-7	59	26.8	0.2	0.10	0.02
3713	Pieters	10/22, 10/24-25	65	6.9	0.1	0.15	0.05
4164	Shilov	1/14-15, 1/24, 1/26-27	64	-	-	0.30	0.03
4542	Mossotti	12/2-3	40	2.947	0.007	0.15	0.02
5133	Phillipadams	12/2-3	28	6.70	0.12	0.40	0.03
5236	Yoko	12/2-3	36	2.768	0.004	0.37	0.05
5619	Shair	10/21-25	83	5.05	0.01	0.5	0.1
5875	Kruga	3/15-18, 3/21	108	5.551	0.002	0.25	0.03
6071	Sakitama	10/22, 10/24-25	76	4.437	0.013	0.10	0.02
6400	Georgealexander	10/21-25	109	-	-	0.20	0.03
6821	Ranevskaya	2/28, 3/4-8	89	2.81	0.01	0.18	0.03
6976	Kanatsu	10/22, 10/24-25	99	4.025	0.002	0.40	0.02
7087	Lewotsky	2/20-22, 2/29-3/1, 3/3-8	264	-	-	0.25	0.03
7569	1989 BK	10/22, 10/24-25	80	3.60	0.04	0.20	0.04
7949	1992 SU	1/29, 2/1	43	17.91	0.04	0.25	0.03
9780	Bandersnatch	3/15-18, 3/21	85	8.234	0.006	0.15	0.05
16182	2000 AH137	11/20, 22, 27, 11/29-12/1	81	-	-	0.10	0.03
17770	Baume	10/22, 10/24-25	64	3.26	0.01	0.20	0.05
18434	Mikesandras	1/24, 1/26-27	58	3.137	0.003	0.25	0.05
34036	2000 OX27	3/15-18, 3/21	80	14.143	0.008	0.90	0.02

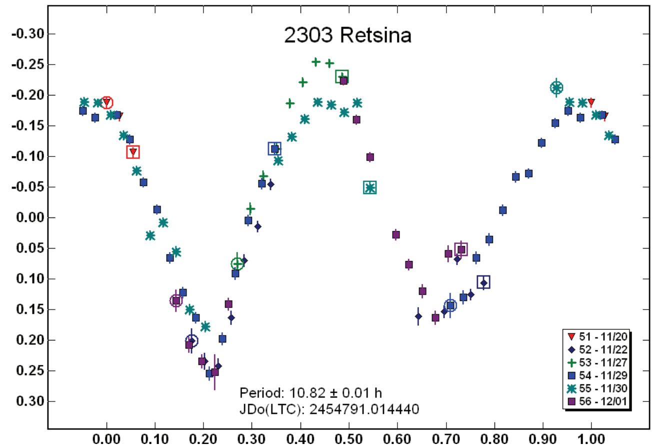


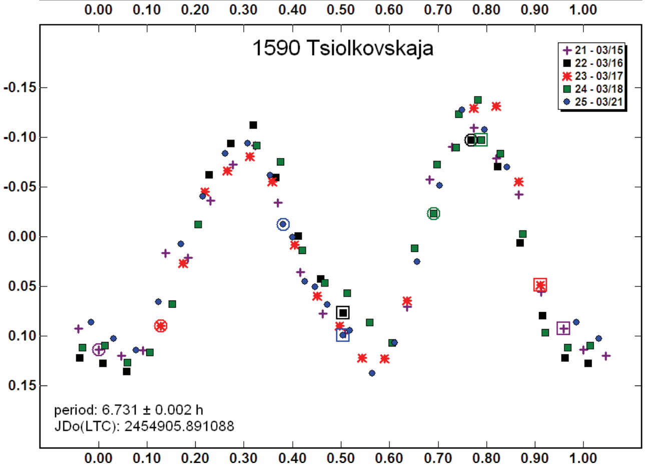


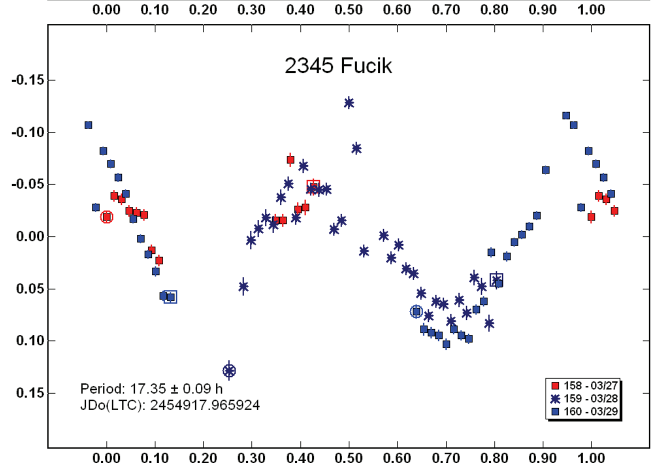

1051 Merope
period: 27.2 ± 0.3 h
JDo(LTC): 2454894.910247
76 - 03/04
77 - 03/05
82 - 03/06
83 - 03/07
84 - 03/08

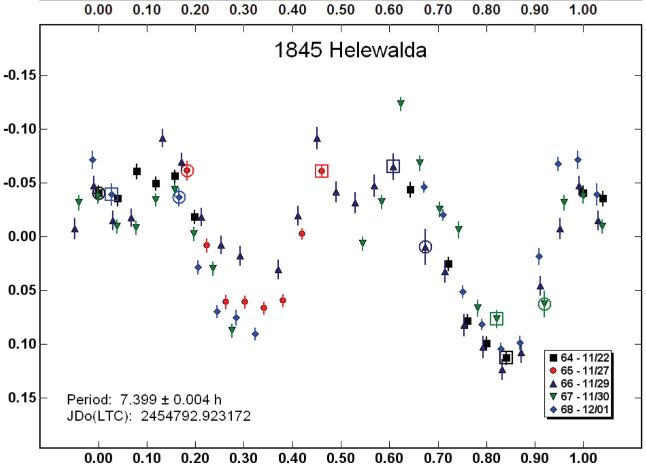

2294 Andronikov
period: 3.154 ± 0.002 h
JDo(LTC): 2454916.128612
26 - 03/25
27 - 03/27
28 - 03/28
29 - 03/29

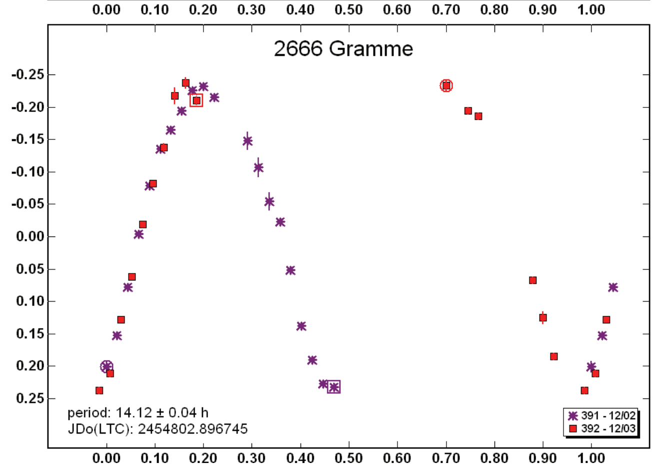

1574 Meyer
period: 12.64 ± 0.05 h
JDo(LTC): 2454917.960797
39 - 03/27
40 - 03/28
41 - 03/29

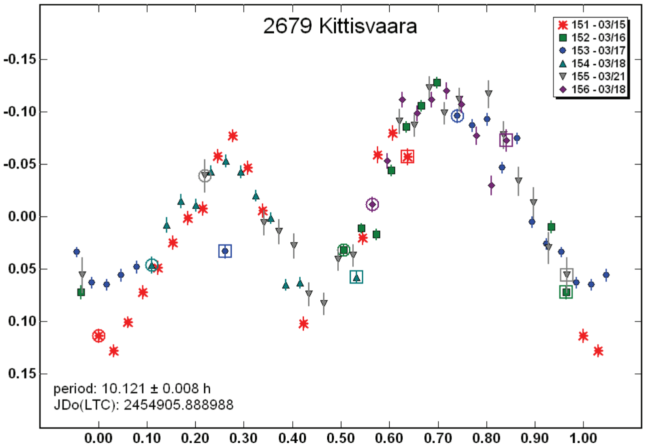

2303 Retsina
Period: 10.82 ± 0.01 h
JDo(LTC): 2454791.014440
51 - 11/20
52 - 11/22
53 - 11/27
54 - 11/29
55 - 11/30
56 - 12/01

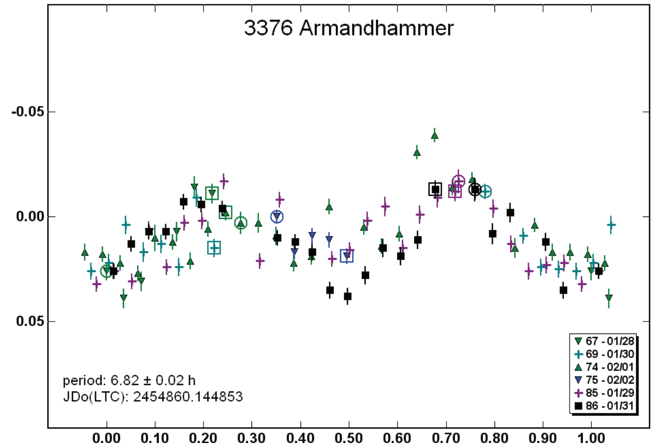

1590 Tsiolkovskaja
21 - 03/15
22 - 03/16
23 - 03/17
24 - 03/18
25 - 03/21
period: 6.731 ± 0.002 h
JDo(LTC): 2454905.891088

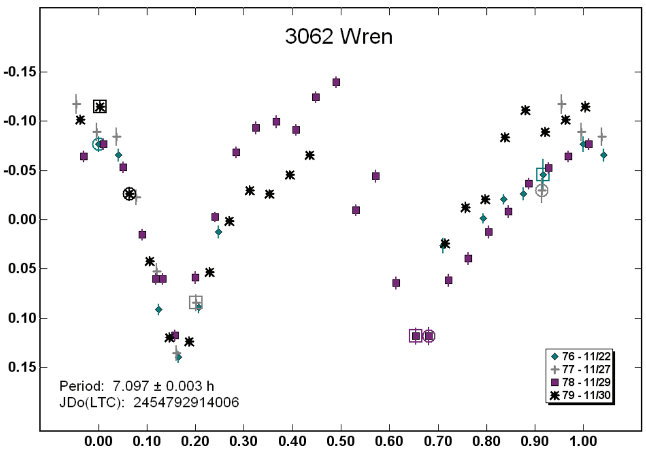

2345 Fucik
Period: 17.35 ± 0.09 h
JDo(LTC): 2454917.965924
158 - 03/27
159 - 03/28
160 - 03/29

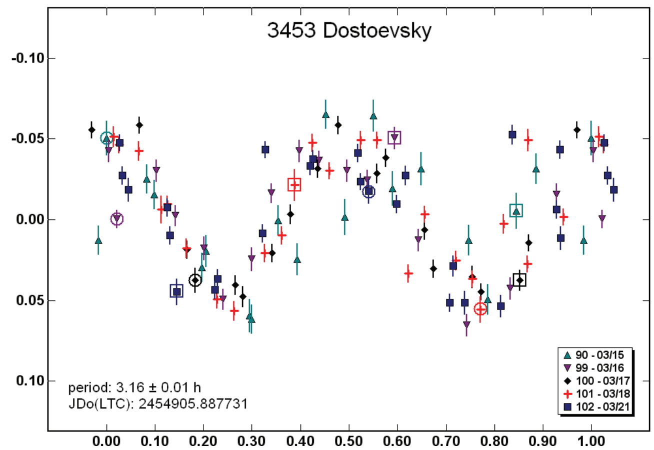

1845 Helewalda
Period: 7.399 ± 0.004 h
JDo(LTC): 2454792.923172
64 - 11/22
65 - 11/27
66 - 11/29
67 - 11/30
68 - 12/01

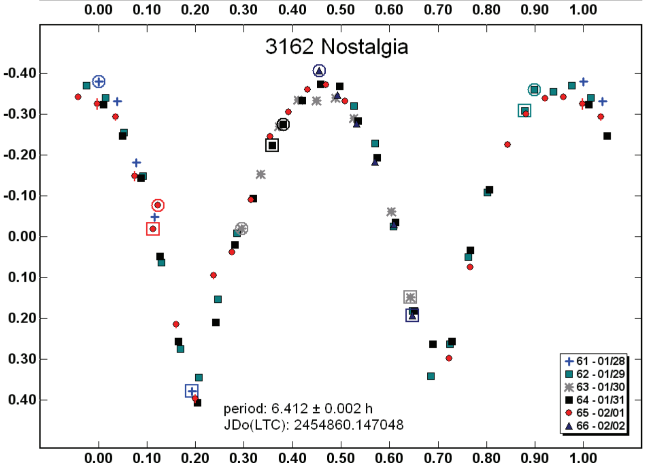

2666 Gramme
period: 14.12 ± 0.04 h
JDo(LTC): 2454802.896745
391 - 12/02
392 - 12/03

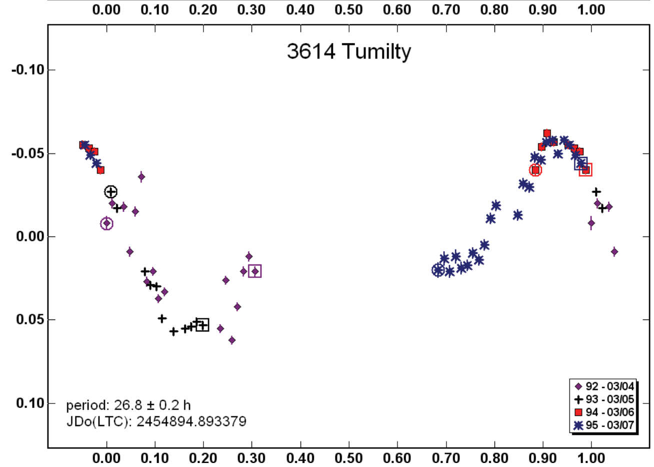

2679 Kittisvaara
151 - 03/15
152 - 03/16
153 - 03/17
154 - 03/18
155 - 03/21
156 - 03/18
period: 10.121 ± 0.008 h
JDo(LTC): 2454905.888988

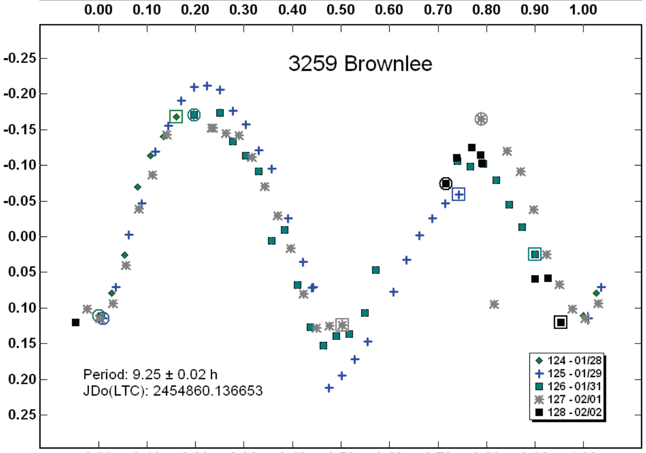

3376 Armandhammer
67 - 01/28
69 - 01/30
74 - 02/01
75 - 02/02
85 - 01/29
86 - 01/31
period: 6.82 ± 0.02 h
JDo(LTC): 2454860.144853

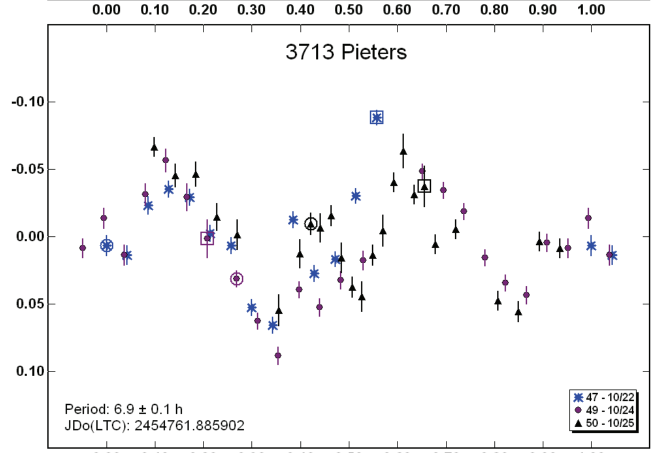

3062 Wren
76 - 11/22
77 - 11/27
78 - 11/29
79 - 11/30
Period: 7.097 ± 0.003 h
JDo(LTC): 2454792914006

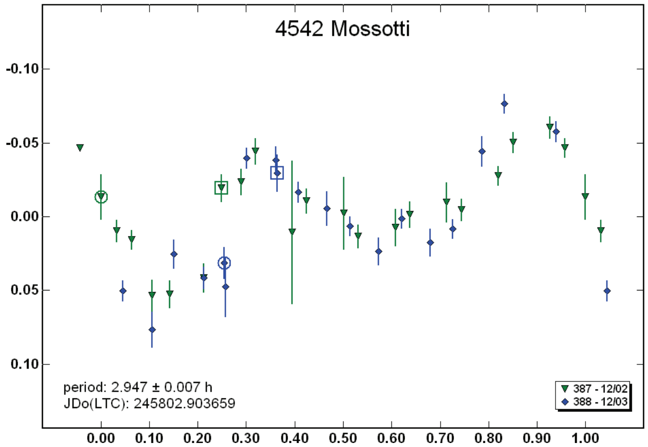

3453 Dostoevsky
90 - 03/15
99 - 03/16
100 - 03/17
101 - 03/18
102 - 03/21
period: 3.16 ± 0.01 h
JDo(LTC): 2454905.887731

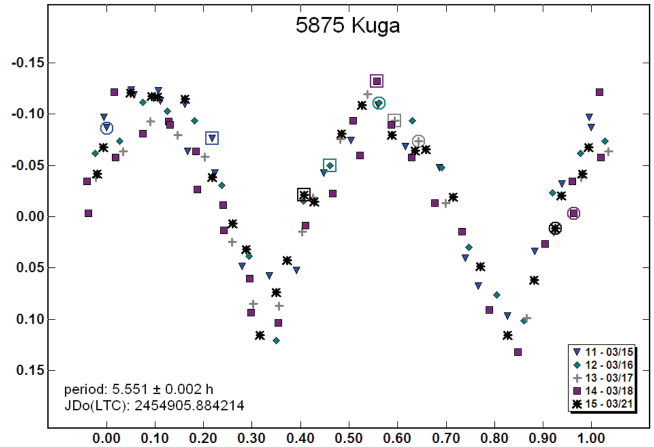

3162 Nostalgia
61 - 01/28
62 - 01/29
63 - 01/30
64 - 01/31
65 - 02/01
66 - 02/02
period: 6.412 ± 0.002 h
JDo(LTC): 2454860.147048

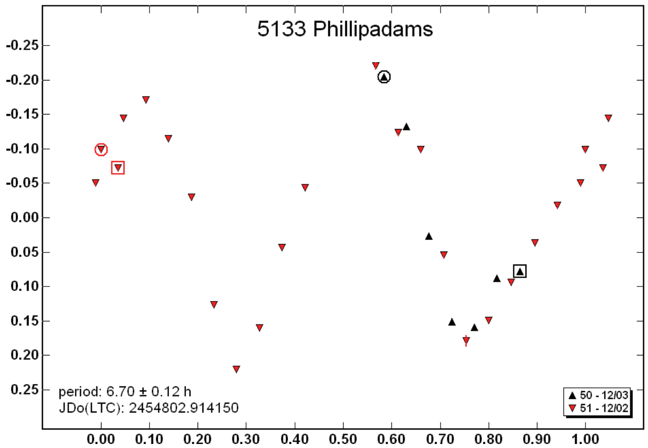

3614 Tumilty
92 - 03/04
93 - 03/05
94 - 03/06
95 - 03/07
period: 26.8 ± 0.2 h
JDo(LTC): 2454894.893379

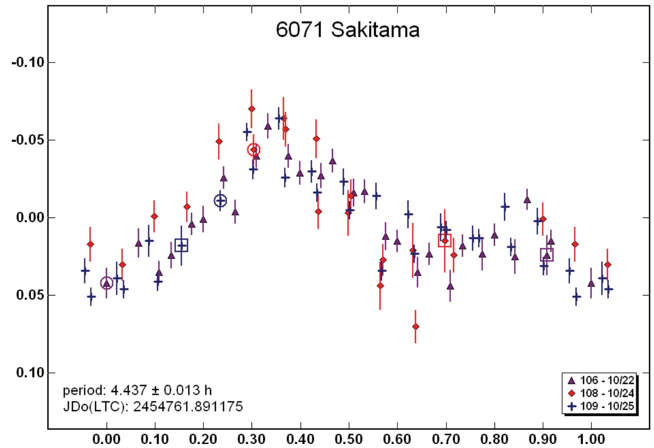

3259 Brownlee
124 - 01/28
125 - 01/29
126 - 01/31
127 - 02/01
128 - 02/02
Period: 9.25 ± 0.02 h
JDo(LTC): 2454860.136653

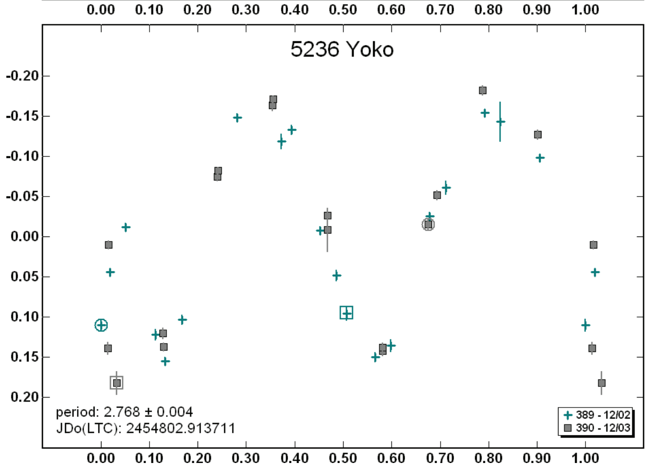

3713 Pieters
47 - 10/22
49 - 10/24
50 - 10/25
Period: 6.9 ± 0.1 h
JDo(LTC): 2454761.885902

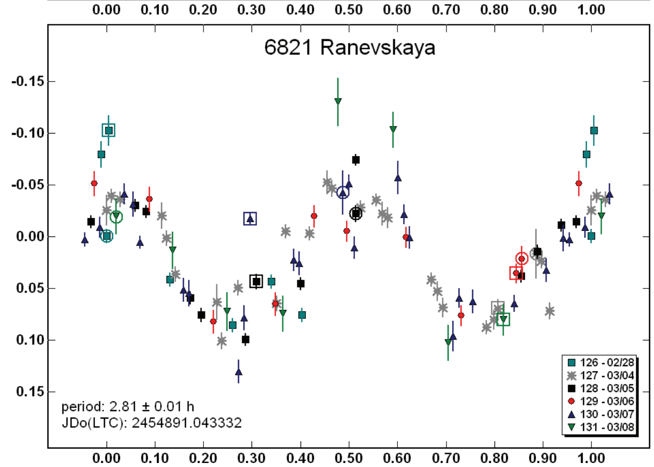

4542 Mossotti
period: 2.947 ± 0.007 h
JDo(LTC): 245802.903659
387 - 12/02
388 - 12/03

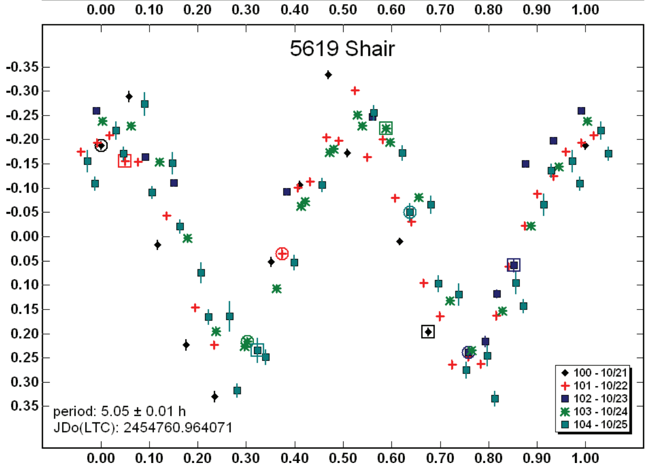

5875 Kuga
period: 5.551 ± 0.002 h
JDo(LTC): 2454905.884214
11 - 03/15
12 - 03/16
13 - 03/17
14 - 03/18
15 - 03/21

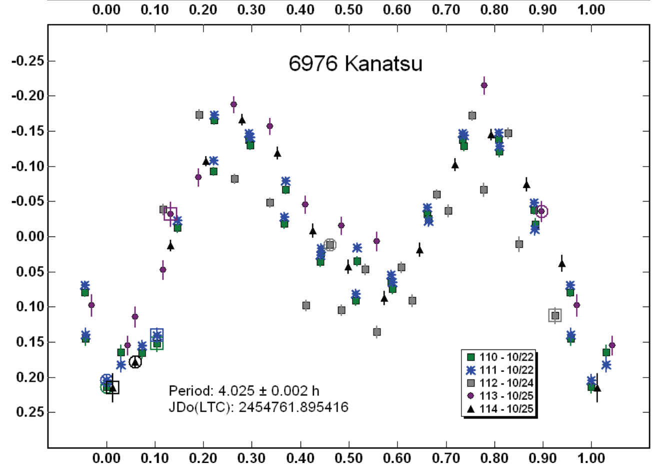

5133 Phillipadams
period: 6.70 ± 0.12 h
JDo(LTC): 2454802.914150
50 - 12/03
51 - 12/02

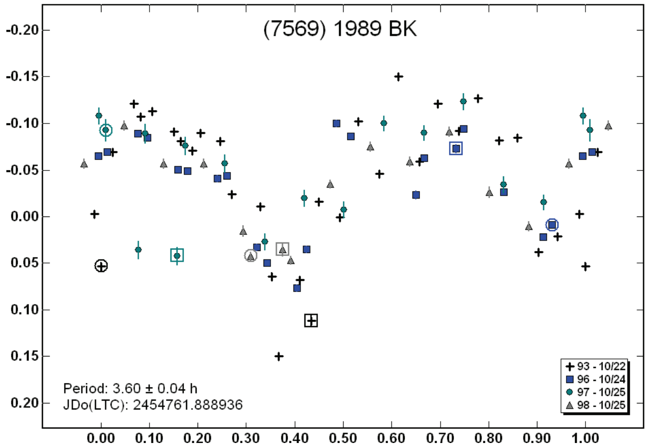

6071 Sakitama
period: 4.437 ± 0.013 h
JDo(LTC): 2454761.891175
106 - 10/22
108 - 10/24
109 - 10/25

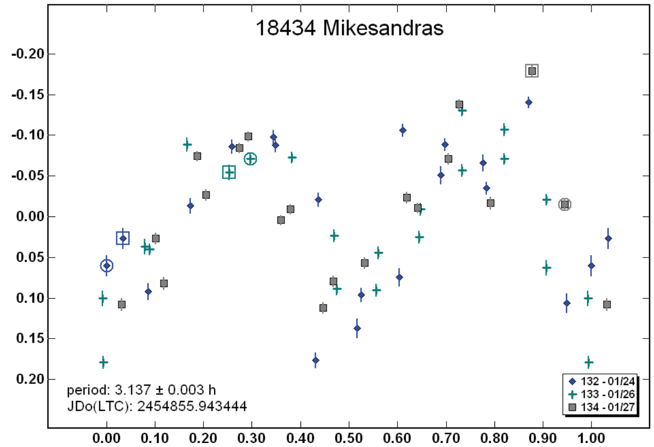

5236 Yoko
period: 2.768 ± 0.004
JDo(LTC): 2454802.913711
389 - 12/02
390 - 12/03

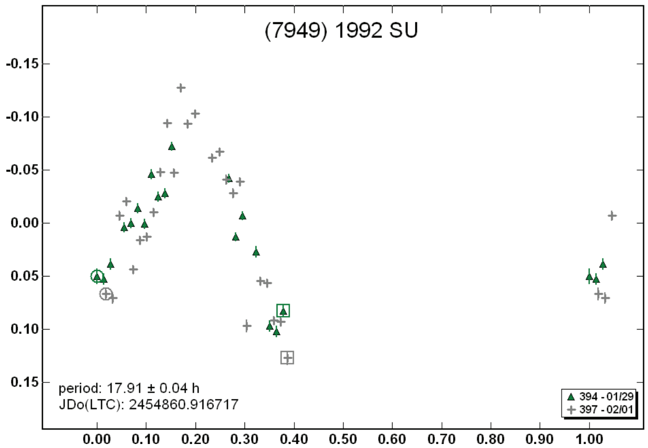

6821 Ranevskaya
period: 2.81 ± 0.01 h
JDo(LTC): 2454891.043332
126 - 02/28
127 - 03/04
128 - 03/05
129 - 03/06
130 - 03/07
131 - 03/08

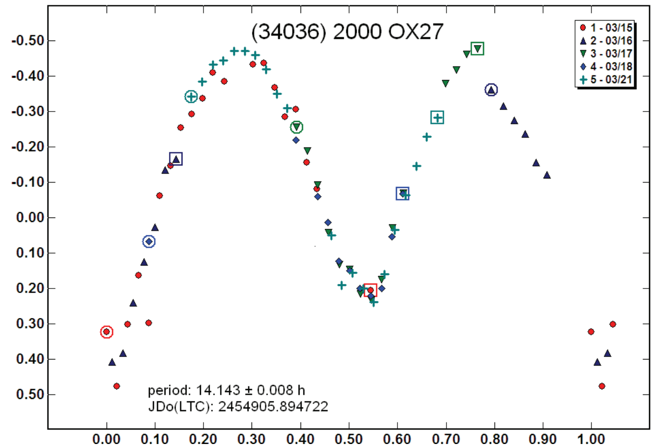

5619 Shair
period: 5.05 ± 0.01 h
JDo(LTC): 2454760.964071
100 - 10/21
101 - 10/22
102 - 10/23
103 - 10/24
104 - 10/25

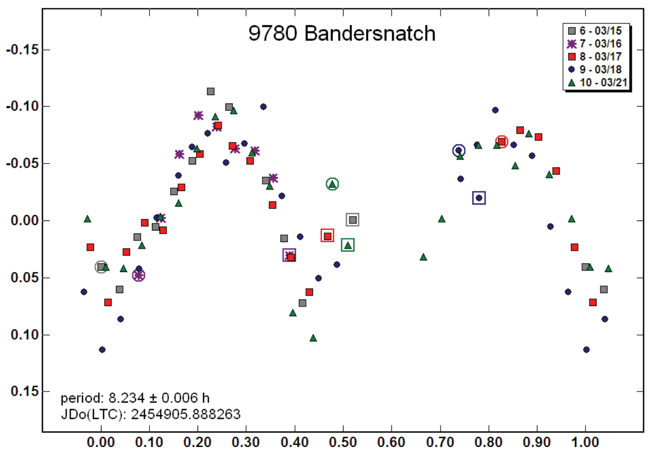

6976 Kanatsu
Period: 4.025 ± 0.002 h
JDo(LTC): 2454761.895416
110 - 10/22
111 - 10/22
112 - 10/24
113 - 10/25
114 - 10/25

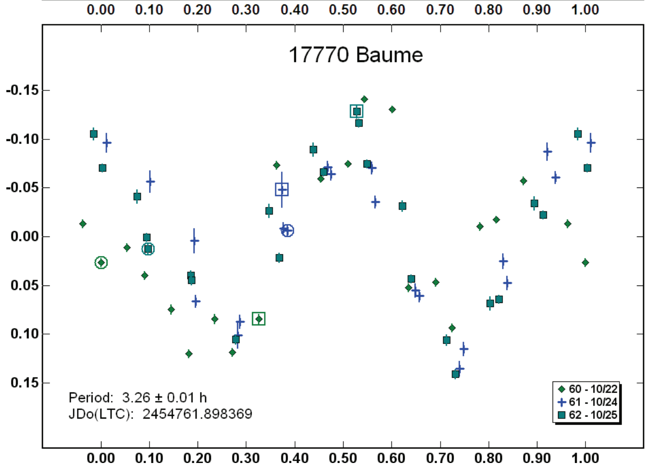












ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES – APRIL TO MAY 2009

Robert D. Stephens
Goat Mountain Astronomical Research Station (GMARS)
11355 Mount Johnson Court, Rancho Cucamonga, CA 91737
RStephens@foxandstephens.com

(Received: 2009 Jun 24)

Lightcurve period and amplitude results from Santana and GMARS Observatories for 2009 April to May are reported: 362 Havnia, 16.92 ± 0.01 h, 0.40 mag; 470 Kila, 290 ± 5 h, 0.26 mag; (93768) 2000 WN22, 2.6814 ± 0.0001 h, 0.30 mag.

