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MINOR PLANET BULLETIN NOW CHANGING TO LIMITED PRINT SUBSCRIPTIONS

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As announced one year ago (*MPB* Volume 36, Number 4, page 194), the *Minor Planet Bulletin* is now evolving 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. Effective with the next issue [Volume 38, Number 1], printed and mailed subscriptions for the *Minor Planet Bulletin* will be available *only* for libraries and major institutions for the purpose of maintaining long-term library archives. 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 to print the electronic version for their own personal, professional, or educational use. Recent *MPB* issues are currently available:

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These changes, now being implemented, 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 recent volumes, double the size of just two years ago. Paid printed and mailed subscription rates for libraries and institutions will rise accordingly to reflect increasing costs for the current and growing number of pages per volume and the more limited print runs. For the first year, at least, these cost increases are being offset by many donations of unused subscription fees by individual subscribers. These donations, and future donations to the library archive project, are greatly appreciated.

LIGHT CURVE ANALYSIS OF ASTEROIDS FROM LEURA AND KINGSGROVE OBSERVATORY IN THE FIRST HALF OF 2009

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Photometric observations of the following asteroids were done from both Kingsgrove and Leura Observatories in the first half of 2009: 31 Euphrosyne (5.529 ± 0.001h); 1729 Beryl (4.8888 ± 0.0003 h); 2965 Surikov (9.061 ± 0.003 h); 4904 Makio (7.830 ± 0.003 h); (11116) 1996 EK (4.401 ± 0.002 h); and (19483) 1998 HA116 (2.7217 ± 0.0008 h)

CCD photometry was performed on 6 asteroids during the first half of 2009. The targets were selected mostly from the CALL website (Warner 2008) with the selection criteria being an average magnitude of V ~ 13 at brightest and a relatively southerly declination, which provided long nightly runs from the two locations. Observations at Kingsgrove Observatory used a 0.25-m Schmidt-Cassegrain (SCT) operating at f/5.2 combined with an ST-402ME SBIG CCD camera operating at 1x1 binning. This resulted in a pixel resolution of 1.40 arcseconds/pixel. The unfiltered exposures were 60 seconds. Leura Observatory used a 0.35m SCT, reduced from f/11 to f/6.5. The camera was an ST-9XE SBIG CCD camera operating at 1x1 binning. The combination produced a 1.80 arc seconds/pixel resolution. All exposures were 300 seconds and unfiltered. *MPO Canopus* v.9.4.0.1 software was used for period analysis which incorporates the Fourier algorithm developed by Harris (1989). Detailed notes

Asteroid	Date (mm/dd/2009)	Obs	Period (h)	Amp (mag)	PA	LPAB	BPAB
31 Euphrosyne	06/06-06/22	K	5.529 ± 0.001	0.10 ± 0.02	8	266	-26
1729 Beryl	05/03-06/23	K	4.8888 ± 0.0003	0.20 ± 0.02	11,2,18	240	-3
2965 Surikov	08/09-08/18	L	9.061 ± 0.003	0.28 ± 0.02	9,13	298	+2
4904 Makio	03/05-03/21	K	7.830 ± 0.003	0.08 ± 0.04	8,13	162	-13
(11116) 1996 EK	03/15-03/24	K	4.401 ± 0.002	0.08 ± 0.04	5,11	168	+4
(19483) 1998 HA116	01/30-02/05	L	2.7217 ± 0.0008	0.10 ± 0.04	6	133	-10

Table 1. Observatory Code: K= Kingsgrove Observatory, L= Leura Observatory. PA is the phase angle at the start and end of the observations. If there are three values, the object reached a minimum phase during the period. LPAB and BPAB are, respectively, the approximate phase angle bisector longitude and latitude during the period.

beyond "normal results" are merited for 31 Euphrosyne.

31 Euphrosyne. This asteroid has been well-studied in the past by numerous authors. This set of observations was requested by Frederick Pilcher for the purpose of providing additional data for spin/shape modeling. A plan to do monthly observations to monitor phase-amplitude evolution failed due to poor weather. Despite its proximity to the galactic plane, the target was bright enough to allow using the star subtraction feature of *MPO Canopus* (Warner 2009) to salvage a large number of data points. The derived synodic period 5.529 ± 0.001 h is consistent with that obtained previously by Pilcher (2008) of 5.530h ± 0.002h.

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.

Oey, J. (2007). "Rotation Period and Amplitude change of Minor Planet 3868 Mendoza." *Minor Planet Bulletin* **34**, 39–40.

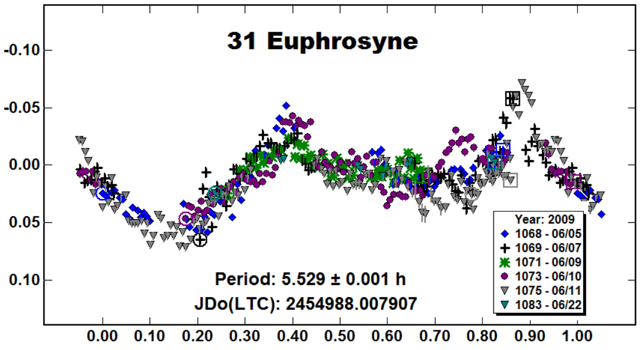
Oey, J. (2008). "Lightcurve Analysis of Asteroids from Kingsgrove and Leura Observatories in the 2nd half of 2007." *Minor Planet Bulletin* ***35***, 132–135.

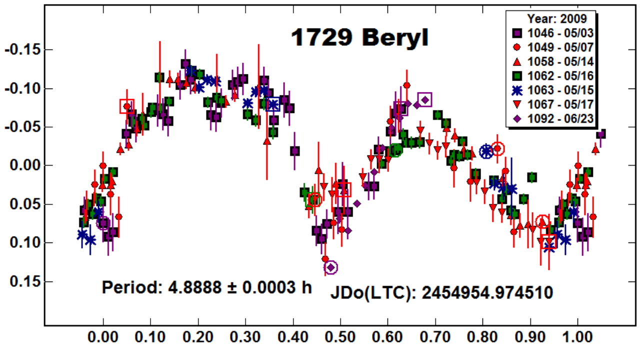
Pilcher, F. and Jardine, D. (2008) "Period Determinations for 31 Euphrosyne, 35 Luekothea, 56 Melete, 137 Meliobea, 155 Scylla, and 264 Libussa." *Minor Planet Bulletin* **36**, 52–54.

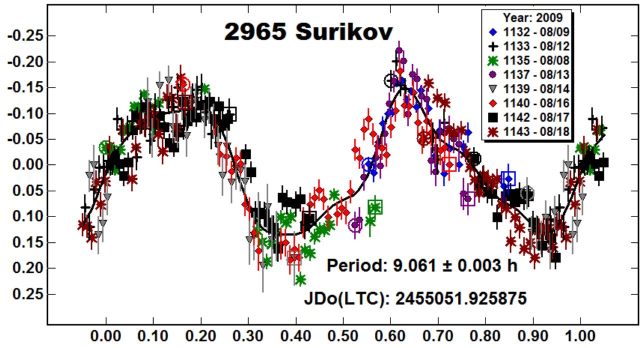
Pravec, P. (2008). "Photometric Survey of Asynchronous Binary Asteroids." http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm

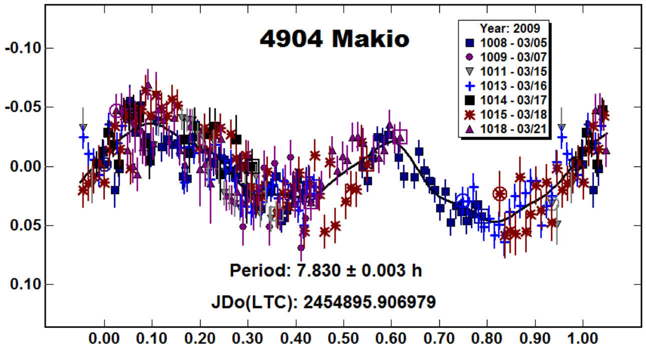
Warner, B.D. (2008). "Potential Lightcurve Targets 2008 July – September."
www.minorplanetobserver.com/astlc/targets_4q_2008.htm

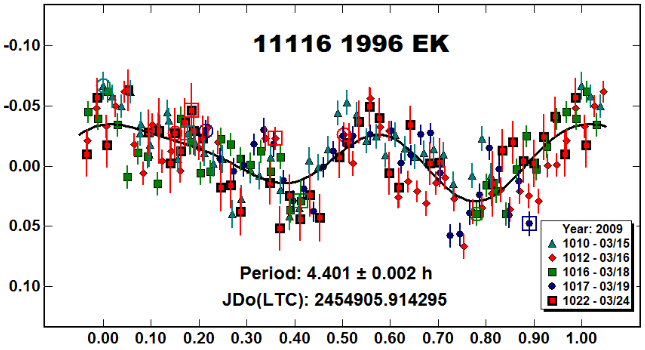
Warner, B.D. (2009). "StarBGone".
www.minorplanetobserver.com/MPOSoftware/StarBGone.htm

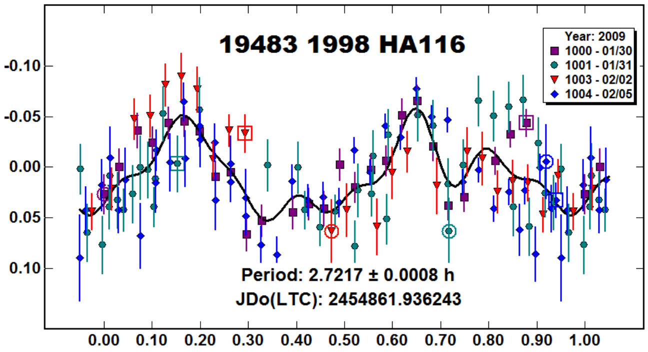












LIGHTCURVE AND H-G PARAMETERS FOR 2004 LEXELL

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Lightcurves and absolute photometry near opposition revealed photometric results for 2004 Lexell: P = 5.4429 ± 0.0003 h, A = 0.42 ± 0.03 mag, H = 12.908 ± 0.064 mag, and G = 0.071 ± 0.056.

Selection of 2004 Lexell was made from the quarterly lightcurve photometry opportunities article published in *The Minor Planet Bulletin,* Warner et al. (2010). Asteroid 2004 was a low intensity target, V magnitudes ranging from 14.7 to 16.7, with nightly visibility of 5 to 6 hours over the period 2010 March 6 to May 5, with opposition on March 5.

Observations were made with a 0.43-meter PlaneWave f/6.8 corrected Dall-Kirkham Astrograph and SBIG ST-10XME camera. The camera was run at -15C and binned 3x3 resulting in a 1.4 arcseconds/pixel scale. No guiding was necessary. A total of 878 images were taken with the 591 higher S/N data plotted and phased. An averaging process was used on higher phase angle images for S/N improvement and plotting of the H-G data. The target and reference stars were imaged with V filter. Exposures were 120 seconds with the exception of May 5, when 180-second exposures were used. The nightly data were reduced using *MPO Canopus/PhotoRed* routines (Bdw Publishing, 2010), using the "selector" feature whereby V magnitude reference stars are selected and the target magnitude computed. With the poor nightly sky conditions this method proved more consistent than nightly reductions using Landolt and Henden fields and reducing the values to standard magnitudes.

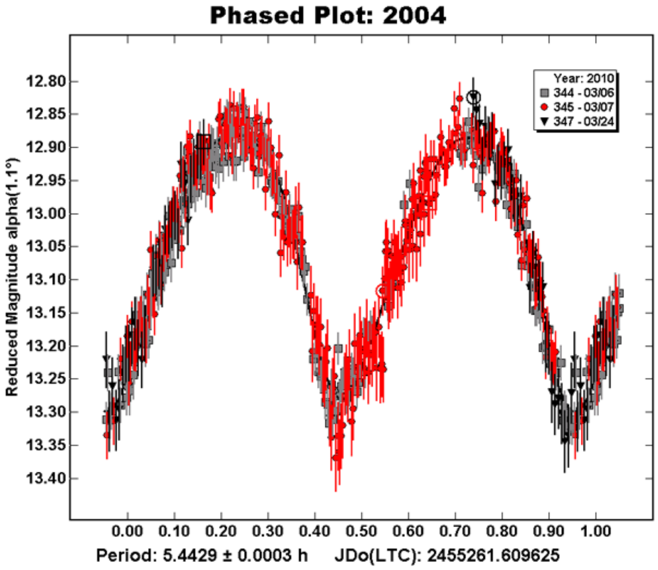
Photometric data of 2004 indicated a probable period of 5.4429 h. Referencing the Asteroid Lightcurve Database (Warner et al., 2009), there were no previously reported data for 2004 Lexell. Examination of the period spectrum gives near equal probability for a single-extrema solution of 2.721 ± 0.001 h and double-extrema solution of 5.4429 ± 0.0003 h. Examination of the phased data indicates a high degree of symmetry but with an amplitude of 0.42 mag, the longer, bimodal solution is virtually assured (Warner, personal correspondence).

For development of the H-G parameters, the data from 2004 Lexell 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 (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 data. For a more complete discussion of the H-G magnitude system and reduction process refer to Vander Haagen (2009) or contact the author by email for an electronic version of that paper. With a derived value of G = 0.071 ± 0.056, the results were correlated with data published on the relationship among albedos, phase slope parameter (G), and taxonomic class shown in Table 4, Warner et al. (2009). 2004 Lexell's slope parameter (G) is typical of asteroids having low albedos, such as those in the C, G, B, F, P, T, and D. However, the albedo is unknown and can only be guessed. Checking the Bus and Binzel (2002) SMASS II spectral classification shows no data for the asteroid. Guessing, for example one of these, such as the Ch class, from the previously noted Table 4, $p_v = 0.056 \pm 0.012$, and derived absolute magnitude, $H = 12.908$, allows calculation of the asteroid diameter using the expression (Pravec and Harris, 2007):

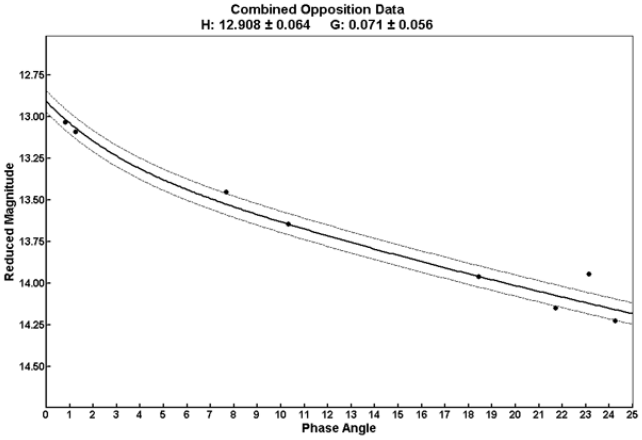
$$\log D_{(\mathrm{km})} = 3.1235 - 0.2H - 0.5\log(p_v)$$

This expression yields $D = 14.7$ km.

Spectral measurements are necessary to establish the subclass and confirm correlation with the slope parameter.



Lightcurve of 2004 Lexell Phased to 5.4429 h



2004 Lexell H-G Parameter Phase Angle Plot Corrected for P = 5.4429 h

References

Bdw Publishing (2010). MPO Software, Canopus version 10.0.0.7 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.

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

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.

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

Warner, B.D., Harris, A.W., Pravec, P., Durech, J., and Benner, L.A.M. (2010). "Lightcurve Photometry Opportunities: 2010 January-March". *The Minor Planet Bulletin* **37**, 37-40.

LIGHTCURVES FOR 890 WALTRAUT, 3162 NOSTALGIA, AND 6867 KUWANO

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Lightcurve observations have yielded period determinations for the followings asteroids: 890 Waltraut, 12.581 ± 0.001 h; 3162 Nostalgia, 6.413 ± 0.002 h; and 6867 Kuwano, 7.37 ± 0.01 h.

Photometric data on three asteroids were collected at Barnes Ridge Observatory, located in northern California at an altitude of 762 meters, during early to mid-2009. A 0.36-m Meade Schmidt-Cassegrain (SCT) operating with a focal reducer at f/6.06 and Apogee U9 camera were used to acquire the images. The camera was binned 1x1 with a resulting image scale of 0.86 arc-seconds per pixel. The images were taken through a clear filter. All exposures were 120 seconds at –25C. Nightly data runs were split into two sets with camera orientation being 0 and 180 degrees to allow adjustment of the zero offset between the two sets. All photometric data were obtained with *MaxIm DL* V5 driven by *ACP* V5 and then analyzed using *MPO Canopus* v9.5 (Warner, 2008). All comparison stars and asteroid targets had SNR ≥ 100.

<u>890 Waltraut.</u> Data were collected from 2009 July 21 through September 9 resulting in 17 data sets and 792 data points. A period of 12.581 ± 0.001 h was determined. A previous lightcurve with a period of 12.58 ± 0.01 hr and amplitude of 0.35 mag was reported by Brinsfield (2009).

<u>3162 Nostalgia.</u> Data were collected from 2008 February 1-3 resulting in 6 data sets and 421 data points. A period of 6.413 ± 0.002 h was determined. This agrees well with the period found by Carbo et al. (2009).

<u>6867 Kuwano.</u> Data were collected from 2009 June 23-27 resulting in 8 data sets and 365 data points. A period of 7.37 ± 0.01 h was determined. A previous lightcurve with a period of 7.367 ± 0.001 h and amplitude of 0.52 mag was reported by Brinsfield (2009). Vander Haagen (2009) reported the same period but with an amplitude of 0.55 mag.

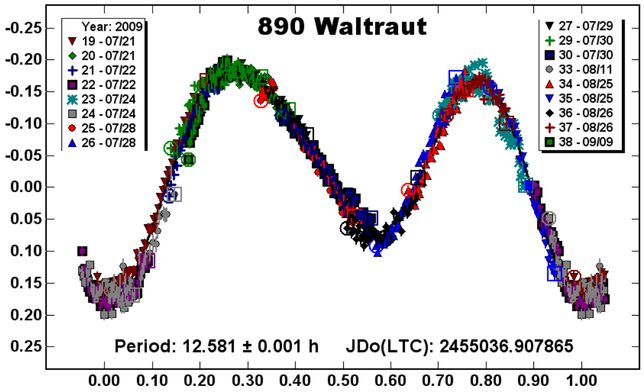
References

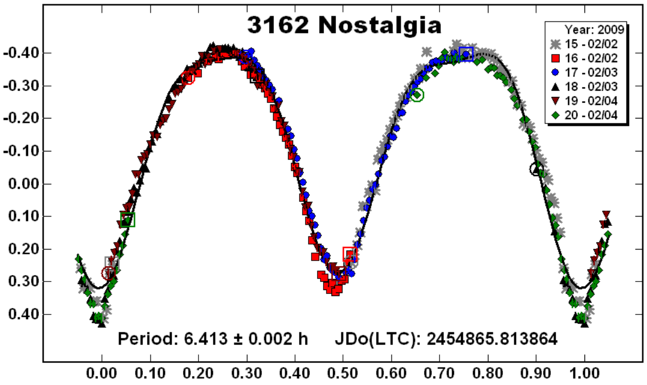
Brinsfield, J. (2009). "Asteroid Lightcurve Analysis At the Via Capote Observatory: 2009 3rd Quarter." *Minor Planet Bulletin* **37**, 19-20.

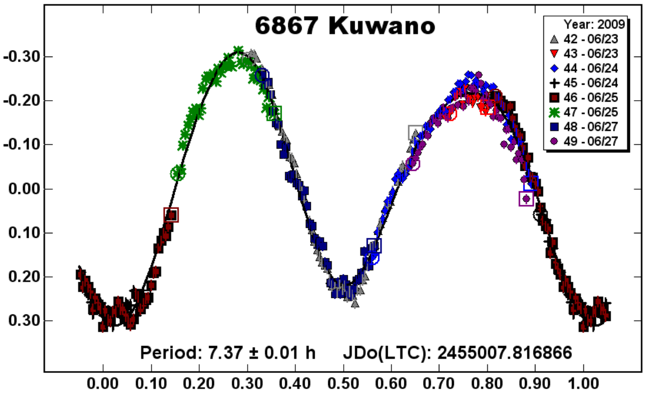
Carbo, L., Kragh, K., Krotz, J., Meiers, A., Shaffer, M., Torno, S., Saupper, J., and Ditteon, R. (2009). "Asteorid Lightcurve Analysis at the Oakley Southern Sky Observatory and Oakley Observatory: 2008 September and October." *Minor Planet Bulletin* **36**, 91-94.

Vander Haagen, G.A. (2009). "Lightcurves of 4285 Hulkower, 6867 Kuwano, and (93768) 2000 WN22." *Minor Planet Bulletin* **36**, 171.

Warner, B.D. (2008). *MPO Canopus* software. Bdw Publishing, Colorado Springs, CO.







LIGHTCURVE ANALYSIS OF 932 HOOVERIA

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CCD observations of the main-belt asteroid 932 Hooveria in 2010 February and March led to a lightcurve with a synodic period of P = 39.15 ± 0.05 h. This contradicted a period of 30 h (Sada, 2004). Re-analysis of the Sada data set gives P = 39.23 ± 0.02 h, putting the two periods in fairly close agreement.

Initial observations of 952 Hooveria were made at the Palmer Divide Observatory in early 2010 February. See Warner (2010) for a general description of PDO equipment and analysis methods. See Warner (2007) and Stephens (2008) for details on data set calibration and linking using 2MASS (Skrutskie et al., 2006) to BVRI conversions. In order to obtain more data a quickly as possible and from a slightly different longitude, assistance was requested from Pollock et al. using the PROMPT 0.45-m telescope in Chile. The final data set of 900 data points spanned 30 days. Analysis of the lightcurve determined a synodic period of P = 39.15 ± 0.05 h and amplitude of A = 0.20 ± 0.01 mag (Fig. 1).

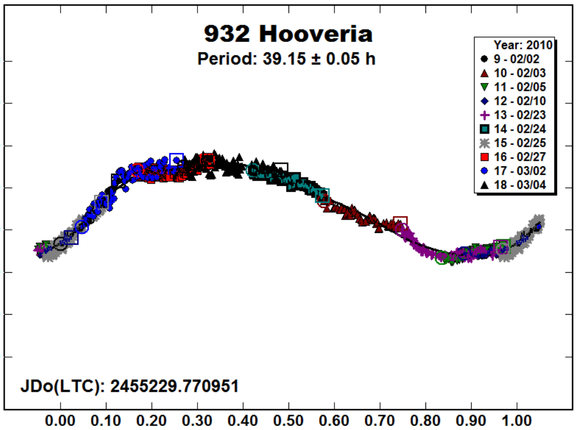

Figure 1. Lightcurve of 932 Hooveria from 2010 data set.

This period did not agree with the P = 30 h found by Sada (2004), who observed the asteroid in 2001 October and 2002 January. As a result of the PDO campaign, Sada remeasured his images, linking the sessions to one another by using the same comparisons whenever possible and calibrating to a nearby LONEOS (Skiff, 2010) field. The revised data set was sent to Warner for analysis, who found a revised period of P = 39.23 ± 0.02 h. This did require, however, shifting one of the calibrated sessions (Oct 20) by 0.16 mag in order to match it with the others.

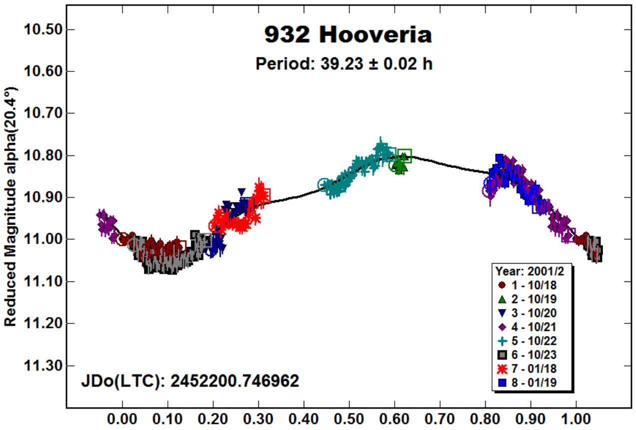

Figure 2. Lightcurve of 932 Hooveria from revised 2001/2 data.

Acknowledgements

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References

Sada, P.V. (2004). "CCD photometry of 932 Hooveria." *Minor Planet Bul.* **31**, 22-23.

Skiff, Brian A. (2010). "Lowell Near-Earth Object Survey (LONEOS) catalog." ftp://ftp.lowell.edu/pub/bas/starcats/

Skrutskie, M.F., 29 colleagues. (2006). "The Two Micron All Sky Survey." *Ap. J.* **131**, 1163-1183.

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

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

Warner, B.D. (2010). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 September-December." *Minor Planet Bul.* **37**, 57-64.

OCCULTATIONS BY 81 TERPSICHORE AND 694 EKARD IN 2009 AT DIFFERENT ROTATIONAL PHASE ANGLES

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M. Kozubal, Y. Liu, P. Maley, W. Morgan, P. Morris,
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During 2009, IOTA observers in North America reported about 250 positive observations for 94 asteroidal occultation events. For two asteroids this included observations of multiple chords on two different dates which allowed well-defined profiles to be obtained at different rotational phase angles. Occultations by 81 Terpsichore on 2009 November 19 and 2009 December 25 yielded best-fit ellipses of 134.0 x 108.9 km and 123.6 x 112.2 km, respectively. Observations of 694 Ekard on 2009 September 23 and 2009 November 8 yielded fitted ellipses of 124.9 x 88.0 km and 88.5 x 104.0 km, respectively.

Introduction

The history of asteroidal occultation observations was reviewed in a previous *Minor Planet Bulletin* article (Timerson et al. 2009).

Successful predictions (Preston, 2009) and observations have increased dramatically, especially since 1997, aided by high-accuracy star catalogs and asteroid ephemerides (Dunham, et al, 2002). The techniques and equipment needed to make these observations are outlined in the IOTA manual (Nugent, 2007). Observations are reported to a regional coordinator who gathers these observations and uses a program called *Occult4* (Herald, 2008) to produce a profile of the asteroid at the time of the event. These asteroidal occultation data are officially deposited and archived, and made available to the astronomical community through the NASA Planetary Data System (Dunham, et. al., 2008). Additional tools such as asteroidal lightcurves (Pilcher) and asteroidal models derived from inversion techniques (Durech) can be combined with occultation results to yield high resolution profiles. The asteroid lightcurve inversion method is described by Kaasalainen and Torppa (2001) and Kaasalainen et al. (2001). It enables one to derive asteroid shape, spin axis direction, and rotation period from its lightcurves observed over several apparitions. The shape is usually modeled as a convex polyhedron. When the shape model and its spin state are known, its orientation with respect to an observer (sky plane projection) can be easily computed. Such a predicted silhouette can then be compared with the occultation chords and scaled to give the best fit. Finally, planning software called *OccultWatcher* allows observers to space themselves across the predicted path of the occultation to gather as many unique chords as conditions allow (Pavlov, 2008).

Occultation Results

81 Terpsichore. North American observers captured Terpsichore occulting stars on two occasions late in 2009. During these events, multiple chords were obtained allowing for the creation of a well-defined profile at different rotational phase angles. On 2009 November 19 at 10:31 UT asteroid 81 Terpsichore occulted the V magnitude 9.0 star TYC 2342-00278-1 (SAO 56567) in Perseus over a long path which included VT and NH. Maximum duration was predicted to be 13.8 seconds. For this event, 3 observers at 6 sites recorded 5 chords across the profile of the asteroid. Three sites used video to record the event while three stations used visual techniques. One station reported no occultation. D. Dunham set up 4 stations, all of which recorded positive events. The resulting chords and least squares ellipse from *Occult4* are shown in Figure 1. These chords produce a smooth ellipse with dimensions of 134.0 ± 4.0 x 108.9 ± 0.7 km. The maximum occultation duration of 12.86 seconds occurred at station 6 and is 7% shorter than predicted, likely because of the orientation of the asteroid at the time of the occultation. The observed path was quite close to the prediction.

About 106 rotational periods later, on 2009 December 25 at 5:00 UT, 81 Terpsichore occulted the V magnitude 8.5 star TYC 1795-00251-1 (SAO 75766) in Aries over a path that included areas from central Canada, through MT and to the coast of central CA. Maximum duration was predicted to be 43.7 seconds. Twelve observers at 12 sites recorded 10 positive occultations and 2 misses. Nine stations used video recording techniques while 3 used visual. The maximum observed duration was 41.36 seconds at station 8, 5% shorter than predicted. The observed path was

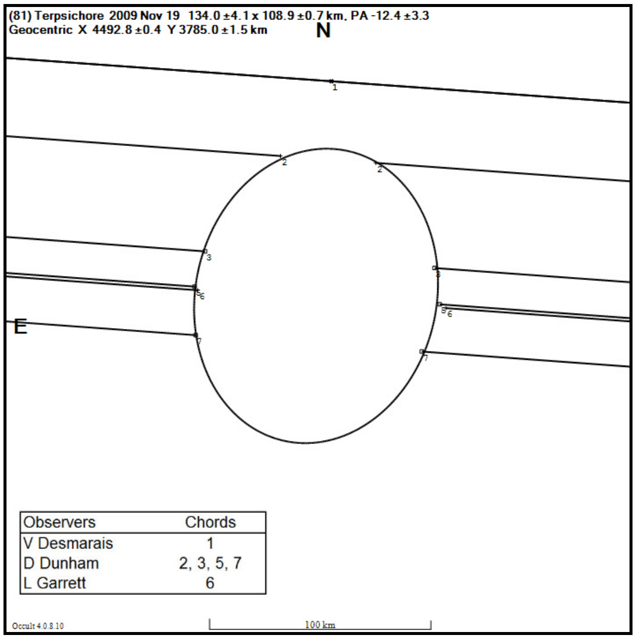
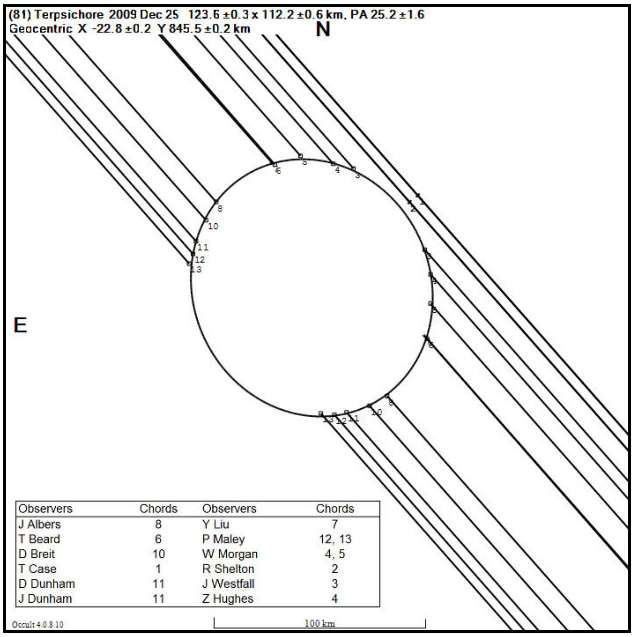


Figure 1. Observed occultation outline for 81 Terpsichore on 2009 November 19 UT with least squares ellipse.

quite close to the prediction. The resulting chords with least squares ellipse from *Occult4* are shown in Figure 2. These chords produced an ellipse with dimensions of 123.6 ± 0.3 x 112.2 ± 0.6 km.

