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ROTATION PERIOD DETERMINATION FOR 280 PHILIA – A TRIUMPH OF GLOBAL COLLABORATION

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To determine the rotation period of the slowly rotating asteroid 280 Philia, five observers from three continents, East Asia, Europe, and North America, collaborated for full global phase coverage. A unique solution was found: $P=70.26 \pm 0.03$ hr; $A=0.15 \pm 0.02$ mag.

The only previous observations of 280 Philia are by Binzel (1987) who suggested a 64 hour period based on a very sparse and irregular lightcurve containing 26 points on 6 consecutive nights in 1984. With a suspected long period and possible commensurability with Earth's rotation period, first author Pilcher organized a campaign in which 5 observers with wide global distribution of longitudes participated. The first two sessions 2010 Dec. 26 and 29 showed slightly displaced maxima which suggested a period near 23 hours or multiple thereof. Lightcurves separated by 8 days (192 hours, or 3 cycles of 64 hours each) 2010 Dec. 26 and 2011 Jan. 3 should be identical if the period is 64 hours, but looked completely different and ruled out a period near 64 hours. During the interval 2010 Dec. 26 – 2011 Mar. 10 observations a total of 9037 data points on 38 sessions were obtained. To make

the lightcurve more readable these have been reduced to 1828 points with binning in sets of 5 with time interval no greater than 10 minutes.

MPO Canopus software was used for lightcurve analysis and expedited the sharing of data among the collaborators, who independently obtained several slightly different rotation periods. A synodic period of 70.26 hours, amplitude 0.15 ± 0.02 magnitudes, represents all of these fairly well, but we suggest a realistic error is ± 0.03 hours rather than the formal error of ± 0.01 hours.

The double period 140.55 hours was also examined. With about 95% phase coverage the two halves of the lightcurve looked the same as each other and as in the 70.26 hour lightcurve. Furthermore for order through 14 the coefficients of the odd harmonics were systematically much smaller than for the even harmonics. A 140.55 hour period can be safely rejected.

Observers and equipment: Observer code: VB = Vladimir Benishek; AF = Andrea Ferrero; HH = Hiromi and Hiroko Hamanowa; FP = Frederick Pilcher; RS = Robert Stephens. Telescope type: Newt = Newtonian; R-C = Ritchey-Chretien; S-C = Schmidt-Cassegrain.

Obs	Telescope	CCD	No. of sessions
VB	40 cm S-C	SBIG ST-10 XME	7
AF	30 cm R-C	FLI cm9	3
HH	40 cm Newt	SBIG ST-8	5
FP	35 cm S-C	SBIG STL-1001E	17
RS	35 cm S-C	SBIG STL-1001E	2
RS	30 cm S-C	SBIG STL-1001E	4

The phase angle (PA), longitude (LPAB) and latitude (BPAB) of phase angle bisector, all in degrees, for first date, date of minimum phase angle, and last date of observation:

Date	PA	LPAB	BPAB
2010/12/26	13.1	124.0	+8.8
2011/01/26	4.0	124.9	+8.7
2011/03/10	16.7	126.9	+7.3

The dates of the sessions by the several observers are listed here. For European observers the session ends on the date following that on which it began; the starting date is provided here. Vladimir Benishek 01/09, 01/16, 01/29, 02/06, 02/08, 02/09, 03/09; Andrea Ferrero 01/13, 01/23, 01/24; Hiromi and Hiroko Hamanowa 01/12, 01/14, 01/17, 02/01, 02/05; Frederick Pilcher 12/26, 12/29, 01/02, 01/03, 01/05, 01/10, 01/12, 01/15, 01/17, 01/25, 01/29, 02/05,

02/06, 02/07, 02/24, 03/01, 03/10; Robert Stephens 01/16, 01/18, 01/24, 01/25, 01/26.

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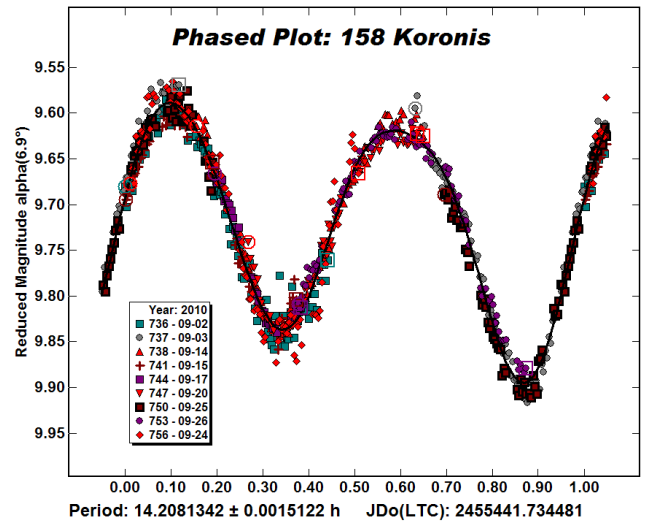
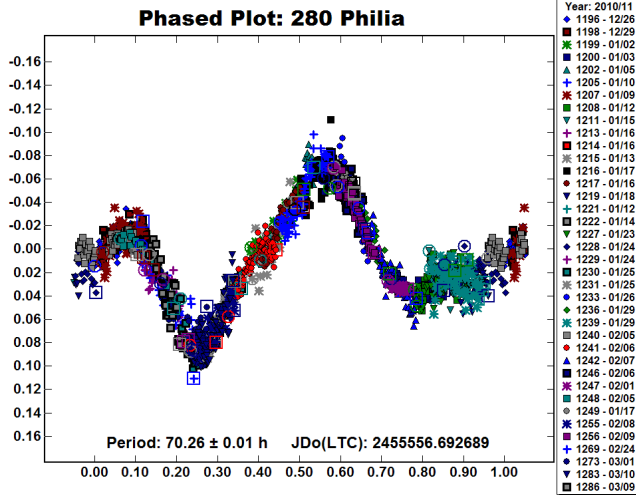


Figure 1: Rotational lightcurve of 158 Koronis near 2010 opposition.

PHASE CURVES OF 158 KORONIS AND 535 MONTAGUE

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Analysis of CCD photometry observations found that the H-G parameters of the phase curve of asteroid 158 Koronis are $H = 9.21 \pm 0.03$, $G = 0.33 \pm 0.03$. The synodic lightcurve period is confirmed to be $P = 14.208 \pm 0.040$ h. The phase curve of asteroid 535 Montague has parameters $H = 9.22 \pm 0.03$, $G = 0.12 \pm 0.03$.

Observational data of the way that asteroid brightness responds to changing solar phase angle is described by the "phase curve". Recent apparitions of 158 Koronis and 535 Montague presented them at near-zero solar phase angle and so provided a relatively rare opportunity to determine their phase curves.

158 Koronis. This asteroid has been previously reported to have lightcurve period of $P \approx 14.18 \pm 0.05$ h (Binzel, 1987) based on three night's observation. Subsequently, Slivan *et al.* (2003) refined this synodic period determination to $P = 14.206 \pm 0.002$ h based on an extensive campaign of observations during the 1998 apparition. They also determined phase curve parameters of $H \approx 9.34$, $G \approx 0.30$, based on observations spanning solar phase angles of $\alpha \approx 2-20$ deg. This asteroid and its associated family have been the subject of spin-pole modeling based on lightcurve analysis (Slivan, 2002). The 2010 apparition of Koronis presented the possibility of observing the asteroid at very low phase angle, $\alpha < 1$

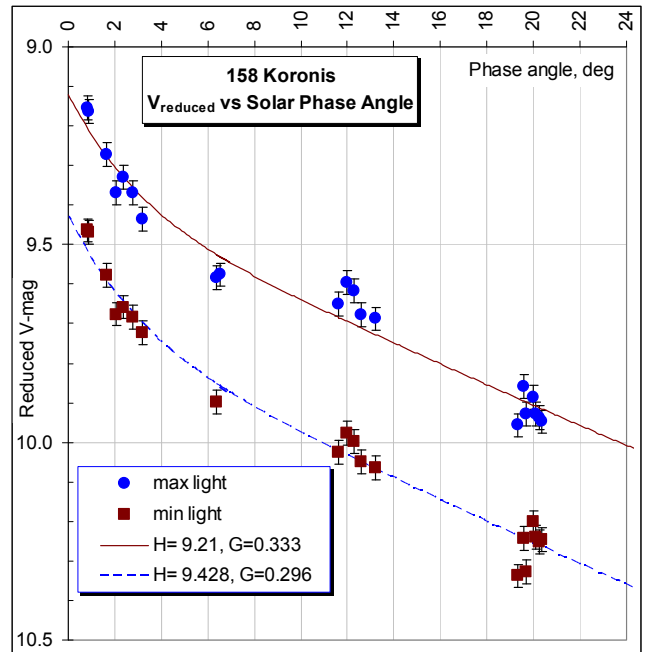


Figure 2: Phase curve of 158 Koronis, showing that the slope parameters based on the rotational lightcurve "max light" (circles) and "min light" (squares) are essentially equal.

degree. This prompted a project at Altimira Observatory to observe the asteroid regularly from pre-opposition, $\alpha \approx -20$ deg, through minimum solar phase ($\alpha = 0.8$ deg), and on to post-opposition, $\alpha \approx 20$ deg, to confirm the phase curve parameters.

All observations were made with a 28-cm (11-in) aperture, f/6.3 Schmidt-Cassegrain telescope, ST-8XE (non-anti-blooming) CCD, unfiltered at Altimira Observatory (G76) in southern California. On most nights, exposure duration was 3 min, yielding SNR > 100 on the target and somewhat higher SNR on the comparison stars. Differential photometry was done with *MPO Canopus*. All comparison stars were selected to have approximately-solar color by using the "comp star selector" tool of *MPO Canopus*.

Landolt standard stars and many of the “lightcurve fields” were observed on two clear and stable nights in C, R, and V bands. Using these data, comp star magnitudes for all “lightcurve fields” were linked and unfiltered (“C-band”) magnitudes were transformed to V band using a transformation determined with *MPO PhotoRed*. The internal consistency of the transformed V_C magnitudes was ± 0.03 mag.

Observed V_C magnitudes were converted to “reduced magnitudes” using

$$V_R = V_C - 5 \log(RE)$$

to remove the “ $1/D^2$ ” effect of changing Earth and Sun distances. In this equation R = Sun distance and E = Earth distance (both measured in AU).

It has become standard to plot the solar phase curve based on the maximum brightness of the rotational lightcurve. Because of the relatively long lightcurve period and unequal primary and secondary maxima of this asteroid, most nights do not permit observation of a brightness maximum. Therefore, points for the phase curve were determined using the procedure defined by Harris and Young (1989) and also described in Buchheim (2010). The essence of this procedure is to collect at least several hours of data on a given night, match the data to a Fourier fit of the entire rotational lightcurve, and then extrapolate the observed V_C data to the nearest brightness maximum. The few nights that offered direct observation of a lightcurve maximum or minimum brightness gave good confidence in the internal consistency of this procedure. For completeness, the same procedure was also used to determine a phase curve based on the lightcurve minima.

The rotational lightcurve, phased on $P = 14.209$ h, is shown in Figure 1, which shows nights that are at relatively low solar phase angle ($\alpha < 7$ deg) and presents a typical “double-peaked” curve that is well-fit by a 4-order Fourier model (used in the phase curve determination).

The resulting plot of asteroid reduced magnitude versus solar phase angle is shown in Figure 2. The best-fit parameters for the brightness at maxima of the rotational lightcurve are:

$$\begin{aligned} H_{max} &= 9.120 \pm 0.03 \\ G_{max} &= 0.333 \pm 0.03 \end{aligned}$$

The phase curve parameters based on the minima of the rotational lightcurve are:

$$\begin{aligned} H_{min} &= 9.428 \pm 0.02 \\ G_{min} &= 0.296 \pm 0.03 \end{aligned}$$

These are consistent with the phase curve for average brightness shown by Slivan (2003).

535 Montague. The period of this asteroid is well-established as $P = 10.248$ h (Koff and Brincat, 2001; Warner, 2006). Both of their lightcurves showed complex structure with primary and secondary peaks having very different magnitudes. The rotational lightcurve near opposition during the 2010 apparition is shown in Figure 3. Although it isn’t shown in the Figure, I note that the shape of the lightcurve changed noticeably as the apparition progressed to larger solar phase angles, with the primary minimum becoming deeper and the secondary maximum becoming weaker. This was accounted for during the phase curve analysis by using two different Fourier fits to the rotational lightcurve – one for low solar phase angles and a different one for large solar phase angles.

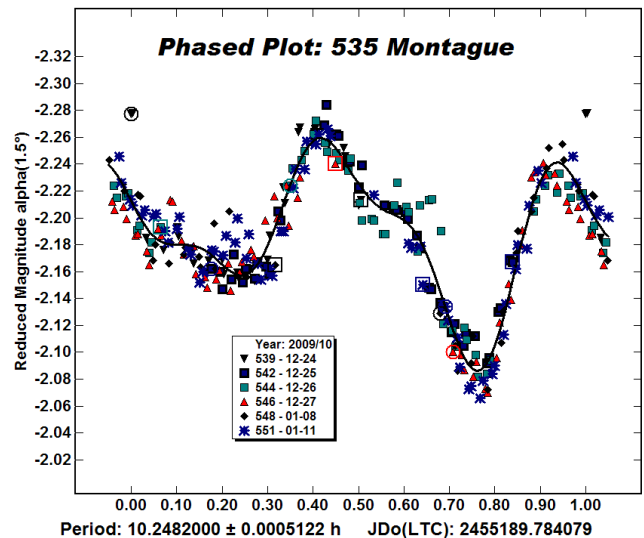


Figure 3: Rotational lightcurve of 535 Montague, near 2009/10 opposition.

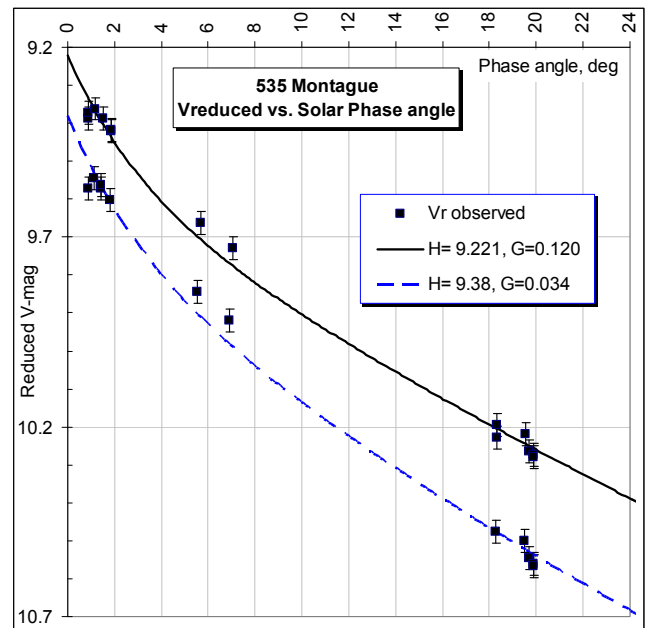


Figure 4. Solar phase curve of 535 Montague. For this asteroid, the slope parameter (G) is significantly different when determined based on the maxima ($G = 0.12$) or minima ($G = 0.03$) of the rotational lightcurve.

The phase curve for 535 Montague was determined using the same procedure as described above, except that (a) CCD photometry was done in C, R, and V band filters and (b) the calibration of compstar magnitudes was done by imaging the lightcurve fields with the remotely-operated “Big Mak” telescope of the Tzec Maun Foundation. The resulting phase curves for both maximum light and minimum light extrema of the lightcurve are shown in Figure 4. The parameters for the maximum light phase curve are:

$$\begin{aligned} H_{max} &= 9.22 \pm 0.03 \\ G_{max} &= 0.12 \pm 0.03 \end{aligned}$$

The parameters for the minimum light phase curve are:

$$H_{\min} = 9.38 \pm 0.03$$

$$G_{\min} = 0.03 \pm 0.03$$

Note that the slope parameter (G) is noticeably different for the phase curves based on maximum and minimum brightness. This is a manifestation of the change in shape of the rotational lightcurve as solar phase angle increases – the gradually deepening primary minimum affects the phase curve points at high solar phase angle.

Acknowledgements

I am pleased to acknowledge the Tzec Maun Foundation for their generous access to remotely-operated telescopes. I am grateful to Dr. Alan Harris for his encouragement and advice related to the construction and interpretation of phase curves.

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A CRITICAL RE-EXAMINATION OF THE ROTATION PERIOD OF 33 POLYHYMNIA

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While an 18.609 hour rotation period of 33 Polyhymnia had been previously well established, new observations made near opposition suggested a 9.306 hour period should be more fully considered. Additional observations made at large phase angle a month later confirm the longer period of 18.608 ± 0.001 hours, amplitude 0.18 ± 0.02 mag as the most secure result.

New observations of 33 Polyhymnia were made at the Organ Mesa Observatory with a Meade 35 cm LX200 GPS S-C, SBIG STL-1001E CCD, differential photometry only, 60 second unguided exposures, clear filter. *MPO Canopus* software was used to measure the images photometrically and prepare the lightcurves. Due to the large number of data points acquired, the lightcurves have been binned in sets of three data points with a maximum of five minutes between points.

Previous rotation period determinations of 33 Polyhymnia are by Zappala et al. (1982), 18.601 hours; and Pilcher (2009), 18.609 hours, both rated secure ($U=3$) by Harris et al. (2010). Both of these periods were obtained with fits to bimodal lightcurves showing small but likely significant asymmetries. A new set of lightcurves was obtained to contribute to a spin/shape model. Observations on 5 nights 2011 Jan. 9 – 24 at phase angles 1.6 to 4.4 degrees showed that the lightcurve phased to near 18.6 hours featured four maxima per cycle, alternately higher and lower, and nearly symmetric. The fit to a 9.306 hour period with two very unequal maxima per cycle was almost equally good. At this stage

of the investigation the period seemed ambiguous. In an attempt to resolve the period ambiguity six additional sessions were obtained 2001 Feb. 11 – 23 at phase angles 10.2 – 13.2 degrees. A search was made for asymmetries between the two halves of the 18.6 hour lightcurve. As is usually the case, the shape of the lightcurve changed appreciably with phase angle due to changes in the aspect angle and shadowing by shape irregularities. To prevent these secular changes from obscuring small differences between the two halves of the lightcurve phased to near 18.6 hours it is necessary to use a subset of observations spanning a short time interval. Two such subsets are available, those from 2011 Jan. 9 – 24 and Feb. 11 – 23, respectively, and lightcurves of both subsets are presented. In the Jan. 9 – 24 subset the only difference systematic over more than one night is that the minimum near phase 0.63 is about 0.02 magnitudes lower than that near phase 0.13. This weakly supports the longer period. But a small adjustment in the instrumental magnitude might remove this difference without significantly increasing the rms residual of the whole plot. In the Feb. 11 – 23 subset the two lower maxima show a great difference systematically over more than one night. This rules out the shorter period and affirms that the longer period is the correct one. The adopted period and amplitude based on all observations on 12 nights 2010 Dec. 7 – 2011 Feb. 23 are 18.608 ± 0.001 hours, 0.18 ± 0.02 magnitudes, respectively. The composite lightcurve including all 12 sessions is also presented in which the considerable changes in lightcurve shape throughout the apparition are clearly shown.

If 33 Polyhymnia had been observed for the first time, without “knowing” an established period near 18.6 hours, the observer might have overlooked the small asymmetry in successive minima and on the basis of the observations through January published a 9.306 hour period with an asymmetric bimodal lightcurve. Thus Polyhymnia serves as a reminder: whenever an amplitude less than about 0.3 magnitude is encountered, observers should use great care in examining half period and double period solutions and obtain additional observations over a wider range of phase angles to guard against possible ambiguity.

Acknowledgments

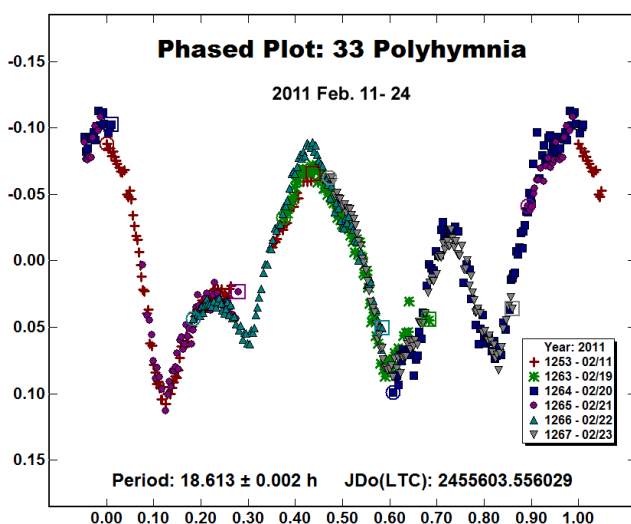
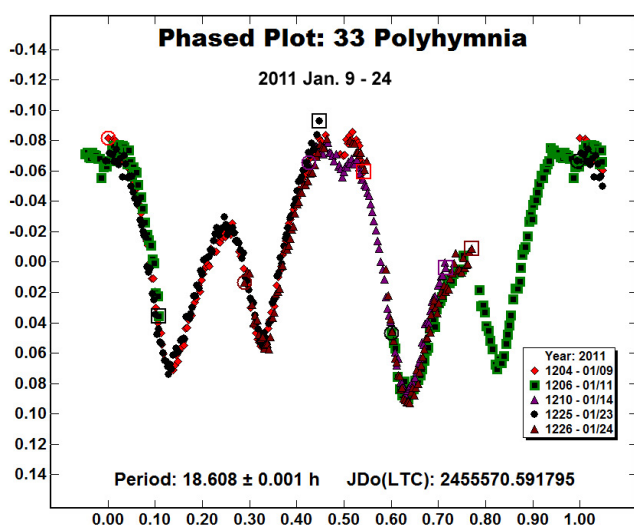
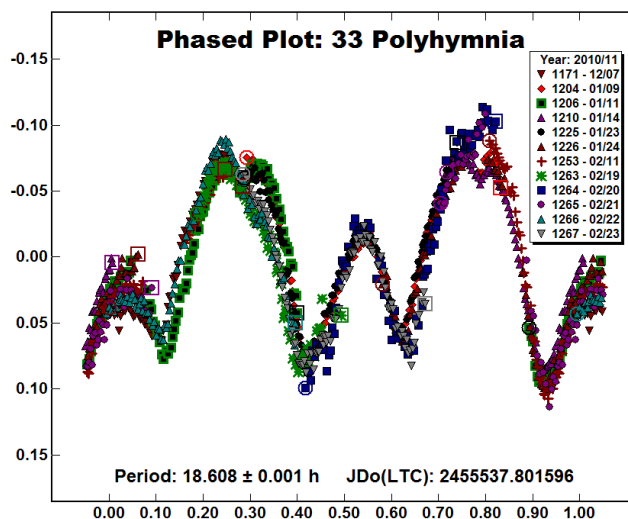
The author thanks Petr Pravec and Alan Harris for helpful suggestions in several stages of this difficult investigation.

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LIGHTCURVE ANALYSIS OF ASTEROIDS 890 WALTRAUT AND 2010 JL33

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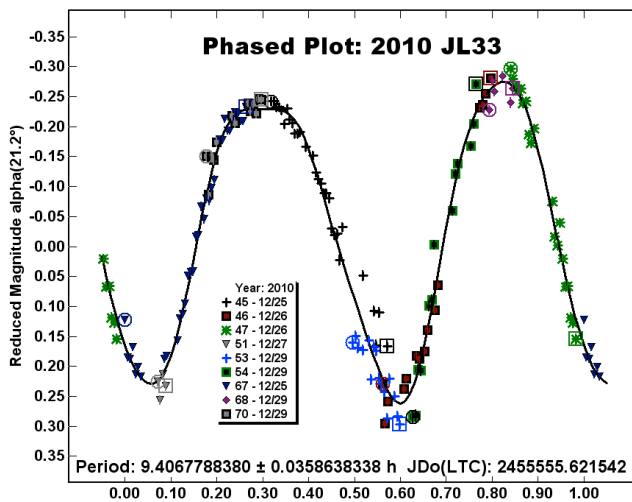
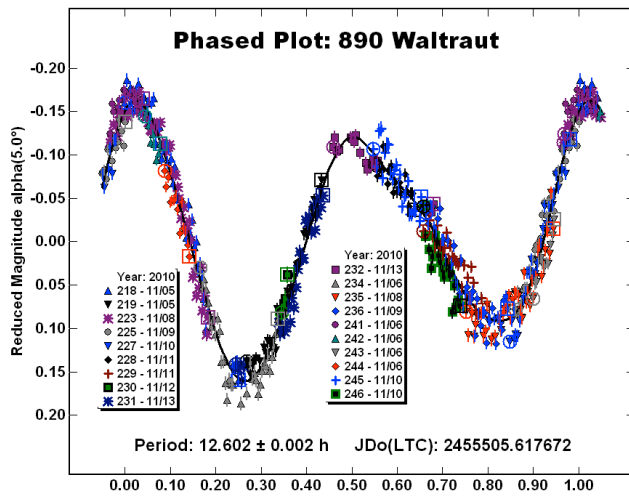
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Lightcurves of asteroids 890 Waltraut and 2010 JL33 were obtained by using observations made in 2010 November and December. We found the synodic rotation period for 890 Waltraut to be $P = 12.602 \pm 0.002$ h with amplitude $A = 0.32 \pm 0.02$ mag. For 2010 JL33 we found $P = 9.41 \pm 0.04$ h, $A = 0.53 \pm 0.03$ mag.

Lightcurves for asteroids 890 Waltraut and 2010 JL33 were derived with images taken with equipment located at New Mexico Skies, USA, and operated remotely from the Marshall Space Flight Center (MSFC). The telescope was an RCOS 0.5-meter f/8.1 Ritchey-Chretien telescope on a German Equatorial Mount. The CCD camera was an Apogee U9000 with a 3056x3056 array of 12-micron pixels. 2x2 binning was applied, creating a 1528x1528 array of 24-micron pixels and image scale of 1.22 arcsec/pixel. Both asteroids were imaged using a Johnson V filter. An infrared pre-flash of the CCD was applied prior to each image begin acquired, including bias, dark, and flat frames. This was done to mitigate the effects of residual bulk images (RBI), which is a serious issue, especially for the Kodak KAF-09000 CCD chips. This technique provides a uniform, repeatable background rather



than the ghost images of bright stars. Images of both asteroids were appropriately dark subtracted and flat fielded using *Maxim DL*.

The asteroids were chosen due to their position, magnitude, and elongation angle. Each frame was inspected; those with stellar apulsers were not considered in the analysis. This ensured accurate light measurement of the asteroid. The asteroid parameters were automatically determined using the Minor Planet Center asteroid database. *MPO Canopus* (Warner, 2010) was used to perform photometric and period analysis according to the FALC method developed by Harris (Harris *et al.* 1989).

890 Waltraut. This is a main belt asteroid 27.33 kilometers in diameter (JPL) that was favorably placed to be imaged in 2010 November. Its lightcurve parameters had been previously found (Brinsfield, 2010), therefore it was used to confirm our data processing procedure. 180-second exposures were taken for Waltraut, which exhibited no streaking due to asteroid motion and so circular target apertures were used.

2010 JL33. This is a near-Earth asteroid with an Apollo orbit. The asteroid was imaged after NASA published radar images of it from their Goldstone Solar System Radar on 2010 Dec 11 and 12 (Agle, 2011). The asteroid shape was clearly seen by Goldstone radar; its diameter was measured to be roughly 1.8 kilometers long and the rotation period was estimated to be 9 hours. The asteroid was small and fast-moving, so a 180-second exposure was needed to achieve

a high enough signal-to-noise ratio, which resulted in some streaking. Elliptical target apertures were used for all sessions due to the streaking. Data were taken in 2010 December and 2011 January, although by January the signal-to-noise ratio on the images was below an acceptable level for photometry. The usable data were taken 2010 December 25, 26, 27, and 29, out of which a lightcurve emerged with period 9.41 ± 0.04 h and amplitude of 0.53 ± 0.03 mag.

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LIGHTCURVE PHOTOMETRY AND H-G PARAMETERS FOR 1342 BRABANTIA

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The main-belt asteroid 1342 Brabantia was observed over seven nights in 2010 December and 2011 January-February with filtered and non-filtered systems. The resulting synodic period is $P = 4.1754 \pm 0.0001$ h with an amplitude $\Delta V = 0.19 \pm 0.01$ mag. The color index $V-R = 0.41 \pm 0.02$ mag. The measured absolute visual magnitude, $H_V = 11.30 \pm 0.05$ mag, and the slope parameter, $G = 0.23 \pm 0.06$, are consistent with a medium albedo object, e.g., type M or S. The diameter is estimated to be $D = 18 \pm 2$ km.

The main-belt asteroid 1342 Brabantia was reported as a lightcurve photometry opportunity in the *Minor Planet Bulletin* (Warner *et al.*, 2011). All the observations were carried out from Gothers Observatory (J03) in Cornwall (UK) and from A81 Balzaretto Observatory in Rome (IT) over the period spanning from 2010 December 18 to 2011 February 04, or a total of 48 days (Table I). The equipment used for observations is described in Table II.

#	Date 2010-2011	Observer	Phase Angle	Data points	Filter
1	Dec 18	D.Sergison	16.9°	23	C
2	Dec 25	D.Sergison	14.4°	75	C
3	Jan 03	D.Sergison	10.0°	73	V
4	Jan 08	D.Sergison	7.9°	48	C
5	Jan 24	L. Franco	7.8°	55	C
6	Feb 03	L. Franco	12.6°	80	C
7	Feb 04	L. Franco	13.1°	70	V, R

Table I. Observations list.

Observer	Country	Telescope	CCD	Filters
D.Sergison	United Kingdom	SCT 0.25-m f/5.5	QHY6 Pro	Astrodon Johnson V
L.Franco	Italy	SCT 0.20-m f/5.5	SBIG ST7-XME	Custom Scientific (Johnson V, Cousins R)

Table II. Observers and equipment list.

Year/Month/Day	UT	V mag	α °
2010 12 18	22:05	12.09	-16.92
2010 12 25	04:24	12.06	-14.37
2011 01 03	22:12	11.87	-10.04
2011 01 08	23:17	11.83	-7.92
2011 01 24	20:48	11.81	+7.77
2011 02 03	21:22	11.98	+12.60
2011 02 04	22:27	12.02	+13.15

Table III. The V magnitude at maximum values of lightcurve, used for compute HV and G.

Before each session, the observers synchronized the computer's clock with atomic clock time via Internet NTP servers, resulting in a timing accuracy of less than one second. All images were calibrated with dark and flat-field frames. Differential aperture photometry was done using *Astrometrica* (Raab, 2010) and *MPO Canopus* (Warner, 2010).

The V and R magnitudes were calibrated using the method described by Dymock and Miles (2009) and CMC-14 selected reference stars with color index near solar values using Vizier Service (VizieR, 2010). The same method was also applied to the Clear magnitude, after its conversion to V magnitude, using previously calculated transformation coefficients. The V and R band frames were acquired in sequence changing alternatively the filters (VRVR...).

Period analysis was done using *MPO Canopus*, which implements the FALC analysis algorithm developed by Harris (Harris *et al.*, 1989). Before starting analysis, the sessions were aligned by changing the DeltaComp value for each session in *MPO Canopus* to reach the zero-point value. The analysis shows a synodic period of $P = 4.1754 \pm 0.0001$ h (see Fig.1). This period is confirmed within error limits by *Peranso* (Vanmunster, 2007) using the ANOVA algorithm (Schwarzenberg-Czern, 1996). The period spectrum (Fig. 2) on a 1-16 h period range shows the principal period and its harmonics, F2, corresponding to period 2.0877 h.

Phased Plot: 1342 Brabantia

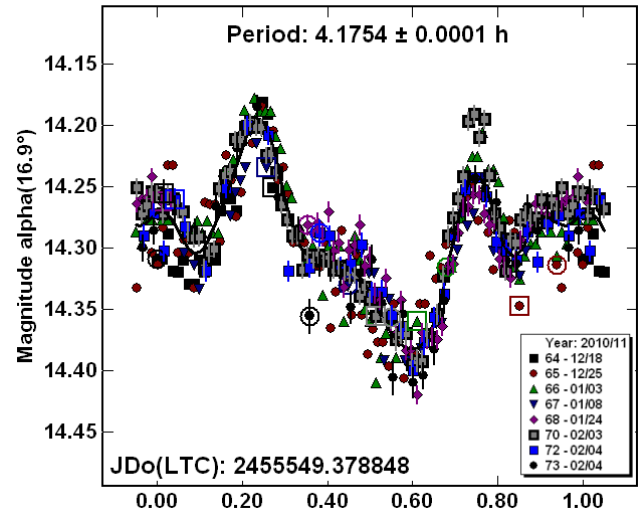
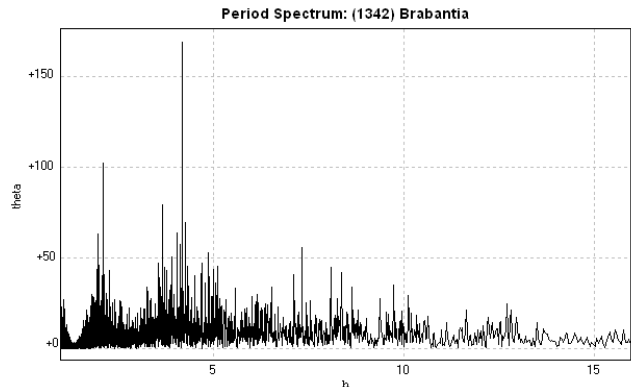
Figure 1. The lightcurve of 1342 Brabantia shows a period of 4.1754 ± 0.0001 h with an amplitude of 0.19 ± 0.01 mag.

Figure 2. The period spectrum shows the principal period and the harmonic, F2.

The amplitude of $A_V = 0.19 \pm 0.01$ mag was found by taking the mean values obtained from measuring the amplitude of the maximum and minimum individual sessions with *Peranso* (polynomial fit).