The author operates telescopes at two observatories. Santana Observatory (MPC 646) is located in Rancho Cucamonga, CA, and GMARS (Goat Mountain Astronomical Research Station, MPC G79) is located at the Riverside Astronomical Society's observing site in Landers, CA. Details of the equipment are in Stephens (2006). All of the targets were chosen from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link website (CALL; Warner et al., 2009). Images were measured 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 (1989).

362 Havnia. All images were acquired using the 0.30-m Schmidt-Cassegrain (SCT) at Santana Observatory with an SBIG STL-1001 CCD camera. Harris and Young (1980) observed Havnia on three nights in 1978 December under poor photometric conditions and reported a period of 18 ± 0.1 h. The period of 16.92 ± 0.01 h found here differs significantly from that previous result.

470 Kilia. Behrend (2009) analyzed observations from 2009 March and reported a period of 2.496 h and amplitude of ~0.02 mag. However, the scatter of within the data set was far greater than the reported amplitude for the partial lightcurve. The data obtained by the author were linked to an internal standard using a method developed by Warner (2007) and described by Stephens (2008) that is included in the latest release of *Canopus*. The asteroid displayed some evidence of non-principal axis of rotation. However, the scatter in the nightly calibrations is at the limit of accuracy of the internal standards (~0.05 mag.) and so it was not possible to find a definitive secondary period. Images on April 22, 25, 25 and May 16 and 17 were acquired using the 0.35-m SCT at GMARS with an SBIG STL-1001 CCD camera. All other images were acquired using the 0.30-m SCT at Santana Observatory.

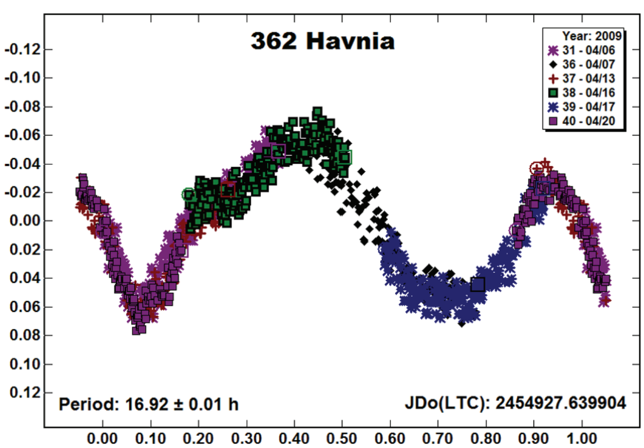
(93768) 2000 WN22. All images were acquired using the 0.35-m SCT at GMARS.

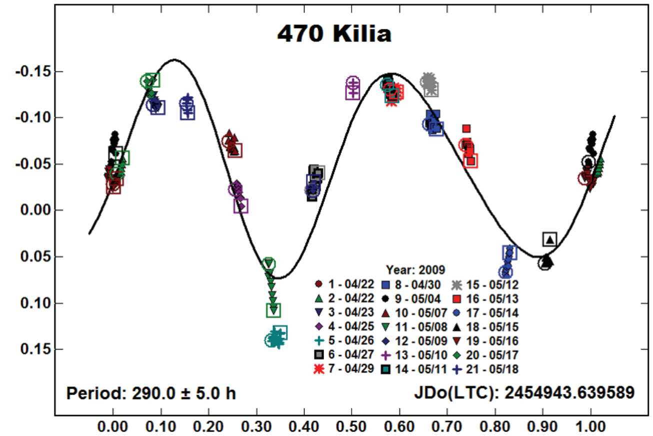
Acknowledgements

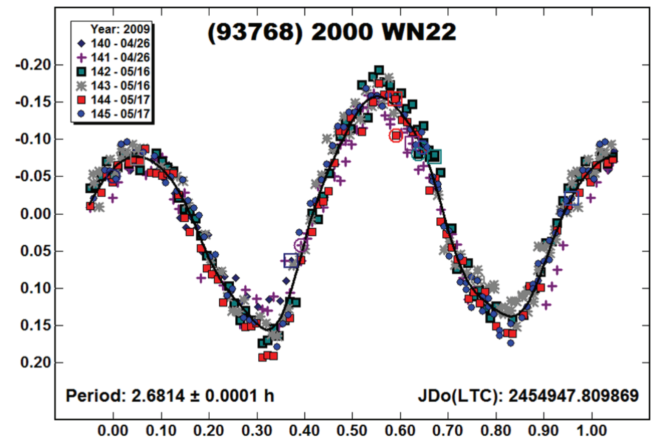
Thanks are given to Dr. Alan Harris of the Space Science Institute, Boulder, CO, and Dr. Petr Pravec of the Astronomical Institute, Czech Republic, for their ongoing support of amateur asteroid research. Also, thanks to Brian Warner for his continuing work and enhancements to the software program *MPO Canopus* which makes it possible for amateur astronomers to analyze and collaborate on asteroid rotational period projects and for maintaining the CALL Web site which helps coordinate collaborative projects between amateur astronomers.

	362 Havnia	470 Kila	(93768) 2000 WN22
Dates	04/06-04/20	04/22-05/18	04/26-05/17
Data Pts	1,203	2,043	430
Phase ang	5.3, 11.0	14.7, 23.4	16.4, 15.4
Avg L_{PAB}	185	187	220
Avg B_{PAB}	3	4	15
Per (h)	16.92	290	2.6814
PE (h)	0.01	5	0.0001
Amp (mag)	0.11	0.26	0.30
AE (mag)	0.03	0.05	0.02

Table I. Observing circumstances. Dates are in 2009.







References

Behrend, R. (2009) Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

Harris, A.W. and Young, J.W. (1980). "Asteroid rotation: III. 1978 Observations." *Icarus* **43**, 20-32.

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.

Stephens, R.D. (2006). "Asteroid Lightcurve Photometry From Santana and GMARS Observatories – September to December 2006." *Minor Planet Bulletin* **34**, 31-32.

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

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

Waner, B.D., Harris, A.W., Pravec, P. (2009) "Asteroid Lightcurve Parameters." *http://www.MinorPlanetObserver.com/astlc/default.htm.*

LIGHTCURVE ANALYSIS AT HUNTERS HILL OBSERVATORY AND COLLABORATING STATIONS – AUTUMN 2009

David Higgins
Hunters Hill Observatory
7 Mawalan Street
Ngunnawal ACT 2913 AUSTRALIA
higginsdj@bigpond.com

Brian D. Warner
Palmer Divide Observatory
Colorado Springs, CO USA

(Received: 2009 May 27)

Lightcurves for seven asteroids were obtained at Hunters Hill Observatory and collaborating stations and then analyzed to determine their synodic period and amplitude. We report on 54 Alexandra, 1622 Chacornac, 1676 Kariba, 4171 Carrasco, (5604) 1992 FE, (5752) 1992 CJ, and (8359) 1989 WD.

Hunters Hill Observatory (HH) is equipped with a 0.36m Schmidt-Cassegrain (SCT) fitted with a Meade f/3.3 focal reducer and an SBIG ST-8E CCD producing a final focal ratio of f/4. The guide scope utilizes a 0.1m SCT fitted with a Meade f/6.3 focal reducer and a Starlight Xpress MX716 CCD. The targets were observed at 1x1 binning, producing a pixel scale of 1.32 arcsec/pixel. The camera was operated with fixed temperatures between –10°C and –15°C. All observations were made with a clear filter with guided exposures ranging from 60 to 180 seconds. *MaxIm DL/CCD*, controlled by DC3 Dreams *ACP5* was used for automated telescope and camera control and image acquisition whilst calibration and image measurement were undertaken by *MPO Canopus* v9. Palmer Divide Observatory (PD) is equipped as described in Warner (2009).

54 Alexandra was observed in support of shape modeling. The synodic period of 7.0227 ± 0.0005 h agrees well with those previously listed in Warner et al. (2009).

1676 Kariba was observed and the data analyzed by Pravec (2009) and at Hunters Hill. Pravec obtained a period of 3.1673 h while Higgins obtained a period of 3.1682 ± 0.0003 h.

(5752) 1992 CJ was observed during the BINAST survey (Pravec 2009). Data taken by Higgins revealed a period of 42.83 h for a monomodal period or 85.6 h for a more typical bimodal period.

(8359) 1989 WD was observed by Hamanowa (2009) who derived a period of 3.0750 h. Higgins could not fit the 2009 apparition data to this period and instead derived a period of 2.89111 ± 0.00009 h. The period spectrum below covers both periods.

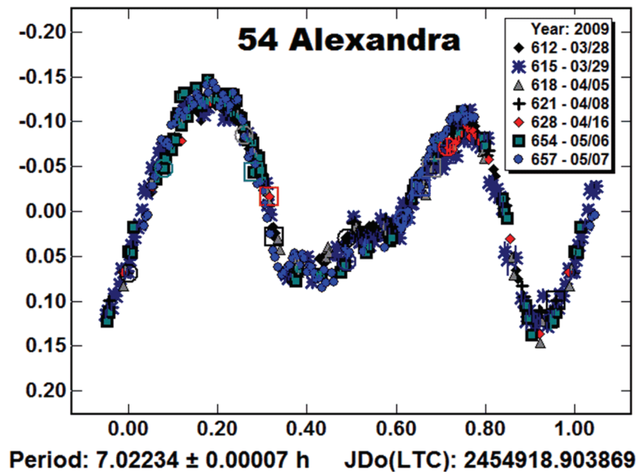
References

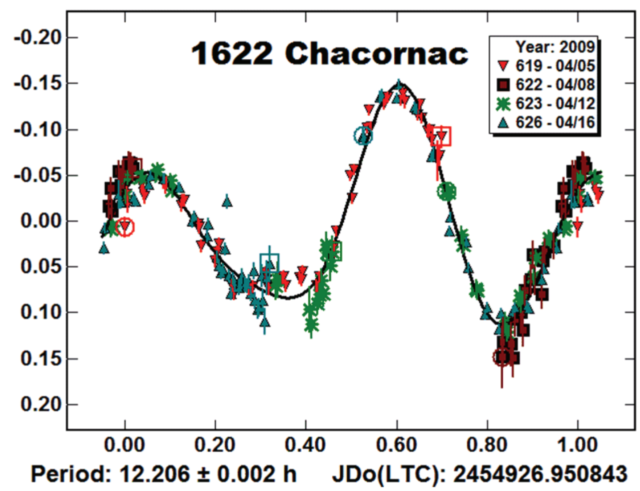
Hamanowa, H.; Hamanowa, H. (2009). http://www2.ocn.ne.jp/~hamaten/astlcdata.htm

Pravec, P. (2009). "Photometric Survey for Binary Asteroids." http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm

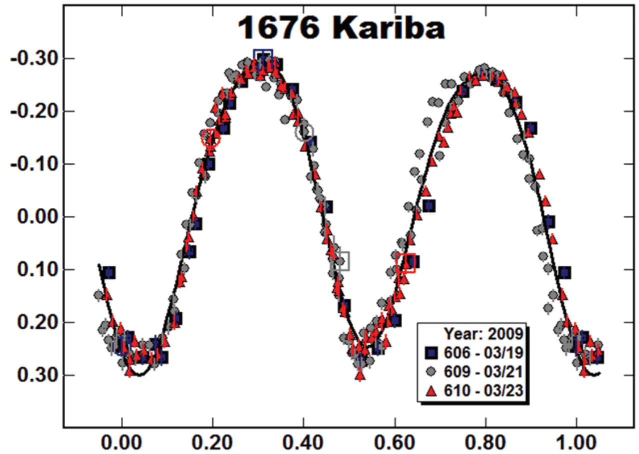
Warner, B.D. (2009). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2008 September-December", *Minor Planet Bul.* **35**, 70-72.

Warner, B.D., Harris, A.W., and Pravec, P. (2009). "Lightcurve Parameter List." http://www.minorplanetobserver.com/astlc/LightcurveParameters.htm

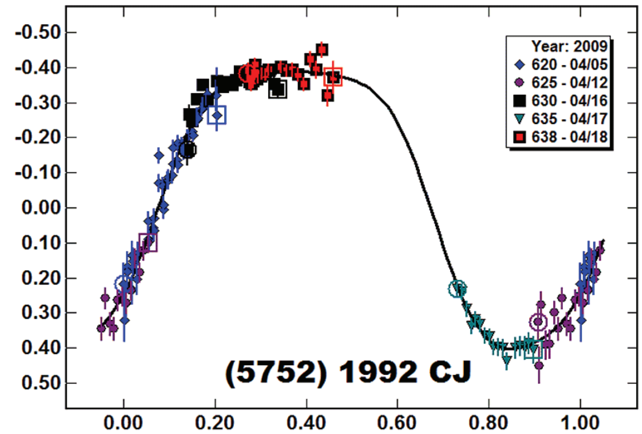




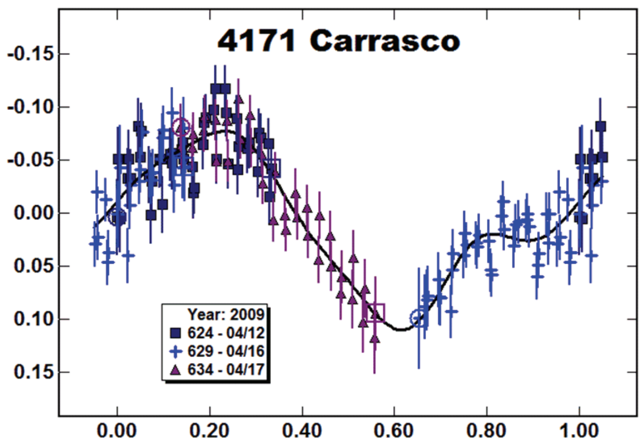
#	Name	Dates (2009) mm/dd	Per(h)	PE	A (mag)	AE	Obs
54	Alexandra	03/28-04/06	7.0227	0.0005	0.28	0.02	HH
1622	Chacornac	04/05-04/16	12.206	0.002	0.25	0.02	HH
1676	Kariba	03/19-03/23	3.1682	0.0003	0.60	0.02	HH
4171	Carrasco	04/12-04/17	16.90	0.03	0.17	0.03	HH
5604	1992 FE	03/18-04/21	5.3375	0.0003	0.15	0.03	HH, PD
5752	1992 CJ	04/05-04/18	85.6	0.08	0.80	0.02	HH
8359	1989 WD	04/18-04/30	2.89111	0.00009	0.61	0.03	HH



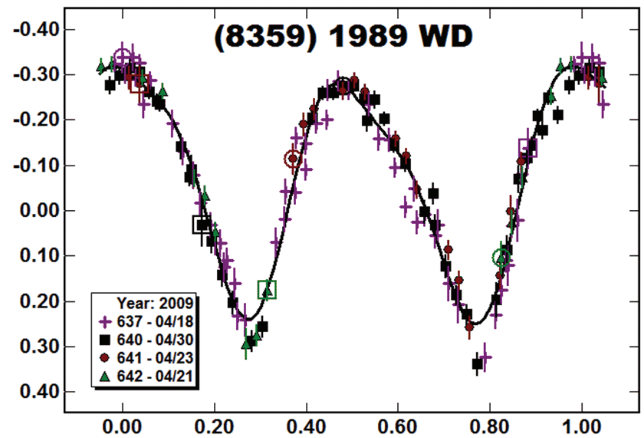
Period: 3.1682 ± 0.0003 h JDo(LTC): 2454909.988818



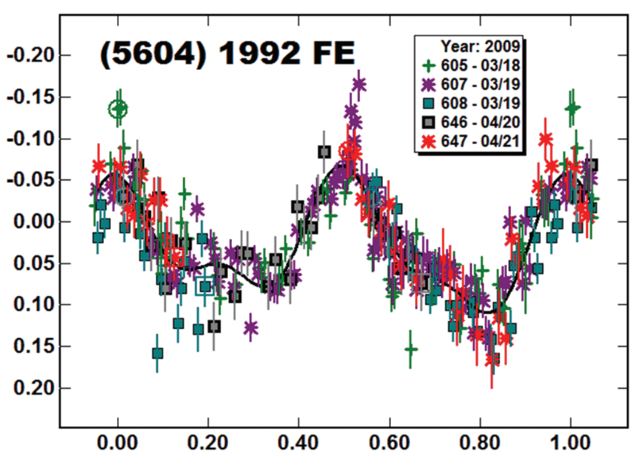
Period: 42.83 ± 0.04 h JDo(LTC): 2454926.910154



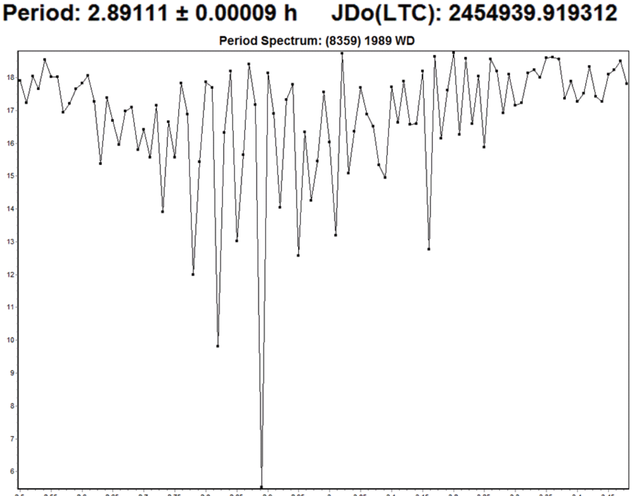
Period: 16.90 ± 0.03 h JDo(LTC): 2454933.899895



Period: 2.89111 ± 0.00009 h JDo(LTC): 2454939.919312



Period: 5.3375 ± 0.0003 h JDo(LTC): 2454908.918302



PHOTOMETRIC OBSERVATIONS OF 169 ZELIA

Robert D. Stephens
Goat Mountain Astronomical Research Station (GMARS)
11355 Mount Johnson Court, Rancho Cucamonga, CA 91737
RStephens@foxandstephens.com

Frederick Pilcher
4438 Organ Mesa Loop, Las Cruces, NM 88011

(Received: 2009 Jun 27)

We report lightcurve parameters for 169 Zelia of P = 14.537 ± 0.001 h and A = 0.14 ± 0.03 mag.

We independently starting observing 169 Zelia in 2009 March but, upon learning of each other's efforts, decided to combine our data into a single set of observations. Stephens obtained observations at Santana Observatory (MPC 646) with a 0.30-m Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD camera as well as at GMARS (Goat Mountain Astronomical Research Station, MPC G79) with a 0.35-m SCT and STL-1001E. Pilcher obtained observations at Organ Mesa Observatory using a 0.35-m Schmidt-Cassegrain (SCT) and STL-1001E. Pilcher's observations were obtained on March 16, 18, 23 and April 5. All others were obtained by Stephens.

All images were unguided and unbinned with no filter. 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 (1989). Both observers selected 169 Zelia from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link website (CALL; Warner et al., 2009). Between 2009 March 16 and April 5, 1761 data points were obtained during which time the phase angle decreased from 11.4° to 2.9°. The L_{PAB} averaged 200° while the B_{PAB} was –3°.

169 Zelia was observed by Harris et al. (1992) on 1981 September 21 and 25. Their partial lightcurve suggested a period exceeding 16 h. Love (1997) observed the asteroid on four nights between 1995 July 22-28. His data fit possible periods of 13.27 or 16.2 h, the shorter period being preferred. Our observations support periods of 14.537 and 21.805 h. The 21.805 h period is a trimodal curve. We prefer the fit of the 14.537 h period which produces a bimodal curve with repeating features at 0.15, 0.55, and 0.95 phase. We also prefer the bimodal fit because the Love bimodal fit was at a somewhat different longitude of L_{PAB} = 270° and B_{PAB} = –7°.

Acknowledgements

Thanks are given to Brian Warner for his continuing work on the software program *MPO Canopus* and for maintaining the CALL Web site which helps coordinate collaborative projects between amateur astronomers.

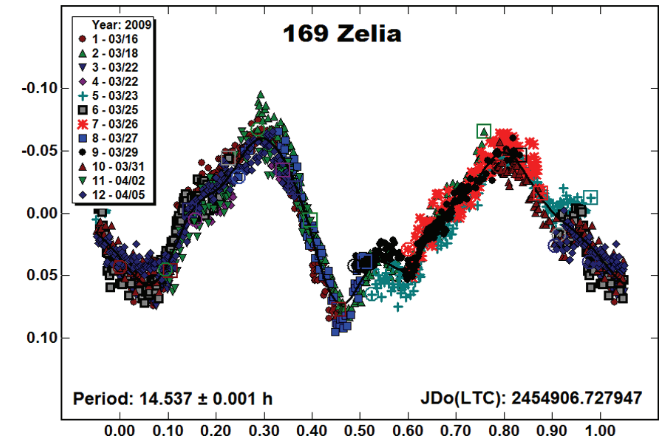
References

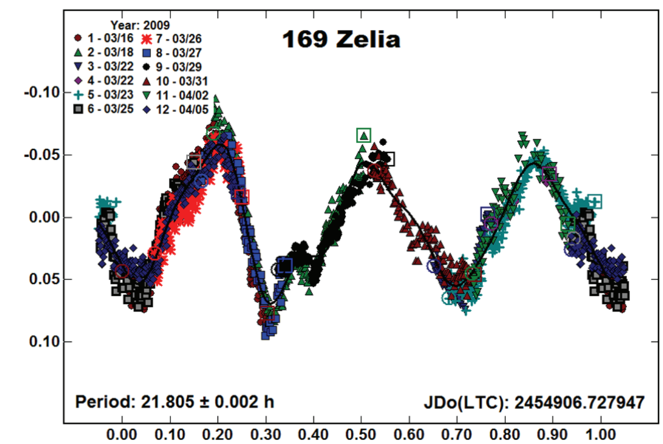
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

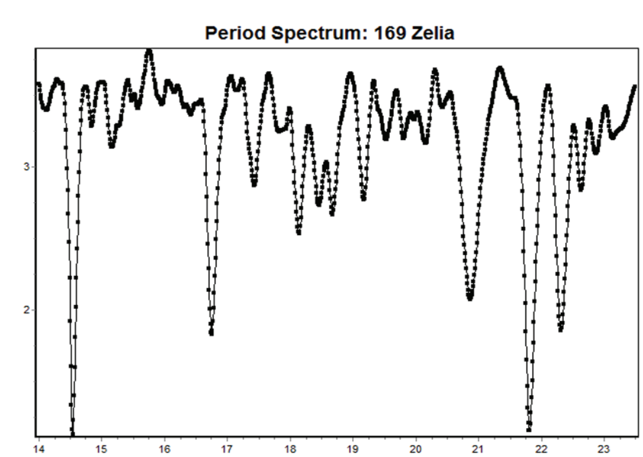
Harris, A.W., Young, J.W., and Dockweler, T. (1992). "Asteroid Lightcurve Observations from 1981." *Icarus* **95**, 115-147.

Love, T. (1997). "CCD Photometry of 169 Zelia." *Minor Planet Bul.* **24**, 11-12.

Warner, B.D., Harris, A.W., and Pravec, P. (2009) Asteroid Lightcurve Parameters *http://www.MinorPlanetObserver.com/astlc/default.htm.*







LIGHTCURVE ANALYSIS OF ASTEROIDS FROM LEURA AND KINGSGROVE OBSERVATORY IN THE SECOND HALF OF 2008

Julian Oey
Kingsgrove Observatory
23 Monaro Ave. Kingsgrove, NSW AUSTRALIA
and
Leura Observatory
94 Rawson Pde. Leura, NSW, AUSTRALIA
julianoey1@optusnet.com.au

(Received: 2009 Jun 21)

Photometric observations of ten asteroids were completed in the last six months of 2008 from both Kingsgrove and Leura Observatories resulting in the determination of their synodic periods.

226	Weringia	11.1496	±	0.0009 h;
677	Aaltje	16.6076	±	0.0006 h;
929	Algunde	3.3110	±	0.0008 h;
1122	Neith	12.599	±	0.006 h;
1449	Virtanen	30.495	±	0.005 h;
1836	Komarov	8.0815	±	0.0004 h;
3576	Galina	5.910	±	0.003 h;
4182	Mount Locke	3.0175	±	0.0003 h;
4332	Milton	3.2978	±	0.0003 h;
(34155)	2000 QJ22	3.0087	±	0.0002 h.

Kingsgrove Observatory used a 0.25m Schmidt-Cassegrain telescope (SCT) operating at f/5.2 combined with an SBIG ST-402ME CCD camera operating at 1x1 binning, resulting in scale of 1.40 arcsec/pixel. Images were unfiltered and 60 s. Most of the asteroids worked at Kingsgrove were taken from the from the CALL website (Warner, 2008) with the selection criteria being <14.0 mag when brightest and at a relatively southerly declination. Leura observatory used a 0.35m SCT working at f/6.5 by using a 0.5x focal reducer. Combined with an SBIG ST-9XE CCD camera at 1x1 binning, the scale was 1.80 arcsec/pixel. All exposures were unfiltered with 300-second integration. The telescope was used mainly on fainter targets selected from Photometric Survey for Asynchronous Binary Asteroid (Pravec, 2008) for follow up and detection work. *MPO Canopus* v.9.4.0.1 software, which incorporates the Fourier algorithm developed by Harris (1989), was used for period analysis.

226 Weringia was observed previously by the author (Oey, 2008). Observations at this most recent apparition were made to refine the previous results. The lightcurve parameters found for 2008 were P = 11.1496 ± 0.0009 h, A = 0.20 ± 0.02 mag. In 2007, the amplitude of the lightcurve was only 0.08 ± 0.04 mag.

677 Aaltje was also observed by the author previously (Oey, 2008). The period derived at that time was 11.056 ± 0.003 h. However, the asteroid was within 20° of the galactic plane at that time. As a result, numerous background stars made getting good data difficult and finding an accurate period even more so. The results from the most recent work, with much cleaner data, show a period of 16.6076 ± 0.0006 h and amplitude of 0.30 ± 0.02 mag. When the 2007 data were forced to a period near this, the result was a monomodal curve with P = 16.46 ± 0.02 h, A = 0.10 ± 0.03 mag.

1122 Neith was a relatively low amplitude lightcurve object. To prevent misinterpretation of the lightcurve as a long period target, a few nights of data were linked by using the same comparison stars on different nights.

1449 Virtanen. This slow sky motion of the asteroid allowed linking of two successive nights by using same comparison stars. The derived synodic period was 30.495 ± 0.005 h with a lightcurve amplitude of 0.60 ± 0.02 mag.

4182 Mount Locke. Observations of this asteroid at Leura Observatory were made after Behrend (2008) reported the possibility of it being binary. A unique period 3.0175 ± 0.0003 h was found with the amplitude being 0.15 ± 0.03 mag. The attenuation seen by the author on August 13 was later found to be due to an atmospheric anomaly. Otherwise, no evidence of a binary nature was seen.

References

Behrend, R. (2008), Observatoire de Genève web site. http://obswww.unige.ch/~behrend/page_cou.html

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.

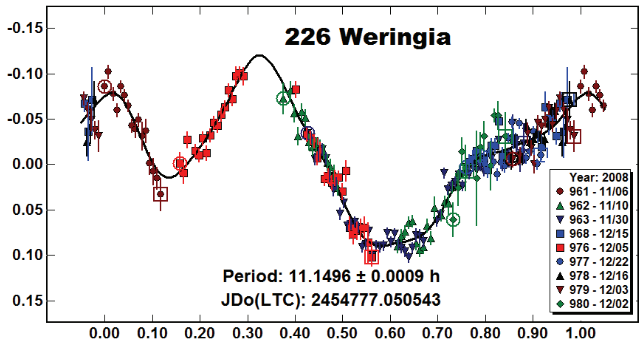
Oey, J. (2008). "Lightcurve Analysis of Asteroids from Kingsgrove and Leura Observatories in the 2nd half of 2007". Minor Planet Bulletin **35**, 132 – 135.