A lightcurve from recent observations of 81 Terpsichore was provided by Frederick Pilcher (Pilcher, 2009), seen here in Figure 3. On the diagram, Pilcher determined the locations along the lightcurve corresponding to the times of the two well-observed occultations. From the profiles, the fitted ellipse areas are approximately 45,844 km^2 for the November event and 43,567 km^2 for the December event. This gives an area ratio of 0.95. However, in looking at the lightcurve, the brightness ratio is 1.05. This inconsistency might be attributed to a lack of sufficient chords for the November event such that important profile information is missed, or the somewhat noisy lightcurve data. This only serves to emphasize the need for better coverage over the entire profile of an asteroid during occultations and, with more data, improved lightcurves and lightcurve inversion models.



Observers	Chords	Observers	Chords
J Albers	8	Y Liu	7
T Beard	6	P Maley	12, 13
D Breit	10	W Morgan	4, 5
T Case	1	R Shelton	2
D Dunham	11	J Westfall	3
J Dunham	11	Z Hughes	4

Figure 2. Observed occultation outline for 81 Terpsichore on 2009 December 25 UT, with least squares ellipse.

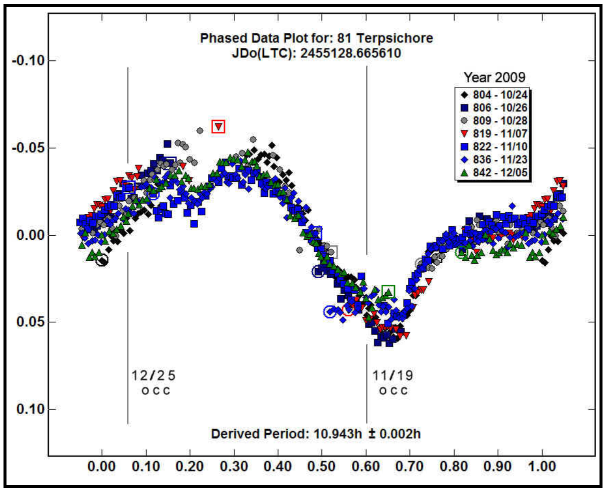
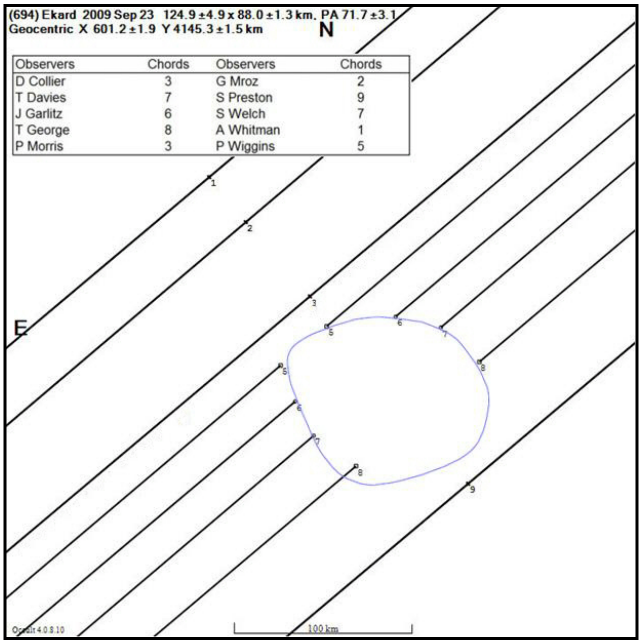


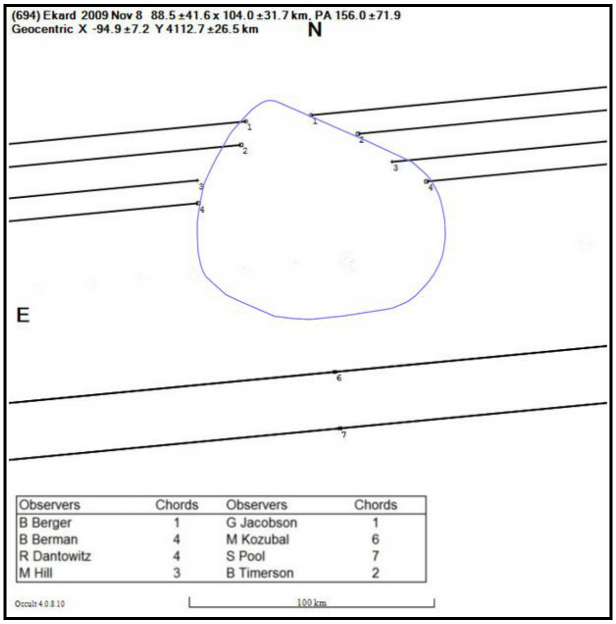
Figure 3. Pilcher lightcurve showing location of two events Involving 81 Terpsichore.

694 Ekard. North American observers captured Ekard occulting stars during four separate events in 2009. On two of those occasions, multiple chords were obtained allowing for the creation of a well-defined profile at different rotational phase angles. On 2009 September 23, from 4:35 UT to 4:42 UT, asteroid 694 Ekard occulted the V mag. 10.3 star TYC 0506-00521-1 in Aquila along a path which included the Pacific NW to southern TX. The maximum predicted duration for this event was 11.2 seconds. Eight observers provided 4 well-spaced chords. Four observers reported misses. For the positive chords, video recording was employed at 3 stations and one used drift scan. Detailed results with maps showing the locations of all observers are posted on the IOTA *Asteroid Occultation Results for North America* webpage (Timerson, 2009). The predicted orientation of Ekard provided by



Observers	Chords	Observers	Chords
D Collier	3	G Mroz	2
T Davies	7	S Preston	9
J Garlitz	6	S Welch	7
T George	8	A Whitman	1
P Morris	3	P Wiggins	5

Figure 4. Observed occultation profile for 694 Ekard on 2009 September 23 UT with light curve inversion model (blue).



Observers	Chords	Observers	Chords
B Berger	1	G Jacobson	1
B Berman	4	M Kozubal	6
R Dantowitz	4	S Pool	7
M Hill	3	B Timerson	2

Figure 5. Observed occultation outline for 694 Ekard on 2009 November 8 UT with light curve inversion model (blue).

J. Durech (Durech, 2009) using the results of Torppa (2003) has been superimposed over the observed chords as created in *Occult4* (figures 4 and 5). Maximum duration of 10.89 seconds occurred at station 7, about 3% shorter than predicted. The actual path shifted about one path-width south from what was predicted with the predicted time a few seconds late. The profile produced using *Occult4* and its least squares fit routine shows an ellipse with dimensions of 124.9 ± 4.9 x 88.0 ± 1.3 km. Fitting the irregular shape model provided by Durech to the observations gives a least-squares equivalent diameter of 90 ± 6 km for the asteroid.

Nearly 64 rotational periods later, on 2009 November 8, in twilight at 22:47 UT, Ekard occulted the V magnitude 10.3 star TYC 0528-00946-1 in Aquarius along a path that included central NY to MA. The predicted maximum duration was 4.6 seconds. Six observers provided four positive observations and 2 misses. Of the four positive results, 3 used video techniques and 1 was visual. The maximum observed duration was 4.45 seconds at station 4, about 3% less than predicted. The path showed an approximate ½ path-width shift north. The observed chords from *Occult4* along with the same lightcurve inversion model (Torppa et al. 2003) superimposed, are shown in Figure 5. The *Occult4* profile showed a least squares profile of an ellipse measuring 88.5 ± 41.6 x 104.0 ± 31.7 km. As previously noted, the model provided by Durech gives a least-squares equivalent diameter of 90 ± 6 km for this irregularly shaped asteroid.

Conclusions

Combining observations from a variety of independent sources provides evidence for the shape of asteroids and their orientation during the time of these observations. This can be seen by the excellent agreement between occultation results and inversion models in the case of Ekard. The discrepancy noted in the Terpsichore observations is evidence of the need for more observations of all types. Even including the lightcurve and occultations in late 2009, there are not enough observations of 81 Terpsichore to obtain a reliable model through lightcurve inversion. The observations reported here will contribute toward such a model, but additional future lightcurves and/or occultations with many observed chords are required to complete the model. Future articles will continue to include occultation results in which multiple chords are observed and for which lightcurves and/or inversion models are available.

Acknowledgements

The work of J. Durech was supported by the grant GACR P209/10/0537 of the Czech Science Foundation and by the Research Program MSM0021620860 of the Ministry of Education.

References

Degenhardt, S. (2009). “Effects of Optical Miniaturization on Occultations”, *The Alt-Az Initiative: Lightweight Telescope Developments and Scientific Research Programs*, Genet, R., Collins Foundation Press.

Dunham D., Goffin E., Manek J., et al. (2002). “Asteroidal Occultation Results Multiply Helped by HIPPARCOS”, *Journal of the Italian Astronomical Society* **73**, 662-665.

Dunham, D., Herald, D., Neese, C. (2008). Asteroid Occultations V6.0. EAR-A-3-RDR- OCCULTATIONS-V6.0. NASA Planetary Data System. http://sbn.psi.edu/pds/resource/occ.html .

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

Durech, Sidorin, and Kaasalainen (2010) “DAMIT: A Database of Asteroid Models”, *Astronomy and Astrophysics*, 513, A46

Herald, D. *Occult4* software (2008).
http://www.lunar-occultations.com/iota/occult4.htm Unpublished profile routine using a least squares fit of an ellipse to the observed occultation chords as projected onto a moving reference frame on the fundamental plane.

Kaasalainen, M. and Torppa, J. (2001). “Optimization methods for asteroid lightcurve inversion. I. Shape determination”. *Icarus* **153**, 24.

Kaasalainen, M., Torppa, J., and Muinonen, K. (2001). “Optimization methods for asteroid lightcurve inversion. II. The complete inverse problem”. *Icarus* **153**, 37.

Nugent, R., Ed. (2007). “*Chasing the Shadow: The IOTA Occultation Observer's Manual*”, International Occultation Timing Association, Houston, TX. ISBN 9780615291246

Pavlov, H. (2008). *OccultWatcher* software.
http://www.hristopavlov.net/OccultWatcher/publish.htm .

Pilcher, F. (2010). “Rotation Period Determinations for 81 Terpsichore, 419 Aurelia, 452 Hamiltonia, 610 Valeska, 649 Josefa, and 652 Jubilatrix,” *Minor Planet Bulletin* **37**, 45-46.

Preston, S. (2009). *Asteroid Occultation Updates*
http://www.asteroidoccultation.com .

Taylor, G.E. (1962). *J. Brit. Astr. Assoc.* **72**, 212.

Timerson, B., *Asteroid Occultation Results for North America*
http://www.asteroidoccultation.com/observations/Results/ .

Timerson, B., et al. (2009). “A Trio of Well-Observed Asteroi Occultations in 2008.” *Minor Planet Bulletin* **36**, 98-100.

Torppa, J. et al. (2003). “Shapes and Rotational Properties of Thirty Asteroids from Photometric Data.” *Icarus* **164**, 364-383.

PERIOD DETERMINATION FOR 4191 ASSESSE

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Lightcurve analysis for 4191 Assesse was performed from observations during its 2010 opposition. The synodic rotation period was found to be 5.6489 ± 0.0003 h and the lightcurve amplitude was 0.70 ± 0.09 mag.

Unfiltered CCD photometric observations of asteroid 4191 Assesse were obtained at the Observatorio Los Algarrobos, Salto, Uruguay (MPC Code I38), from 2010 May to June. It was selected among the “Potential Lightcurve Targets 2010 April - June” list that appeared in the Collaborative Asteroid Lightcurve Link (CALL) web-site (Warner, 2009) due to having a favorable sky location, a comparatively bright magnitude, and a reported period being both relatively short and uncertain. In this last regard, this Eunomia-family asteroid had been measured in 1997 for about 4 hours on two nights (Angeli et al. 2001), providing a period of 5.4 h with a reliability code (Harris et al. 1999) of 1.

Observations were made using a 0.3-m Meade LX-200R f/10 working with a 0.63 focal reducer. The CCD imager was a QSI 516wsg NABG with a 1536 x 1024 array of 9-micron pixels. Exposures were 120 s working at –20C, unguided, and unfiltered at 2x2 binning, yielding an image scale of 1.9 arcseconds per pixel. All images were dark and flat field corrected. The images were measured using *MPO Canopus* (Bdw Publishing) version 10.1.0.7 with a differential photometry technique. The data were light-time corrected. Period analysis was also done with *Canopus*, which incorporates the Fourier analysis algorithm developed by Harris et al. (1989).

From more than 850 data points obtained during six sessions (three of them longer than 6 h), covering a phase angle from 10.6º to 3.1º, a period of 5.6489 ± 0.0003 h was determined along with a lightcurve peak-to-peak amplitude of 0.70 ± 0.09 mag. Data points from a seventh short “bad” session were not included.

Acknowledgements

Thanks to Brian D. Warner for a fruitful exchange of emails regarding the preparation of this report.

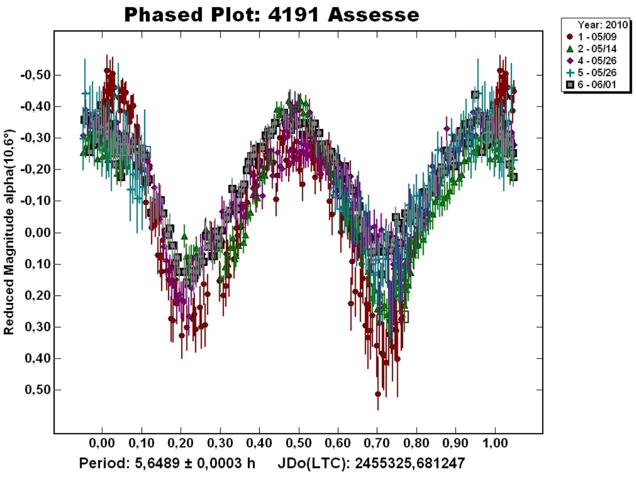
References

Angeli, C. A., Guimaraes, T. A., Lazzaro, D., Duffard, R., Fernandez, S., Florczak, M., Mothe-Diniz, T., Carvano, J. M., and Betzler, A. S. (2001). “Rotation Periods for Small Main-Belt Asteroids from CCD Photometry.” *The Astronomical Journal* 121, 2245-2252.

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.

Harris, A. W., Young, J. W., Bowell, E., and Tholen, D. J. (1999). “Asteroid lightcurve observations from 1981 to 1983.” *Icarus* 142, 173-201.

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



LIGHTCURVE ANALYSIS OF 188 MENIPPE

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CCD observations of the main-belt asteroid 188 Menippe at the Palmer Divide and Hunters Hill Observatories found a synodic rotation rate of 11.98 ± 0.02 h and lightcurve amplitude of 0.28 ± 0.02 mag.

CCD photometric observations were made of the main-belt asteroid, 188 Menippe, in 2010 February. Those at the Palmer Divide Observatory were made using a 0.35-m Schmidt-Cassegrain Telescope (SCT) working at f/9.1 coupled with an FLI-1001E. The resulting scale was ~1.2 arcsec/pixel. Exposures were 240 s using an R filter. Hunters Hill Observatory used a 0.35-m SCT with SBIG ST-8E. Exposures were 240 s using a clear filter. Darks and bias frames were created and merged in *MPO Canopus*. Night-to-night linking of the PDO data was accomplished using 2MASS J-K to BVRI conversions (see Warner, 2007, and references therein). Period analysis on the combined data set was also done in *MPO Canopus* using the algorithm developed by Harris (Harris et al., 1989).

The initial observations were made at PDO on 2010 February 2, 3, and 5. At this point, a period of almost exactly 12 hours was a strong possibility, meaning it would be nearly impossible for a single station or several at about the same longitude to find the period of the asteroid. A request for supporting observations was made to Hunters Hill Observatory (HHO), which is located about 135° west of PDO. Observations from HHO were made on February 9 and 16 while additional observations were made at PDO on February 10 and 11. The two sessions provided by HHO, the one on Feb 16 covering more than six hours, filled in the missing parts of the lightcurve and confirmed a final period of 11.98 ± 0.02 h. The amplitude of the lightcurve is 0.28 ± 0.02 mag. Our period agrees with the 11.974 h found by Barucci et al. (1994). On 2010 February 9, the mid-date of the observations, the phase angle (α) was 5.4° while the Phase Angle Bisector longitude and latitude were, respectively, 145° and -14°.

The “Reduced Magnitude” in the plot uses R magnitudes that are corrected to unity distance using –5 * log (Rr), with R and r being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle of the earliest session ($\alpha = 6.4°$) using $G = 0.15$.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX 09AB48G, by National Science Foundation grant AST-0907650, and by a 2007 Gene Shoemaker NEO Grant from the Planetary Society. Funding for observations at Hunters Hill is provided in part 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

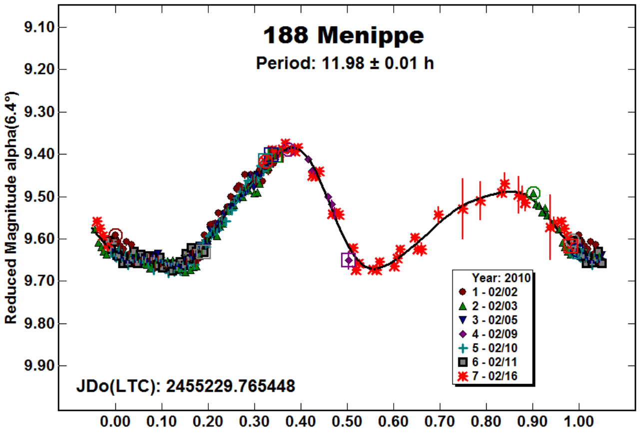
joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by NASA and NSF.

References

Barucci, M.A., Di Martino, M., Dotto, E., Fulchignoni, M., Rotundi, A., and Burchi, R. (1994). “Rotational properties of small asteroids: Photoelectric observations of 16 asteroids.” *Icarus* **109**, 267-273.

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. (2007). “Initial Results of a Dedicated H-G Project.” *Minor Planet Bul.* **34**, 113-119.



ROTATION PERIOD DETERMINATION FOR 310 MARGARITA

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A synodic rotation period of 12.069 ± 0.001 h and amplitude 0.15 ± 0.02 mag. have been found for 310 Margarita.

The two authors began observing 310 Margarita independently. When they learned of each other’s work on the CALL Website (2010) they agreed to combine their observations and prepare a collaborative paper. The observations by Pilcher were made at the Organ Mesa Observatory with a 35 cm Meade LS200 GPS S-C, SBIG STL1001-E CCD, unguided, clear filter, 60 s exposures, differential photometry only. Those by Oey were made at the Kingsgrove Observatory with a 25 cm S-C telescope with a SBIG ST9XE CCD operating at f10 unfiltered. Image measurement and data analysis are with *MPO Canopus.* In the lightcurve the large number of data points acquired for each target have been binned into sets of 3 with a maximum time difference of 5 minutes between plotted points.

Harris et al. (2009) list no previous observations. The first sessions suggested a period near 12.07 hours, slightly greater than Earth commensurable, for which the portion of the lightcurve observable from a single location will circulate very slowly to the left. This makes it especially valuable to make observations from two locations at widely different longitudes. Those parts of the lightcurve not visible within a several day interval from one location may be sampled from the other. Observations on 25 nights 2010 Mar. 9 – May 31 show a period 12.069 ± 0.001 hours, amplitude 0.15 ± 0.02 magnitudes. Over this interval observations at either single site would be compatible also with a period twice as great, likely with 4 maxima and minima per cycle, but with a considerable portion of the lightcurve unsampled. Combining the observations provides full phase coverage for an assumed 24.141 hour period. It should be noted that in the lightcurve phased to 12.069 hours the minimum near phase 0.1 is 0.04 magnitude lower May 30-31 near phase angle 20.4 degrees than on several previous nights at much smaller phase angles. These May 30 and 31 observations are the only ones showing this particular minimum in the 24.141 hour lightcurve, the two halves of which otherwise look nearly identical. We favor a 12.069 hour rotation period in which the greater depth of the minimum observed May 30 and 31 is a consequence of amplitude being greater at larger phase angles due to enhanced shadowing effects. Therefore we reject the 24.141 hour period with quadrimodal lightcurve and shape almost but not entirely symmetric over a 180 degree rotation.

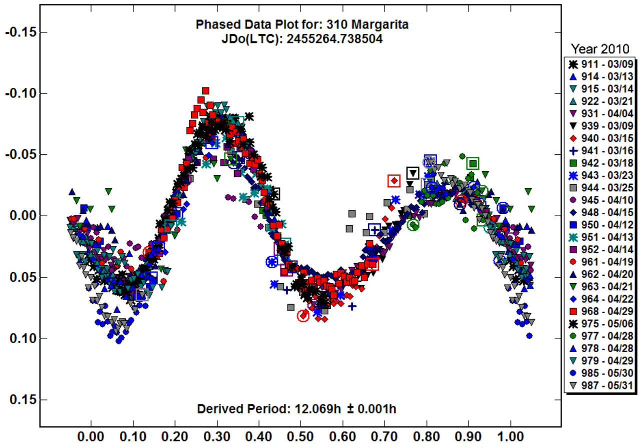
Acknowledgement

The authors thank Dr. Petr Pravec for valuable assistance in the period determination.

References

CALL website (2010). http://www.MinorPlanetObserver.com

Harris, A. W., Pravec, P., and Warner, B. D. (2009) “Asteroid Lightcurve Data File: Apr. 8, 2009,” http://www.MinorPlanetObserver.com/astlc/default.htm.



LIGHTCURVE DETERMINATION OF 2954 DELSEMME, 3305 CEADAMS, AND 7476 OGILSBIE

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(Received: 8 June)

CCD photometric observations of three asteroids were obtained and analyzed at the Bigmuskie Observatory, Italy, in 2010 April and May: 2954 Delsemme; 3305 Ceadams; and 7476 Ogilsbie

Starting in 2010 April, I added photometric studies of asteroids in addition to my ongoing work of measuring astrometric positions. My goal was to observe asteroids reaching a favorable sky location from my position to obtain the lightcurves and then determine rotation periods. Observations were made using a 0.3-m Ritchey-Chretien working at f/8 coupled to a Finger Lakes MaxCam CM-9 CCD camera. The camera was operated at –20°C. *MPO Canopus* (Warner 2010) was used to measure the unfiltered images using differential photometry as well as for period analysis of the data. The maximum duration for observing runs was about 7 hours, less if the asteroid had a negative declination.

2954 Delsemme. The initial session on 2010 May 19 clearly showed a bimodal curve with a period $P \sim 4.7$ h, although the period spectrum did show other possible solutions. The second session on May 20 refined the period solution to 4.68 ± 0.02 h. This is in good agreement with Wisniewski et al. (1997), who found $P = 4.69$ h.

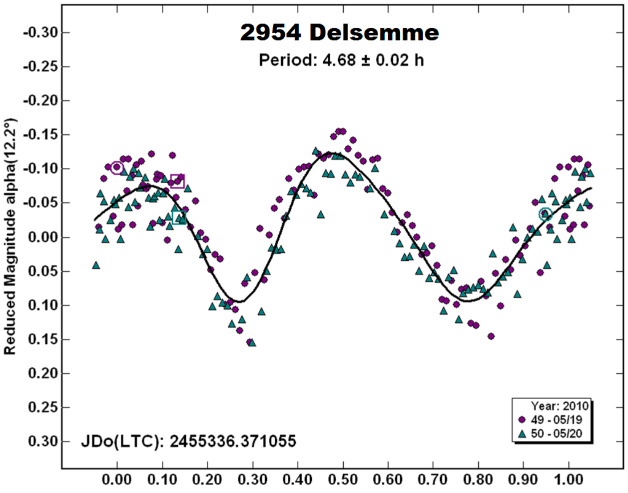
3305 Ceadams. Because this asteroid was faint ($V > 15$) it was a more difficult target for my system. I obtained additional sessions to make sure of the period solution. The initial solution was for a curve with four maxima and minima per cycle. The second session changed this to three pairs but the data had a very poor fit to the modeled curve. After three sessions followed by about three weeks of bad weather, a fourth session helped to reach the final bimodal lightcurve solution of $P = 2.729 \pm 0.001$ h.

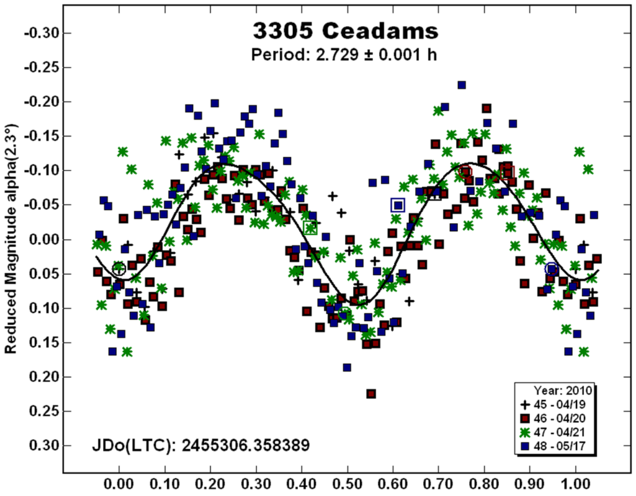
7476 Ogilsbie. Using four sessions in 2010 April, I found a convincing solution with a period of $P = 3.92 \pm 0.01$ h. Analysis using less than the full data produced less secure results.

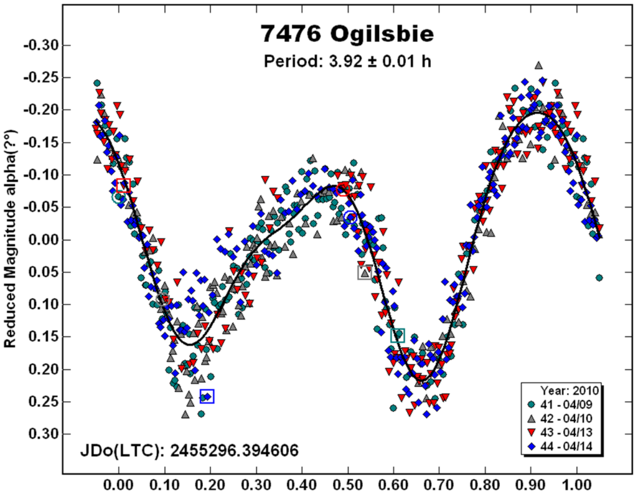
References

Warner, B.D. (2010). *MPO Canopus* software, v10.1.0.6. Bdw Publishing, Colorado Springs, CO.

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







ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 2010 FEBRUARY-MAY

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Photometric data for eight asteroids were obtained at the Via Capote Observatory from 2010 February through May. Synodic periods from the resulting lightcurves were found for: 1845 Helewalda (7.4 h); 2090 Mizuho (5.47 h); 2297 Daghestan (7.75 h); 2881 Meiden (3.48 h); 4569 Baerbel (2.737 h); 5691 Fredwatson (106.25 h); 11100 Lai (> 5 hrs); and (22295) 1989 SZ9 (3.80 h). Several of these targets had no previously published photometric lightcurve data.

CCD photometric observations were made of eight asteroids from 2010 February through May to determine the synodic rotation periods. Observations at the Via Capote Observatory in southern California were made using a Meade LX200 0.36-m Schmidt-Cassegrain (SCT) working at f/10. The CCD imager was an Apogee 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. All images were dark, flat field, and bias corrected. Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. Comparison stars were chosen and linked using the "Comp Star Selection" tool embedded within the *Canopus* analysis package. The data were light-time corrected. Period analysis was also done with *Canopus*, which implements the Fourier analysis algorithm developed by Harris (Harris et al., 1989). Most target selections were made using the Collaborative Asteroid Lightcurve Link (CALL) web-site (Warner, 2010) and "Lightcurve Opportunities" articles from the *Minor Planet Bulletin*. Priority was given to asteroids that did not have a published rotation period.

The results are summarized in the table below. Individual lightcurve plots along with additional comments, as required, are also presented. The reference phase angle (α) listed on the plots is for the first session in the data set.

1845 Helewalda. The low declination of this target limited the number of usable sessions that could be obtained and so only partial coverage was achieved. The results of this study agree well with those of DeGraff (2001) and Carbo (2009). There was an interesting feature at phase 0.28 where the maxima exhibited a dip. This was also apparently observed by the Carbo group.

2297 Daghestan. Behrend (2010) reported a provisional period of 7.7 h with an amplitude of 0.37 mag. These compare to 7.75 h and 0.24 mag found in this study.

2881 Meiden. Toward the end of this campaign, the object faded to near the practical magnitude limit for the system and so the resultant data on these later sessions became rather noisy.

11100 Lai. Coincidently, this object was in the field of view for the April 8 observing session for 2297 Daghestan and was at or near a very favorable opposition. Despite the favorable apparition, the target was near the practical magnitude limit for the system and the study was abandoned after two additional dedicated sessions were completed. The April 16 session suggests the period to be something greater than 5 hours.

References

Behrend, R. (2010). Observatoire de Geneve web site: http://obswww.unige.ch/~behrend/page_cou.html

Carbo, L., Green, D., Kragh, K., Krotz, J., Meiers, A., Patino, B., Pligge, Z., Shaffer, N., and Ditteon, R. (2009). *Minor Planet Bul.* **36**, 152-157.