The asteroid was observed both in V and R band at Balzaretto Observatory on 2011 Feb 04. This allowed us to find the color index of $V-R = 0.41 \pm 0.02$ (mean of 35 values). This value is typical of an M-type asteroid (Shevchenko and Lupishko, 1998).

The absolute magnitude (H) and slope parameter (G) were found using the H-G Calculator function of *MPO Canopus*. Seven values obtained pre- and post-opposition of the asteroid, using the maximum values of the lightcurve, were measured with polynomial fit of *Peranso*. We obtained $H_V = 11.30 \pm 0.05$ mag and $G = 0.23 \pm 0.06$. This value is consistent with an M-type asteroid (Shevchenko and Lupishko, 1998) but it is also consistent with other moderate albedo classes such as S.

Assuming an M-type, the geometric albedo is $p_V = 0.17 \pm 0.04$ (Shevchenko and Lupishko, 1998). From this, we can estimate a diameter of $D = 18 \pm 2$ km using the expression (Pravec and Harris, 2007):

$$D_{(km)} = \frac{1329}{\sqrt{p_v}} 10^{-0.2H_v} \quad (1)$$

Unfortunately, there are no V values at small phase angles, near 0° , which are necessary for an optimal fit and so the uncertainty is still relatively high. However, our values agree well with those reported in the JPL Small-Body Database Browser (JPL, 2011): $H_V = 11.30$ and $D = 18$ km.

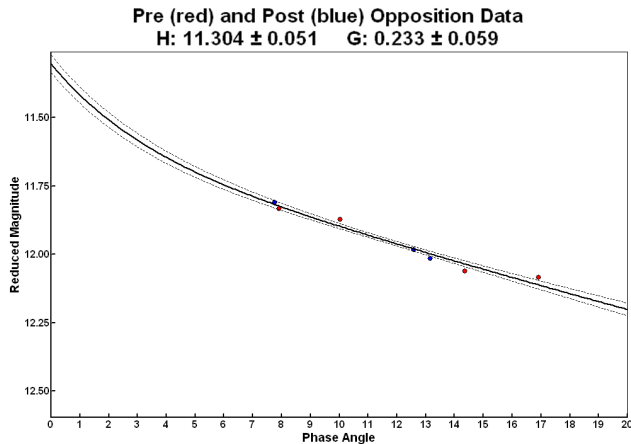


Figure 4. Visual reduced magnitude vs. phase angle for $H_V = 11.30 \pm 0.05$ and $G = 0.23 \pm 0.06$.

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PHOTOMETRIC OBSERVATIONS OF 321 FLORENTINA

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The minor planet 321 Florentina was observed during its oppositions of 2001 and 2011. The lightcurve of 2011 February displays a 0.52 ± 0.02 mag amplitude in R filter and a synodic rotation period consistent with the 2.870 ± 0.001 h value already known.

The Koronis dynamical family member 321 Florentina was discovered in 1891 by Johann Palisa. Since 1955, photometric investigations of this S-class, 28 km diameter asteroid include those by van Houten-Groeneveld and van Houten (1958), Pilcher (1983), Slivan and Binzel (1996), Thizy (1999, unpublished data; see Behrend, 2011), Frey (2000), Slivan *et al.* (2003), Tungalag *et al.* (2003), and Warner (2006). These authors reported lightcurve amplitudes ranging from 0.31 to 0.61 mag and a synodic rotation period of 2.870 ± 0.001 h. Slivan *et al.* (2003) used lightcurve inversion methods to derive a 3D morphological model and estimate the orientation of the rotation pole of the object. The data presented in this paper are the result of observations performed in 2001 and 2011.

Observations on 2001 March 20 and 21 were carried out from the astronomical station of Château-Renard (Saint-Véran, French Alps; longitude: $6^\circ 54' 24''$ E; latitude: $44^\circ 41' 52''$ N; altitude: 2930 m), a facility operated by Paris-Meudon Observatory and by AstroQueyras, an amateur association. At that time, Florentina was at solar phase angle $\alpha \sim 11.7^\circ$ and $V \sim 14.5$ mag. Images were taken at 2x2 binning with a 14-bit Hi-SIS 22 CCD camera attached to a 0.62-m Cassegrain telescope. A 0.33x Optec telecompressor was used to obtain a working focal ratio of $f/3$. The integration time of each image was 60 s. No filter was used and the effective wavelength of the observations approximately matched the V + R band.

On 2011 February 25 and 26, the 0.6-m $f/3.5$ Newtonian telescope of Pic du Midi Observatory (French Pyrénées; longitude: $0^\circ 08' 32''$ E; latitude: $42^\circ 56' 12''$ N; altitude: 2861 m) was used. Florentina was at phase angle $\alpha \sim 4.7^\circ$ $V \sim 14.1$ mag. Images were obtained at 3x3 binning with an SBIG STL-6303E CCD camera and R filter. The integration time of each image was 120 s.

All CCD images were reduced with *Iris* version 5.55 software developed by Buil (2011). Scientific frames were corrected for bias, dark and flat-field effects. Flux measurements were performed by synthetic aperture photometry, i.e., by integrating the counts in a circular diaphragm; a concentric annulus was used for computing and extracting the median value of the sky background.

Only differential magnitudes were computed. During the observational runs, some images were taken with a V filter. This permitted estimating the color indices of the field stars and so use only non-variable comparison stars that had a color similar to that of Florentina. We carefully checked that the extinction effects were negligible, thus the lightcurves were not affected – within a ± 0.01 mag range – by differential colors. In both runs, the typical one-sigma uncertainty of the differential magnitudes was estimated to be ± 0.01 mag, which was in agreement with the dispersion of the measurements of the local comparison stars.

The phased lightcurves of 321 Florentina obtained in 2001 March and 2011 February are presented in Figures 1 and 2, respectively. The composite lightcurves are based on and consistent with the previous rotation period of 2.870 ± 0.001 h. The 2001 March lightcurve includes only one-third of the rotation period and displays a 0.47 ± 0.02 mag unfiltered amplitude. In 2011 February, the R amplitude was 0.52 ± 0.02 mag. According to Josef Ďurech (private communication), these new lightcurves confirm the previous model established by Slivan *et al.* (2003). The updated model and our lightcurves are available in DAMIT (Ďurech, 2011).

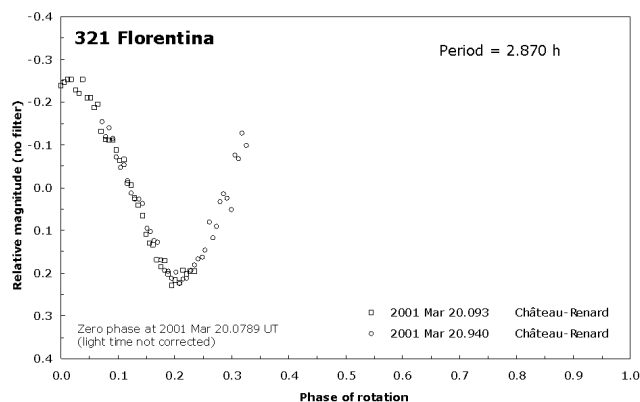


Figure 1. Composite lightcurve of 321 Florentina for March 2001.

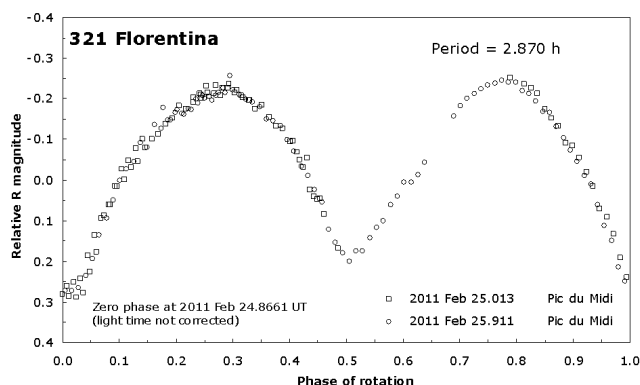


Figure 2. Composite lightcurve of 321 Florentina for February 2011.

Acknowledgments

We gratefully acknowledge Josef Ďurech for helping improve this manuscript and Jean-François Le Borgne (observatoire Midi-Pyrénées) for his assistance to find several referenced papers. We also thank Christophe Lehénaff for his assistance during our run at Château-Renard station. The 0.6-m telescope of Pic du Midi Observatory is operated by observatoire Midi-Pyrénées and Association T60, an amateur association.

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ASTEROID 9233 ITAGIJUN LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY

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(Received: 19 February)

9233 Itagijun was observed across opposition from 2010 May 20 to July 17. Although not at all secure, this campaign suggested that the asteroid is a long period rotator with an estimated period of 110.95 ± 0.30 h. Some techniques used for resolving the period estimate are discussed below.

Observations of 9233 Itagijun were made using a Meade LX200 0.35-m f/10 Schmidt-Cassegrain telescope (SCT) and Alta U6 CCD camera (1024x1024 array of 24-micron pixels). All observations were unfiltered at 1x binning, yielding an image scale of 1.44 arcsec/pixel, and were dark and flat field corrected. Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The data were light-time corrected. Period analysis was also done with *MPO Canopus* using an implementation of the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989).

9233 Itagijun was selected because there was no reported period analysis on the object and because it was nicely positioned to complement an early evening target that was setting at about the time 9233 Itagijun was crossing the meridian. This observing plan resulted in shorter observing sessions than if it had been the primary target of interest. Additionally, 9233 Itagijun was positioned in proximity to the Milky Way central core and, as such, there were numerous background stars to deal with throughout the campaign.

Using purely differential photometric techniques, the individual sessions were not well-linked from night-to-night. The long period nature of the lightcurve, coupled with the short sessions, made this lack of good linkage a serious challenge and resulted in a number of ambiguous periods in the initial analysis. In the 9 sessions on this target, there were no obvious inflection points in the data, just ascending, descending, or flat trending. To resolve some of the period ambiguities, sessions that had strongly ascending or descending data trending were used to constrain the period solution space on the assumption of a bimodal lightcurve. Additionally there was a concerted effort to image the target on three consecutive nights (sessions 5-7), which helped to eliminate a number of solutions.

Some of the data just did not seem to fit with $P \sim 111$ h, which stood out in analysis when those data were excluded. The author contacted Brian Warner to solicit his assistance in analyzing the data. He identified several sessions where he suspected that some of the comparison stars were unreliable and suggested that I exclude those stars from the analysis. He also suggested that I re-

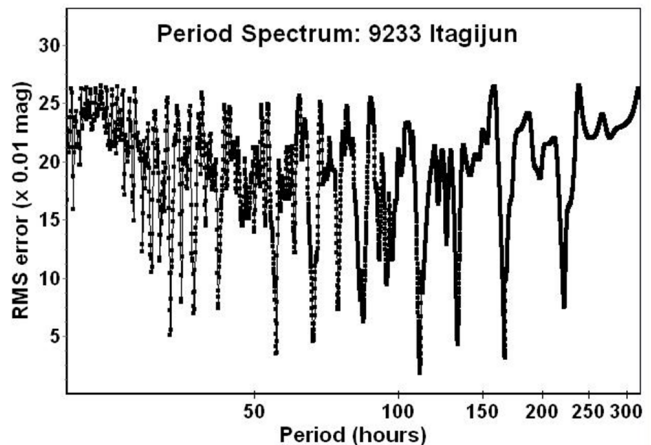
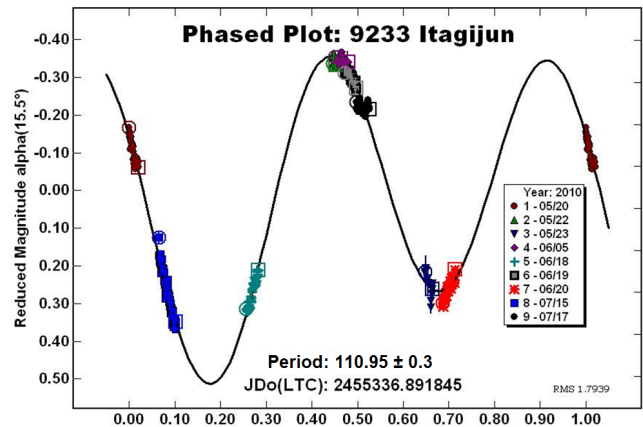
measure the final session of the campaign since its data trended in the “wrong direction” given the assumed period of 111 h. When re-measuring the images for the last session, extra care was taken with regards with the numerous background stars close to the asteroid’s path. With the changes in place, the complete data set seemed to settle into a period of just under 111h.

Acknowledgements

The author wishes to express his continued appreciation for the mentoring that Brian Warner has provided over the past few years. This project is one of many examples of his willingness and desire to help develop and foster the amateur astronomy community.

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#	Name	Date Range (mm/dd) 2010	Data Points	Phase	LPAB	BPAB	Per (h)	PE	Amp (m)	AE
9233	Itagijun	06/05 - 07/17	322	9, 7, 19	265	9	110.95	0.3	0.62	0.1

Table I. Observing circumstances. If multiple values for the phase angle are given, the object reached a minimum value during the span of observations. The middle value is the minimum phase angle. PAB is the Phase Angle Bisector.

ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY OBSERVATORY: 2010 SEPTEMBER THRU OCTOBER

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(Received: 9 March)

Photometric data for 14 asteroids were collected over 7 nights of observing during 2010 September thru October at the Oakley Observatory. The asteroids were: 919 Ilsebill, 2120 Tyumenia, 2650 Elinor, 2869 Nepryadva, 3152 Jones, 3237 Victorplatt, 4290 Heisei, 4970 Druyan, 9190 Masako, 14790 Beletskij, (16694) 1995 AJ, (17939) 1999 HH8, (23766) 1998 MZ23, and (31485) 1999 CM51.

Fourteen asteroids were observed from the Oakley Observatory in Terre Haute, Indiana, on the nights of 2010 September 30, October 1, and October 7-11. From the data, we were able to find lightcurves for 8 asteroids. Out of that group, 6 were previously unrecorded results. Of the 2 previously recorded results, neither was reasonably close to previously published periods. The 6 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 hope that we would be able to improve previous results. A new 0.5-m 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 arcsec/pixel. Exposure times varied between 45 and 180 seconds. This was the first use of this telescope for research. As a result, our estimated exposure times were too short, resulting in very noisy data. Calibration of the images was done using master twilight flats, darks, and bias frames. All calibration frames were created using *CCDSOFT*. *MPO Canopus* was used to measure the processed images.

As far as we are aware, these are the first reported period determinations for 919 Ilsebill, 4290 Heisei, 9190 Masako, 14790 Beletskij, (23766) 1998 MZ23, and (31485) 1999 CM51. No repeatable pattern was found for 2869 Nepryadva, 3152 Jones,

3237 Victorplatt, 4970 Druyan, (16694) 1995 AJ, or (17939) 1999 HH8. Our data for these asteroids were too noisy for us to determine periods or we didn't have enough data, so we are reporting the magnitude variations only. Results from all of the asteroids are listed in the table below.

2120 Tyumenia. Our data are inconsistent with the period of 2.7690 ± 0.0005 h found by Warner (2005) but consistent with the period of 17.47 ± 0.07 h found by Oliver *et al.* (2008).

2650 Elinor. Our data are inconsistent with the period of 9.087 ± 0.006 h found by Behrend (2010).

3152 Jones. We believe this asteroid has a period greater than 20 h and small amplitude, but we did not have enough data to determine the period.

3237 Victorplatt. Our data were too noisy to determine a period independently, but they were inconsistent with the period of 10.36 h found by Behrend (2010).

(17939) 1999 HH8. Our data were too noisy to determine a period independently, but they were inconsistent with the period of 5.10 ± 0.01 h found by Clark (2006).

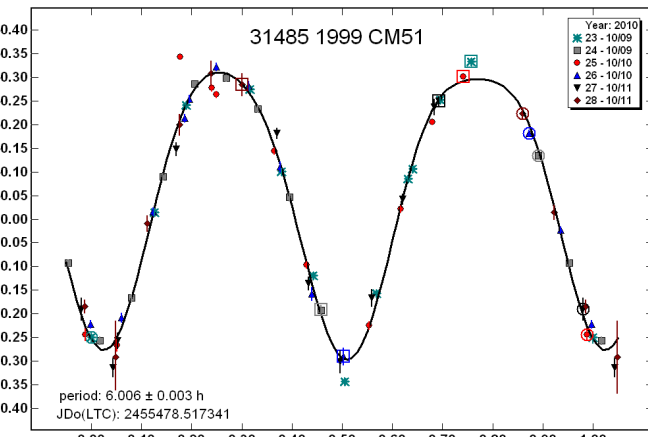
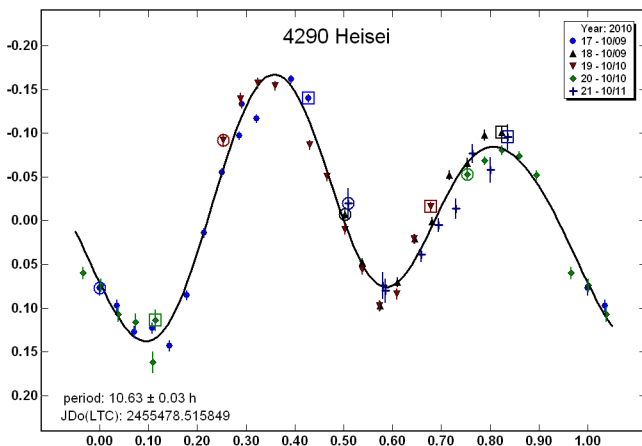
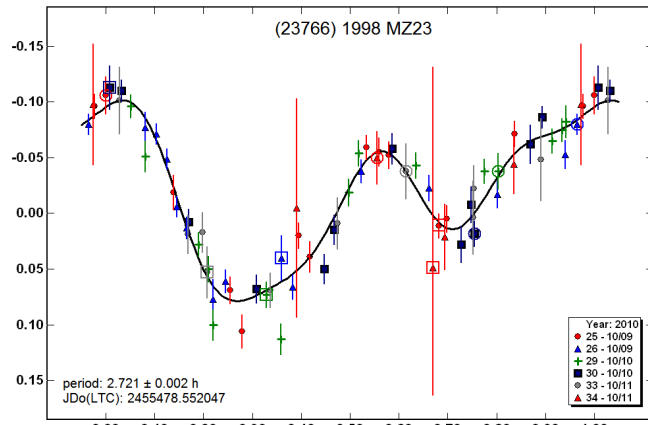
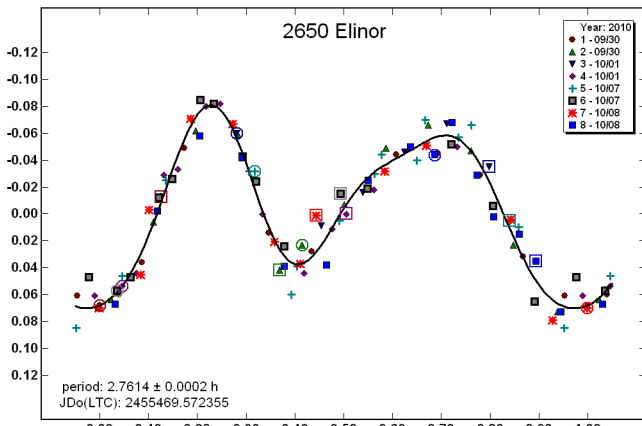
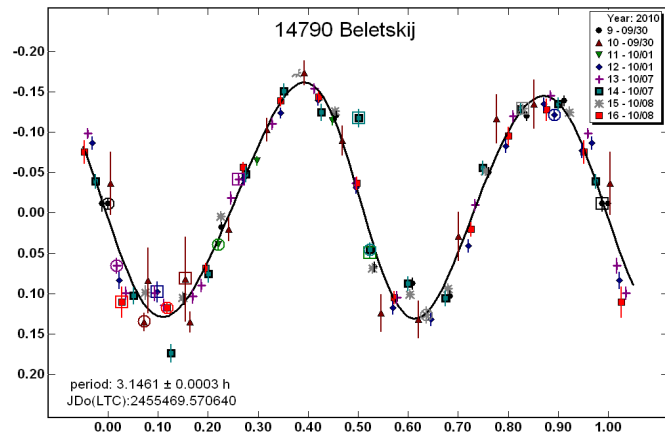
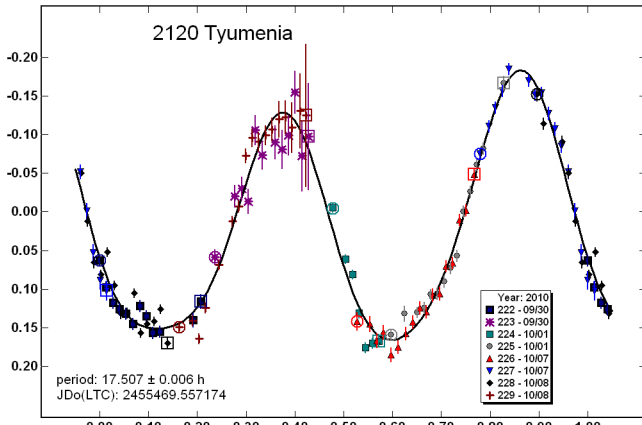
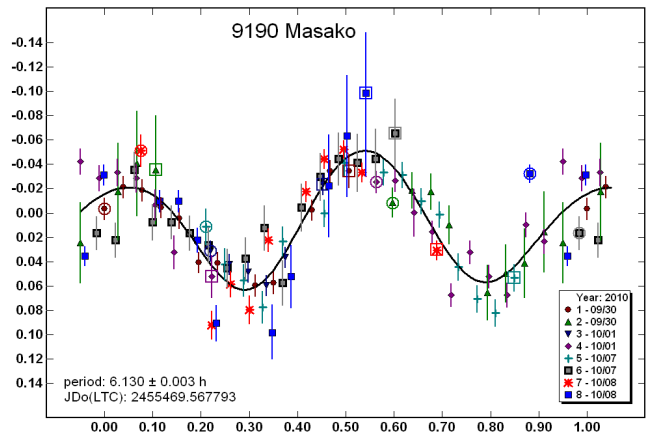
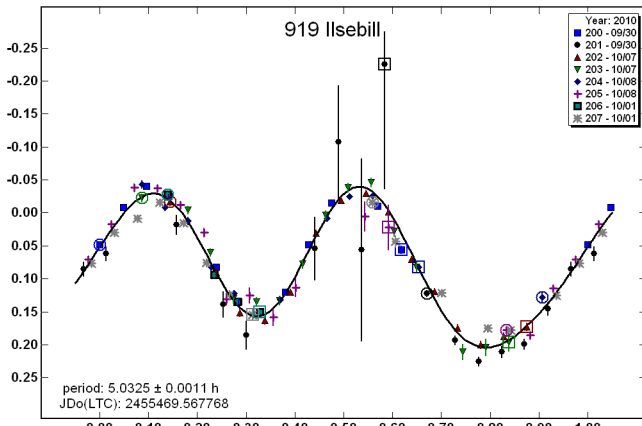
Acknowledgement

The Oakley Foundation provided funds for the 0.5-meter Ritchey-Chretien optical tube assembly used in this research.

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Number	Name	Dates 2010 mm/dd	Data Points	Period (h)	P.E. (h)	Amp (mag)	A.E. (mag)
919	Ilsebill	9/30-10/1, 10/7-10/8	97	5.0325	0.0011	0.25	0.02
2120	Tyumenia	9/30-10/1, 10/7-10/8	112	17.507	0.006	0.33	0.03
2650	Elinor	9/30-10/1, 10/7-10/8	101	2.7614	0.0002	1.40	0.10
2869	Nepryadva	10/9-10/11	57	-	-	0.04	0.02
3152	Jones	10/9-10/11	67	-	-	0.09	0.03
3237	Victorplatt	10/9-10/11	48	-	-	0.12	0.04
4290	Heisei	10/9-10/11	55	10.63	0.03	0.30	0.04
4970	Druyan	9/30-10/1, 10/7-10/8	95	-	-	0.30	0.04
9190	Masako	9/30-10/1, 10/7-10/8	101	6.130	0.003	0.12	0.03
14790	Beletskij	9/30-10/1, 10/7-10/8	98	3.1460	0.0003	0.30	0.04
16694	1995 AJ	9/30-10/1, 10/7-10/8	98	-	-	0.15	0.03
17939	1999 HH8	10/9-10/11	61	-	-	0.18	0.04
23766	1998 MZ23	10/9-10/11	70	2.721	0.002	0.18	0.02
31485	1999 CM51	10/9-10/11	64	6.006	0.003	0.68	0.04



**LIGHTCURVE ANALYSIS OF ASTEROIDS
(6577) 1978 VB6, 6619 KOLYA, 9549 AKPLATONOV,
(12466) 1997 AS12, (15154) 2000 FW30, AND
(32505) 2001 KF17**

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(Received: 7 March)

We report on lightcurve observations and analysis of six asteroids with R magnitudes dimmer than 14.5. The asteroids were observed for 15 nights from 2009 March through June primarily using the 0.9-meter SARA telescope at Kitt Peak National Observatory. Data for asteroid 6577 was obtained using the 0.97 meter telescope at Holcomb Observatory in Indianapolis, IN.

From early 2009 March through late June we obtained photometric observations of six asteroids: (6577) 1978 VB6, 6619 Kolya, 9549 Akplatonov, (12466) 1997 AS12, (15154) 2000 FW30, and (32505) 2001 KF17. Images for five of the asteroids were obtained using the Southeastern Association for Research in Astronomy (SARA) 0.9-m telescope located at Kitt Peak National Observatory. The SARA telescope works at $f/7.5$ and is equipped with an Apogee U42 2048x2048 array of 13.5 micron pixels. Given the focal length of the telescope and size of the pixels, 2x2 binning was used to achieve a scale of 0.825 arcsec/pixel. For asteroid 6577, the observations were taken using an I filter with the 0.97-m $f/16$ Cassegrain telescope at Holcomb Observatory located on the Butler University campus in Indianapolis, IN. The autoguider for the Holcomb telescope was not working properly that evening so exposure times were limited to 60 seconds. The Holcomb telescope is equipped with an Apogee E6 1024x1024 pixel camera. 1x1 binning was used, giving a scale 0.33 arcsec/pixel. The seeing was typically 2.5 arcsec except at the end of the night when it approached 3.5 arcsec. All images were processed using *Maxim DL*. After image processing lightcurve analysis was done using *MPO Canopus*.

(6577) 1978 VB6. The data for 6577 were taken using the Holcomb telescope. The data from the Holcomb telescope differs from the SARA telescope primarily due to the sky background of Indianapolis and an asteroid altitude that is 10° lower in the sky than Kitt Peak. Toward the end of the night of June 27, clouds moved in and seeing degraded, which resulted in larger error bars. Even with these difficulties, we were able to obtain a period of $P = 6.984 \pm 0.002$ h and $A = 0.85$ mag.

6619 Kolya. 6619 Kolya was observed 4 times: 2009 March 3, 10, 11, and 14. The length of the exposures was 2 minutes. Being at $R \approx 14.6$, this was sufficient to give reasonable signal-to-noise and prevent overexposure of the asteroid or comparison stars if due to changes in seeing. The nights of March 3, 11, and 14 were nearly cloudless. On March 10, thick clouds along with a nearly full moon continuously interfered with the observing so that auto guiding was repeatedly lost. Thus the data for that night was not used. The full moon also interfered on the night of March 11, but the data were reasonably accurate given the bright conditions. On the night of March 14, Kolya passed near the spill over on the

CCD of an overexposed 10^{th} magnitude star. The annulus aperture happened to lie in these columns. These images were processed differently to remove the overflow. The 3 nights were sufficient to get a period of $P = 10.5001 \pm 0.0004$ h and amplitude of $A = 0.4$ mag.

9549 Akplatonov. When observed in 2009 May, the 15.3 magnitude asteroid happened to lie near the plane of the Milky Way. This resulted in a very crowded field that affected the photometry, even with the subtraction of nearby stars. Despite this difficulty, we found $P = 2.8431 \pm 0.0004$ h and $A = 0.18$ mag.

(12466) 1997 AS12. Fourier analysis of the data for this asteroid produced several possible periods with the most likely being $P = 2.6753 \pm 0.0004$ h and a relatively small amplitude of $A = 0.06$ mag. Given the amount of repetition in our observations, we are confident of this period, although multiples of 2 and 3 times this are possible.

(15154) 2000 FW30. Unfortunately, clouds interfered with the observations so that a full night of data was not achieved on any of the three nights that we observed. From the data that were obtained, the preliminary period was $P = 13.31 \pm 0.04$ h with an amplitude of $A = 0.08$ mag. However, there is a possibility that the period is much larger than this and thus this asteroid should be studied further.

(32505) 2001 KF17. Although observed for only 32 nights, the period of this asteroid was short enough to sample a portion of the lightcurve twice. The resulting period was $P = 4.560 \pm 0.015$ h and the amplitude was $A = 0.47$ mag.

No.	Name	Date (UT) yyyy.mm.dd	UT Range hh:mm	R Mag
6577	1978 VB6	2009.06.24	04:49–09:11	–
6577	1978 VB6	2009.06.27	03:49–09:08	–
6619	Kolya	2009.03.03	04:46–10:39	14.54
6619	Kolya	2009.03.11	03:28–12:33	14.66
6619	Kolya	2009.03.14	03:14–10:02	14.71
9549	Akplatonov	2009.05.24	05:25–11:01	15.34
9549	Akplatonov	2009.05.29	04:29–11:04	15.24
12466	1997 AS12	2009.04.24	04:43–09:18	15.93
12466	1997 AS12	2009.05.01	04:35–11:26	15.93
12466	1997 AS12	2009.05.03	04:14–10:56	15.94
15154	2000 FW30	2009.05.12	03:46–09:59	16.02
15154	2000 FW30	2009.05.13	03:22–05:43	16.03
15154	2000 FW30	2009.05.15	03:42–10:21	15.05
32505	2001 KF17	2009.06.06	04:19–10:28	15.40

Table I. Observations

Number	Name	Period (hrs)	Amp (mag)
6577	1978 VB6	6.948 ± 0.002	0.80
6619	Kolya	10.501 ± 0.0004	0.39
9549	Akplatonov	2.843 ± 0.0004	0.19
12466	1997 AS12	2.675 ± 0.004	0.06
15154	2000 FW30	13.372 ± 0.037	0.07
32505	2001 KF17	4.583 ± 0.016	0.50

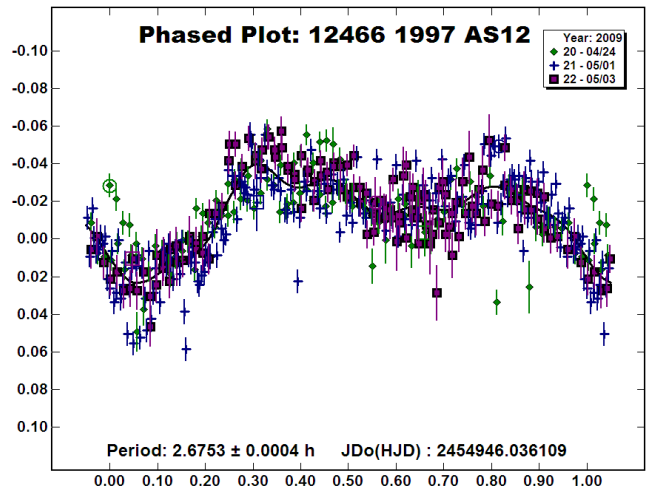
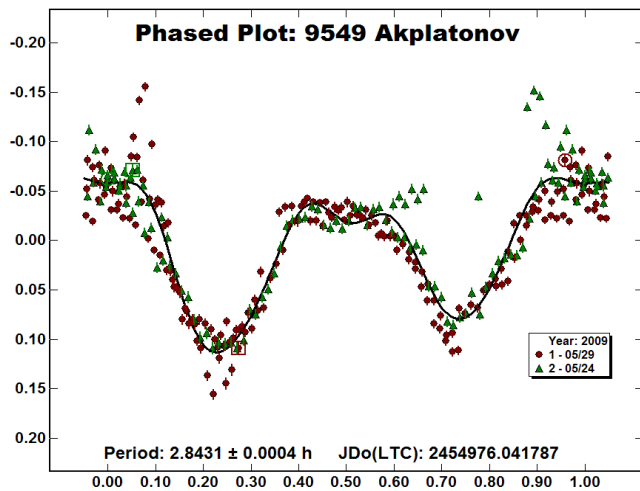
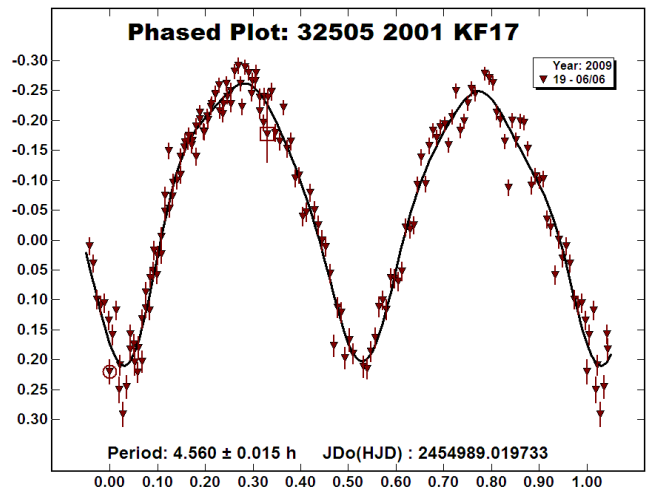
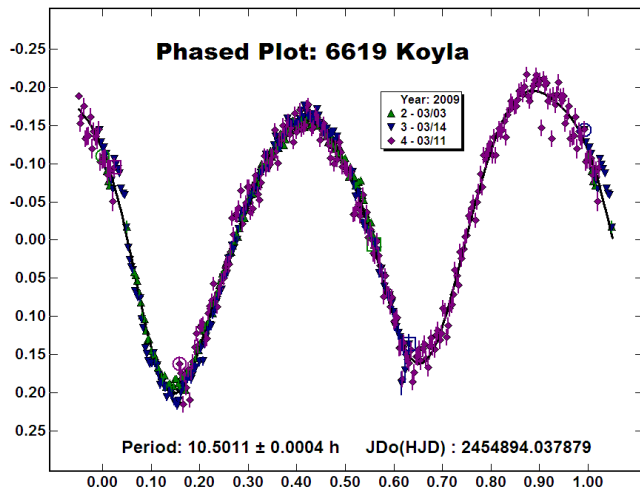
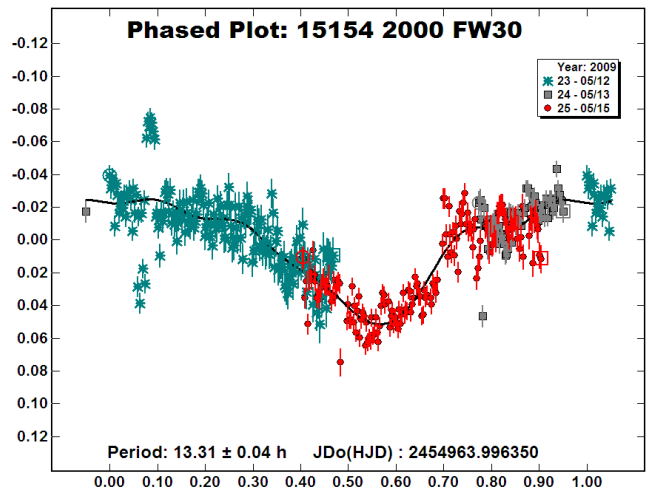
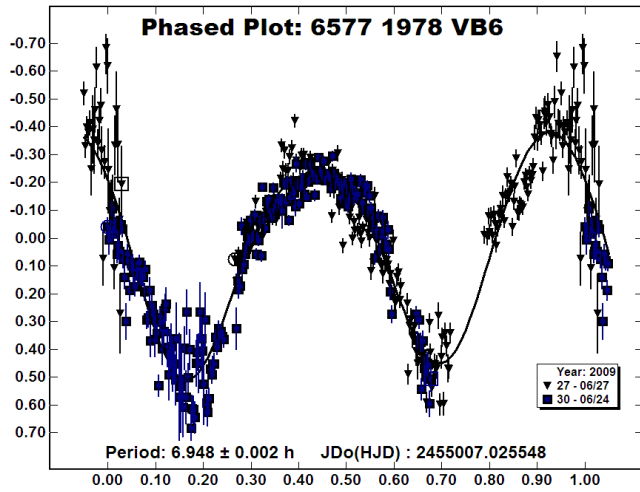
Table II. Summary of Results