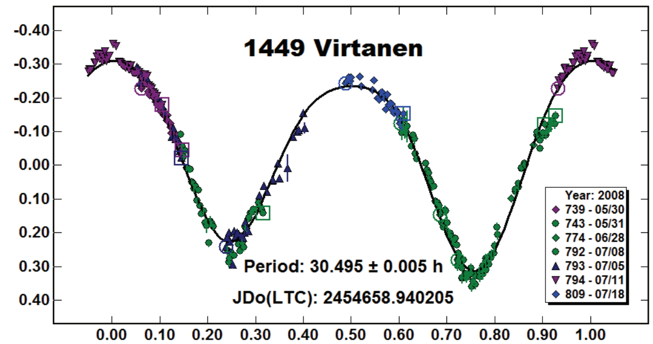
Warner, B.D. (2008). "Potential Lightcurve Targets 2008 July–September". On CALL web site: http://www.minorplanetobserver.com/astlc/targets_4q_2008.htm

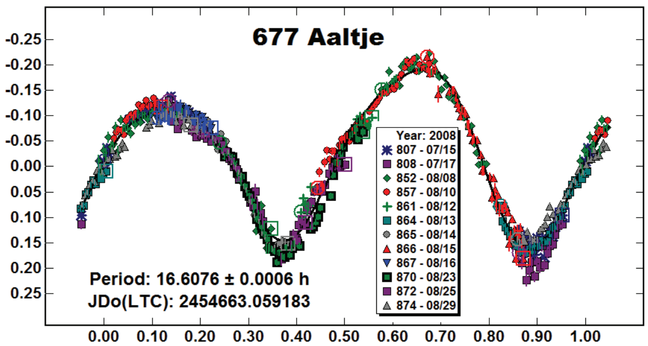
Pravec, P. (2008). "Photometric Survey of Asynchronous Binary Asteroids." http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm

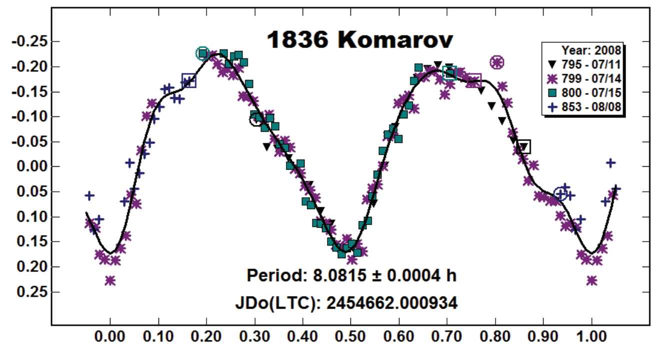
Name	Date 2008(mm/dd)	Obs	Period (h)	Amp (mag)	PA	LPAB	BPAB
226 Weringia	11/06-12/02	K	11.1496 ± 0.0009	0.20 ± 0.02	10,7,11	65	-18
677 Aaltje	07/15-08/29	K	16.6076 ± 0.0006	0.30 ± 0.02	16	340	8
929 Algunde	07/30-08/02	L	3.3110 ± 0.0008	0.13 ± 0.02	15	340	8
1122 Neith	08/31-09/29	K	12.599 ± 0.006	0.08 ± 0.02	18	7	-6
1449 Virtanen	05/30-07/18	K	30.495 ± 0.005	0.60 ± 0.02	6,23	247	5
1836 Komarov	07/11-07/15	K	8.8015 ± 0.0004	0.39 ± 0.02	3	288	2
3576 Galina	10/01-10/08	L	5.910 ± 0.003	0.04 ± 0.01	3	9	-3
4182 Mount Locke	08/13-09/02	L	3.0175 ± 0.0003	0.15 ± 0.03	5,9	323	9
4332 Milton	08/31-09/11	K	3.2978 ± 0.0003	0.30 ± 0.05	28,24	19	-10
(34155) 2000 QJ22	10/25-12/08	K	3.0087 ± 0.0002	0.10 ± 0.03	15,19	47	-16

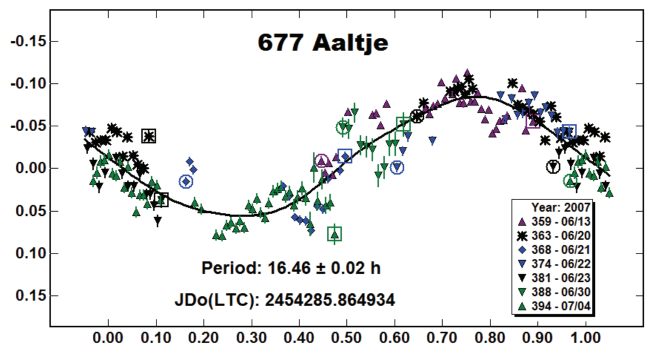
Table 1. Observatory code: K = Kingsgrove; L = Leura

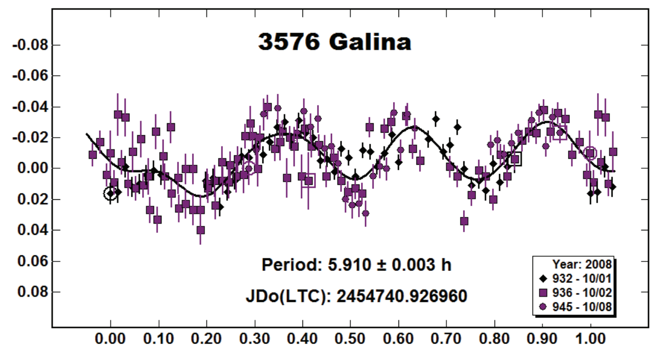

226 Weringia
Period: 11.1496 ± 0.0009 h
JDo(LTC): 2454777.050543
Year: 2008
961 - 11/06
962 - 11/10
963 - 11/30
968 - 12/15
976 - 12/05
977 - 12/22
978 - 12/16
979 - 12/03
980 - 12/02

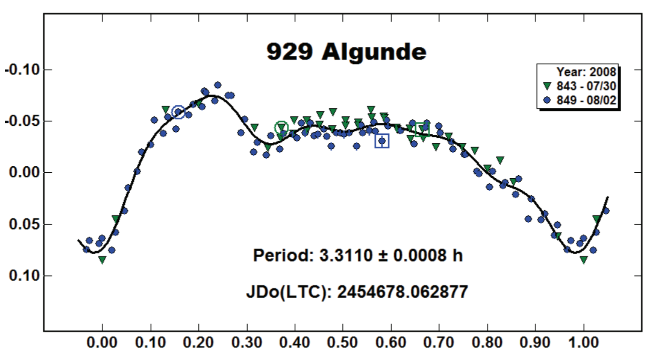

1449 Virtanen
Period: 30.495 ± 0.005 h
JDo(LTC): 2454658.940205
Year: 2008
739 - 05/30
743 - 05/31
774 - 06/28
792 - 07/08
793 - 07/05
794 - 07/11
809 - 07/18

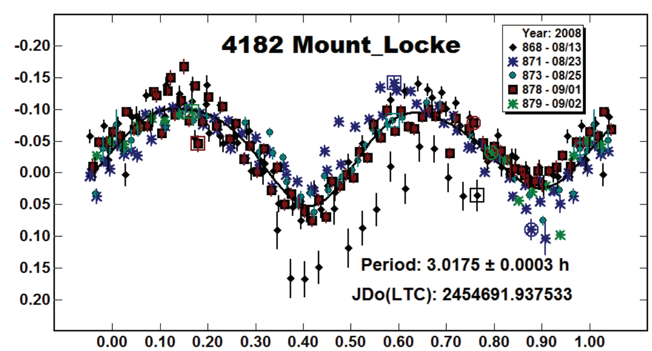

677 Aaltje
Period: 16.6076 ± 0.0006 h
JDo(LTC): 2454663.059183
Year: 2008
807 - 07/15
808 - 07/17
852 - 08/08
857 - 08/10
861 - 08/12
864 - 08/13
865 - 08/14
866 - 08/15
867 - 08/16
870 - 08/23
872 - 08/25
874 - 08/29

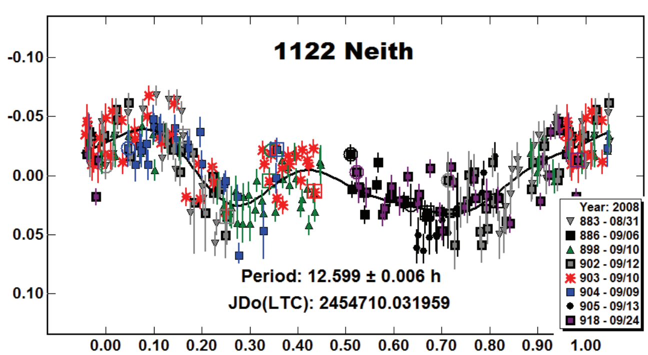

1836 Komarov
Period: 8.0815 ± 0.0004 h
JDo(LTC): 2454662.000934
Year: 2008
795 - 07/11
799 - 07/14
800 - 07/15
853 - 08/08

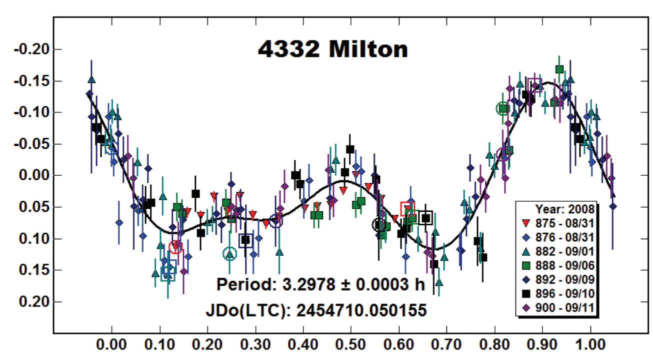

677 Aaltje
Period: 16.46 ± 0.02 h
JDo(LTC): 2454285.864934
Year: 2007
359 - 06/13
363 - 06/20
368 - 06/21
374 - 06/22
381 - 06/23
388 - 06/30
394 - 07/04

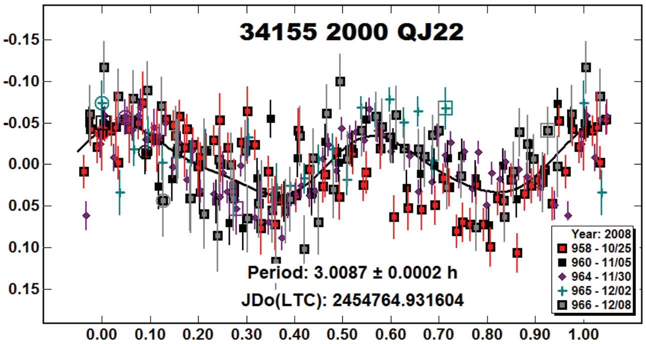

3576 Galina
Period: 5.910 ± 0.003 h
JDo(LTC): 2454740.926960
Year: 2008
932 - 10/01
936 - 10/02
945 - 10/08


929 Algunde
Period: 3.3110 ± 0.0008 h
JDo(LTC): 2454678.062877
Year: 2008
843 - 07/30
849 - 08/02


4182 Mount_Locke
Period: 3.0175 ± 0.0003 h
JDo(LTC): 2454691.937533
Year: 2008
868 - 08/13
871 - 08/23
873 - 08/25
878 - 09/01
879 - 09/02


1122 Neith
Period: 12.599 ± 0.006 h
JDo(LTC): 2454710.031959
Year: 2008
883 - 08/31
886 - 09/06
898 - 09/10
902 - 09/12
903 - 09/10
904 - 09/09
905 - 09/13
918 - 09/24


4332 Milton
Period: 3.2978 ± 0.0003 h
JDo(LTC): 2454710.050155
Year: 2008
875 - 08/31
876 - 08/31
882 - 09/01
888 - 09/06
892 - 09/09
896 - 09/10
900 - 09/11



ANALYSIS OF THE LIGHTCURVES OF 198 AMPELLA AND 2008 SV11

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

Robert D. Stephens
Goat Mountain Asteroid Research Station (GMARS)
Landers, CA USA

(Received: 2009 Jun 29)

We report on our collaborations to obtain photometric data on two asteroids. 198 Ampella, a main-belt object, was observed to check previously reported periods. We found a synodic period of 20.778 ± 0.003 h, which is double that of the most reliable of those previous results. The near-Earth asteroid 2008 SV11 was observed in support of radar observations. We found a period of 32.4 ± 0.1 h. However, the shape of the lightcurve was very unusual and so the period remains in some doubt. Radar observations indicate a strongly bifurcated body.

Equipment and basic image acquisition methods used by the authors have been previously described (see Stephens, 2006; Warner, 2009). We linked our observations from night-to-night using the 2MASS (Neugebaur and Leighton, 1969) to BVRI conversions developed by Warner (2007) and applied as described by Stephens (2008).

198 Ampella. Despite its relatively large size and brightness, this main belt asteroid had only one previously published lightcurve, that by DeYoung and Schmidt (1993) who reported a period of 10.383 h. The authors observed the asteroid in 2009 April, obtaining data on 13 nights, with the intent of confirming the period and providing data for future shape modeling. Our analysis found a period of 20.778 ± 0.003 h with an amplitude of 0.13 ± 0.01 mag, or double that of DeYoung and Schmidt. The lightcurve shows our data phased to the longer period. When forced to the shorter period, the curve is monomodal and the RMS fit is significantly higher. We note that the observing runs by DeYoung and Schmidt were separated by no less than two days and sometimes a week or more. We believe this led to a "rotational uncertainty" in their solution such that they found the shorter period, which we do not believe to be correct.

2008 SV11. Photometric observations by the authors were made of this near-Earth asteroid in 2009 April to support radar observations at Arecibo by Brozovic, Benner, Nolan, and Howell. As more data became available, the solution changed dramatically, but it finally settled to something around 32 h. This seemed to agree with radar observations (low Doppler shift) that indicated a longer period and also a bifurcated body. Starting on April 19 and continuing for through April 22, the last day the asteroid could be readily observed from our location, the curve suddenly "went flat" and showed only a steady rise within the phased lightcurve. We could find no observational, systematic, or reduction causes and so must presume that the change was due to a combination of the asteroid's shape and changing viewing aspect. Since the aspect did not change dramatically over this short interval, this explanation also has difficulties. Our data have been sent to Howell at Arecibo with the hope that the combination of optical and lightcurve data can resolve the mystery.

We also used the data to determine the absolute magnitude (*H*) of the asteroid, first by forcing the phase slope parameter (*G*) to 0.24, the default for type S (Warner et al., 2009), the presumed type of the asteroid. This gave $H = 18.4 \pm 0.1$, the same value assumed by the Minor Planet Center. We then allowed both values to float and $H = 18.0 \pm 0.2$, $G = -0.07$. We have adopted the first solution as the more likely since it relies on a more likely value for *G*. If we had been able to obtain data near opposition, phase angles < 3°, it would have been possible to find a more definitive solution.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

References

Neugebauer, G. and Leighton, R.B. (1969). Two-micron Sky Survey: A Preliminary Catalog. NASA.

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 21-22.

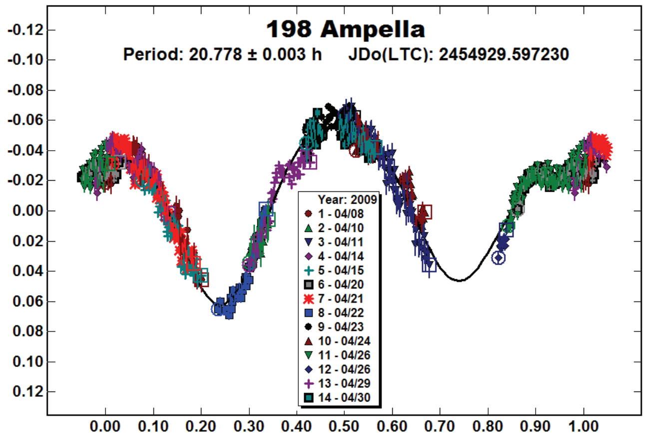
Warner, B.D. (2007b). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

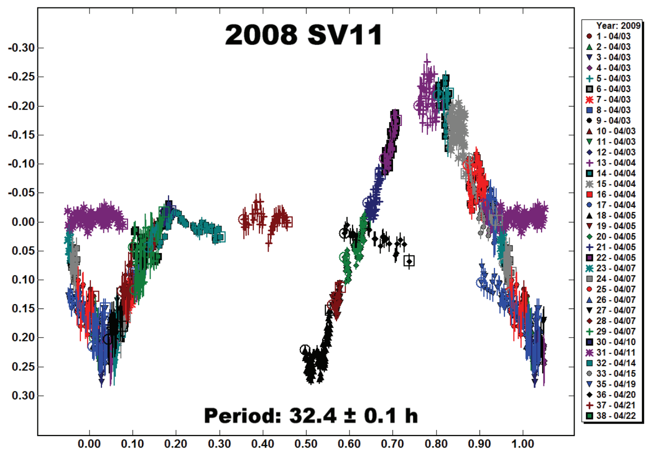
Warner, B.D. (2009). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2008 December – 2009 March." *Minor Planet Bul.* **36**, 109-116.

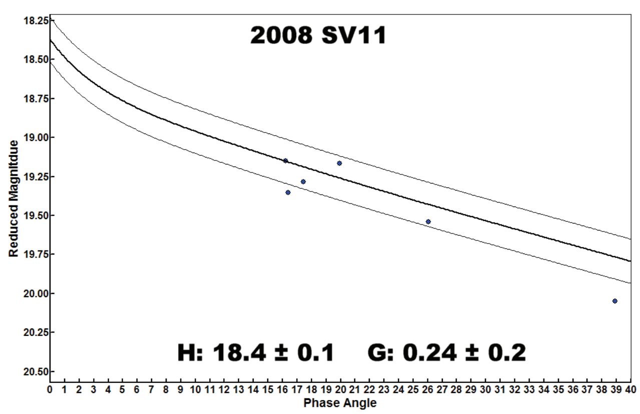
Warner, B.D., Harris, A.W., and Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146.

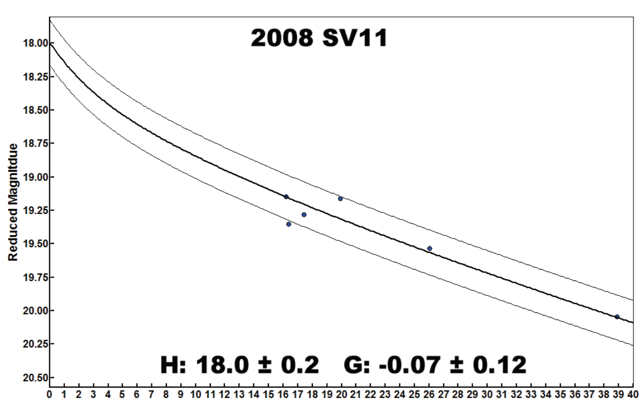
Asteroid	2009	α	L_{PAB}	B_{PAB}
198 Ampella	04/08-30	11,17	163	-11
2008 SV11	04/03-21	40,16,18	172,199	7,-5

Table I. Observing circumstances. The phase angle column gives the values on the first and last date. For 2008 SV11, the middle date is the minimum phase angle. The phase angle bisector columns give the value for the first and last date of observation.









2577 LITVA: A HUNGARIA BINARY

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

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

Alan. W. Harris
Space Science Institute, La Canada, CA USA

David Higgins
Hunters Hill Observatory
Ngunnawal ACT AUSTRALIA

Colin Bembrick
Mt Tarana Observatory
Bathurst, NSW AUSTRALIA

James W. Brinsfield
Via Capote Observatory
Thousand Oaks, CA USA

Donald P. Pray
Carbuncle Hill Observatory
W. Brookfield, MA USA

Joseph Pollock
Physics and Astronomy Dept., Appalachian State Univ.
Boone, NC USA

Daniel Reichart, Kevin Ivarsen, Josh Haislip, Aaron LaCluyze, Melissa Nysewander
PROMPT, UNC-Chapel Hill, NC USA

Adrián Galád
Modra Observatory, Bratislava, SLOVAKIA
Astronomical Institute, Ondřejov, CZECH REPUBLIC

(Received: 2009 Jul 9)

Observations of the Hungaria asteroid 2577 Litva in 2009 late February to early April show that the asteroid is a binary. The primary period (synodic) is 2.81258 ± 0.00002 h and the orbital period (synodic) is 35.81 ± 0.01 h. The depth of mutual events (occultations and eclipses) indicate a size ratio of *Ds/Dp* (lower limit) = 0.34 ± 0.02. A secondary period of 5.6842 ± 0.0002 h was also found. This is due either to the rotation of the satellite that is not tidally locked with the orbital period or a third body.

Initial observations of the Hungaria asteroid 2577 Litva were made by Warner at the Palmer Divide Observatory (PDO) in late 2009 February as part of an ongoing study of that group/family of asteroids. Wisniewski et al. (1997) worked the asteroid in 1988 and found a period of 5.618 h with an amplitude of 0.36 mag. Stephens (2004) reported a period of 2.82 h and amplitude of 0.30 mag while Behrend (2009) reported a period of 2.81 h and amplitude of 0.14 mag. When the initial data from the 2009 PDO campaign were analyzed, there were unusual aspects with one interpretation being a second period within the data. At this point, observers within the Binary Asteroid Survey (Pravec et al., 2006) were contacted to provide additional data.

After several more nights, the combined data set began to show mutual events due to occultations and eclipses within a binary system and analysis could start on finding the rotation period of the primary and orbital period of the satellite. Even after subtracting those two periods from the data, we still found strong indications of yet another period. The two most likely explanations were the rotation of the satellite, meaning that it was not tidally locked to its orbital period, or there was a third body in the system. We saw no additional mutual events, but that could be attributed to unfavorable system geometry and/or viewing aspect or that the orbital period of the tertiary was so long that our short observing windows did not allow seeing events. At this point we cannot rule out either possibility for the additional period.

Table I summaries our findings, which are based on a subset of the data from 2009 March 4 – April 1. The data on Feb 28 and Mar 1 do not show any events and, while the period matches what we report here, the shape of the lightcurve was significantly different, which may have indicated that the primary's lightcurve was rapidly evolving. We urge follow-up observations of this system in order to refine these findings and to confirm the cause of the secondary period.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. The work at Ondřejov was supported by the Grant Agency of the Czech Republic, Grant 205/09/1107. The work at Carbuncle Hill Observatory was supported by a Gene Shoemaker NEO Grant from the Planetary Society.

References

Behrend, R. (2009). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html.

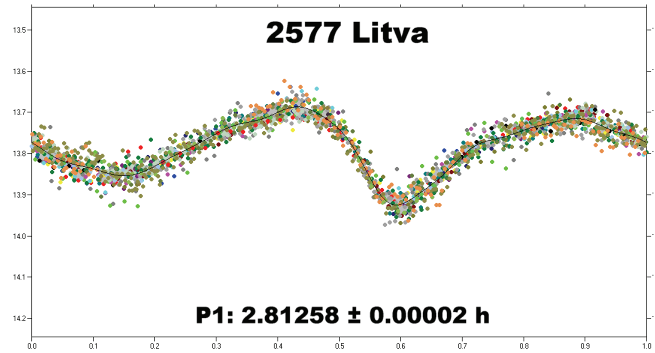
Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, L., and 53 co-authors (2006). "Photometric Survey of Binary Near-Earth Asteroids." *Icarus* **181**, 63-93.

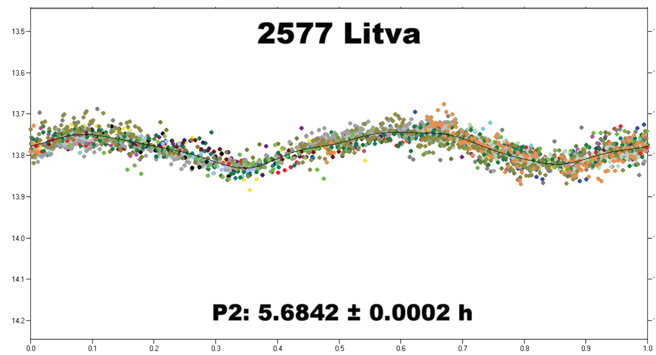
Stephens, R.D. (2004). "Photometry of 1196 Sheba, 1341 Edmee, 1656 Suomi, 2577 Litva, and 2612 Kathryn." *Minor Planet Bul.* **31**, 95-97.

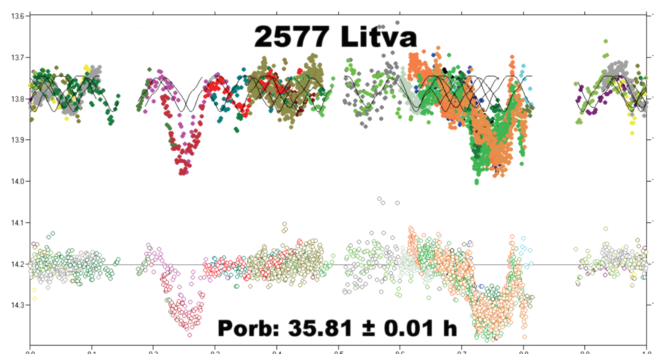
Wisniewski, W.Z., Michalowski, T.M., Harris, A.W., and McMillan, R.S. (1997). "Photometric Observations of 125 Asteroids." *Icarus* **126**, 395-449.

2755 Litva Results	
P1 (synodic)	2.81258 ± 0.00002 h
P2 (synodic)	5.6842 ± 0.0002
P(orb)	35.81 ± 0.01
A1	0.24 ± 0.02 mag
A2	0.09 ± 0.01
A(events)	0.14 ± 0.01 mag
Ds/Dp (lower limit)	0.34 ± 0.02

Table I. Summary of results for 2577 Litva.







ANALYSIS OF THE LIGHTCURVE OF 6179 BRETT

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

Donald P. Pray
Carbuncle Hill Observatory
W. Brookfield, MA 01585 USA

(Received: 2009 Jul 2)

We report on our collaboration to determine the lightcurve parameters for the Phocaea member asteroid, 6179 Brett. Our analysis found a synodic period of 9.403 ± 0.001 h and an amplitude of 0.67 ± 0.02 mag.

Both authors started to observe the Phocaea member asteroid, 6179 Brett, in 2009 April as part of the Photometric Survey for Asynchronous Binary Asteroids (Pravec, 2009). We combined our efforts to overcome weather and to extend runs on a given night.

This allowed us to find a solution sooner than might otherwise be possible for a single station. Warner used 0.35-m Schmidt-Cassegrain (SCT) with FLI-1001E CCD camera working at a scale of ~1.2 arcsec/pixel. Exposures were guided, unfiltered, and 240 s. Pray used a 0.5-m f/4 Newtonian reflector and SBIG ST-10XME camera, yielding a scale of ~2.0 arcsec/pixel. Exposures were
130 s, unfiltered, and unguided. We both used *MPO Canopus* to perform differential photometry on the reduced images. All data were light-time corrected. The merged data set was then used for period analysis, again in *Canopus*, which employs the FALC Fourier analysis algorithm by Harris (1989). The resulting lightcurve, shown below, has a synodic period of 9.403 ± 0.001 h and amplitude of 0.67 ± 0.02 mag.

Given the large amplitude and period, it was very unlikely that the asteroid was an asynchronous binary and so it was tempting to stop work once the period could be established. However, in order to maintain the integrity of the Survey, Pravec urged additional observations until the entire curve had been covered at least twice. This is an important point: in order to assure that biases in the asteroid lightcurve database (Warner et al., 2009) are kept to minimum, an asteroid's lightcurve should be completed as much as possible, whether in a survey or not. This includes staying with targets that don't present a quick and/or easy solution.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a 2007 Gene Shoemaker NEO Grant from the Planetary Society. Funding for observations at Carbuncle Hill Observatory is provided by a Gene Shoemaker NEO Grant from the Planetary Society.

References

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.

Pravec, P. (2009). "Photometric Survey for Asynchronous Binary Asteroids" web site.
http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm

Warner, B.D., Harris, A.W., and Pravec, P. (2009). "The asteroid lightcurve database." Icarus 202, 134-146.

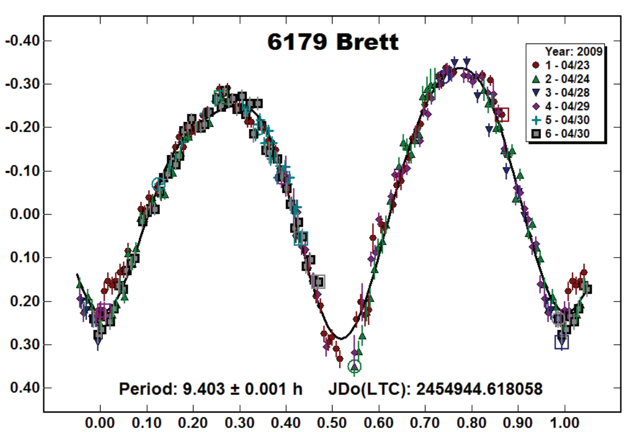


Figure 1. Lightcurve for 6179 Brett. The solid line is a fourth-order Fourier fit of the data.

PERIOD DETERMINATION OF 780 ARMENIA: AN INTER-LONGITUDE COLLABORATION

Vladimir Benishek
Belgrade Astronomical Observatory
Volgina 7, 11060 Belgrade 38 SERBIA
vlaben@yahoo.com

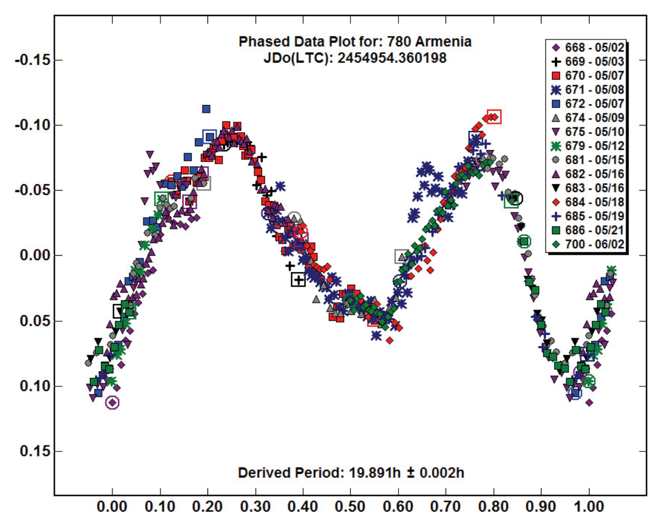
Frederick Pilcher
Organ Mesa Observatory
Las Cruces, NM USA

(Received: 2009 Jul 13)

We report the result of a collaborative effort to determine the lightcurve parameters for the main-belt asteroid 780 Armenia from two widely-separated geographic longitudes. The synodic rotation period and amplitude were found to be 19.891 ± 0.002 h and 0.18 ± 0.03 mag, respectively.

780 Armenia is a main-belt asteroid discovered in 1914 by G. N. Neujmin at Simeis. The only previously reported parameters were those by Behrend (2009) with a period (*P*) of ~13 h and amplitude (*A*) of ~0.1 mag. The asteroid was also listed as a potential observing target on the CALL website for 2009 April-June (Warner and Harris, 2009) and marked with an uncertainty flag of *U* = 1, which indicates preliminary and very likely incorrect parameters. Assuming that the period might be much longer than previously reported, the authors agreed to undertake a joint observational effort to determine a secure set of parameters. The observations started on 2009 May 2, when the apparent magnitude of the target was 14.1, and continued until June 2. Pilcher at Organ Mesa Observatory used a Meade 0.35-m LX200 GPS f/11 Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD. Benishek at Belgrade Observatory used a Meade 0.4-m LX200 GPS f/10 SCT and Apogee AP47p CCD. All observations were unfiltered. Instrumental magnitudes were found and used for period analysis with *MPO Canopus* software.

Even after the first observing runs it was clear that the period was considerably longer than 13 h. Initially, it was difficult to resolve the ambiguity between a bimodal solution with *P* ~ 20 h and a more favorable RMS error versus a trimodal solution with *P* = 29.86 h that was still very likely. However, a deep narrow



minimum observed on May 16 showed for the first time the overlapping of this minimum with one of the shallow minima for the trimodal solution, or namely, a significant misfit. This greatly improved confidence in the bimodal solution, which was confirmed by subsequent observations. Once the secure period was found, it was gradually improved by adding new observations. The final result is composed of 15 independent segments (8 by Pilcher and 7 by Benishek, many of which are overlapping), that provide dense coverage of the complete bimodal lightcurve with P = 19.891 ± 0.002 h and A = 0.18 ± 0.03 mag. In conclusion, we point to this case as underlining the value and efficiency of inter-longitude collaborations among observers in asteroid period determination work.

References

Behrend, R. (2009). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html

Warner, B. D. and Harris, A. W. (2009). "Potential Lightcurve Targets, 2009 April-June." http://www.minorplanetobserver.com/astlc/targets_2q_2009.htm

LIGHTCURVE ANALYSIS OF MINOR PLANETS 427 GALENE AND 5489 OBERKOCHEN

Peter Caspari
BDI Observatory
PO Box 194 Regents Park
NSW 2143, AUSTRALIA
pcaspa@hotmail.com

(Received: 2009 Jul 14)

Minor planet 427 Ganele was observed over six nights in 2009 April and May and 5489 Oberkochen was observed over eight nights in 2008 August and September. Rotational periods of 3.705 h with A = 0.6 mag and 5.625 h with A = 0.4 mag, respectively, were determined. A is the peak-to-peak magnitude change.

Equipment and imaging techniques employed at BDI Observatory are as described in Caspari (2008). The resulting images were measured using *MPO Canopus* (Warner, 2009a), which uses differential aperture photometry to determine the values used for analysis.

427 Galene This is a main-belt object with a diameter of 33.8 ± 2.0 km based on an albedo of 0.26 ± 0.03 (Gray, 2008). It was selected since it had no known period and was in a favourable location for BDI Observatory considering light pollution and obstructions. The lightcurve exhibits a typical bimodal curve. Analysis found a synodic period of 3.705 ± 0.005 h and A = 0.6 mag.

5489 Oberkochen This is a main-belt object with an assumed diameter of 33 km based on an assumed albedo of 0.04 (Gray, 2008). This target was selected from the CALL's lightcurve targets page (Warner, 2009b) since it was relatively bright and in a favourable location for BDI Observatory. The target had no known period. The lightcurve exhibits a typical bimodal curve. The derived synodic period is 5.625 ± 0.005 h and A = 0.4 mag.