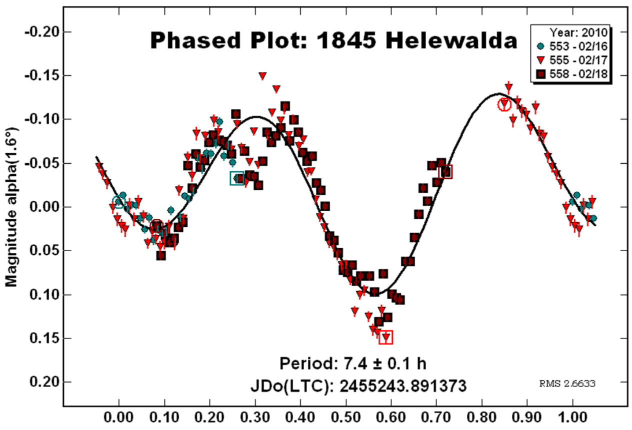
DeGraff, D.R. and Kern, J.S. (2001) *Bul. Amer. Astron. Soc.* **33**, 1403.

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. (2010) CALL web site. http://www.MinorPlanetObserver.com/astlc/default.htm

#	Name	Date Range (mm/dd) 2010	Data Points	Phase	L_{PAB}	B_{PAB}	Per(h)	PE	Amp (mag)	AE
1845	Helewalda	02/16-02/18	167	2.1,1.3	152	+2	7.4	0.1	0.28	0.04
2090	Mizuho	02/17-02/18	129	1.2	152	+2	5.47	0.01	0.30	0.05
2297	Daghestan	04/08-04/24	269	1.0,0.7,5.9	200	+2	7.75	0.01	0.24	0.05
2881	Meiden	02/11-04/27	323	7.6,31.1	141	-3	3.48	0.01	0.18	0.08
4569	Baerbel	04/25-05/01	192	6.4,9.2	202	+0	2.737	0.001	0.24	0.05
5691	Fredwatson	04/09-05/15	714	15.1,27.1	176	+7	106.25	0.02	>1.2	
11100	Lai	04/08-04/16	185	1.4,1.0,4.0	200	+2	> 5	0.5	>0.15	
(22295)	1989 SZ9	04/02-04/07	385	6.3,9.3	182	-1	3.80	0.01	0.04	0.02

Table I. Observation circumstances. The phase column gives the phase angle at the beginning and end of the data set. When three numbers are given, the middle value is the minimum phase angle observed. The two PAB columns give the approximate longitude and latitude of the phase angle bisector.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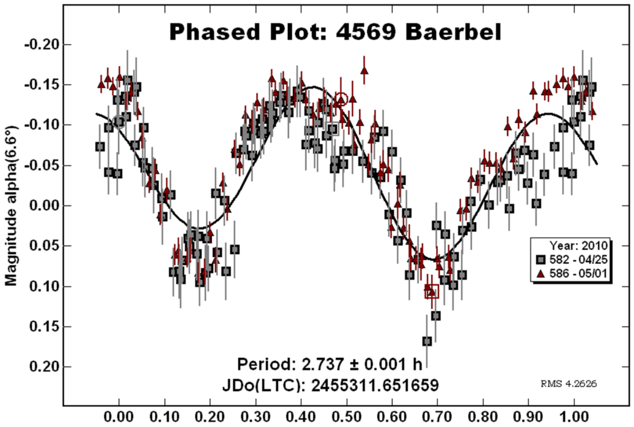
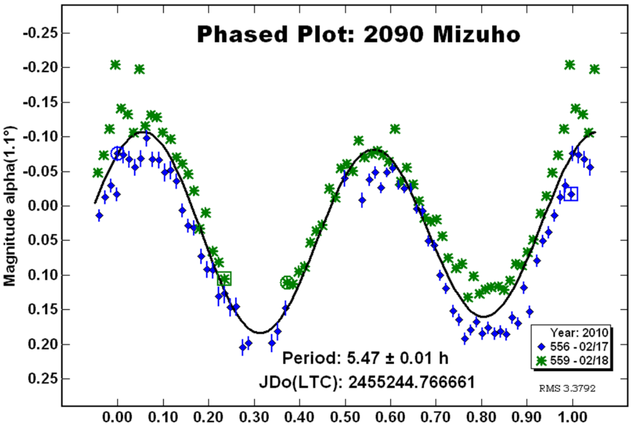
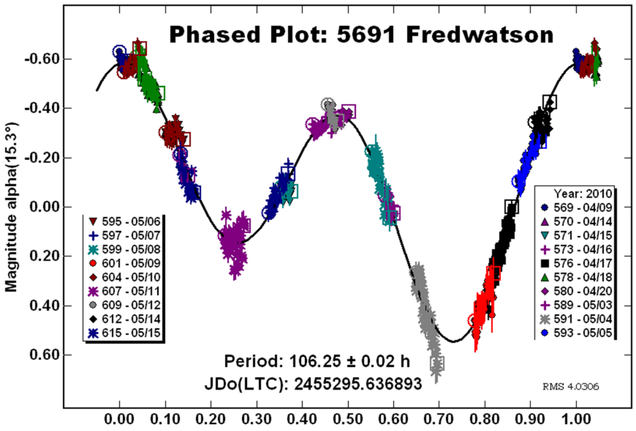
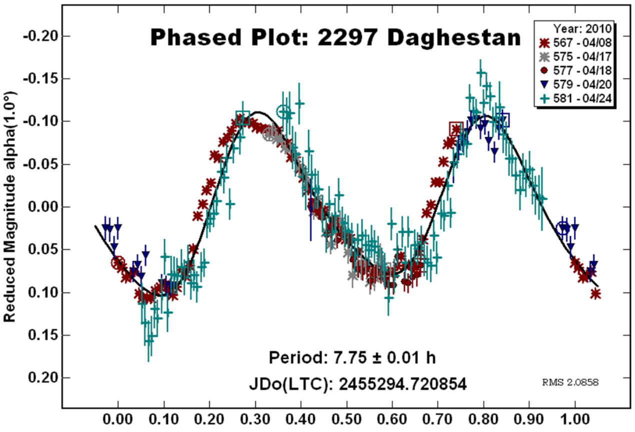
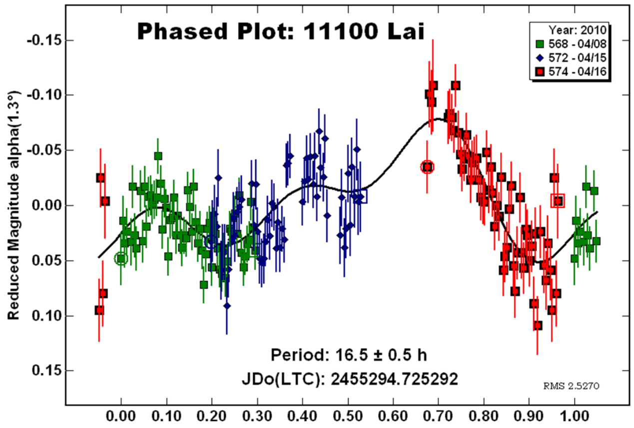
Year: 2010
553 - 02/16
555 - 02/17
558 - 02/18
Magnitude alpha(1.6°)
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 7.4 ± 0.1 h
JDo(LTC): 2455243.891373
RMS 2.6633

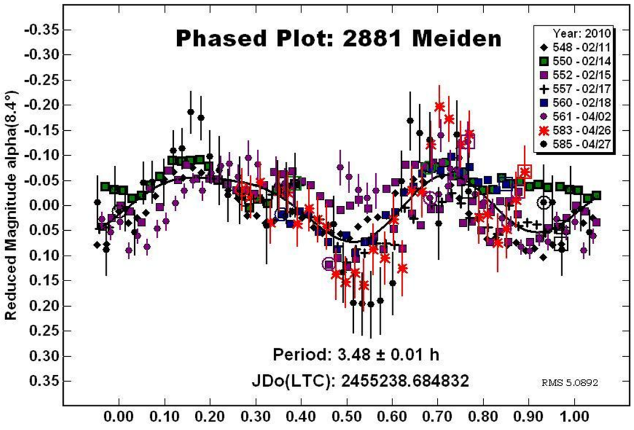

Phased Plot: 4569 Baerbel
Year: 2010
582 - 04/25
586 - 05/01
Magnitude alpha(6.6°)
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 2.737 ± 0.001 h
JDo(LTC): 2455311.651659
RMS 4.2626

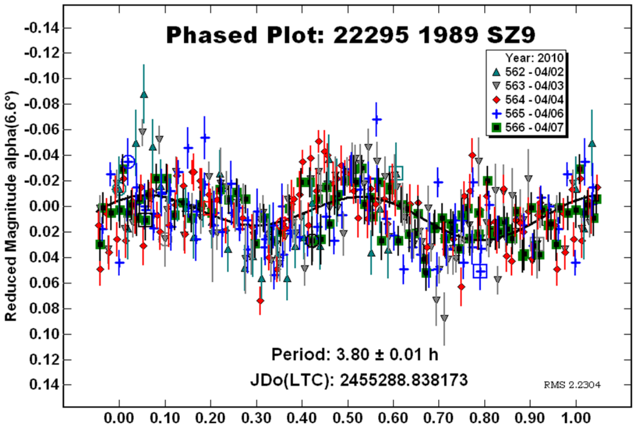

Phased Plot: 2090 Mizuho
Year: 2010
556 - 02/17
559 - 02/18
Magnitude alpha(1.1°)
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 5.47 ± 0.01 h
JDo(LTC): 2455244.766661
RMS 3.3792


Phased Plot: 5691 Fredwatson
595 - 05/06
597 - 05/07
599 - 05/08
601 - 05/09
604 - 05/10
607 - 05/11
609 - 05/12
612 - 05/14
615 - 05/15
Year: 2010
569 - 04/09
570 - 04/14
571 - 04/15
573 - 04/16
576 - 04/17
578 - 04/18
580 - 04/20
589 - 05/03
591 - 05/04
593 - 05/05
Magnitude alpha(15.3°)
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 106.25 ± 0.02 h
JDo(LTC): 2455295.636893
RMS 4.0306


Phased Plot: 2297 Daghestan
Year: 2010
567 - 04/08
575 - 04/17
577 - 04/18
579 - 04/20
581 - 04/24
Reduced Magnitude alpha(1.0°)
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 7.75 ± 0.01 h
JDo(LTC): 2455294.720854
RMS 2.0858


Phased Plot: 11100 Lai
Year: 2010
568 - 04/08
572 - 04/15
574 - 04/16
Reduced Magnitude alpha(1.3°)
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 16.5 ± 0.5 h
JDo(LTC): 2455294.725292
RMS 2.5270


Phased Plot: 2881 Meiden
Year: 2010
548 - 02/11
550 - 02/14
552 - 02/15
557 - 02/17
560 - 02/18
561 - 04/02
583 - 04/26
585 - 04/27
Reduced Magnitude alpha(8.4°)
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 3.48 ± 0.01 h
JDo(LTC): 2455238.684832
RMS 5.0892


Phased Plot: 22295 1989 SZ9
Year: 2010
562 - 04/02
563 - 04/03
564 - 04/04
565 - 04/06
566 - 04/07
Reduced Magnitude alpha(6.6°)
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 3.80 ± 0.01 h
JDo(LTC): 2455288.838173
RMS 2.2304

ROTATION PERIOD DETERMINATIONS FOR 80 SAPPHO, 145 ADEONA, 217 EUDORA, 274 PHILAGORIA, 567 ELEUTHERIA, AND 826 HENRIKA

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Synodic rotation periods and amplitudes have been found for: 80 Sappho 14.025 ± 0.001 h, 0.14 ± 0.02 mag; 145 Adeona 15.071 ± 0.001 h, 0.15 ± 0.02 mag; 217 Eudora 25.470 ± 0.05 h, 0.08 ± 0.02 mag; 274 Philagoria 17.938 ± 0.001 h, 0.44 ± 0.03 mag; 567 Eleutheria 7.718 ± 0.001 h, 0.34 ± 0.02 mag; 826 Henrika 5.9846 ± 0.0001 h, 0.25 ± 0.02 mag.

All of these observations have been made at the Organ Mesa Observatory. Equipment consists of a 35 cm Meade LS200 GPS S-C, SBIG STL-1001E CCD, unguided, R filter for 80 Sappho and clear filter for all other targets, 60 s exposures, differential photometry only. Image measurement and data analysis are with *MPO Canopus.* In the lightcurves the large number of data points acquired for each target have been binned into sets of three with a maximum time difference of 5 minutes between plotted points.

<u>80 Sappho.</u> Harris et al. (2009) list a period 14.030 hours, reliability 3, based on several investigations. New lightcurves were obtained to contribute to spin/shape modeling. Observations on 4 nights 2010 Apr. 26 – May 9 show a period 14.025 ± 0.001 hours, amplitude 0.14 ± 0.02 magnitudes.

<u>145 Adeona.</u> The small amplitude and irregular shape of the lightcurve has caused three previous studies to obtain three different periods: Debehogne et al. (1982), 20.6 hours; and Burchi et al. (1985), 8.1 hours, both from very sparse data sets. Stephens (2009), from a much denser data set, finds 15.086 hours. New observations on 10 nights 2010 Apr. 5 – June 1 show a period 15.071 ± 0.001 hours, amplitude 0.15 ± 0.02 magnitudes with a lightcurve having 4 very unequal minima in each rotational cycle. The period is in good agreement with Stephens (2009). His lightcurve had amplitude 0.05 magnitudes near longitude 70 degrees which is evidently much closer to rotational pole than 220 degrees near which the new observations were made. A careful inspection of the data of Debehogne et al. (1982) and Burchi et al. (1985) shows that they are compatible with a period near 15.07 hours. Hence a period near 15.07 hours can now be considered well established.

<u>217 Eudora.</u> Lagerkvist et al. (1998) on the basis of a very fragmentary lightcurve containing a minimum but no maximum reported a possible period of 12.54 hours, amplitude >= 0.16 magnitudes. Buchheim et al. (2007) obtained a period of 25.253 hours, amplitude 0.24 magnitudes with 75% phase coverage on their published lightcurve. A new investigation on 8 nights 2010 Feb. 24-Apr. 14 did not achieve secure reliability because of a combination of faint magnitude around 15, low amplitude 0.08 ± 0.02 magnitudes, and near commensurability with Earth rotation period. All local minima on the period spectrum between 10 and 70 hours were investigated. The best visual fit, and one with lowest residual, is for 25.470 hours, but others may not be completely ruled out. The actual error is likely to be closer to 0.05 hours, or even larger, than to the formal error of 0.005 hours. The data of Lagerkvist et al. (1998) are also compatible with twice his period. A period slightly greater than 25 hours with pole much closer to longitude 170 degrees near which the new observations were made than to 240 degrees of the Buchheim et al. (2007) observations supports moderately well all currently available data.

<u>274 Philagoria.</u> Behrend (2010) lists a period of 17.96 hours. New observations on 6 nights 2010 Feb. 26 – Apr. 10 confirm this value by showing a period 17.938 ± 0.001 hours, amplitude 0.44 ± 0.03 magnitudes.

<u>567 Eleutheria.</u> Gil-Hutton and Canada (2003) list a period of 12.673 hours. New observations on 5 nights 2010 Apr. 9 – May 5 show a period 7.718 ± 0.001 hours, amplitude 0.34 ± 0.02 magnitudes.

<u>826 Henrika.</u> Harris et al. (2009) list no previous observations. New observations on 6 nights 2010 Mar. 26 – May 4 show a period 5.9846 ± 0.0001 hours, amplitude 0.25 ± 0.02 magnitudes.

References

Behrend, R., Observatoire de Geneve web site: (2010). http://obswww.unige.ch/~behrend/page_cou.html.

Burchi, R., D'Ambrosio, V., Tempersi, P., and Lanciano, N. (1985). "Rotational properties of asteroids 2, 12, 80, 145 and 354" *Astron. Astrophys. Suppl Ser.* **60**, 9-15.

Buchheim, R. K., Roy, R., and Behrend, R. (2007). "Lightcurves for 122 Gerda, 217 Eudora, 631 Philippina, 670 Ottegebe, and 972 Cohnia," *Minor Planet Bull.* **34**, 13-14.

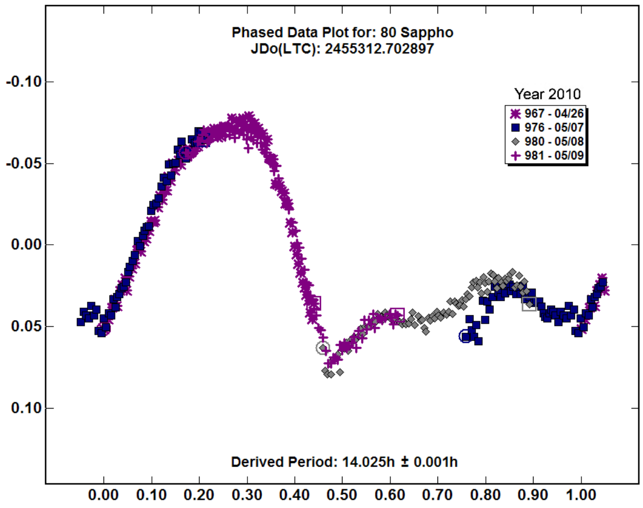
Debehogne, H., Lagerkvist, C.-I., and Zappala, V. (1982). "Physical Studies of asteroids VIII. Photoelectric photometry of the asteroids 42, 48, 93, 105, 145, and 245." *Astron. Astrophys. Suppl. Ser.* **50**, 277-281.

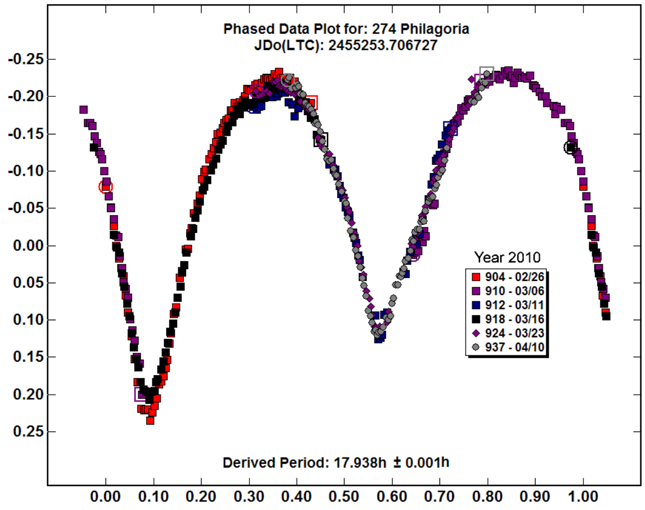
Gil-Hutton, R. and Canada, M. (2003). "Photometry of Fourteen Main Belt Asteroids," *Revista Mexica de Astronomica y Astrofisica* **39**, 69-76.

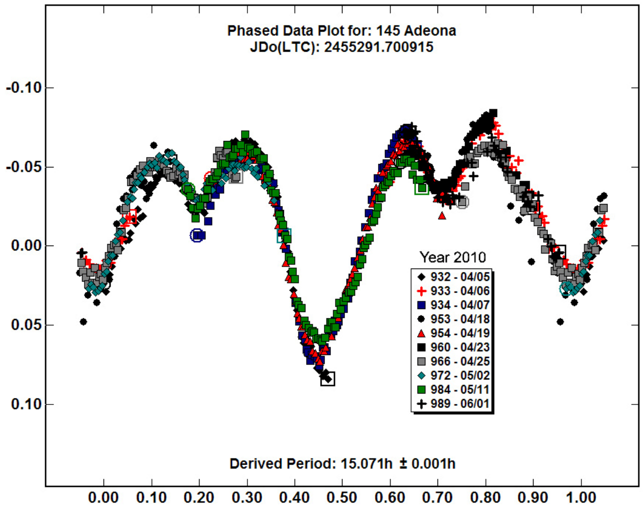
Harris, A. W., Pravec, P., and Warner, B. D. (2009). "Asteroid Lightcurve Data File: Apr. 8, 2009," http://www.MinorPlanetObserver.com/astlc/default.htm.

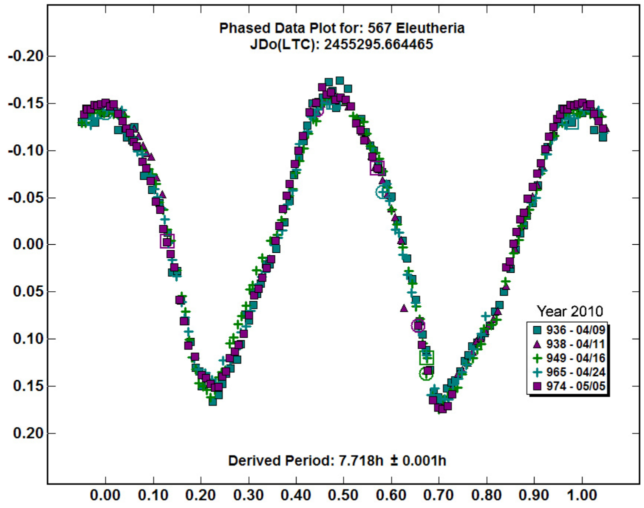
Lagerkvist, C.-I., Bel'skaya, I., Erikson, A., Shevchenko, V., Mottola, S., Chiorny, V., Magnusson, P., Nathues, A., and Piironen, J., (1998). "Physical Studies of Asteroids XXXIII. The Spin-rate of M-type Asteroids," *Astron. Astrophys. Suppl. Ser.* **131**, 55-62.

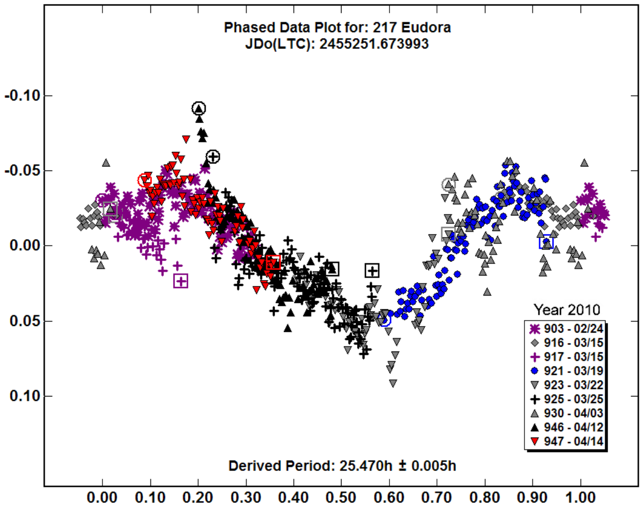
Stephens, R. D. (2009). "Asteroids Observed from GMARS and Santana Observatories," *Minor Planet Bull.* **36**, 59-62.

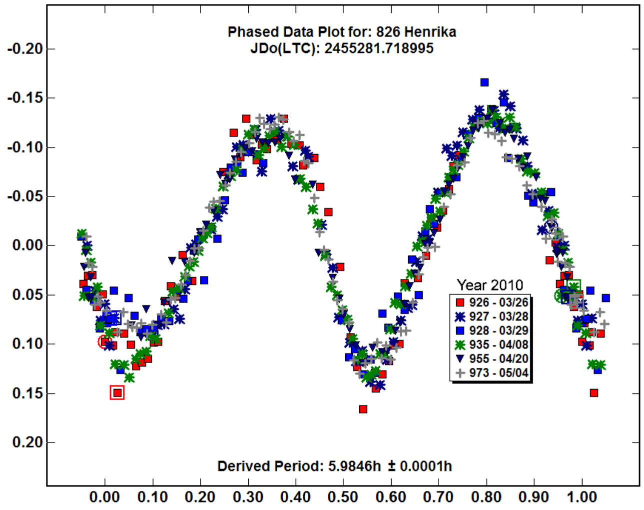

Phased Data Plot for: 80 Sappho
JDo(LTC): 2455312.702897
Year 2010
967 - 04/26
976 - 05/07
980 - 05/08
981 - 05/09
Derived Period: 14.025h ± 0.001h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 274 Philagoria
JDo(LTC): 2455253.706727
Year 2010
904 - 02/26
910 - 03/06
912 - 03/11
918 - 03/16
924 - 03/23
937 - 04/10
Derived Period: 17.938h ± 0.001h
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 145 Adeona
JDo(LTC): 2455291.700915
Year 2010
932 - 04/05
933 - 04/06
934 - 04/07
953 - 04/18
954 - 04/19
960 - 04/23
966 - 04/25
972 - 05/02
984 - 05/11
989 - 06/01
Derived Period: 15.071h ± 0.001h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 567 Eleutheria
JDo(LTC): 2455295.664465
Year 2010
936 - 04/09
938 - 04/11
949 - 04/16
965 - 04/24
974 - 05/05
Derived Period: 7.718h ± 0.001h
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 217 Eudora
JDo(LTC): 2455251.673993
Year 2010
903 - 02/24
916 - 03/15
917 - 03/15
921 - 03/19
923 - 03/22
925 - 03/25
930 - 04/03
946 - 04/12
947 - 04/14
Derived Period: 25.470h ± 0.005h
-0.10
-0.05
0.00
0.05
0.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00


Phased Data Plot for: 826 Henrika
JDo(LTC): 2455281.718995
Year 2010
926 - 03/26
927 - 03/28
928 - 03/29
935 - 04/08
955 - 04/20
973 - 05/04
Derived Period: 5.9846h ± 0.0001h
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00

UPON FURTHER REVIEW: II. AN EXAMINATION OF PREVIOUS LIGHTCURVE ANALYSIS FROM THE PALMER DIVIDE OBSERVATORY

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(Received: 16 June Revised: 17 Aug)

Updated results are given for six asteroids previously reported from the Palmer Divide Observatory. The original images were remeasured to obtain new data sets using the latest version of MPO Canopus photometry software, analysis tools, and revised techniques for linking multiple observing runs covering several days to several weeks. Results that were previously not reported or had significantly different periods and/or amplitudes were found for 1329 Eliane, 1582 Martir, 2023 Asaph, 8041 Masumoto, (26853) 1992 UQ2, and (52387) 1993 OM7. This is the second in a series of papers that examines results obtained during the initial years of the asteroid lightcurve program at PDO.

The availability of improved analysis tools and techniques along with the experience gained over more than a decade of asteroid lightcurve photometry have lead to a program to re-examine the early work and results at the Palmer Divide Observatory (c. 1999-2006). In most cases, changes in the period and/or amplitude as a result of the new analysis were statistically insignificant. However, there were some cases where the new results were significantly different. This paper is the second in a series that reports updated results from the new analysis, giving updates on 6 of the 17 significant revisions. Subsequent papers will complete the list of revisions from the initial state of this effort. Subsequent stages will likely produce additional updates.

For background on the justification and methodology of this project, see the first paper in the series (Warner, 2010).

Presentation of the New Analysis

A brief analysis of the new data set and lightcurve based on that new data set are given below, even if there is no significant difference in the period. The "improvement" may be a revised amplitude or "simply better data" to be used for modeling in the future (e.g., the U code may have a higher rating; see Warner et al., 2009, for information about the U code rating system). The exact observing details will not be given. Instead, a table lists the original and new results along with a reference to the original paper. The original reference gives data on the equipment used and references to results from other authors and so those will not be repeated here.

The plots show the *R-band* reduced magnitude of the asteroid. This means that the data for each night were corrected to "unity distance" using –5*log(rR) where r was the Earth-asteroid distance and R was the Sun-asteroid distance, both in AU. The data were also corrected to the phase angle of the earliest session using G = 0.15 (unless otherwise stated).

1329 Eliane. This appears to be a slow rotator that was incorrectly identified in the previous work due to the lack of linking onto an internal standard. The period given here is based on a half-period solution but is still rather weak.

1582 Martir. A half-period solution with good fit to a monomodal curve is the foundation for the proposed new period of 9.84 h for this asteroid. Fits of the new data to the previous period of 15.67 h were unrealistic.

2023 Asaph. The revised data could not be fit to the original period of 4.74 h. However periods of 3.87 h and 6.28 h were more likely. The low amplitude and large errors make for an uncertain solution.

8041 Masumoto. The solution of P = 34 h offered here is based on a half-period search (monomodal curve). The nearly 0.3 mag amplitude of the lightcurve and low phase angle virtually assure a bimodal solution.

(26853) 1992 UQ2. Analysis for this asteroid was not previously reported. The trimodal solution seems real due to the asymmetry of the various segments of the curve.

(52387) 1993 OM7. The previous solution of ~8 h was eliminated after re-measurement removed much of the short-term variations and the linking to an internal standard showed a long-term component. The revised analysis is in agreement with that by Pravec (2010) and Benner et al. (2006).

Acknowledgements

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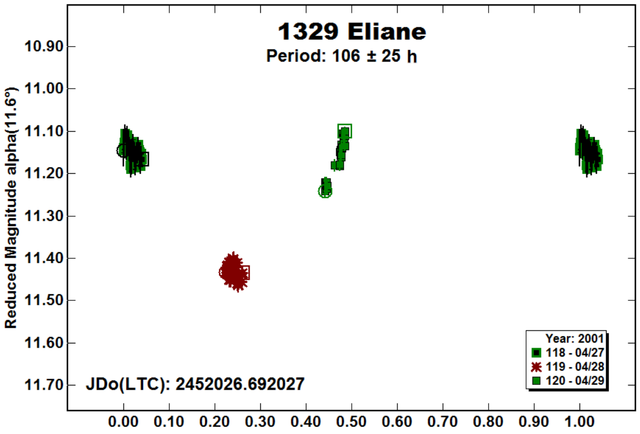
References

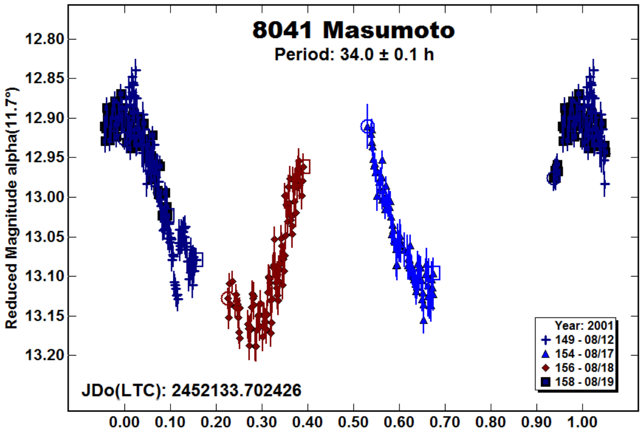
Benner, L.A.M., Nolan, M.C., Ostro, S.J., Giorgini, J.D., Pray, D.P., Harris, A.W., Magri, C., and Margo, J.-L. (2006). "Near-Earth Asteroid 2005 CR37: Radar images and photometry of a candidate contact binary." *Icarus* **182**, 472-481.