Acknowledgements

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

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

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

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

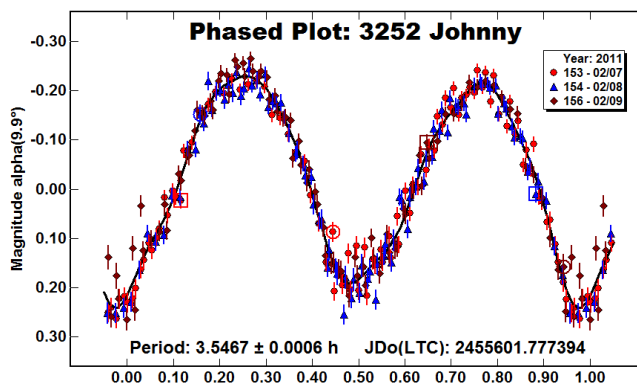
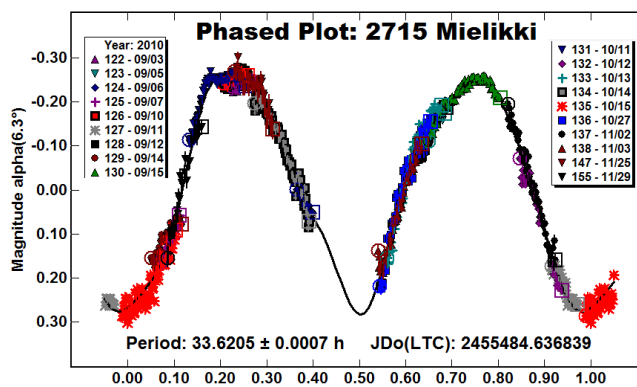
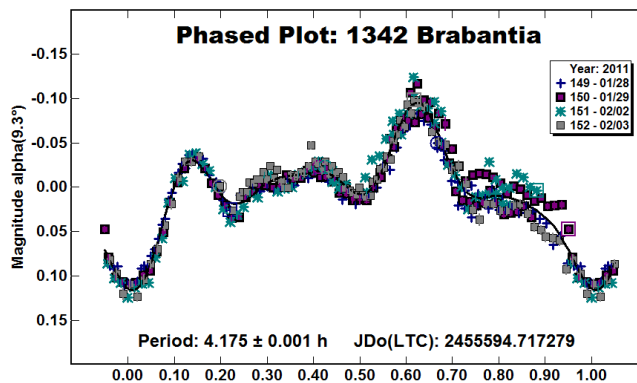
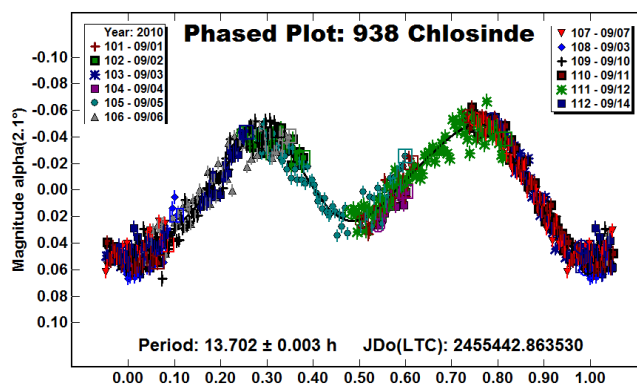
1342 Brabantia. Data were collected from 2011 January 28 through February 03 resulting in 4 data sets totaling 341 data points. A period of 4.175 ± 0.001 h was determined with a peak-to-peak amplitude of 0.21 mag. Based on the period, the asteroid was tracked through 35.95 revolutions.

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

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

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

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(Received: 29 March)

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

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

On “Targets of Opportunity” and Half-Period Analysis

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

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

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

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

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

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

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

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

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

3447 Burckhalter. This Hungaria asteroid has been a conundrum for some time. Warner (2002) first reported a period of 22.8 h, but with a poor data set obtained in 2002 October. Behrend (2011), using data from about the same time, found a period of 22 h. Warner and Bembrick (2005) combined new data sets and found a period of 60.0 h. The author reviewed the 2001 data (Warner, 2011), re-measuring the images with updated software, and found a period of 51 h. The last work was in press when it was realized that an upcoming apparition had been overlooked. An observing campaign to “settle things once and for all” was started in 2010 mid-December and completed in 2011 late January. A period of 59.8 h was strongly favored but the data did not all fit. On the

belief that the object was tumbling (non-principal axis rotation; see Pravec *et al.*, 2005), the entire 2011 data set was submitted to Petr Pravec, Astronomical Institute, Czech Republic, for his analysis. He confirmed the one period of 59.8 and the fact that the object was tumbling. However, the data set was insufficient to find the second period with certainty, though one at 67.5 h was favored. Furthermore, it was not possible to determine if the true periods are those reported here or if they are a linear combination of two others expressed as frequencies, e.g., $2/f_1 + 2/f_2$. A campaign involving observers well-separated in longitude and calibrated data will be required to make that determination.

3511 Tsvetaeva. This outer main belt asteroid was a target of opportunity. The data set allowed finding the period to <0.1 h. The result agrees with one derived using a more extensive set previously obtained by the author (Warner, 2006a).

4490 Bamberg. The most recent data from PDO are in reasonable agreement with results previously reported by the author (Warner, 2006b; Warner, 2009).

6384 Kervin. This was follow up to earlier works: Warner (2006c and 2008b) and Pravec *et al.* (2011).

6493 Cathybennett. This was follow up to earlier work by the author (Warner, 2009).

7187 Isobe. Analysis of the 2011 data found a period of 4.2432 h with a weak secondary period of $P = 16.37 \pm 0.05$ h and $A = 0.05 \pm 0.01$ mag. The shorter period contradicted the results from two previous campaigns (Warner, 2005 and 2008a) of $P \sim 2.5$ h. The images from those earlier efforts were re-measured using better night-to-night zero point calibrations. In both cases, a period of $P \sim 4.24$ h was found as well as the weak secondary period: 2004, $P = 16.33 \pm 0.04$ h, $A = 0.12 \pm 0.01$ mag; 2007, $P = 16.28 \pm 0.02$ h, $A = 0.08 \pm 0.01$ mag. Under such circumstances, the tendency is to believe that the secondary period is due to a satellite. However, the secondary period, despite the amplitude, does not stand out significantly in a period spectrum, its lightcurve is ill-defined, and there are no indications of mutual events (occultations or eclipses). Observations at future apparitions are strongly encouraged.

(7579) 1990 TN1. This was follow up to previous work by the author (Warner, 2008b).

(10779) 1990 YM. The solution for this target of opportunity is based on half-period analysis. Its orbit places it among the Eumonia group.

(13578) 1993 MK. Similar to 7187 Isobe, analysis of the observations in 2011 contradicted earlier results of $P \sim 7.9$ h (Warner, 2008b and 2009). The 0.26 mag amplitude in 2011 gave more confidence in a shorter solution of $P = 3.960$ h. The original images were re-measured. The new results for the two earlier campaigns still do not warrant better than $U = 2$ (see Warner *et al.*, 2009), mostly because – as stand-alone lightcurves – their low amplitudes and shapes cannot formally exclude a doubled period.

13822 Stevedodson. This Flora asteroid was a target of opportunity and subsequently given follow up as a planned target.

(16562) 1992 AV1. Despite extensive coverage and some slight asymmetries in the lightcurve, the result of $P = 12.251$ h cannot be considered completely unambiguous. The lightcurve for the half-period ($P = 6.123$ h) is nearly flat.

(19131) 1988 CY3. The amplitude of the lightcurve for this target of opportunity and the fact that the data set covered more than one (assumed) bimodal cycle give reasonable confidence in the solution, despite the significant error bars. This is an outer main belt asteroid with $D \sim 8$ km.

(20936) 4835 T-1. This asteroid was previously observed by the author (Warner, 2008a). The period of 5.679 h reported at that time seems almost certainly wrong. Skiff (2011) observed the asteroid about a month earlier in 2011 and found a period of $P = 3.293$, $A = 0.06$ mag, assuming a monomodal curve. A double-period of $P \sim 6.65$ h cannot be ruled out.

(21056) 1991 CA1. This is follow up to previous work by the author (Warner, 2006a).

(42612) 1998 EL3. The half-period solution for this Flora asteroid (a target of opportunity) shows a single peak with extended flat section. The amplitude of $A \sim 0.3$ mag favors a bimodal solution, especially given the low phase angle.

(46784) 1998 HK117. The half-period solution is plotted since the full-period solution has a large gap that makes the solution less obvious. Here again, the amplitude of ~ 0.3 mag and low phase angle favor a bimodal solution.

(46803) 1998 KL33. Based on the rise of 0.4 mag over the time span of the observations, a bimodal lightcurve can be presumed. In that case, the period is at least 4 times the length of the observations since no definitive maximum or minimum was seen. This leads to $P > 12$ h, but nothing more definitive. The asteroid is a member of the Baptistina orbital group with $D \sim 4.6$ km.

(61461) 2000 QA31. The data set was just short of covering the full bimodal cycle of this middle main belt asteroid. Even so, the solution is based on the half-period.

(65739) 1993 SG13. The large amplitude allowed finding a reasonable period solution despite the large error bars. The asteroid had a sky magnitude of $R \sim 19.0$, making it remarkable that a lightcurve could be obtained at all with a 0.35-m telescope.

2001 GU8. The solution is based on half-period analysis. This is a member of the Flora orbital group with $D \sim 1.3$ km.

2006 WH2. Only the raw data are plotted. The span of the data set and plot suggest that $P > 16$ h.

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#	Name	mm/dd 2010*/2011	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
434	Hungaria (H)	03/01-03/12	560	7.3, 11.5	155	-9	26.456	0.003	0.70	0.02
1019	Strackea (H)	02/11-02/15	128	19.3, 20.7	112	-15	4.047	0.005	0.25	0.01
2035	Stearns (H)	01/22-02/10	624	16.5, 19.5	123	+30	51.89	0.20	0.16	0.01
2047	Smetana (H)	02/12-02/28	159	24.7, 20.7	172	+29	2.4801	0.0005	0.16	0.01
3266	Bernardus (H)	12/12-12/26*	248	14.7, 8.9	93	-14	10.754	0.002	0.38	0.02
3447	Burckhalter (H)	12/12*-01/27	1759	25.4, 16.4	122	+26	59.8 ⁽⁵⁾	0.1	0.39	0.02
3511	Tsvetaeva	03/01	105	37.2	52	-9	6.22	0.05	0.82	0.02
4490	Bambery (H)	02/11-02/13	141	26.7	100	-14	5.816	0.005	1.02	0.02
6384	Kerwin (H)	01/28-02/03	279	19.6	144	+33	3.617	0.001	0.10	0.01
6493	Cathybenett (H)	01/29-02/10	204	6.2, 3.8	136	-4	3.4785	0.0005	0.22	0.02
7187	Isobe (H)	08/29-09/02 ⁽¹⁾	299	18.0, 16.9	353	+19	4.247	0.001	0.15	0.01
"	"	11/11-12/16 ⁽²⁾	292	27.5, 19.4	83	+28	4.2432	0.0005	0.13	0.01
"	"	02/12-03/01	241	6.1, 5.6, 9.1	149	-8	4.2432	0.0005	0.12	0.01
7579	1990 TN1 (H)	01/22-01/28	432	5.4	122	+7	18.31	0.01	0.91	0.02
7781	Townsend (H)	12/12*-01/07	768	18.5, 13.8	102	+23	81.1	0.2	0.58	0.02
10779	1991 LW	01/28	99	7.5	137	+11	18.3	0.5	0.66	0.02
12265	1990 FG	03/02-03/23	454	7.8, 14.8	160	+9	56.6	0.2	0.65	0.03
13578	1993 MK (H)	12/29-01/12 ⁽³⁾	257	20.1, 23.9	72	-18	3.963	0.001	0.10	0.01
"	"	05/28-05/30 ⁽⁴⁾	140	17.2	246	+26	3.961	0.005	0.11	0.01
"	"	01/07-01/11	217	9.4, 7.1	121	+3	3.960	0.001	0.26	0.02
13822	Stevedodson	01/11-01/15	131	1.8, 3.9	107	-2	5.590	0.005	0.58	0.03
16562	1992 AV1	12/27*-02/10	817	9.8, 2.7, 21.0	107	0	12.251	0.003	0.07	0.01
19131	1988 CY3	03/11	42	7.2	154	-10	2.94	0.05	0.51	0.03
20936	4835 T-1 (H)	02/15-03/03	235	20.4, 24.2	123	+24	3.321	0.002	0.15	0.02
21056	1991 CA1 (H)	01/02-01/06	110	13.0, 11.1	108	-14	5.58	0.02	0.13	0.02
22696	1998 QT105	02/11	73	4.8	136	+9	7.8	0.5	0.26	0.03
23336	2579 P-L	02/03	82	5.5	136	+10	2.56	0.01	0.10	0.01
42612	1998 EL3	01/03	47	3.6	108	-4	9.0	0.3	0.32	0.03
46784	1998 HK117	02/13	63	5.9	136	+8	19.	2.	0.27	0.02
46803	1998 KL33	03/15	28	10.2	160	+9	>12.		>0.4	
48470	1991 TC2 (H)	01/08-01/15	187	26.7	108	+38	10.48	0.02	0.19	0.02
61461	2000 QA31	01/28	94	3.8	122	+7	12.2	0.5	0.62	0.03
65739	1993 SG13	02/13	21	3.6	150	-8	2.5	0.2	0.10	0.05
89550	2001 XU97	01/02	73	4.1	108	-4	9.0	0.2	0.65	0.03
101771	1999 FB58	02/13	82	5.7	136	+9	4.69	0.05	0.66	0.03
113567	2002 TV36	03/11	34	5.5	167	+9	5.5	0.3	1.46	0.03
2001	GU8	03/15	43	8.5	167	+9	7.20	0.20	0.75	0.05
2006	WH2	01/11	57	1.9	107	-2	>16.		>0.3	

(1)=2004 (2)=2007 (3)=2007/08 (4)=2009 (5) Tumbler. P2 = 67.5 h.

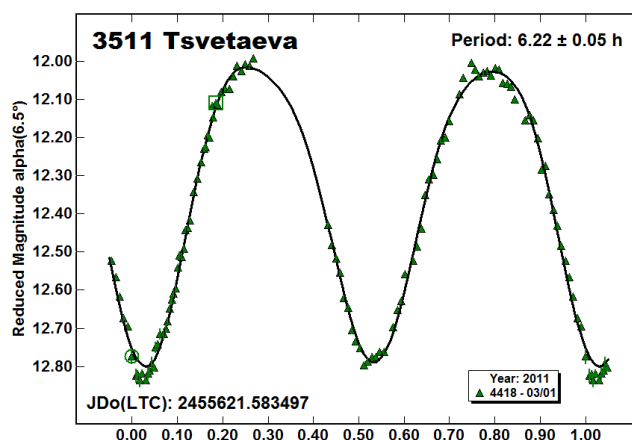
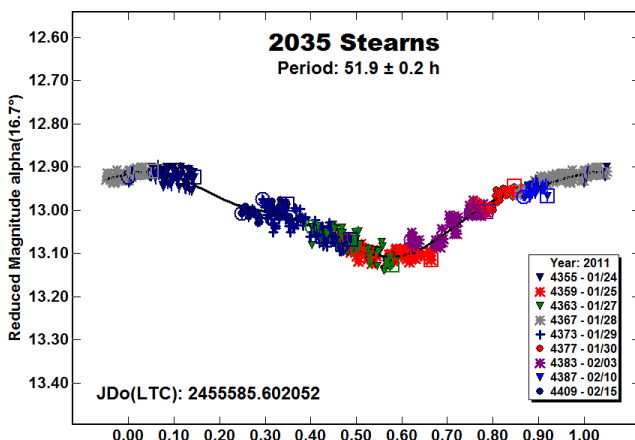
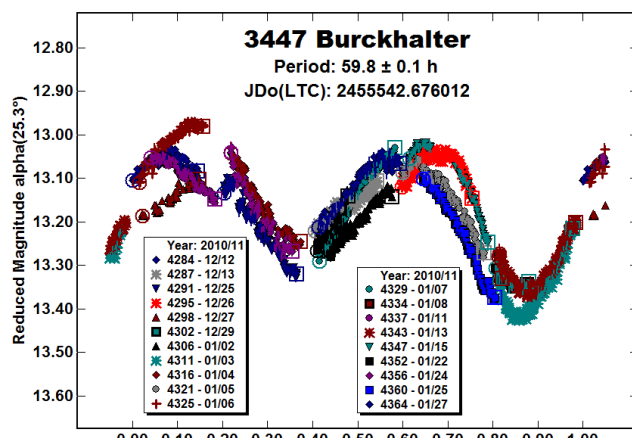
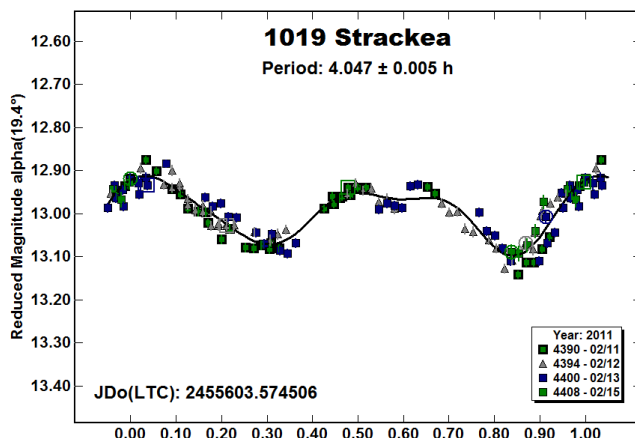
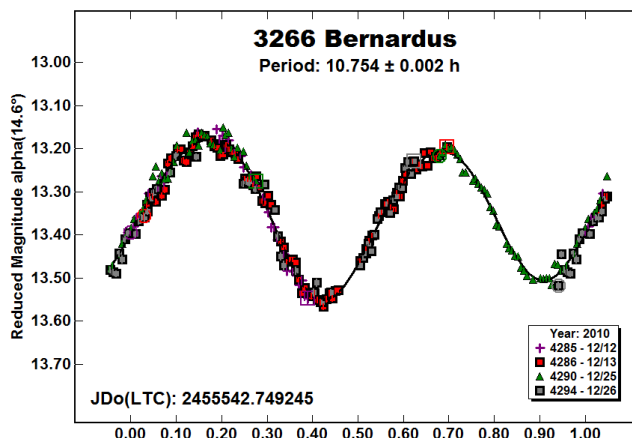
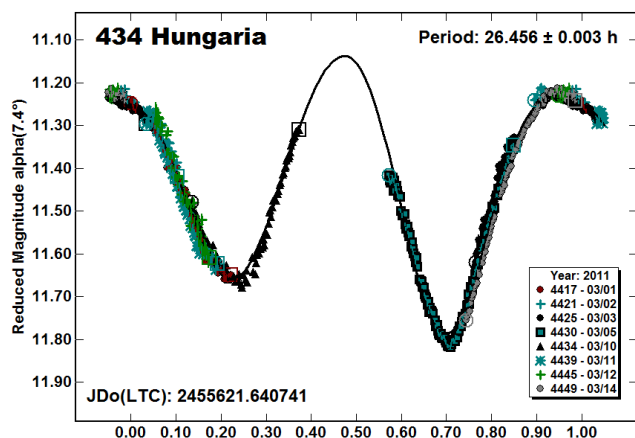
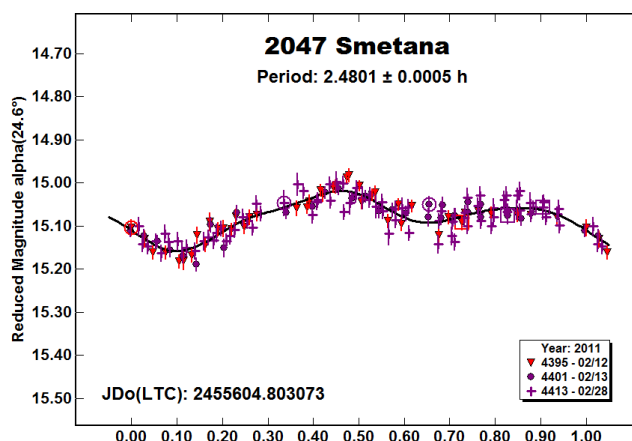
Table I. Observing circumstances. Asteroids with "(H)" after the name are members of the Hungaria group. The phase angle (α) is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change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