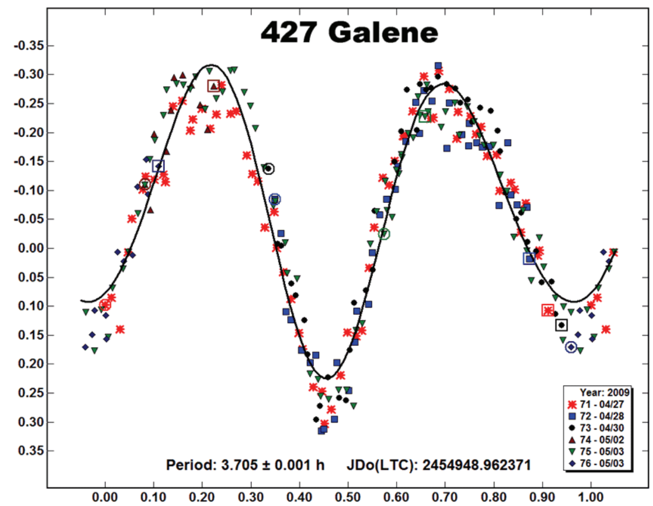
References

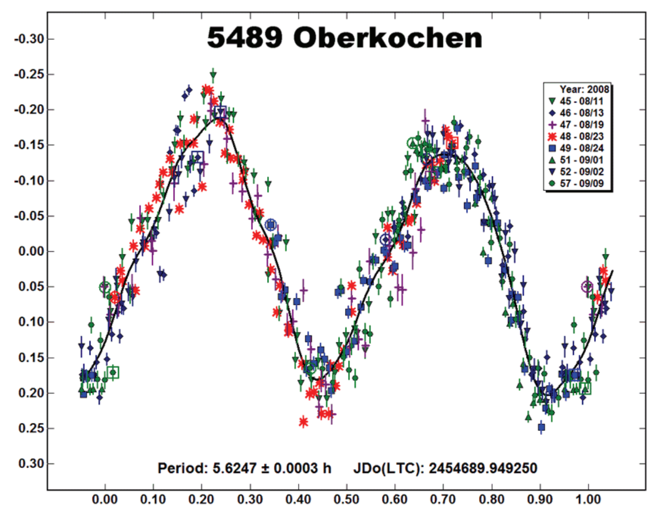
Caspari, P. (2008). "Minor Planet Lightcurve Analysis of 1157 Arabia and 1836 Komarov." *Minor Planet Bul.* **35**, 185.

Gray, B. (2008). Guide software v8. Project Pluto, Bowdoinham, Maine.

Warner, B.D. (2009a). MPO Canopus v9.4.0.3. Bdw Publishing, Colorado Springs, CO.

Warner, B.D. (2009b) "CALL Site Sections / Lightcurve Targets." http://www.minorplanetobserver.com/astlc/default.htm





ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 2ND QUARTER 2009

James W. Brinsfield
Via Capote Observatory
5180 Via Capote, Thousand Oaks CA 91320
jbrinsfi@gmail.com

(Received: 2009 Jun 28)

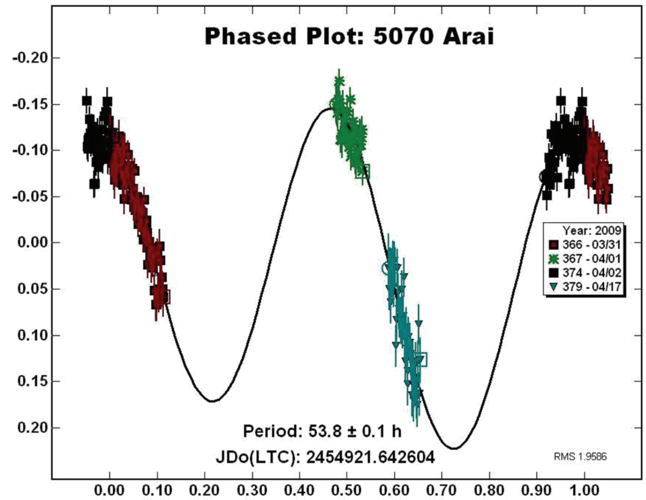
Three asteroids were observed and lightcurves were measured at the Via Capote Observatory from 2009 March through May. The resulting periods were: 5070 Arai (>48 h), 8338 Ralhan (5.27 h), and (8359) 1989 WD (2.89 h).

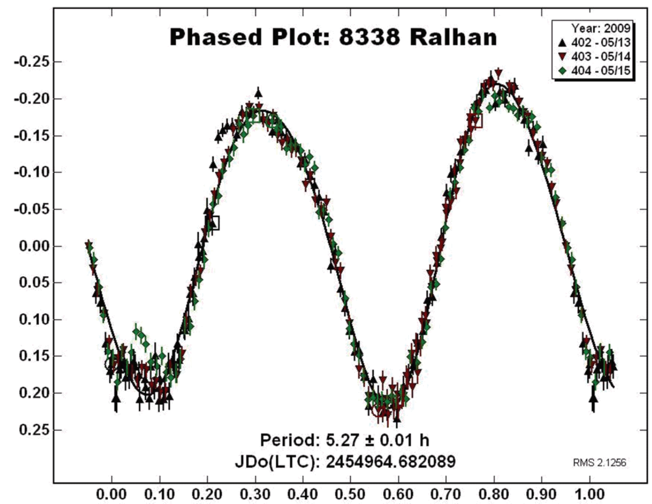
Observations of three minor planets were made using a Meade LX200 0.35-m Schmidt-Cassegrain (SCT) working at f/10. The CCD imager was an Alta U6 with a 1024x1024 array of 24-micron pixels. All observations were made unfiltered at 1x binning yielding an image scale of 1.44” per pixel and were dark and flat field corrected. Images were measured using *MPO Canopus* (Bdw Publishing) and differential photometry. The data were light-time corrected. Period analysis was also done with *Canopus*, incorporating the Fourier analysis algorithm developed by Harris (1989). Most target selections were made using the Collaborative Asteroid Lightcurve Link (CALL) web-site and “Lightcurve Opportunities” articles from the Minor Planet Bulletin. Priority was given to asteroids that did not have a published rotational period.

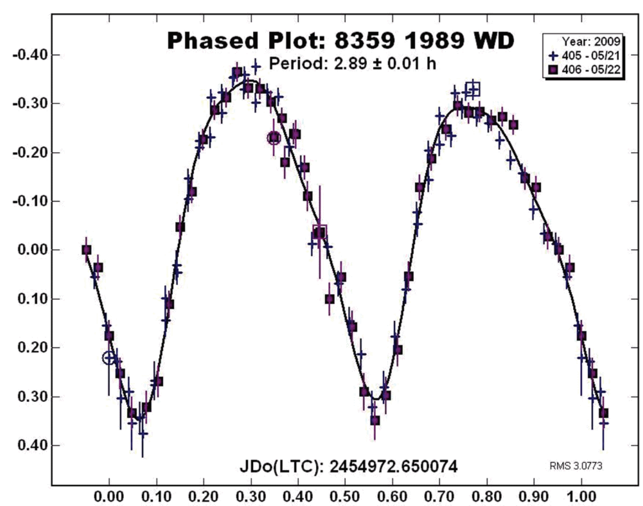
The results are summarized in the table below and include average phase angle information across the observational period. Where three numbers are indicated for phase angle, measurements of the target occurred over opposition. The middle value is the minimum phase angle observed and the two end values are the phase angles at the beginning and end of the observing campaign. Individual lightcurve plots along with additional comments, as required, are also presented. None of the three targets studied during the reporting period had published lightcurves. 5070 Arai was not fully characterized due to the limiting magnitude of the local sky conditions and hardware limitations. Phasing the data to the half period would suggest a period of greater than 48 hours and the data best fit a curve of 53.8 hours. The estimated magnitude of the curve exceeds 0.29.

References

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.







#	Name	Date (mm/dd) 2009	Data Points	Phase	L_{PAB}	B_{PAB}	Per(h)	PE	Amp(m)	AE
	5070 Arai	03/31-04/17	218	12	168	-2	> 48	0.1	>0.29	
	8338 Ralhan	05/13-01/15	331	7	229	8	5.27	0.01	0.44	0.02
	(8359) 1989 WD	05/21-05/22	107	16	212	4	2.89	0.01	0.7	0.02

THE LIGHTCURVES OF 1146 BIARMIA AND 5598 CARLMURRAY

Russell I. Durkee
Shed of Science Observatory
5213 Washburn Ave. S. Minneapolis, MN, USA
shedofscience@earthlink.net

(Received: 2009 Jul 7)

The lightcurves of asteroids 1146 Biarmia and 5598 Carlmurray were measured during the first half of 2009. 1146 Biarmia was found to have a synodic rotation period of 5.4700 ± 0.0002 h with an amplitude of 0.20 ± 0.02 mag. 5589 Carlmurray was found to have a synodic rotation period of 2.9226 ± 0.0002 h and an amplitude of 0.32 ± 0.03 mag.

Observations of asteroid 1146 Biarmia and 5589 Carlmurray were made in 2009 at the Shed of Science Observatory with a 0.35-m Schmidt-Cassegrain (SCT) operating at f/8.5 using an SBIG ST10XE and Celestron UHC light pollution filter. Images for 1146 Biarmia were binned 2x2, producing a scale of 0.94 arcsec/pixel. Images of 5598 Carlmurray were binned 3x3, resulting in an image scale of 1.41 arcsec/pixel.

1146 Biarmia. This asteroid was observed over seven nights in 2009 June. It was previously observed by Warner (2000), who reported a period of 11.514 h based on two night's data. Our data provided significantly more coverage. Initial measurements supported the longer period, but as double coverage of the lightcurve was obtained for its lower amplitude portions, the shorter solution of P = 5.4700 ± 0.0002 h became dominant and was adopted. The period spectrum covering both periods is shown below. The solution is rated as U = 3 (see Warner et al., 2009, for the definition of the U rating).

5598 Carlmurray. This asteroid was initially selected for observation as part of the Photometric Survey for Asynchronous Binary Asteroids by Petr Pravec (Pravec et al., 2006). It was observed over three nights in 2009 January. The derived period of P = 2.9226 ± 0.0002 h is unique and rated as U = 3 (Pravec, 2009).

Acknowledgements

Thanks to Brian Warner and Petr Pravec for their assistance in the analysis of 1146 Biarmia, and 5598 Carlmurray, respectively. Funding for observations at The Shed of Science is supported in part by a Gene Shoemaker NEO grant from the Planetary Society.

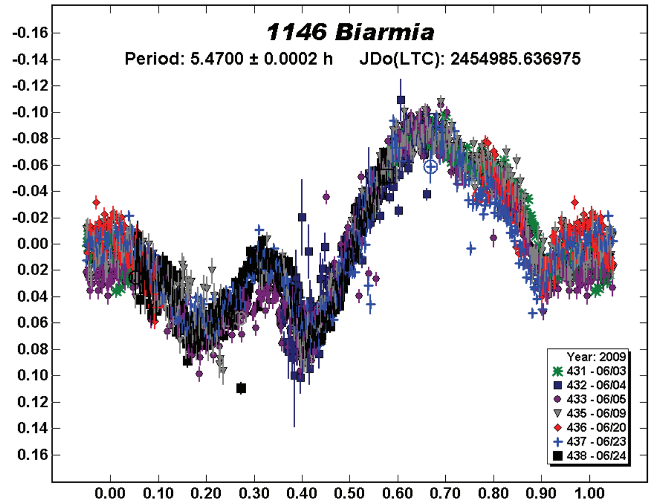
References

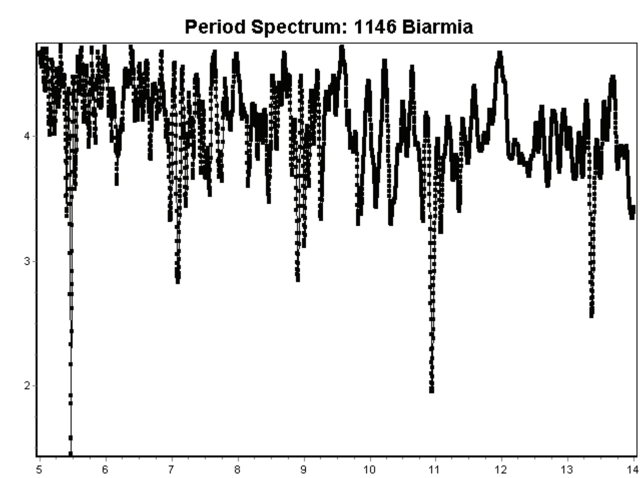
Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, L., and 53 co-authors (2006). "Photometric Survey of Binary Near-Earth Asteroids." *Icarus* **181**, 63-93.

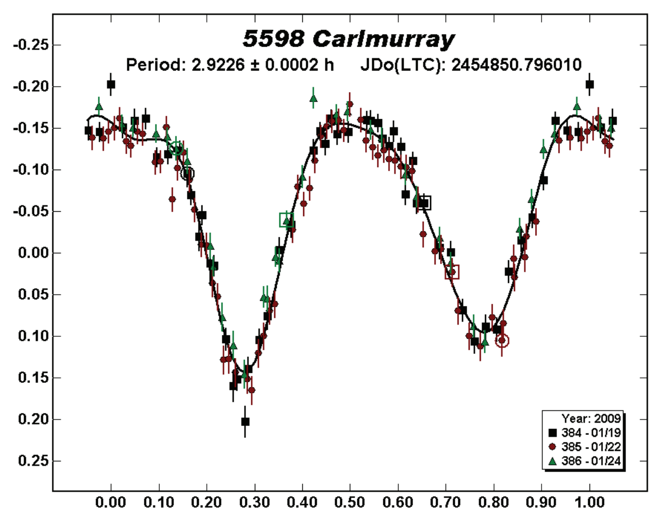
Pravec, P. (2009). "Prepublished Periods of Asteroids." http://www.asu.cas.cz/~ppravec/newres.htm

Warner, B.D. (2000). "Asteroid Photometry at the Palmer Divide Observatory." *Minor Planet Bul*. **27**, 4-6.

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146.







LIGHTCURVES OF 4285 HULKOWER, 6867 KUWANO, AND (93768) 2000 WN22

Gary A. Vander Haagen
Stonegate Observatory, 825 Stonegate Road
Ann Arbor, MI 48103
garyvh2@att.net

(Received: 2009 Jul 10)

Analysis of their lightcurves revealed the following periods and amplitudes for three asteroids: 4285 Hulkower, 6.149 ± 0.001 h, 0.68 ± 0.05 mag; 6867 Kuwano, 7.367 ± 0.001 h, 0.55 ± 0.05 mag; and (93768) 2000 WN22, 2.679 ± 0.002 h, 0.33 ± 0.03 mag.

Photometric data for three asteroids were collected using a 36-cm Celestron C-14, SBIG ST-10XME camera, and clear filter at Stonegate Observatory. The camera was binned 3x3, resulting in an image scale of 1.9 arcsec/pixel. Exposures ranged from 60-120 s at –15C depending upon conditions. All photometric data were obtained and analyzed using *MPO Canopus* (Warner, 2008). Previous asteroid lightcurve data was reviewed in *The Asteroid Lightcurve Database,* (LCDB, Warner, B.D., Harris, A.W., Pravec, P., 2009) with latest revisions at the *Collaborative Asteroid Lightcurve Link* web site (Warner, 2009).

4285 Hulkower. Data were collected from 2009 May 13 through June 27 resulting in 7 data sets and 266 data points. A period of 6.149 ± 0.001 h was determined. Previous data reported by Pravec (2009) indicate a period of 6.150 h and amplitude of 0.58 mag.

6867 Kuwano. Data were collected from 2009 June 24 through July 9 resulting in 5 data sets and 364 data points. A period of 7.367 ± 0.001 h was determined. There were no previously reported data on this asteroid.

(93768) 2000 WN22. Data were collected on 2009 May 13 and May 15 resulting in 117 data points. The short visibility and sky conditions precluded any further observations. A period of 2.679 ± 0.002 h was determined. Previous data reported by Pravec (2009) indicate a period of 2.6821 h and amplitude of 0.29.

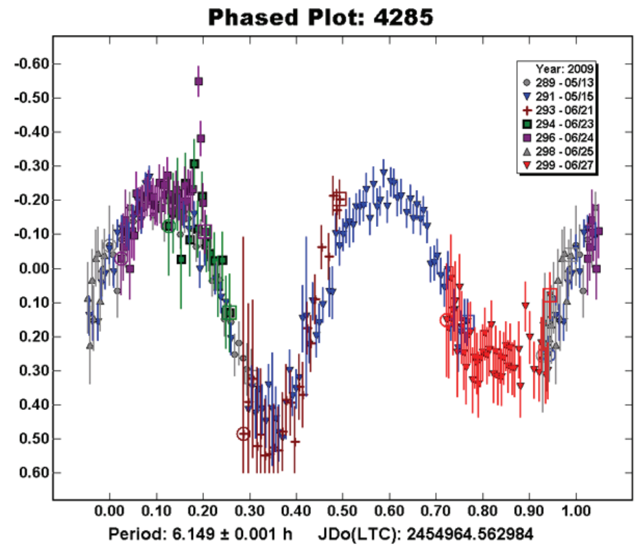
References

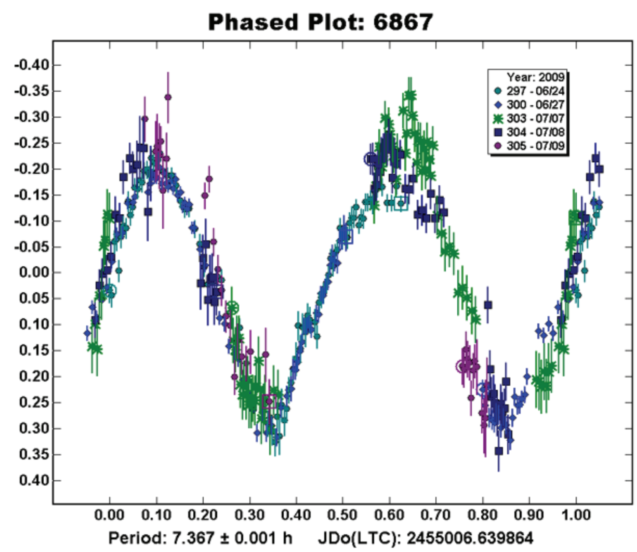
Pravec, P., Wolf, M., and Sarounova, L. (2009). "Ondrejov Asteroid Photometry Project."
http://www.asu.cas.cz/~ppravec/neo.htm

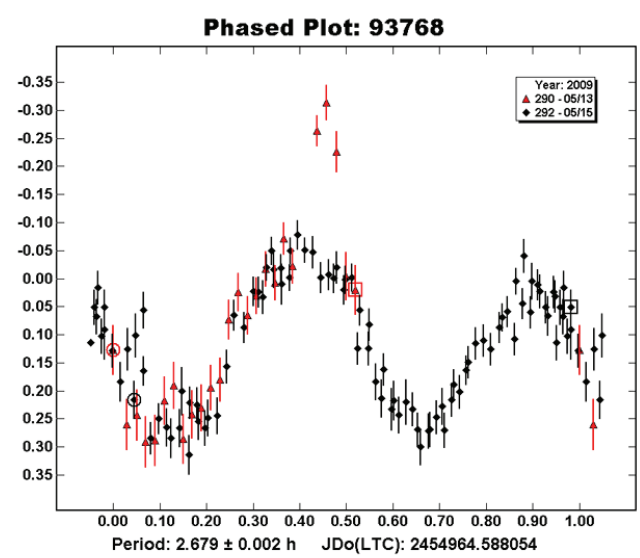
Warner, B.D. (2008). MPO Software, *Canopus* version 9.5.0.5, Bdw Publishing, http://minorplanetobserver.com/

Warner, B.D. (2009). "Collaborative Asteroid Lightcurve Link" web site: http://www.minorplanetobserver.com/astlc/default.htm

Warner, B.D., Harris, A.W., and Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146.







ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2009 MARCH–JUNE

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

(Received: 2009 Jul 4)

Lightcurves for 19 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2009 March through June: 118 Peitho, 191 Kolga, 193 Ambrosia, 364 Isara, 521 Brixia, 1019 Strackea, 1025 Riema, 3266 Bernardus, 3873 Roddy, 3895 Earhart, 4483 Petofi, 4490 Bambery, 4795 Kihara, (6250) 1991 VX1, 6493 Cathybennett, 6510 Tarry, 11789 Kempowski, 11976 Josephthurn, (13578) 1993 MK.

Observations of 19 asteroids were made at the Palmer Divide Observatory from 2009 March through June. One of four telescopes/camera combinations was used: 0.5m Ritchey-Chretien/SBIG STL-1001E, 0.35m SCT/FLI ProLine1001E, 0.35m SCT/ST-9E, or 0.35m SCT/STL-1001E. All images were 1x1 binning, resulting in a scale of approximately 1.2 arcseconds per pixel. All exposures were unfiltered and guided with exposures of 120-240 s. All images were processed and measured using *MPO Canopus* employing differential aperture photometry. Period analysis was also done using *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris et al., 1989).

The results are summarized in the table below, as are individual plots. The data and curves are presented without comment except when warranted. An "(H)" follows the name of an asteroid in the table if it is a member of the Hungaria group/family, which is a primary target of the PDO observing program. The plots are "phased", i.e., they range from 0.0 to 1.0 of the stated period. Most of the plots are scaled such that 0.8 mag has the same linear size as the horizontal axis from 0.0 to 1.0. This is done to allow direct comparison of amplitudes and to avoid the visual impression that the amplitude variation is greater than it actually is, which can create the impression of a physically implausible lightcurve. For low amplitude lightcurves, the scale has been expanded so that the curve is more than a nearly flat line. Even so, this was done as little as possible to avoid creating misleading interpretations. Night-to-night calibration of the data (generally < ±0.05 mag) was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (see Warner 2007 and Stephens 2008).

118 Peitho. Previous findings include Stanzel and Schober (1980, 7.78 h) and Behrend (2009, 7.8033 h). The data obtained at PDO fit a synodic period of 7.823 ± 0.002 h.

193 Kolga. This asteroid was chosen with the hope of resolving which, if any, of the previous solutions was the more likely. These include 27.8 h (Holliday, 2001), 13.7 h (Behrend, 2009), and 13.078 h (Gil-Hutton, 2003). Data at the PDO obtained on 5 nights over a week's time fit a synodic period of 17.625 ± 0.004 h, or none of the above. Attempts to fit the data to the other periods failed decisively.

193 Ambrosia. The period of 6.580 ± 0.001 h found with PDO data agrees with that found by DeYoung and Schmidt (1996).

364 Isara. The period of 9.156 ± 0.001 h found at PDO agrees with that found by Yang (1965).

521 Brixia. The only previous period was > 24 h reported by Surdej et al. (1983). Unfortunately, the asteroid was not very cooperative for this campaign. Given the low amplitude of 0.11 ± 0.02 mag, it is not possible to say definitively if the solution should be monomodal or bimodal. Assuming the former, a period of 9.78 ± 0.02 h is found. If the bimodal solution is adopted, the period is 19.57 ± 0.02 h, with another possible solution at ~18.35 h. Plots of the first two periods are presented below. More data will be needed to solve this asteroid's rotation rate.

1019 Strackea. Ivanova et al. (2002) found a period of 3.832 h with an amplitude of 0.31 mag. Behrend (2009) reports P = 3.98, A = 0.17. The former would seem to be conclusive given the amplitude and the 7 nights of data with several of them being

#	Name	mm/dd 2009	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
118	Peitho	05/07-05/14	400	20.8,21.9	177	6	7.823	0.002	0.15	0.02
191	Kolga	05/07-05/14	319	15.2,16.4	180	6	17.625	0.004	0.30	0.03
193	Ambrosia	04/10-04/21	450	17.5,19.9	161	0	6.580	0.001	0.11	0.02
364	Isara	05/07-05/14	416	13.8,16.1	198	7	9.156	0.001	0.37	0.02
521	Brixia	05/07-05/14	200	19.2	161	11	9.78/19.57	0.02	0.11	0.02
1019	Strackea (H)	04/20-04/22	155	30.1	244	38	4.044	0.002	0.15	0.01
1025	Riema (H)	05/28-05/30	93	26.0	283	34	3.566	0.003	0.11	0.02
3266	Bernardus (H)	03/22-04/07	232	21.5,20.2	203	36	10.757	0.001	0.63	0.02
3873	Roddy (H)	06/16-06/23	203	9.9,14.2	252	5	2.480	0.001	0.06	0.01
3895	Earhart	04/20-04/21	146	19.4	224	32	3.564	0.001	0.28	0.02
4483	Petofi (H)	03/28-04/01	124	22.9,24.0	148	-15	4.334	0.001	0.86	0.02
4490	Bambery (H)	03/28-04/07	170	23.5,22.1	221	34	5.823	0.001	1.16	0.02
4795	Kihara	04/23-05/14	249	6.0,16.3	208	7	16.03	0.01	0.25	0.02
6250	1991 VX1 (H)	05/28-06/24	207	8.4,22.0	239	10	82.6	0.5	0.78	0.05
6493	Cathybennett (H)	05/28-05/30	114	20.5	261	32	3.490	0.005	0.19	0.02
6510	Tarry	04/21-04/22	187	17.8	205	26	6.370	0.003	0.50	0.02
11789	Kempowski (H)	04/21-04/30	260	16.6,19.9	193	14	48.6	0.5	>0.4	
11976	Josephthurn (H)	04/22-04/30	105	2.6	216	0	3.50	0.01	0.08	0.02
13578	1993 MK (H)	05/28-05/30	152	17.2	246	27	7.95	0.03	0.15	0.03

Table I. Observing circumstances. The phase angle is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change significantly and the average value is given. L_{PAB} and B_{PAB} are each the average phase angle bisector longitude and latitude, unless two values are given (first/last date in range).

consecutive. However, the PDO data, also on contiguous dates, cannot be fit to that period, but instead give a best fit with a period of 4.044 ± 0.002 h. The period spectrum for the PDO data (see below) shows a very weak solution at 3.84 h, close to that of Ivanova et al. More data will be needed for this asteroid as well to solve the conundrum.

1025 Riema. Schevchenko et al. (2003) reported a period of 6.557 h for this Hungaria asteroid. Stephens (2003) found 3.580 h. The PDO data support the shorter period.

3873 Roddy. The author worked this asteroid in late 2005 (Warner, 2006) and found a period of 2.4782 h. There were hints of mutual events (occultations or eclipses in a binary system). There were no such indications in 2009. The phase angle bisector longitudes differed by ~138° for the two apparitions. It's possible, but not considered likely, that the different aspect in 2009 prevented seeing such events. However, further follow-up is recommended, just in case.

4483 Petofi. The period for this asteroid is well-established (see Warner et al., 2009, for several references). The PDO data affirmed the period by finding $P = 4.334 \pm 0.001$ h.

4490 Bambery. The author worked this asteroid in 2006 (Warner, 2006). The 2009 apparition was used to build the data set for shape and spin axis modeling. The period found with the 2009 data, $P = 5.823 \pm 0.001$ h, is in excellent agreement with the previously found period of $P = 5.815$ h.

(6250) 1991 VX1. The approximate period for a tumbling damping time equal to the age of the Solar System for this asteroid is 78 h; therefore, the derived period of 82.6 ± 0.5 h would make this a good candidate to be tumbling (see Pravec et al., 2005, for more on damping time and tumbling, or non-principal axis rotation). However, the symmetry of the curve's overall shape and maxima and minima show no outward indication of tumbling. Unfortunately a combination of prolonged bad weather, a waxing moon, and rapidly fading asteroid prevented obtaining additional data.

11789 Kempowski. Review of the individual sessions in combination with the Fourier analysis in *MPO Canopus*, favors a period of 48.6 ± 0.5 h for this Hungaria asteroid. A solution of ~24.2 h cannot be formally excluded, however.

11976 Josephthurn. The low amplitude led to several solutions. A period of 3.50 ± 0.01 h produced the most symmetrical bimodal solution, although one at ~4.89 h had a lower RMS error. A search of possible half-periods, which would be a monomodal curve, favored a period of 1.75 h (and definitely shied away from a half-period of 2.45 h), lending support to the 3.5 h solution. The 1.75 h period is well below the so-called "spin barrier", which – if true – would mean that the asteroid could not be a rubble pile and, given its size ($D \sim 4.5$ km), that it would likely break apart even if a monolith. So, the 3.5 h period is the more likely of the two. That still does not preclude a longer period with a more complex curve.

(13578) 1993 MK. The author previously reported the period to be 7.924 h (Warner, 2008). The 2009 apparition data are in fair agreement, yielding a period of 7.95 ± 0.03 h. The 2008 data set was more extensive and covered a longer span of time, thus allowing a greater precision and higher accuracy.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society.

References

Behrend, R. (2009). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html.

DeYoung, J.A. and Schmidt, R.E. (1996). "The Lightcurve and Period of the Minor Planet 193 Ambrosia." *Minor Planet Bul.* **23**, 42.

Gil-Hutton, R. and Canada, M. (2003). "Photometry of Fourteen Main Belt Asteroids." *Revista Mexicana de Astronomica y Astrofisica* **39**, 69-76.

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.

Holliday, B. (2001). "Photometry of Asteroid 191 Kolga and 1200 Imperatrix." *Minor Planet Bul.* **28**, 13.

Ivanova, V.G., Apostolovska, G., Borisov, G.B., and Bilkina, B.I. (2002). "Results from photometric studies of asteroids at Rozhen National Observatory, Bulgaria." *Proc. ACM 2002, ESA SP* **500**, 505-508.

Pravec, P., Harris, A.W., Scheirich, P., Kušnirák, P., Šarounová, L., and 15 colleagues. (2005). "Tumbling Asteroids." *Icarus* **173**, 108-131.

Shevchenko, V.G., Krugly, Yu.N., Chiorny, V.G., Bel'skaya, I.N., and Gaftonyuk, N.M. (2003). "Rotation and photometric properties of E-type asteroids." *Planet. Space Sci.* **51**, 525-532.

Stanzel, R. and Schober, H.J. (1980). "The asteroids 118 Peitho and 952 CAIA – Rotation periods and lightcurves from photoelectric observations." *Astron. Astrophys. Suppl. Ser.* **39**, 3-5.

Stephens, R.D. (2003). "Photometry of 628 Christine, 754 Malabar, 815 Coppelia, and 125 Riema." *Minor Planet Bul.* **30**, 69-70.

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 21-22.

Surdej, J., Surdej, A., and Louis, B. (1983). "UBV photometry of the minor planets 86 Semele, 521 Brixia, 53 Kalypso, and 113 Amalthea." *Astron. Astrophys. Suppl. Ser.* **52**, 203-211.

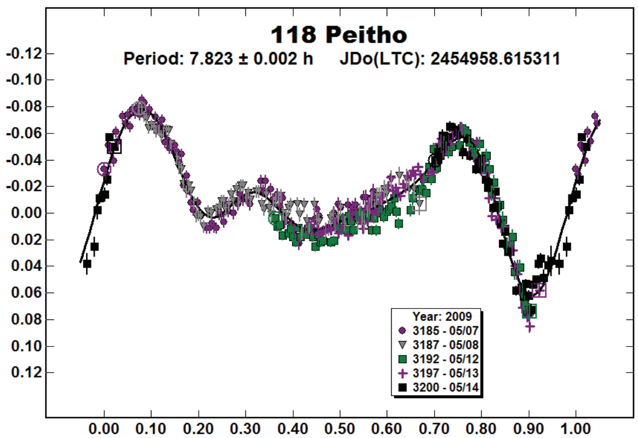
Warner, B.D. (2006). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: March-June 2006." *Minor Planet Bul.* **33**, 82-84.