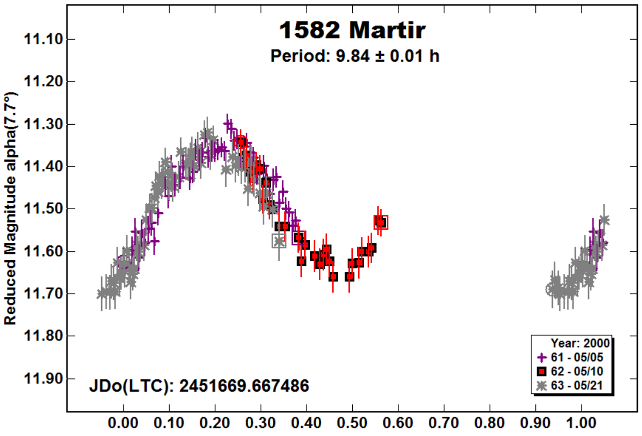
Pravec, P., Wolf, M., and Sarounova, L. (2010). "Ondrejov Asteroid Photometry Project" website: http://www.asu.cas.cz/~ppravec/neo.htm

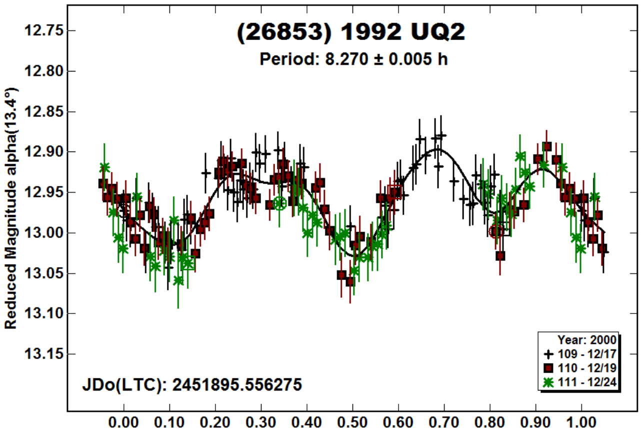
Warner, B.D., Harris, A.W., and Pravec, P. (2009c). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146.

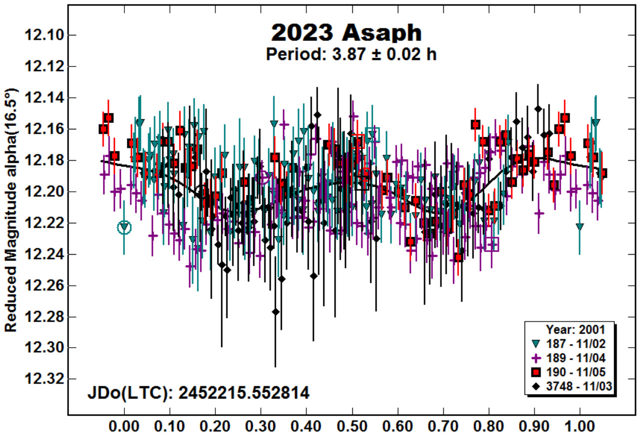
Warner, B.D. (2010). "Upon Further Review: I. An Examination of Previous Lightcurve Analysis from the Palmer Divide Observatory." *Minor Planet Bulletin* **37**, 127-130.

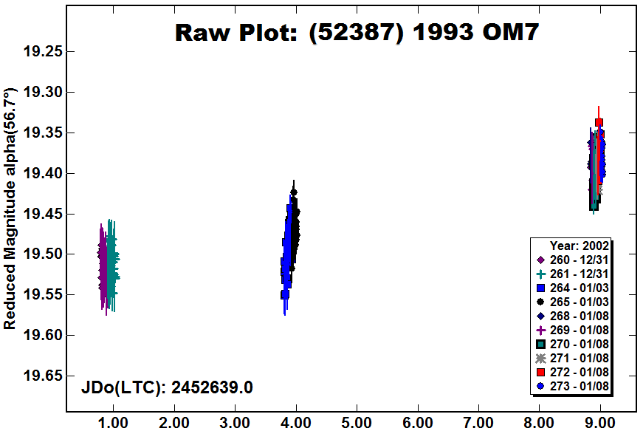












		Original				Revised				
#	Name	Per	Amp	U	Ref	Per	PE	Amp	AE	U
1329	Eliane	8.0	0.08	2	Warner; MPB 29, 14-15	106	25	>0.30		2-
1582	Martir	15.757	0.36	2	Warner; MPB 27, 53-54	9.84	0.01	0.31	0.01	2
2023	Asaph	4.74	0.06	2-	Warner; MPB 30, 61-64	3.87[1]	0.02	0.05	0.01	2-
8041	Masumoto	14.10	0.30	2	Warner; MPB 29, 14-15	34.0	0.1	0.27	0.03	2
26853	1992 UQ2				Not previously published	8.270	0.005	0.14	0.01	2+
52387	1993 OM7	7.412	0.10	2	Not previously published	Long				1

Table I. Summary of original and revised results. The period is in hour and the amplitude is in magnitudes. The U code rating is based on the criteria outlined in the Lightcurve Database (Warner et al., 2009c). Unless otherwise stated, the references are from the *Minor Planet Bulletin* for the original results, with only the volume and page numbers given.

[1] Ambiguous; 6.28 h also possible.

ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY SOUTHERN SKY OBSERVATORY: 2009 OCTOBER THRU 2010 APRIL

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(Received: 30 June)

Photometric data for 44 asteroids were collected over 54 nights of observing during 2009 October thru 2010 April at the Oakley Southern Sky Observatory. The asteroids were: 826 Henrika, 918 Itha, 983 Gunila, 1049 Gotho, 1167 Dubiago, 1181 Lilith, 1227 Geranium, 1604 Tombaugh, 1636 Porter, 1826 Miller, 1977 Shura, 2004 Lexell, 2196 Ellicott, 2303 Retsina, 2307 Garuda, 2601 Bologna, 2609 Kiril-Metodi, 2851 Harbin, 2881 Meiden, 3118 Claytonsmith, 3324 Avsyuk, 3640 Gostin, 4207 Chernova, 4536 Drewpinsky, 4838 Billmclaughlin, 5235 Jean-Loup, 5274 Degewij, 5240 Kwasan, (6019) 1991 RO6, 6091 Mitsuru, 6961 Ashitaka, (7111) 1985 QA1, (8228) 1996 YB2, 11017 Billputnam, (13023) 1988 XT1, (14741) 2000 EQ49, 15938 Bohnenblust, 16463 Nayoro, (17633) 1996 JU, (21023) 1989 DK, 21558 Alisonliu, (21594) 1998 VP31, (34459) 2000 SC91, and (189099) 2001 RO.

Forty-four asteroids were observed from the Oakley Southern Sky Observatory in New South Wales, Australia, on the nights of 2009 October 20-24; November 9-10, 14; 2010 January 18-23; February 15, 17-20, 24; March 10-24; and April 1-5, 10, 12-16, 18-19, 21-23. From the data, we were able to find lightcurves for 35 asteroids. Out of those 35, 28 were previously unrecorded results. Out of the 7 previously recorded, 3 were consistent with previously published periods, 2 were reasonably close to previous results, and 2 were inconsistent with previously published periods. The 9 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 f/8.1 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. 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.

No repeatable pattern was found for the following asteroids: 918 Itha, 983 Gunila, 1167 Dubiago, 1181 Lilith, 2601 Bologna, 4536 Drewpinsky, 5235 Jean-Loup, (13023) 1988 XT1, and (14741) 2000 EQ49. Our data for these asteroids were too noisy or insufficient in number for us to determine periods, so we are reporting the magnitude variations only. Results from all of the asteroids are listed in the table below.

826 Henrika. Our data are consistent with the period of 5.984 ± 0.0003 h found by Pilcher (2010).

983 Gunila. Shipley et al. (2008) reported no period but an amplitude of 0.25 mag from observations in 2008.

1167 Dubiago. Dahlgren et al. (1991) reported a period of 14.3 h and amplitude of 0.23 mag.

1604 Tombaugh. Our data are reasonably close to the period of 7.040 ± 0.001 h found by Binzel (1987), although Sarneczky (1999) found a period of 6.15 h.

1826 Miller. Our data are inconsistent with the period of 6.77 ± 0.01 h found by Behrend (2009).

2303 Retsina. Our data are consistent with the period of 10.82 ± 0.01 h found by Carbo et al. (2009).

5274 Degewij. We tried fitting to the period of 3.731 ± 0.002 h, but the data fit better to 7.5802 ± 0.0005 h.

5240 Kwasan. Our data are reasonably close to the periods of 5.35 ± 0.01 h found by Ivanova (2002) and 5.50 ± 0.01 h found by Behrend (2010).

(8228) 1996 YB2. Our data are inconsistent with the period of 10 h found by Behrend (2009).

(189099) 2001 RO. Our data are consistent with the period of 5.7161 ± 0.0010 h found by Pravec et al. (2010).

Acknowledgements

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References

Behrend, R. (2009, 2010). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html

Binzel, R.P. (1987) “A Photoelectric Survey of 130 Asteroids.” *Icarus* **72**, 135-208..

Carbo, L., Green, D., Kragh, K., Krotz, J., Meiers, A., Patino, B., Pligge, Z., Shaffer, N., and Ditteon, R. (2009). “Asteroid Lightcurve Analysis at the Oakley Southern Sky Observatory: 2008 October thru 2009 March.” *Minor Planet Bul.* **36**, 152-157.

Dahlgren, M., Lagerkvist, C.-I., Fitzsimmons, A., and Williams, I. P. (1991). “Differential CCD photometry of Dubiago, Chiron and Hektor.” *Mon. Not. Roy. Astron. Soc.* **250**, 115-118.

Ivanova, V. G., Apostolovska, G., Borisov, G. B., and Bilkina, B. I. (2002). “Results from Photometric Studies of Asteroids at Rozhen National Observatory, Bulgaria.” In: *Proceedings of Asteroids, Comets, Meteors - ACM 2002*. Ed. Barbara Warmbein. ESA SP-500. p. 505 – 508.

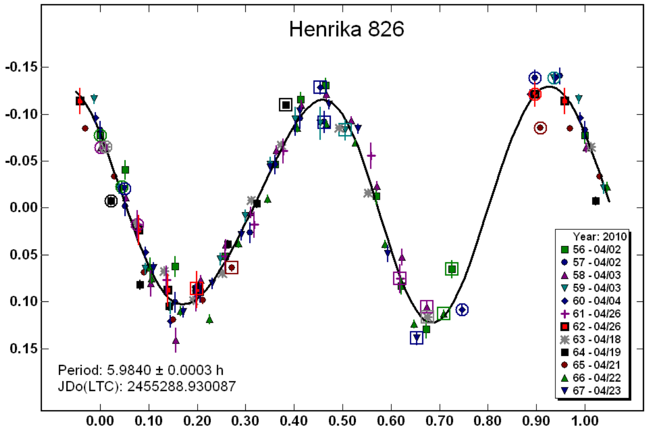
Pilcher, F. (2010). http://aslc-nm.org/Pilcher.html

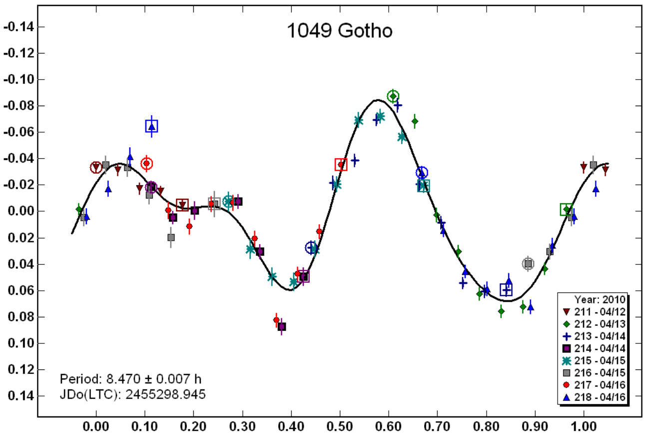
Pravec, P., Scheirich, P., Kusnirak, P., and Hornoch, K. (2010). Ondrejov Asteroid Photometry Project web site. http://www.asu.cas.cz/~ppravec/neo.htm

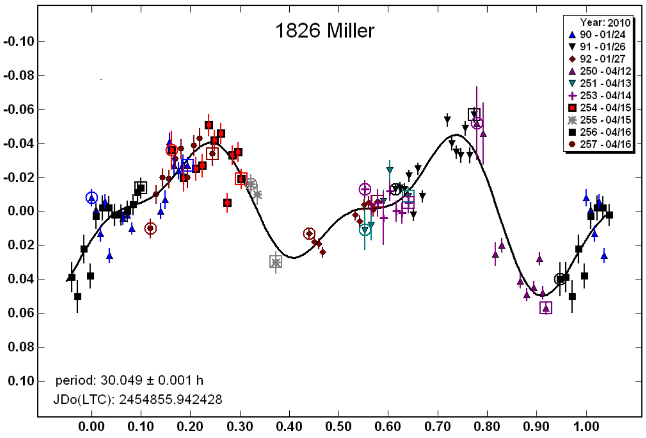
Number	Name	Dates mm/dd/2010 (2009*)	Data Points	Period (h)	P.E (h)	Amp (mag)	A.E. (mag)
826	Henrika	4/2-4,18-19,21-23	118	5.9840	0.0003	0.26	0.02
918	Itha	4/1-5,10,18-19,21-23	78	-	-	0.15	0.01
983	Gunila	1/18-23	128	-	-	0.05	0.04
1049	Gotho	4/12-16	70	8.470	0.007	0.17	0.03
1167	Dubiago	3/20-24	79	-	-	0.10	0.01
1181	Lilith	3/16-22	124	-	-	0.13	0.02
1227	Geranium	4/1-5,10,19,21-23	123	12.363	0.004	0.13	0.05
1604	Tombaugh	4/12-16	74	7.047	0.004	0.18	0.02
1636	Porter	1/18-23	111	2.9653	0.0007	0.26	0.03
1826	Miller	1/24,26-27, 4/12-16	100	30.049	0.001	0.11	0.02
1977	Shura	3/20-24	73	7.461	0.004	0.40	0.04
2004	Lexell	3/20-24	76	5.441	0.002	0.60	0.06
2196	Ellicott	2/15,17-20,24	80	9.0706	0.006	0.14	0.03
2303	Retsina	2/15,17-20,24	79	10.818	0.003	0.43	0.03
2307	Garuda	3/16-19,21,24	138	29.64	0.03	0.35	0.04
2601	Bologna	3/16-20,23	132	-	-	0.10	0.01
2609	Kiril-Metodi	2/15,17-20	75	4.9433	0.0007	0.85	0.04
2851	Harbin	10/20-21*	29	5.414	0.006	0.79	0.04
2881	Meiden	2/15,17-20	44	20.08	0.07	0.24	0.02
3118	Claytonsmith	3/20-24	97	15.794	0.012	0.42	0.04
3324	Avsyuk	3/16-19,21,23	126	8.6140	0.0018	0.34	0.03
3640	Gostin	3/10-15	75	3.2641	0.0005	0.47	0.05
4207	Chernova	3/10-15	56	10.288	0.015	0.14	0.03
4536	Drewpinsky	4/12-16	54	-	-	0.15	0.03
4838	Billmclaughlin	3/10-15	54	5.199	0.005	0.09	0.02
5235	Jean-Loup	4/12-16	72	-	-	0.09	0.01
5240	Kwasan	3/20-24	58	5.676	0.003	0.56	0.03
5274	Degewij	4/2-5,19,21-23	117	7.5802	0.0006	0.22	0.03
6019	1991 RO6	3/16-19,22,24	143	5.760	0.007	0.41	0.04
6091	Mitsuru	4/19,21-23	45	5.853	0.003	0.88	0.05
6961	Ashitaka	4/1-5,10,18-23	136	3.1457	0.0002	0.16	0.03
7111	1985 QA1	3/16-19	90	11.21	0.01	0.24	0.02
8228	1996 YB2	1/18-23	131	8.353	0.005	0.24	0.03
11017	Billputnam	11/9-10,14*	45	6.749	0.001	0.46	0.02
13023	1988 XT1	10/22-24*	91	-	-	0.23	0.07
14741	2000 EQ49	1/18-23	105	-	-	0.07	0.01
15938	Bohnenblust	4/12-16	83	3.906	0.003	0.16	0.03
16463	Nayoro	1/18-23	132	14.666	0.009	0.30	0.03
17633	1996 JU	2/15,17-20,24	76	6.2098	0.0004	0.29	0.02
21023	1989 DK	2/15,17-20,24	85	7.598	0.002	0.29	0.02
21558	Alisonliu	4/13-16	67	4.886	0.003	0.14	0.02
21594	1998 VP31	4/1-5,10,19,21-23	137	5.5865	0.0004	0.36	0.05
34459	2000 SC91	2/15,17-20,24	72	2.7791	0.0006	0.16	0.02
189099	2001 RO	1/18-23	131	5.722	0.005	0.17	0.04

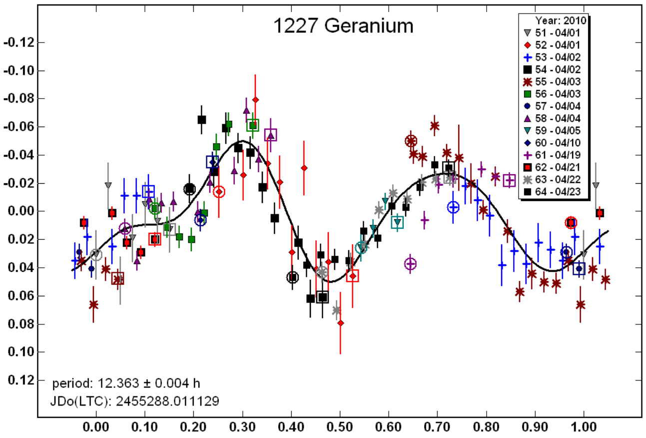
Sarneczky, K., Szabo, G., and Kiss, L.L. (1999). “CCD Observations of 11 Faint Asteroids.” *Astron. Astrophys. Suppl. Ser.* **137**, 363-368.

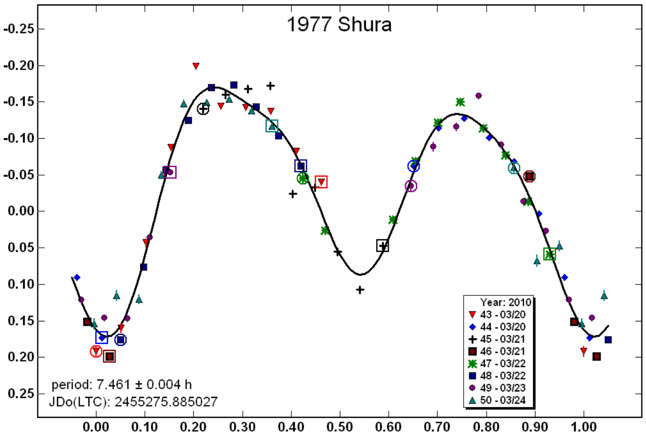
Shipley, H., Dillard, A., Kendal, J., Reichert, M., Sauppe, J., Shaffer, N., Kleeman, T., and Ditteon, R. (2008). “Asteroid Lightcurve Analysis at the Oakley Observatory - September 2007.” *Minor Planet Bul.* **35**, 99-101.

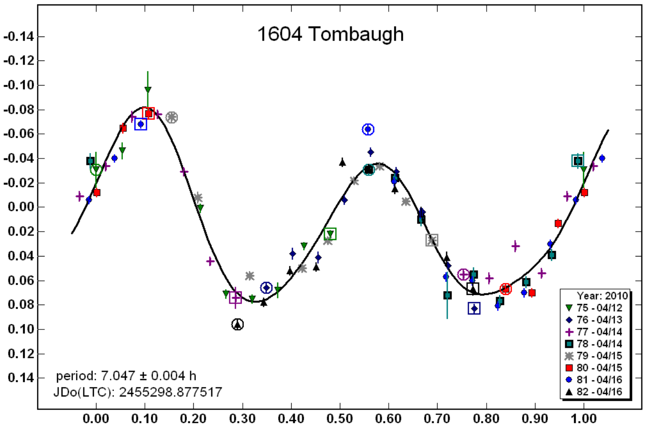


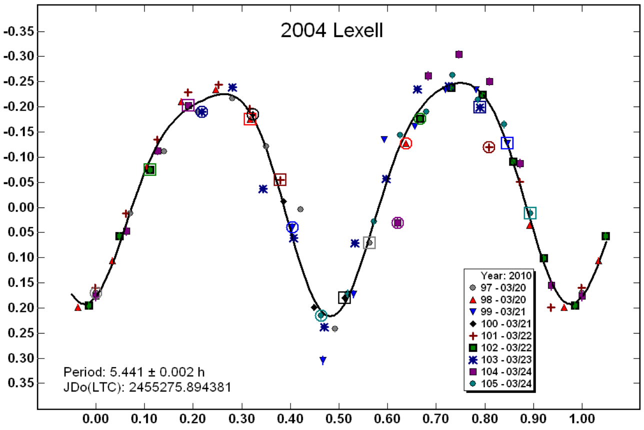

1049 Gotho
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Period: 8.470 ± 0.007 h
JDo(LTC): 2455298.945
Year: 2010
211 - 04/12
212 - 04/13
213 - 04/14
214 - 04/14
215 - 04/15
216 - 04/15
217 - 04/16
218 - 04/16
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

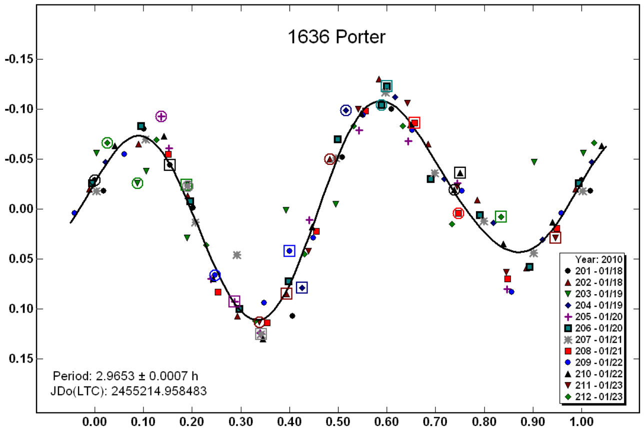

1826 Miller
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
Period: 30.049 ± 0.001 h
JDo(LTC): 2454855.942428
Year: 2010
90 - 01/24
91 - 01/26
92 - 01/27
250 - 04/12
251 - 04/13
253 - 04/14
254 - 04/15
255 - 04/15
256 - 04/16
257 - 04/16
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

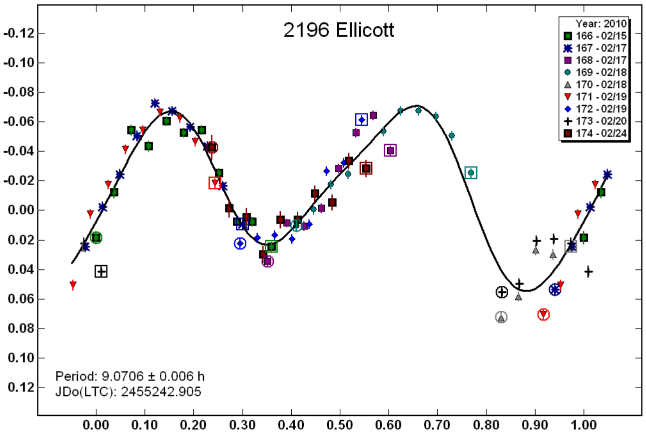

1227 Geranium
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
period: 12.363 ± 0.004 h
JDo(LTC): 2455288.011129
Year: 2010
51 - 04/01
52 - 04/01
53 - 04/02
54 - 04/02
55 - 04/03
56 - 04/03
57 - 04/04
58 - 04/04
59 - 04/05
60 - 04/10
61 - 04/19
62 - 04/21
63 - 04/22
64 - 04/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

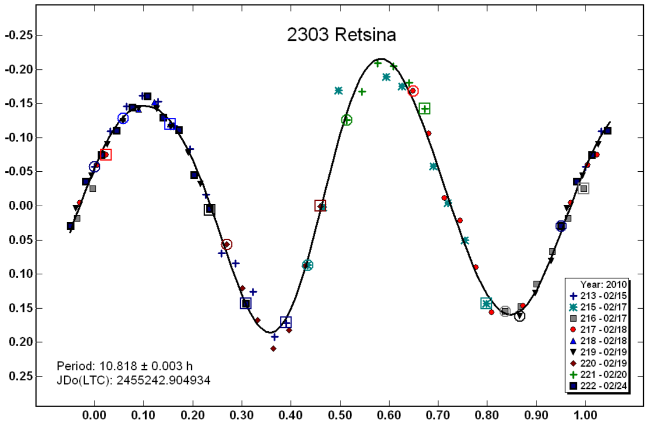

1977 Shura
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
period: 7.461 ± 0.004 h
JDo(LTC): 2455275.885027
Year: 2010
43 - 03/20
44 - 03/20
45 - 03/21
46 - 03/21
47 - 03/22
48 - 03/22
49 - 03/23
50 - 03/24
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

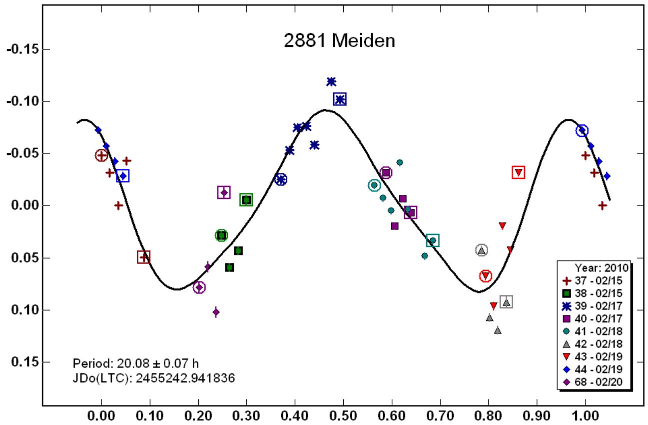

1604 Tombaugh
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
period: 7.047 ± 0.004 h
JDo(LTC): 2455298.877517
Year: 2010
75 - 04/12
76 - 04/13
77 - 04/14
78 - 04/14
79 - 04/15
80 - 04/15
81 - 04/16
82 - 04/16
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

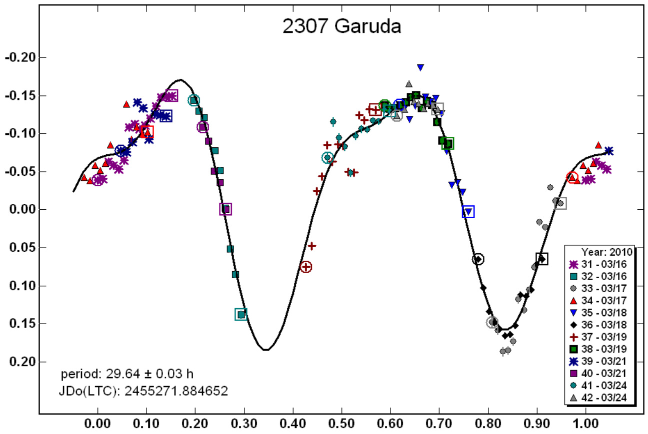

2004 Lexell
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Period: 5.441 ± 0.002 h
JDo(LTC): 2455275.894381
Year: 2010
97 - 03/20
98 - 03/20
99 - 03/21
100 - 03/21
101 - 03/22
102 - 03/22
103 - 03/23
104 - 03/24
105 - 03/24
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

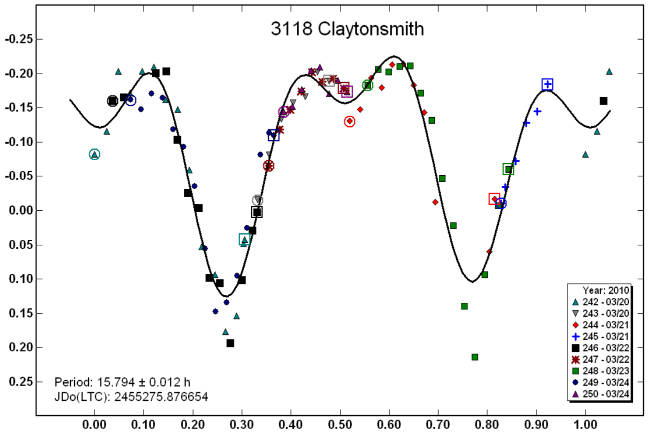

1636 Porter
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
Period: 2.9653 ± 0.0007 h
JDo(LTC): 2455214.958483
Year: 2010
201 - 01/18
202 - 01/18
203 - 01/19
204 - 01/19
205 - 01/20
206 - 01/20
207 - 01/21
208 - 01/21
209 - 01/22
210 - 01/22
211 - 01/23
212 - 01/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

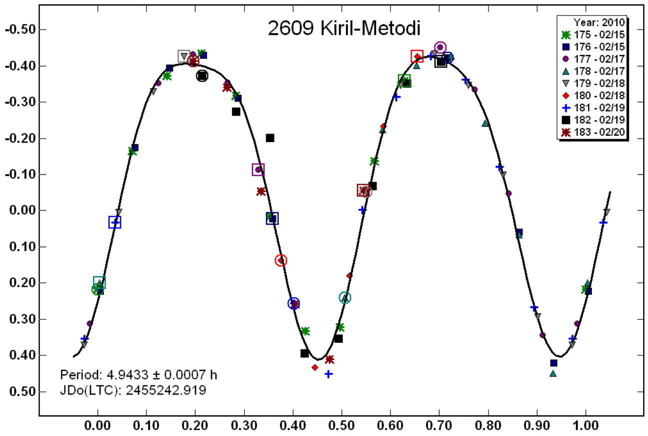

2196 Ellicott
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
Period: 9.0706 ± 0.006 h
JDo(LTC): 2455242.905
Year: 2010
166 - 02/15
167 - 02/17
168 - 02/17
169 - 02/18
170 - 02/18
171 - 02/19
172 - 02/19
173 - 02/20
174 - 02/24
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00