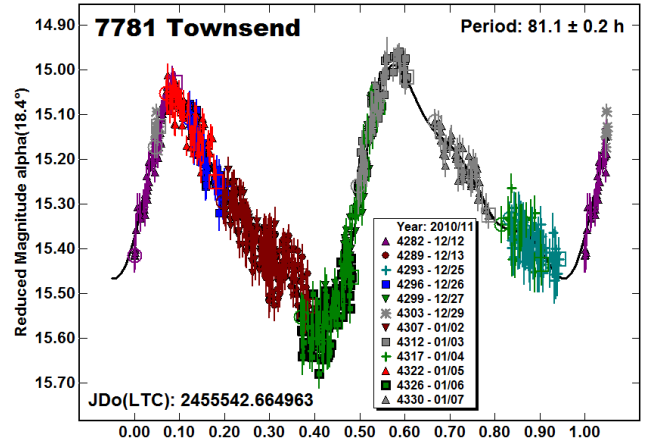
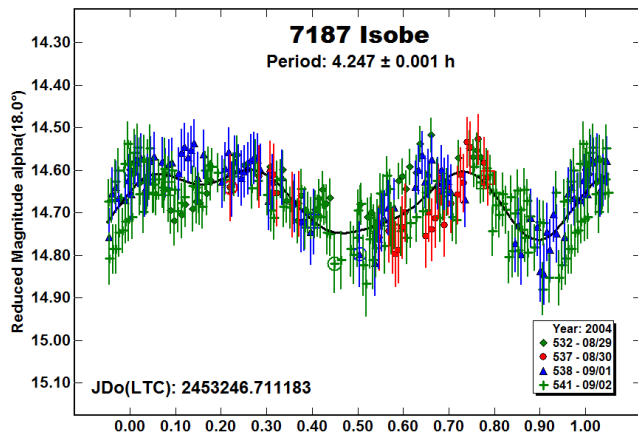
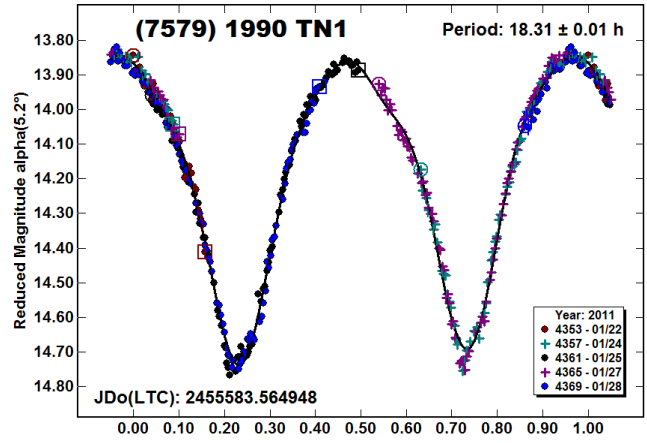
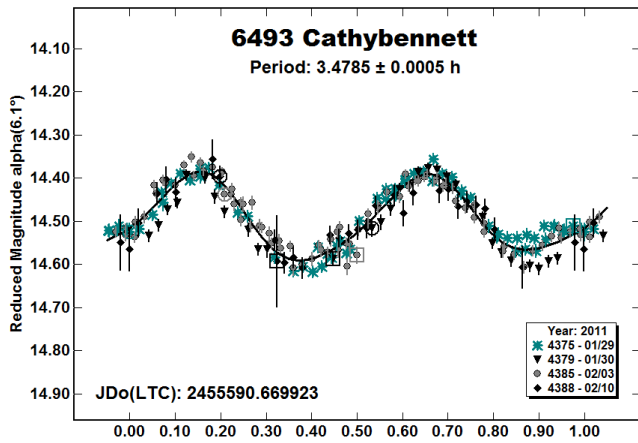
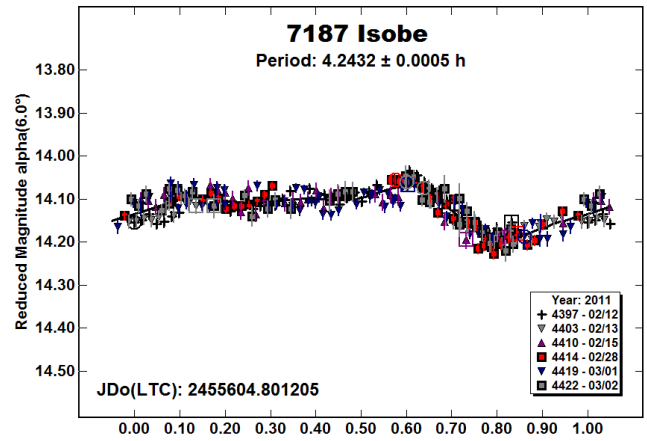
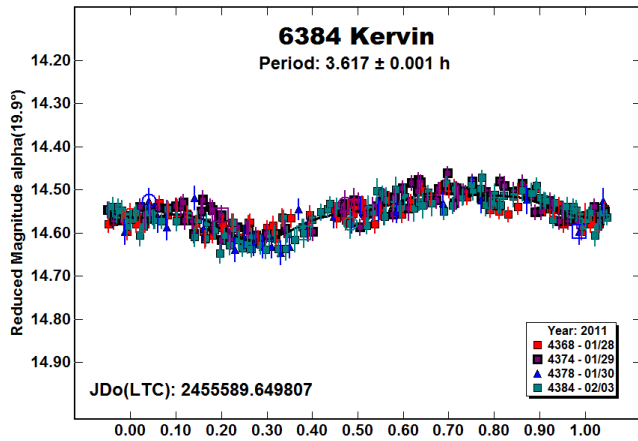
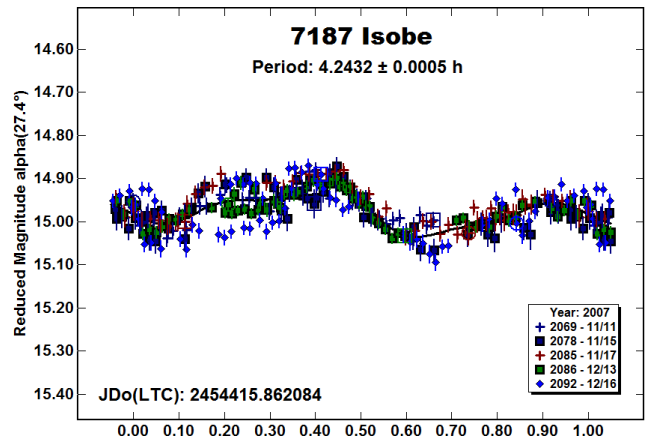
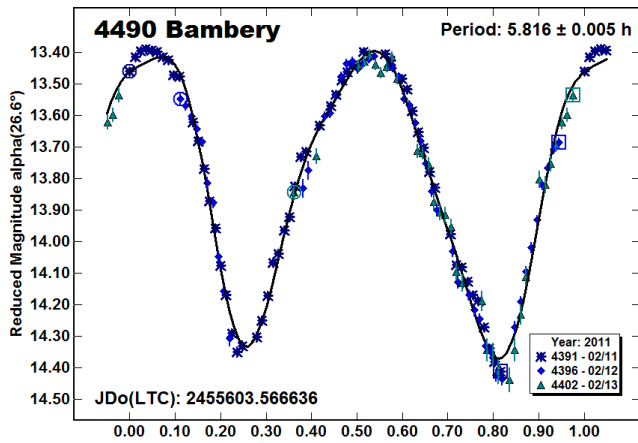
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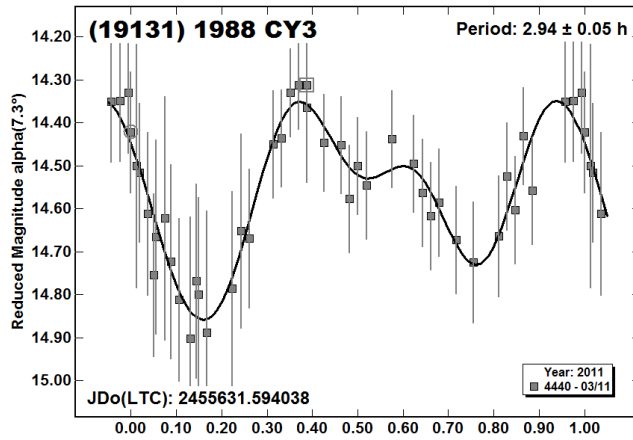
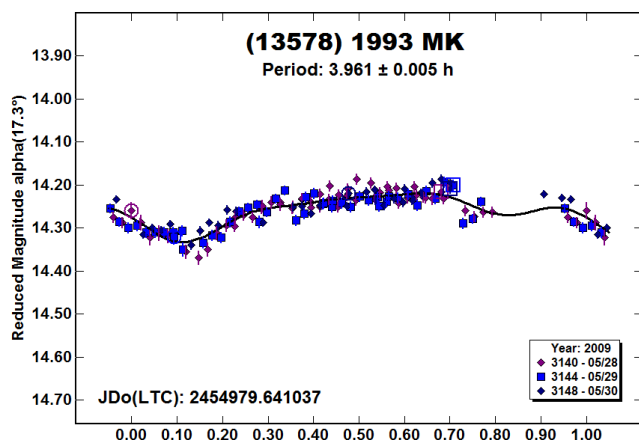
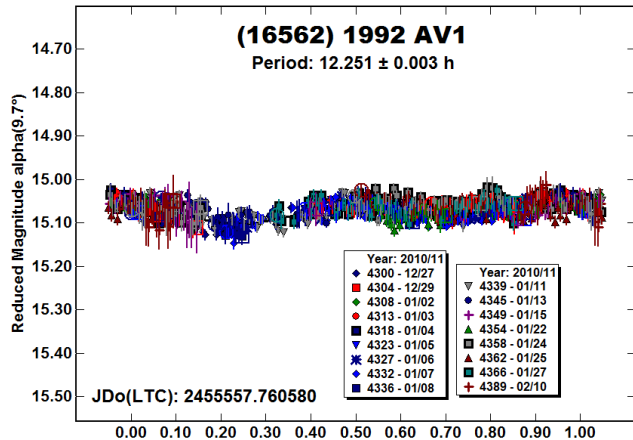
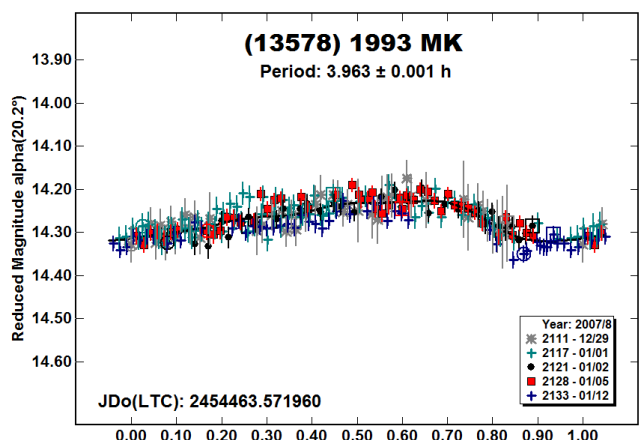
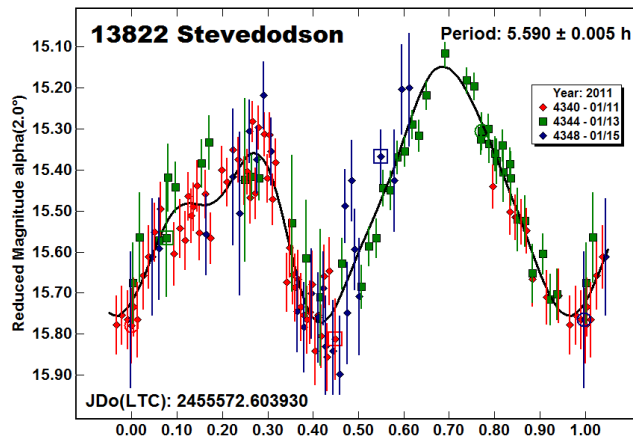
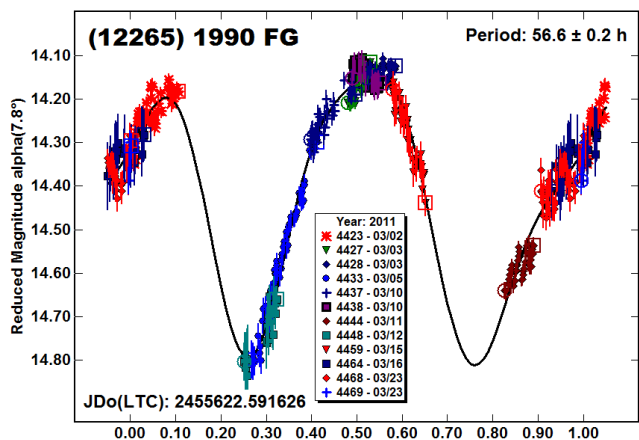
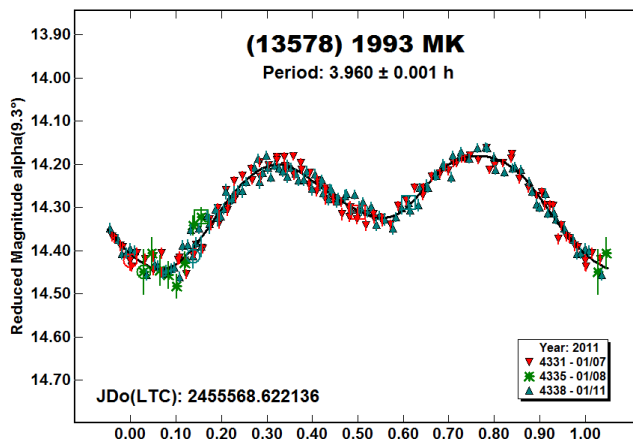
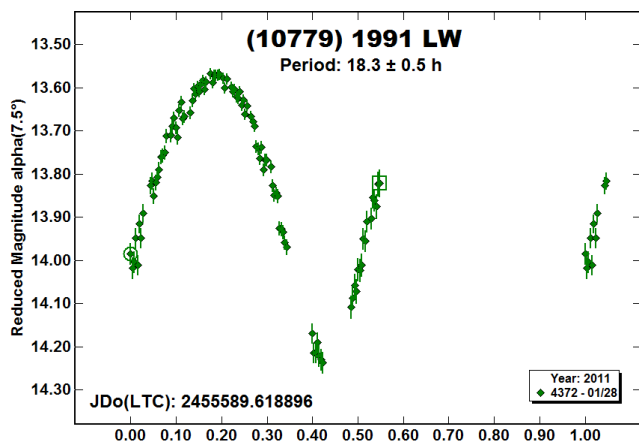
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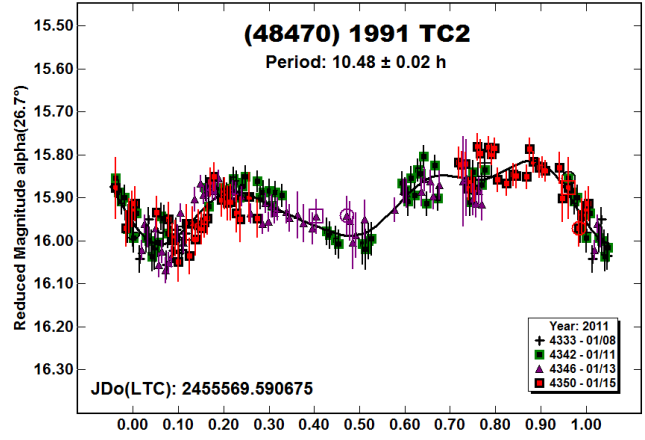
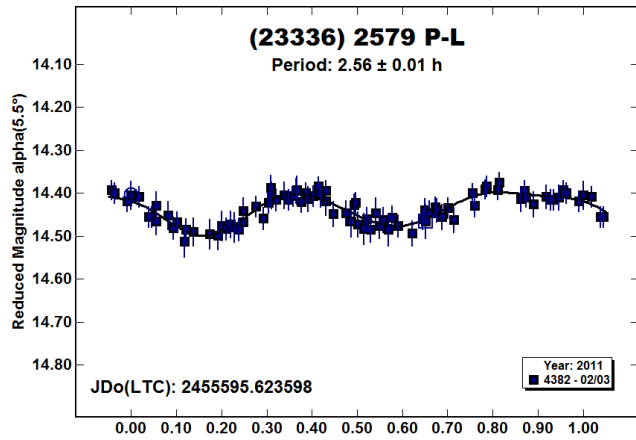
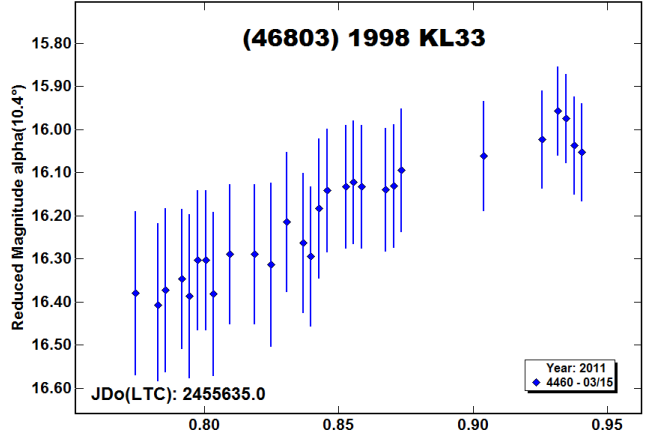
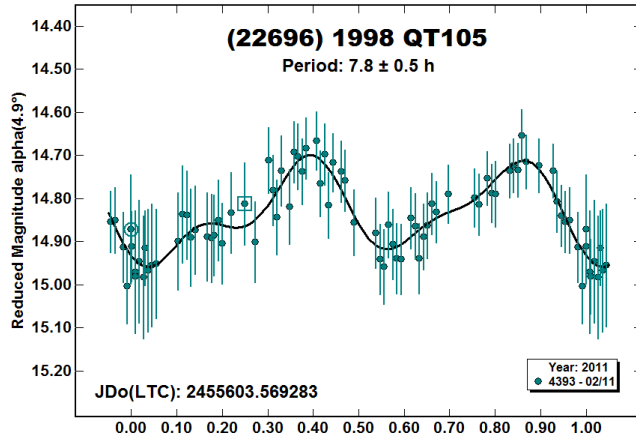
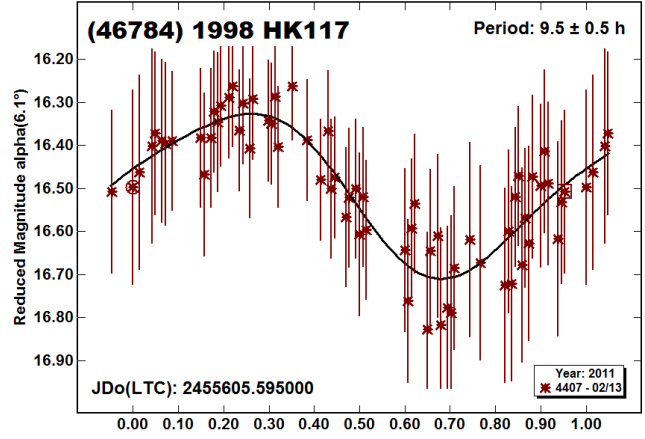
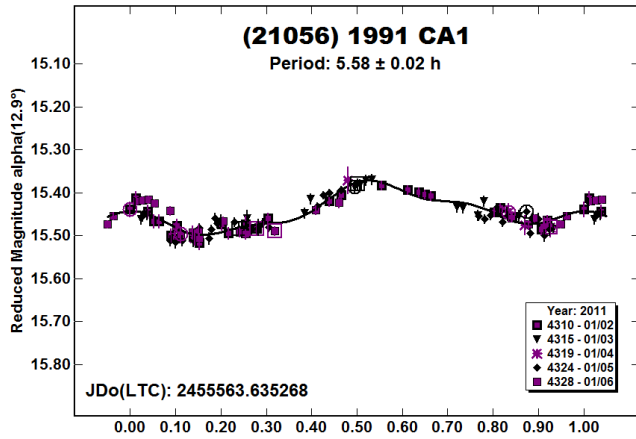
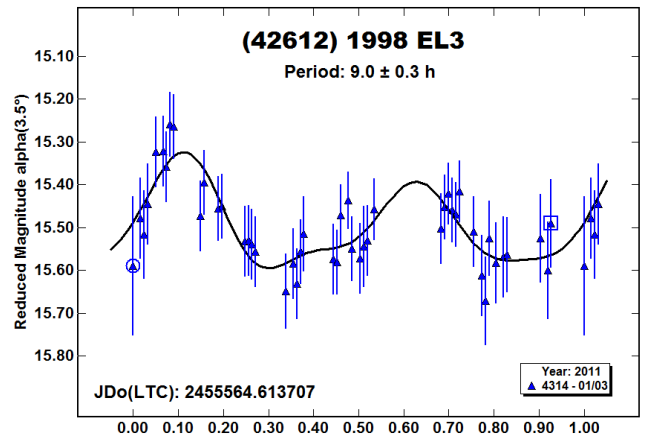
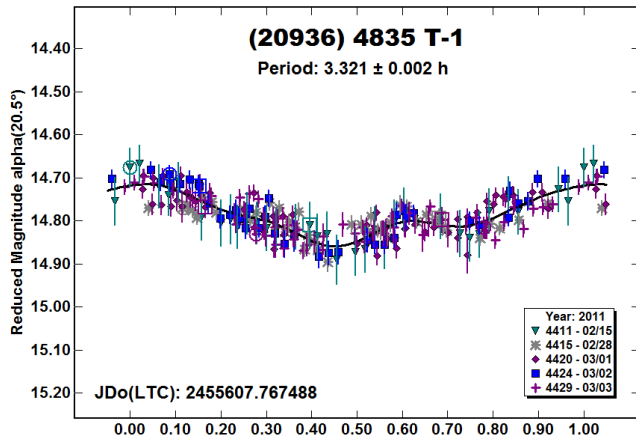
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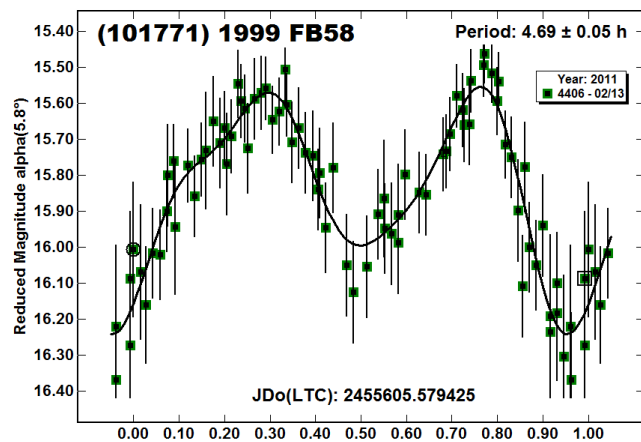
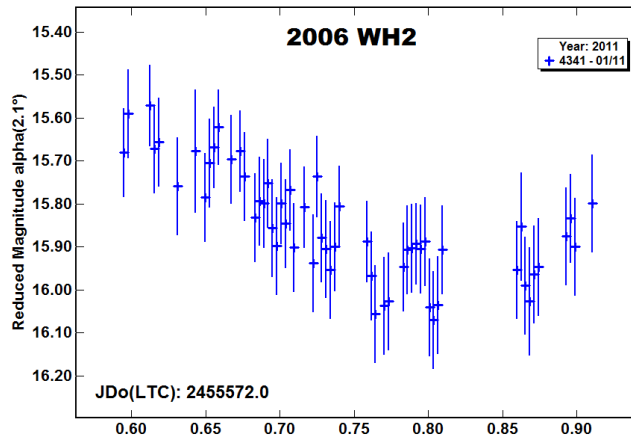
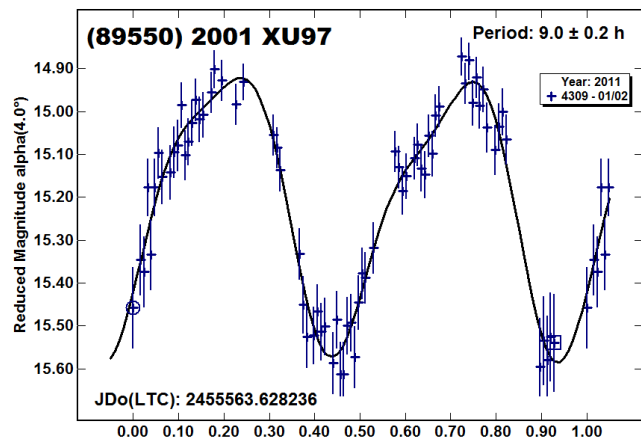
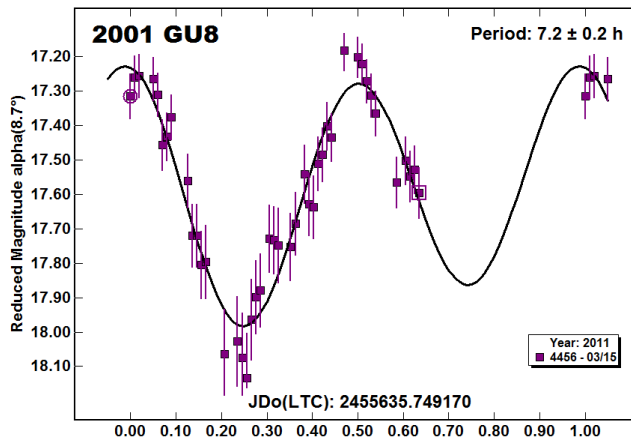
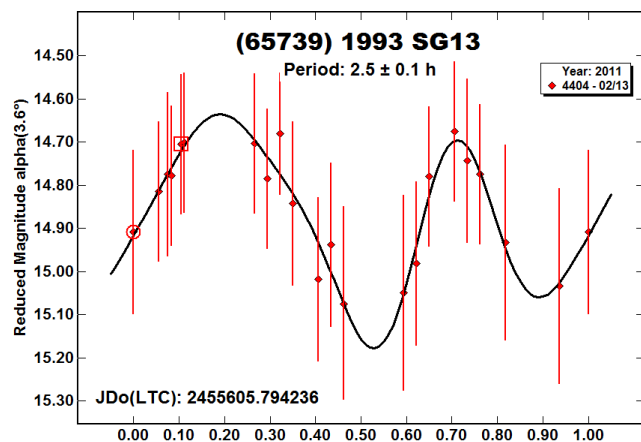
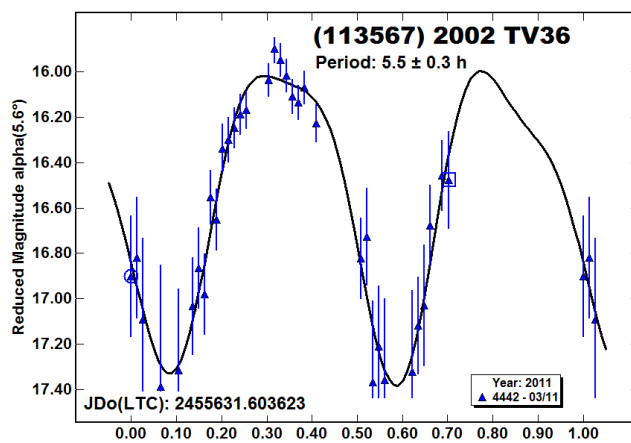
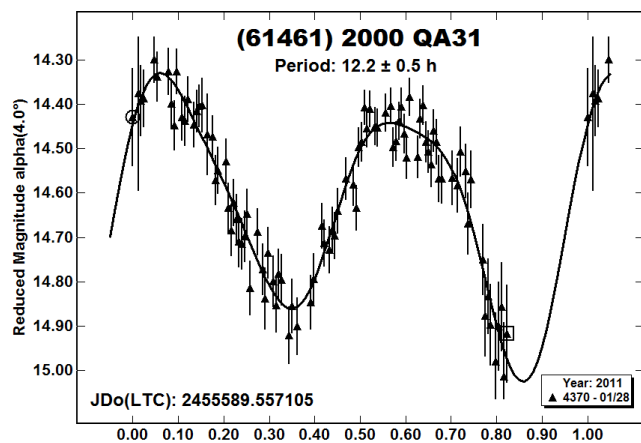
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LIGHTCURVE ANALYSIS OF 27810 DAVETURNER: A LONG PERIOD HUNGARIA

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CCD photometric observations of the Hungaria asteroid 27810 Daveturner were made by a collaboration of three observatories. Analysis of the final data set found a synodic rotation period of $P = 540 \pm 20$ h with a lightcurve amplitude of 0.43 ± 0.03 mag. While the long period makes the asteroid a candidate for being in non-principal axis rotation (NPAR or “tumbling”), the data show no signs of such. The long period is hardly unusual since slow rotators are common among the Hungarias, accounting for approximately 30% of those with established rotation rates.

CCD photometric observations of the Hungaria asteroid 27810 Daveturner were started in 2011 late January at the Palmer Divide Observatory. The equipment consisted of a 0.35-m Schmidt-Cassegrain telescope (SCT) with a Finger Lakes ProLine 1001E CCD camera operating at -40° C. Exposures were guided and 4 minutes in duration. To avoid long gaps between observing sessions due to weather, requests for observations were made to the Center for Solar System Studies (CS3) and Lowell Observatory. CS3 used an f/6.5 0.35-m SCT and SBIG ST-7XME camera operating at -28° C. Exposures were 4 minutes and guided. The 0.78-m telescope at Anderson Mesa site operated by Lowell Observatory used a camera with e2v 2Kx2K CCD chip cooled by a Cryotiger chiller to -112° C. The image scale was 0.46 arcsec/pixel when binned 2x2. Exposures were 90s using a Cousins R filter.

All images were measured using *MPO Canopus* and, specifically, the CompStarSelector feature that allows selecting up to 5 near-solar color stars within the field of view for differential photometry. The Cousins R magnitudes for the comparisons were derived using the 2MASS to BVRI formulae developed by Warner (2007). In most cases, this allows night-to-night zero point agreement to ± 0.02 - 0.03 mag. This is particularly important when working long period objects since the observations usually span several weeks and involve a number of different fields. It is even more critical when working with data sets from different observers and/or systems.

The combined data set of approximately 1060 data points was obtained from 2011 January 28-February 28. While there were a sufficient number of sessions to cover the complete cycle and some overlap, the gaps in time between some sessions made it more

convenient to find the half-period (monomodal lightcurve) and then double the result, the amplitude of 0.43 mag and low phase angle virtually assuring that the true lightcurve is bimodal. Analysis found a period of $P = 540 \pm 20$ h with $A = 0.43 \pm 0.03$ mag. The period and diameter ($D \sim 4$ km) make this a candidate for being a “tumbler,” i.e., in non-principal axis rotation (NPAR; see Pravec *et al.*, 2005 for a discussion of NPAR and tumbling damping times). However, within the calibration errors, the lightcurve repeated itself on the second cycle and so there were no obvious indications of tumbling action. It’s possible that the asteroid could be near the start or end of a tumbling state, which would produce a very low amplitude secondary component in the lightcurve. It would take high-precision calibrated data to make that determination.

Of the approximately 200 Hungaria asteroids with known rotation periods, nearly 30% are considered to be slow rotators ($P > 24$ h; see Warner *et al.* 2009a, 2009b). This trait has been found in a more general population of smaller asteroids that includes near-Earth asteroids (Pravec *et al.*, 2008, and references therein). The YORP (Yarkovsky-O’Keefe-Radzievskii-Paddack) effect, a thermal process that can cause asteroid spin rates to increase or decrease, is believed to be the mechanism behind slow rotators. Whether or not slow rotators become tumblers may depend on other factors in addition to YORP (Vokrouhlický *et al.*, 2007).

Given the dominance of slow rotators among smaller asteroids, and with indications that larger, more distant objects may also show an excess of slow rotators, it is even more critical that asteroid lightcurve work now include at least some sort of internal calibration so that arbitrary nightly zero point adjustments are kept to a minimum. As demonstrated here, this is particularly important if the data come from a number of observers. Without some sort of calibration process, the derived solution will always be suspect since arbitrary adjustments of nightly zero points may mask the true nature of an object.

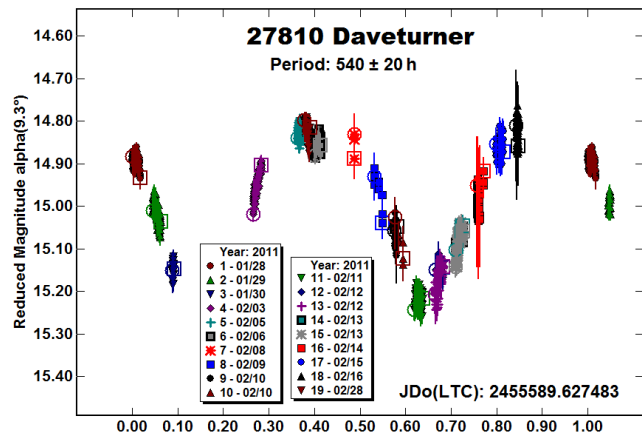


Fig. 1. The lightcurve for 27810 Daveturner. The magnitudes are Cousins R, reduced to unity distances using $-5\log(DR)$. The data were reduced to the constant phase angle of $\square = 9.3^\circ$, for Jan 28, using $G = 0.15$.

Acknowledgements

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846 LIPPERTA: A VERY SLOW ROTATOR

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Lightcurve study of the asteroid 846 Lipperta indicates a very long rotation period, most likely $P = 1641 \pm 23$ h, and a lightcurve amplitude of 0.3 mag during the apparition of 2010-2011. This makes it one of the slower rotators with well-determined lightcurve parameters.

What began as a simple differential photometry lightcurve project turned into a very long photometric study of the asteroid 846 Lipperta when it became apparent that the object had a very long rotation period. Gartrelle, using the 0.66-m telescope at Badlands Observatory in Quinn, SD, and Buchheim, using the 0.28-m telescope at Altimira Observatory, observed the asteroid on a total of 33 nights, from 2010 Oct 17 through 2011 Jan 23. During that time span the solar phase angle changed from $\alpha \approx -11^\circ$ to $\alpha \approx +21^\circ$, passing through minimum solar phase $\alpha \approx 0.26^\circ$ on 2010 Nov 16. The lightcurve reported here is based on unfiltered CCD images. Differential photometry was done with

MPO Canopus software. In addition, Buchheim made BVR band images on several nights, calibrated with Landolt standard stars and reduced with *MPO PhotoRed* to determine the color index of the asteroid.

We could find very little formal research on 846 Lipperta. Spectrophotometric observations were obtained by Lazzaro *et al.* (2004) in 1997 for the Eight Color Asteroid Survey (ECAS). Tholen and Bus taxonomic classifications of C were assigned, indicative of iron bearing hydrated silicates. The ECAS team developed an initial spectra with reflectance of 1.0 between 0.5 and 0.9 μ m. An inconclusive spectra for the asteroid was produced by multiple researchers and appears on the NASA Small Bodies Data Ferret web site. There have been several previous reports of lightcurve studies on this asteroid, but they concluded only that the period was "long" (or a similar non-specific term) or failed to reach any conclusion. These include Galeev *et al.* (2007), who attempted a lightcurve but drew no conclusion, Behrend (2010), who reports limited data from the apparitions of 2004 and 2006, and Tedesco (1979), who inferred a period $P > 24$ h.

The first indication that this object might be a slow-rotator was that each individual night showed a virtually flat lightcurve over observing periods as long as 6 hours. Figure 1 shows the lightcurves from several nights (some with arbitrary offsets in the magnitude scale for visibility) illustrating this situation. This lack of variation in brightness could be caused by (a) very slow rotation, (b) near pole-on viewing aspect, or (c) a spherical body with uniform albedo.

MPO Canopus includes a routine that calculates the asteroid's reduced magnitude using

$$V_R = V - 5\log(RD)$$

where R is the Sun distance and D is the Earth distance, both measured in AU, to remove the "1/D²" effect of changing Sun and Earth distance. *MPO Canopus* also applies the *H-G* model to remove the secular effect of changing solar phase angle. The asteroid's brightness, plotted as reduced magnitudes adjusted to constant solar phase using slope parameter $G = 0.15$ throughout the span of our observations, is shown in Figure 2. This shows that there is a quite significant brightness change, presumably representing the asteroid's rotational lightcurve.

Since the asteroid's brightness is essentially constant over any single night, the alignment of asteroid brightness from night-to-night to "link" multiple nights into a consolidated lightcurve is totally dependent on the accuracy of comparison star magnitudes. There are no characteristic bumps or wiggles that can be used to check the alignment of data from different nights. Recognizing this sensitivity to comp-star magnitudes, the following procedure was used. First, all comparison stars were selected from the MPO Star Catalog subset of stars whose color indices are approximately solar. This ensured that the comp stars were all similar in color and were similar to the color of the asteroid.

Second, the full set of lightcurve data was put onto a single instrumental magnitude scale by linking the brightness of the comparison stars on each night to a single "anchor" star for the entire span of observations. In the case where a comparison star from night A is in the same field-of-view as a (different) comparison star from night B, the fundamental equation relating the C band magnitudes of the two stars is:

$$C_B = C_A - (IM_A - IM_B) \quad \text{Eq. 1}$$

One comparison star from night A is assigned a magnitude and is used as the reference to determine the magnitudes of the all of the comparison stars from all other nights. In the case of this project, one of the comparison stars from the night of 2010 Nov 03 was used as the fundamental reference, i.e., the “anchor star”. The anchor star was assigned a magnitude of $C_A = 12.772$. This is a more-or-less arbitrary value but it is the V mag of the star given in the MPO Star Catalog (for the record, this anchor star is MPO3 J03391927 +1943549 = GSC 1243:75 at J2000 coordinates RA = 03h 39m 19.3s, Dec = +19°43'54"). There is no term involving the stars' color indices in Eq. 1 because all observation-nights are being analyzed on the instrumental “C band” system. No attempt is made to put this onto the standard Johnson-Cousins V-band. We note, however, that the implied “C mags” of the comparison stars and asteroid are consistent with standard V-band magnitudes to within about ± 0.1 mag.

Third, whenever possible, the same set of comparison stars was used for several consecutive nights to avoid the risk of injecting spurious variations in asteroid brightness caused by the use of different sets of comparison stars. As the asteroid moved away from one set of comparison stars, the linking of various nights' comparison stars was done in two ways, depending on the night involved. In many cases, images from “night 1” contained at least one of the comparison stars used for differential photometry on “night 2”. In this situation, the science images taken for asteroid differential photometry were directly linked via Eq. 1. In other situations (e.g. where there was a gap of several nights between observations), it was necessary to take images of the two fields on a single night at nearly-equal low air mass so that the conditions of the two images were equivalent. Three nights in 2011 January at Altimira Observatory were devoted to this purpose, each night collecting images of several “lightcurve fields” at air masses between $X = 1.0$ and $X = 1.3$. These three nights were selected based on their good (clear and stable) atmospheric conditions. The atmospheric extinction on each of these nights was determined by the “Hardie method” (Hardie, 1962) using standard Landolt fields observed at different air masses. Knowing the first-order extinction (k'_C) enabled correction for the modest effect of observing the comp stars at different air mass:

$$C_B = C_A - [(IM_A - k'_C \cdot X_A) - (IM_B - k'_C \cdot X_B)] \quad \text{Eq. 2}$$

No correction for atmospheric extinction is included in Eq. 1 because, for the relatively small field of view, the air mass is essentially the same for both stars. Cross-checks of several comp stars imaged on different nights showed overall consistency of 0.02 mag (full range).

It was found that there was a small offset in the asteroid C magnitude between Altimira Observatory and Badlands Observatory observations. This is most likely related to slightly different spectral response of the two instruments. It was accommodated by adding an offset of 0.05 mag to the linked C mags for all observations from Badlands Observatory to line them up with Altimira Observatory observations. No other adjustments were made to any of the determined asteroid C magnitudes. The generally smooth trends of reduced magnitude on adjacent nights (shown in Figure 2) gave confidence in the linking of brightness across the span of observations.

The suspected rotational lightcurve was investigated by a search for plausible lightcurve periods by iterating the Fourier analysis routine in *MPO Canopus* with a 4-order Fourier model from $P = 16$ h to $P = 2100$ h. The only plausible periods found (based on minima in the curve of RMS vs. P, were:

P (h)	RMS
825	2.36
1436	2.57
1641	1.59
2140	2.04

Table 1. Period sweep of (846) Lipperta lightcurve data, with data points grouped 7:1 to reduce noise

Rotational lightcurves, wrapped to each of these four possible periods, were examined. An 825-h period presents a “single-peak” lightcurve – possible but atypical. A 1436-h period presents a typical double-peak lightcurve with the two peaks separated by a bit more than one-half rotation.

The lightcurve wrapped to the best-fit period $P = 1641$ h is shown in Figure 3. This is a subjectively attractive “two-peak” rotational lightcurve with the two brightness peaks nicely symmetrical – separated by one-half rotation at rotational phases $\theta \approx 0.20$ and $\theta \approx 0.70$ – and there are several widely-separated nights that line up well when wrapped to this period. It has the lowest formal error of the four identified candidate periods.

A lightcurve wrapped to $P = 2140$ h also presents a two-peak rotational lightcurve with the two brightness peaks separated by 0.4 rotation. However, we discount this result partly because it is not as good a formal fit compared to $P = 1641$ h and partly because the total span of observations (from 2010 Oct 20 to 2011 Jan 23) is only 2280 h (95 days), meaning that this lightcurve is almost equivalent to the unwrapped curve.

On several nights near opposition, the Altimira Observatory imaging sequence included BVR images of the asteroid. From these, and the known transformation coefficients for Altimira Observatory, the color indices of the asteroid were determined:

$$\begin{aligned} B-V &= 0.57 \pm 0.05 \\ V-R &= 0.33 \pm 0.03 \end{aligned}$$

The B-V result is consistent with the Small Bodies Node, which reports B-V = 0.61. The V-R result confirms that the asteroid is essentially the same color as the solar-color comp stars selected from the MPO Star Catalog.

Conclusions

846 Lipperta has a very long rotation period, $P = 1641 \pm 23$ hr, with a lightcurve amplitude of $\Delta m \approx 0.3$ mag during the 2010-2011 apparition.

This is an extraordinarily slow rotation. Only one reported period in the Asteroid Lightcurve data base (LCDB; Warner *et al.*, 2009) is longer: the near-Earth asteroid (162058) 1997 AE12, which has a reported period of $P = 1880$ h (Pravec, 2010). The LCDB contains only 13 asteroids with periods longer than 500 h. Among these slow-rotators, this report on 846 Lipperta is rare in that it is based on a span of observations that encompasses more than one rotation period ($\Delta T_{\text{span}} = 1.4 P$).

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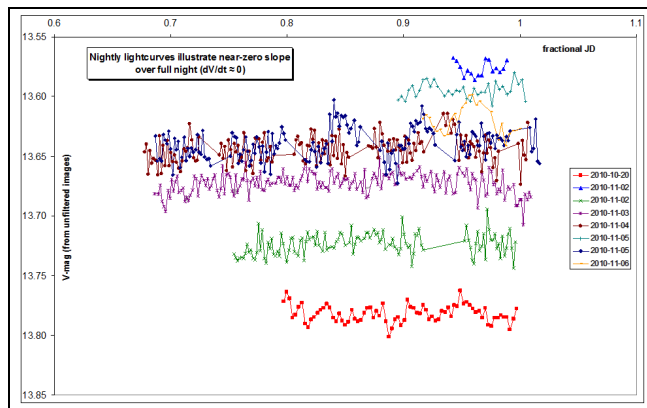


Figure 1. Asteroid brightness is essentially constant over all-night observations.

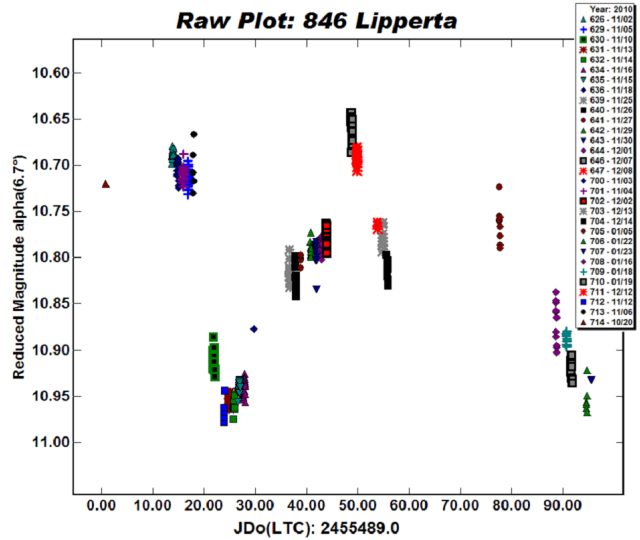


Figure 2: Reduced Magnitude (adjusted to constant solar phase angle) vs. JD for (846) Lipperta during 2010-2011 apparition. Minimum solar phase angle (□ □ 0.26 degrees) occurred at JD 2455517 (2010 Nov 16, or day 28 on the X-axis). MPO Canopus incorporates a phase angle adjustment based on the IAU-recommended H-G model of brightness versus solar phase angle, which is used in this plot. The reduced magnitudes illustrated here have all been adjusted to a constant solar phase angle (□ = □6.7 deg) using a slope parameter of G= 0.15.