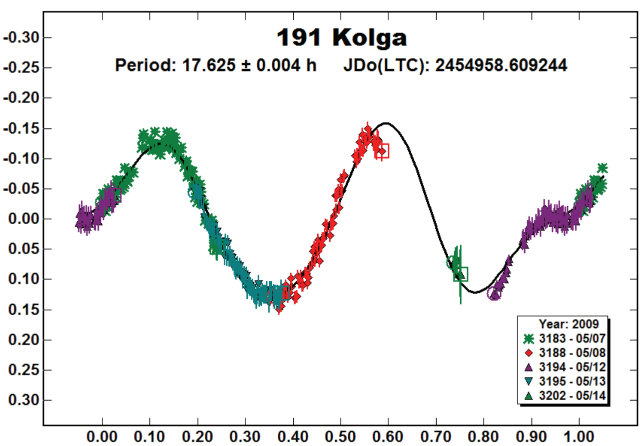
Warner, B.D. (2007). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

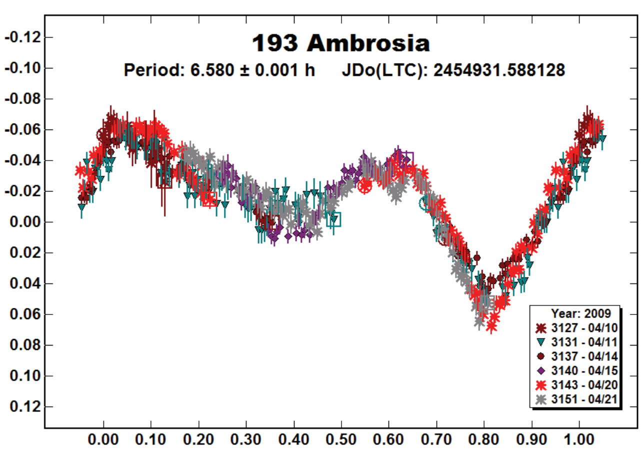
Warner, B.D. (2008). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: December 2007–March 2008." *Minor Planet Bul.* **35**, 95-98.

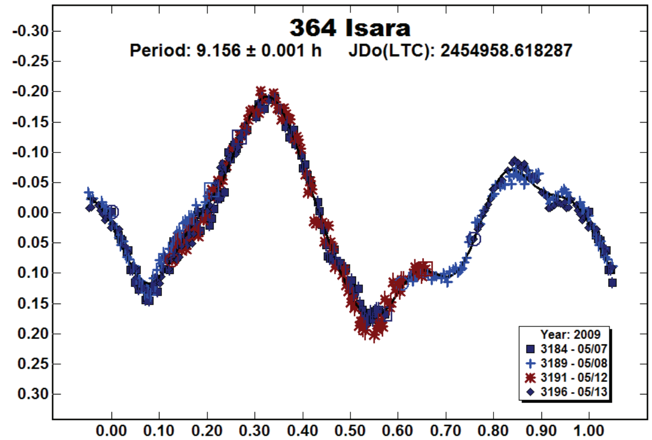
Warner, B.D., Harris, A.W., and Pravec, P. (2009) "The Asteroid Lightcurve Database." *Icarus* 202, 134-146.

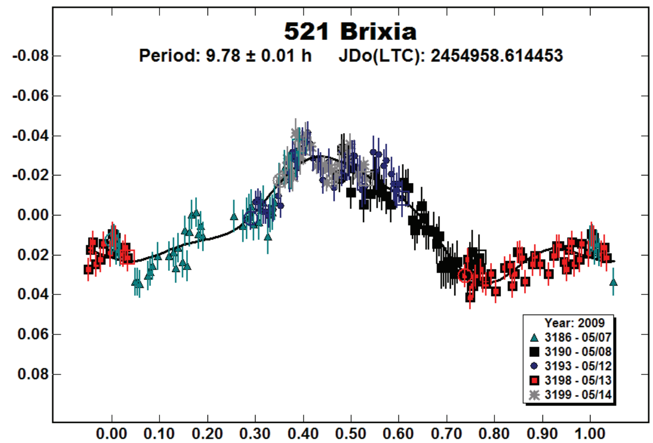
Yang, X.-y., Zhang, Y.-y., and Li, X.-q. (1965) *Acta Astron. Sin.* **13**, 66-74.

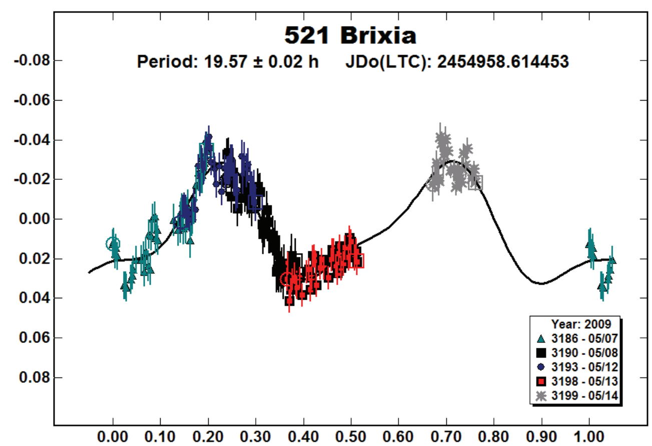


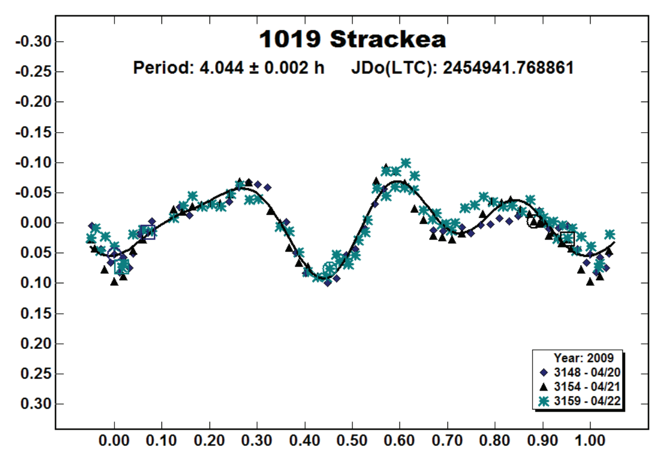


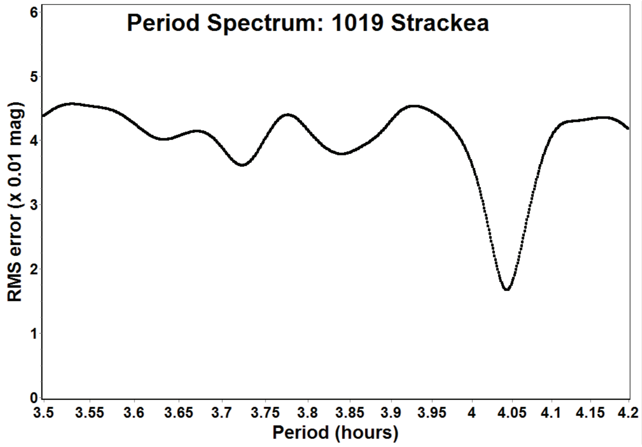


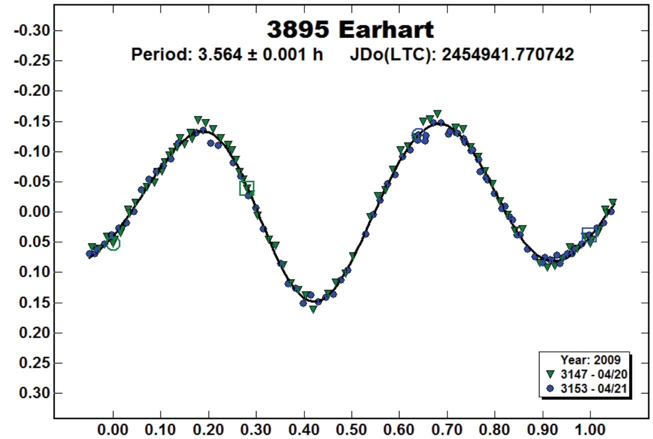


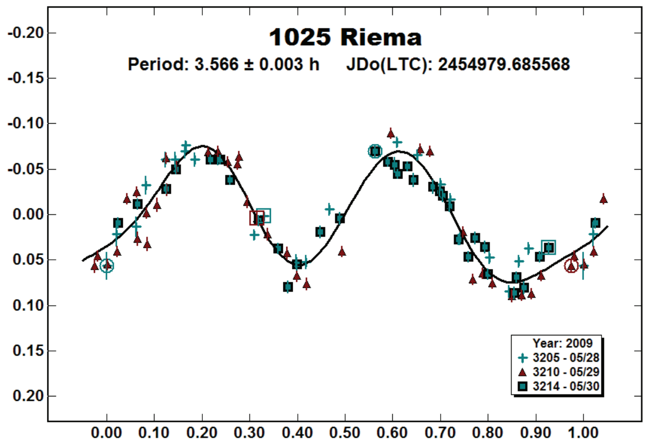


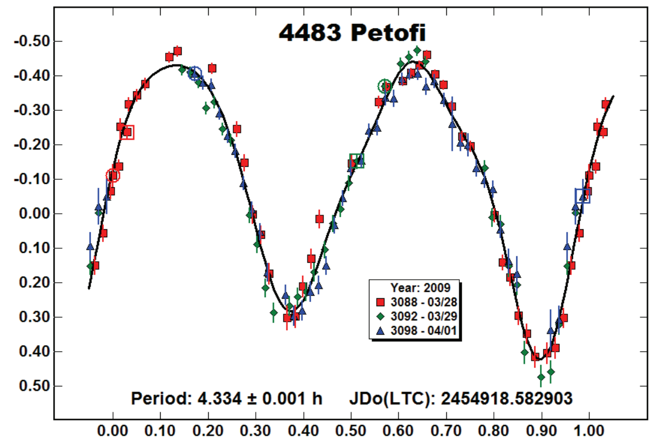


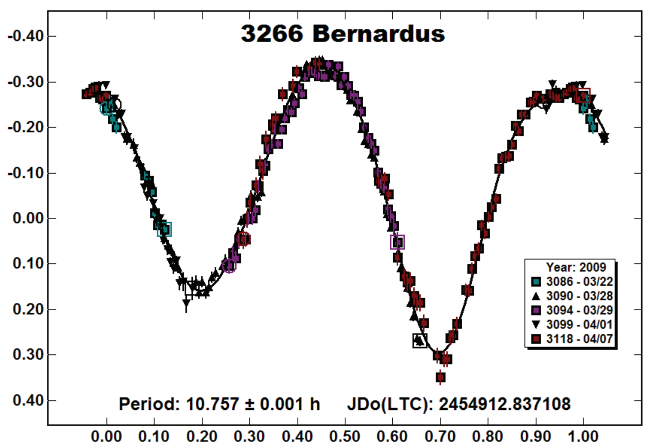


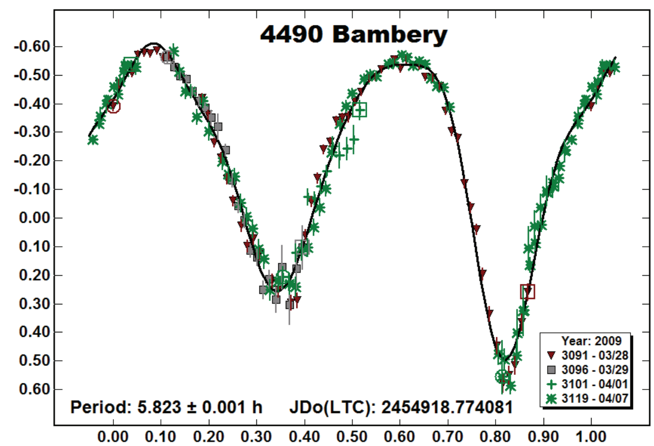

Period Spectrum: 1019 Strackea
RMS error (x 0.01 mag)
Period (hours)

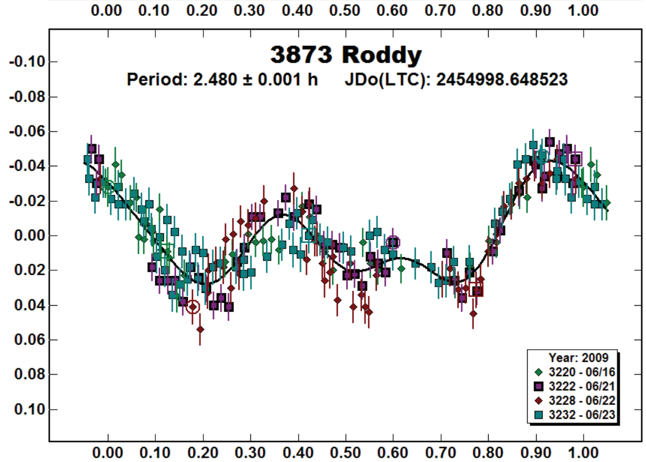

3895 Earhart
Period: 3.564 ± 0.001 h JDo(LTC): 2454941.770742
Year: 2009
3147 - 04/20
3153 - 04/21

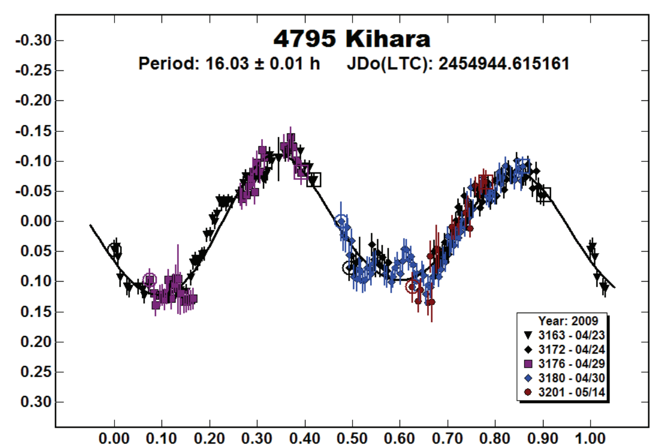

1025 Riema
Period: 3.566 ± 0.003 h JDo(LTC): 2454979.685568
Year: 2009
3205 - 05/28
3210 - 05/29
3214 - 05/30

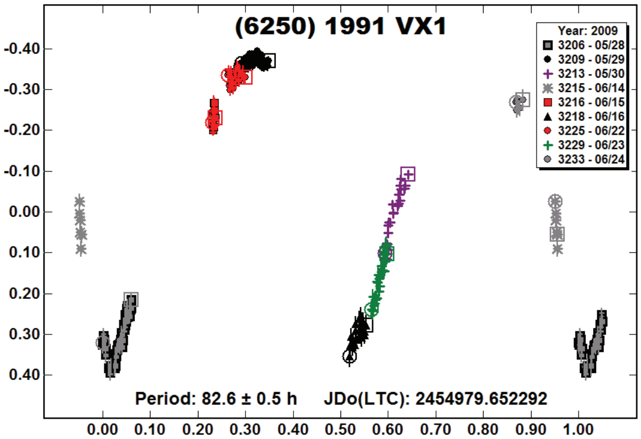

4483 Petofi
Year: 2009
3088 - 03/28
3092 - 03/29
3098 - 04/01
Period: 4.334 ± 0.001 h JDo(LTC): 2454918.582903

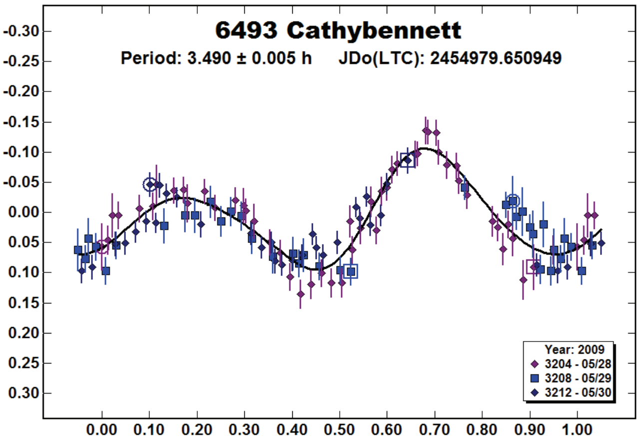

3266 Bernardus
Year: 2009
3086 - 03/22
3090 - 03/28
3094 - 03/29
3099 - 04/01
3118 - 04/07
Period: 10.757 ± 0.001 h JDo(LTC): 2454912.837108

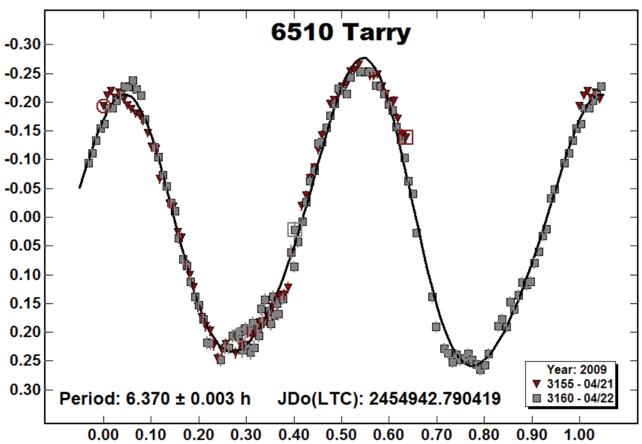

4490 Bambery
Year: 2009
3091 - 03/28
3096 - 03/29
3101 - 04/01
3119 - 04/07
Period: 5.823 ± 0.001 h JDo(LTC): 2454918.774081

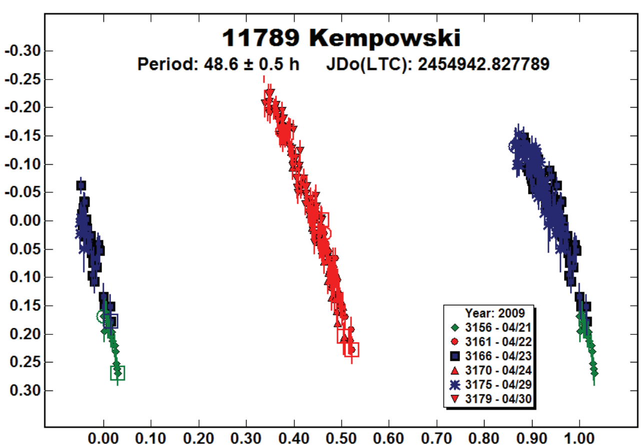

3873 Roddy
Period: 2.480 ± 0.001 h JDo(LTC): 2454998.648523
Year: 2009
3220 - 06/16
3222 - 06/21
3228 - 06/22
3232 - 06/23

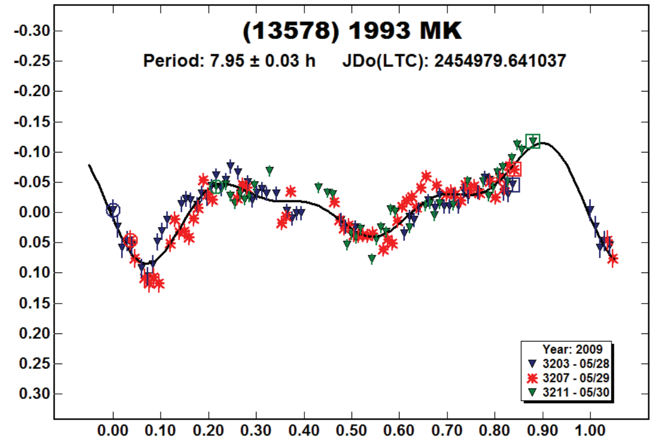

4795 Kihara
Period: 16.03 ± 0.01 h JDo(LTC): 2454944.615161
Year: 2009
3163 - 04/23
3172 - 04/24
3176 - 04/29
3180 - 04/30
3201 - 05/14











A RE-EXAMINATION OF THE LIGHTCURVES FOR SEVEN HUNGARIA ASTEROIDS

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

Robert D. Stephens
Goat Mountain Asteroid Research Station (GMARS)
Landers, CA USA

Alan W. Harris
Space Science Institute
La Canada, CA USA

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

(Received: 2009 Jul 2)

During the course of a study of long period asteroids ($f < 1$ d^{-1}) within the Hungaria asteroid population, the lightcurves for seven asteroids were re-examined using updated software and techniques. Several were found to have significantly different periods from those previously reported by two of the authors (Warner and Stephens). The most significant change was 2074 Shoemaker, which was initially reported to have a period of 57 h but now appears to be a binary asteroid with a primary period of 2.5328 ± 0.0004 h and a possible orbital period of 55.52 ± 0.01 h. The other asteroids that were re-examined were 1919 Clemence, 3043 San Diego, 3353 Jarvis, 4142 Dersu-Uzala, (20232) 1997 YK, and (101549) 1998 YY2. The re-examination showed once again the importance of placing data on at least an internal system to achieve accurate night-to-night calibrations.

Authors Warner and Harris have conducted a concentrated study on the Hungaria population of asteroids since 2004 with one result being the determination of lightcurve parameters for approximately 130 Hungaria members and the discovery of no less than 7 binary asteroids. Analysis of the rotation rates shows strong excess of “slow rotators”, i.e., those with a period >24 h (or frequency, $f < 1\ d^{-1}$). Warner, Harris, and Pravec are now looking at the distribution of the slow rotators in more detail. Part of that effort has been taking another look at ambiguous or questionable findings found in the early stages of the Hungaria study.

In 2007 Warner derived a set of formulae to convert 2MASS (Neugebaur and Leighton, 1969) J-K magnitudes to the Johnson-Cousins BVRI system (Warner, 2007c). The application of those magnitudes for working long period asteroids was discussed in detail by Stephens (2008). All observations by Warner and Stephens now use this technique to provide accurate (<0.05 mag) night-to-night calibrations. This has become critical for such work since there was (and still is) a strong temptation to try to fit low amplitude lightcurves artificially by visual inspection when, in fact, the amplitude was due to noise and the overall trend from a given night was actually a very small increase or decrease in brightness. That these multiple sessions were actually small segments of a much longer period lightcurve became obvious only when the night-to-night levels were fixed according to the calibrations and a number of sessions were available.

Warner and Stephens applied the "2MASS method" in *MPO Canopus* (Warner, 2009) by re-measuring images of seven Hungaria asteroids that were observed before the method was available. As a result, the period and amplitudes of several curves changed significantly and a probable new binary asteroid was discovered.

<u>1919 Clemence</u>. The period of this Hungaria asteroid was first reported to be 68.5 h with an amplitude of 0.60 mag. (Warner, 2005). After the new analysis, a period we found a period of 67.4 ± 0.1 h. and amplitude of 0.15 ± 0.03 mag. If the Fourier analysis is limited to only 2 orders, the solution is unique. However, higher orders allow for other solutions, including those that involve more than two maxima and minima per cycle. Using the U code rating in the asteroid lightcurve database (LCDB, Warner et al., 2009), we give this U = 2 at best.

<u>2074 Shoemaker</u>. Stephens (2004) reported this Hungaria to have a period of 57.02 h with an amplitude of 0.45 mag. This was based on visually fitting different sessions and presuming the minor variations were noise. It appears instead that this is very likely a newly discovered binary asteroid. The new analysis found a distinct main period of 2.5328 ± 0.0004 h with two suggestive "events" (mutual occultation or eclipses) that appear to be total because of flat bottoms. From these, we found an orbital period of 55.5 ± 0.5 h. The error assumes a circular orbit. If not circular, the error could be 2-3x larger. The orbital period is constrained as much by the absence of events at other times as by the coincidence of the two observed events. Other orbit periods would predict mutual events on other nights where none were observed. Unfortunately, the only gap in coverage of the 55.5 h period falls exactly where one would expect the other (primary?) event to fall. Assuming the events are secondary, the size ratio (Ds/Dp) is ~0.25. However, it must be clearly said that the data set is too limited to state these conclusions with certainty. We urge careful observations of this asteroid at the next possible opportunity.

<u>3043 San Diego</u>. Warner (2005) reported a period of 30.72 h and 0.37 mag amplitude. The new analysis shows a much different result with a period of 105.7 ± 0.1 h and amplitude ~0.6 mag. If so, the lightcurve shows asymmetrical minimums, which may be an indication that it is tumbling.

<u>3353 Jarvis</u>. The period for Jarvis was first reported to be 40.8 h with an amplitude of 0.10 mag (Warner, 2007a). The new analysis finds a period of 202.0 ± 0.5 h and amplitude ~0.6 mag. This and 3043 San Diego were prime examples of how relying on only visual inspection, i.e., *not* linking data to at least an internal system, can lead to significantly different results.

<u>4142 Dersu-Uzala.</u> The period first reported by Warner (2007b) was 71.2 h with an amplitude of 0.22 mag. We now believe the more likely period is nearly double that, 140 ± 3 h, with a maximum amplitude of 0.65 mag. The significantly different depths of the two minimums may be an indication that the asteroid is tumbling. However, the limited data set prevents stating this and the error in the period with any certainty.

<u>(20231) 1997 YK</u>. Warner (2006) reported a period of 48.2 h and amplitude >0.22 mag. Our new analysis cannot find a unique period. Indications are that this asteroid is in a highly agitated state of tumbling and has a relatively short "primary" period. The plot below shows the complete raw data set with no attempt to force the data to a fixed period. Working with the individual sessions gives considerably different results. For example, when using only the data from Oct. 3, forcing a period of ~14 h creates a curve that approximates about 25% of a symmetrical bimodal solution. The Oct. 1 data alone implies a period of around two or more days. A much more extensive data set is needed to fully determine the rotation characteristics.

<u>(101549) 1998 YY29</u>. The new analysis yields $P = 56.7 \pm 0.1$ h, $A = 0.51 \pm 0.03$ mag., which is only a small difference from the original solution of $P = 56.5$ h, $A = 0.70$ mag. If nothing else, the new analysis confirmed both the approximate period and the unusual shape of the lightcurve, the latter possibly indicating that the asteroid is in some state of tumbling. Again, a more extensive data set would be required to fully determine the rotational characteristics.

Conclusion

While this exercise was important to our study of slowly rotating Hungaria asteroids, we hope that it serves another purpose: to demonstrate the importance of putting data onto at least an internal system in which the observer has confidence and to avoid "fixing" data by artificially adjusting zero points without good justification. It also demonstrates that one should re-evaluate past results as possible or appropriate when new methods or tools become available. That may be time-consuming but getting to "the truth" is never a waste of time.

Warner also emphasizes that out of the approximately 140 lightcurves for Hungaria asteroids obtained at the Palmer Divide Observatory, only a very small handful required new analysis. Most of the data were already on an internal system and/or the data for one or more individual sessions were sufficiently conclusive so as to remove ambiguities due to zero point adjustments.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

References

Neugebauer, G. and Leighton, R.B. (1969). Two-micron Sky Survey: A Preliminary Catalog. NASA.

Stephens, R.D. (2004). "Photometry of 804 Hispania, 899 Jokaste, 1306 Scythia, and 2074 Shoemaker." *Minor Planet Bul.* **31**, 40-41.

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 21-22.

Warner, B.D. (2005). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: Winter 2004-2005." *Minor Planet Bul.* **32**, 54-58.

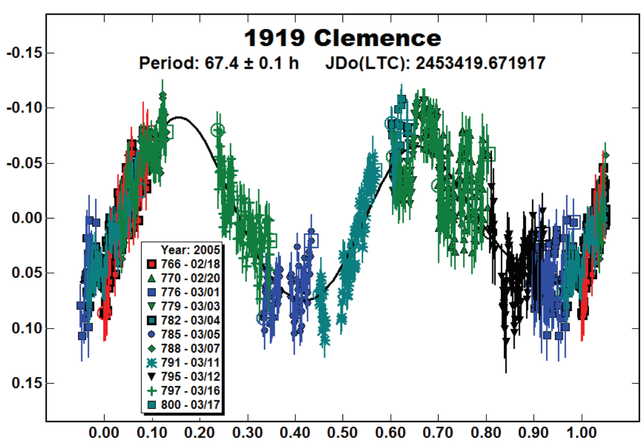
Warner, B.D. (2006). "Analysis of 13 Asteroid Lightcurves Obtained at the Palmer Divide Observatory." *Minor Planet Bul.* **33**, 39-41.

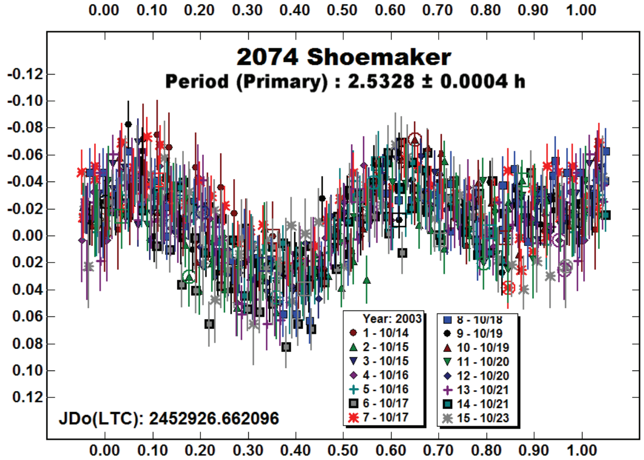
Warner, B.D. (2007a). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: June-September 2006." *Minor Planet Bul.* **34**, 8-10.

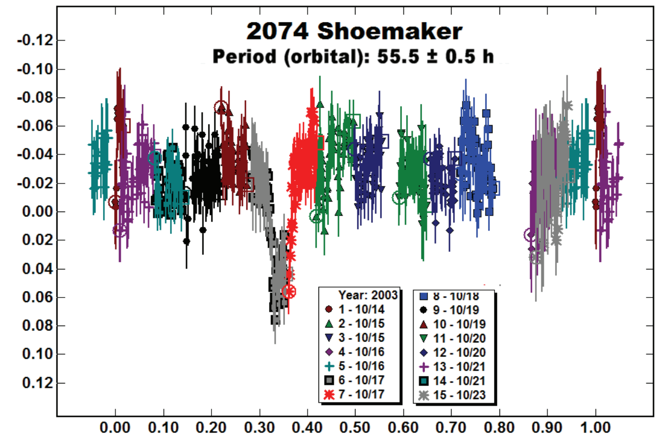
Warner, B.D. (2007b). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: September-December 2006." *Minor Planet Bul.* **34**, 32-37.

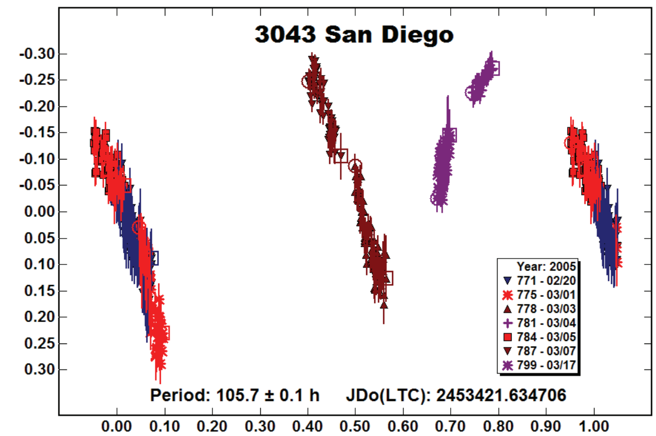
Warner, B.D. (2007c). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

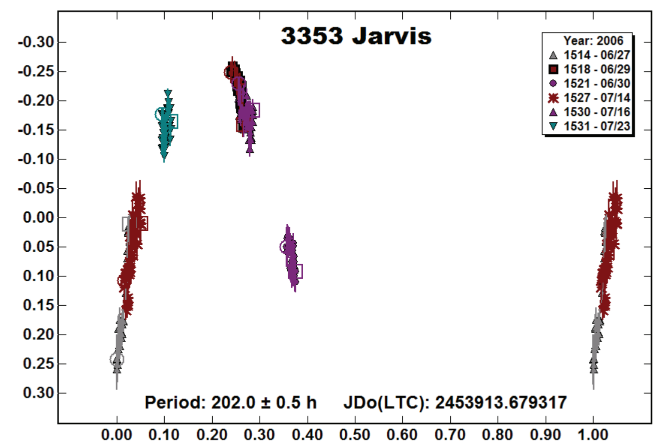
Warner, B.D., Harris, A.W., and Pravec, P. (2009) "The asteroid lightcurve database." *Icarus* **202**, 134-146.