2303 Retsina
-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 10.818 ± 0.003 h
JDo(LTC): 2455242.904934
Year: 2010
213 - 02/15
215 - 02/17
216 - 02/17
217 - 02/18
218 - 02/18
219 - 02/19
220 - 02/19
221 - 02/20
222 - 02/24


2881 Meiden
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 20.08 ± 0.07 h
JDo(LTC): 2455242.941836
Year: 2010
37 - 02/15
38 - 02/15
39 - 02/17
40 - 02/17
41 - 02/18
42 - 02/18
43 - 02/19
44 - 02/19
68 - 02/20


2307 Garuda
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
period: 29.64 ± 0.03 h
JDo(LTC): 2455271.884652
Year: 2010
31 - 03/16
32 - 03/16
33 - 03/17
34 - 03/17
35 - 03/18
36 - 03/18
37 - 03/19
38 - 03/19
39 - 03/21
40 - 03/21
41 - 03/24
42 - 03/24


3118 Claytonsmith
-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 15.794 ± 0.012 h
JDo(LTC): 2455275.876654
Year: 2010
242 - 03/20
243 - 03/20
244 - 03/21
245 - 03/21
246 - 03/22
247 - 03/22
248 - 03/23
249 - 03/24
250 - 03/24


2609 Kiril-Metodi
-0.50 -0.40 -0.30 -0.20 -0.10 0.00 0.10 0.20 0.30 0.40 0.50
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 4.9433 ± 0.0007 h
JDo(LTC): 2455242.919
Year: 2010
175 - 02/15
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179 - 02/18
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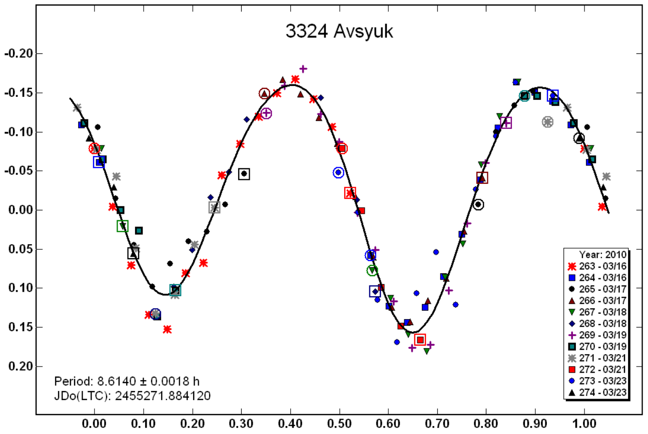
181 - 02/19
182 - 02/19
183 - 02/20


3324 Avsyuk
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 8.6140 ± 0.0018 h
JDo(LTC): 2455271.884120
Year: 2010
263 - 03/16
264 - 03/16
265 - 03/17
266 - 03/17
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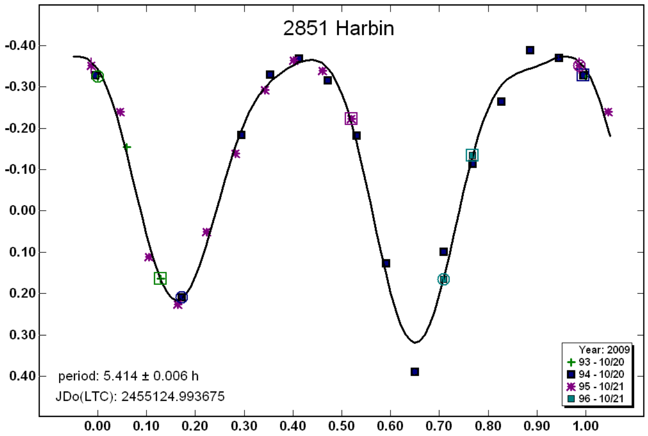
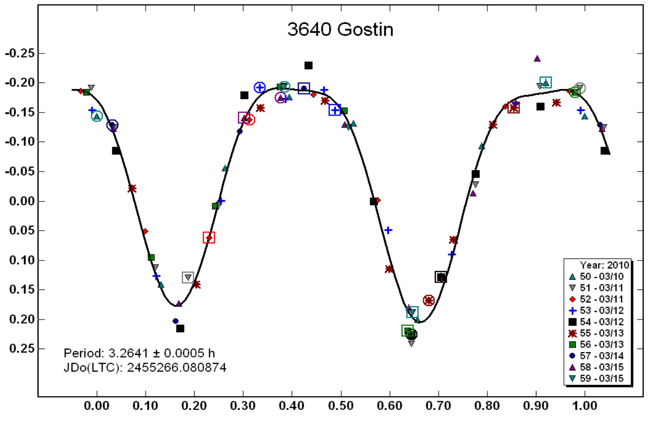
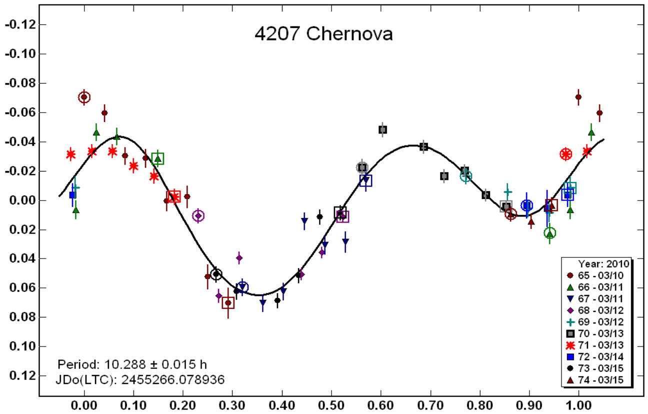
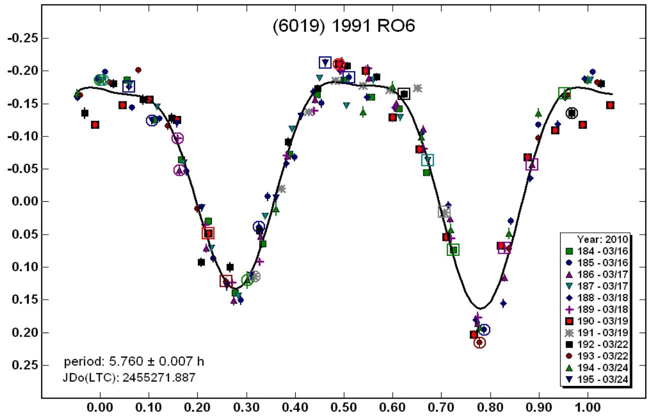
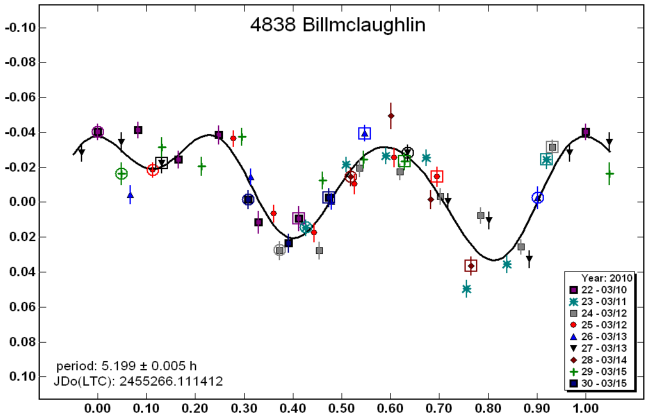
273 - 03/23
274 - 03/23

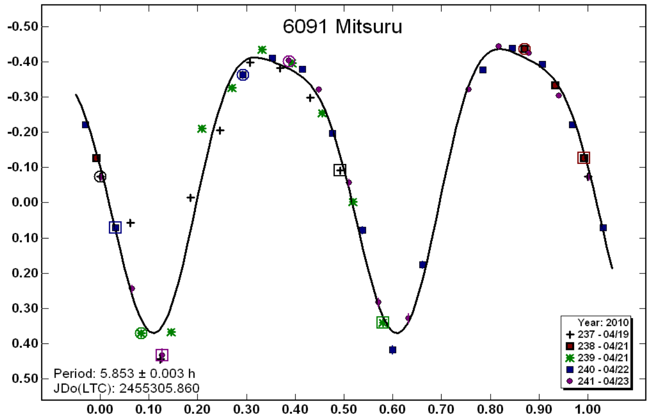

2851 Harbin
-0.40 -0.30 -0.20 -0.10 0.00 0.10 0.20 0.30 0.40
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
period: 5.414 ± 0.006 h
JDo(LTC): 2455124.993675
Year: 2009
93 - 10/20
94 - 10/20
95 - 10/21
96 - 10/21

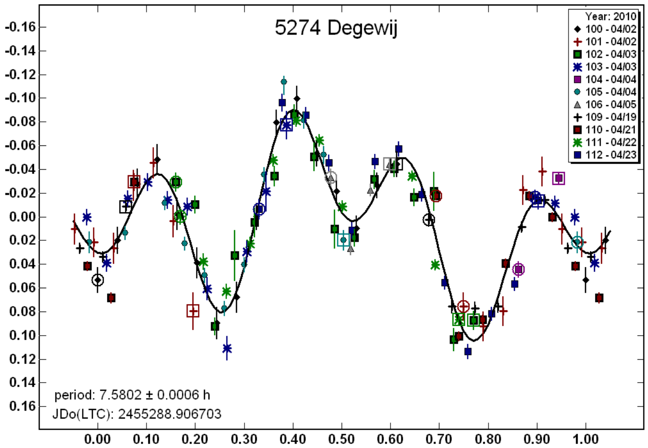

3640 Gostin
-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 3.2641 ± 0.0005 h
JDo(LTC): 2455266.080874
Year: 2010
50 - 03/10
51 - 03/11
52 - 03/11
53 - 03/12
54 - 03/12
55 - 03/13
56 - 03/13
57 - 03/14
58 - 03/15
59 - 03/15

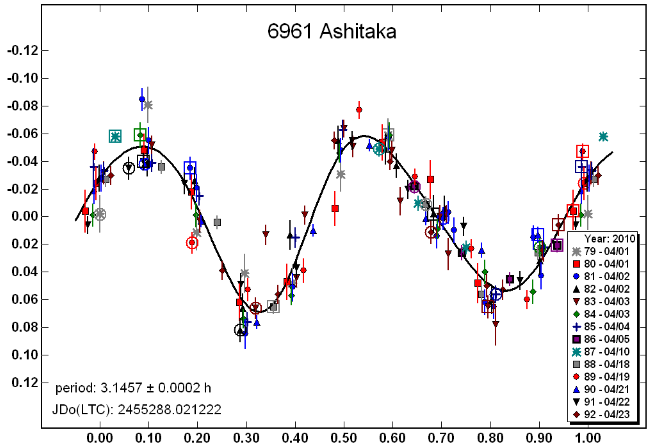

4207 Chernova
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
Period: 10.288 ± 0.015 h
JDo(LTC): 2455266.078936
Year: 2010
● 65 - 03/10
▲ 66 - 03/11
▼ 67 - 03/11
◆ 68 - 03/12
+ 69 - 03/12
■ 70 - 03/13
✱ 71 - 03/13
■ 72 - 03/14
● 73 - 03/15
▲ 74 - 03/15
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

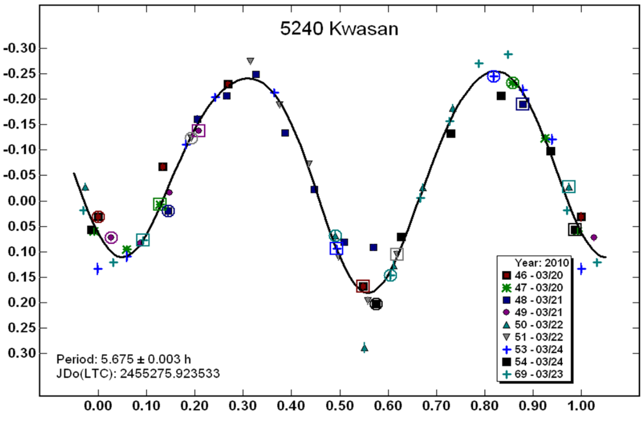

(6019) 1991 RO6
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
period: 5.760 ± 0.007 h
JDo(LTC): 2455271.887
Year: 2010
■ 184 - 03/16
● 185 - 03/16
▲ 186 - 03/17
▼ 187 - 03/17
◆ 188 - 03/18
+ 189 - 03/18
■ 190 - 03/19
✱ 191 - 03/19
■ 192 - 03/22
● 193 - 03/22
▲ 194 - 03/24
▼ 195 - 03/24
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

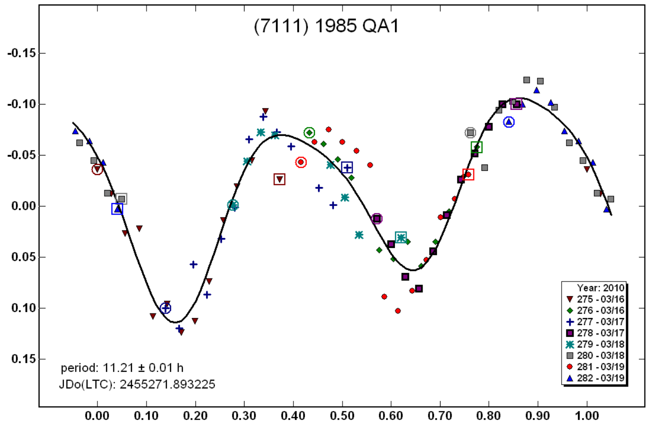

4838 Billmclaughlin
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
period: 5.199 ± 0.005 h
JDo(LTC): 2455266.111412
Year: 2010
■ 22 - 03/10
✱ 23 - 03/11
■ 24 - 03/12
● 25 - 03/12
▲ 26 - 03/13
▼ 27 - 03/13
◆ 28 - 03/14
+ 29 - 03/15
■ 30 - 03/15
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

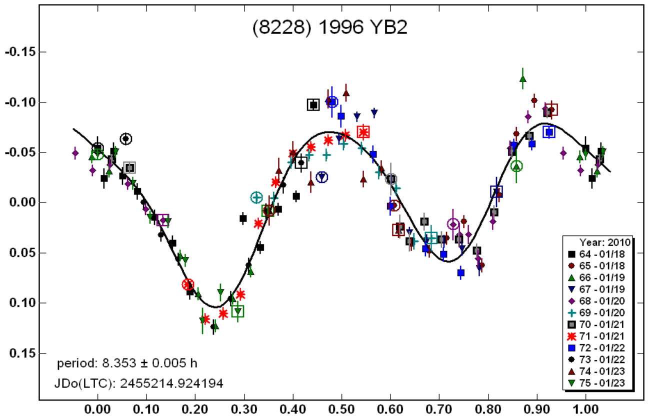

6091 Mitsuru
-0.50
-0.40
-0.30
-0.20
-0.10
0.00
0.10
0.20
0.30
0.40
0.50
Period: 5.853 ± 0.003 h
JDo(LTC): 2455305.860
Year: 2010
+ 237 - 04/19
■ 238 - 04/21
✱ 239 - 04/21
■ 240 - 04/22
● 241 - 04/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

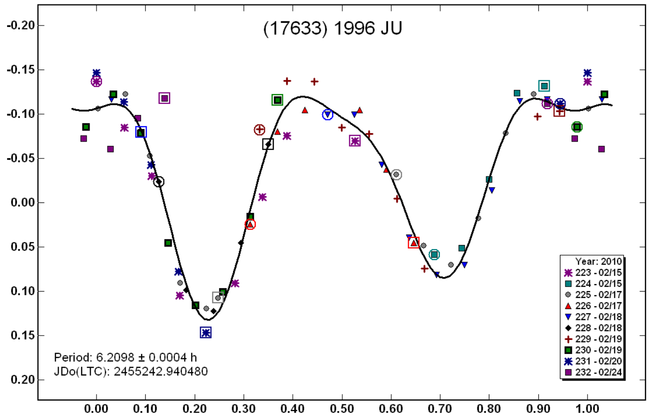

5274 Degewij
-0.16
-0.14
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
period: 7.5802 ± 0.0006 h
JDo(LTC): 2455288.906703
Year: 2010
◆ 100 - 04/02
+ 101 - 04/02
■ 102 - 04/03
✱ 103 - 04/03
■ 104 - 04/04
● 105 - 04/04
▲ 106 - 04/05
+ 109 - 04/19
■ 110 - 04/21
✱ 111 - 04/22
■ 112 - 04/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

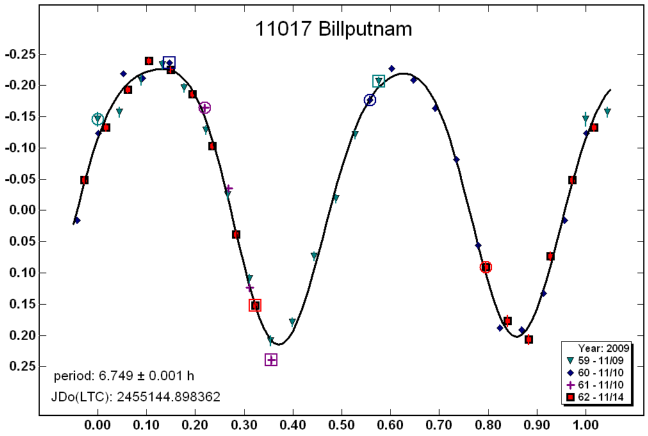

6961 Ashitaka
-0.12
-0.10
-0.08
-0.06
-0.04
-0.02
0.00
0.02
0.04
0.06
0.08
0.10
0.12
period: 3.1457 ± 0.0002 h
JDo(LTC): 2455288.021222
Year: 2010
✱ 79 - 04/01
■ 80 - 04/01
● 81 - 04/02
▲ 82 - 04/02
▼ 83 - 04/03
◆ 84 - 04/03
+ 85 - 04/04
■ 86 - 04/05
✱ 87 - 04/10
■ 88 - 04/18
● 89 - 04/19
▲ 90 - 04/21
▼ 91 - 04/22
◆ 92 - 04/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

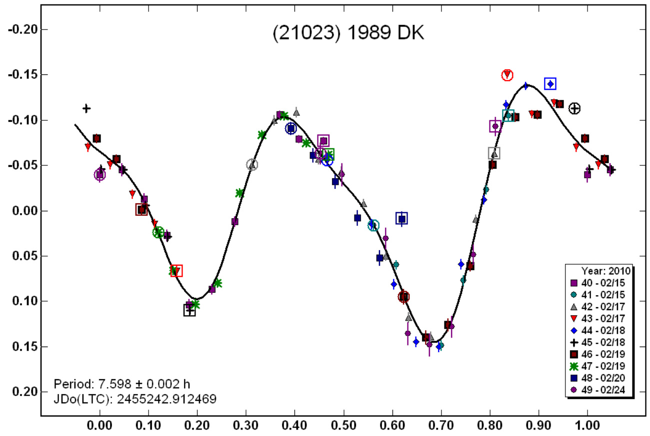

5240 Kwasan
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Period: 5.675 ± 0.003 h
JDo(LTC): 2455275.923533
Year: 2010
■ 46 - 03/20
✱ 47 - 03/20
■ 48 - 03/21
● 49 - 03/21
▲ 50 - 03/22
▼ 51 - 03/22
+ 53 - 03/24
■ 54 - 03/24
+ 69 - 03/23
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

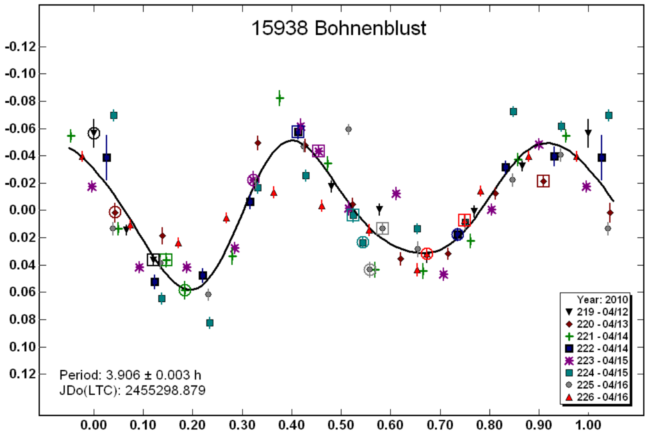

(7111) 1985 QA1
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
period: 11.21 ± 0.01 h
JDo(LTC): 2455271.893225
Year: 2010
▼ 275 - 03/16
◆ 276 - 03/16
+ 277 - 03/17
■ 278 - 03/17
✱ 279 - 03/18
■ 280 - 03/18
● 281 - 03/19
▲ 282 - 03/19
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00

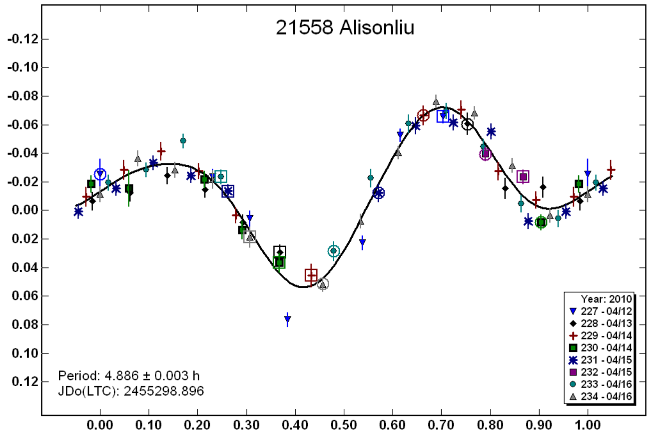

(8228) 1996 YB2
-0.15 -0.10 -0.05 0.00 0.05 0.10 0.15
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
period: 8.353 ± 0.005 h
JDo(LTC): 2455214.924194
Year: 2010
64 - 01/18
65 - 01/18
66 - 01/19
67 - 01/19
68 - 01/20
69 - 01/20
70 - 01/21
71 - 01/21
72 - 01/22
73 - 01/22
74 - 01/23
75 - 01/23

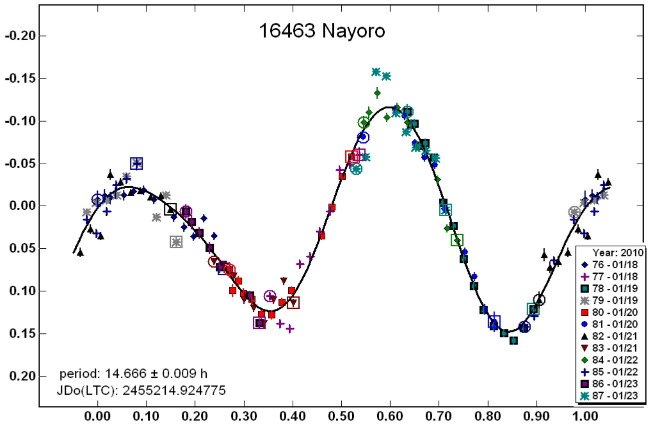

(17633) 1996 JU
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 6.2098 ± 0.0004 h
JDo(LTC): 2455242.940480
Year: 2010
223 - 02/15
224 - 02/15
225 - 02/17
226 - 02/17
227 - 02/18
228 - 02/18
229 - 02/19
230 - 02/19
231 - 02/20
232 - 02/24

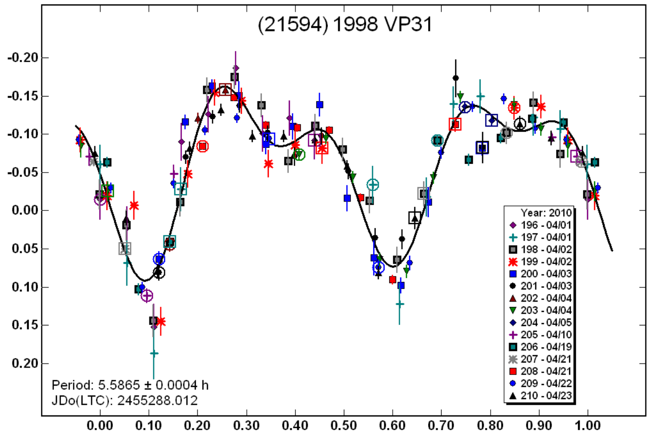

11017 Billputnam
-0.25 -0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20 0.25
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
period: 6.749 ± 0.001 h
JDo(LTC): 2455144.898362
Year: 2009
59 - 11/09
60 - 11/10
61 - 11/10
62 - 11/14


(21023) 1989 DK
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 7.598 ± 0.002 h
JDo(LTC): 2455242.912469
Year: 2010
40 - 02/15
41 - 02/15
42 - 02/17
43 - 02/17
44 - 02/18
45 - 02/18
46 - 02/19
47 - 02/19
48 - 02/20
49 - 02/24


15938 Bohnenblust
-0.12 -0.10 -0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06 0.08 0.10 0.12
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 3.906 ± 0.003 h
JDo(LTC): 2455298.879
Year: 2010
219 - 04/12
220 - 04/13
221 - 04/14
222 - 04/14
223 - 04/15
224 - 04/15
225 - 04/16
226 - 04/16


21558 Alisonliu
-0.12 -0.10 -0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06 0.08 0.10 0.12
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 4.886 ± 0.003 h
JDo(LTC): 2455298.896
Year: 2010
227 - 04/12
228 - 04/13
229 - 04/14
230 - 04/14
231 - 04/15
232 - 04/15
233 - 04/16
234 - 04/16


16463 Nayoro
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
period: 14.666 ± 0.009 h
JDo(LTC): 2455214.924775
Year: 2010
76 - 01/18
77 - 01/18
78 - 01/19
79 - 01/19
80 - 01/20
81 - 01/20
82 - 01/21
83 - 01/21
84 - 01/22
85 - 01/22
86 - 01/23
87 - 01/23


(21594) 1998 VP31
-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Period: 5.5865 ± 0.0004 h
JDo(LTC): 2455288.012
Year: 2010
196 - 04/01
197 - 04/01
198 - 04/02
199 - 04/02
200 - 04/03
201 - 04/03
202 - 04/04
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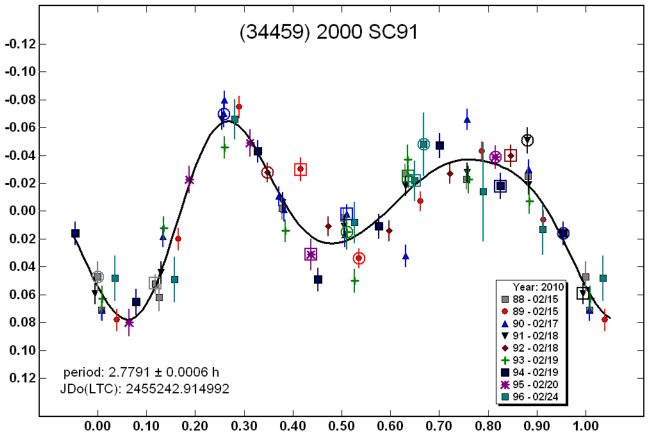
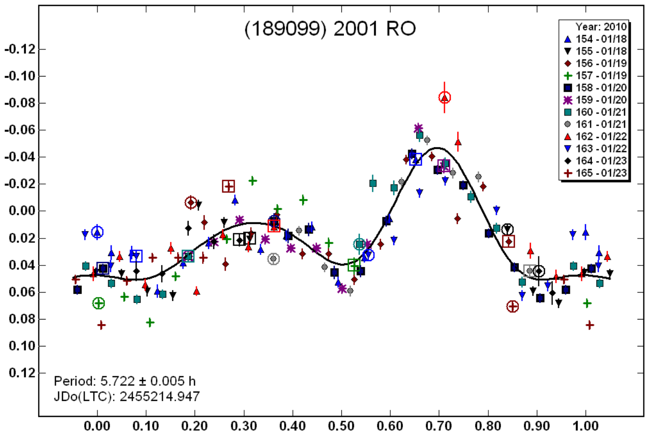
209 - 04/22
210 - 04/23





LIGHTCURVE ANALYSIS OF MAIN BELT ASTEROIDS 185 EUNIKE, 567 ELEUTHERIA, AND 2500 ALASCATTALO

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Photometric measurements for three main-belt asteroids from 2010 April through yield results: 185 Eunike, P = 11.20±0.05 h, A = 0.14±0.05 mag. 567 Eleutheria, P = 7.71±0.05 h, A = 0.30±0.05 mag. No reasonable period determination could be made for 2500 Alascattalo, with A < 0.20 mag.

Observations and lightcurve analysis were conducted at Shadowbox Observatory during 2010 April and May on main-belt asteroids 195 Eunike, 567 Eleutheria and 2500 Alascattalo. The first two were observed using a 0.3-m Schmidt-Cassegrain (SCT) operating at f/6.1 on a German Equatorial mount (GEM). The CCD imager was an SBIG ST9 working at 1x1 binning, which resulted in an image scale of 2.2 arc seconds/pixel. An SBIG AO-8 adaptive optics unit was employed. All images were taken through a Johnson V-band filter. Depending on ambient air temperature, the camera temperature was set between –15°C and –40°C. Image acquisition and reduction were done with *CCDSoft*. Images were reduced with master dark and sky-flat frames.

Imaging sessions of 195 Eunike and 567 Eleutheria began when they reached 30 degrees or higher elevation, and continued until the telescope tube came into close proximity to the telescope mount. Due to 567 Eleutheria's relatively low declination (–3 degrees), the geometry of the telescope tube and equatorial mount combination allowed continuous tracking for nearly 2 hours past the meridian. This allowed the target to be imaged close to the 30 degree elevation practical limit for photometry (Warner, 2006) without the need to "meridian flip" the mount (*not* an automated process at Shadowbox Observatory). Not only was the meridian flip problem described by Miles and Warner (2009) avoided, but an interruption of the observer's sleep was equally unnecessary!

Observations were reduced using differential photometry. Period analysis was done with *MPO Canopus*, incorporating the Fourier analysis algorithm developed by Harris (Harris et al., 1989). A minimum of two comparison stars from the UCAC3 catalog were used on each image.

185 Eunike. A total of 614 data points were analyzed. A period of P = 11.20 ± 0.05 h and amplitude of A = 0.14 ± 0.05 mag were found. Debehogne et al. (1978) found a period of 10.83 h. To match the 10.83 h period the author would have to remove an observing session that there was no compelling reason to remove (interference by clouds, a drastic change in transparency, equipment problems or the like). So while not ruling out 10.83 h, a better fit was found at 11.20 h.