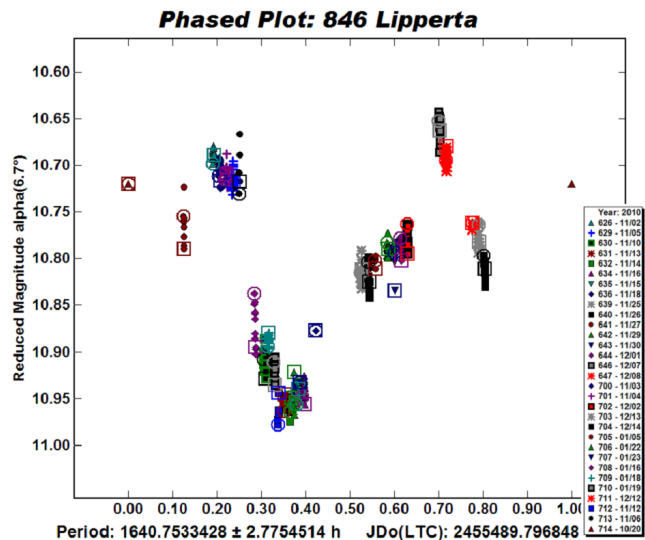


Figure 3: Lightcurve of Lipperta wrapped to P = 1641 hr. In this curve, each displayed data point is the average of (approximately) 7 observations to reduce the photometric noise.

ASTEROID LIGHTCURVE ANALYSIS AT THE VIA CAPOTE OBSERVATORY: 1ST QUARTER 2011

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Five asteroids were observed and their lightcurves measured at the Via Capote Observatory in early 2011: 862 Franzia (5.014 ± 0.001 h), 1383 Limburgia (> 5.0 h), 2802 Weisell (14.683 ± 0.002 h), 3577 Putilin (18.270 ± 0.002 h), and 52266 Van Flandern (9.89 ± 0.01 h)

CCD photometric observations were made of five asteroids in early 2011 at the Via Capote Observatory in southern California. See the introduction in Brinsfield (2011) for a description of equipment and software tools used for observations and measurements. For most sessions reported here, night-to-night zero point calibration was accomplished by selecting up to five comparison stars exhibiting 2MASS B-V color indexes similar to the sun. See Warner (2007) and Stephens (2008) for a further discussion of this process. Target selections were made using the Collaborative Asteroid Lightcurve Link (CALL) web-site and "Lightcurve Opportunities" articles from the *Minor Planet Bulletin*.

The results are summarized in the table below and include average phase angle information across the observational period. Individual lightcurve plots along with additional comments, as required, are also presented. All data reported here are available in ALCDEF-compliant format at the IAU Minor Planet Center Light Curve Database (http://minorplanetcenter.net/light_curve).

862 Franzia. Warner (2005) reported a period of 15.05 h and an ambiguous 7.6 h period using data obtained at two different apparitions, the first in 2000 and the second in 2004. Warner (2010) reported results on reanalyzed data with updated tools, and revised the period estimate to 7.52 h ($A = 0.13$ mag) for the data obtained in 2000 and 7.65 h ($A = 0.10$ mag), with a less likely period of 15.27 h for the data obtained in 2004. Behrend (2011) reports a provisional period of 5.05 h and 0.07 mag. The data reported here favor a period of 5.014 h with an amplitude of 0.20 mag. Using higher harmonic orders in the period analysis, there were indications of a possible period around 7 hours. In private communication with Warner, the 5.014 ± 0.001 h period was acknowledged as the favored one, while the 7-hour candidate was not sufficiently differentiated from noise, prompting the standard declaration for "more data".

1383 Limburgia. The campaign was interrupted by weather and subsequently the asteroid dropped below practical limits for the equipment at the Via Capote Observatory. Analysis of what data were obtained suggests that the period is longer than 5 h and the amplitude is greater than 0.07 mag. There are no other known reports of a period.

2802 Weisell. Behrend (2011) reports a period of 37.74 h with an amplitude of 0.41 mag. The data reported here favor a period of 14.683 ± 0.002 h with an amplitude of 0.37 mag. A less favorable period of just over 38 h can also be identified in the power spectrum graph shown below.

3577 Putilin. Dahlgren (1998) reports a period of 29.0 h with an amplitude of 0.27 mag. Analysis of the data from this apparition produced a preferred period of 18.270 ± 0.002 h with an amplitude of 0.24 h. There was some evidence of a period at just over 29 h. However, the period spectrum indicates this to be very weak.

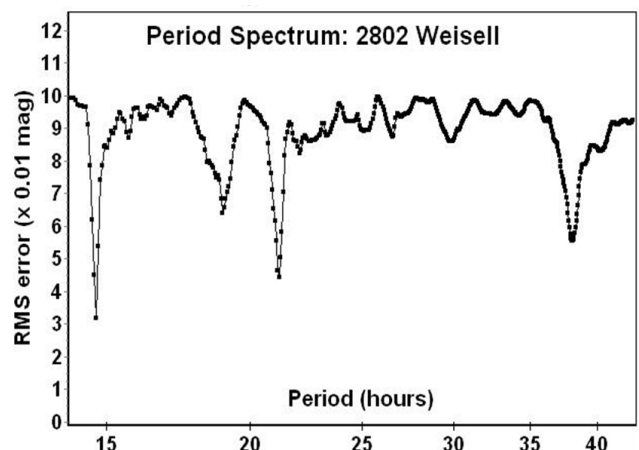
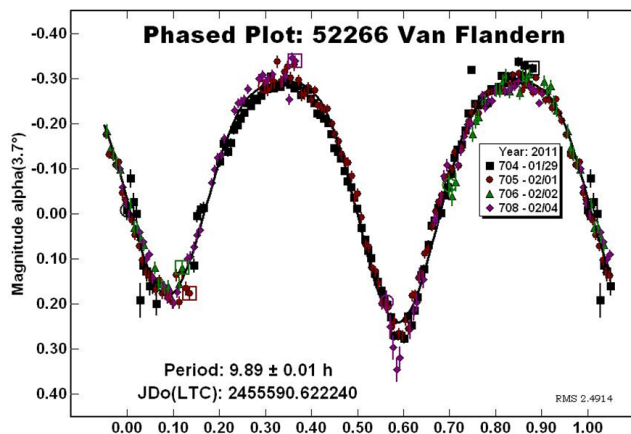
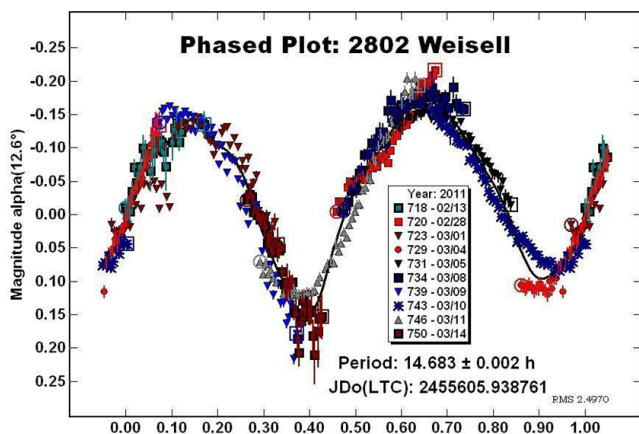
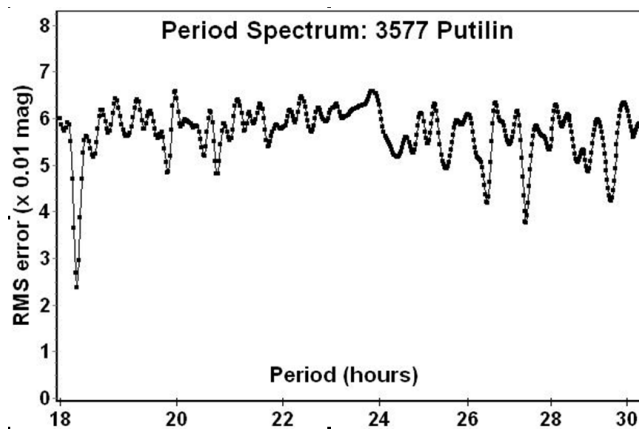
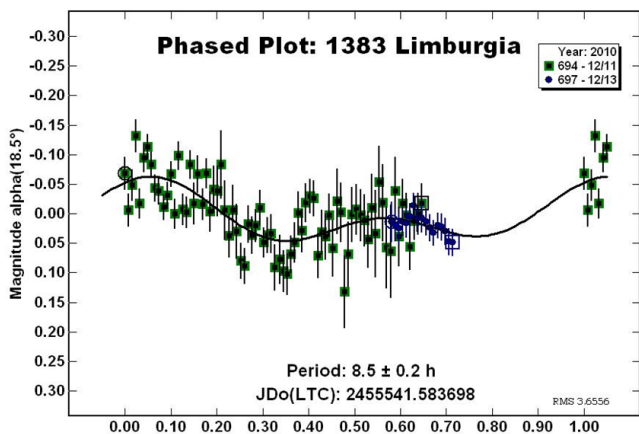
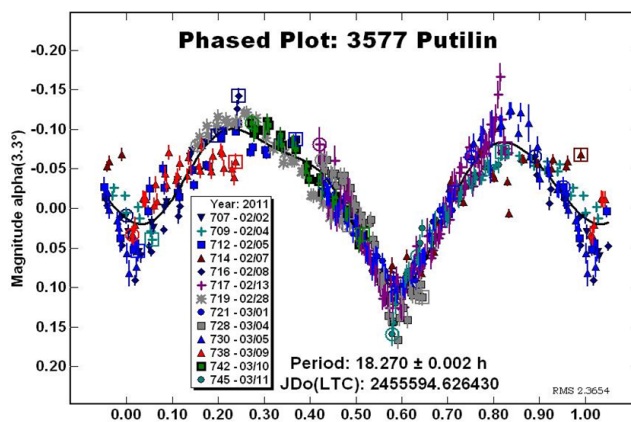
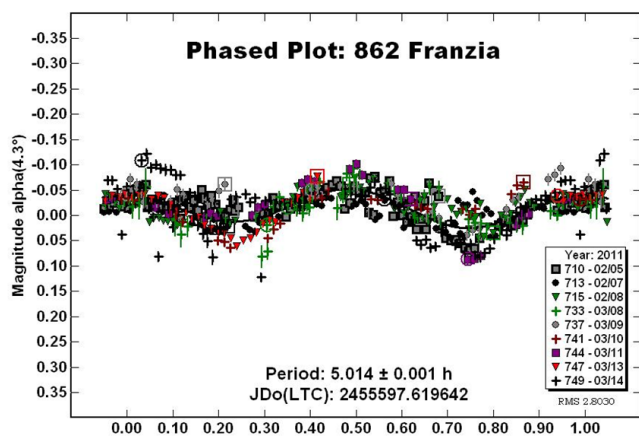
52266 Van Flandern. Behrend (2011) reports a period of 9.65 h and an amplitude of 0.59 mag. This agrees reasonably well with the 9.89 ± 0.01 h and 0.58 mag results obtained in this study.

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#	Name	Date Range (mm/dd) 2011 * 2010	Data Points	Phase	L _{PAB}	B _{PAB}	Per (h)	PE	Amp (m)	AE
862	Franzia	02/05 - 03/14	539	11	127	-4	5.014	0.001	0.20	0.03
1383	Limburgia	*12/11 - 12/13	95	19	32	0	>5		>0.07	
2802	Weisell	02/13 - 03/14	477	8	175	8	14.683	0.002	0.37	0.03
3577	Putilin	02/02 - 03/14	464	8	125	-2	18.270	0.002	0.24	0.025
52266	Van Flandern	01/29 - 02/04	338	6	124	-3	9.89	0.01	0.58	0.02

Table I. Observing circumstances. If multiple values for the phase angle are given, the object reached a minimum value during the span of observations. The middle value is the minimum phase angle. PAB is the Phase Angle Bisector.



**ROTATION PERIOD DETERMINATIONS FOR
28 BELLONA, 81 TERPSICHORE, 126 VELLEDA,
150 NUWA, 161 ATHOR, 419 AURELIA, AND
632 PYRRHA**

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Synodic rotation periods and lightcurve amplitudes have been found for 28 Bellona 15.706 ± 0.001 h, 0.06 ± 0.01 mag with one maximum and minimum per cycle; 81 Terpsichore 10.945 ± 0.001 hours, 0.09 ± 0.01 mag with one maximum and minima per cycle; 126 Velleda 5.3672 ± 0.0001 hours, 0.09 ± 0.01 mag; 150 Nuwa 8.1347 ± 0.0001 hours, 0.17 ± 0.02 mag; 161 Athor 7.2798 ± 0.0001 hours, 0.19 ± 0.02 mag; 419 Aurelia 16.781 ± 0.001 hours, 0.15 ± 0.02 mag with an irregular lightcurve; 632 Pyrrha 4.1167 ± 0.0001 hours, 0.40 ± 0.04 mag.

Observations of all of the objects reported here were made at the Organ Mesa Observatory with a Meade 35 cm LX200 GPS S-C, SBIG STL-1001E CCD, differential photometry only, unguided exposures, clear filter. *MPO Canopus* software was used to measure the images photometrically and prepare the lightcurves. Due to the large number of data points acquired the lightcurves have been binned in sets of three data points with a maximum of five minutes between points.

28 Bellona. The first rotation period investigation for Bellona was by van Houten-Groeneveld et al. (1979). They recognized an inability to accurately count cycles between observations on widely spaced dates, and suggested possible periods of 14.950, 15.697, 16.523, 17.441, and 18.467 hours. Harris and Young (1983) found a period of 15.695 hours and thereby determined which of the periods of van Houten-Groeneveld et al. (1979) was correct. More recent determinations include Warner (2007), 15.707 hours; Behrend (2011), 16.32 hours. Durech et al. (2011) combined all of these observations to obtain a sidereal period of 15.70785 hours, with as usual two ambiguous pole positions and longitude and latitude 284 deg, +10 deg; 103 deg, -8 deg, respectively. New observations on 7 nights 2010 Dec. 16 – 2011 Feb. 13 show a period 15.706 ± 0.001 hours, amplitude 0.06 ± 0.01 magnitudes, with one maximum and minimum per cycle. The new observations are consistent with all previous studies except Behrend (2011), which is now ruled out. They were made along an arc between longitude and latitude 119 deg, -9 deg, and 108 deg, -6 deg, respectively, close to the poles found by Durech et al. (2011). Many asteroids when observed near polar aspect illustrate the monomodal lightcurves found here.

81 Terpsichore Pilcher (2010) published a period of 10.943 hours which Harris et al. (2010) rated as secure. Timerson et al. (2010) published two moderately well observed occultations during the time frame of Pilcher's lightcurve and found the phase on the lightcurve of each occultation. These data made Terpsichore an especially useful target for lightcurve inversion modeling. New lightcurves were obtained on 5 nights 2011 Feb. 15 – Mar. 15 to assist this modeling. They show a period 10.945 ± 0.001 hours, amplitude 0.09 ± 0.01 magnitudes, with one maximum and

minimum per cycle. This is compatible with the earlier period determination.

126 Velleda. Previous rotation period determinations are by Dovgopoul et al. (1992), 5.364 hours; Licchelli (2006), 5.366 hours; and Behrend (2011), 5.36 hours. New observations on 5 nights 2011 Jan. 16 – Feb. 25 show a period 5.3672 ± 0.0001 hours, amplitude 0.09 ± 0.01 magnitudes and are fully compatible with all of the previous determinations.

150 Nuwa. Di Martino (1984) obtained lightcurves on three nights which he interpreted as compatible with either 8.14 or 12.2 hour rotation periods. Other previous rotation period determinations are by Armstrong (1996), 8.14 hours; Blanco et al. (1996), 8.140 hours; and Behrend (2011), 8.139 hours. For a period slightly longer than Earth commensurate the segment of the lightcurve visible from a single location circulates slowly to the left. The observing strategy for the new observations was to obtain a lightcurve at varying intervals of 5 to 10 days until full phase coverage for both suggested periods was obtained. New observations on 5 nights 2010 Dec. 11 – 2011 Jan. 28 show a period of 8.1347 ± 0.0001 hours, amplitude 0.17 ± 0.02 magnitudes. This is consistent with all previous results except for the suggested 12.2 hour period, which is ruled out.

161 Athor. Pilcher and Higgins (2008) published a secure period determination of 7.281 hours. Therein they evaluated several previous period determinations listed in Harris et al. (2010) which, though some are not individually definitive, are all consistent with a period near 7.28 hours. New lightcurves were obtained on 7 nights 2010 Nov. 11 – 2011 Jan. 31 to contribute to a spin/shape model. They show a period 7.2798 ± 0.0001 hours, amplitude 0.19 ± 0.02 magnitudes.

419 Aurelia. Several previous investigations have all shown irregular lightcurves with amplitudes up to 0.16 magnitudes. The shapes of the lightcurves varied greatly with oppositions at widely varying longitudes. Rotation periods found from these are: Harris and Young (1989) 16.709 hours or possibly 16.804 hours; Lagerkvist et al. (1992) a very uncertain 18.9 hours; Riccioli et al. (1995) 16.63 hours; Riccioli et al. (2001) 16.630 hours; Pilcher (2008) 16.784 hours; Pilcher (2010) 16.781 hours; Behrend (2011) 20.16 hours. Although a secure period of 16.784 hours is stated by Harris et al. (2010), new lightcurves were obtained on 11 nights 2010 Oct. 26 – 2011 Feb. 10 to contribute to a spin/shape model. These show a period of 16.781 ± 0.001 hours, maximum amplitude 0.15 ± 0.02 magnitudes, with an irregular lightcurve, in excellent agreement with previous studies. This and previous lightcurves show that 419 Aurelia has a more irregular shape than most asteroids. The 0.15 magnitude amplitude indicates these irregularities exist on a scale up to about 1/4 of the mean radius.

632 Pyrrha. Previous period determinations are by Lagerkvist (1978), 4.6 hours, and by Cieza et al. (1999), 4.687 hours. New observations on 5 nights 2011 Feb. 10 – Mar. 11 show a period 4.1167 ± 0.0001 hours, amplitude 0.40 ± 0.04 magnitudes, and rule out both of the previous period determinations.

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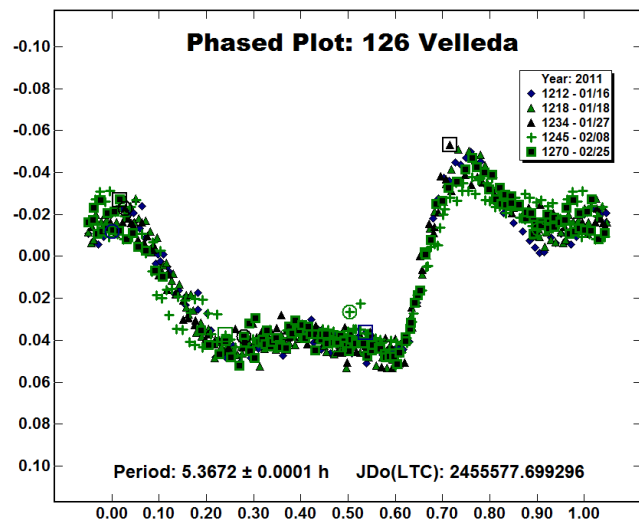
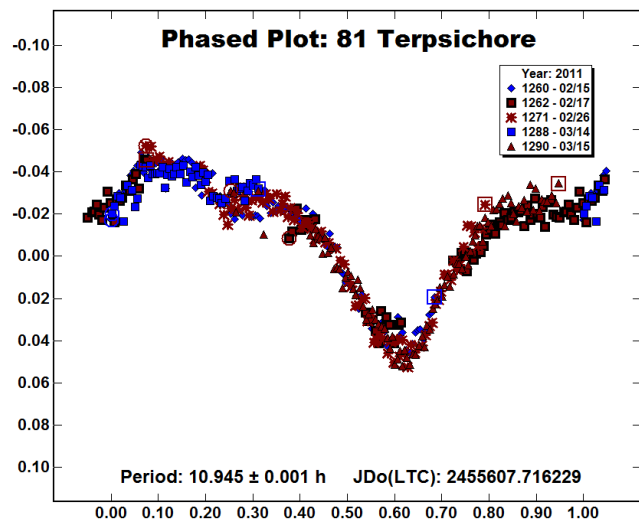
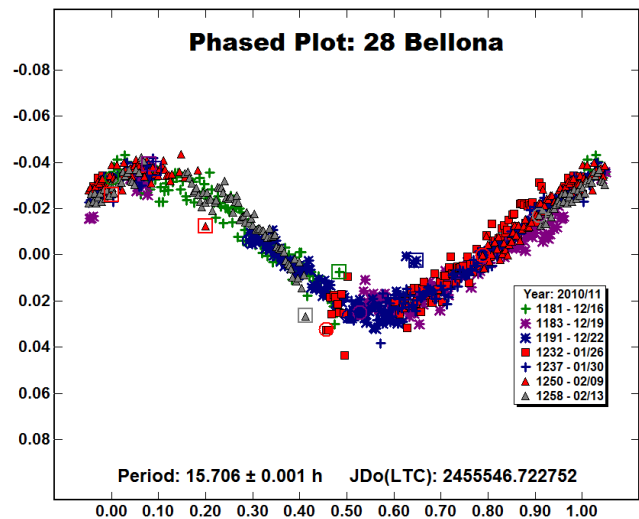
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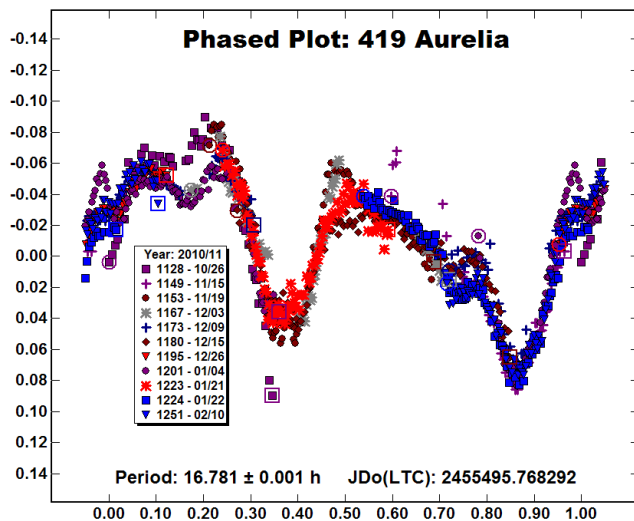
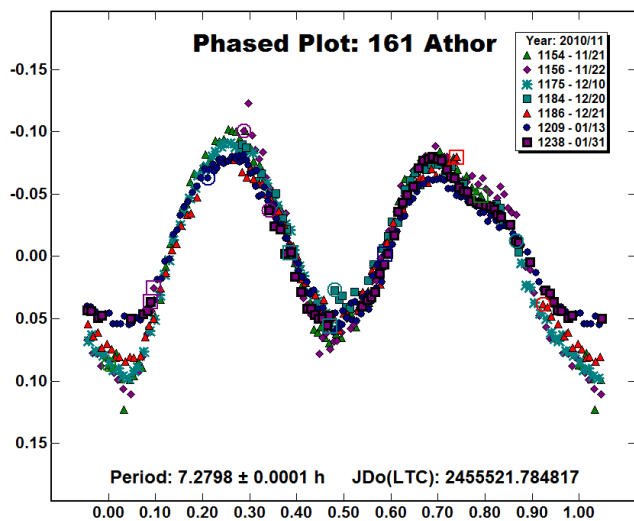
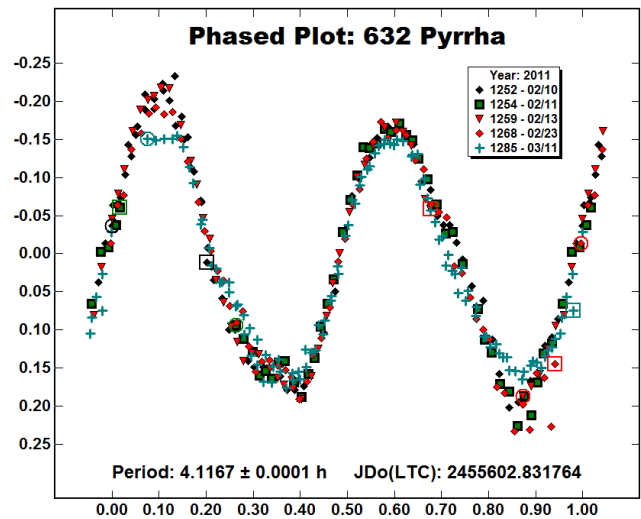
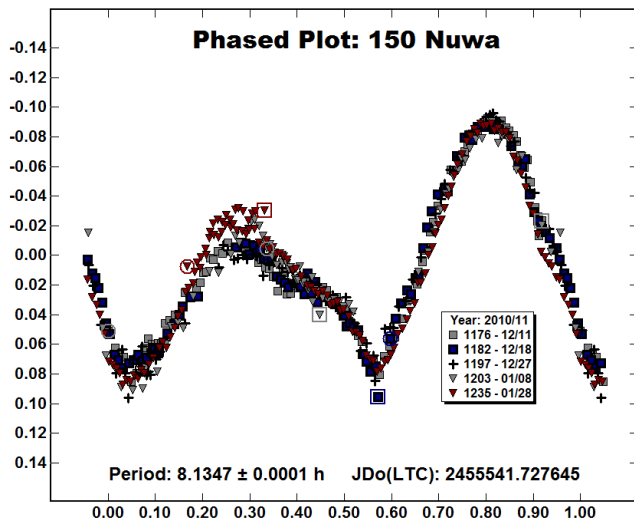
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CCD PHOTOMETRY AND LIGHTCURVE ANALYSIS OF 1318 NERINA, 4175 BILLBAUM, AND 5168 JENNER FROM OBSERVATORI CARMELITA (MPC B20) IN TIANA

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Observations carried out during 2011 January, February, and early March allowed us to determine the synodic periods of main-belt asteroids 1318 Nerina, 4175 Billbaum, and 5168 Jenner. For 1318 Nerina we derived a period of 2.528 ± 0.001 h, very much in line with a previous estimate. For 4175 Billbaum, a period of 2.908 ± 0.001 h with an amplitude of 0.18 mag was found. 5168 Jenner also showed a rapid rotational period of 3.258 ± 0.001 h, amplitude 0.39 mag.

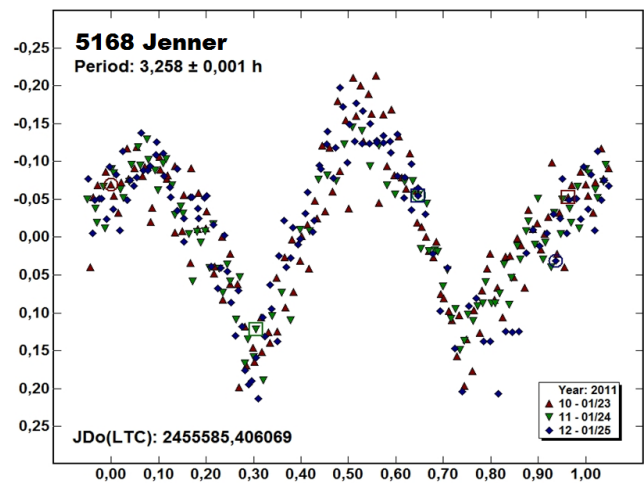
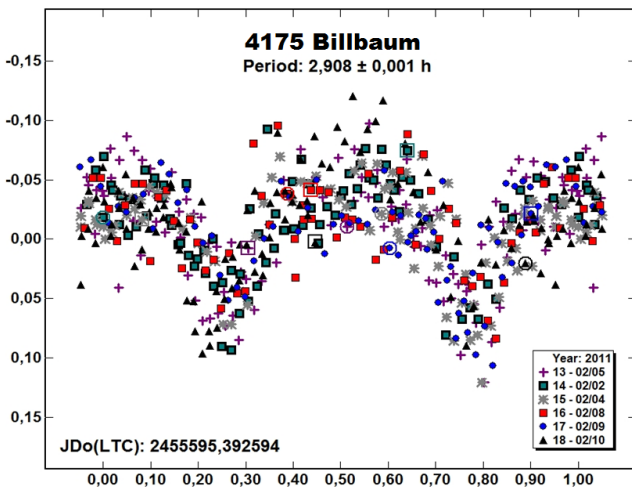
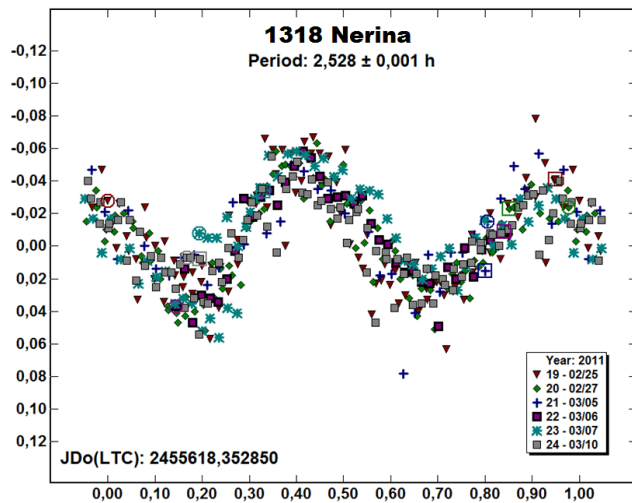
The *Carmelita Observatory* (MPC B20) is situated in the town of Tiana, in the southernmost part of the *Serra de Marina*, a moderately polluted suburban park 15 km north of Barcelona, Spain. The Observatory is equipped with an Astro-Physics AP900 German Equatorial Mount (GEM) on a fixed pier, a 25-cm Schmidt-Cassegrain telescope with a focal reducer, and a dual-chip SBIG ST8-XME CCD camera with filter wheel yielding a 34.0×22.7 arcmin field of view with a resolution of 1.33 arcsec/pixel. We used *Maxim DL* to acquire images and then calibrate with master bias, dark, and flat frames. Analysis of observations carried out with the same equipment during 2010 September and October allowed us to determine the synodic period of 1730 Marceline and 1996 Adams (Aymami, 2010).

1318 Nerina. We followed this asteroid on six nights from 2011 February 25 to March 10. It was selected from the list of Lightcurve Photometry Opportunities (Warner *et al.*, 2011) in order to try to improve the quality of the previously reported period of 2.536 h, amplitude 0.16 mag (Clark, 2007). We captured 439 150s C filter images with the CCD operating at a temperature of -14° C. Using the CMC-14 catalogue, we measured the asteroid

brightness at $R = 13.8$ with *Astrometrica* (Raab, 2011). The resulting lightcurve was produced with *MPO Canopus* (Warner, 2003) and shows a synodic period of 2.528 ± 0.001 h, which is in good agreement with the one suggested by Clark. The amplitude (A) was 0.12 mag. The lightcurve also shows an asymmetry with two maxima of different depth.

4175 Billbaum. We collected 604 images (150s) on six nights from 2011 February 2 to February 10 through a C filter with *Maxim DL* acquisition software. The CCD camera operated at -14° C. *Astrometrica* reported a magnitude of $R = 14.5$ -14.8 when using the CMC-14 catalog. We performed differential photometry of the asteroid with *Fotodif* (Castellano, 2011) as the images were being downloaded. This routine provided hints of small brightness variations and suggested a brief rotational period of modest amplitude. With *MPO Canopus* we derived a lightcurve showing a period of $2.908 \text{ h} \pm 0.001 \text{ h}$ and amplitude $A = 0.18$ mag. Warner *et al.* (2010) list no previous lightcurve parameters.

5168 Jenner. This asteroid was also in the Lightcurve Photometry Opportunities list (Warner *et al.* 2011). A total of 335 calibrated images of 150s through a C filter were collected with *Maxim DL* on the nights of 2011 January 23-25 with the CCD working at -20° C. The asteroid brightness was at $R = 14.9$ -15.1 as measured against the CMC-14 catalogue. Despite the asteroid's relatively modest brightness, we were able to construct a lightcurve. Analysis with *MPO Canopus* found a synodic period of 3.258 ± 0.001 h with an amplitude $A = 0.39$ mag.



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**GENERAL REPORT OF POSITION OBSERVATIONS
BY THE ALPO MINOR PLANETS SECTION
FOR THE YEAR 2010**

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(Received: 6 April)

Observations of positions of minor planets by members of the Minor Planets Section in calendar year 2010 are summarized.

During the year 2010 a total of 1398 positions of 423 different minor planets were reported by members of the Minor Planets Section. All of these are approximate visual positions.

The summary lists minor planets in numerical order, the observer and telescope aperture (in cm), UT dates of the observations, and the total number of observations in that period. The year is 2010 in each case.

Positional observations were contributed by the following observers:

Observer, Instrument	Location	Planets	Positions
Bookamer, Richard E. 41 cm reflector	Sebastian, Florida USA	87	334
Faure, Gerard 20 cm Celestron,	Col de l'Arzelier, France	32	75
Harvey, G. Roger 74 cm Newtonian	Concord, North Carolina, USA	185	631
Hudgens, Ben 41 cm f/4.5 Dobsonian 51 cm f/4.5 Dobsonian 81 cm f/5.0 Dobsonian	Stephenville, Texas, USA Lipan, Texas French Camp, MS	126	283
Pryal, Jim 20 cm f/10 SCT 12 cm f/8.33 refractor	Federal Way, WA USA and environs	16	34
Watson, William W. 20 cm Celestron	Tonawanda, NY USA and vicinity.	8	41

The faintest of the first 1000 minor planets to be numbered is 878 Mildred. Veteran visual observers R. Harvey and B. Hudgens journeyed to the Rainwater Observatory of the French Camp Academy, French Camp, MS 39745 USA where Edwin Austin kindly granted time on the 81 cm Dobsonian. Here Harvey and Hudgens successfully visually observed this object August 2 and 4. We congratulate Harvey for now having visually observed all of the first 1000 asteroids.

MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.
4 Vesta	Pryal, 12 Watson, 20	Feb 17-Mar 6 Mar 5-Apr 15	4 10
8 Flora	Harvey, 73	Sep 5	3
12 Victoria	Pryal, 20	May 14	2
36 Atalante	Pryal, 20	Oct 14	2
50 Virginia	Bookamer, 41	Feb 8	2
54 Alexandra	Pryal, 20	Oct 7	2

MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.
60 Echo	Pryal, 20	Mar 7	2
73 Klytia	Hudgens, 41	Mar 10-11	2
80 Sappho	Pryal, 20	May 14	2
92 Undina	Pryal, 20	Aug 16-17	2
123 Brunhild	Watson, 20	Dec 12	2
137 Meliboea	Bookamer, 41	Jan 16	2
144 Vibilia	Pryal, 20	Nov 4	2
175 Andromache	Pryal, 20	Oct 14	2
179 Klytaemnestra	Pryal, 20	Nov 4	2
212 Medea	Watson, 20	Dec 12	2
233 Asterope	Pryal, 20 Watson, 20	Oct 7 Sep 11-Oct 7	2 7
247 Eukrate	Pryal, 20	Oct 7	2
256 Walpurga	Bookamer, 41	Jan 16-Feb 4	5
260 Huberta	Bookamer, 41	Jan 3	2
274 Philagoria	Bookamer, 41	Apr 2	3
277 Elvira	Bookamer, 41	Mar 4-14	7
293 Brasilia	Bookamer, 41	Jan 11	2
307 Nike	Bookamer, 41	Feb 8-Mar 14	10
310 Margarita	Bookamer, 41	May 16	3
333 Badenia	Bookamer, 41	Jan 5	3
354 Eleonora	Watson, 20	Mar 6-8	3
381 Myrrha	Pryal, 20	May 14	2
425 Cornelia	Bookamer, 41	Jan 11	2
436 Patricia	Bookamer, 41	Mar 14	3
465 Alekto	Bookamer, 41	Mar 6-14	6
467 Laura	Faure, 20	Oct 8	2
473 Nolli	Hudgens, 41	Apr 17	2
475 Ocllo	Hudgens, 41	Dec 2	2
477 Italia	Pryal, 20	Oct 7	2
480 Hansa	Watson, 20	Nov 3-12	5
502 Sigune	Pryal, 20	Feb 20	2
509 Iolanda	Bookamer, 41	Apr 10	2
519 Sylvania	Pryal, 20	Oct 14	2
532 Herculina	Watson, 20	Apr 6-15	3
535 Montague	Bookamer, 41	Mar 6	2
560 Delia	Bookamer, 41	Feb 21	3
561 Ingwelde	Hudgens, 41	Dec 9	2
564 Dudu	Bookamer, 41	Jun 10	3
574 Reginhild	Bookamer, 41	Nov 25	3
581 Tauntonia	Bookamer, 41	Jan 6	3
617 Patroclus	Hudgens, 41	Jul 5-6	2
633 Zelima	Bookamer, 41	Jan 10	3
641 Agnes	Bookamer, 41	Dec 26	2
658 Asteria	Bookamer, 41	Mar 20	2
666 Desdemona	Bookamer, 41	Jan 12	3
722 Frieda	Bookamer, 41	Sep 12	3
725 Amanda	Bookamer, 41	Oct 9	3
728 Leonisis	Hudgens, 41	Jan 18	2

MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.	MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.
736 Harvard	Bookamer, 41	Dec 4	3	1266 Tone	Bookamer, 41	Aug 12	4
755 Quintilla	Bookamer, 41	May 8-30	4	1321 Majuba	Bookamer, 41	Jun 20	3
766 Moguntia	Bookamer, 41	Mar 15-20	7	1328 Devota	Hudgens, 41	Oct 10-11	2
793 Arizona	Hudgens, 41	May 6	2	1330 Spiridonia	Bookamer, 41 Hudgens, 41	Feb 8-Mar 14 Feb 6	10 2
815 Coppelia	Bookamer, 41	Dec 5	4	1340 Yvette	Hudgens, 41	Jun 2-5	2
816 Juliana	Bookamer, 41	Mar 20	3	1353 Maartje	Bookamer, 41	Sep 4	3
817 Annika	Bookamer, 41	Sep 4	3	1357 Khama	Hudgens, 41	Nov 6-8	2
829 Academia	Bookamer, 41	Apr 10	3	1373 Cincinnati	Faure, 20	Sep 3	2
836 Jole	Faure, 20 Hudgens, 41	Sep 10-11 Sep 6	2 2	1383 Limburgia	Hudgens, 41	Oct 12-13	2
840 Zenobia	Faure, 20	Oct 8	3	1391 Carelia	Hudgens, 41	Jul 5-6	2
858 El Djezair	Bookamer, 41	May 30	2	1396 Outeniqua	Bookamer, 41	Jun 20	3
859 Bouzareah	Bookamer, 41	Jan 7	3	1415 Malautra	Bookamer, 41	Mar 10	3
878 Mildred	Harvey, Hudgens, 81	Aug 2-4	12	1425 Tuorla	Hudgens, 41	Sep 5-6	2
881 Athene	Faure, 20	Sep 3	2	1428 Mombasa	Hudgens, 41	Jan 18	2
892 Seeligeria	Bookamer, 41	Mar 7-20	7	1451 Granö	Faure, 20	Apr 19	2
910 Anneliese	Bookamer, 41	May 13	3	1469 Linzia	Faure, 20	Oct 8	2
914 Palisana	Bookamer, 41 Faure, 20	Jan 16-Apr 4 Mar 13	11 2	1477 Bonsdorffia	Hudgens, 41	Dec 10	2
941 Murray	Hudgens, 41	Feb 6	2	1486 Marilyn	Hudgens, 41	Oct 12-13	2
954 Li	Bookamer, 41	Aug 10	3	1496 Turku	Faure, 20 Hudgens, 41	Sep 10-11 Sep 15-16	2 2
958 Asplinda	Harvey, 73 Hudgens, 51	Feb 21 Feb 16	3 2	1502 Arenda	Hudgens, 41	Nov 6-8	2
967 Helionape	Bookamer, 41	Jul 18	3	1512 Oulu	Hudgens, 41	Jun 1-2	2
981 Martina	Bookamer, 41	Oct 31	3	1516 Henry	Hudgens, 41	Feb 10	2
996 Hilaritas	Bookamer, 41	Mar 15	3	1519 Kajaani	Hudgens, 41	Sep 16	2
1010 Marlene	Bookamer, 41	Jan 7	3	1521 Seinäjoki	Hudgens, 41	Oct 12-13	2
1038 Tuckia	Faure, 20	Nov 6	2	1524 Joensuu	Hudgens, 41	Sep 5-6	2
1041 Asta	Bookamer, 41	Jan 7	3	1549 Mikko	Bookamer, 41	Feb 4	4
1050 Meta	Faure, 20	Sep 11	2	1567 Alikoski	Bookamer, 41	Apr 3	4
1058 Grubba	Bookamer, 41	Oct 9	3	1584 Fuji	Bookamer, 41	Dec 4	3
1068 Nofretete	Faure, 20 Hudgens, 41	Sep 3 Sep 5-6	2 2	1589 Fanatica	Hudgens, 41	Sep 5-6	2
1075 Helina	Bookamer, 41	Nov 6	3	1591 Baize	Hudgens, 41	May 5	2
1079 Mimosa	Hudgens, 41	Feb 10	2	1610 Mirnaya	Hudgens, 41	Dec 10	2
1080 Orchis	Bookamer, 41 Faure, 20	Oct 31 Nov 5-6	3 2	1617 Alschmitt	Hudgens, 41	Jun 17	2
1095 Tulipa	Bookamer, 41 Faure, 20	Apr 8 Apr 19-20	3 2	1625 The NORC	Faure, 20	Sep 3-4	3
1109 Tata	Bookamer, 41	May 16	3	1630 Milet	Hudgens, 41	Jan22-Feb 10	4
1129 Neujmina	Bookamer, 41	Jan 3-5	5	1643 Brown	Hudgens, 41	Sep 30	2
1142 Aetolia	Hudgens, 41	Apr 22	2	1652 Hergé	Hudgens, 41	May 3	2
1150 Achaia	Faure, 20	Sep 3	2	1661 Granule	Hudgens, 41	Jul 6	2
1154 Astronomia	Hudgens, 41	Jun 1-2	2	1663 van den Bos	Bookamer, 41	Oct 2	3
1175 Margo	Hudgens, 41	Aug 8-9	2	1669 Dagmar	Hudgens, 41	Apr 16	2
1178 Irmela	Hudgens, 41	Mar 4-10	4	1674 Groeneveld	Hudgens, 41	Dec 10	2
1187 Afra	Faure, 20	Sep 3-10	5	1680 Per Brahe	Bookamer, 41	May 16	4
1194 Aletta	Bookamer, 41	Mar 4-14	7	1684 Iguassú	Hudgens, 41	Jun 5-17	3
1199 Geldonia	Faure, 20	Nov 5	2	1693 Hertzprung	Bookamer, 41	May 31	4
1239 Queteleta	Hudgens, 41	Jan 22-Feb 6	3	1699 Honkasalo	Bookamer, 41	Sep 12	3
1259 Ógyalla	Hudgens, 41	Mar 10-11	2	1708 Pólit	Bookamer, 41	Jan 19	3
				1737 Severny	Hudgens, 41	Feb 14	2
				1739 Meyermann	Hudgens, 41	Jun 17	2

MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.	MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.
1773 Rumpelstilz	Bookamer, 41	May 8	4	2617 Jiangxi	Bookamer, 41	Jan 5	3
1795 Woltjer	Hudgens, 41	Apr 16	2	2649 Oongaq	Hudgens, 41	Dec 3	2
1801 Titicaca	Hudgens, 41	Oct 30-31	2	2650 Elinor	Bookamer, 41	Sep 18	3
1811 Bruwer	Hudgens, 41	Sep 5-6	2	2688 Halley	Harvey, 73	May 5	3
1823 Gliese	Hudgens, 41	Mar 13-14	2	2715 Mielikki	Hudgens, 41	Sep 5-6	2
1829 Dawson	Bookamer, 41	Jan 10	3	2801 Huygens	Harvey, 73	Oct 3	3
	Hudgens, 41	Jan 18	2	2848 ASP	Hudgens, 41	Nov 1	2
1837 Osita	Hudgens, 41	Jun 17	2	2853 Harvill	Harvey, 73	Nov 7	3
1850 Kohoutek	Hudgens, 41	Jul 5-6	2		Hudgens, 41	Nov 6-7	2
1854 Skvortsov	Hudgens, 41	Feb 14	2	2919 Dali	Harvey, 73	Jul 11	3
1860 Barbarossa	Hudgens, 41	Oct 29-31	3	2954 Delsemme	Hudgens, 41	May 6	2
1867 Deiphobus	Hudgens, 41	Jul 14	2	2995 Taratuta	Harvey, 73	Mar 24	3
1888 Zu Chong-Zhi	Bookamer, 41	Jan 7	3	2996 Bowman	Harvey, 73	Oct 31	3
1889 Pakhmutova	Hudgens, 41	Dec 10	2	3053 Dresden	Hudgens, 41	Aug 8-9	2
1908 Pobeda	Hudgens, 41	Jun 5-17	3	3066 McFadden	Bookamer, 41	Nov 6	3
1933 Tinchén	Hudgens, 41	Sep 15-16	2	3104 Dürer	Faure, 20	Sep 10	2
1952 Hesburgh	Bookamer, 41	Jan 6	3	3112 Velimir	Hudgens, 41	Aug 8-9	2
1961 Dufour	Hudgens, 41	Mar 10-11	2	3133 Sendai	Hudgens, 41	Oct 12-13	2
1968 Mehlretter	Hudgens, 41	Jun 16-17	2	3173 McNaught	Hudgens, 41	Sep 5-6	2
1983 Bok	Harvey, 73	Nov 28	3	3184 Raab	Faure, 20	Sep 4	2
					Hudgens, 41	Sep 5	2
1996 Adams	Faure, 20	Nov 5	2	3221 Changshi	Hudgens, 41	Sep 16	2
1998 Titius	Hudgens, 41	Jun 3	2	3222 Liller	Harvey, 73	Jul 4	3
2012 Guo Shou-Jing	Harvey, 73	Aug 31	3	3259 Brownlee	Bookamer, 41	May 31-Jun 12	5
2014 Vasilevskis	Bookamer, 41	Apr 3-6	4	3276 Porta Coeli	Harvey, 73	Dec 4	3
2021 Poincaré	Hudgens, 41	Sep 28-30	2	3295 Murakami	Hudgens, 41	Sep 15-16	2
2114 Wallenquist	Hudgens, 41	Apr 9-16	3	3296 Bosque Alegre	Harvey, 73	Nov 13	3
2121 Sevastopol	Bookamer, 41	Oct 2	3	3305 Ceadams	Harvey, 73	Apr 13	3
2213 Meeus	Hudgens, 41	Oct 10	2	3317 Paris	Hudgens, 41	Jul 14-15	2
2293 Guernica	Hudgens, 41	Feb 14	2	3388 Tsanghinchi	Harvey, 73	Dec 28	3
2294 Andronikov	Harvey, 73	Jul 11	3	3389 Sinzot	Harvey, 73	Nov 13	3
2297 Daghestan	Faure, 20	Apr 19-20	2	3408 Shalamov	Hudgens, 41	Sep 16	2
	Hudgens, 41	Apr 11-16	3	3459 Bodil	Hudgens, 41	Jun 17	2
2360 Volgo-Don	Hudgens, 41	Nov 1	2	3468 Urgenta	Harvey, 73	Nov 28	3
2366 Aaryn	Harvey, 73	Dec 28	3	3510 Veeder	Harvey, 73	Aug 31	3
2375 Radek	Bookamer, 41	Apr 8-10	4				
	Hudgens, 41	Apr 22	2	3554 Amun	Faure, 20	Mar 13-14	6
2381 Landi	Faure, 20	Mar 13-14	3	3614 Tumilty	Hudgens, 41	Jul 14	2
2429 Schürer	Hudgens, 41	Oct 12-13	2	3674 Erbisbühl	Bookamer, 41	Aug 10	3
2437 Amnestia	Hudgens, 41	Sep 30	2	3699 Milborne	Harvey, 73	Oct 30	3
2443 Tomeileen	Bookamer, 41	Jan 11	3	3738 Ots	Hudgens, 41	Aug 8-9	2
2446 Lunacharsky	Hudgens, 41	May 6	2	3754 Kathleen	Bookamer, 41	Mar 6	3
2488 Bryan	Harvey, 73	Nov 13	3	3808 Tempel	Harvey, 73	Feb 20-21	3
2492 Kutuzov	Harvey, 73	Apr 18	3	3833 Calingasta	Hudgens, 41	Aug 8-9	2
2493 Elmer	Harvey, 73	Oct 2	3	3851 Alhambra	Harvey, 73	Feb 17	3
2500 Alascattalo	Hudgens, 41	May 3	2	3877 Braes	Harvey, 73	Jul 4	3
2501 Lohja	Bookamer, 41	Jun 12	3	3833 Verbano	Hudgens, 41	Sep 28-30	2
2530 Shipka	Harvey, 73	Oct 2	3	3910 Liszt	Harvey, 73	Mar 24	3
2575 Bulgaria	Hudgens, 41	Jul 14	2	3921 Klement'ev	Hudgens, 41	Sep 16	2
2584 Turkmenia	Harvey, 73	Oct 3	3	3945 Gerasimenko	Harvey, 73	Oct 31	3
2607 Yakutia	Hudgens, 41	Aug 8-9	2				

MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.	MINOR PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2006)	NO. OBS.
3947 Swedenborg	Harvey, 73	Oct 31	3	5430 Luu	Hudgens, 41	Jul 14	2
3985 Raybatson	Hudgens, 41	Jun 17	2	5483 Cherkashin	Hudgens, 41	Jun 1-2	2
3989 Odin	Harvey, 73	Nov 13	3	5492 Thoma	Harvey, 73	Oct 9	3
4000 Hipparchus	Harvey, 73	Jan 19	3	5534 1941 UN	Bookamer, 41 Hudgens, 41	Dec 3 Dec 3	3 2
4039 Souseki	Harvey, 73	Nov 28	3	5550 1981 UB1	Harvey, 73	Jan 19	3
4051 Hatanaka	Faure, 20	Sep 3	2	5573 1981 QX	Harvey, 73	Jul 4	3
4077 Asuka	Harvey, 73	Jan 10	3	5616 Vogtland	Harvey, 73	Jan 6	3
4085 Weir	Harvey, 73	Apr 13	3	5632 Ingelehmann	Harvey, 73	Jan 7	3
4127 Kyogoku	Harvey, 73	Oct 10	3	5714 Krasinsky	Harvey, 73	Oct 9	3
4132 Bartók	Hudgens, 41	Jan 18	2	5723 Hudson	Harvey, 73	Oct 10	3
4189 Sayany	Harvey, 73	Jul 11	3	5754 1992 FR2	Harvey, 73	Sep 5	3
4211 Rosniblett	Faure, 20 Harvey, 73	Oct 9 Oct 2	2 3	5803 Ötzi	Hudgens, 41	Sep 16	2
4215 Kamo	Harvey, 73	Dec 28	3	5869 Tanith	Harvey, 73	Nov 14	3
4223 Shikoku	Faure, 20	Sep 10	2	5967 Edithlevy	Harvey, 73	Feb 4	3
4252 Godwin	Harvey, 73	Apr 18	3	6163 Reimers	Harvey, 73	Oct 16	3
4290 Heisei	Harvey, 73	Oct 9	3	6273 Kiruna	Harvey, 73	Nov 13	3
4298 Jorgenúnez	Hudgens, 41	Oct 31-Nov 1	3	6290 1985 CA2	Harvey, 73	Nov 13	3
4360 Xuyi	Harvey, 73	Oct 9	3	6302 Tengkogen	Harvey, 73	Jan 11	3
4376 Shigemori	Harvey, 73	Jan 6	3	6307 Maiztegui	Harvey, 73	Dec 29	3
4410 Kamiumintara	Harvey, 73	Oct 31	3	6348 1995 CH1	Harvey, 73	Jan 6	3
4436 1983 EX	Harvey, 73	Nov 28	3	6353 Semper	Harvey, 73	Nov 28	3
4472 Navashin	Harvey, 73	Oct 2	3	6361 1978 VL11	Harvey, 73 Hudgens, 41	May 5 May 8	3 2
4502 Elizabethann	Hudgens, 41	Mar 4-11	5	6382 1988 EL	Harvey, 73	Feb 17	3
4525 Johnbauer	Harvey, 73	Jan 6	3	6386 Keithnoll	Bookamer, 41	Dec 12	3
4632 Udagawa	Harvey, 73	Nov 14	3	6388 1984 WL1	Harvey, 73	Dec 28	3
4644 Oumu	Harvey, 73	Apr 18	3	6399 Harada	Harvey, 73	Mar 24	3
4717 Kaneko	Harvey, 73	Nov 13	3	6410 Fujiwara	Harvey, 73	Oct 10	3
4729 Mikhailmil'	Hudgens, 41	Dec 3	2	6414 Mizunuma	Harvey, 73	Jan 6-7	3
4744 1988 RF5	Bookamer, 41	Apr 5-10	6	6448 1991 CW	Harvey, 73	Nov 28	3
4788 Simpson	Harvey, 73	Dec 4	3	6484 Barthibbs	Harvey, 73	Jan 7	3
4800 1989 TG17	Harvey, 73	Oct 10	3	6659 Pietsch	Harvey, 73	Nov 14	6
4860 Gubbio	Faure, 20	Sep 10	2	6660 Matsumoto	Harvey, 73	Nov 13	3
4889 Praetorius	Harvey, 73	Dec 28	3	6673 Degas	Harvey, 73 Hudgens, 41	Oct 9 Sep 28-30	3 2
4916 Brumberg	Harvey, 73	Feb 17	3	6706 1988 VD3	Harvey, 73	Oct 31	3
4964 Kourovka	Harvey, 73	Oct 30	3	6880 Hayamiyu	Harvey, 73	Jan 14	3
4988 Chushuho	Harvey, 73	Nov 28	3	6898 Saint-Marys	Harvey, 73	May 9	3
5104 Skripnichenko	Hudgens, 41	Apr 16	2	7091 1992 JA	Harvey, 73 Hudgens, 41	May 9 Jun 2-5	6 2
5116 Korsør	Harvey, 73	Jan 7	3	7203 Sigeki	Harvey, 73	Jan 11	3
5131 1990 BG	Hudgens, 41	Jan 22-Feb 6	3	7302 1993 CQ	Harvey, 73	Oct 9	3
5142 Okutama	Faure, 20	Nov 5	2	7381 Mamontov	Harvey, 73	Oct 9	3
5144 Achatas	Hudgens, 41	Jun 17	2	7476 Ogiltsbie	Hudgens, 41	Apr 22	2
5169 Duffell	Harvey, 73	Nov 13	3	7558 Yurlov	Harvey, 73	Dec 28	3
5215 Tsurui	Bookamer, 41	Jul 19	2	7590 Aterui	Harvey, 73	Jan 11	3
5225 Loral	Harvey, 73	Oct 17	3	7691 Brady	Harvey, 73	Nov 13	3
5316 Filatov	Harvey, 73	Nov 13	3	7711 Řip	Harvey, 73	Nov 7	3
5325 Silver	Hudgens, 41	Jul 14	2	7736 Nizhnij Novgorod	Harvey, 73	Aug 31	3
5357 1992 EL	Faure, 20	Oct 8-9	2				
5359 Markzakharov	Harvey, 73	Oct 31	3				

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7837 Mutsumi	Harvey, 73	Oct 30	3	19261 1995 MB	Harvey, 73 Hudgens, 41	Jun 21 Jul 12-14	6 3
8091 1992 BG	Harvey, 73	Feb 17	3	19912 Aurapententa	Harvey, 73	Sep 6	3
8159 Fukuoka	Harvey, 73	Dec 28	3	20187 Janapittichová	Harvey, 73	Nov 7	6
8259 1983 UG	Harvey, 73	Oct 16	3	20310 1998 FD117	Harvey, 73	Oct 30	3
8292 1992 SU14	Harvey, 73	Nov 7	3	20691 1999 VY72	Harvey, 73	Nov 28	3
8306 Miyaji	Harvey, 73	Dec 4	3	20898 Fountainhills	Hudgens, 41	Jan 18	2
8444 Popovich	Harvey, 73	Oct 30	3	23080 1999 XH100	Harvey, 73	May 9	3
8563 1995 US	Harvey, 73	Sep 5	3	24737 1992 ED14	Harvey, 73	Oct 9	3
8611 1977 UM4	Harvey, 73	Oct 10	3	24738 1992 EK14	Harvey, 73	Sep 5	3
9052 Uhland	Harvey, 73	Oct 3	3	24761 Ahau	Harvey, 73	Jan 19	6
9805 1997 NZ	Harvey, 73	Sep 5	3	24980 1998 KF2	Harvey, 73	Oct 30	3
10217 Richardcook	Harvey, 73	Oct 30	3	27748 Vivianhoette	Harvey, 73	Jan 10	3
10357 1993 SL3	Hudgens, 41	Sep 30	2	28637 2000 FB48	Harvey, 73	Sep 6	3
10452 Zuev	Harvey, 73 Hudgens, 41	Sep 6 Sep 5-6	3 2	29311 Lesire	Harvey, 73	Nov 28	3
10496 1986 RK	Harvey, 73	Jul 5	3	29769 1999 CE28	Harvey, 73	Nov 7	3
10721 Tuterov	Harvey, 73	Oct 10	3	30105 2000 FO3	Harvey, 73	May 9	3
10731 1988 BL3	Harvey, 73	Oct 30	3	30856 1991 XE	Harvey, 73	May 9	3
10829 Matsuobasho	Harvey, 73	Nov 7	3	33717 1999 LS26	Harvey, 73	Jan 19	3
11079 Mitsunori	Harvey, 73	Jan 13	3	33750 Davehiggins	Harvey, 73	Mar 24	3
11086 Nagatayuji	Harvey, 73	Oct 16	3	34708 2001 OG95	Harvey, 73	Jan 6	3
11202 Teddunham	Harvey, 73	Oct 3	3	36294 2000 GS152	Harvey, 73	Nov 7	3
11220 1999 JM25	Harvey, 73	Oct 31	3	40717 1999 SC2	Harvey, 73	Oct 17	3
11277 Ballard	Harvey, 73	Jun 21	3	41691 2000 AK119	Harvey, 73	Jul 5	3
11822 1981 TK	Harvey, 73	Oct 30	3	45224 1999 XO209	Harvey, 73	Jan 11	3
11836 Eileen	Harvey, 73	Dec 28	3	54789 2001 MZ7	Bookamer, 41 Harvey, 73 Hudgens, 41	Jan 12-Feb 8 Jan 11 Jan 18-Feb 14	12 6 4
11852 Shoumen	Hudgens, 41	Sep 5-6	2	66146 1998 TU3	Bookamer, 41	Sep 18	4
11919 1992 UD2	Harvey, 73	Nov 7	3	66284 1999 JU15	Harvey, 73	Oct 16-30	6
13155 1995 SB1	Harvey, 73	Nov 7	3	103067 1999 XA143	Harvey, 73	Jan 19	6
13374 1998 VT10	Harvey, 73	Apr 18	3	154029 2002 CY46	Faure, 20 Harvey, 73	Sep 4 Sep 5	3 6
13628 1995 WE	Harvey, 73	Jan 5-6	4	2001 PT9	Harvey, 73	Feb 21	6
14425 1991 TJ2	Hudgens, 41	Aug 8-9	2	2002 VE68	Harvey, 73	Nov 7	6
14426 1991 UO2	Harvey, 73	Jan 13	3	2003 UV11	Bookamer, 41 Hudgens, 41 Watson, 20	Oct 28 Oct 27-30 Oct 30	15 9 9
14657 1998 YU27	Harvey, 73	Sep 1-3	3	2005 GC120	Harvey, 73	Dec 4	6
14706 2000 CQ2	Harvey, 73	Oct 17	3	2005 YU55	Harvey, 73	Apr 17	6
14741 2000 EQ49	Harvey, 73	Jan 14	3	2007 RU17	Harvey, 73	Oct 16	6
14790 Beletskij	Hudgens, 41	Sep 28-30	2	2009 UN3	Harvey, 73	Feb 11	6
14999 1997 VX8	Harvey, 73	Dec 4	3	2010 AL30	Harvey, 73	Jan 13	3
15490 1999 CJ81	Harvey, 73	Dec 4	3	2010 BC	Harvey, 73	Jan 23	6
15491 1999 CW85	Hudgens, 41	Jul 14	2	2010 GU21	Harvey, 73	May 1	6
15710 Böcklin	Harvey, 73	Jun 12	6	2010 JL33	Bookamer, 41 Harvey, 73	Dec 12 Dec 9	5 6
16463 Nayoro	Harvey, 73	Jan 10	3	2010 RC130	Harvey, 73	Oct 3	6
16694 1995 AJ	Harvey, 73	Oct 3	3	2010 SC41	Harvey, 73	Dec 2	6
17312 7622 P-L	Harvey, 73	Nov 17	3				
17520 1993 BX2	Harvey, 73	Feb 17	3				
17890 1999 DU6	Harvey, 73	Jan 13	3				
18042 1999 RF2	Harvey, 73	Feb 18	3				
18922 2000 PU12	Harvey, 73	Jan 7	3				

ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2011 JANUARY - MARCH

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(Received: 5 April)

Lightcurves results for three asteroids were obtained at Santana Observatory from 2011 January to March: 1177 Gonnessia, $P=30.51 \pm 0.02$ h, $A=0.11 \pm 0.02$ mag.; 1318 Nerina, $P=2.5280 \pm 0.0005$ h, $A=0.11 \pm 0.02$ mag.; and 5168 Jenner, $P=3.257 \pm 0.001$ h, $A=0.24 \pm 0.02$ mag.

Observations at Santana Observatory (MPC Code 646) were made with a 0.30-m Schmidt-Cassegrain (SCT) with an SBIG STL-1001E. 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 also done using *MPO Canopus* using the Fourier analysis algorithm (FALC) developed by Harris (Harris *et al.*, 1989). The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner *et al.*, 2011).

The results are summarized in the table below, as are individual plots. The plots are “phased”, i.e., they range from 0.0 to 1.0 of the stated period. The plots are scaled such that 1.0 mag has the same linear size as the horizontal axis from 0.0 to 1.0. Night-to-night calibration of the data (generally $< \pm 0.05$ mag) was done using field stars converted to approximate Cousins R magnitudes based on 2MASS J-K colors (Warner, 2007; Stephens, 2008).

1177 Gonnessia. Warner (2003) reported a period of 6.82 h using sparse data over 5 nights in July 2003 ($L_{PAB} = 15^\circ$). Upon learning of the new period determination, Warner reprocessed the images using field stars converted to approximate Cousins R magnitudes and found the data set was too sparse to determine a longer period. However the amplitude was at least 0.15 magnitudes (private communication). Behrend (2011) reported the period was 12 h based upon a single night's observations on 2002 July 16 with an amplitude of about 0.20 magnitudes ($L_{PAB} = 312^\circ$).

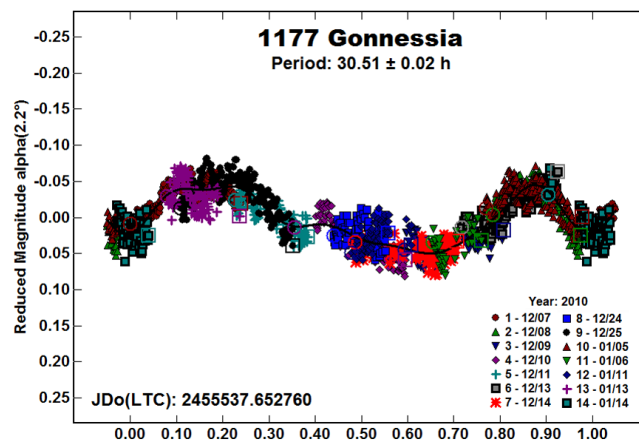
1318 Nerina. Behrend (2011) reported a period of 2.54 h based on a single night's observations on 2011 January 02, which did not span the entire rotational period. Clark (2007) reported a period of 2.536 h based on three sessions in 2007 February and March. Both are in good agreement with the period reported here. Russ Durkee obtained a single night overlapping these observations on 2011 February 8. He determined a period of 2.503 h (private communication) which is in reasonable agreement with this result.

5168 Jenner. Sergison (2011) reported a period of 3.262 h based on three sessions in 2011 March 2011, which is in good agreement with the result given here.

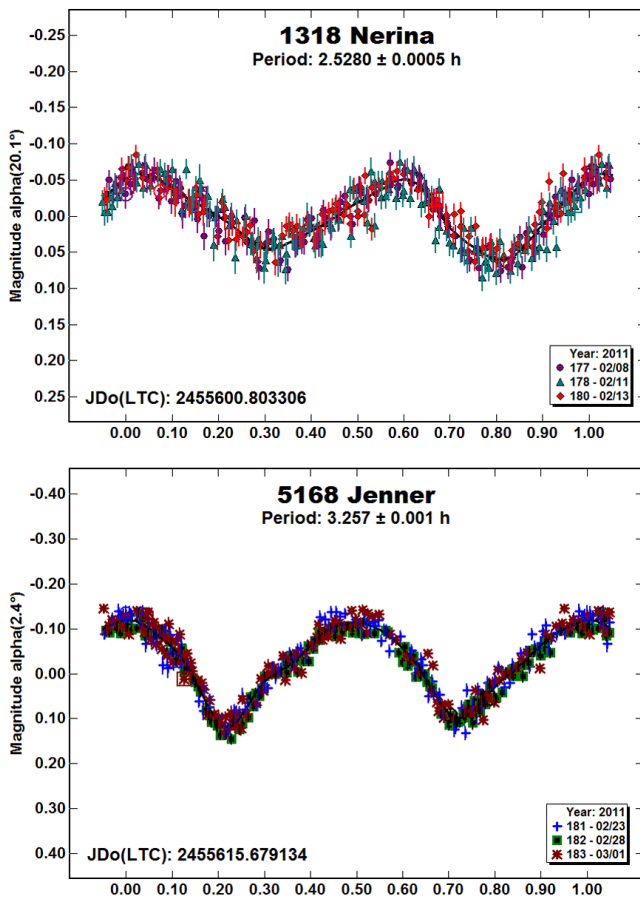
The data were uploaded to The Minor Planet Center's Lightcurve database (MPC, 2011).

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#	Name	mm/dd 2010/11	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
1177	Gonnessia	12/07 - 01/14	1731	2.2, 0.9, 10.8	80	-4	30.51	0.02	0.11	0.02
1318	Nerina	02/08 - 02/13	386	20.3, 18.0	168	12	2.5280	0.0005	0.11	0.02
5168	Jenner	02/23 - 03/01	397	2.6, 1.0, 2.0	157	1	3.257	0.001	0.24	0.02



THE LIGHTCURVE FOR THE LONG-PERIOD ASTEROID 1663 VAN DEN BOS

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The main-belt asteroid 1663 van den Bos was observed 2010 September to November. The derived lightcurve has a synodic period of 740 ± 10 h and amplitude of 0.8 ± 0.05 mag.

Observations of the main-belt asteroid 1663 van den Bos were made by the authors from 2010 September 27 through November 01. The combined data set consists of 3088 data points. Most images were unbinned with no filter. Stephens' observations were with a 0.30-m or a 0.35-m SCT with a SBIG STL-1001e CCD camera. Higgins observations were made with a 0.35-m SCT using a SBIG STL-8e CCD Camera. 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 (Harris et al., 1989).

Night-to-night calibration of the zero points was done by using 2MASS magnitudes of up to five comparison stars of similar color to an asteroid. See Warner (2007) and Stephens (2008) for a further discussion of this process that provides calibration of the nightly zero points typically good to within 0.05 magnitudes. When working long-period asteroids where a single observing session typically produces a flat curve, it is necessary to calibrate the night-to-night zero points.