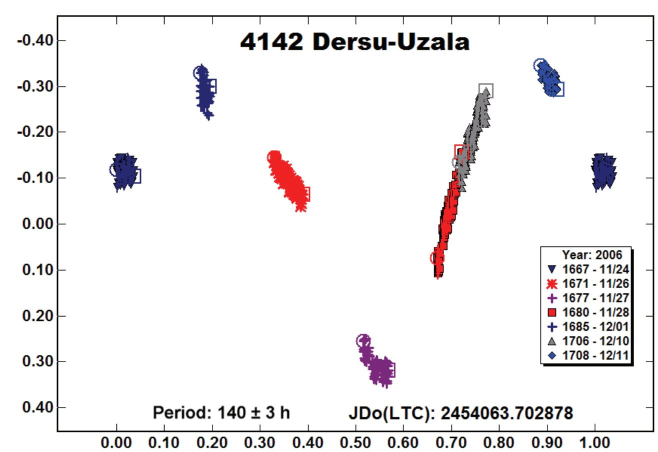


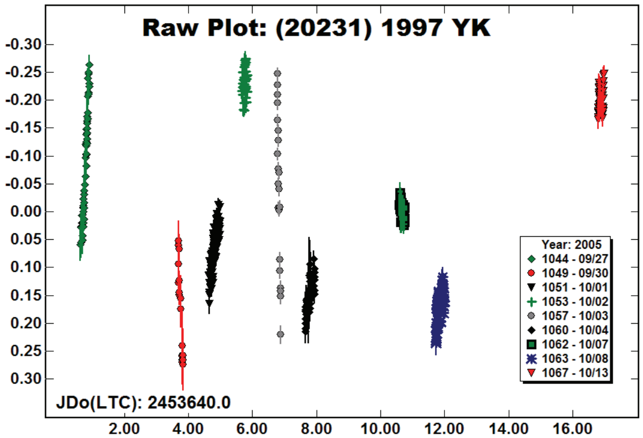


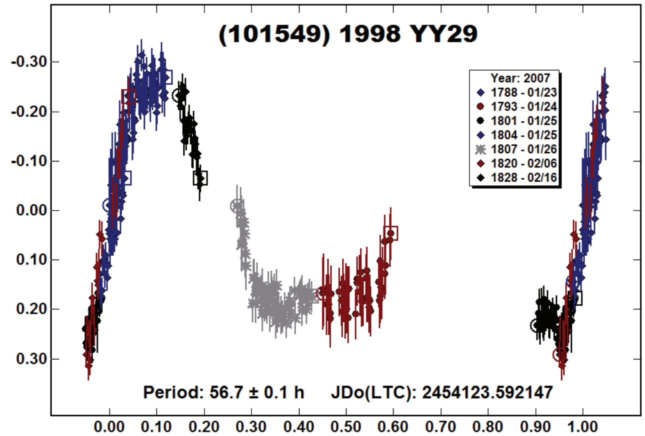












ANALYSIS OF THE SLOW ROTATOR (143651) 2003 QO104

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

Robert D. Stephens
Goat Mountain Asteroid Research Station (GMARS)
Landers, CA USA

Albino Carbognani
Saint-Barthelemy Observatory
Lignan 39, 11020 Nus (Aosta), ITALY

(Received: 2009 Jul 7)

We report on our collaboration to obtain photometric data on the near-Earth asteroid (143651) 2003 QO104 in support of radar observations. Our initial data indicated a slowly rotating asteroid, which allowed radar observers to change their observing schedule accordingly. After obtaining data from 2009 March through April, we were able to determine a synodic period of 115 ± 1 h and amplitude of 1.60 ± 0.05 mag. There are indications that the asteroid may be in non-principal axis rotation, i.e., tumbling.

Observations of the near-Earth asteroid (143651) 2003 QO104 were started by Warner and Carbognani in 2009 mid-March. Stephens contributed data during the campaign to help avoid gaps due to weather and other circumstances. Warner and Stephens linked their observations from night-to-night using the 2MASS (Neugebaur and Leighton, 1969) to BVRI conversions developed by Warner (2007) and applied as described by Stephens (2008).

Initial indications were for a long period, probably > 24 h and amplitude of at least 0.5 mag. As more data became available, it was increasingly obvious that the asteroid had a much longer period and larger amplitude. This proved important to radar observers (Benner, private communications) since the slow rotation would mean higher signal-to-noise values. Accordingly, observing schedules at both Arecibo and Goldstone were changed to obtain additional data. The final data set of photometric observations spanned from 2009 March 17 to April 19. During that time, all but one session – April 15 – "fell into line." Disregarding this anomaly, we derived a synodic period of 114.42 ± 0.02 h and amplitude of 1.60 ± 0.05 mag for the ~1.9 km diameter asteroid

Tumbling Considerations

Figure 1 shows the entire lightcurve data set phased to the adopted period of 114.42 h. Note how the April 15 session appears to cover a minimum but is displaced both in time and zero point from the rest of the curve. Figure 2 is a close-up of the plot in Figure 1, showing in more detail the "break-away" April 15 session. If one assumes a minimum was captured, then the vertical displacement (change in zero point) is ~0.75 mag and the period that would match it to the minimum covered on March 17 would be 115.5 h. This period would, however, seriously spoil the match-up of other parts of the composite. Such mis-fits in both time and magnitude level are common signs of tumbling. If we adopt that explanation, then the period is not a constant single value; we thus adopt a period of 115 ± 1 h. Exploring the alternate assumption of observational error on April 15, if one removes the first ten or so data points from the session, removing the apparent minimum, then a shift of ~0.35 mag brings the session into line with the rest of the curve with the period of 114.42 h. This offset in the zero point is considerably larger than the average error of the calibration method used (~ ±0.05 mag), though offsets that large have been seen under rare circumstances. As a check, the images were measured a second time using a different set of comparison stars. The result was the same apparent capture of a minimum and the large magnitude displacement.

The conclusion from all this is that the April 15 session may be an indication of tumbling since it, being from a second cycle, did not match the curve based on the first cycle. In support of this contention, the maxima and minima are not quite equal, which is another potential sign of tumbling. The lack of overlapping coverage prevents a more certain determination. Had we obtained more data from a second cycle and they also did not match with those from the first, then that would have been almost conclusive evidence of tumbling. Finally, in support of tumbling, the approximate tumbling damping time for the given period and diameter of the asteroid is on the order of 85 Gyr. This is the time that it would take the asteroid to stabilize into single (principal) axis rotation. That is many times longer than the age of the Universe, let alone the Solar System. See Pravec et al. (2005) for a thorough discussion of tumbling asteroids.

We note that this campaign provides yet another example of the importance of collaboration among optical observers, coordination with observers in other disciplines, and of putting optical data onto at least an internal system in order to analyze data correctly.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

We thank Alan W. Harris of Space Science Institute (USA) and Petr Pravec of the Astronomical Institute (Czech Republic) for their insights and comments regarding this work.

References

Neugebauer, G. and Leighton, R.B. (1969). Two-micron Sky Survey: A Preliminary Catalog. NASA.

Pravec, P., Harris, A.W., Scheirich, P., Kušnirák, P., Šarounová, L., and 15 colleagues (2005). "Tumbling Asteroids." *Icarus* **173**, 108-131.

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 21-22.

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

Warner, B.D., Harris, A.W., and Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146.

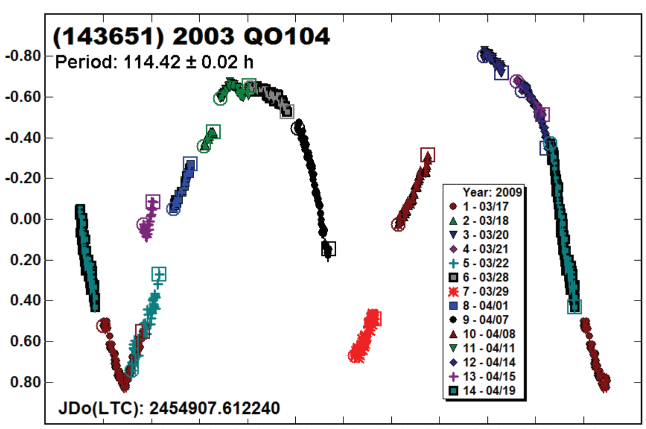


Figure 1. Lightcurve of (143651) 2003 QO104.

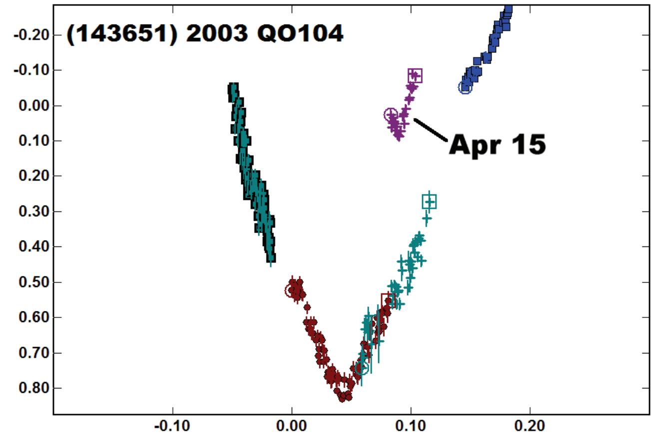


Figure 2. Close-up of Figure 1 showing details of the April 15 data.

PHOTOMETRIC OBSERVATIONS AND LIGHTCURVE ANALYSIS OF NEAR-EARTH ASTEROIDS (136849) 1998 CS1, 2006 SZ217, AND 2008 UE7

Quanzhi Ye
Department of Atmospheric Science, Sun Yat-sen University, Guangzhou, China (mainland)
tom6740@gmail.com

Liaoshan Shi
School of Physics and Engineering, Sun Yat-sen University, Guangzhou, China (mainland)

Wentao Xu
School of Physics and Technology, Wuhan University, Wuhan, China (mainland)

Hung-Chin Lin
Graduate Institute of Astronomy, National Central University, Chung-li, Taiwan

Junfeng Zhang
Department of Atmospheric Science, Sun Yat-sen University, Guangzhou, China (mainland)

(Received: 2009 Jul 3)

Near-Earth Asteroids (NEAs) (136849) 1998 CS1, 2006 SZ217, and 2008 UE7 were observed photometrically in the course of Lulin Sky Survey (LUSS) in 2008 December and 2009 January. The rotation periods and lightcurve amplitudes for these three asteroids have been determined as: (136849) 1998 CS1, 4.150 ± 0.001 h and 0.11 mag; 2006 SZ217, 3.2474 ± 0.0001 h and 0.10 mag; 2008 UE7, 3.25146 ± 0.00001 h and 0.13 mag.

Photometric studies of three near-Earth asteroids (NEAs) were carried out in 2008 December and 2009 January in the course of Lulin Sky Survey (LUSS). LUSS was equipped with a 0.41-m Ritchey-Chretien telescope operating at f/6.25 and a back-illuminated Apogee U42 CCD. The program's main goal is obtaining astrometric observations of asteroids and comets, but photometric studies are performed occasionally, usually targeting unusual asteroids such as NEAs or those with a large orbital eccentricity. CCD images were reduced and calibrated remotely by the automatic pipeline *INT* (Ye, 2008) and then were transferred to a local computer. The brightness variations of asteroids were determined by differential photometry using *MPO Canopus* while the astrometric data was measured by *MPT* (Ye, 2008). The observing procedure and result for each asteroid is described below.

(136849) 1998 CS1 was discovered by Beijing Schmidt CCD Asteroid Program (SCAP) on 1998 Feburary 9 (Tichy et al., 1998) and is classified as a Potentially Hazardous Asteroid (PHA). No photometric result has been published before this work. From 2009 January 8 to 11, three nights of data were successfully obtained and a period of 4.150 ± 0.001 h was found. However, an internal calibration was not done due to an insufficient number of comparison stars. We note that the curves from different nights do not fit with each other very well. The possibility of a period of 5.54 h or a much longer one, although not significant, cannot be ruled out. We attempted to get more images on January 14-17 but failed due to bad weather and technical problems. Further observations are recommended for this target.

2006 SZ217 was discovered by the Spacewatch program on 2006 September 30 (Bressi et al., 2006); no photometric result has been published before this work. Five nights of data were taken on December 6-15 but they suffered due to strong moonlight, resulting in errors as large as ±0.1 mag. However, a period of 3.2474 ± 0.0001 h can still be derived with some confidence.

2008 UE7 was discovered by the LINEAR program on 2008 October 26 (Young et al., 2008) and is classified as a PHA; no previous photometric result could be found. We obtained a total of five nights of data of acceptable quality from 2008 December 1-7. Based on that data, we found a period of 3.25146 ± 0.00001 h.

Acknowledgements

We would like to thank Hsiang-Yao Hsiao and Chi Sheng Lin for their assistance with obtaining the observations. This work is supported by a 2007 Gene Shoemaker NEO Grant from the Planetary Society. The 0.41-m Ritchey-Chretien telescope is operated with support from the Graduate Institute of Astronomy, National Central University.

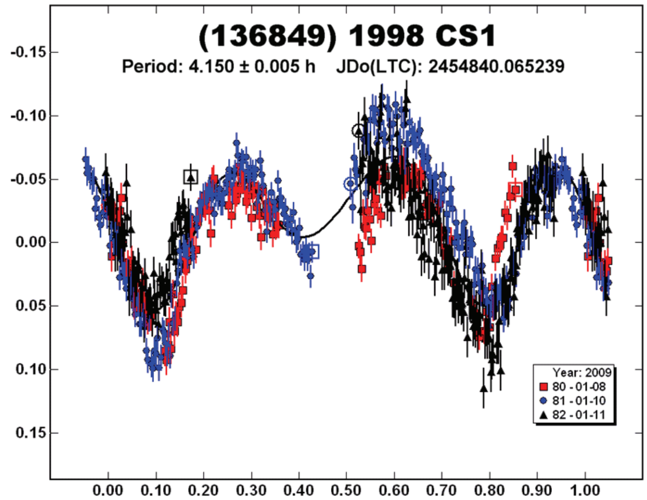
Reference

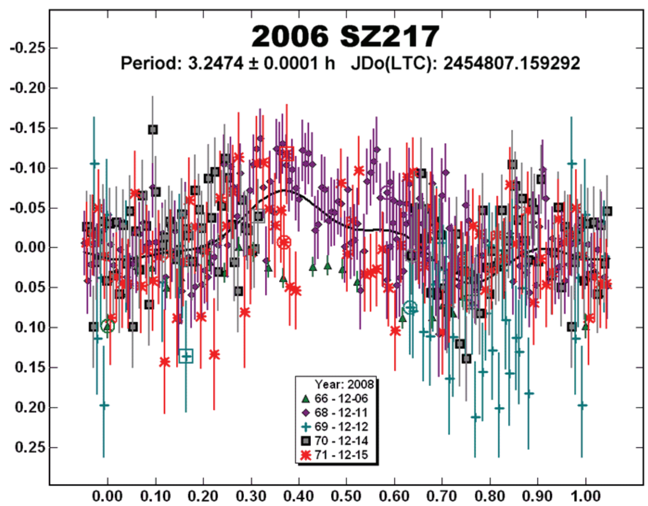
Bressi, T. H., Read, M. T., Tubbiolo, A. F., Hug, G., Tibbets, D., McGaha, J. E., Kowalski, R. A., Beshore, E. C., Christensen, E. J., Garradd, G. J., Gibbs, A. R., Grauer, A. D., Hill, R. E., Larson, S. M., McNaught, R. H., Birtwhistle, P., and Spahr, T. B. (2006). "2006 SZ217." *MPEC* 2006-T01.

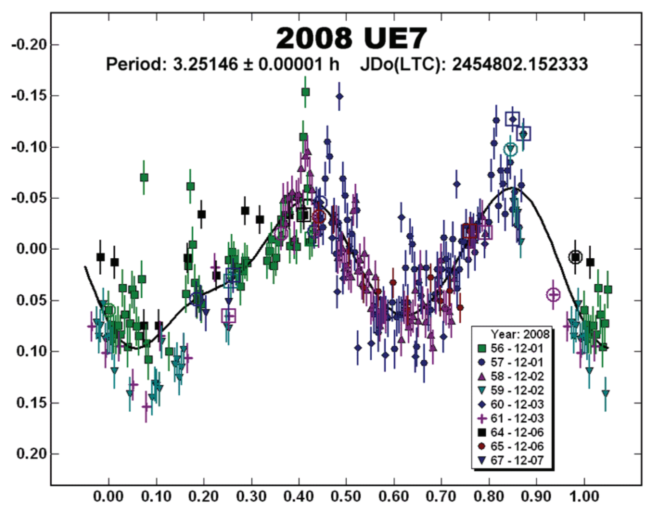
Tichy, M., Moravec, Z., Tesi, L., Boattini, A., Forti, G., Zhu, J., Chen, Y. J., Zheng, Z. Y., Li, X. Y., Nakamura, A., and Williams, G. V. (1998). "1998 CS1." *MPEC* 1998-C27.

Ye, Q.-z., Lin, H.-C., Lin, C. S., and Shih, C.-y. (2008). "Lulin Sky Survey.", *Lulin Observatory Annual Report* **5**, 58.

Young, J., Bezpalko, M., Torres, D., Kracke, R., Spitz, G., Kistler, J., Stuart, J., Scruggs, S., Ryan, W. H., Birtwhistle, P., and Spahr, T. B. (2008). "2008 UE7." *MPEC* 2008-U72.







LIGHTCURVE AND ABSOLUTE MAGNITUDE OF 1909 ALEKHIN

Roger Dymock
67 Haslar Crescent, Waterlooville, Hampshire PO7 6DD
ENGLAND
roger.dymock@ntlworld.com

(Received: 2009 Jul 1)

Observations of 1909 Alekhin resulted in a rotational period of 148.6 ± 0.2 h and an absolute magnitude of 12.91 ± 0.07.

The asteroid 1909 Alekhin was chosen from a list of asteroids with suspect absolute magnitude values published by the Minor Planets Section of the Association of Lunar and Planetary Observers (ALPO) as part of their Magnitude Alert Project (MAP). Richard Miles, Director of the Asteroids and Remote Planets (ARPS) Section of the British Astronomical Association (BAA), suggested that I attempt to construct both a lightcurve and a phase curve from my observations.

For this project I used the Sierra Stars Observatory Network (SSON) 0.61-m robotic telescope located in California, USA. The work was partially funded by a BAA grant for which I am most grateful. Using the SSON telescope is simple and the owner, Rich Williams, has been extremely helpful in all matters relating to the operation of this facility. Imaging was conducted between 2009 March 24 and May 27. Images, each of 60 s duration, were taken through a V filter and spaced approximately 1 hour apart. Towards the end of the observing period the number of images that could be obtained was limited by the reducing hours of darkness, the waxing moon, and the decreasing altitude of the asteroid. Measurement of V magnitudes has become a relatively simple task by using a method in *Astrometrica* that converts r' magnitudes from the CMC14 catalog to V (Miles and Dymock, 2009). Magnitudes were measured using Astrometrica choosing the CMC14 catalogue while positions were similarly measured but using the USNO B1 catalogue. The relevant data were imported into *MPO Canopus* and a lightcurve and phase curve built up as each night's images were obtained. It soon became clear that the rotational period of this asteroid was unusual in its long duration. Long period asteroids have presented problems in the past due to the difficulty of combining session data when different comparison stars are used. This usually meant resorting to absolute or all-sky photometry. Inputting absolute rather than differential magnitudes made the combining of many nights' data a simple task since there was no need to use the CompAdjust form in *Canopus* to adjust the data from different sessions. Analysis of seventeen nights' images suggested that the rotational period was 148.6 ± 0.2 h (Figure 1). This being close to 6 days coupled with the short nights prevented a complete lightcurve being obtained. Petr Pravec of Ondřejov Observatory analysed my data independently and derived a unique solution of 148.8 h.

Using the *MPO Canopus H-G* calculator, the absolute magnitude, *H*, was determined to be 12.91 ± 0.07 with the value for the slope parameter, *G*, to be 0.19 ± 0.06. The value given by the Minor Planet Center and JPL is *H* = 12.3, which is based on *G* = 0.15. The Asteroids Dynamic Site (AstDys) gives *H* = 12.6, also using *G* = 0.15. The new values for *H* and *G* values (and the observational data) have been forwarded to the Magnitude Alert Project for inclusion in a future *Minor Planet Bulletin* paper.

Acknowledgements

My thanks to Richard Miles, Petr Pravec, and Herbert Raab. Thanks are given also to Alan Harris, Petr Pravec, and Brian Warner for a fruitful exchange of emails on the subject of slow rotating asteroids and to the BAA for their grant in support of this project.

References

ALPO Magnitude Alert Project web site: http://astrosurf.com/aude/map/index_us.htm

Asteroids Dynamic web site: http://hamilton.dm.unipi.it/astdys/

Astrometrica software: http://www.astrometrica.at/

BAA Asteroids and Remote Planets Section web site: http://britastro.org/asteroids/

BAA Robotic Telescope Project: http://www.britastro.org/iandi/robotic02.htm

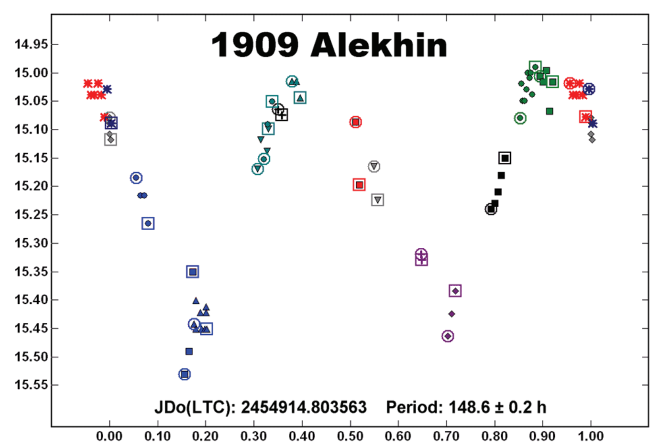
JPL Horizons web site: http://ssd.jpl.nasa.gov/horizons.cgi

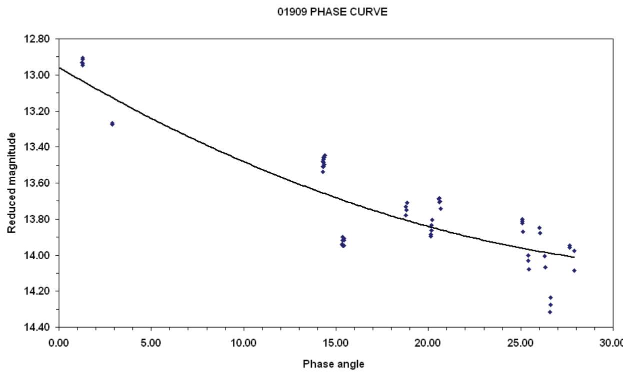
Miles, R., Dymock, R. (2009). "A method for determining the V magnitude of asteroids from CCD image." *J.B.A.A.* ***119*****,** 149-156. (Available on-line at http://britastro.org/asteroids/JBAA%20119%20149-156%20Dymock1.pdf

Minor Planet Center web site: http://www.cfa.harvard.edu/iau/mpc.html

MPO Canopus: http://www.minorplanetobserver.com/MPOsoftware/MPOcanopus.htm

Sierra Stars Observatory Network web site: http://www.sierrastars.com/





BYPRODUCT TARGETS DURING PHOTOMETRIC OBSERVATIONS FROM MODRA

Adrián Galád
Modra Observatory,
Department of Astronomy, Physics of the Earth, and Meteorology
FMFI UK, 842 48 Bratislava, SLOVAKIA
and
Astronomical Institute AS CR, 251 65 Ondřejov,
CZECH REPUBLIC
galad@fmph.uniba.sk

(Received: 2009 Jul 12)

Lightcurve analysis of asteroids 1446 Sillapää, 2986 Mrinalini, 4979 Otawara, (12815) 1996 DL2, (14901) 1992 SH, (15914) 1997 UM3, (16717) 1995 UJ8, (24039) 1999 SS8, (27204) 1999 CY74, 44217 Whittle, (48073) 2001 FC13, and (99812) 2002 LW31 is reported.

The field of view of the 0.60-m f/5.5 telescope with AP8p CCD-camera at Modra is 25’ x 25’. It sometimes enables us to observe some “byproduct asteroids” along with those that were part of our planned observations. A set of 12 of such byproduct asteroids is presented here.

1446 Sillanpää. This target appeared by chance in the field of another asteroid being worked at Modra one month after it was studied by a group of observers in Photometric Survey for Asynchronous Binary Asteroids (Pravec, 2006). However, our new observations could not be joined with the previous data obtained by Pray, Higgins, and Marchis (Pravec 2009) since the amplitude of the lightcurve had increased by ~0.16 mag due to increased solar phase angle.

2986 Mrinalini and (12815) 1996 DL2. Only tentative lightcurves based on two short linked sessions are presented for these targets. A simple shape of the lightcurves is assumed. Except for the periods given here, one of ~11.9 h also fits the data nearly as well for both asteroids.

4979 Otawara. The synodic rotation period of this asteroid was previously found to be 2.707 ± 0.005 h (Doressoundiram et al., 1999; Le Bras et al., 2001; Fauvaud et al., 2003; and Fornasier et al., 2003). Our observations are in agreement, within errors, with those results.

(14901) 1992 SH. Two branches of mutually linked but short sessions were not enough to determine the synodic rotation period unambiguously. The presented composite lightcurve is not fully covered by observations. However, visual inspection of other possible composite lightcurves (e.g., P = 3.7464 h) offers only less probable results.

(15914) 1997 UM3. Two linked sessions were obtained two months after a favorable apparition for this asteroid. Except for the presented result, a period near 8.5 h would fit the data about as well. Based on the relative brightness of other objects in the field of view, it seemed that the asteroid was fainter by ~0.5 mag than predicted when using the absolute magnitude (H) and slope parameter (G) values given by Minor Planet Center.

(16717) 1995 UJ8, (48073) 2001 FC13, and (99812) 2002 LW31. Linked sessions indicate that these faint asteroids rotate slowly.

(24039) 1999 SS8. The rotation period was unambiguously and quickly derived due to the large amplitude of the lightcurve.

(27204) 1999 CY74 and 44217 Whittle. These asteroids were observed in the same field of view but only on two consecutive nights. Interestingly, the amplitude of their lightcurves was large and even the periods were similar. However, the results are not firm.

Acknowledgements

I’m grateful to Petr Pravec, Ondřejov Observatory, Czech Republic, for his ALC software used in data analysis. The work was supported by the Slovak Grant Agency for Science VEGA, Grant 2/0016/09 and the Grant Agency of the Czech Republic, Grant 205/09/1107.

References

Doressoundiram, A., Weissman, P. R., Fulchignoni, M., Barucci, M. A., Le Bras, A., Colas, F., Lecacheux, J., Birlan, M., Lazzarin, M., Fornasier, S., Dotto, E., Barbieri, C., Sykes, M. V., Larson, S., and Hergenrother, C. (1999). “4979 Otawara: flyby target of the Rosetta mission.” *Astronomy and Astrophysics* **352**, 697-702.

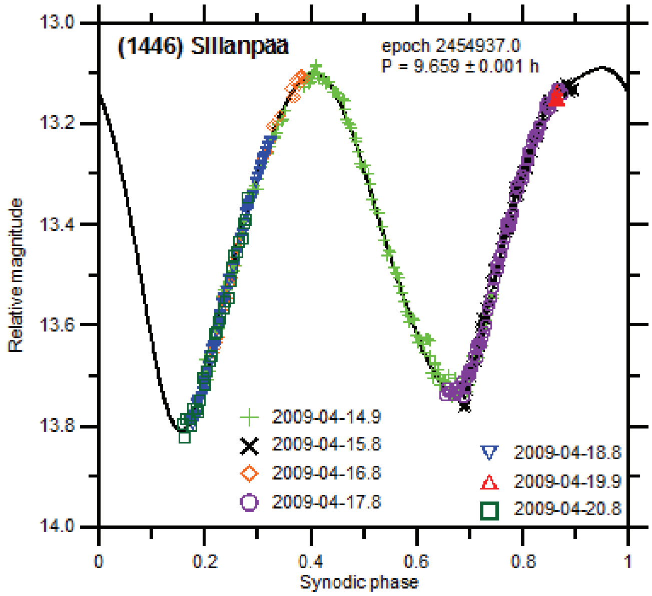
Fauvaud, S., Fauvaud, M., and Paschke, A. (2003). “CCD photometric observations of the minor planet 4979 Otawara.” *Minor Planet Bulletin* **30**, 73.

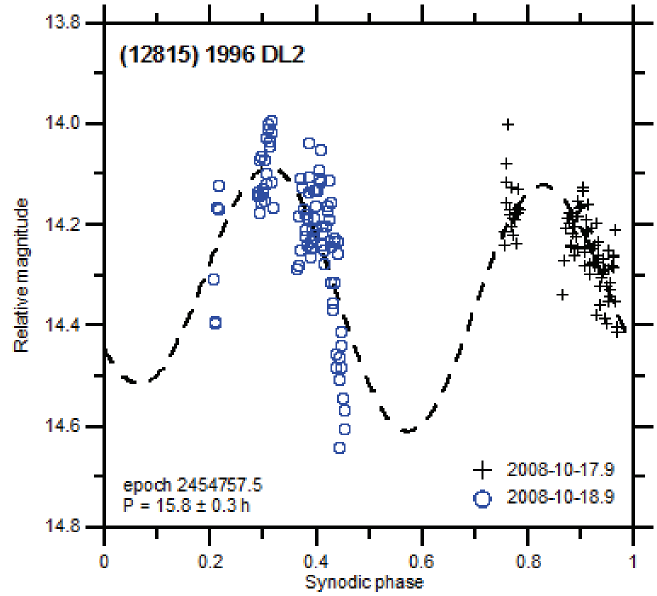
Fornasier, S., Barucci, M. A., Binzel, R. P., Birlan, M., Fulchignoni, M., Barbieri, C., Bus, S. J., Harris, A. W., Rivkin, A. S., Lazzarin, M., Dotto, E., Michałowski, T., Doressoundiram, A., Bertini, I., and Peixinho, N. (2003). “A portrait of 4979 Otawara, target of the Rosetta space mission.” *Astronomy and Astrophysics* **398**, 327-333.