567 Eleutheria. This asteroid was observed in support of a call for lightcurves of asteroids having either no or poorly constrained lightcurve parameters (Warner et al., 2010a). A check of the Observing Notification Page of the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2010b) did not reveal that any other observers were working this target. A total of 297 data points were analyzed. A period of P = 7.71 ± 0.05 h was found with an amplitude of A = 0.30 ± 0.05 mag.

2500 Ascallatto. This asteroid was observed from 2010 May 2-7 using the 0.61-m f/10 classical Cassegrain telescope at Sierra Stars Observatory. The imager was a FLI ProLine camera with a KAF-9000 (12-micron pixels). The resulting scale was 0.8 arcseconds/pixel. Only four observing sessions were obtained before a mechanical problem disabled the telescope for an extended period of time. No discernable pattern outside the margin of error of the observations was noted. The sparse data set over a short period of time prevented determining if the asteroid has a low lightcurve amplitude due to a nearly spheroidal shape and/or its rotation axis being along the light of sight, or that it has a long rotation period. No published lightcurve data for this object were found to offer any clues about the true nature of the system. The figure shows a period of 2.85 h, one of many possible solutions.

Acknowledgements

This paper makes use of data products from The Third U.S. Naval Observatory CCD Astrograph Catalog (UCAC3).

References

Debehogne, H., Surdej, A., and Surdej, J. (1978). "Photoelectric lightcurves of the minor planets 29 Amphitrite, 121 Hermione and 185 Eunike." *Astron. Astrophys. Suppl. Ser.* **32**, 127-133.

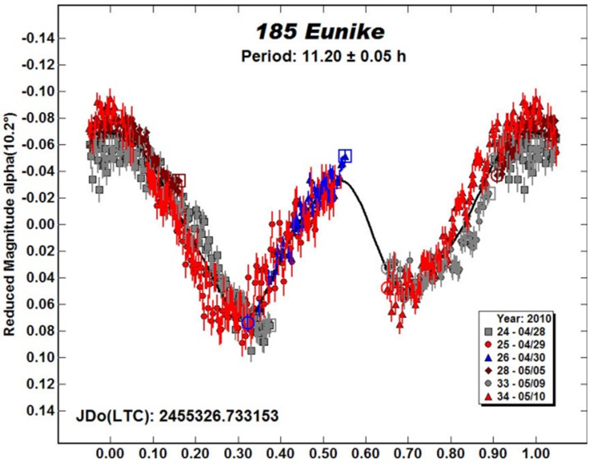
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

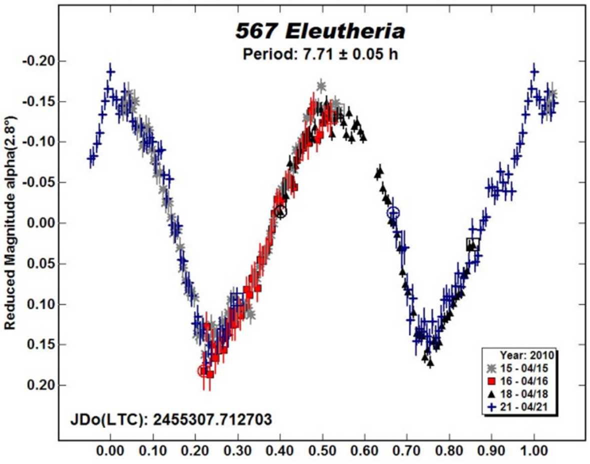
Miles, R. and Warner, B. D. (2009). "The Rotation Period of 4265 Kani and an Example of the Meridian Flip Problem." *Minor Planet Bul.* **36**, 66-68.

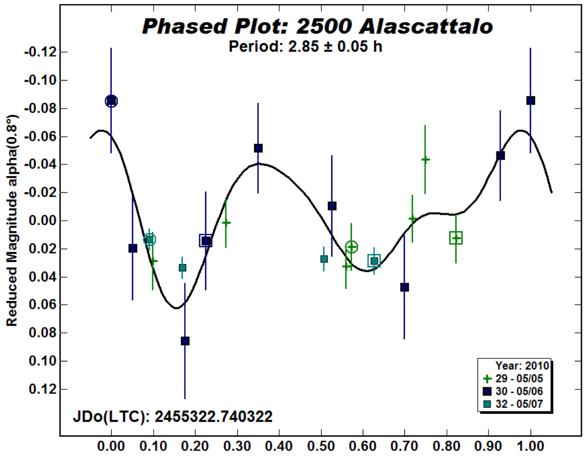
Warner, B. D. (2006). *A Practical Guide to Lightcurve Photometry and Analysis*. Springer, New York.

Warner, B.D., Harris, A.W., Pravec, P., Duech, J., and Benner, L.A.M. (2010a). "Lightcurve Photometry Opportunities: 2010 April – June" *Minor Planet Bul.* **37**, 77-80.

Warner, B.D, Harris, A.W., and Pravec, P. (2010b). "Collaborative Asteroid Lightcurve Link (CALL) Observing Notifications Page." http://www.MinorPlanetObserver.com/astlc/ObservingNotifications.htm.







ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2010 APRIL - JUNE

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Lightcurves for five asteroids were obtained from Santana and GMARS Observatories from 2010 April to June: 824 Anastasia, 869 Mellena, 996 Hilaritas, 1451 Grano, and 2114 Wallenquist.

Observations at Santana Observatory (MPC Code 646) were made with a 0.30-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. Observations at GMARS (Goat Mountain Astronomical Research Station, MPC G79) were made with two telescopes, both 0.35-m SCT using SBIG STL-1001E CCD Cameras. 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). Except for 824 Anastasia, the asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2010).

The results are summarized in the table below, as are individual plots. 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 1.0 mag has the same linear size as the horizontal axis from 0.0 to 1.0. This is done 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. The scale was shrunk for high amplitude lightcurves. 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 (Warner 2007 and Stephens 2008).

824 Anastasia. Observations of Anastasia were undertaken in support of an occultation project organized by the International Occultation and Timing Association (IOTA). 824 Anastasia occulted Zeta Ophiuchi on April 6, 2010 through a path crossing Southern California. Unfortunately, the path of the occultation was west of the prediction and more than 60 observers missed viewing the occultation. Only four observers well outside the path observed chords across the profile (IOTA 2010). Even though the observing group did not get the results it wanted, the four chords give a result consistent with the previously estimated 34 km radius.

#	Name	mm/dd 2010	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
824	Anastasia	04/04 - 05/22	3,060	17.7, 5.5	242	10	250	1	1.20	0.05
869	Mellena	05/02 - 06/06	766	18.6, 7.0	256	11	6.5155	0.005	0.27	0.03
996	Hilaritas	03/15 - 03/17	521	2.1, 1.3, 5.4	310	3	10.05	0.01	0.63	0.03
1451	Grano	03/18 - 04/08	1,443	0.6, 13.2	177	1	138.00	0.05	0.65	0.01
2114	Wallenquist	04/10 - 04/17	275	1.1, 4.1	198	0	5.510	0.005	0.22	0.03

Images on 04/14, 04/15, 04/25, 04/26, 04/27, 05/03, 05/04, 05/05, 05/06, 05/20, 05/21, and 05/22 were taken at Santana Observatory. All others were taken at GMARS. Based upon a single night's observations in March 2007, Behrend (2010) reported the period was greater than 20 h.

The occultation occurred at approximately 0.20 on the phase plot. Since this was near a minimum, it implies a small cross section during the occultation. The IOTA chords suggest an elongation of 1.5:1. The amplitude of the complete lightcurve suggests an overall elongation of 3:1

869 Mellena. Images on 06/02, 06/03 and 06/04 were obtained at Santana Observatory. All others were at GMARS. There was no previous period reported.

996 Hilaritas. All images were taken at Santana Observatory. Angeli (2001) obtained two nights in April 1999 and based upon a partial lightcurve estimated the period to be 17.2 h which appears to be an alias of this 10.05 h period.

1451 Grano. Images on 03/20, 04/02 and 04/03 were obtained at GMARS. All others were at Santana Observatory. Behrend (2010) reported a period of 5.109 hours with an amplitude of 0.06 magnitudes over three nights between May 19 and July 9, 2007. The formal errors were as large as the reported amplitude. Using night-to-night data calibrated to an internal standard, it is apparent Grano has a long period. The best fit of the data was approximately 138 hours with three sessions, notably the first and last sessions well off the trend line. This gives a suggestion that Grano is in a non-principal axis state of rotation (tumbling).

2114 Wallenquist. All Images were obtained at GMARS. Behrend (2010) reported a period of 5.49 hours with an amplitude of 0.3 magnitudes over three nights between May 19 and July 9, 2007. This is in good agreement with this period.

References

Angeli, C.A., Duffard, R., Fernandez, S., Florczak, M., Morthe-Diniz, T., Carvano, J.M., and Bertzler, A.S. (2001). "Rotational Periods for Small Main-Belt Asteroids From CCD Photometry." *Astron. Journal* **121**, 2245-2252.

Behrend, R. (2010). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html.*

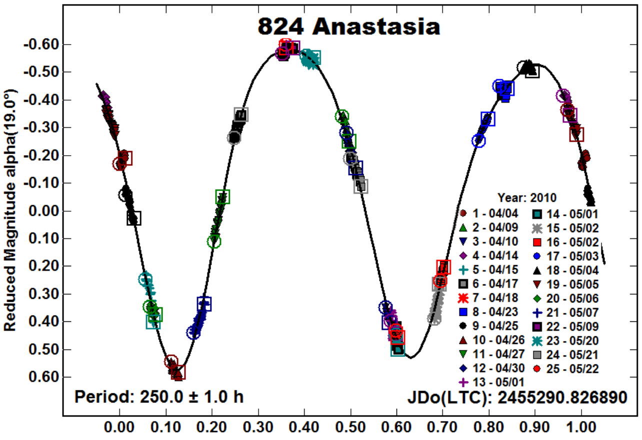
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

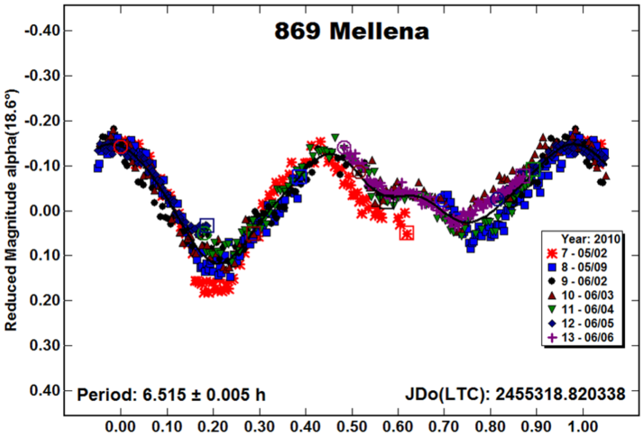
IOTA Results webpage (2010). *http://www.asteroidoccultation.com/observations/Results/Data2010/20100406_AnastasiaProfile.jpg*

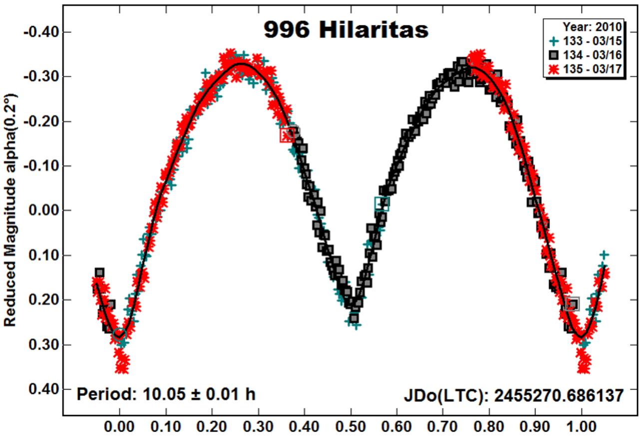
Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul.* **35**, 31-32.

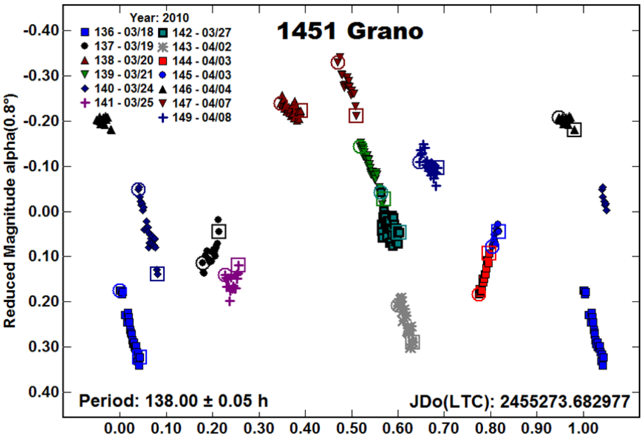
Warner, B.D. (2007). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

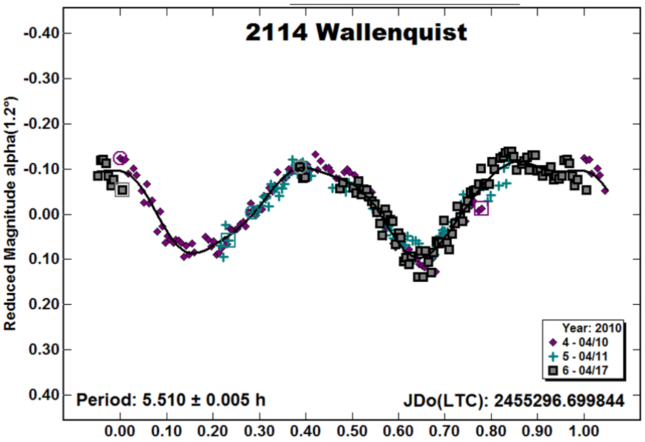
Warner, B.D., Harris, A.W., and Pravec, P. (2010). Lightcurve Targets *http://www.MinorPlanetObserver.com/astlc/default.htm.*











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

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Lightcurves for 19 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2010 March through June: 413 Edburga, 2204 Lyyli, 2449 Kenos, 3225 Hoag, 3416 Dorrit, 3483 Svetlov, 3800 Karayusuf, 4461 Sayama, 4713 Steel, 5081 Sanguin, 5427 Jensmartin, 5641 McCleese, 6249 Jennifer, 6635 Zuber, 6911 Nancygreen, (29147) 1988 GG, (30856) 1991 XE, (48147) 2001 FO160, and (103501) 2000 AT245.

CCD photometric observations of 19 asteroids were made at the Palmer Divide Observatory (PDO) from 2010 March through June. See the introduction in Warner (2010) for a discussion of equipment, analysis software and methods, and overview of the plot scaling. The “Reduced Magnitude” in the plots uses R magnitudes corrected to unity distance using -5 * log (Rr) with R and r being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle given in parentheses, i.e., alpha(X°), using $G = 0.15$ unless otherwise stated.

413 Edburga. This asteroid was observed as a “full moon project” to resolve the ambiguity between two previously reported periods: 15 h (Hainaut-Rouelle et al., 1995) and 12.1 h (Behrend, 2010). The PDO data gave a convincing solution of $P = 15.773$ h and $A = 0.36$ mag.

2204 Lyyli. Mohamed et al. (1994) reported $P = 10$ h for this Mars-crosser while Gil-Hutton and Canada (2003) found $P = 9.51$ h. Neither of these could be fit to the PDO data, which gave $P = 11.063$ h with $A = 0.40$ mag.

2449 Kenos. Wisniewski et al. (1997) found $P = 4.188$ h but with $P = 3.862$ h as a possible solution. Warner (2007) found $P = 3.8492$ h. The latest PDO data gave $P = 3.846$ h with $A = 0.23$ mag.

3225 Hoag. Warner (2007, 2009b) previously reported $P \sim 2.372$ h. The asteroid was observed in 2010 for additional modeling data and to check if it might be binary (see Warner et al., 2010, for a serendipitous story concerning 2131 Mayall and repeated follow-up). The 2010 PDO data gave $P = 2.3722$ and $A = 0.12$.

3416 Dorrit. Bennefeld (2009) found $P = 2.714$ h based on two consecutive nights but with data point errors of ~0.04 mag. Using the PDO data, which consisted of two consecutive nights and a third three days removed from the first two, there was a much weaker solution in the period spectrum around that value, but it was obviously not a good fit. Instead, the data gave $P = 2.574$ h with $A = 0.21$ mag.

3800 Karayusuf. Warner (2008) found $P = 2.2319$ h with some suspicious data that might have been attributed to a satellite. No evidence of such was found in the 2010 apparition. The latest data gave $P = 2.232$ h with $A = 0.15$ mag.

4713 Steel. The PDO data gave $P = 5.199$ h with $A = 0.42$ mag. The period is reasonable agreement with that from Behrend (2010) of $P = 5.186$ h.

5427 Jensmartin. Warner (2009a) found $P = 5.810$ h from observations in 2008. The 2010 follow-up observations gave $P = 5.813$ h with $A = 0.55$ mag.

5641 McCleese. Warner et al. (2006a) found $P = 7.268$ h with $A = 0.06$ mag. Behrend (2010), using data from 2005 and 2007, found $P = 28.8$ h. The 2010 PDO data set benefited from well-linked data over the nearly six weeks of observations. These gave $P = 418$ h with $A = 1.3$ mag, thus making this Hungaria asteroid a very slow rotator and demonstrating the need to provide accurate linking and prolonged observations when the data indicate only a small but steady change over each session. One must also avoid the temptation to find solutions based on what is mostly noise in the data.

6249 Jennifer. Both Warner et al. (2006b) and Behrend (2010) previously reported a period of approximately 4.6 h. In both cases, the amplitudes were $A \leq 0.11$ mag. Such low amplitude curves, especially if monomodal (as Behrend found), leave open the possibility that the true period solution is something other than what was found, often one-half. The 2010 PDO data produced a lightcurve amplitude of $A = 0.32$ mag, which almost assures that the lightcurve is bimodal and so a period solution featuring such a curve is very likely correct. The period of $P = 4.961$ h confirmed the earlier findings.

6911 Nancygreen. In Warner (2006), the period for this asteroid was P = 5.3 h. Despite an amplitude of 0.52 mag, the period was uncertain. In Warner (2009a), the period was P = 4.33 h with A = 0.10 mag. It was hoped that the 2010 observations at PDO would resolve the ambiguity. Instead, they added a third, much different solution of P = 17.14 h with A = 0.22 mag to the puzzle.

(29147) 1988 GG. This asteroid appears to be in non-principal axis rotation (NPAR; see Pravec et al., 2005). The dominant period is P = 99 h but since the lightcurve did not repeat itself, this is only a suggested solution.

(30856) 1991 XE. This asteroid was observed as follow-up to work done by the author in 2007 (Warner, 2007) that produced P = 5.353 h and A = 0.70 mag. The 2010 data gave P = 5.355 h and A = 0.75 mag.

(48147) 2001 FO160. Two solutions are possible, P = 13.09 h and P = 26.17 h, both with A = 0.25 mag. Given the amplitude, the longer period, which has a bimodal solution, is usually favored. A period spectrum is also given to show that some other solutions cannot be formally excluded.

(103501) 2000 AT45. The period of P = 29.95 h presented in the plot is the most likely of several solutions with the double period, P = 59.85 h, being one of the alternatives.

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References

Behrend, R. (2010). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

Bennefeld, C., Aguilar, V., Cooper, T., Hupp, W., Pecha, J., and Soar, E. (2009). "Asteroid Lightcurve Analysis at Ricky Observatory." *Minor Planet Bul.* **36**, 123-124.

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

Hainaut-Rouelle, M.-C., Hainaut, O.R., and Detal, A. (1995). "Lightcurves of selected minor planets." *Astron. Astrophys. Suppl. Ser.* **112**, 125-142.

Mohamed, R.A., Krugly, Yu.N., and Velichko, F.P. (1994). "Photometry of two Mars-crossing asteroids 2078 Nanking and 2204 Lyyli." *Planet. Space Sci.* **42**, 341-343.

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

Warner, B.D., Pravec, P., Kušnirák, P., Galad, A., Koronis, L., Pray, D.P., Cooney, Jr., W., Gross, J., Terrell, D., Nudds, S., and Durkee, R. (2006a). "The enigmatic lightcurve for the Hungaria asteroid 5641 McCleese." *Minor Planet Bul.* **33**, 21-23.

Warner, B.D., Gross, J., and Harris, A.W. (2006b). "Analysis of the lightcurve for 6249 Jennifer." *Minor Planet Bul.* **33**, 23-24.

Warner, B.D. (2007). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: December 2006 - March 2007." *Minor Planet Bul.* **34**, 72-77.

Warner, B.D. (2008). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: February – May 2008." *Minor Planet Bul.* **35**, 163-167.

Warner, B.D. (2009a). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2008 May – September." *Minor Planet Bul.* **36**, 7-13.

Warner, B.D. (2009b). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2008 September-December." *Minor Planet Bul.* **36**, 70-73.

Warner, B.D. (2010). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 June-September." *Minor Planet Bul.* **37**,

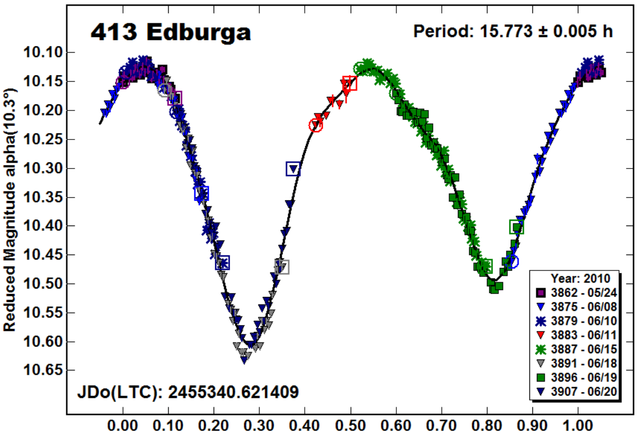
#	Name	mm/dd 2010	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
413	Edburga	05/24-06/20	307	10.2,16.9	225	18	15.773	0.005	0.36	0.02
2204	Lyyli	05/05-06/07	220	12.8,18.8	199	18	11.063	0.001	0.40	0.02
2449	Kenos (H)	06/08-06/18	176	33.7,33.2	278	40	3.846	0.001	0.23	0.02
3225	Hoag (H)	04/25-05/03	189	22.4,21.1	239	26	2.3722	0.0005	0.12	0.01
3416	Dorrit (H)	03/21-03/25	179	6.3,6.0	182	10	2.574	0.002	0.21	0.01
3483	Svetlov (H)	05/01-05/04	169	15.1,15.2	216	25	6.790	0.005	0.23	0.02
3800	Karayusuf (H)	03/17-03/22	266	27.3,27.0	186	28	2.232	0.002	0.15	0.01
4461	Sayama	06/21-07/02	232	12.4,15.3	250	17	40.75	0.20	0.60	0.03
4713	Steel (H)	05/01-05/04	203	22.1,22.2	217	31	5.199	0.002	0.42	0.02
5081	Sanguin	03/25-04/10	239	12.5,17.7	170	18	10.262	0.003	0.53	0.02
5427	Jensmartin (H)	04/25-05/04	134	7.7,12.6	205	-5	5.813	0.003	0.55	0.02
5641	McCleese (H)	05/16-07/01	938	32.1,24.3	268	32	418.	5.	1.30	0.10
6249	Jennifer (H)	06/11-06/18	127	18.8,19.5	265	29	4.961	0.005	0.32	0.03
6635	Zuber (H)	06/19-06/22	92	22.1,21.6	292	33	5.546	0.005	0.63	0.03
6911	Nancygreen (H)	05/05-06/08	297	8.9,18.7	230	15	17.14	0.01	0.22	0.02
29147	1988 GG	03/12-04/11	663	15.7,20.6	172	19	99. (NPAR?)	3.	0.80	0.05
30856	1991 XE (H)	05/04-05/09	160	15.8,15.1	228	23	5.355	0.002	0.75	0.02
48147	2001 FO160	05/04-06/07	284	13.6,17.6	229	23	26.17/13.09	0.02	0.25	0.02
103501	2000 AT245	03/17-04/09	298	12.2,21.6	165	7	29.95/59.85	0.10	0.16	0.02

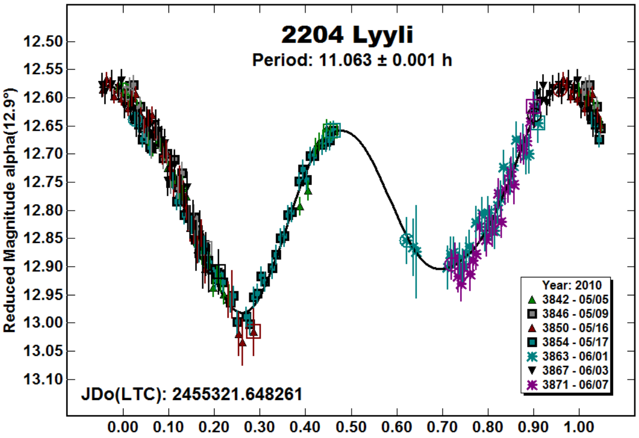
Table I. Observing circumstances. Asteroids with "(H)" after the name are members of the Hungaria group. The phase angle (α) is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change 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).

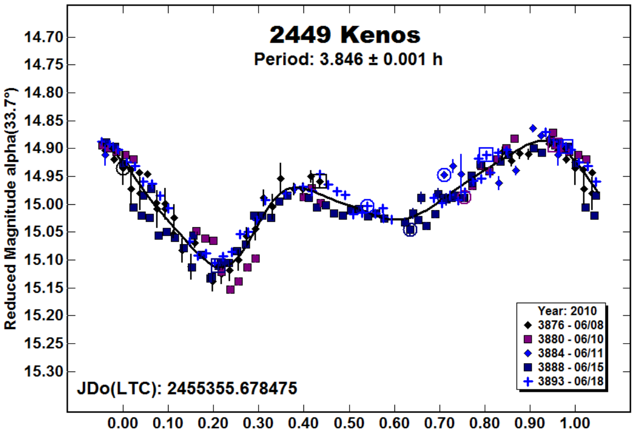
24-27.

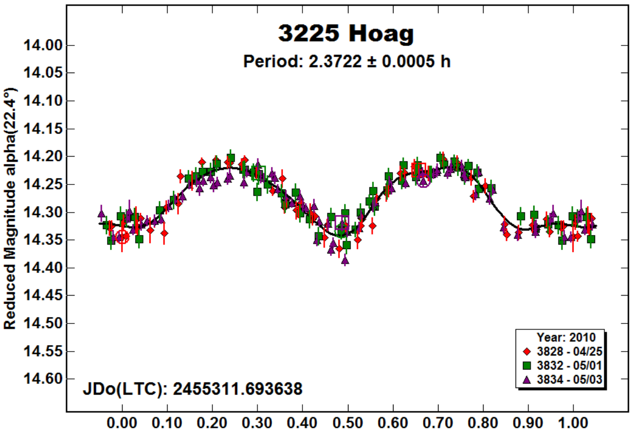
Warner, B.D., Pravec, P., Kušnirák, P., Hornoch, K., Harris, A.W., Stephens, R.D., Casulli, S., Coonery, Jr., W.R., Gross, J., Terrell, D., and 20 colleagues (2010). "A Trio of Hungaria Binary Asteroids." *Minor Planet Bul.* **37**, 70-73.

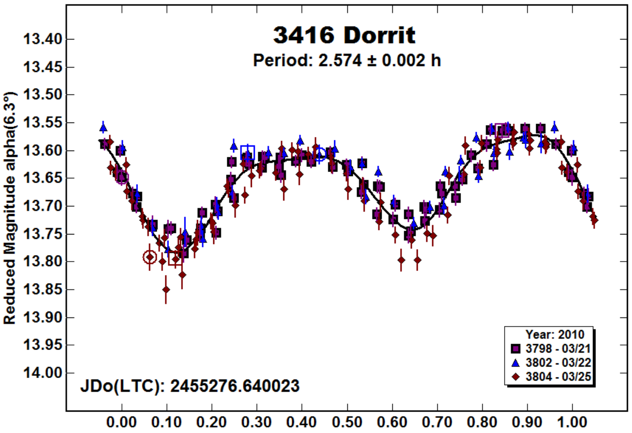
Wisniewski, W.Z., Michalowski, T.M., Harris, A.W., and McMillan, R.S. (1997). "Photometric Observations of 125 Asteroids." *Icarus* **126**, 395-449.