1663 van den Bos does not have a previously reported rotational period. Stephens and Higgins independently selected it from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2010).

The combination of the 720 h period and estimated size of 12 km make the asteroid a good candidate for tumbling, or non-principal axis rotation (Pravec et al., 2005). After observing the asteroid for a full rotational period, the first maximum was 0.1 magnitude brighter than it was on the previous rotation. However, the conversion of the 2MASS magnitudes has errors up to ± 0.05 mag. For this reason we cannot say for certain whether or not van de Bos is tumbling.

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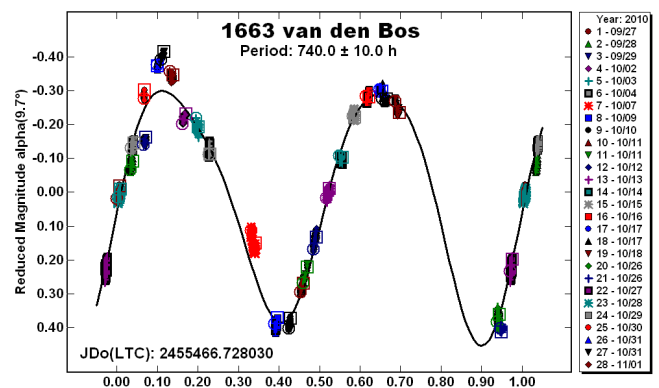


Figure 1: Lightcurve of 1663 van den Bos. Avg. $L_{PAB} = 17^\circ$, Avg. $B_{PAB} = -7^\circ$.

ASTEROIDS OBSERVED FROM THE SHED OF SCIENCE OBSERVATORY 2010 OCTOBER - 2011 APRIL

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Lightcurve measurements from the Shed of Science Observatory from 2010 October to 2011 April are reported: 902 Probitas: $P = 10.115 \pm 0.002$ h, $A = 0.12 \pm 0.02$ mag; 1318 Nerina: $P = 2.50 \pm 0.05$ h, $A = 0.10 \pm 0.02$ mag; 3388 Tsanghinchi: $P = 3.257 \pm 0.001$ h; $A = 0.33 \pm 0.05$ mag; (137605) 1999 VK174: $P = 28.0 \pm 0.5$ h, $A = 0.45 \pm 0.05$ mag.

Lightcurves of four asteroids at the Shed of Science Observatory were completed between 2010 October and 2011 April using a 0.35-m Schmidt Cassegrain (SCT) and SBIG ST10XE CCD camera working at a scale of 0.94 arcsec/pixel. Exposures were made through a Celestron UHC LPR filter. All images were dark and flat field corrected. Images were measured using *MPO Canopus* with a differential photometry technique. The "Comp Star Selector" in *MPO Canopus* was used to link sessions to a common zero point. The data were light-time corrected. Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989).

902 Probitas. A period of $P = 10.115 \pm 0.002$ h, $A = 0.12 \pm 0.02$ mag were determined. These results are in agreement with previous results by Behrend (2011a).

1318 Nerina. Observations over a single night indicate a period of $P = 2.50 \pm 0.05$ h, $A = 0.10 \pm 0.02$ mag. These are in agreement with results found by Stephens (personal communications), who measured this asteroid about the same time.

3388 Tsanghinchi. A period of $P = 3.257 \pm 0.001$ h, $A = 0.33 \pm 0.05$ mag were determined based on data over four nights. This result is in agreement with that reported by Behrend (2011b) based on data obtained in 2008.

(137605) 1999 VK174. The analysis of data obtained over seven nights found a period of $P = 28.0 \pm 0.5$ h, $A = 0.45 \pm 0.05$ mag.

Acknowledgements

Partial funding for work at the Shed of Science is provided by Gene Shoemaker NEO Grants from the Planetary Society.

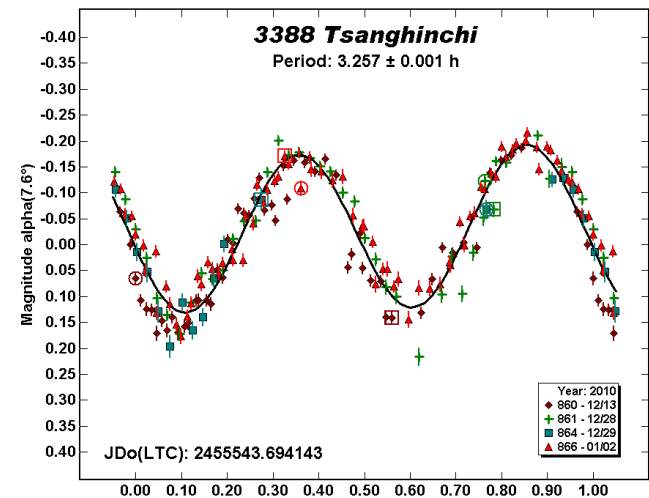
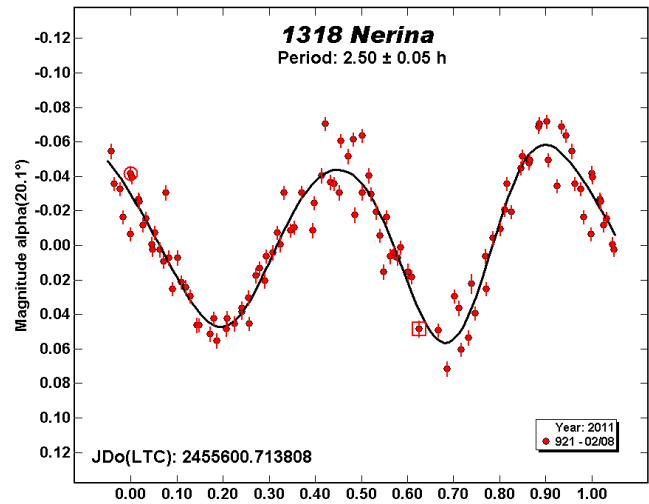
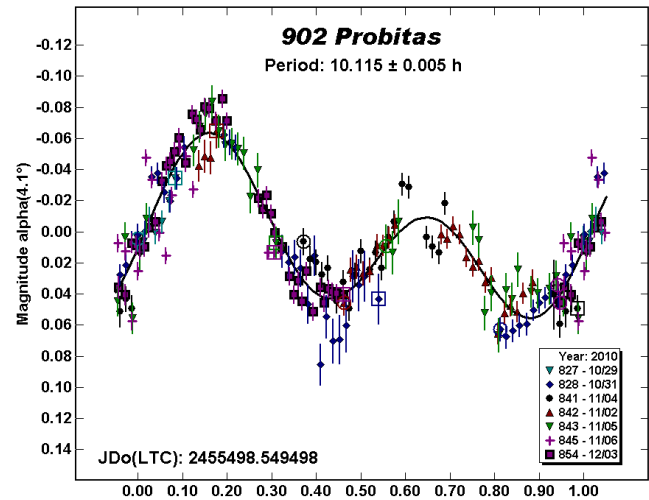
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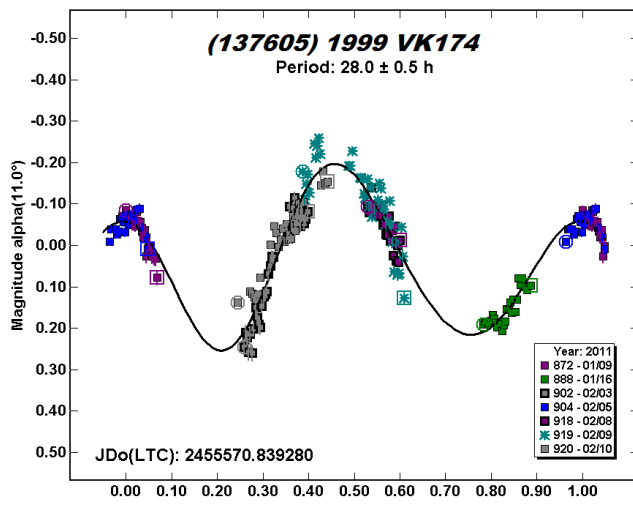
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LIGHTCURVE ANALYSIS OF HUNGARIA ASTEROID 4464 VULCANO

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Analysis of CCD photometry of the Hungaria asteroid 4464 Vulcano obtained in 2010 December shows that its synodic period is 3.2036 h with an amplitude of 0.09 mag. This revises a previous result of 6.4 h. Initial observations indicated the possibility of two periods. However, as more data were obtained, the strength of the second period in the period analysis spectrum diminished nearly to the vanishing point, exemplifying the need for careful analysis and obtaining sufficient evidence of unusual behavior.

CCD photometric observations of the Hungaria asteroid 4464 Vulcano were started at the Palmer Divide Observatory in 2010 early December as follow-up to earlier work in 2007 (Warner 2008). The images were taken with a 0.35-m Schmidt-Cassegrain telescope and SBIG STL-1001E CCD camera. Exposures were unfiltered and 240 s. Night-to-night calibration of the data from PDO was done by using 2MASS magnitudes for field stars from the 2MASS (Neugebauer and Leighton, 1969) or UCAC2 catalog (Zacharias et al., 2004) with the J-K magnitudes converted to

Cousins R using formulae by Warner (2007). See Stephens (2008) for more details on the calibration process using these magnitudes.

Initial Fourier analysis using *MPO Canopus* by Warner showed the presence of two periods, $P_1 \sim 3.2$ and $P_2 \sim 3.7$ h, possibly indicating a binary object. The data were submitted to Ondřejov where the two periods were also found using the initial data set. An observing campaign was organized with Modra Observatory and PDO providing additional data. Observations at Modra were made using a 0.6-m telescope with Apogee AP8 CCD. Exposures used a clear filter and were 90 s. As more data became available, the strength of the second period (3.7 h) in a period spectrum diminished, eventually almost to the vanishing point. The final analysis found a period of 3.2036 ± 0.0005 h with an amplitude of 0.09 ± 0.01 mag (Figure 1). One session from Modra did show some deviations that were approximately correct for an eclipse or occultation by a satellite, but there were no confirming observations.

In light of the later work, the original data from the 2007 campaign (four consecutive nights from Nov 2-5) were checked against the shorter periods with one of $P = 3.193$ h with a monomodal solution standing out (Figure 2). Interestingly, a weak secondary period of 3.673 h was also found. Both had a few data points that strayed randomly from the mean lightcurve by more than the average observational errors, just as occurred with the initial data for the 2010 campaign. Looking more closely, the two periods differ by almost exactly one revolution over a 24-hour period (~ 7.5 versus ~ 6.5), the difference being about 0.02 rotations per day. This probably explains why, with the 2010 data set that covered a much longer span, about three weeks, one of the two solutions gradually disappeared, i.e., as more data became available, it was possible to differentiate between the “true” period and an alias.

Furthermore, given the relatively short span of the observations, it seemed unlikely that the viewing geometry changed sufficiently such that evidence of a satellite would simply vanish. This is supported by the fact that the shape and amplitude of the data phased to the remaining period of 3.2 h remained substantially the same throughout the period. On the other hand, the one session with a suspicious deviation and the fact that the period and size make the asteroid a good candidate for being binary, warrant at least a mention and serve as a good reason for obtaining detailed, well-calibrated data at future apparitions.

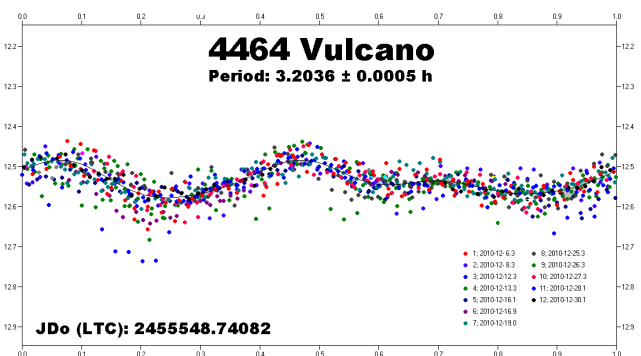


Figure 1. Lightcurve of 4464 Vulcano, 2010 data set.

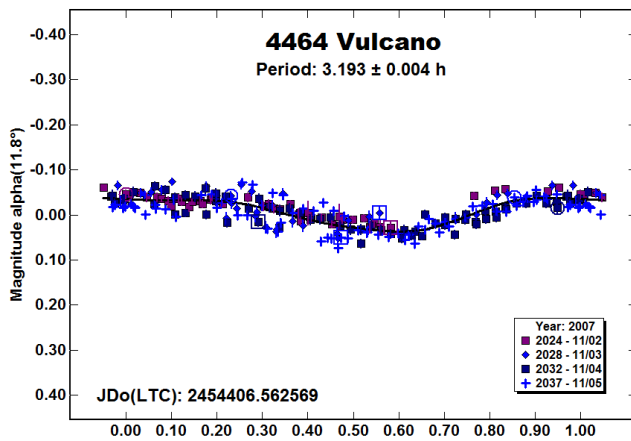


Figure 2. Lightcurve of 4464 Vulcano, 2007 data set forced to monomodal solution.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX10AL35G, by National Science Foundation grant AST-1032896, and by a 2007 Gene Shoemaker NEO Grant from the Planetary Society. The work at Modra was supported by the Slovak Grant Agency for Science VEGA, Grants 2/0016/09, and 1/0636/09, as well as the Grant Agency of the Czech Republic, Grant 205/09/1107. This publication makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. Modra Observatory thanks those at <http://www.astronomy.net> for their procedures and software components used in Modra's data processing pipeline.

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MINOR PLANET LIGHTCURVE ANALYSIS AT BASSANO BRESCIANO OBSERVATORY 2010 OCTOBER - 2011 MARCH

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(Received: 15 April)

Lightcurves for eight minor planets were obtained at Bassano Bresciano Observatory from 2010 October to 2011 March: 283 Emma, 334 Chicago, 933 Susi, 948 Jucunda, 1080 Orchis, 1318 Nerina, 1342 Brabantia, and 4452 Ullacharles.

Photometric measurements of eight minor planets were made using the Schmidt 0.32-m f/3.1 telescope at Bassano Bresciano Observatory (565). The images were taken with Starlight CCD camera HX-516 located at prime focus. 120 sec exposure times and 2x2 binning were used for all images as was a Johnson V filter until 2010 December. Afterward, the filter was removed in order to increase the S/N ratio. All exposures were unguided. *Polypus* software (Bassano Bresciano Observatory, 2010) was used to control the telescope and camera, allowing us to work without an operator on more than one minor planet for up to 7 hours each night. Flat field and dark frame calibration images were captured each night. All exposures were taken when the target's altitude was more than 30°.

All images were corrected with dark and flat field. *MPO Canopus* (BDW Publishing, 2010) was used to perform differential photometry on the reduced images. Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989). Comparison stars were selected with a colour index as near as possible to V-R = 0.45 in order to minimize colour error from different sessions. All periods were found as the solution with lowest RMS error. Sessions were linked to a common zero point by adjusting the DeltaComp value in *MPO Canopus*. The values were adjusted such that the final period solution had the the lowest RMS error.

283 Emma. The Asteroid Lightcurve Database (Warner *et al.*, 2009) reports a period of 6.888 h and amplitude 0.11-0.57 mag with quality code 3. We observed the asteroid for 5 nights covering 18 days span. All measurements had a good S/N ratio. The longest session shows almost all of a bimodal rotation. The period corresponding to a bimodal lightcurve is $P = 6.896 \pm 0.001$ h and amplitude $A = 0.22 \pm 0.02$ mag.

334 Chicago. Warner *et al.* (2009) give a period 7.371 h and amplitude 0.15-0.67 mag with quality code 3. We observed for 4 nights covering a 17 day span. All measurements had a good S/N ratio. At least one maximum and one minimum were captured in all sessions. Our analysis for a bimodal lightcurve gives $P = 7.359 \pm 0.001$ h and amplitude $A = 0.35 \pm 0.02$ mag.

933 Susi. We selected this asteroid from a list in the *Minor Planet Bulletin* (Warner *et al.*, 2011) that gave a period 2.08 h and amplitude 0.08 mag with quality code 1. We observed for 3 nights covering a 2 day span. All sessions showed more than one complete rotation and a clear bimodal shape. Our analysis gives $P = 4.623 \pm 0.003$ h and amplitude $A = 0.32 \pm 0.02$ mag.

948 Jucunda. Selected from the *Minor Planet Bulletin* lists (Warner *et al.*, 2011), no previous period was reported for this asteroid. The initial observations showed only a slow change over an entire night and so many nights were needed in order to catch the complete lightcurve. Our observations included 8 nights over a 19 day span. Due to little overlapping of individual sessions, the DeltaComp (nightly zero point) was adjusted by inspection. The result of our analysis was a bimodal lightcurve with $P = 28.64 \pm 0.012$ h and amplitude $A = 0.35 \pm 0.03$ mag.

1080 Orchis. Warner *et al.* (2010) gave no previous period in their regular lightcurve opportunities article in the *Minor Planet Bulletin*. Observations covered a 20 day span with 5 nights. The period spectrum in *MPO Canopus* favored solutions that were simple ratios of an Earth day. A careful analysis of slopes from minimum to maximum determined that the most probable solution was near 2/3 day. Our final analysis found $P = 16.06 \pm 0.004$ h and amplitude $A = 0.35 \pm 0.03$ mag.

1318 Nerina. Warner *et al.* (2009) report a period of 2.53 h and amplitude 0.16 mag with quality code 2. Our observations covered a 2 day span with 3 nights. The high S/N ratio made it possible to evaluate the low amplitude lightcurve of this asteroid. All sessions show more than one complete rotation. We found $P = 2.528 \pm 0.003$ h and amplitude $A = 0.08 \pm 0.02$ mag.

1342 Brabantia. No previous period was reported in the lists in the *Minor Planet Bulletin* (Warner *et al.*, 2011). Our observations covered a 13 day span with 4 nights. All sessions showed at least one maximum and one minimum and a clear bimodal shape. Our analysis gives $P = 8.345 \pm 0.002$ h and amplitude $A = 0.20 \pm 0.02$ mag.

4452 Ullacharles. A period of 9.36 hours and amplitude 0.43 with quality code 2 are given in the Lightcurve Database (Warner *et al.*, 2009). We found a period of $P = 9.138 \pm 0.011$ h and amplitude $A = 0.42 \pm 0.04$ mag.

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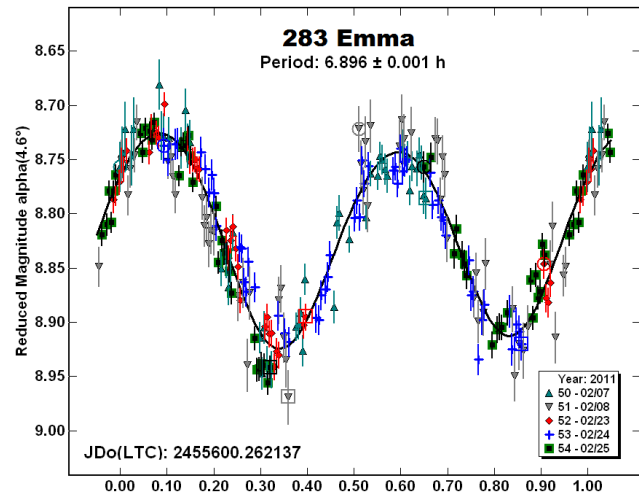
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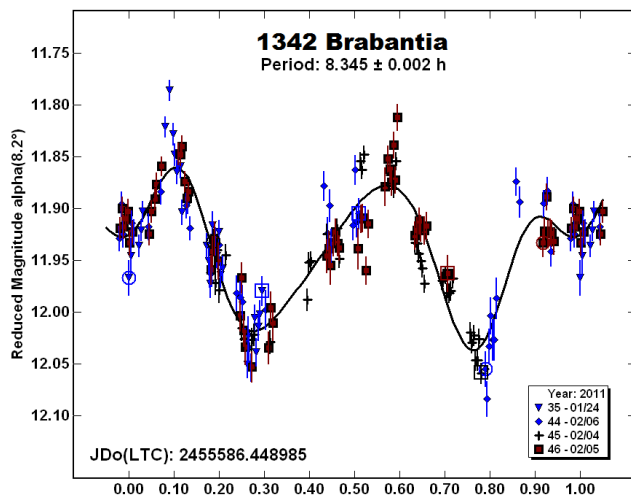
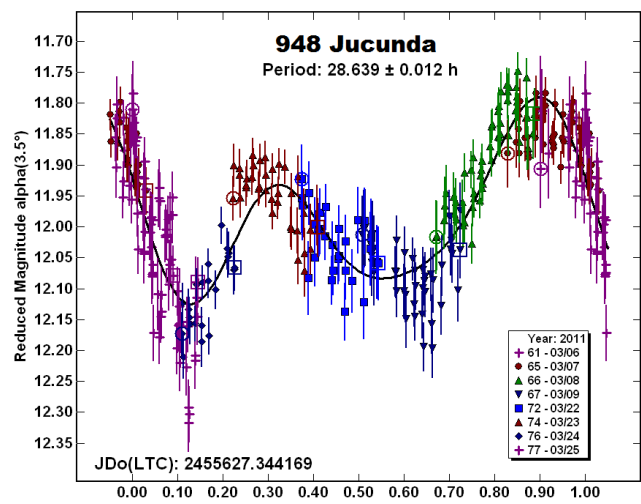
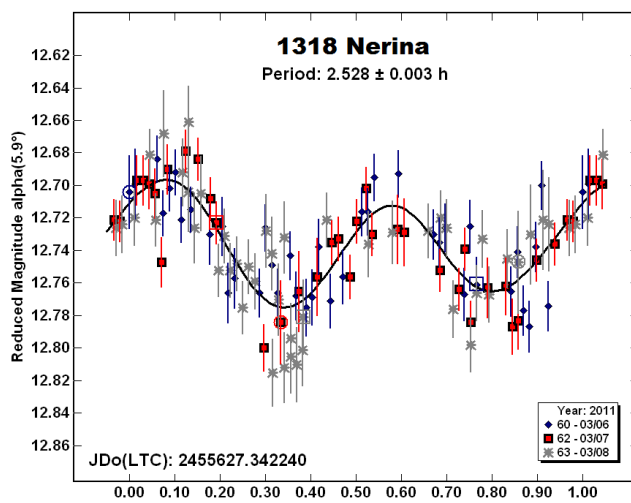
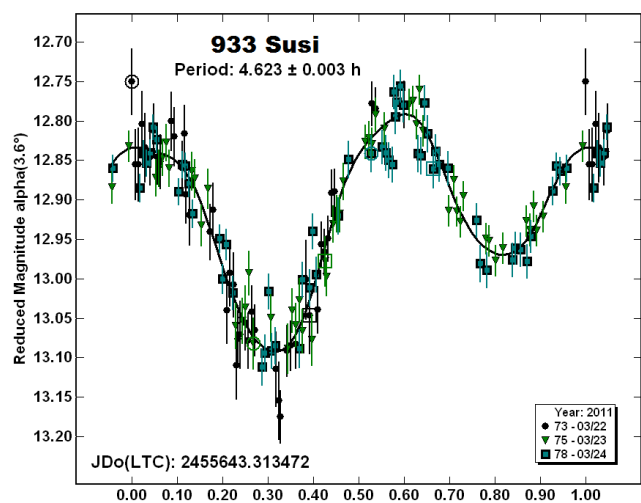
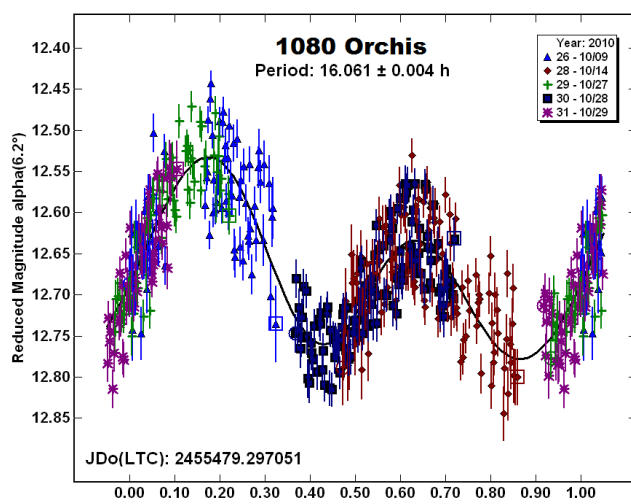
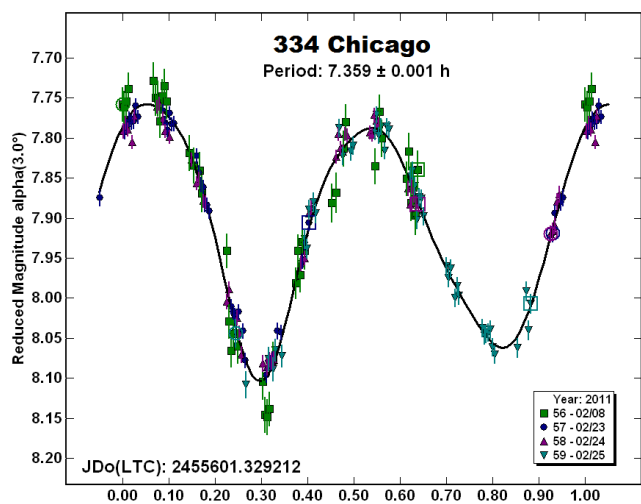
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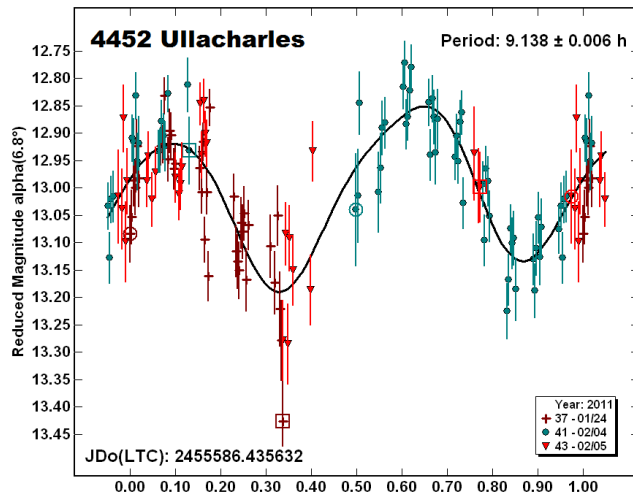
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Asteroid	Date	Phase Angle	Time h.	Num. Obs	Filter
283 Emma	2011-02-07	4.6	4.5	50	C
283 Emma	2011-02-08	5.0	6.0	56	C
283 Emma	2011-02-23	9.7	3.5	38	C
283 Emma	2011-02-24	10.0	5.3	56	C
283 Emma	2011-02-25	10.3	4.5	52	C
334 Chicago	2011-02-08	3.0	4.7	56	C
334 Chicago	2011-02-23	7.1	3.8	40	C
334 Chicago	2011-02-24	7.3	5.3	51	C
334 Chicago	2011-02-25	7.6	4.5	46	C
933 Susi	2011-03-22	3.6	6.3	44	C
933 Susi	2011-03-23	3.8	5.3	53	C
933 Susi	2011-03-24	4.0	5.2	57	C
948 Jucunda	2011-03-06	3.5	4.2	44	C
948 Jucunda	2011-03-07	2.6	5.8	49	C
948 Jucunda	2011-03-08	2.1	6.2	56	C
948 Jucunda	2011-03-09	1.7	6.2	45	C
948 Jucunda	2011-03-22	4.5	4.8	29	C
948 Jucunda	2011-03-23	4.9	5.3	38	C
948 Jucunda	2011-03-24	5.3	4.0	25	C
948 Jucunda	2011-03-25	5.8	5.3	33	C
1080 Orchis	2010-10-09	6.1	5.3	79	V
1080 Orchis	2010-10-14	3.4	6.3	128	V
1080 Orchis	2010-10-27	6.2	4.5	66	V
1080 Orchis	2010-10-28	6.9	5.7	119	V
1080 Orchis	2010-10-29	7.5	3.0	64	V
1318 Nerina	2011-03-06	5.4	4.3	60	C
1318 Nerina	2011-03-07	4.9	4.7	35	C
1318 Nerina	2011-03-08	4.5	6.5	47	C
1342 Brabantia	2011-01-24	8.2	2.5	32	C
1342 Brabantia	2011-02-04	13.7	5.3	45	C
1342 Brabantia	2011-02-05	14.2	6.5	63	C
1342 Brabantia	2011-02-06	14.7	6.0	39	C
4452 Ullacharles	2011-01-24	6.8	3.0	36	C
4452 Ullacharles	2011-02-04	11.3	7.0	60	C
4452 Ullacharles	2011-02-05	11.7	6.7	28	C

Table I. Observing circumstances for eight asteroids.







SAVE THE LIGHTCURVES!

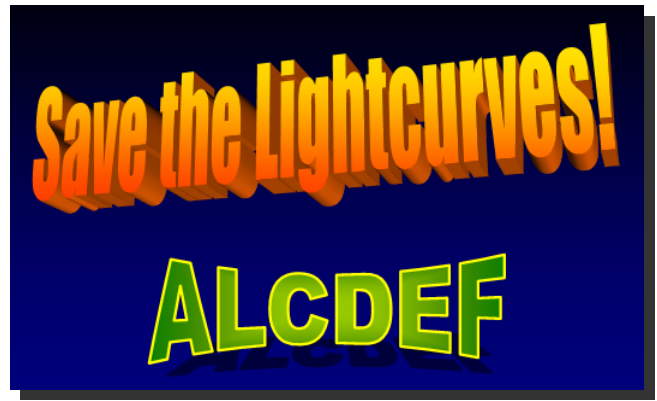
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The lack of a central repository for asteroid time-series (lightcurve) photometry has put large amounts of data at risk of being forever lost as computers crash and the original researchers pass on. These data are vital to critical current work on theories regarding the origin and evolution of the asteroid population as a whole and of specific families/groups or types of asteroids. A first step toward creating such a repository is defining a minimum set of data and format for submitting current and future observations. The Asteroid Lightcurve Data Exchange Format (ALCDEF) has been proposed by the authors for this first step. In a recent development, the Minor Planet Center, long the recognized central repository for asteroid astrometry data, has agreed to host a site where researchers can upload and download asteroid photometry using the ALCDEF standard. We outline other steps that have been taken to have the ALCDEF standard generally accepted as well as describe a new gateway web site that leads to the ALCDEF pages as well as the Collaborative Asteroid Lightcurve Link (CALL) site commonly used by many asteroid photometrists.



For many years, the asteroid photometry community has sought what the astrometry community has long-enjoyed: a central repository for observations to which all researchers can have access to data vital for any number of topics. These include studies on rotational statistics, defining the role and limits of thermal effects such as Yarkovsky and YORP (Yakovsky-O'Keefe-Radzievskii-Paddack) on orbital migration, binary asteroid formation, and spin axis alignments, to name just a few. Unfortunately, the vast majority of legacy asteroid photometry can be found only in “dusty filing cabinets” (paper or the computer equivalent), where it remains unavailable to most researchers and is at risk of being lost forever when the original observer passes on, a computer crashes, or some other disaster strikes. Handling the problems of legacy data is just one of the issues to be addressed. More important, however, we believed it was time to do something that would prevent unabated growth of legacy data. Toward this end, we proposed a new standard format for asteroid photometry data (Stephens *et al.*, 2010) at the Division of Planetary Sciences meeting in Pasadena, CA. The proposal was well-received and minor revisions to the standard were made as a result of conversations at that meeting. Instead of providing a lengthy description of the format here, we suggest that you download the most recent PDF document defining the standard from

<http://www.minorplanet.info/alcdef.html>

In brief, the format calls for simple text files that, for each individual lightcurve (usually meaning the data from a single night for a single object) there are two “blocks” of information. One (“metadata”) gives observation details such as the object observed, a mid-date/time for the data, phase angle, filter used, type of data (differential or absolute values), and so on. The second (“data”) gives the actual data, which consists of a minimum of the Julian Date and a magnitude. The estimated error and air mass are optional. A single file can contain any number of lightcurves for any number of objects, though usually a file will have data for only one object.

While the standard does allow corrected data to be submitted, it's important to note that the database is intended to store “raw” data. For example, the Julian Dates for the observations should be the actual date of observation and not forced to coincide with a JD that is an offset from a fixed value based on an assumed rotation period. In this “light”, the data should not include any corrections such as for light-time travel or to unity distances using $-5\log(RA)$. If any corrections are applied, they should be of such a nature that the uncorrected data can be easily reconstructed and the correction value that was used given in the metadata block(s). The point is to allow the researcher to do his own analysis with as pure of data as possible.

The idea for ALCDEF came from discussions with Minor Planet Center Director, Timothy Spahr, who expressed interest in the MPC hosting asteroid lightcurve photometry. For many reasons, that idea was put on hold for almost two years, until soon after the DPS meeting, when we were contacted by Gareth Williams, Assistant Director of the Minor Planet Center, asking if we were still interested in the MPC hosting a web page and being the central repository for lightcurve data. This was soon followed by the development of a web site where data following the ALCDEF standard could be uploaded or retrieved. That site is at

http://minorplanetcenter.net/light_curve

As of 2011 mid-April, the MPC web site has 815929 observations in 10613 lightcurves for 1490 different asteroids. Data from this site have already been used for important work on spin axis analysis (e.g., Hanuš *et al.*, 2011). However, this is – we hope – only the beginning. We regularly upload our observations to the ALCDEF site after publication of the lightcurve analysis appears in the *Minor Planet Bulletin*. *MPO Canopus*, used by many authors of *MPB* papers, has been adapted to generate ALCDEF-compliant reports. We've contacted Herbert Raab (*Astrometrica*) and Richard Berry (*AIP4WIN*), both of whom have expressed strong interest in adapting their programs to create ALCDEF files. If any other software authors are interested, we will be glad to work with them. We have also been in contact with several members of the professional community who do regular work in asteroid lightcurve photometry and they have or are planning to adopt the ALCDEF standard for future data. The involvement of the Minor Planet Center should help speed acceptance of the ALCDEF format, which could be critical when future deep/wide-sky surveys start coming on line and produce vast numbers of asteroid photometry that can be used for asteroid shape and spin axis modeling (see Āurech *et al.*, 2009, and references therein).