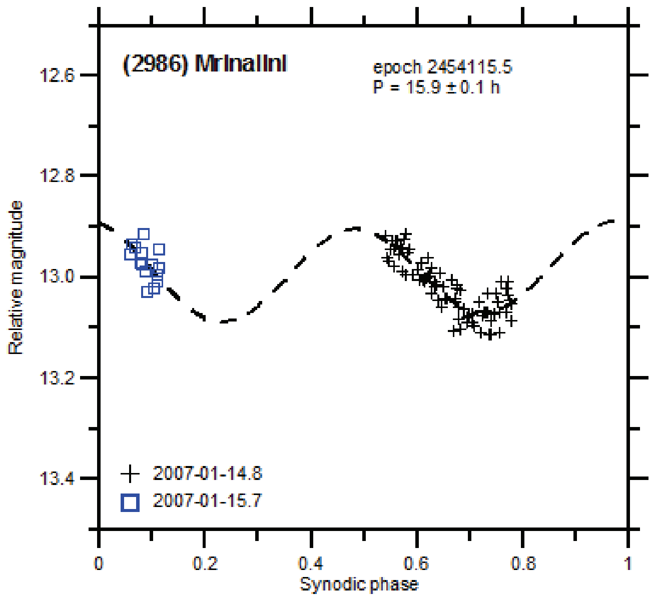
Le Bras, A., Dotto, E., Fulchignoni, M., Doressoundiram, A., Barucci, M. A., Le Mouélic, S., Forni, O., and Quirico, E. (2001). “The 2000 Rosetta asteroid targets observational campaign: 140 Siwa and 4979 Otawara.” *Astronomy and Astrophysics* **379**, 660-663.

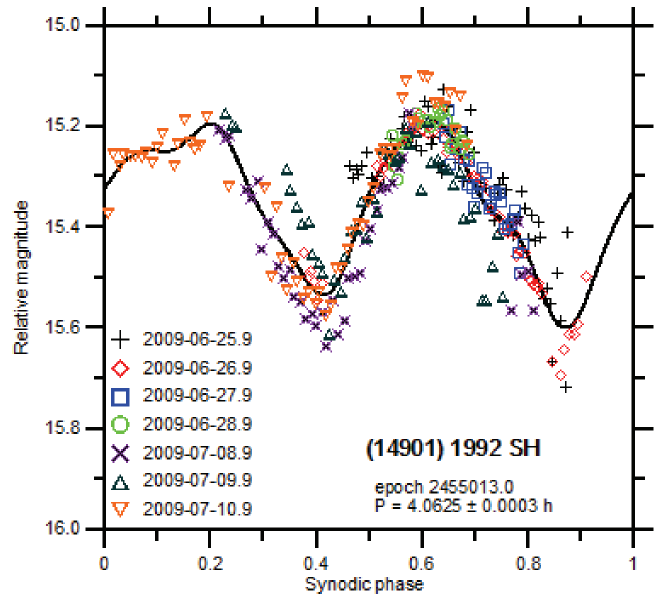
Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, L., and 53 co-authors (2006). “Photometric Survey of Binary Near-Earth Asteroids.” *Icarus* **181**, 63-93.

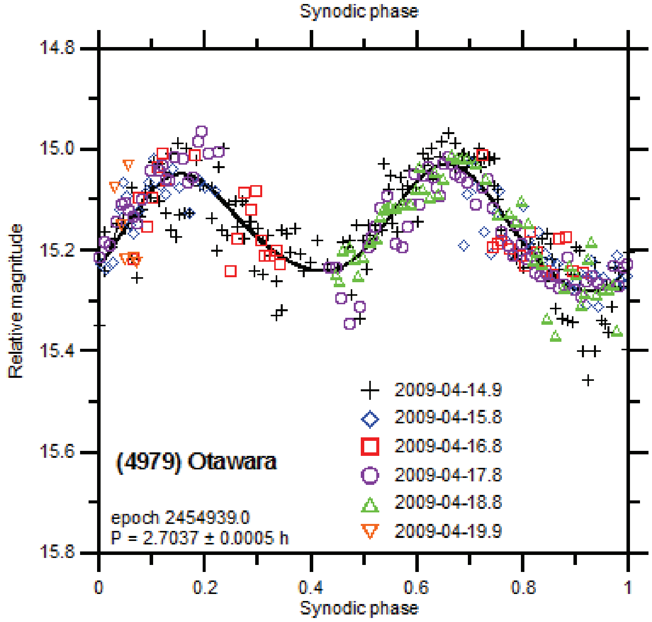
Pravec, P. (2009). “Prepublished periods of asteroids.” http://www.asu.cas.cz/~ppravec/newres.txt

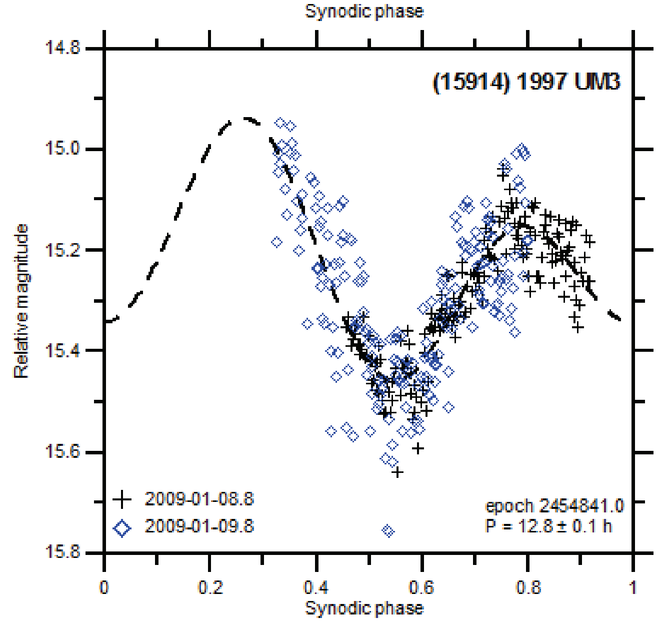

(1446) Sillanpää
epoch 2454937.0
P = 9.659 ± 0.001 h
2009-04-14.9
2009-04-15.8
2009-04-16.8
2009-04-17.8
2009-04-18.8
2009-04-19.9
2009-04-20.8
Relative magnitude
Synodic phase

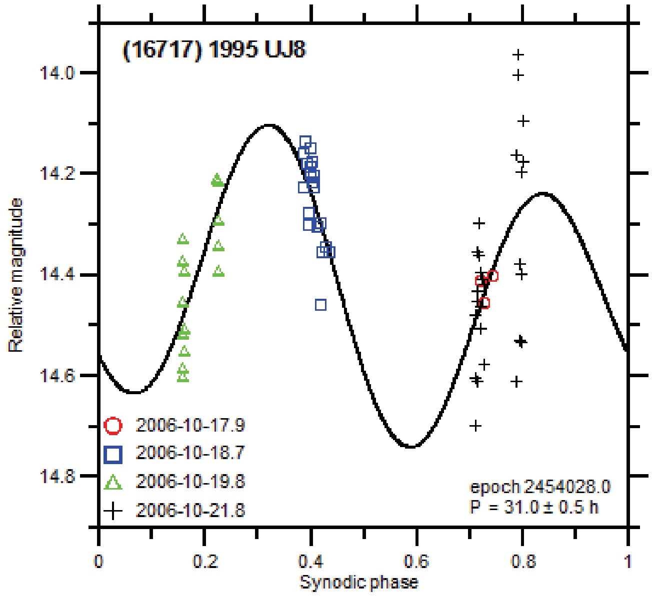

(12815) 1996 DL2
epoch 2454757.5
P = 15.8 ± 0.3 h
2008-10-17.9
2008-10-18.9
Relative magnitude
Synodic phase

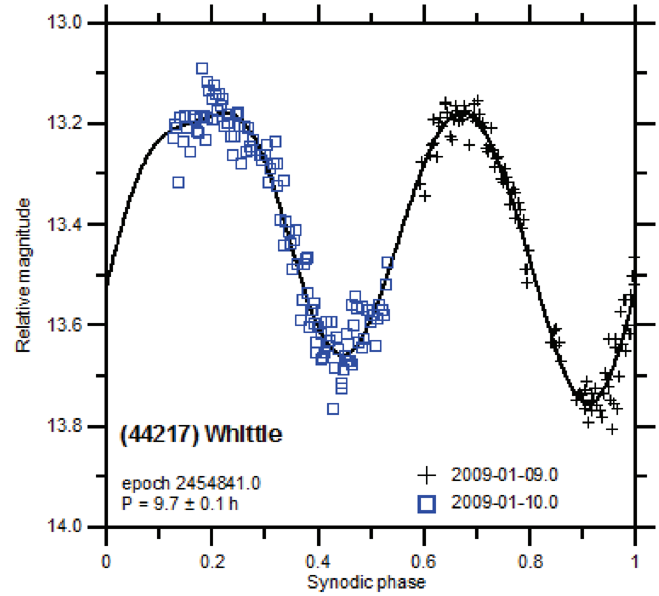

(2986) Mrinalini
epoch 2454115.5
P = 15.9 ± 0.1 h
2007-01-14.8
2007-01-15.7
Relative magnitude
Synodic phase

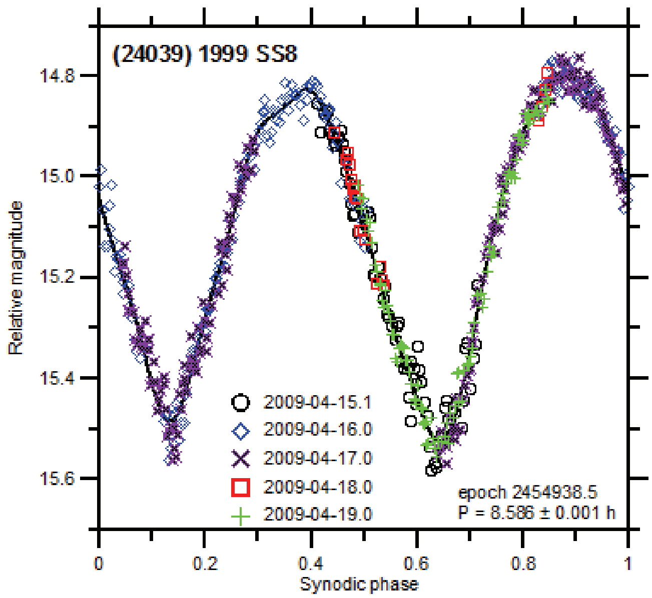

(14901) 1992 SH
epoch 2455013.0
P = 4.0625 ± 0.0003 h
2009-06-25.9
2009-06-26.9
2009-06-27.9
2009-06-28.9
2009-07-08.9
2009-07-09.9
2009-07-10.9
Relative magnitude
Synodic phase

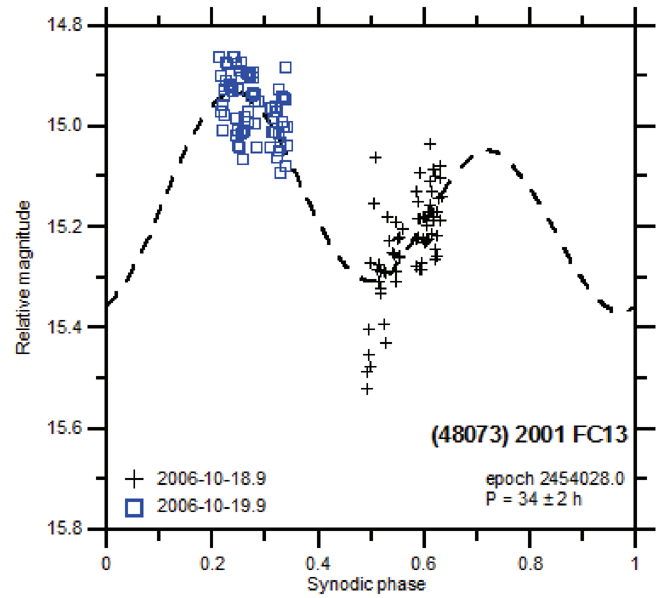

(4979) Otawara
epoch 2454939.0
P = 2.7037 ± 0.0005 h
2009-04-14.9
2009-04-15.8
2009-04-16.8
2009-04-17.8
2009-04-18.8
2009-04-19.9
Relative magnitude
Synodic phase

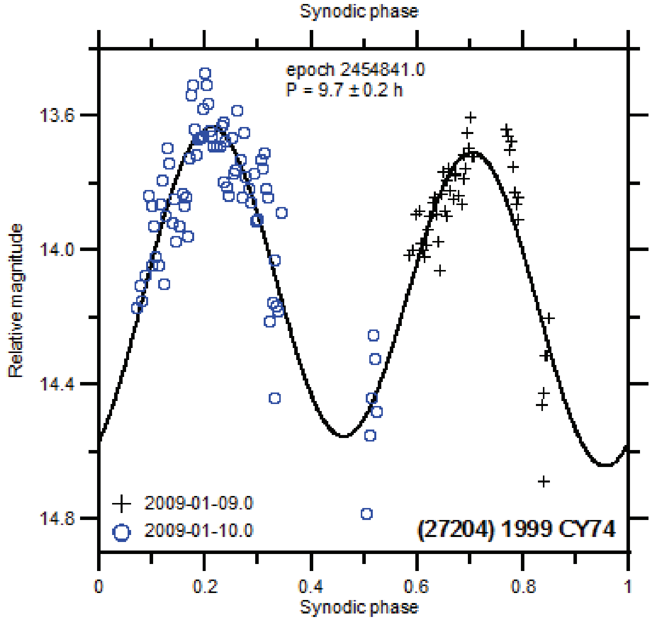

(15914) 1997 UM3
epoch 2454841.0
P = 12.8 ± 0.1 h
2009-01-08.8
2009-01-09.8
Relative magnitude
Synodic phase

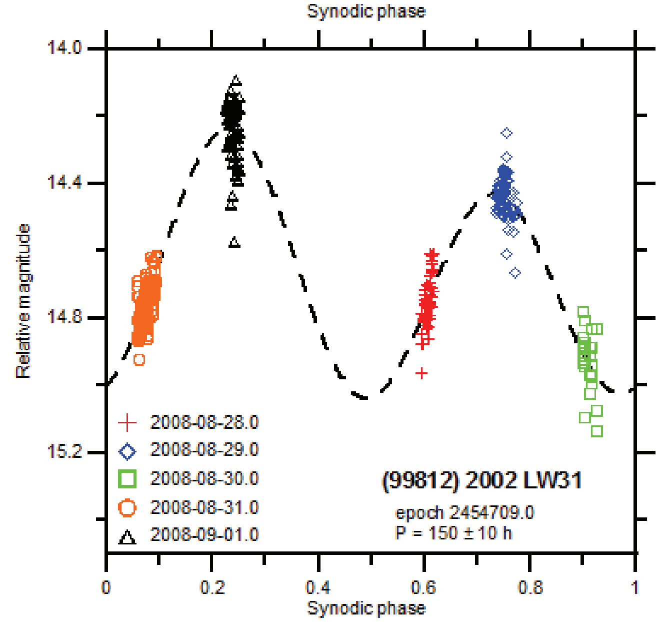

(16717) 1995 UJ8
Relative magnitude
14.0
14.2
14.4
14.6
14.8
2006-10-17.9
2006-10-18.7
2006-10-19.8
2006-10-21.8
epoch 2454028.0
P = 31.0 ± 0.5 h
0
0.2
0.4
0.6
0.8
1
Synodic phase


(44217) Whittle
Relative magnitude
13.0
13.2
13.4
13.6
13.8
14.0
epoch 2454841.0
P = 9.7 ± 0.1 h
2009-01-09.0
2009-01-10.0
0
0.2
0.4
0.6
0.8
1
Synodic phase


(24039) 1999 SS8
Relative magnitude
14.8
15.0
15.2
15.4
15.6
2009-04-15.1
2009-04-16.0
2009-04-17.0
2009-04-18.0
2009-04-19.0
epoch 2454938.5
P = 8.586 ± 0.001 h
0
0.2
0.4
0.6
0.8
1
Synodic phase


(48073) 2001 FC13
Relative magnitude
14.8
15.0
15.2
15.4
15.6
15.8
2006-10-18.9
2006-10-19.9
epoch 2454028.0
P = 34 ± 2 h
0
0.2
0.4
0.6
0.8
1
Synodic phase


(27204) 1999 CY74
epoch 2454841.0
P = 9.7 ± 0.2 h
Relative magnitude
13.6
14.0
14.4
14.8
2009-01-09.0
2009-01-10.0
0
0.2
0.4
0.6
0.8
1
Synodic phase


(99812) 2002 LW31
Relative magnitude
14.0
14.4
14.8
15.2
2008-08-28.0
2008-08-29.0
2008-08-30.0
2008-08-31.0
2008-09-01.0
epoch 2454709.0
P = 150 ± 10 h
0
0.2
0.4
0.6
0.8
1
Synodic phase

Number	Name	Dates yyyy mm/dd	Phases deg	LPAB deg	BPAB deg	Period [h]	Amp [mag]
1446	Sillapää	2009 04/15-21	14.6-17.4	182	1	9.659 ± 0.001	0.71
2986	Mrinalini	2007 01/15-16	17.0-17.2	61	1	(15.9 ± 0.1)	0.2
4979	Otawara	2009 04/15-20	14.0-16.5	181	1	2.7037 ± 0.0005	0.26
(12815)	1996 DL2	2008 10/18-19	7.4-7.8	7	-4	(15.8 ± 0.3)	(0.5)
(14901)	1992 SH	2009 06/26-07/11	13.4-18.3	255	16	4.0625 ± 0.0003	0.41
(15914)	1997 UM3	2009 01/09-10	27.7-27.9	57	3	12.8 ± 0.1	0.5
(16717)	1995 UJ8	2006 10/18-22	7.6-8.9	9	9	31.0 ± 0.5	0.6
(24039)	1999 SS8	2009 04/15-19	8.1-9.2	215	12	8.586 ± 0.001	0.73
(27204)	1999 CY74	2009 01/09-10	2.8-3.0	114	-5	9.7 ± 0.2	1.0
44217	Whittle	2009 01/09-10	3.3-3.6	114	-5	9.7 ± 0.1	0.58
(48073)	2001 FC13	2006 10/19-20	1.7-2.2	29	2	34 ± 2	(0.5)
(99812)	2002 LW31	2008 08/28-09/01	4.0-5.4	344	6	150 ± 10	0.8

Table I. Asteroids with observation dates, minimum and maximum solar phase angles, phase angle bisector values, derived synodic rotation periods with uncertainties, and lightcurve amplitudes.

LIGHTCURVES FOR FIVE CLOSE APPROACH ASTEROIDS

Peter Birtwhistle
Great Shefford Observatory
Phlox Cottage, Wantage Road
Great Shefford, Berkshire, RG17 7DA
UNITED KINGDOM
peter@birtwhi.demon.co.uk

(Received: 2009 Jul 12)

Lightcurves for five near-Earth asteroids observed from Great Shefford Observatory during close approaches between 2009 March and 2009 May are reported: (143651) 2003 QO104, 2009 FH, 2009 HM82, 2009 KW2 and 2009 KL8.

Targets with favourable viewing circumstances were selected based on the ongoing NEO astrometric programme being conducted at Great Shefford Observatory (MPC code J95). A 0.40-m Schmidt-Cassegrain (SCT) operating at f/6 and an Apogee Alta U47+ CCD camera were used. The CCD was operated at 2x2 binning, resulting in a resolution of 2.16 arcsec/pixel and the camera was cooled to between –30°C and –40°C, depending on the local ambient temperature. All exposures were taken unfiltered and integrations were limited generally by the fast apparent motion of the objects. *MPO Canopus* version 9.5.0.3 (Warner, 2008), incorporating the Fourier algorithm developed by Harris (Harris et al., 1989) was used for image measurement using differential aperture photometry and lightcurve analysis. The fast motion of 2009 FH, 2009 HM82, 2009 KW2 and 2009 KL8 required frequent telescope repositioning and by necessity, many different sets of comparison stars. Each of the four objects has a relatively short rotation period and in all cases two or more rotations occurred for each field captured. Small adjustments to the zero points of the comparison star sets used for these four objects have been made to reduce the RMS of the fitted lightcurves to a minimum. All lightcurve plots are "phased" according to the period values given below.

(143651) 2003 QO104. Data were collected on 15 nights from 2009 Apr 22 through May 28. This confirms a similar result by Warner et al. (2009) from observations covering significantly more of the lightcurve obtained between 2009 Mar 17 and Apr 19.

2009 FH. This small NEO was observed for over 2 h during a very close approach to Earth when it reached 15th mag. Due to the fast apparent motion integrations were limited to 2 and 4 s.

2009 HM82. Observed for an hour on 2009 May 2 and for 3 hours on May 3/4, 2009 HM82 was relatively faint at 18th mag and this resulted in a very noisy lightcurve. Integrations were between 8 and 16s.

2009 KW2. Although 15th mag when observed during a close approach on 2009 May 24/25 it was at low altitude (12 deg, rising to 19 deg) and integrations were limited to 2 s due to its fast motion. 35 rotations were completed during the 2 hours of observation.

2009 KL8. Observed on 2009 May 31 when it was at its brightest at 18th mag, two days before closest approach. Another noisy lightcurve resulted from the low S/N measurements.

Acknowledgments

The author is indebted to Brian Warner for his work on *MPO Canopus* and his invaluable assistance and support.

#	Name	2009 mm/dd	Data pts	Phase (deg)	PAB_L (deg)	PAB_B (deg)	Per (h)	PE	Amp (mag)	AE
143651	2003 QO104	04/22-05/28	1768	60.7-85.9	184.0	14.9	113.3	0.1	1.4	0.1
	2009 FH	03/17	422	46.7-48.4	153.5	-2.1	0.1073	0.0001	0.33	0.05
	2009 HM82	05/02-05/04	393	25.7-36.1	228.8	16.4	0.1270	0.0001	0.9	0.3
	2009 KW2	05/24-05/25	916	6.1-9.5	247.5	1.1	0.05686	0.00008	0.67	0.15
	2009 KL8	05/31	580	74.2-75.4	249.5	38.3	0.0447	0.0001	0.75	0.25

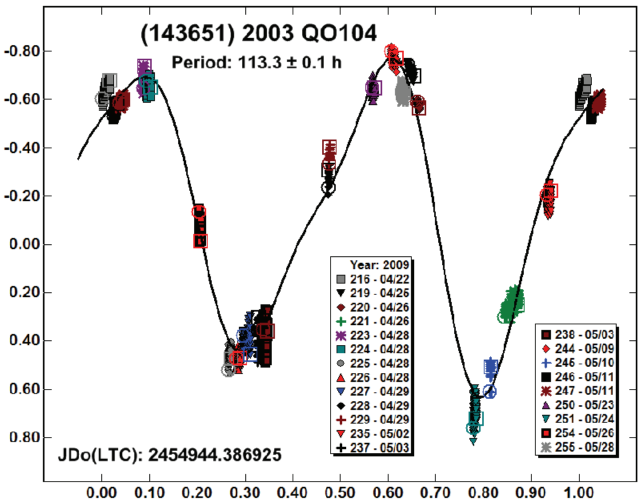
Table I. Observing circumstances, including observation dates, phase angle range, average phase angle bisector longitude and latitude, derived synodic rotation period with error estimate, lightcurve amplitude with error estimate.

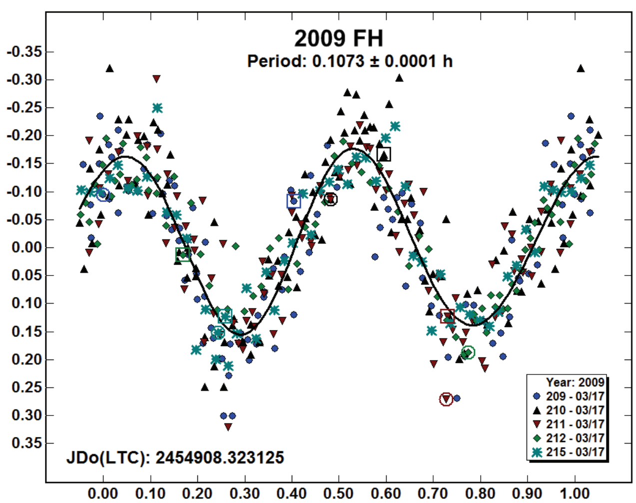
References

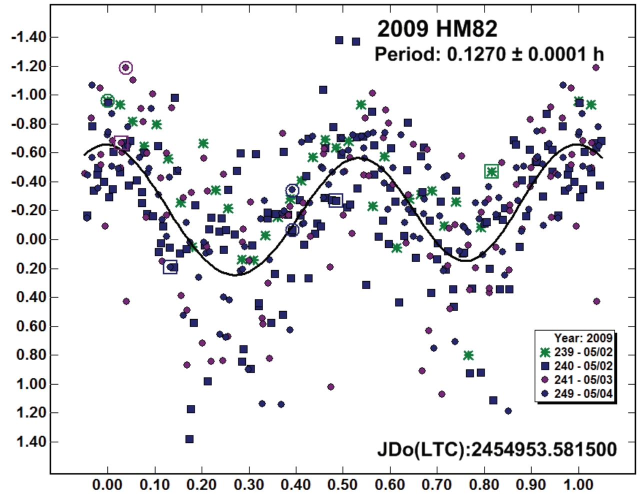
Harris, A. W., Young, J. W., Bowell, E., Martin, L. J., Millis, R. L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H. J., Debehogne, H, and Zeigler, K. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

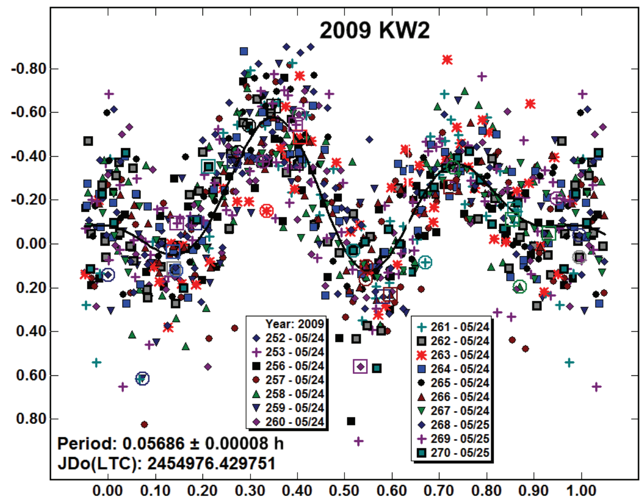
Warner, B. D. (2008) MPO Software, Canopus v 9.5.0.3. Bdw Publishing, Colorado Springs, CO.

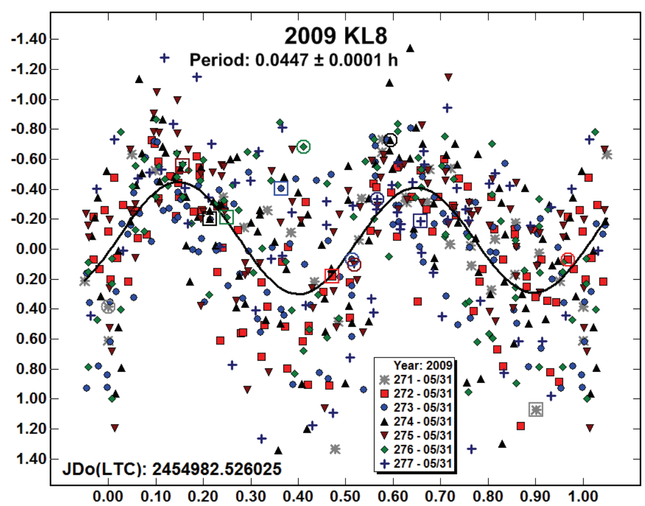
Warner, B. D., Stephens, R. D., and Carbognani, A. (2009). "Analysis of the Slow Rotator (143651) 2003 QO104." *Minor Planet Bul.* **36**, 179-180.











LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2009 OCTOBER - DECEMBER

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

Alan W. Harris
Space Science Institute
La Canada, CA 91011-3364 USA

Petr Pravec
Astronomical Institute
CZ-25165 Ondrejov, CZECH REPUBLIC

Josef Durech
Astronomical Institute
Charles University in Prague
18000 Prague, CZECH REPUBLIC
durech@sirrah.troja.mff.cuni.cz

Lance A.M. Benner
Jet Propulsion Laboratory
Pasadena, CA 91109-8099 USA
lance@reason.jpl.nasa.gov

We present four lists of "targets of opportunity" for the period 2009 October-September. The first list is those asteroids reaching <15m at brightest during the period and have either no or poorly constrained lightcurve parameters. In some cases, the asteroid may not be favorably positioned again for many years, if ever. The goal for these asteroids is to find a well-determined rotation rate. Don't hesitate to solicit help from other observers at widely spread longitudes should the initial findings show that a single station may not be able to finish the job.

The Low Phase Angle list includes asteroids that reach very low phase angles. Getting accurate, calibrated measurements (usually V band) at or very near the day of opposition can provide important information for those studying the "opposition effect", which is when objects near opposition brighten more than simple geometry would predict.

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. For modeling work, absolute photometry is recommended, meaning that the data should be "absolute" values put onto a standard system, usually Johnson V. If this is not possible or practical, good relative photometry, where all differential values are based on a calibrated internal or standard zero point, is just as acceptable. The most productive effort comes when you get lightcurves close to opposition as well as when the phase angle is ≥ 15° since this provides the most modeling information. This can be difficult at times but the extra effort can and will pay off. In any event, get what you can. Those doing modeling should refer to the Database of Asteroid Models from Inversion Techniques (DAMIT) project web site at the Astronomical Institute of the Charles University, Czech Republic (*http://astro.troja.mff.cuni.cz/projects/asteroids3D*). Results and the original data for a large number of asteroid models can be browsed and downloaded from this location.

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations made to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. Reducing to standard magnitudes is not required but high precision work, 0.01-0.03 mag, usually is. *The geocentric ephemerides are for planning purposes only.* The date range may not always coincide with the dates of planned radar observations. Use the on-line services such as those from the Minor Planet Center (*http://cfa-www.harvard.edu/iau/mpc.html*) or JPL's Horizons (*http://ssd.jpl.nasa.gov/?horizons*) to generate high-accuracy *topocentric* ephemerides. Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

There are several web sites of particular interest for coordinating radar and optical observations. Future targets (up to 2020) can be found at *http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html*. Past radar targets can be found at *http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html*. This page can be used to plan optical observations for those past targets with no or poorly-known rotation periods. Obtaining a rotation period will significantly improve the value of the radar data and help with 3D shape estimation. Slightly different information for Arecibo is given at *http://www.naic.edu/~pradar/sched.shtml*. For Goldstone, additional information is available at *http://echo.jpl.nasa.gov/asteroids/goldstone_asteroid_schedule.html*.

Once you have analyzed your data, it's important that you publish your results. Papers appearing in the *Minor Planet Bulletin* are indexed in the Astrophysical Data System (ADS) and so can be referenced by others in subsequent papers. It's also important to make the data available at least on a personal website or upon request.

In the first three sets of tables, Dec is the declination, U is the quality code of the lightcurve, and α is the solar phase angle. See the documentation for the asteroid lightcurve data base (LCDB) for an explanation of the U code (*www.minorplanetobserver.com/astlc/LightcurveParameters.htm*). Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing as a guide and double-check your work.

U = 2 Does *Not* Mean "No Data Needed"

The U value given in the tables is the one adopted in the LCDB. Objects with no U rating or U = 1 should be given higher priority when possible. ***We strongly urge that you do not overlook asteroids with U = 2 on the assumption that the period is sufficiently established.*** Regardless, you should not let the existing period influence your analysis since even high quality ratings have been proven wrong at times.

Funding for Warner and Harris in support of this article is provided by NASA grant NNX 09AB48G and by National Science Foundation grant AST-0607505.