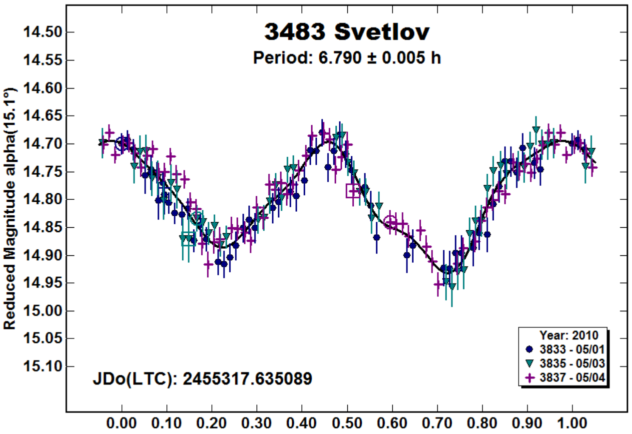


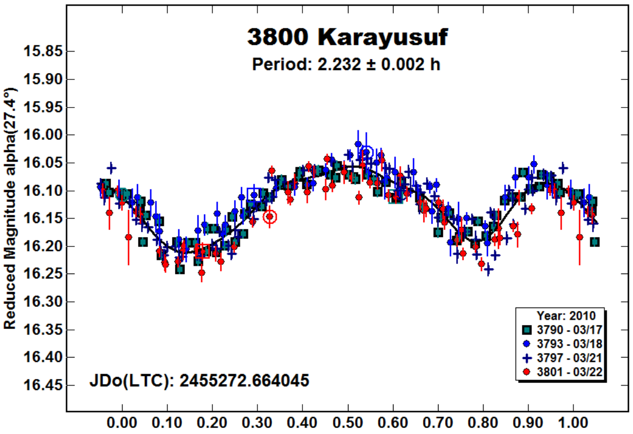


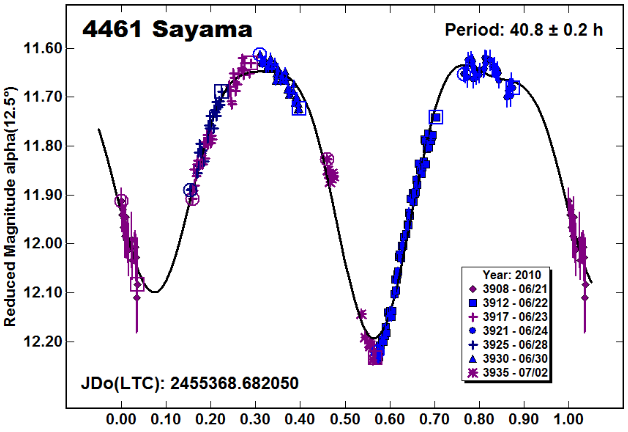








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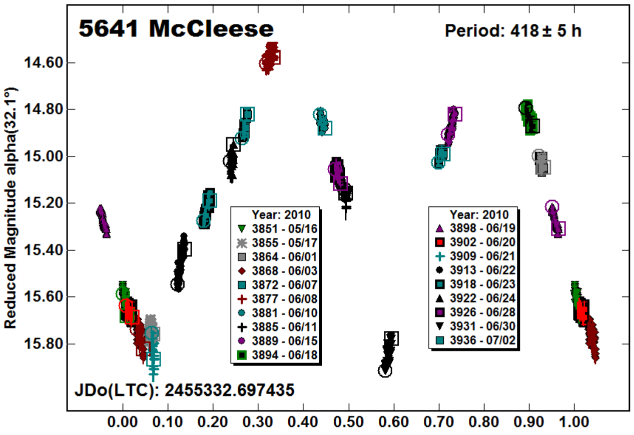
Period: 40.8 ± 0.2 h
Reduced Magnitude alpha(12.5°)
11.60 11.70 11.80 11.90 12.00 12.10 12.20
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3908 - 06/21
3912 - 06/22
3917 - 06/23
3921 - 06/24
3925 - 06/28
3930 - 06/30
3935 - 07/02
JDo(LTC): 2455368.682050


5641 McCleese
Period: 418 ± 5 h
Reduced Magnitude alpha(32.1°)
14.60 14.80 15.00 15.20 15.40 15.60 15.80
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3851 - 05/16
3855 - 05/17
3864 - 06/01
3868 - 06/03
3872 - 06/07
3877 - 06/08
3881 - 06/10
3885 - 06/11
3889 - 06/15
3894 - 06/18
Year: 2010
3898 - 06/19
3902 - 06/20
3909 - 06/21
3913 - 06/22
3918 - 06/23
3922 - 06/24
3926 - 06/28
3931 - 06/30
3936 - 07/02
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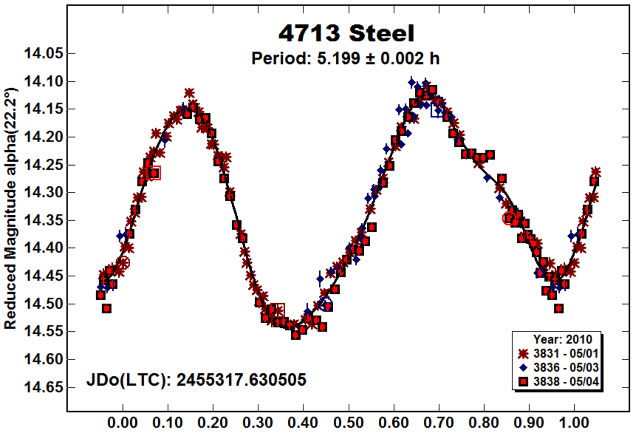
4713 Steel
Period: 5.199 ± 0.002 h
Reduced Magnitude alpha(22.2°)
14.05 14.10 14.15 14.20 14.25 14.30 14.35 14.40 14.45 14.50 14.55 14.60 14.65
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3831 - 05/01
3836 - 05/03
3838 - 05/04
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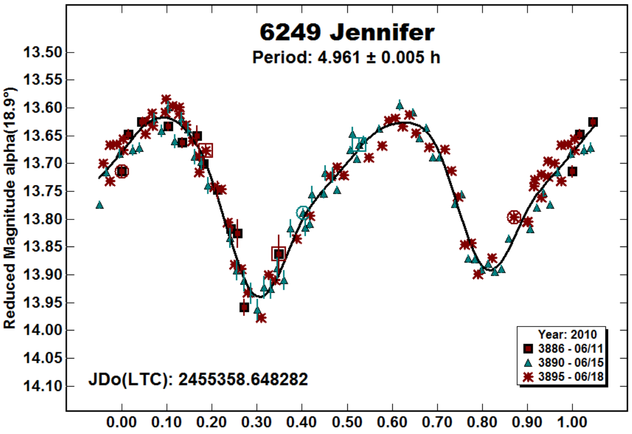
6249 Jennifer
Period: 4.961 ± 0.005 h
Reduced Magnitude alpha(18.9°)
13.50 13.55 13.60 13.65 13.70 13.75 13.80 13.85 13.90 13.95 14.00 14.05 14.10
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3886 - 06/11
3890 - 06/15
3895 - 06/18
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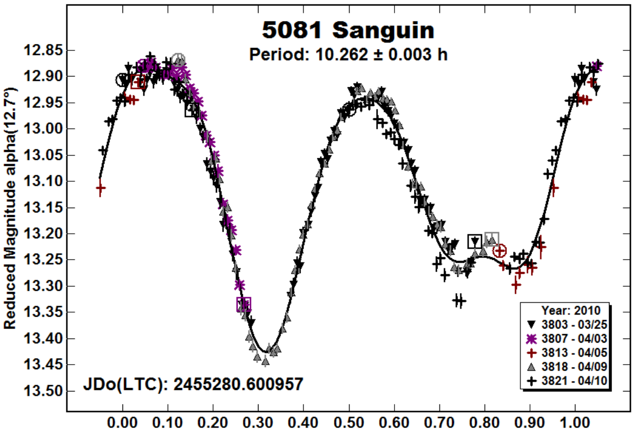
5081 Sanguin
Period: 10.262 ± 0.003 h
Reduced Magnitude alpha(12.7°)
12.85 12.90 12.95 13.00 13.05 13.10 13.15 13.20 13.25 13.30 13.35 13.40 13.45 13.50
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
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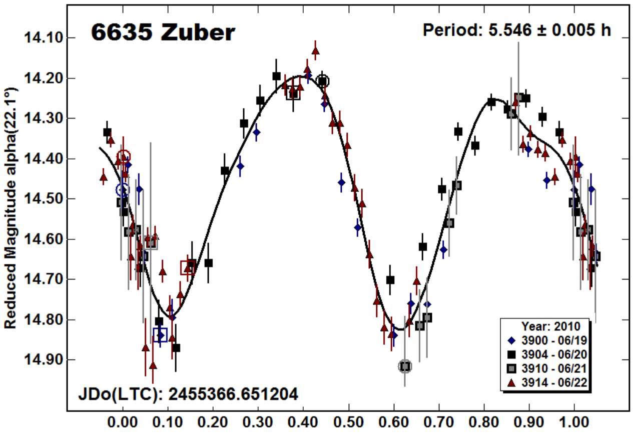
3807 - 04/03
3813 - 04/05
3818 - 04/09
3821 - 04/10
JDo(LTC): 2455280.600957


6635 Zuber
Period: 5.546 ± 0.005 h
Reduced Magnitude alpha(22.1°)
14.10 14.20 14.30 14.40 14.50 14.60 14.70 14.80 14.90
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3900 - 06/19
3904 - 06/20
3910 - 06/21
3914 - 06/22
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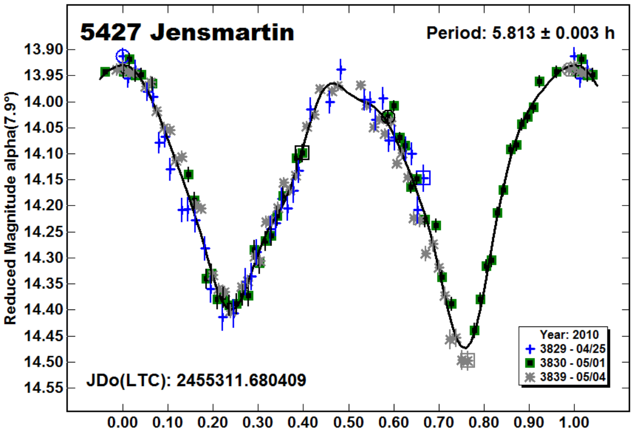
5427 Jensmartin
Period: 5.813 ± 0.003 h
Reduced Magnitude alpha(7.9°)
13.90 13.95 14.00 14.05 14.10 14.15 14.20 14.25 14.30 14.35 14.40 14.45 14.50 14.55
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
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3839 - 05/04
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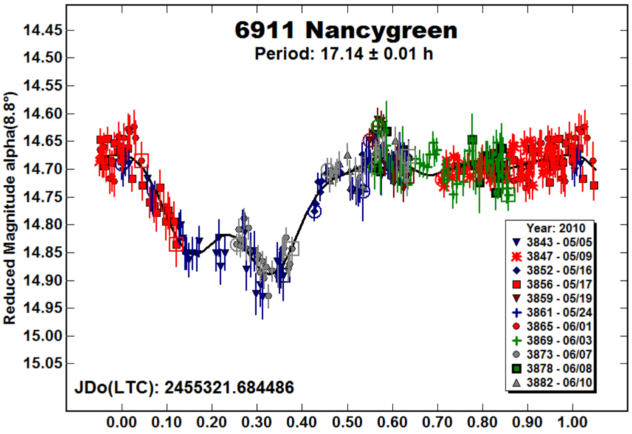
6911 Nancygreen
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Reduced Magnitude alpha(8.8°)
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0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
Year: 2010
3843 - 05/05
3847 - 05/09
3852 - 05/16
3856 - 05/17
3859 - 05/19
3861 - 05/24
3865 - 06/01
3869 - 06/03
3873 - 06/07
3878 - 06/08
3882 - 06/10
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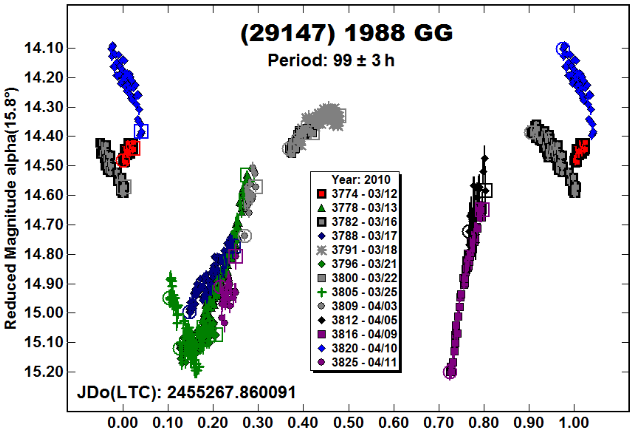

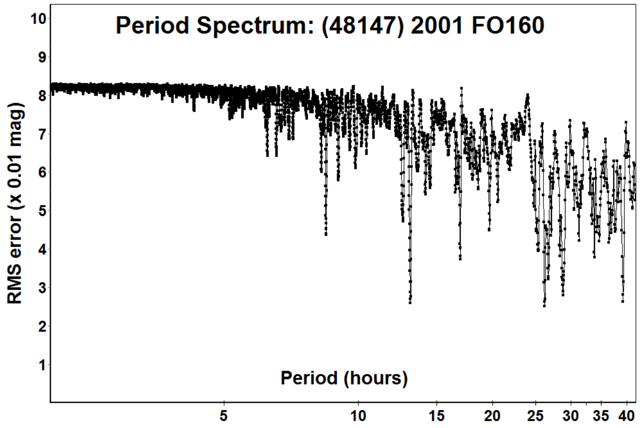

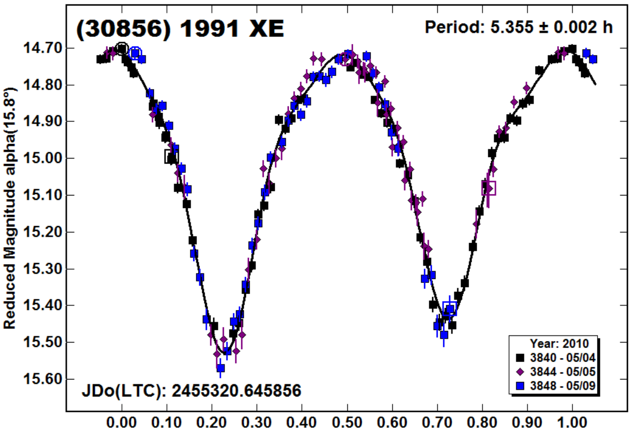

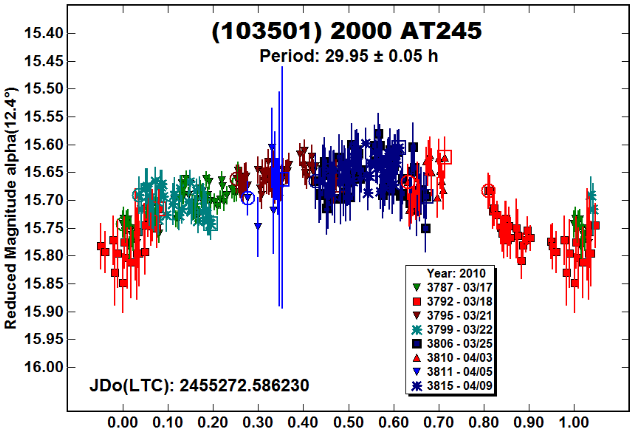

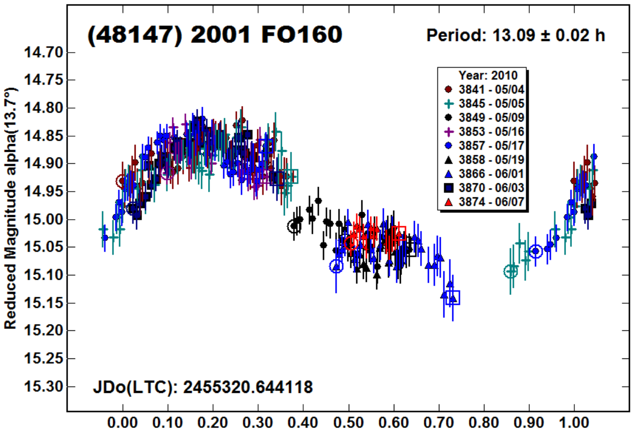

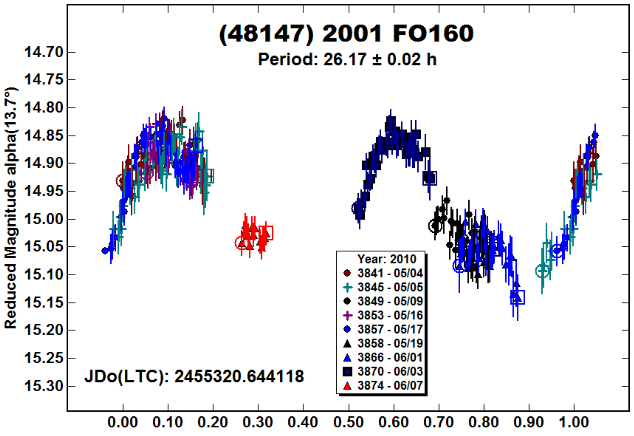

THE LIGHTCURVE OF NEAR-EARTH ASTEROID 2010 NR1

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(Received: 15 July)

A lightcurve for the newly-discovered Near-Earth asteroid 2010 NR1, was obtained from Tzec Maun Observatory in Moorook, South Australia (MPC Code D96) from a single night's observations on 2010 July 10. An approximate period of 0.89 h was found along with an amplitude of 1.8 mag, indicating a very-elongated body.

Observations of the near-Earth asteroid 2010 NR1 were obtained by utilizing a 0.15-m TOA-150 refractor and a SBIG STL-6303 CCD imager. All images were with a clear filter, unguided, and using three-minute exposures. The camera was binned 2x2 giving 3.4 arc-second pixels. Measurements were made using *MPO Canopus* (Warner, 2010a). This particular near-Earth asteroid had no published lightcurve since it had only just been discovered. As well as generating a lightcurve, confirmation astrometry was also submitted to the Minor Planet Center. At the time of imaging this object, it was temporarily designated as RN4AF02. A second night of follow-up observations was impossible due to poor sky conditions over a period of several nights. These appear to be the only lightcurve observations obtained of 2010 NR1 since it quickly faded after discovery.

Based on 2010 NR1's large lightcurve amplitude of 1.8 mag., it is assumed that this object is that of a highly elongated body. From the 14 data points acquired of this object over the period of nearly an hour, it was determined that this object has a rotational period of 0.89 ± 0.04 h. 2010 NR1 has an H value of 21.9 (MPC), which places it in the range of 110 to 240 meters, depending on the assumed albedo. With a rotational period of 0.89 ± 0.04 h, this object is likely that of a body that is "strength-dominated", e.g., a monolithic body, rather than that of a "rubble pile" or "gravitationally-bound" asteroid.

References

Warner, B. D. (2010a). MPO Software, Canopus version 10. Bdw Publishing, Colorado Springs, CO.

Warner, B.D. (2010b). *A Companion Guide to the MPO Canopus/PhotoRed Reference Manual.* Bdw Publishing, Colorado Springs, CO.

IAU Minor Planet Center.
www.minorplanetcenter.org/iau/mpc.html

Tzec Maun Foundation - www.tzecmaun.org

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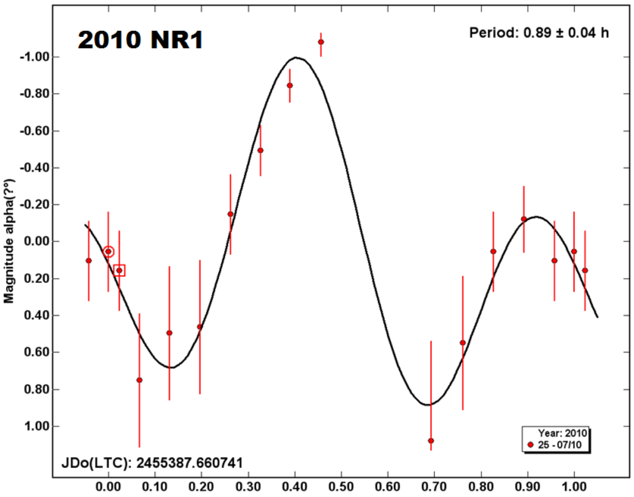
I would like to give gratitude to the Tzec Maun Foundation for providing access to equipment capable of producing data, which allows this research to be produced.



ROTATION PERIOD DETERMINATION FOR 2375 RADEK

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(Received: 14 July)

A synodic rotation period of 16.875 ± 0.001 h and amplitude of 0.20 ± 0.01 mag were determined for the asteroid 2375 Radek from unfiltered CCD photometric observations carried out at two locations, Belgrade, Serbia, and Las Cruces, NM, USA.

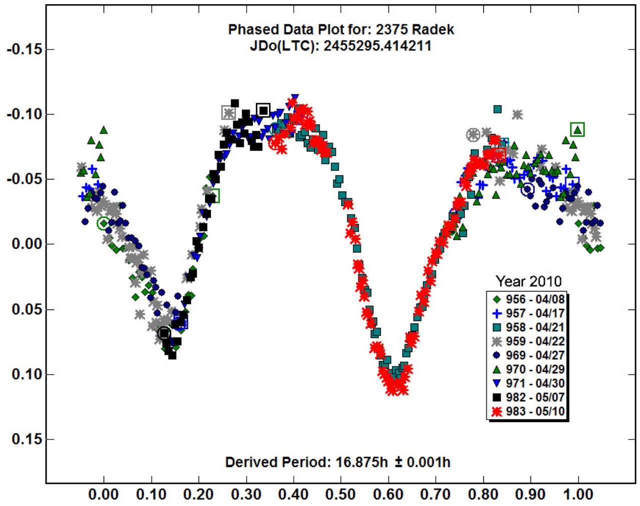
2375 Radek is a main-belt asteroid discovered in 1975 by L. Kohoutek in Bergedorf. Prior to our work no results for the rotation period of this asteroid were known. Sada et al. (2005) reported an unsuccessful attempt to find an unambiguous period from their 2004 observations. The object was favorably suited for photometric observations in 2010 April and May when it reached V~14.1 in opposition on April 29. It was listed as a potential lightcurve target in the period 2010 April-June on the CALL web site (Warner and Harris, 2010). Benishek started the observations on 2010 April 8 at the Belgrade Astronomical Observatory employing a 0.4-m SCT operating at f/10 with an unguided SBIG ST-10 XME CCD camera. Pilcher at Organ Mesa Observatory joined the observations on 2010 April 21 using a 0.35-m SCT operating at f/10 and equipped with an unguided SBIG STL-1001E CCD camera. The object was observed over 9 nights until May 10. All observations were unfiltered.

The photometric reductions as well as the period analysis were performed using *MPO Canopus* software by BDW Publishing. Linkage of the individual data sets was achieved by adjusting instrumental magnitudes. The period analysis performed with all 9 sessions gives an unambiguous solution of P = 16.875 ± 0.001 h. The amplitude of 0.20 ± 0.01 mag was found from the composite bimodal lightcurve.

References

Sada, P.V., Canizales, E.D., and Armada, E.M. (2005). "CCD Photometry of Asteroids 651 Antikleia, 738 Alagasta, and 2151 Hadwiger using a Remote Commercial Telescope." *Minor Planet Bulletin* **32**, 73-75.

Warner, B.D. and Harris, A.W. (2010). "Potential Lightcurve Targets, 2010 April-June."
http://www.minorplanetobserver.com/astlc/targets_2q_2010.htm



NEW LIGHTCURVES OF 40 HARMONIA AND 105 ARTEMIS

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Abstract. Lightcurves obtained 2010 May to July yield synodic rotation periods and amplitudes for: 40 Harmonia 8.909 ± 0.001 h, 0.18 ± 0.01 mag; and 105 Artemis 37.150 ± 0.001 h, 0.16 ± 0.02 mag.

All of these reported observations have been made at the Organ Mesa Observatory. Equipment consists of a 35 cm Meade LX200 GPS S-C, SBIG STL-1001E CCD, R filter, unguided, instrumental magnitudes only. The lightcurves have been drawn with the large number of data points acquired for each target in this study binned in sets of three with a maximum of five minutes between points.

40 Harmonia. Harris et. al. (2010) state a secure period of 8.910 hours based on several independent and mutually compatible studies. Additional lightcurves were obtained on 5 nights 2010 May 30 – June 14 to contribute to spin/shape modeling. These show a period 8.909 ± 0.001 hours, amplitude 0.18 ± 0.02 magnitudes, fully compatible with previous studies.

105 Artemis. The long period and irregular lightcurve caused several early observers to obtain widely differing periods. Tedesco (1979) obtained one 6 hour irregular lightcurve with amplitude 0.02 mag and guessed a period of 20 hours. Debehogne et. al. (1982) obtained a single lightcurve showing an increase of 0.05 mag in 4 hours. Schober et. al. (1994) published a period 16.84 h, amplitude 0.14 mag, with 0.08 mag scatter in the data. Shevchenko et. al. (2002) obtained a period 19.65 h. Tungalag et. al. (2002) combined all previous observations to obtain a period 18.54998 h. Le Crone et. al. (2004) obtained a period 17.80 h. Higgins (2010) obtained 2006 Mar. 18 – May 22 the most dense data set to date in support of Arecibo radar observations and found a period 37.2 ± 0.1 h. Higley et. al. (2008) used all the data listed above to obtain a spin/shape model with period 37.15506 h. New observations on 15 nights 2010 May 12 – July 10 show a period 37.150 ± 0.001 hours, amplitude 0.16 ± 0.02 magnitudes with an irregular lightcurve.

References

Debehogne, H., Lagerkvist, C.-I., and Zappala, V. (1982). “Physical Studies of Asteroids VIII. Photoelectric photometry of the asteroids 42, 48, 93, 105, 145, and 245.” *Astron. Astrophys. Suppl. Ser.* **50**, 277-281.

Harris, A. W., Pravec, P., and Warner, B. D. (2010). “Asteroid Lightcurve Data File: May 21, 2010.” http://www.MinorPlanetObserver.com/astlc/default,htm.

Higgins, D. (2010). http://david-higgins.com/Astronomy

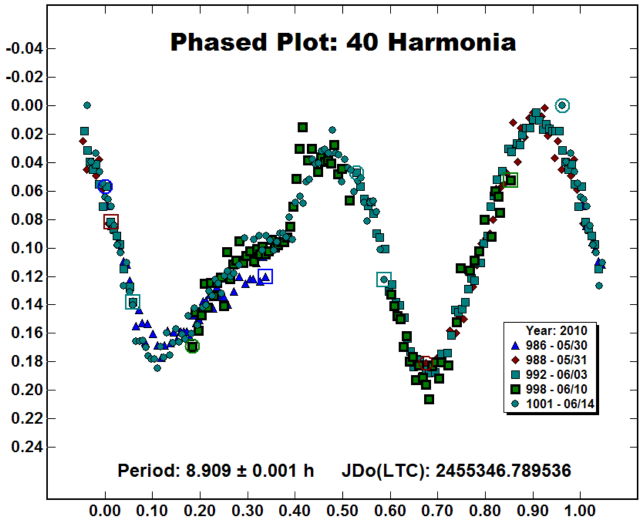
Higley, S., Hardesen, P., and Dyvig, R. (2008). “Shape and spin axis models for 2 Pallas (revisited), 5 Astraea, 24 Themis, and 105 Artemis.” *Minor Planet Bull.* **35**, 63-66.

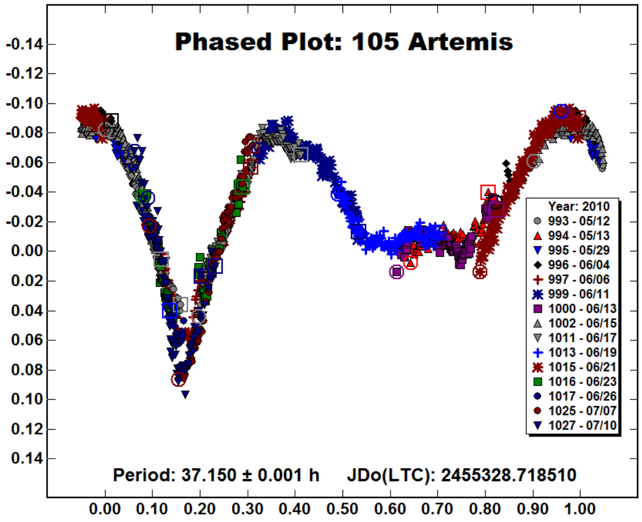
LeCrone, C., Duncan, A., and Kirkpatrick, E. (2004). “Lightcurves and Periods for Asteroids 105 Artemis, 978 Aidamina, and 1103 Sequoia.” *Minor Planet Bull.* **31**, 77-78.

Schober, H. J., Erikson, A., Hahn, G., Lagerkvist, C.-I., Albrecht, R., Ornig, W., Schroll, A., and Stadler, M. (1994). “Physical studies of asteroids XXVIII. Lightcurves and photoelectric photometry of asteroids 2, 14, 51, 105, 181, 238, 258, 369, 377, 46, 487, 626, 1048, and 2183.” *Astron. Astrophys. Suppl. Ser.* **105**, 277-281.

Tedesco, E. F. (1979). Ph. D. Dissertation, New Mexico State University.

Tungalag, N., Shevchenko, V. C., and Lupishko, D. F. (2002). *Kin. Fiz. Neb.* Tel 18, 508-516.





LIGHTCURVE ANALYSIS OF 279 THULE

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A campaign involving asteroid observers from the US, Australia, and New Zealand was established to determine the rotation period of the outer main-belt asteroid, 279 Thule. Several conflicting periods had been reported as well as the possibility of the object being binary. Neither this campaign nor one conducted in 2008 by Pravec et al. found evidence of a satellite. We find a period of 15.962 ± 0.003 h. While there is good confidence in the result, despite it contradicting all previous periods, the matter of the asteroid's true rotation period may still be open.

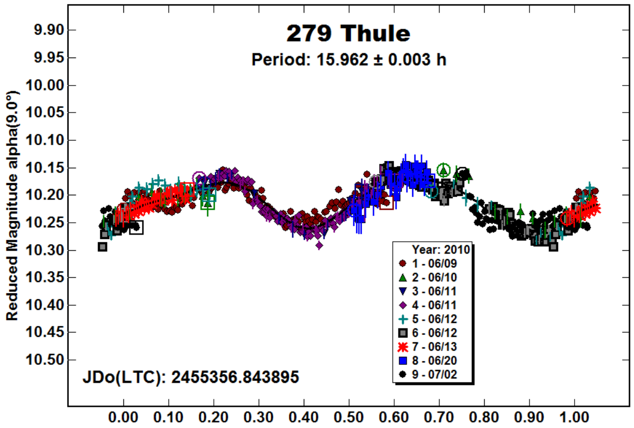
Despite what many might think, a large number of low-numbered asteroids, those below 1000, do not have well-determined rotation periods. In the Asteroid Lightcurve Database (LCDB; Warner et al., 2009), there are summary line entries for 944 of the first 1000 numbered objects. Of these only 683 have well-determined periods (U = 3 or 3- in the LCDB rating system); 177 have ratings that indicate a probable but still not certain period (U = 2+, 2, or 2–); while 46 have very poorly determined periods (U = 1 or 1+, "may be wrong"); and 10 have no periods at all, just an indication that some data have been obtained but not even a rough estimate of a period can be made. One of the 177 asteroids currently listed with a rating in the 2 range is 279 Thule.