Unresolved Issues

An issue common to any public database is when data should be submitted. For those authors who contribute regularly to the *Minor Planet Bulletin*, data will likely be submitted about the time a paper is submitted or at least as soon as it appears. Their work is based more on producing immediate results that can be used for broader study over time. However, there are observing programs that have broader studies as their goal and so there is a need to maintain control of data access until the intended analysis can be done. Sometimes this can mean years, even decades, can elapse before the data can be released. While the delay is understandable in many cases, there is the danger that it will be lost due to some catastrophe or, by not making it available sooner, it's value is actually diminished or the chance for other important discoveries are missed. There are no easy answers but we hope that the development of a standard format for data and the fact that the MPC is hosting a repository will lead to discussions among researchers, administrators, and others that lead to making the most amount of data being available in the least amount of time.

One of the questions raised during the DPS meeting and afterward about ALCDEF was assuring proper attribution for the data. The standard includes some "mandatory" fields that indicate the primary contact for questions about the data set, a means for contacting that person, and the observers involved in obtaining the data. There is the implied understanding that those using the data will exercise due diligence and give proper attribution or even co-authorship as legally and ethically required.

There is also the question of vetting the data, i.e., finding some way to determine a given data set's quality. This is not so easily done with asteroid photometry as in other cases. For example, for astrometry, data points that are significant outliers in orbital solutions based on a number of other data points can be quickly spotted. In photometry, what may appear to be outliers or noisy data may be evidence of a satellite or tumbling (non-principal axis rotation). In the end, the practical solution is a policy of "user beware" where the data user relies on information in the header and errors (if given), quality of fit to a solution, and even observer reputation to assign an appropriate weight to a given data set.

While ALCDEF addresses what to do with current and future data, there is still the problem of cleaning out the "dusty filing cabinets." We are developing software and processes whereby we can convert what data are available to the ALCDEF standard and then submit it to the MPC web site. This will be a long and tedious task, the value of which may still be uncertain. Assuming the proposed deep/wide-field surveys come to fruition, then sometime about 5-10 years after they begin, there will sufficient sparse data (see Āurech *et al.*, 2009) such that most of the legacy data will be rendered moot. However, we cannot assume this will come to pass and some studies will require much longer base-lines of data and so we will continue with our plans until the situation is better defined.

The MinorPlanet.Info Gateway

As part of the initial work on the ALCDEF standard, when a large, well-recognized central hosting site was not yet established, Warner began work on revamping the widely-used Collaborative Asteroid Lightcurve (CALL) web site so that it would not only continue serving to coordinate asteroid lightcurve work but provide access to ALCDEF data and other services. The result was the MinorPlanet.Info gateway:

<http://www.minorplanet.info>

This site serves as a gateway to the CALL web site and an introductory site for ALCDEF. It also provides access to back issues of the *Minor Planet Bulletin* from 1994 to present and the asteroid lightcurve database (LCDB; Warner *et al.*, 2009). For the LCDB, the full set of publicly-released files is available but there is also a page where one can do a search of the LCDB Summary data using a "search by example" form. For example, one can quickly look to see what lightcurve parameters are entered for members of a specific asteroid family or those objects with a diameter $10 < D < 40$ km.

In addition to these and others, there are links to external sites such as the Minor Planet Center, NASA, and JPL. We hope to add more features to the site and make it a vital tool for those doing asteroid lightcurve photometry and research based on the data from such work.

Acknowledgements

Funding for maintenance of the MinorPlanet.info gateway and efforts for establishing the ALCDEF standard are provided in part by NASA grant NNX10AL35G and by National Science Foundation grant AST-1032896.

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LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2011 JULY-SEPTEMBER

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We present lists of asteroid photometry opportunities for objects reaching a favorable apparition and having no or poorly-defined lightcurve parameters. Additional data on these objects will help with shape and spin axis modeling via lightcurve inversion. We also include lists of objects that will be the target of radar observations. Lightcurves for these objects can help constrain pole solutions and/or remove rotation period ambiguities that might not come from using radar data alone.

We present four lists of “targets of opportunity” for the period 2011 July-September. For background on the program details for each of the opportunity lists, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188. 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:

<http://www.minorplanet.info/lightcurvedatabase.html>

Objects with $U = 1$ should be given higher priority when possible. *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. Note that the lightcurve amplitude in the tables could be more or less than what’s given. Use the listing only as a guide.

The first list is an *abbreviated list* of those asteroids reaching $V < 15.0$ 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. A more complete list as well as one including objects $V < 16.0$ can be found on the CALL web site.

http://www.minorplanet.info/CALL/targets_2011_Q3.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 spin axis and/or shape modeling. Those doing work for modeling should contact Josef Ďurech at the email address above and/or 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 to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. *High-precision work, 0.01-0.02 mag, is preferred, especially if the object is a known or potential binary.* 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

As always, we encourage observations of asteroids even if they have well-established lightcurve parameters and especially if they are lacking good spin axis and/or shape model solutions. Every lightcurve of sufficient quality supports efforts to resolve a number of questions about the evolution of individual asteroids and the general population. For example, 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 NEA pole alignments, including whether or not the thermal YORP effect is forcing pole orientations into a limited number of preferred directions (see La Spina *et al.*, 2004, *Nature* **428**, 400-401). Data from many apparitions can help determine if an asteroid’s rotation rate is being affected by YORP, which can also cause the rotation rate of a smaller, irregularly-shaped asteroid to increase or

decrease. See Lowry *et al.* (2007) *Science* **316**, 272-274 and Kaasalainen *et al.* (2007) *Nature* **446**, 420-422.

Changes in the Radar-Optical Opportunities Listings

Starting with this issue, the ephemeris listings for the optical-radar listings now include lunar elongation and phase. Phase values range from 0.0 (new) to 1.0 (full). If the value is positive, the moon is waxing – between new and full. If the value is negative, the moon is waning – between full and new. The listing also includes the galactic latitude. When this value is near 0°, the asteroid is likely in rich star fields and so may be difficult to work. The precision of the positions and distances have been reduced to accommodate the additional information. We thank Brian Skiff at Lowell Observatory for his suggestions.

It is important to emphasize that the ephemerides that we provide are only guides for when you might observe a given asteroid. Obviously, you should use your discretion and experience to make your observing program as effective as possible.

Once you've analyzed your data, it's important to 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

#	Name	Brightest			LCDB Data	
		Date	Mag	Dec U	Period	Amp
2844	Hess	07 01.4	14.5	-20		
2676	Aarhus	07 01.0	14.9	-25		
4396	Gressmann	07 02.8	14.7	-30		
873	Mechthild	07 03.9	14.0	-16 2	10.6	0.33
1991	Darwin	07 08.3	14.1	-32 2	4.7	0.08
12191	Vorontsova	07 11.3	15.0	-30		
9607	1992 DS6	07 14.5	15.0	-37		
12853	1998 FZ97	07 15.9	15.0	-11		
3539	Weimar	07 15.0	15.0	-9		
3084	Kondratyuk	07 16.9	14.9	-13		
1592	Mathieu	07 19.9	13.2	-26 2+	28.46	0.50
562	Salome	07 19.9	13.8	-33 2	6.35	0.11-0.37
2130	Evdokiya	07 20.8	14.3	-31		
1763	Williams	07 21.9	13.4	-22 2	>36.	>0.3
5642	Bobbywilliams	07 21.0	15.0	-43		
1288	Santa	07 23.3	14.9	-20 2	8.28	0.46
3229	Solnhofen	07 24.0	14.1	-22		
11354	1997 XY9	07 26.9	15.0	-18		
14982	1997 TH19	07 26.1	14.4	-27		
2015	Kachuevskaya	07 26.0	14.8	-34		
4603	Bertaud	07 27.6	14.3	-33 1	9.6	0.01
6192	1990 KB1	07 30.6	13.2	-21 1+	11.1	0.12
2567	Elba	07 31.2	14.4	-14		
2122	Pyatiletka	07 31.8	14.8	-23		
3910	Liszt	07 31.4	15.0	-30		
2731	Cucula	08 01.3	14.1	-10		
23143	2000 AZ177	08 02.6	14.6	-9		
6160	Minakata	08 03.9	15.0	-8		
1718	Namibia	08 03.7	14.7	-2		
1702	Kalahari	08 04.8	14.2	-25		
2492	Kutuzov	08 04.6	14.8	-18		
10283	Cromer	08 04.3	15.0	-23		
6780	Borodin	08 05.8	14.9	-19		
10347	Murom	08 06.9	14.7	-14		
7938	1990 SL2	08 06.2	14.9	-28		
16835	1997 WT34	08 08.5	14.8	-15		
6649	Yokotatakao	08 09.5	14.1	-18		
918	Itha	08 09.5	13.5	-21 ?		
4273	Dunhuang	08 09.8	15.0	-17		
9143	Burkhead	08 10.7	14.6	-19		
2070	Humason	08 10.5	14.8	-20		
3631	Sigyn	08 10.1	14.3	-10		
5064	Tanchozuru	08 11.2	14.5	-11 2-	8.13	0.7
3116	Goodricke	08 12.0	13.8	-25 2	10.	0.09

Lightcurve Opportunities (continued)

#	Name	Brightest			LCDB Data	
		Date	Mag	Dec U	Period	Amp
4796	Lewis	08 13.4	14.6	-13		
4482	Frerebasile	08 16.6	14.4	-30		
3431	Nakano	08 16.0	14.5	-11 2	9.2	0.24
19251	Totziens	08 17.8	15.0	+0		
9175	Graun	08 17.6	14.7	-16 1	>0.	0.2
1711	Sandrine	08 17.4	14.7	-16		
6787	1991 PF15	08 18.2	15.0	-7		
1734	Zhongolovich	08 20.8	14.3	-5		
4456	Mawson	08 20.4	14.7	-34		
1335	Demouлина	08 21.6	14.4	-10 2+	74.86	0.06-0.78
10303	Freret	08 22.3	15.0	-10		
16182	2000 AH137	08 23.9	14.4	-16 ?		
6331	1992 FZ1	08 24.0	14.7	-16		
14510	1996 ES2	08 24.8	14.9	-14		
2997	Cabrera	08 25.4	14.5	-16		
13441	2098 P-L	08 26.7	14.4	+3		
1151	Ithaka	08 26.1	14.3	+3		
668	Dora	08 26.5	14.2	+0		
14342	Iglik	08 27.5	14.2	-9		
1026	Ingrid	08 27.8	14.7	-18 2	5.	0.5
1325	Inanda	08 28.1	13.1	-20 2	20.52	0.16
7750	McEwen	08 29.9	14.7	+25		
4618	Shakhovskoj	08 31.7	15.0	-11		
1283	Komsomolia	08 31.3	13.6	-9 1+	96.	1.03
4738	1985 RZ4	08 31.0	14.9	-15		
6042	Cheshirecat	08 31.2	14.5	-41 2	10.05	0.40
16827	1997 WD2	09 02.8	14.8	-21		
10722	Monari	09 03.6	14.9	-20		
9531	Jean-Luc	09 03.4	15.0	-12		
1986	Plaut	09 03.8	14.8	-8		
1406	Komppa	09 05.8	13.8	-4 2	3.49	0.20
7451	Verbitskaya	09 06.0	15.0	-11		
10123	Fideoja	09 06.5	15.0	-15		
5818	1989 RC1	09 07.6	14.4	-29		
16698	1995 CX	09 07.3	14.9	-22		
500	Selinur	09 07.7	12.0	+7 2+	8.00	0.16
1759	Kienle	09 08.3	14.1	-7 2	29.25	0.30
1430	Somalia	09 09.1	14.7	-4		
10488	1985 RS1	09 09.0	14.9	-9		
1593	Fagnes	09 09.4	14.2	-19 2	25.1	0.47
191	Kolga	09 12.7	12.5	-7 2+	17.62	0.30-0.40
987	Wallia	09 12.3	12.2	+2 2	10.52	0.36
1820	Lohmann	09 14.7	14.0	-8		
27111	1998 VV34	09 14.1	14.7	-4		
18105	2000 NT3	09 14.7	15.0	-5		
10151	Rubens	09 14.7	15.0	+0		
14335	Alexosipov	09 14.7	14.6	-4		
1501	Baade	09 15.2	13.7	-10 2	15.13	0.40
7559	Kirstinemeyer	09 15.1	14.9	-18		
688	Melanie	09 16.7	13.3	-3 2-	20.	0.07
5701	Baltuck	09 17.8	14.9	-9		
5657	Groombridge	09 17.1	14.8	-5		
1769	Carlostorres	09 18.8	14.1	+0		
17256	2000 HZ22	09 18.6	14.9	-2		
1470	Carla	09 20.8	14.8	-1		
1077	Campanula	09 21.9	13.6	+2		
5364	1980 RC1	09 21.3	14.5	+5		
2687	Tortali	09 22.9	14.7	-12 2	21.75	0.19
1361	Leuschneria	09 22.0	14.6	-8		
3172	Hirst	09 22.6	14.3	-7		
14427	1991 VJ2	09 23.4	15.0	+4		
1768	Appenzella	09 23.4	14.5	-1		
4615	Zinner	09 23.8	14.0	-1		
15040	1998 XC	09 24.6	14.9	+7		
10586	Jansteen	09 24.3	14.9	-8		
2344	Xizang	09 24.6	14.6	-6		
25317	1999 BL12	09 25.3	14.7	-12		
1255	Schilowa	09 25.0	13.7	+11 2	29.53	0.15
15464	1999 AN5	09 25.4	15.0	-2		
2084	Okayama	09 29.9	14.4	-3		

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp	U
607	Jenny	07 03.2	0.48	13.5	-24	8.524	0.21	2
21	Lutetia	07 04.2	0.99	9.4	-25	8.1655	0.06-0.25	3
274	Philagoria	07 10.9	0.53	13.9	-24	17.96	0.43-0.51	2
76	Freia	07 14.3	0.73	13.4	-19	9.969	0.10-0.33	3
222	Lucia	07 15.0	0.66	12.7	-23	7.80	0.25-0.33	3
487	Venetia	07 15.3	0.29	11.5	-21	13.28	0.05-0.30	2
556	Phyllis	07 16.4	0.41	13.0	-20	4.293	0.27	3
522	Helga	07 17.8	0.10	13.8	-21	8.129	0.17-0.30	3
182	Elsa	07 19.0	0.19	12.2	-21	80.088	0.72	3

Low Phase Angle Opportunities (continued)

#	Name	Date	α	V	Dec	Period	Amp	U
1763	Williams	07 21.8	0.61	13.5	-22	>36.	0.3	2
113	Amalthea	07 31.1	0.25	11.4	-19	9.935	0.20	3
538	Friederike	08 01.4	0.80	13.0	-16	27.	0.12	1
984	Gretia	08 02.5	0.54	11.9	-19	5.778	0.4	-0.63 3
1086	Nata	08 10.8	0.28	13.8	-15	18.074	0.17	2
208	Lacrimosa	08 11.7	0.67	12.8	-17	14.085	0.15-0.33	3
167	Urda	08 24.5	0.36	12.8	-10	13.07	0.24-0.39	3
667	Denise	08 26.9	0.06	13.6	-10	12.687	0.24	3
14342	Igluka	08 27.4	0.59	13.9	-09			
385	Ilmatar	08 30.5	0.97	11.8	-12	62.35	0.50	3
1283	Komsomolia	08 31.3	0.14	13.6	-09	96.	1.03	1+
192	Nausikaa	09 02.2	0.58	8.3	-09	13.625	0.15-0.40	3
190	Ismene	09 05.6	0.48	13.2	-05	6.52	0.10-0.15	3
308	Polyxo	09 07.7	0.79	11.6	-04	12.032	0.08-0.20	3
688	Melanie	09 16.8	0.31	13.3	-03	20.	0.07	2-
184	Dejopeja	09 17.2	0.19	12.9	-02	6.455	0.25-0.3	3
24	Themis	09 20.4	0.22	11.8	-02	8.374	0.09-0.14	3
122	Gerda	09 22.9	0.07	12.3	+00	10.685	0.11-0.26	3
48	Doris	09 23.3	0.24	10.9	+01	11.89	0.35	3
4615	Zinner	09 23.8	0.37	14.0	-01			

Shape/Spin Modeling Opportunities

There are two lists here. The first is for objects for which good occultation profiles are available. These are used to constrain the models obtained from lightcurve inversion, eliminating ambiguous solutions and fixing the size of asteroid. Lightcurves are needed for modeling and/or to establish the rotation phase angle at the time the profile was obtained. The second list is of those objects for which another set of lightcurves from one more apparitions will allow either an initial or a refined solution.

Occultation Profiles Available

#	Name	Brightest			Period	LCDB DATA		U
		Date	Mag	Dec		Amp		
76	Freia	07 14.4	13.3	-19	9.969	0.10	0.33	3
522	Helga	07 17.9	13.8	-21	8.129	0.17	0.30	3
704	Interamnia	07 18.6	9.9	-14	8.727	0.03	0.11	3
102	Miriam	08 01.2	11.6	-09	23.613	0.04	0.14	3
120	Lachesis	08 03.6	12.0	-23	46.551	0.14	0.22	3
381	Myrrha	08 11.2	12.3	-19	6.572		0.36	3
308	Polyxo	09 07.6	11.5	-04	12.032	0.08	0.15	2+

Inversion Modeling Candidates

#	Name	Brightest			Period	LCDB Data		U
		Date	Mag	Dec		Amp		
312	Pierretta	07 05.2	11.9	-38	10.282		0.32	3
2332	Kalm	07 05.6	14.7	-38	22.8		0.39	2
1991	Darwin	07 08.3	14.1	-32	4.7		0.08	2
2111	Tselina	07 08.7	14.9	-09	6.563		0.17	3
567	Eleutheria	07 18.7	13.6	-32	7.71	0.26	0.50	3
934	Thuringia	07 24.2	13.8	-31	8.166	0.52	0.66	3
502	Sigune	07 28.9	14.3	-13	10.922	0.35	0.44	3
1103	Sequoia	07 31.1	13.8	+09	3.03784		0.51	3
733	Mocia	08 02.6	14.2	-33	11.374		0.29	3
299	Thora	08 06.8	14.1	-14				1-
692	Hippodamia	08 22.8	15.0	-44	8.98		0.50	3
157	Dejanira	08 30.9	14.7	-27	15.825	0.33	0.52	3
1568	Aisleen	09 06.7	13.6	-23	6.68		0.41	3
1313	Berna	09 13.8	14.5	+12	25.46		0.25	3
1350	Rosselia	09 17.4	14.0	-05	8.140		0.53	3
852	Wladilena	09 20.2	11.7	-26	4.6134	0.30	0.32	3
486	Cremona	09 21.1	14.3	-16	65.15	0.8	1.00	3-
2156	Kate	09 27.1	13.7	-01	5.62		0.60	3

Radar-Optical Opportunities

Use the ephemerides below to judge your best chances for observing. Some of the targets may be too faint to do accurate photometry with backyard telescopes. However, accurate astrometry using techniques such as "stack and track" is still

possible and can be helpful for those asteroids where the position uncertainties are significant. Note that the intervals in the ephemerides are not always the same and that *geocentric* positions are given. Use these web sites to generate updated and *topocentric* positions:

MPC: <http://cfa-www.harvard.edu/iau/mpc.html>
JPL: <http://ssd.jpl.nasa.gov/?horizons>

In the ephemerides below, ED and SD are, respectively, the Earth and Sun distances (AU), V is the estimated Johnson V magnitude, and α is the phase angle. SE and ME are the great circles distances (in degrees) of the Sun and Moon from the asteroid. MP is the lunar phase and GB is the galactic latitude. "PHA" in the header indicates that the object is a "potentially hazardous asteroid", meaning that at some (long distant) time, its orbit might take it very close to Earth.

(242450) 2004 QY2 (2011 July, H = 14.7, PHA)

There are no known lightcurve parameters this 3.5 km NEA. The size does make it a potential binary candidate, so high-precision observations are encouraged.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	01 55.2	+15 59	0.32	0.94	15.5	95.1	66	62	+0.00	-44
07/03	02 10.7	+21 04	0.32	0.92	15.6	98.4	63	84	+0.03	-38
07/05	02 27.3	+26 00	0.33	0.90	15.7	101.3	60	107	+0.16	-32
07/07	02 45.0	+30 39	0.34	0.88	15.9	103.9	57	130	+0.36	-26
07/09	03 03.8	+34 55	0.35	0.86	16.0	106.1	55	151	+0.59	-21
07/11	03 23.5	+38 42	0.36	0.85	16.2	107.8	52	163	+0.79	-15
07/13	03 44.0	+41 57	0.38	0.83	16.3	109.0	50	152	+0.94	-10
07/15	04 05.0	+44 41	0.40	0.81	16.4	109.8	49	133	+1.00	-6

(5496) 1973 NA (2011 July, H = 15.3)

This $D \sim 2.6$ km NEA will be a good target for Southern Hemisphere observers in early July. The rapid sky motion will require short exposures.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	22 32.0	-54 59	0.28	1.20	15.1	42.7	127	123	+0.00	-52
07/03	22 22.7	-61 38	0.30	1.22	15.3	41.8	127	129	+0.03	-48
07/05	22 10.3	-67 13	0.33	1.24	15.5	41.4	126	120	+0.16	-43
07/07	21 53.7	-71 49	0.36	1.26	15.7	41.4	125	102	+0.36	-39
07/09	21 31.0	-75 33	0.39	1.27	15.9	41.5	124	83	+0.59	-36
07/11	21 00.2	-78 29	0.42	1.29	16.1	41.6	122	68	+0.79	-33
07/13	20 19.0	-80 41	0.45	1.31	16.3	41.7	121	60	+0.94	-30
07/15	19 26.8	-82 08	0.49	1.33	16.5	41.8	119	62	+1.00	-28

1917 Cuyo (2011 July-August, H = 13.9)

The rotation period for this 3.4 km NEA is 2.690 h. Reported amplitudes range from 0.26-0.44 mag. The size and rotation period make it a good candidate for being a binary. Lightcurve data will supplement previously obtained radar data for modeling.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	18 40.5	+26 22	0.96	1.79	16.3	25.5	130	131	+0.00	+14
07/06	18 33.9	+27 07	0.93	1.76	16.2	26.3	130	112	+0.25	+16
07/11	18 27.0	+27 36	0.90	1.73	16.1	27.4	129	66	+0.79	+17
07/16	18 20.0	+27 49	0.87	1.69	16.0	28.6	127	52	-0.99	+19
07/21	18 13.1	+27 44	0.85	1.66	15.9	30.0	125	85	-0.70	+20
07/26	18 06.6	+27 23	0.83	1.63	15.9	31.6	123	122	-0.24	+21
07/31	18 00.7	+26 43	0.81	1.59	15.8	33.3	121	123	+0.00	+22
08/05	17 55.7	+25 48	0.79	1.56	15.8	35.0	118	78	+0.34	+23
08/10	17 51.7	+24 36	0.78	1.52	15.8	36.9	116	47	+0.85	+23
08/15	17 48.9	+23 11	0.76	1.49	15.7	38.8	113	72	-0.98	+24

3103 Eger (2011 July-August, H = 15.4)

This period for this asteroid is 5.707 h. Reported amplitudes have ranged from 0.55-1.55 mag. A pole and shape model exists but

additional dense lightcurves in support of radar this time around can further refine the model. Also, Durech *et al.* (2009) reported evidence of YORP influence on the rotation rate. High-quality observations could help confirm this.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/01	21 56.1	+11 26	0.38	1.25	15.4	44.6	120	117	+0.00	-33
07/11	22 34.1	+09 38	0.29	1.19	14.8	45.8	123	109	+0.79	-40
07/21	23 33.3	+04 25	0.21	1.14	14.1	49.2	122	8	-0.70	-53
07/31	01 10.9	-06 47	0.16	1.09	13.7	59.3	113	115	+0.00	-69
08/10	03 21.8	-20 10	0.16	1.04	14.2	76.8	94	121	+0.85	-55
08/20	05 11.2	-26 17	0.20	0.99	15.1	89.3	79	62	-0.68	-33

(7889) 1994 LX (2011 July-August, H = 15.3)

No radar observations are planned this time around for 1994 LX but new lightcurve data can be used to complement earlier radar for modeling. The rotation period 2.74 h with the reported amplitude on the order of 0.35 mag, but that was when the asteroid was at large phase angles. The lower phase angles for this apparition may result in a lower amplitude. Here again, the size and rotation period make it a good binary candidate and so high-precision, well-calibrated data should be the rule.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
07/05	20 28.2	-19 24	0.70	1.68	16.4	13.2	158	155	+0.16	-30
07/10	20 18.1	-22 49	0.67	1.68	16.2	8.8	165	81	+0.70	-29
07/15	20 06.3	-26 23	0.66	1.67	15.9	5.2	171	13	+1.00	-27
07/20	19 53.0	-29 57	0.65	1.66	15.9	5.6	171	59	-0.79	-26
07/25	19 38.7	-33 23	0.65	1.65	16.1	9.7	164	121	-0.33	-24
07/30	19 23.9	-36 33	0.66	1.64	16.3	14.4	156	161	-0.01	-22
08/04	19 09.3	-39 20	0.68	1.63	16.5	19.0	148	94	+0.23	-20
08/09	18 55.5	-41 43	0.70	1.62	16.7	23.3	141	29	+0.77	-18

2003 QC10 (2011 August-September, H = 17.8)

This NEA has an estimated diameter of only 800 meters. There are no lightcurve parameters given in the LCDB. This target is fainter than we usually include; we hope that those with access to 0.5-m and larger telescopes will give it a try.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/25	01 51.2	+07 45	0.42	1.29	18.2	41.3	123	69	-0.21	-52
08/27	01 57.8	+08 25	0.39	1.27	18.0	42.1	123	94	-0.06	-51
08/29	02 05.2	+09 10	0.36	1.24	17.8	43.1	123	121	+0.00	-50
08/31	02 13.8	+10 02	0.33	1.22	17.6	44.4	122	148	+0.05	-48
09/02	02 23.8	+11 01	0.30	1.19	17.4	45.9	122	172	+0.21	-46
09/04	02 35.7	+12 10	0.27	1.17	17.2	48.0	121	158	+0.42	-43
09/06	02 50.2	+13 31	0.24	1.15	17.0	50.6	119	135	+0.64	-40
09/08	03 08.3	+15 06	0.22	1.12	16.8	54.0	116	114	+0.82	-36

(253841) 2003 YG118 (2011 August-September, H = 17.0)

Behrend (2011, http://obswww.unige.ch/~behrend/page_cou.html) reported observations from 2011 February but with no definitive results for period or amplitude. The estimated diameter for this NEA is 1.1 km.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/20	23 37.0	-05 23	0.96	1.92	19.2	13.4	154	43	-0.68	-62
08/22	23 33.5	-05 35	0.97	1.94	19.2	12.0	157	68	-0.49	-62
08/24	23 29.9	-05 47	0.98	1.96	19.2	10.5	159	93	-0.30	-61
08/26	23 26.4	-05 59	0.99	1.97	19.2	9.0	162	121	-0.13	-61
08/28	23 22.8	-06 11	1.00	1.99	19.1	7.5	165	149	-0.02	-60
08/30	23 19.2	-06 22	1.01	2.01	19.1	6.1	168	173	+0.01	-60
09/01	23 15.7	-06 34	1.02	2.02	19.1	4.6	171	148	+0.12	-59
09/03	23 12.2	-06 46	1.03	2.04	19.0	3.2	173	119	+0.31	-59

(265187) 2003 YS117 (2011 August-September, H = 18.3)

There are no lightcurve parameters reported in the LCDB for this NEA. The estimated diameter is only 650 meters. While the faintness of this object might dictate long exposures, they would “smear” a short-period lightcurve. Use as short of exposures as possible but also take as many as possible so that you can “beat down the noise” by overwhelming the data set with a large number of observations.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/20	01 29.1	+78 47	0.39	1.05	18.9	74.3	84	62	-0.68	+16
08/22	01 07.4	+79 41	0.40	1.06	19.0	72.6	85	60	-0.49	+17
08/24	00 43.4	+80 24	0.41	1.07	19.0	71.0	86	65	-0.30	+18
08/26	00 17.3	+80 57	0.43	1.08	19.1	69.5	87	74	-0.13	+18
08/28	23 49.8	+81 20	0.44	1.09	19.1	68.1	88	86	-0.02	+19
08/30	23 21.7	+81 32	0.45	1.10	19.1	66.7	89	99	+0.01	+19
09/01	22 54.2	+81 34	0.46	1.11	19.2	65.4	90	108	+0.12	+20
09/03	22 28.2	+81 28	0.48	1.12	19.2	64.2	91	113	+0.31	+20

2008 EK1 (2011 August-September, H = 20.3)

This tiny NEA, 260 meters, will be nearly circumpolar for northern observers in late August.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
08/25	19 22.7	+51 38	0.20	1.09	19.2	62.5	107	106	-0.21	+16
08/27	18 58.2	+50 39	0.18	1.07	19.0	65.9	105	111	-0.06	+20
08/29	18 27.9	+48 50	0.15	1.05	18.8	70.4	101	106	+0.00	+24
08/31	17 50.7	+45 38	0.13	1.03	18.6	76.4	96	92	+0.05	+29
09/02	17 06.5	+40 06	0.11	1.01	18.5	84.5	89	71	+0.21	+36
09/04	16 16.9	+31 03	0.09	1.00	18.6	95.5	79	53	+0.42	+45

(219071) 1997 US9 (2011 September-October, H = 17.2)

This is a 1-km NEA with a period of 3.520 h (Pravec *et al.*) based on observations in 1998. The amplitude at that time was 0.2. The LCDB rating is U = 2, meaning that additional observations of sufficient precision could prove very useful.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/20	01 29.7	+42 00	0.40	1.30	17.4	35.6	131	51	-0.56	-20
09/22	01 25.6	+40 59	0.40	1.31	17.3	33.8	134	73	-0.35	-21
09/24	01 21.2	+39 52	0.39	1.31	17.2	31.9	136	99	-0.16	-23
09/26	01 16.6	+38 38	0.38	1.32	17.1	29.8	139	126	-0.03	-24
09/28	01 11.9	+37 18	0.38	1.32	17.0	27.8	142	151	+0.01	-25
09/30	01 07.0	+35 51	0.37	1.32	16.9	25.6	145	154	+0.10	-27
10/02	01 02.2	+34 17	0.37	1.33	16.8	23.5	148	131	+0.27	-29
10/04	00 57.3	+32 36	0.36	1.33	16.7	21.4	151	105	+0.49	-30

1036 Ganymed (2011 July-September, H = 9.5)

The period for Ganymed is 10.3 h. At 32 km, this is the largest known member of the NEAs. Pole and shape models were previously determined. The lengthening nights of late northern summer and early fall combined with the brightness of the asteroid make it a good learning project for those getting started in asteroid photometry, with one caveat: the amplitude of previous lightcurves range from 0.10 to 0.45 mag. If the amplitude is low this time around, that could make analysis more difficult. Be careful about not saturating the asteroid on CCD images.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
09/15	00 59.0	+60 31	0.44	1.25	9.7	47.4	114	49	-0.94	-2
09/20	01 14.7	+57 45	0.42	1.26	9.5	44.7	118	55	-0.56	-5
09/25	01 27.9	+54 10	0.40	1.27	9.3	41.1	124	103	-0.09	-8
09/30	01 38.6	+49 44	0.38	1.28	9.1	36.7	130	147	+0.10	-12
10/05	01 47.0	+44 28	0.37	1.30	9.0	31.5	137	106	+0.59	-17
10/10	01 53.5	+38 29	0.36	1.31	8.8	25.4	146	49	+0.96	-23
10/15	01 58.3	+32 00	0.36	1.33	8.6	18.8	154	22	-0.92	-29
10/20	02 02.0	+25 22	0.37	1.35	8.5	12.0	164	78	-0.51	-35

IN THIS ISSUE

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

Number	Name	Page	EP	Number	Name	Page	EP
1177	Gonnessia	165	39	7781	Townsend	142	16
1318	Nerina	158	32	9190	Masako	137	11
1318	Nerina	165	39	9233	Itagijun	136	10
1318	Nerina	167	41	9549	Akplatonov	139	13
1318	Nerina	169	43	10779	1991 LW	142	16
1342	Brabantia	132	6	12265	1990 FG	142	16
1342	Brabantia	141	15	12466	1997 AS12	139	13
1342	Brabantia	169	43	13578	1993 MK	142	16
1383	Limburgia	154	28	13822	Stevedodson	142	16
1663	van den Bos	166	40	14790	Beletskij	137	11
2035	Stearns	142	16	15154	2000 FW30	139	13
2047	Smetana	142	16	16562	1992 AV1	142	16
2120	Tyumenia	137	11	16694	1995 AJ	137	11
2650	Elinor	137	11	17939	1999 HH8	137	11
2715	Mielikka	141	15	19131	1988 CY3	142	16
2802	Weisell	154	28	20936	4835 T-1	142	16
2869	Nepryadva	137	11	21056	1991 CA1	142	16
3152	Jones	137	11	22696	1998 QT105	142	16
3237	Victorplatt	137	11	23336	2579 P-L	142	16
3252	Johnny	141	15	23766	1998 MZ23	137	11
3266	Bernardus	142	16	27810	Daveturner	150	24
3388	Tsanghinchi	167	41	31485	1999 CM51	137	11
3447	Burckhalter	142	16	32505	2001 KF17	139	13
3511	Tsvetaeva	142	16	42612	1998 EL3	142	16
3577	Putilin	154	28	46784	1998 HK117	142	16
4175	Billbaum	158	32	46803	1998 KL33	142	16
4290	Heisei	137	11	48470	1991 TC2	142	16
4452	Ullacharles	169	43	52266	Van Flandern	154	28
4464	Vulcano	168	42	61461	2000 QA31	142	16
4490	Bambery	142	16	65739	1993 SG13	142	16
4970	Druyan	137	11	89550	2001 XU97	142	16
5168	Jenner	158	32	101771	1999 FB58	142	16
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