Lightcurve Opportunities

#	Name	Brightest Date	Brightest Mag	Dec	U	LCDB Data Period	LCDB Data Amp
2476	Andersen	10 01.5	14.6	-12			
23587	Abukumado	10 01.7	14.8	+ 1			
2031	BAM	10 01.1	14.2	+ 0			
	2009 HD21	10 02.2	14.7	-57			
1498	Lahti	10 03.8	14.8	+23			
1114	Lorraine	10 03.5	13.6	+ 6	1	33.	0.16
9515	Dubner	10 03.6	14.9	-10			
2856	Roser	10 04.4	15.0	+ 3	2+	13.73	0.49
2717	Tellervo	10 04.7	13.7	+ 2			
994	Otthild	10 04.1	12.8	+ 9	2+	5.95	0.09-0.14

Lightcurve Opportunities (continued)

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
7774	1992 UU2	10 04.2	15.0	- 7			
8131	Scanlon	10 07.7	15.0	+12			
126	Velleda	10 08.2	11.4	+ 5	2	5.36	0.07-0.22
14162	1998 TV1	10 08.0	14.9	-14			
10711	Pskov	10 08.0	14.6	+ 7			
3844	Lujiaxi	10 09.3	14.6	+ 1			
3522	Becker	10 11.0	14.7	+ 8			
2402	Satpaev	10 11.8	14.8	+14			
978	Aidamina	10 11.7	13.0	+18	2	10.09	0.13
455	Bruchsalia	10 11.0	10.8	-12	2+	11.83	0.12
4422	Jarre	10 14.0	13.9	+ 1	2	5.42	0.12
159402	1999 AP10	10 14.3	12.9	+27			
50713	2000 EZ135	10 15.2	15.0	+10			
5421	Ulanova	10 18.9	15.0	+16			
16558	1991 VQ2	10 19.0	14.8	+ 0	2	37.37	0.22
3077	Henderson	10 19.2	14.8	+13			
2107	Ilmari	10 19.5	14.3	+14			
1576	Fabiola	10 19.6	14.3	+ 9	2	6.7	0.2
42284	2001 TV8	10 19.3	14.7	+ 1			
5230	Asahina	10 20.8	14.9	+ 2			
1057	Wanda	10 22.5	13.3	+16	2	28.8	0.14-0.41
6066	Hendricks	10 23.2	14.8	+ 0			
150	Nuwa	10 23.8	11.4	+11	2+	8.14	0.08-0.31
2534	Houzeau	10 24.6	14.1	+11			
29308	1993 UF1	10 25.9	14.9	+ 9			
3567	Alvema	10 25.0	14.3	+23			
1215	Boyer	10 25.2	14.2	-14			
990	Yerkes	10 25.8	13.8	+23			
4308	Magarach	10 26.4	15.0	+31			
439	Ohio	10 27.4	13.9	+ 7	2	19.2	0.24
611	Valeria	10 28.6	12.9	+ 4	2	6.98	0.10-0.16
1798	Watts	10 28.9	14.2	+11			
952	Caia	10 28.3	11.7	+18	2	7.51	0.13
	2005 RQ6	10 29.5	14.9	+14			
16009	1999 CM8	10 30.1	14.4	+13			
610	Valeska	10 30.5	14.8	+21			
4103	Chahine	10 31.0	13.5	+32			
2475	Semenov	10 31.1	14.7	+12			
712	Boliviana	11 03.8	10.4	+19	2	11.73	0.11
2874	Jim Young	11 04.8	14.8	+10	2	131.3	0.7
1447	Utra	11 05.6	14.2	+17			
1583	Antilochus	11 06.9	15.0	+14	1 >	12.	0.04-0.32
2326	Tololo	11 06.0	14.4	- 6			
8369	1991 GR	11 06.9	14.3	+29			
1750	Eckert	11 07.1	14.4	+48			
	2000 XK44	11 08.1	13.8	+15			
458	Hercynia	11 08.3	12.6	- 5	2	22.3	0.35
384	Burdigala	11 08.7	12.1	+16	1 >	17.	>0.03
1530	Rantaseppa	11 09.7	14.5	+25			
457	Alleghenia	11 09.3	14.4	+25			
55760	1992 BL1	11 10.2	14.6	-36			
	2000 TO64	11 10.6	14.0	+01			
3486	Fulchignoni	11 11.0	15.0	+18			
15010	1998 QL92	11 13.1	14.9	+15			
3534	Sax	11 14.9	14.9	+22			
6181	Bobweber	11 15.1	14.9	+33			
1564	Srbija	11 16.9	14.3	+ 4	2	29.64	0.37
1424	Sundmania	11 16.4	13.7	+21	1 >	12.	>0.1
81	Terpsichore	11 20.4	11.2	+31	2	11.02	0.10
2085	Henan	11 20.0	14.4	+14	1	32.	0.5
592	Bathseba	11 20.1	12.9	+ 5	2	6.57	0.32
1271	Isergina	11 21.9	14.4	+11			
3067	Akhmatova	11 24.7	14.7	+29			
2813	Zappala	11 25.6	14.7	+16			
3353	Jarvis	11 27.7	15.0	+21	2	40.8	0.10
22759	1998 XA4	11 29.1	15.0	+27			
346	Hermentaria	11 29.9	10.4	+16	2	28.43	0.07-0.20
6610	Burwitz	11 29.2	14.2	+23	2	3.01	0.22
16669	Rionuevo	12 01.0	14.8	+23			
20810	2000 SE266	12 01.3	14.8	+23			
20805	2000 SC220	12 04.5	15.0	+28			
3905	Doppler	12 04.3	14.8	+50			
15967	Clairearmstrong	12 04.2	14.6	+ 4			
5202	1983 XX	12 05.4	15.0	+27			
5781	Barkhatova	12 06.8	14.6	+23			
3003	Koncek	12 06.3	15.0	+14			
3986	Rozhkovskij	12 08.0	14.5	+27	2	4.26	0.26
3565	Ojima	12 09.7	15.0	+20			
4455	Ruriko	12 10.5	14.9	+19	2	4.23	0.41
2825	Crosby	12 13.4	14.9	+30			
2850	Mozhaiskij	12 13.1	14.6	+17			
1653	Yakhontovia	12 14.6	13.0	+29	2	15.41	0.03
1149	Volga	12 15.4	14.1	+23	2	27.5	0.26
2235	Vittore	12 16.0	14.5	- 2			
1218	Aster	12 17.2	14.8	+26			
1934	Jeffers	12 18.9	14.1	+24			

Lightcurve Opportunities (continued)

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
111	Ate	12 20.8	10.7	+29	2	22.2	0.1
2244	Tesla	12 22.5	14.8	+20			
1384	Kniertje	12 23.5	14.3	+ 5	2	9.80	0.11-0.33
56283	1999 LU1	12 24.3	15.0	+28			
2834	Christy Carol	12 25.1	14.5	+13			
1129	Neujmina	12 25.8	13.9	+22	2	7.61	0.06
2512	Tavastia	12 25.2	14.4	+29			
3707	Schroter	12 26.5	14.6	+26			
7683	Wuwenjun	12 26.0	15.0	+23			
5724	1986 WE	12 26.9	14.8	+22			

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp.	U
1114	Lorraine	10 03.5	0.55	13.7	+06	33.	0.16	2
126	Velleda	10 08.3	0.38	11.5	+05	5.364	0.07-0.22	2
428	Monachia	10 10.3	0.23	12.8	+07	3.63384	0.26-0.33	3
160	Una	10 10.9	0.37	12.2	+08	5.61	0.14	3
244	Sita	10 12.4	0.58	13.4	+08			
1223	Neckar	10 17.9	0.41	14.0	+08	7.821	0.16-0.45	3
153	Hilda	10 18.4	0.98	13.2	+13	5.11	0.05	2
124	Alkeste	10 21.0	0.55	11.7	+09	9.921	0.15	3
150	Nuwa	10 23.8	0.16	11.5	+11	8.140	0.09	2
1130	Skuld	10 24.9	0.20	13.5	+12	4.810	0.50	3
1419	Danzig	10 25.3	0.23	13.1	+12	8.1202	0.81-0.92	3
268	Adorea	10 31.8	0.98	13.1	+11	7.80	0.15-0.20	3
743	Eugenisis	11 07.0	0.24	13.2	+17	10.23	0.20	3
636	Erika	11 08.0	0.89	12.9	+19	14.603	0.29-0.33	3
384	Burdigala	11 08.7	0.21	12.1	+16	> 17.	0.03	1
770	Bali	11 10.2	0.31	12.2	+18	5.9513	0.40-0.55	3
229	Adelinda	11 12.5	0.36	13.5	+19	6.60	0.04-0.30	3
138	Tolosa	11 15.1	0.10	11.5	+18	10.101	0.4	3
1424	Sundmania	11 16.5	0.84	13.7	+21	> 12.	0.1	2
1423	Jose	11 20.1	0.08	13.8	+20	12.307	0.68-0.82	3
423	Diotima	11 24.1	0.69	11.6	+18	4.775	0.06-0.20	3
383	Janina	11 26.0	0.78	13.2	+19	6.4	0.17	3
379	Huenna	11 27.5	0.84	12.7	+19	7.022	0.09	2
2525	O'Steen	11 29.1	0.54	14.0	+20	3.55	0.19	2
321	Florentina	11 30.9	0.69	13.6	+24	2.871	0.33-0.42	3
596	Scheila	12 01.0	0.21	13.5	+21	15.848	0.09	2
278	Paulina	12 02.2	0.54	13.4	+24	6.497	0.41	3
394	Arduina	12 06.8	0.46	13.1	+24	16.5	0.29-0.54	3
121	Hermione	12 08.1	0.17	11.6	+23	5.55128	0.04-0.45	3
19	Fortuna	12 09.7	0.97	9.3	+21	7.4432	0.19-0.35	3
263	Dresda	12 09.8	0.48	14.0	+22	16.809	0.37-0.40	3
774	Armor	12 09.9	0.28	13.4	+22	25.162	0.34	2
142	Polana	12 11.2	0.70	13.7	+25	9.764	0.11	3
171	Ophelia	12 16.6	0.36	12.2	+22	6.66535	0.14-0.45	3
539	Pamina	12 17.3	0.73	12.7	+25	13.903	0.10	3
128	Nemesis	12 18.6	0.69	10.7	+25	39.	0.10	3
1244	Deira	12 21.4	0.87	13.9	+26	210.6	0.50	2
782	Montefiore	12 21.8	0.73	13.6	+25	4.08	0.43	3
1129	Neujmina	12 25.8	0.36	13.9	+22	7.61	0.06	2
535	Montague	12 27.8	0.85	12.6	+25	10.2482	0.25	3

Shape/Spin Modeling Opportunities

#	Name	Brightest Date	Mag	Dec	Per (h)	Amp.	U
173	Ino	10 05.0	10.4	-12	6.163	0.04 0.11	3
419	Aurelia	10 06.8	11.5	+09	16.788	0.07 0.27	3
18	Melpomene	10 09.3	7.8	-08	11.570	0.10 0.32	3
93	Minerva	10 14.7	11.3	+12	5.982	0.04 0.10	3
335	Roberta	11 01.6	12.3	+07	12.054	0.05 0.13	3
344	Desiderata	11 05.0	11.6	+13	10.77	0.17	3
139	Juewa	11 10.1	11.9	+28	20.991	0.18 0.20	3
47	Aglaja	11 11.2	11.6	+23	13.178	0.03 0.17	3
51	Nemausa	11 15.8	10.6	+05	7.783	0.10 0.14	3
38	Leda	12 11.1	11.1	+30	12.84	0.16	2
334	Chicago	12 11.2	13.1	+18	7.361	0.15 0.67	3
238	Hypatia	12 25.6	12.2	+04	8.86	0.12 0.15	3
11	Parthenope	12 26.0	9.8	+20	9.43	0.05 0.12	2
313	Chaldaea	12 29.5	11.2	+01	8.392	0.12 0.22	3
60	Echo	12 31.	13.0	-06	25.208	0.10 0.19	3
64	Angelina	12 31.	12.5	+03	8.752	0.04 0.44	3
69	Hesperia	12 31.	12.3	+01	5.655	0.12 0.20	3
71	Niobe	12 31.	12.8	+30	35.81	0.22	3-
113	Amalthea	12 31.	13.3	+02	9.935	0.19 0.26	3
323	Brucia	12 31.	13.9	-30	9.46	0.23 0.36	3
354	Eleonora	12 31.	11.6	-13	4.277	0.12 0.30	3
674	Rachele	12 31.	12.1	+05	30.962	0.16	2

Radar-Optical Opportunities

Use the ephemerides to judge your best chances for observing. Note that the intervals in the ephemerides are not always the same and that *geocentric* positions are given. Use the resources given above to generate updated and *topocentric* positions. In the ephemerides, E.D. and S.D. are, respectively, the Earth and Sun distances (AU), V is the V magnitude, and α is the phase angle.

(159402) 1999 AP10 (2009 Oct-Dec)
There are no known lightcurve parameters for this near-Earth asteroid of about 1.6 km diameter.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/01	22 14.88	-01 48.1	0.121	1.104	13.34	30.3
10/11	21 54.46	+18 12.7	0.088	1.060	12.95	44.2
10/21	21 19.94	+50 21.5	0.076	1.029	13.10	62.5
10/31	19 01.62	+78 51.5	0.091	1.013	13.83	74.9
11/10	12 08.31	+77 06.0	0.120	1.013	14.47	75.8
11/20	10 54.94	+67 43.0	0.154	1.030	14.86	70.1
11/30	10 24.75	+61 33.0	0.188	1.062	15.09	61.6
12/10	9 59.44	+57 13.8	0.221	1.107	15.25	51.6
12/20	9 32.45	+53 43.9	0.256	1.162	15.38	41.1

(164121) 2003 YT1 (2009 Oct-Nov)
This is a known binary asteroid with a primary period of ~2.34 h. Radar observations by Nolan et al. (2004) indicate that the secondary's rotation rate is < 6 h and so not synchronous with its orbital period, which is about 30 h. The size ratio is Ds/Dp ~ 0.2, so mutual events may be visible. High-precision (0.01-0.02 mag) data are very desirable. If you suspect capturing mutual events, contact Petr Pravec at the email address above.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/20	6 58.50	+05 28.1	0.171	1.042	14.91	69.9
10/23	7 25.81	+15 48.3	0.143	1.027	14.60	73.3
10/26	8 08.45	+29 41.9	0.125	1.012	14.44	78.3
10/29	9 18.34	+44 55.1	0.119	0.997	14.55	84.9
11/01	11 03.69	+55 31.9	0.129	0.982	14.94	90.9
11/04	12 55.91	+58 09.5	0.152	0.967	15.42	94.9

2000 XK44 (2009 Nov-Dec)
There are no known lightcurve parameters. The diameter of this NEA is estimated to be 0.6 km.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/01	3 27.55	-08 04.1	0.076	1.060	14.28	25.4
11/06	3 39.23	+08 11.0	0.074	1.063	13.90	14.4
11/11	3 50.08	+23 37.5	0.080	1.068	13.96	11.4
11/16	3 59.81	+35 56.5	0.092	1.076	14.48	17.3
11/21	4 08.39	+44 45.5	0.108	1.086	15.03	22.9
11/26	4 15.92	+50 44.5	0.127	1.099	15.52	26.6
12/01	4 22.55	+54 40.8	0.148	1.113	15.94	28.8

2000 TO64 (2009 Nov-Dec)
There are no known lightcurve parameters. This apparition for the 1.4 km NEA favors observers in the Southern Hemisphere. The orbit for this asteroid is similar to Jupiter-family comets with a Tisserand parameter of T = 2.801. Observers should be on the look-out for cometary activity.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/01	21 15.33	+41 54.1	0.168	1.059	15.07	62.5
11/06	22 11.82	+25 30.1	0.128	1.054	14.32	57.6
11/11	23 16.28	-01 01.9	0.114	1.053	13.96	53.8
11/16	0 19.49	-25 50.3	0.135	1.056	14.42	56.8
11/21	1 13.40	-39 54.3	0.179	1.064	15.16	60.5
11/26	1 55.67	-46 46.1	0.232	1.075	15.79	61.9
12/01	2 27.90	-50 07.2	0.290	1.090	16.30	61.7

2000 UJ1 (2009 Nov)
There are no known lightcurve parameters. The moon will be between full and last quarter during the time of the ephemeris.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/01	22 20.23	+59 14.5	0.148	1.067	15.62	56.0
11/03	22 52.68	+50 48.7	0.130	1.069	15.20	50.7
11/05	23 20.11	+39 39.8	0.118	1.072	14.82	44.8
11/07	23 43.05	+26 14.2	0.112	1.074	14.58	40.0
11/09	0 02.21	+12 02.3	0.113	1.077	14.56	38.3
11/11	0 18.29	-01 00.6	0.122	1.080	14.79	40.3
11/13	0 31.90	-11 45.6	0.136	1.083	15.14	44.0

19 Fortuna (2009 Nov-Dec)
The period for this asteroid is well-known, being ~7.44 h.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/01	5 35.22	+21 54.3	1.281	2.098	10.34	19.8
11/11	5 32.04	+21 39.5	1.219	2.108	10.09	15.6
11/21	5 25.31	+21 22.3	1.175	2.118	9.83	10.6
12/01	5 15.96	+21 03.1	1.154	2.130	9.54	5.1
12/11	5 05.41	+20 43.0	1.157	2.142	9.29	1.2
12/21	4 55.33	+20 24.4	1.188	2.154	9.70	6.5
12/31	4 47.30	+20 10.3	1.242	2.168	10.04	11.6

53 Kalypso (2009 Nov-Dec)
Surprisingly, this low-numbered asteroid's period is not well known. Period estimates range from 18-27 h and the amplitude has tended to be relatively low, < 0.15 mag. A collaboration among observers at widely-separated longitudes may solve the period question.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/01	5 27.35	+14 53.9	1.315	2.142	12.02	18.8
11/11	5 25.17	+14 29.0	1.236	2.131	11.75	15.0
11/21	5 19.73	+14 08.4	1.176	2.120	11.46	10.6
12/01	5 11.73	+13 55.0	1.138	2.110	11.18	6.0
12/11	5 02.38	+13 51.5	1.125	2.102	11.07	4.4
12/21	4 53.21	+13 59.8	1.136	2.095	11.26	8.2
12/31	4 45.79	+14 20.6	1.172	2.090	11.52	13.0

MPB EDITOR RETURNS

The *MPB* Editor, Professor Richard Binzel (MIT), is returning from sabbatical and taking over the full editorial duties effective with *MPB* 37-1. Manuscripts to be considered for publication in Volume 37 and beyond may now be directed to the Editor. Thanks are owed to Brian D. Warner for his year-long service as "Acting Editor" and his oversight during a particularly prolific period of activity. Congratulations to all! We additionally thank Brian Warner for continuing to serve as Assistant Editor.

INDEX TO VOLUME 36

Owings, L.E. "Lightcurves for 155 Scylla and 2358 Bahner" 51-52.

Pilcher, F. "Minor Planets at Unusually Favorable Elongations in 2009" 20-22.

Pilcher, F. "Period Determinations for 33 Polyhymnia, 38 Leda, 50 Virginia, 189 Phthia, and 290 Bruna" 25-27.

Pilcher, F. "Call for Observations" 40.

Pilcher, F. "General Report of Position Observations by the ALPO Minor Planets Section for the Year 2007" 78-83.

Pilcher, F. "Rotation Period Determinations for 120 Lachesis, 131 Vala, 157 Dejanira, and 271 Penthesilea" 100-102.

Pilcher, F. "New Lightcurves of 8 Flora, 13 Egeria, 14 Irene, 25 Phocaea, 40 Harmonia, 74 Galatea, and 122 Gerda" 133-136.

Pilcher, F. and Benishek, V. "Period Determinations for 634 Ute and 805 Hormuthia" 29-30.

Pilcher, F., Benishek, V., Krajewski, R. "Period Determination for 182 Elsa: A Collaboration Triumph" 40.

Pilcher, F., Benishek, V., Oey, J. "Period Determination for 178 Belisana" 68.

Pilcher, F. and Binzel, R. P. "Minor Planet Bulletin Evolving to Limited Print Subscriptions" 194.

Pilcher, F. and Jardine, D. "Period Determinations for 31 Euphrosyne, 35 Leukothea, 56 Melete, 137 Melioboea, 155 Scylla, and 264 Libussa" 52-54.

Polishook, D. "Lightcurves and Spin Periods from the Wise Observatory: 2008 August – 2009 March" 104-107.

Polishook, D. "Lightcurves for Shape Modeling Obtained at the Wise Observatory" 119-120.

Ruthroff, J. C. "Photometric Observations and Lightcurve Analysis of Asteroids 129 Antigone, 174 Phaedra, 232 Russia, 291 Alice, and 343 Ostara" 121-122.

Sheridan, E. E. "Lightcurve Results for 99 Dike, 313 Chaldaea, 872 Holda, 1274 Delportia, and 7304 Namiki" 55-56.

Stecher, G., Ford, L., Bianchi, N., Warner, B. D., Robinson, L. "On the Period of 1506 Xosa" 138-139.

Stephens, R.D. "Asteroids Observed from GMARS and Santana Observatories"

18-19.
59-62.
"2009 January – February" 125-126.
"April to May 2009" 157-158.

Stephens, R. D. and Pilcher F. "Photometric Observations of 169 Zelia" 161.

Timerson, B., Durech, J., Aguirre, S., Benner, L., Blanchette, D., Breit, D., Campbell, S., Campbell, T., Carlisle, R., Castro, E., Clark, D., Clark, J., Correa, A., Coughlin, K., Degenhardt, S., Dunham, D., Fleishman, R., Frankenberger, R., Gabriel, P., Harris, B., Herald, D., Hicks, M., Hofler, G., Holmes, A., Jones, R., Lambert, R., Lucas, G., Lyzenga, G., MacDouigal, C., Maley, P., Morgan, W., Mroz, G., Nolthenius, R., Nugent, R., Preston, S., Rodriguez, C., Royer, R., Sada, P., Sanchez, E., Sanford, J., Sorensen, B., Stanton, R., Venable, R., Vincent, M., Wasson, R., Wilson, E., Owen, B., Young, J. "A Trio of Well-observed Asteroid Occultations in 2008" 98-100.

Vander Haagen, G. A. "Lightcurves of 4135 Svetlanov, 5614 Yakovlev, and (5985) 1942 RJ" 2.

Vander Haagen, G. A. "Lightcurves and H-G Parameters for 901 Brunsia and 946 Poesia" 136-138.

Vander Haagen, G. A. "Lightcurves of 4285 Hulkower, 6868 Kuwano, and (93768) 2000 WN22" 171.

Warner, B. "Notes from the Acting Editor" 1.

Warner, B. D., "Asteroid Lightcurve Analysis at the Palmer Divide Observatory"

"2008 May – September" 7-13.
"2008 September – December" 70-73.
"2008 December – 2009 March" 109-116.
"2009 March – June" 172-176.

Warner, B. D. "Asteroid-Deep Sky Appulses in 2009" 23.

Warner, B. D. "Analysis of the Hungaria Binary Asteroid 3309 Brorfelde" 108.

Warner, B. D., Harris, A. W., Pravec, P., Benner, L.A.M., Durech, J. "Lightcurve Photometry Opportunities"

"January-March 2009" 31-33.
"2009 April-June" 70-72.
"2009 July-September" 128-131.
"2009 October-December" 188-190.

Warner, B. D., Harris, A. W., Pravec, P., Cooney, Jr., W. R., Gross, J., Terrell, D., Oey, J., Vilagi, Jozef, Gajdos, S., Brinsfield, J.W., Pollock, J., Reichart, D., Ivarsen, K., Haislip, LaCluyze, Nysewander, M., Marchis, F., Baek, M. "5905 Johnson: A Hungaria Binary" 89-90.

Warner, B. D. and Higgins, D. "Lightcurve Analysis of Hungaria Asteroid 4440 Tchantches" 90.

Warner, B. D., Pravec, P., Harris, A. W., Higgins, D., Bembrick, C., Brinsfield, J. W., Pray, D. P., Pollock, J., Reichart, D., Ivarsen, K., LaCluyze, A., Nysewander, M. "2577 Litva: A Hungaria Binary" 165-166.

Warner, B. D. and Pray, D. P. "Analysis of the Lightcurve of 6179 Brett" 166-167.

Warner, B.D. and Stephens, R. D. "Lightcurve Analysis of Two Binary Asteroids: (76818) 2000 RG79 and (185851) 2000 DP107" 62-63.

Warner, B. D. and Stephens, R. D. "The Lightcurve for the Long-Period Hungaria Asteroid 1235 Schorria" 102-103.

Warner, B. D. and Stephens, R. D. "Analysis of the Lightcurves of 198 Ampella and 2008 SV11" 164-165.

Warner, B. D., Stephens, R. D., Carbognani, A. "Analysis of the Slow Rotator (143651) 2003 QO104" 179-180.

Warner, B. D., Stephens, R. D., Harris, A. W., Pravec, P. "A Re-examination of the Lightcurves for 7 Hungaria Asteroids" 176-179.

Warner, B. D., Stephens, R. D., Harris, A. W., Shepard, M. K. "Coordinated Lightcurve and Radar Observations of 110 Lydia and 135 Hertha" 38-39.

Warner, B. D., Ye, Q., Shi, L., Hung-Chi, L., Stephens, R. D. "The Curious Case of (162900) 2001 HG1" 56-57.

Yankov, A. Ditteon, R. "Lightcurves and Periods for Asteroids 1081 Reseda, 2117 Danmark, 2315 Czechoslovakia, 2871 Schober, 6392 Takashimiz, and (6409) 1992 VC" 3-4.

Ye, Q., Shi, L., Lin, H.-C. "Multi-color Photometry of 1998 BE7" 41-42.

Ye, Q., Shi, L. Lin, H.-C. "CCD Lightcurve Analysis of (53430) 1999 TY16" 126.

Ye, Q., Shi, L., Xu, W., Lin, H-C., Zhang, J. "Photometric Observations and Lightcurve Analysis of Near-Earth Asteroids (136849) 1998 CS1, 2006 SZ217, and 2008 UE7" 180-181.

IN THIS ISSUE

This list gives those asteroids in this issue for which physical observations (excluding astrometric only) were made. This includes lightcurves, color index, and H-G determinations, etc. In some cases, no specific results are reported due to a lack of or poor quality data. The page number is for the first page of the paper mentioning the asteroid. EP is the "go to page" value in the electronic version.

MINOR PLANET BULLETIN EVOLVING TO LIMITED PRINT SUBSCRIPTIONS

Friderick Pilcher
Minor Planets Section Recorder

Richard P. Binzel
Minor Planet Bulletin Editor

Beginning with Volume 38 (January 2011; about one year from now), the *Minor Planet Bulletin* will evolve to being a "limited print journal." The *Minor Planet Bulletin* will continue, as at present, to be available "free" in electronic format. However, paid printed and mailed subscriptions will be highly limited; these will be eligible *only* for libraries and major institutions for the purpose of maintaining long-term library archives of the *Minor Planet Bulletin*. Electronic archival of all *Minor Planet Bulletin* articles will continue in the Astrophysical Data System http://www.adsabs.harvard.edu/. Individuals who desire paper versions of any *Minor Planet Bulletin* issue are free (now and in the future) to download and print the electronic version for their own personal, professional, or educational use via:

http://www.minorplanetobserver.com/mpb/default.htm

These changes follow the modern evolution toward electronic publishing and are precipitated by the continued growth in the size of the *MPB*. This growth is well exemplified by the nearly 200 pages for the current volume, double the size of just two years ago. Paid printed and mailed subscription rates for libraries and institutions will rise accordingly to reflect the current and growing number of pages per volume and the more limited print runs.

The changes are not driven just by modernization and economics; they are driven by the necessity for keeping the volunteer operation of the *MPB* as streamlined as possible in the face of the growing page demand. Limited numbers of physically printed pages enables great production freedom, flexibility, and efficiency (e.g. always starting articles in a new column or new page) creates additional white space that is not a problem for electronic files. A very limited number of issues to print and mail greatly reduces the bourgeoning total bulk and total task of *MPB* distribution.

A practical consequence of this change is that all current subscriptions (and renewals) will be possible only through Volume 37, Issue No. 4. All subscription renewals for printed and mailed copies (whether for the full year or pro-rated for whatever remainder of Volume 37 may be owed) will be honored at the current subscription rate. Subscription rates for printed and mailed copies for Volume 38 and beyond, available *only* for libraries and major institutions, will be announced in an upcoming issue. Individual subscribers who have prepaid beyond Volume 37, Issue No. 4, will receive notification regarding the choice of a refund or donation of their remaining balance.

* * * * *

THE MINOR PLANET BULLETIN (ISSN 1052-8091) is the quarterly journal of the Minor Planets Section of the Association of Lunar and Planetary Observers – ALPO. Beginning with volume 32, the current issues of the *MPB* are available on line, free of charge at http://www.minorplanetobserver.com /mpb/default.htm.

Nonmembers are invited to join ALPO by communicating with: Matthew L. Will, A.L.P.O. Membership Secretary, P.O. Box 13456, Springfield, IL 62791-3456 (will008@attglobal.net). The Minor Planets Section is directed by its Coordinator, Prof. Frederick Pilcher, 4438 Organ Mesa Loop, Las Cruces, NM 88011 USA (pilcher@ic.edu), assisted by Lawrence Garrett, 206 River Road, Fairfax, VT 05454 USA (LSGasteroid@msn.com). Dr. Alan W. Harris (Space Science Institute; awharris@spacescience.org), Dr. Petr Pravec (Ondrejov Observatory; ppravec@asu.cas.cz), and Steve Larson (Lunar and Planetary Laboratory; slarson@lpl.arizona.edu) serve as Scientific Advisors. The Asteroid Photometry Coordinator is Brian D. Warner, Palmer Divide Observatory, 17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA (brian@MinorPlanetObserver.com).

The Minor Planet Bulletin is edited by Dr. Richard P. Binzel, MIT 54-410, Cambridge MA 02139 USA (rpb@mit.edu). Brian Warner (address above) is the Assistant Editor. The *MPB* is produced by Dr. Robert A. Werner, JPL MS 301-150, 4800 Oak Grove Drive, Pasadena, CA 91109 USA (robert.a.werner@jpl.nasa.gov) and distributed by Derald D. Nye.

The contact for all subscriptions, address changes, etc. is:

Mr. Derald D. Nye
Minor Planet Bulletin
10385 East Observatory Drive
Corona de Tucson, AZ 85641-2309 USA
(nye@kw-obsv.org)
(Telephone: 520-762-5504)

Subscription rates for Volume 37 (calendar year 2010) of the *Minor Planet Bulletin* by postal delivery (North America):

Payment by check: $24.00
Payment by credit card: $25.00
Outside North America: $34.00/$35.00

Beginning with Volume 38 (January 2011), new subscription rates will be in effect. These rates will be announced in the coming months. For Volume 38 and beyond, print subscriptions will be limited to libraries and major institutions *only* as print subscriptions to individual subscribers will cease to be available. Individuals are free (now and in the future) to print the *MPB* for their own use from the freely available electronic file. (See announcement, this page.) Checks or money orders for all or a pro-rated part of Volume 37 (calendar year 2010) should be in US dollars, drawn on a US bank, and made payable to the "Minor Planet Bulletin." At present, no subscription payment beyond Volume 37, Issue No. 4 can be accepted. To pay by credit card, (Visa, Mastercard, or Discover) please send by mail your credit card number, your name exactly as it appears on the card, and the expiration date. Be sure to specify the desired length of your subscription. Credit card charges will be made through "Roadrunner Mkt, Corona AZ." When sending your subscription order, be sure to include your full mailing address and an email address, if available. The numbers in the upper-right corner of your mailing label indicate the volume and issue number with which your current subscription expires.

Authors are strongly encouraged to submit their manuscripts by electronic mail (rpb@mit.edu). Electronic submissions can be formatted either using a Microsoft Word template document available at the web page given above, or else as text-only. A printed version of the file and figures may be requested. All materials must arrive by the deadline for each issue. Visual photometry observations, positional observations, any type of observation not covered above, and general information requests should be sent to the Coordinator.

* * * * *

The deadline for the next issue (37-1) is October 15, 2009. The deadline for issue 37-2 is January 15, 2010.