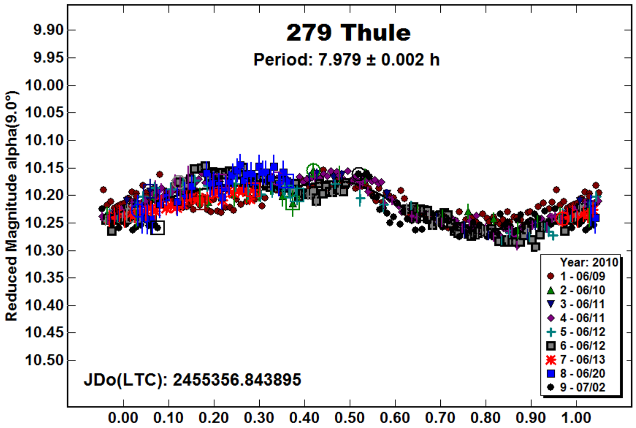
As a result of discussions via email regarding the uncertainty of the period and some suspicion of a satellite due to data from Hamanowa and Hamanowa (2010), an observing campaign was organized involving observers principally from Australia and New Zealand since the asteroid was well south of the equator and the Southern Hemisphere winter was approaching. This would allow prolonged observing runs that would be critical in resolving the asteroid's rotation period. Observers from the US (Coley and Stephens) provided additional observations. While these were shorter runs, they were from significantly different longitudes, thus helping further with resolving period ambiguities.

The campaign generated more than 1600 data points in 9 sessions from 2010 June 9 through July 2. Data were combined into a single set and analyzed by Warner using *MPO Canopus*, which employs the FALC Fourier analysis algorithm developed by Harris (Harris et al., 1989). The result was a synodic period of P = 15.962 ± 0.003 h and amplitude A = 0.10 ± 0.01 mag. The data were binned 3x in the plots below to make them easier to review.

This differs from the period by Pravec et al. (2010) of P = 11.942 h based on observations from 2008 that had A = 0.04 mag and is about double the period found by Zappala et al. (1989). Behrend (2010) found a period of 5.75 h using the Hamanowa data. We checked the fit of the 2010 data to the other periods. While the differences are subtle, the long sessions from the Southern Hemisphere observers allowed us to exclude the previously reported periods. A plot using the 2010 data phased to the half-period of ~7.9 h shows the subtlety involved in discriminating among solutions.

While we are confident in our solution of 15.96 h, the fact that the lightcurve amplitude is always very small (< 0.1 mag) means that a protracted campaign with all data put onto a common system to within 0.01 mag may be needed to remove all doubt.





Acknowledgements

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References

Behrend, R. (2010). Observatoire de Geneve web site, http://obswww.unige.ch/~behrend/page_cou.html

Hamanowa, H. and Hamanowa, H. (2010). Hamanowa Astronomical Obs. web site:
http://www2.ocn.ne.jp/~hamaten/astlcdata.htm

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., Wolf, M., and Sarounova, L. (2010). http://www.asu.cas.cz/~ppravec/neo.htm

Warner, B.D. (2006). "Initial Results of 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.

Zappala, V., Di Martino, M., Cellino, A., Farinella, P., et al. (1989). *Icarus* **82**, 354-368.

LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2010 OCTOBER - DECEMBER

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Once again the spotlight is on several near-Earth asteroids (NEAs) for radar support that may present some challenges given their fast sky motion, faintness, and/or proximity to the Sun. For more background on the program details for each of the opportunity lists, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188.

As always, we urge observations of asteroids even if they have well-established lightcurve parameters, especially if they do not yet have good spin axis or shape models. Every lightcurve of sufficient quality provides valuable information in support of such efforts, which are needed to resolve a number of questions about the evolution of individual asteroids and the general population. Furthermore, data over many apparitions can help determine if an asteroid's rotation rate is being affected by the YORP effect, a thermal effect that can cause a smaller, irregularly-shaped asteroid to speed up or slow down. This is done by seeing if a constant sidereal period fits all the data equally well or if a small linear change in the period produces better results. See Lowry et al. (2007) *Science* **316**, 272-274 and Kaasalainen et al. (2007) *Nature* **446**, 420-422.

Lightcurves, new or repeats, of NEAs are also important for solving spin axis models, specifically the orientation of the asteroid's axis of rotation. Pole directions are known for only about 30 NEAs out of a population of 6800. This is hardly sufficient to make even the most general of statements about pole alignments, including whether or not YORP is forcing pole orientations into a limited number of preferred directions (see La Spina et al., 2004, *Nature* **428**, 400-401).

The Opportunities Lists

We present four lists of "targets of opportunity" for the period 2010 October-December. 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 asteroid lightcurve data base (LCDB) documentation 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 only as a guide.

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

The first list is an *abbreviated list* of those asteroids reaching V < 14.5 at brightest during the period and have either no or poorly constrained lightcurve parameters. The goal for these asteroids is to find a well-determined rotation rate. More completed lists, including objects V < 16.0 can be found on the CALL web site.

http://www.minorplanetobserver.com/astlc/targets_3q_2010.htm

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."

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Those doing work for modeling should contact Josef Durech at the email address above and visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site for existing data and models: *http://astro.troja.mff.cuni.cz/projects/asteroids3D.*

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. High-precision work, 0.01-0.03 mag, is preferred. Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

Future radar targets:
http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html

Past radar targets:
http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html
Arecibo targets:
http://www.naic.edu/~pradar/sched.shtml
Goldstone targets:
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.

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Lightcurve Opportunities

		Brightest				LCDB Data	
#	Name	Date	Mag	Dec	U	Period	Amp
2437	Amnestia	10 01.5	14.3	+ 6			
1982	Cline	10 03.8	13.9	- 3			
1996	Adams	10 04.5	14.5	+ 9	2	3.08	0.23
3894	Williamcooke	10 07.0	14.5	- 6			
1663	van den Bos	10 08.8	13.6	- 4			
879	Ricarda	10 13.4	13.6	+30	2	82.9	0.37
1521	Seinajoki	10 13.0	14.6	+10			
101496	1998 XM3	10 15.1	14.6	+ 3			
4349	Tiburcio	10 15.3	13.8	-10			
6425	1994 WZ3	10 15.2	14.1	+12			
296	Phaetusa	10 16.8	13.9	+ 6			
2429	Schurer	10 19.4	14.5	+14	2	7.07	0.28
1080	Orchis	10 20.3	13.4	+14			
1383	Limburgia	10 21.1	14.4	+11			
2175	Andrea Doria	10 22.5	14.4	+13			
705	Erminia	10 22.4	12.5	+28	2	53.96	0.12
7081	Ludibunda	10 23.9	14.7	+16			
3133	Sendai	10 26.8	13.7	+12			
2699	Kalinin	10 26.1	14.4	- 2			
902	Probitas	10 27.1	14.2	+21	2+	10.11	0.18
20310	1998 FD117	10 27.9	14.7	+14			
1328	Devota	10 27.8	14.3	+14	2-	17.49	0.20
17312	7622 P-L	10 28.6	14.8	+11			
319	Leona	10 28.5	13.3	+ 5	1	9.6	0.03
1253	Frisia	10 28.2	14.4	+13			
1550	Tito	10 28.7	12.9	+ 4	2	54.2	0.23
645	Agrippina	10 28.7	13.8	+19	2	32.6	0.18
10217	Richardcook	11 01.0	14.6	+33			
2848	ASP	11 01.4	14.2	+16			
4298	Jorgenunez	11 03.6	14.4	+11			
3277	Aaronson	11 04.1	14.1	+ 6			
619	Triberga	11 04.7	13.0	+ 3	2	29.41	0.30-0.45
2360	Volgo-Don	11 05.0	14.4	+16			
1133	Lugduna	11 06.9	13.3	+13			
7837	Mutsumi	11 07.8	14.4	+18			
1646	Rosseland	11 07.0	14.1	+ 1	2	69.2	0.13
838	Seraphina	11 09.0	13.4	+21	2	15.67	0.07-0.30
1357	Khama	11 10.2	14.8	+ 5			
149	Medusa	11 11.7	12.5	+16	2	26.	>0.33
2853	Harvill	11 15.0	14.5	+15			
846	Lipperta	11 16.9	13.3	+19	1	>24.	>0.02
1312	Vassar	11 18.0	14.5	-14			
6734	Benzenberg	11 19.9	14.6	+19	1		0.19
5534	1941 UN	11 20.4	13.6	+32	2		
764	Gedania	11 20.8	13.3	+25	2	24.97	0.09-0.35
2219	Mannucci	11 22.8	14.5	+18	1		0.3
571	Dulcinea	11 22.6	13.1	+30	1	>24.	>0.15
4729	Mikhailmil'	11 23.3	14.3	+21			
574	Reginhild	11 23.1	13.3	+33			
6111	Davemckay	11 25.7	14.6	+17			
2649	Oongaq	11 30.4	14.2	+21	2	8.64	0.28
27496	2000 GC125	12 04.3	14.6	- 2	2	4.70	0.10
1190	Pelagia	12 05.8	14.5	+27			
5288	Nankichi	12 10.0	14.5	+29	2	13.78	0.19
4289	Biwako	12 11.1	14.2	+24			
1177	Gonnessia	12 12.7	13.8	+20	2	6.81	0.11
2301	Whitford	12 19.0	13.8	+26			
3388	Tsanghinchi	12 21.2	14.5	+12	2	3.24	0.33

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp	U
207	Hedda	10 05.6	0.84	12.5	+03	>12.	0.03	1
5714	Krasinsky	10 16.4	0.19	14.9	+09			
1383	Limburgia	10 21.1	0.09	14.5	+11			
1256	Normannia	10 21.3	0.76	14.8	+13	6.8	0.06	1
1486	Marilyn	10 26.1	0.09	14.8	+12			
3133	Sendai	10 26.8	0.58	14.2	+12			
1328	Devota	10 27.8	0.43	14.3	+14			
1253	Frisia	10 28.3	0.16	14.4	+13			
1082	Pirola	10 29.0	0.96	14.0	+11			
2848	ASP	11 01.4	0.51	14.2	+16			
6413	Iye	11 03.5	0.71	14.9	+16			
2360	Volgo-Don	11 05.0	0.20	14.4	+16			
7837	Mutsumi	11 08.0	0.77	14.8	+18			
846	Lipperta	11 16.9	0.09	13.4	+19	>24.	0.02	1
2697	Albina	11 17.5	0.92	14.7	+22	9.6	0.02	1
6734	Benzenberg	11 20.0	0.12	14.7	+19			
5392	Parker	11 20.6	0.70	14.8	+21	45.	0.2	1
1912	Anubis	11 21.7	0.56	14.7	+19			
2057	Rosemary	11 22.0	0.70	14.7	+22			
2286	Fesenkov	11 22.0	0.04	15.0	+20			
2219	Mannucci	11 22.9	0.85	14.5	+18			
4729	Mikhailmil'	11 23.4	0.51	14.3	+21			
2379	Heiskanen	11 24.3	0.25	14.8	+20			
1440	Rostia	11 29.9	0.49	15.0	+23			
4540	Oriani	12 02.9	0.28	15.0	+21			
14999	1997 VX8	12 04.2	0.94	14.9	+24			
561	Ingwelde	12 07.0	0.80	15.0	+20			
2831	Stevin	12 07.9	0.43	14.5	+22			
4289	Biwako	12 11.1	0.30	14.3	+24			

Shape/Spin Modeling Opportunities

		Brightest			Per		
#	Name	Date	Mag	Dec	(h)	Amp	U
97	Klotho	10 05.1	10.1	-06	35.15	0.07 0.3	3
347	Pariana	10 30.2	13.0	+00	4.0529	0.09 0.42	3
389	Industria	11 04.7	11.6	+26	8.53	0.18 0.34	3
65	Cybele	11 08.8	11.8	+12	4.036	0.04 0.12	2
480	Hansa	11 20.1	11.4	+19	16.19	0.20 0.58	3
337	Devosa	11 21.3	11.0	+33	4.65	0.08 0.75	3
37	Fides	11 28.4	9.6	+26	7.3335	0.10 0.25	3
212	Medea	12 10.7	12.0	+28	10.283	0.04 0.13	3
375	Ursula	12 11.8	12.2	+45	16.83	0.17	2
419	Aurelia	12 22.8	12.9	+20	16.788	0.07 0.27	3
42	Isis	12 31.	11.8	+26	13.597	0.24 0.35	3
93	Minerva	12 31.	12.2	+35	5.982	0.04 0.10	3
139	Juewa	12 31.	12.0	+10	20.991	0.20	3
335	Roberta	12 31.	13.5	+14	12.054	0.05 0.17	3

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 web sites below 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.

Minor Planet Center: *http://cfa-www.harvard.edu/iau/mpc.html*
JPL Horizons: *http://ssd.jpl.nasa.gov/?horizons*

The first three objects are repeats from MPB 37-3 since they are best observed in October.

(137032) 1998 UO1 (2010 October, H = 16.7)

Periods ranging from ~3 to 4 h have been reported for this NEA. Radar observations show *D* ~ 1.2 km and a nearly spheroidal shape. There were hints of a companion in the radar but nothing conclusive. High-precision observations will be needed to have any chance of detecting a satellite, if it exists. Note that ephemeris has 1-day intervals.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/01	16 25.13	+11 06.4	0.082	0.964	15.69	115.0
10/02	17 12.73	+14 35.2	0.084	0.978	15.07	103.4
10/03	17 58.13	+17 16.0	0.089	0.993	14.71	92.6
10/04	18 38.41	+19 03.8	0.097	1.007	14.55	83.2
10/05	19 12.43	+20 08.1	0.107	1.022	14.52	75.4
10/06	19 40.42	+20 42.2	0.119	1.036	14.58	69.2
10/07	20 03.26	+20 57.3	0.132	1.050	14.68	64.1
10/08	20 21.93	+21 01.1	0.146	1.064	14.80	60.0
10/09	20 37.33	+20 58.4	0.160	1.078	14.94	56.7
10/10	20 50.17	+20 52.2	0.176	1.092	15.09	54.0

(153814) 2001 WN5 (2010 October, H = 18.3)

There are no known lightcurve parameters for this NEA. Its estimate size is about 650 meters. The somewhat fast sky motion and estimated magnitude favors larger telescopes so that exposure times can be kept to a minimum. In 2028, the asteroid passes at 0.6 lunar distances, the close known approach by an object of this size for the next two centuries.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/01	17 36.01	-08 24.8	0.127	0.980	17.21	96.0
10/06	18 41.50	-05 32.6	0.112	1.003	16.54	85.2
10/11	19 58.70	-01 34.3	0.107	1.029	16.00	70.9
10/16	21 14.43	+02 29.6	0.115	1.056	15.78	56.5
10/21	22 16.64	+05 36.7	0.134	1.085	15.85	45.4
10/26	23 03.11	+07 39.4	0.161	1.116	16.11	38.1
10/31	23 37.20	+08 57.2	0.194	1.148	16.45	33.9
11/05	0 02.79	+09 48.9	0.231	1.181	16.83	31.6

(162269) 1999 VO6 (2010 October, H = 17.0)

This NEA has an estimated size of 1.2 km. There are no known lightcurve parameters. It's decidedly a Northern Hemisphere target as it rides near the north celestial pole during October.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/01	3 32.88	+64 26.1	0.254	1.115	16.34	57.5
10/03	3 53.35	+67 04.1	0.221	1.090	16.08	60.7
10/05	4 27.82	+70 14.4	0.189	1.065	15.82	65.0
10/07	5 34.33	+73 40.3	0.158	1.040	15.57	71.1
10/09	7 47.01	+75 13.4	0.130	1.014	15.39	79.9
10/11	10 26.57	+69 09.9	0.106	0.987	15.42	93.2
10/13	11 58.40	+53 15.5	0.091	0.960	16.03	112.3

2007 RU17 (2010 October, H = 18.2)

There are no known lightcurve parameters for this asteroid with an estimated diameter of 0.68 km. Given the large range of phase angles, this object could be an excellent study to determine H and G parameters (absolute magnitude and phase slope parameter).

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/10	1 41.27	+11 38.7	0.319	1.313	16.90	8.6
10/13	1 28.38	+11 40.2	0.274	1.271	16.31	4.6
10/16	1 10.48	+11 37.3	0.231	1.228	15.80	3.4
10/19	0 44.90	+11 24.9	0.191	1.184	15.63	10.2
10/22	0 07.18	+10 50.8	0.155	1.139	15.47	20.9
10/25	23 10.71	+09 27.2	0.126	1.093	15.38	36.5
10/28	21 50.79	+06 31.2	0.108	1.046	15.57	58.3
10/31	20 17.85	+02 06.4	0.107	0.999	16.28	83.8

2003 UV11 (2010 October, H = 19.3)

The estimated size of this asteroid is only 400 meters. In late October it reaches V = 12.0, making it an easy visual target to show the neighbors. However, its sky motion then will be extremely fast, making good photometry difficult. Better opportunities for getting a lightcurve occur about a week before the spectacular fly-by.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/19	3 03.38	+14 38.2	0.166	1.151	16.68	19.2
10/21	2 59.88	+14 56.6	0.136	1.125	16.13	17.3
10/23	2 54.14	+15 24.1	0.106	1.097	15.46	14.8
10/25	2 43.70	+16 10.4	0.077	1.070	14.58	11.3
10/27	2 20.17	+17 44.2	0.048	1.042	13.29	6.1
10/29	0 50.89	+21 45.4	0.022	1.014	12.02	20.7
10/31	18 18.15	+04 04.5	0.018	0.985	15.15	117.3
11/02	16 28.17	-07 16.7	0.043	0.955	20.49	148.2

2002 VE68 (2010 November, H = 20.3)

A preliminary period of 13.5 h was found by Pravec et al. The amplitude was > 0.8 mag, indicating a very elongated body. Given the period, a collaboration among observers at well-separated longitudes is in order. The estimated size is only 0.26 km.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
10/29	7 37.19	+65 03.7	0.057	1.010	16.61	71.2
11/01	5 49.44	+68 30.7	0.047	1.015	15.85	60.9
11/04	3 04.91	+64 09.4	0.039	1.018	15.07	47.5
11/07	1 11.95	+47 39.0	0.035	1.020	14.55	35.9
11/10	0 18.15	+27 17.9	0.038	1.021	14.75	37.2
11/13	23 50.64	+11 08.2	0.046	1.020	15.43	47.0
11/16	23 34.91	+00 17.0	0.056	1.019	16.14	56.3
11/19	23 25.17	-06 52.9	0.069	1.017	16.77	63.6

3282 Epona (2010 November, H = 15.5)

A period of 2.381 h has been determined by Pravec et al. with an amplitude ranging from 0.05-0.38 during the 1999 apparition. Be prepared for anything in-between. The estimated size is 2.6 km.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/05	19 10.83	+39 31.4	0.201	0.990	14.96	84.7
11/10	21 14.65	+36 12.9	0.202	1.054	14.49	66.3
11/15	22 45.86	+27 56.9	0.237	1.117	14.53	52.1
11/20	23 40.84	+20 24.6	0.293	1.178	14.89	44.1
11/25	0 15.03	+15 02.3	0.363	1.237	15.35	40.2
11/30	0 38.23	+11 23.5	0.442	1.294	15.82	38.4
12/05	0 55.35	+08 55.0	0.525	1.349	16.26	37.5
12/10	1 08.92	+07 13.8	0.612	1.402	16.67	37.0

2005 GC120 (2010 December, H = 19.6)

There are no known lightcurve parameters for this 0.34 km asteroid. Somewhat larger telescopes will be needed given the faintness and sky motion of this NEA.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
12/01	22 28.88	-23 43.2	0.044	0.981	16.27	95.7
12/03	23 42.22	-02 45.9	0.048	0.999	15.64	73.1
12/05	0 31.76	+12 26.0	0.060	1.016	15.71	57.7
12/07	1 04.84	+21 29.9	0.077	1.034	16.04	49.2
12/09	1 27.85	+26 56.9	0.096	1.051	16.42	44.5
12/11	1 44.65	+30 25.5	0.116	1.068	16.80	41.7
12/13	1 57.51	+32 46.7	0.137	1.085	17.15	40.1
12/15	2 07.76	+34 26.9	0.158	1.102	17.47	39.1

2010 JL33 (2010 December, H = 17.7)

This 900-meter NEA will put on a nice visual show for modest backyard telescopes around the December 10th. It should be a relatively easy photometry target as well. There are no lightcurve parameters.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
12/06	19 21.52	+07 01.5	0.057	0.948	17.06	129.9
12/10	22 10.83	+49 07.8	0.044	0.992	13.65	78.9
12/14	2 42.86	+55 12.8	0.072	1.038	13.68	40.9
12/18	4 05.38	+48 01.3	0.115	1.084	14.42	28.0
12/22	4 34.85	+43 42.8	0.162	1.130	15.10	23.0
12/26	4 49.86	+41 02.7	0.211	1.177	15.70	21.0
12/30	4 59.28	+39 13.1	0.261	1.224	16.24	20.5
01/03	5 06.11	+37 52.1	0.314	1.271	16.73	20.8

2006 VB14 (2010 December, H = 18.6)

There are no lightcurve parameters for this asteroid with an estimated size of 0.6 km. Those with larger scopes can take on the added project of determining the H and G parameters while those with modest scopes have the best chance for lightcurve work the middle part of the month.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
11/25	8 51.64	+49 51.7	0.194	1.089	17.10	54.1
11/30	8 15.24	+46 56.8	0.152	1.085	16.34	46.4
12/05	7 18.05	+40 15.8	0.113	1.078	15.33	33.4
12/10	5 58.08	+24 38.2	0.086	1.069	13.99	11.0
12/15	4 31.97	-00 53.5	0.081	1.057	14.34	25.7
12/20	3 23.02	-21 34.6	0.102	1.042	15.58	52.8
12/25	2 36.16	-32 25.7	0.137	1.025	16.65	68.6
12/30	2 05.12	-37 58.2	0.176	1.005	17.46	77.9

INSTRUCTIONS FOR AUTHORS

The *Minor Planet Bulletin* is open to papers on all aspects of minor planet study. Theoretical, observational, historical, review, and other topics from amateur and professional astronomers are welcome. The level of presentation should be such as to be readily understood by most amateur astronomers. The preferred language is English. All observational and theoretical papers will be reviewed by another researcher prior to publication to insure that results are presented clearly and concisely. Typically, papers will be published within three months of receipt. However, material submitted by the posted deadline may or may not appear in that issue, depending on available space and editorial processing.

The *MPB* will not generally publish articles on instrumentation. Persons interested in details of CCD instrumentation should consult web sites that provide both general information and specifics for given programs, such as:

> American Association of Variable Star Observers (AAVSO). An excellent CCD photometry handbook can be found on this site. http://www.aavso.org
>
> International Occultation Timing Association (IOTA). http://www.lunar-occultations.com/iota/iotandx.htm

Astrometry measurements should be submitted to the IAU Minor Planet Center http://minorplanetcenter.org/iau/mpc.html and are no longer being published or reproduced in the *MPB*.

Checking Previous Research

When reporting lightcurve results, all authors should consult the Astrophysics Data System (ADS, http://adsabs.harvard.edu/abstract_service.html) and the Asteroid Lightcurve Database (http://www.minorplanetobserver.com/astlc/LightcurveParameters.htm) to look for previous results on each object on which you are publishing. If using the LCDB, your reference to previous results should not be to the LCDB. Instead, your reference should be to the original author and publication where the currently accepted "best result" is reported, e.g. Lagerkvist (1978). Claims of priority: "These are the first lightcurves reported for asteroid x." are not appropriate style for the *Minor Planet Bulletin*. Instead: "A search of the Asteroid Lightcurve Database does not reveal any previously reported results for asteroid x."

If previous results have been reported and they are different from yours (beyond the error margins), try fitting your data to those other periods and report the results of these alternative fits as part of the paper. This can be a brief statement, e.g., "The data were checked against the period of 10.45 h found by Smith (2010) but this produced a very unconvincing fit."

Manuscript Preparation

Authors are asked to carefully comply with the guidelines below in order to minimize the time required for editorial tasks.

We strongly encourage that all submissions be made electronically using MS Word or OpenOffice files (saved in MS Word format). If using Word 2007 or 2010, please save in DOC instead of DOCX format.

It is strongly requested that all manuscripts be prepared using the MS Word template found at:

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

Manuscripts should be less than 1000 words. Longer manuscripts may be returned for revision or delayed pending available space. For general articles, the number of tables plus figures should not exceed two.

For lightcurve articles, authors are encouraged to combine as many objects together in a single article as possible. When presenting data on more than one asteroid, the asteroids should be listed in numerical order throughout – in the abstract, text body, and in any tables. Unnumbered asteroids should be listed after any numbered asteroids and by designation, which is – generally – the order of discovery. See recent *MPB* issues for examples.

Note that your article may not start at the upper left of a page. Therefore, do not worry too much to prepare a "perfect" layout.

Tables

Tables should be numbered consecutively in Roman numerals. The font size should be large enough to allow for clear reproduction, usually no less than 7 point, preferably 8 point. Keep the number of columns to a minimum and try to avoid multi-line cells, except for headers. Place tables at the end of the text, after any figures. The layout editor will place them how and where appropriate. Generally, use only white backgrounds for tables.

Please do not embed tables as objects, e.g., as an Excel spreadsheet table. Instead, create a text box and insert a Word table within the text box. Turn off the "Anchor to Text" property in order to make it easier to change the layout of the paper as needed. Using a text box is particularly important if the table will span more than one column. *Do not* use section breaks in order to span a table across the page.

Figures

Figures should be numbered consecutively in Arabic numerals. When only one or two figures are involved, you can insert them within the body of the text. If there are several figures, they should be placed after the text (usually after the References section). It is preferred that you insert the graphics yourself, even if only at the end of the article, instead of supplying them as a set of files that must be inserted by the editors.

Use 300 dpi or higher resolution. Generally, use only white backgrounds for figures and solid colors for symbols. If the figure is in color, make it such that the grayscale rendering of the figure is *easily* legible. For example, yellow symbols on a white background are *not* suitable. Labeling should be large enough to be easily readable when reproduced.

Do not use color as the sole feature distinguishing data series in a figure. The black-and-white rendering of the archival printed copy of *MPB* might not show any differences.

If at all possible, use GIF or PNG format for all figures since these are mostly lossless but highly compressed. Plots in JPG format can degrade, making symbols hard to read. BMP format files are much larger and can cause problems when several megabytes in size.

Lightcurve plot symbols should be easily differentiated from one another. Each lightcurve should contain a legend that identifies each symbol with a date or other reference, the name of the object, the period (and error). If there is room, also include the JD for zero phase or the first data point of a raw data plot. See recent sample issues for examples.

Please do not embed figures as objects, e.g., Excel charts. If necessary, make a screen shot of the chart and edit it in a graphics editor, saving it as a GIF or PNG file. Use Insert | Picture | File on the Word main menu to insert graphics.

If inserting a figure that will span more than one column, use a text box with appropriate wrapping to hold the figure. Do not use section breaks to change to a single column. *It is very rare that a figure needs to be more than one column wide.*

Equations and Special Symbols

If including equations with Greek characters or special symbols for any reason, please use only Times New Roman, Arial, or Symbol (Windows TrueType) fonts. Use the extended characters of these fonts to insert special characters such as eastern European diacritical characters. This is done on a Windows machine by ALT+XXXX, where XXXX is a four-digit code *entered on the numeric keypad*. The Character Map system utility can also be used to locate and copy the necessary character.

When special characters are used, please include a PDF that *clearly* shows how those characters should appear.

Accepted Abbreviations and Other Conventions

The following abbreviations for units are preferred in the *MPB*:

days	d
degrees	° (Alt+0176, see notes under "Equations and Special Symbols"), or deg
hours	h
magnitudes	mag
meters	m
minutes	min
plus/minus	± (Alt+0177, see notes under "Equations and Special Symbols")
seconds	s

A space should separate a value and unit, e.g,. 7.1334 h. An exception to this is when the unit is used as part of a description, e.g., 0.4-m telescope, 14-inch SCT, or 30-s exposures.

If including a value and error, include the units only once, after the error, e.g., 7.144 ± 0.005 h.

"lightcurve" is a single word.

Use a leading zero for a number whose magnitude is less than 1, e.g. 0.35.

When referring to a numbered asteroid that is named, do not put the number in parentheses, e.g., 1 Ceres instead of (1) Ceres.

When the asteroid is numbered but has only its MPC designation, put the number in parentheses, e.g., (178956) 2001 QN185. Note that the number in the designation is not subscripted.

Dates

In order to standardize dates and avoid confusion due to different formats, we prefer that ANSI date format be used, i.e., year-month-day. For example, 2010 Nov 12 or 2010 November 12 when written in full text. If using only the month and year, put the year before the month, i.e., 2008 November.

If using only month and day and writing out the month name, put the month first, e.g., November 12 or Nov. 12. Month names (full or three-letter abbreviation) are preferred in text body instead of numbers, i.e., Aug 4 instead of 08/04, to avoid any confusion (is 08/04 August 4 or April 8?)

In a table, such as giving a range of dates for observations, numbers can be used to save space. The column head (or table caption) should clearly indicate the format, e.g., "mm/dd". Unless the year changes, include only the month and day in the table entries but indicate the year in the column header (or table caption).

References

Authors must closely follow the standard reference style for the *Minor Planet Bulletin*, or their manuscript may be rejected or delayed until a subsequent issue. References should be cited in the text such as Harris and Young (1980) for one or two authors or Bowell et al. (1979) for more than two authors. If the author and year are within the parentheses, separate the author and year with a comma. If multiple references are given within parentheses, separate the references with a semicolon. For example: "The results are in good agreement with earlier works (Smith, 1999; Jones, 2010)."

The reference section should list papers in alphabetical order of the first author's last name. Include the full list of authors in the citation in the References section, unless it exceeds 15. In that case, use "and xxx colleagues" (without the quotes) as the "last author" where xxx is the number of unlisted authors. Use surname, initials for each author, separating author names with commas (e.g., Astronomer, J.Q., Assistant, H.I.S.)

Include the full title of the work in addition to the publication, volume, and page numbers. Include *both* beginning page number and ending page number for articles spanning more than one page. The reference format for a journal article, book chapter, and book are as follows:

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.

Pravec, P., Harris, A.W., and Michalowski, T. (2002). “Asteroid Rotations.” In *Asteroids III* (W.F. Bottke, A. Cellino, P. Paolicchi, R.P. Binzel, eds.) pp 113-122. Univ. Arizona Press, Tucson.

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

Manuscript Submission

All material should be submitted electronically to the *Minor Planet Bulletin* editor, Professor Richard Binzel:

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14741	2000 EQ49	152	18
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17633	1996 JU	152	18
19483	1998 HA116	135	1
21023	1989 DK	152	18
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The deadline for the next issue (38-1) is October 15, 2010. The deadline for issue 38-2 is January 15, 2011.