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THE LIGHTCURVE ANALYSIS OF FIVE ASTEROIDS

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Photometric data for five asteroids were collected at the Xuyi Observatory: 121 Hermione, 620 Drakonia, 877 Walkure, 933 Susi, and 2903 Zhuhai. A new period of 5.27 h is reported for 2903 Zhuhai.

All observations reported here were made at the Xuyi Observatory (D29) in China where the equipment consists of a 0.4-m f/10 Meade LX200 Schmidt-Cassegrain (SCT), Apogee Alta U6 CCD camera without shutter, and a clear filter. The image scale was 1.3 arcseconds per pixel. Exposure time was 90 seconds. Because there was no shutter, we took a light frame and then a bias frame by removing smear caused by the stars moving through the field during the exposure. Calibration of these images was done by using master twilight flats or a supersky flat frame. All calibration frames were created using *IDL*. *MPO Canopus* was used to measure the processed images and do the period analysis of the lightcurve.

<u>121 Hermione.</u> This 209 km C-type asteroid is a binary system (Marchis, 2005) belonging to the Cybele family. In all, 272 images were taken on 2011 March 7 and covered one synodic period (5.55128 h, JPL Solar System Dynamics website). The resulting lightcurve shows an amplitude of 0.08 ± 0.01 mag.

<u>620 Drakonia.</u> Images were taken on 2011 Feb 24 and Mar 8. There were not enough data to form a complete curve. Assuming a period near that reported by Warner (2002), we found a good fit with P = 5.480 ± 0.003 h and A = 0.65 ± 0.01 mag.

<u>877 Walkure.</u> Rene Roy (Behrend 2010) reported a period of 17.436 h. New observations on seven nights from 2011 Jan 3 to March 26 indicate a period of 17.424 ± 0.004 h with an amplitude of 0.44 ± 0.02 mag.

<u>933 Susi.</u> Data were collected from 2011 Mar 7 to 9. A period of 4.621 ± 0.002 h was determined with an amplitude of 0.52 ± 0.01 mag. The results are consistent with that reported by Higgins (2011).

<u>2903 Zhuhai.</u> This S-type asteroid belonging to the Maria family was worked by Alvarez *et al*. (2004), who were looking for possible correlations between rotational periods, amplitudes, and sizes. Based on their observations, they reported a period of 6.152 h. Our new observations on two nights (2010 Dec 28 and 29) show a period of 5.27 ± 0.01 h with amplitude 0.55 ± 0.02 mag. The data were checked against the period of 6.152 h reported by Alvarez but this produced a very unconvincing fit.

Acknowledgements

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References

Alvarez-Candal, A., Duffard, R., Angeli, C.A., Lazzaro, D., and Fernandez, S. (2004). "Rotational lightcurves of asteroids belonging to families." *Icarus* **172**, 388-401.

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

Binzel, R.P. (2005). "A photoelectric survey of 130 asteroids." *Icarus* **72**, 135-208.

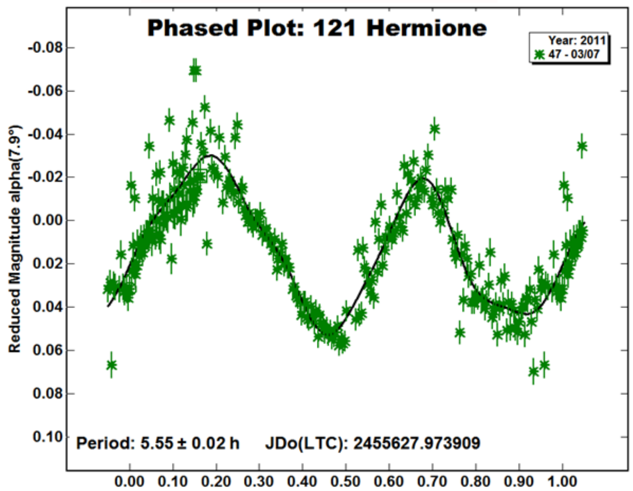
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

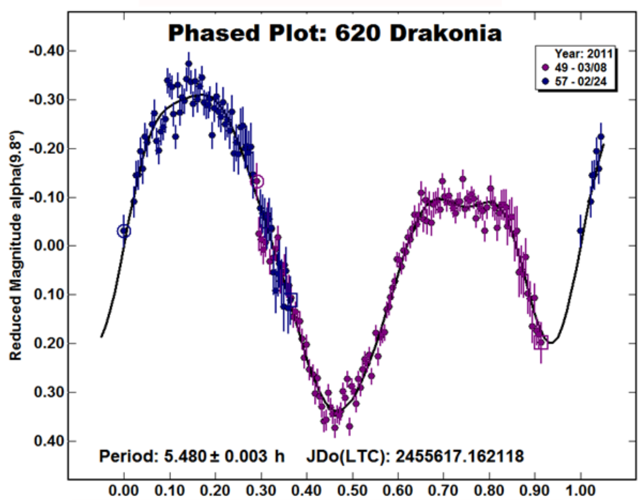
Higgins, D. (2011). *http://www.david-higginscom/Astronomy/asteroid/results/output/933.htm*

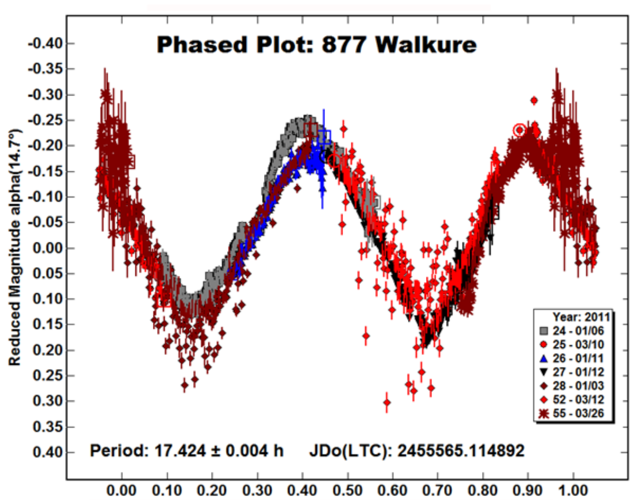
Marchis,F., Hestroffer, D., Descamps, P., Berthier, J., Laver, C., and de Pater, I. (2005). "Mass and density of asteroid 121 Hermione from an analysis of its companion orbit." *Icarus* **178**, 450-464.

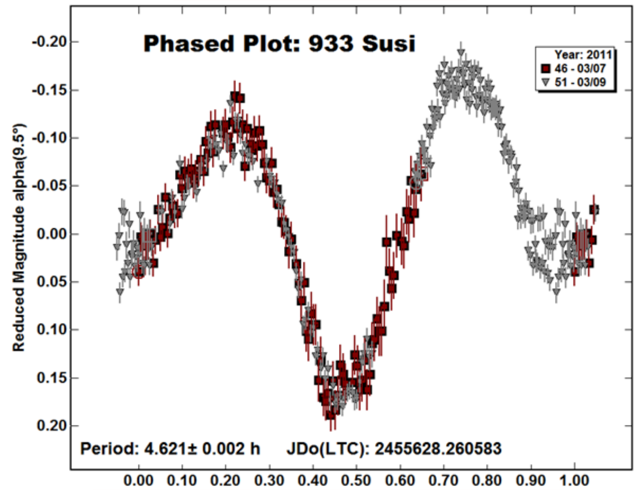
Warner, B.D. (2002). "Asteroid Photometry at the Palmer Divide Observatory: Results for 620 Drakonia, 3447 Burkhalter, and 7816 Hanoi." *Minor Planet Bul*. **29**, 27-28.

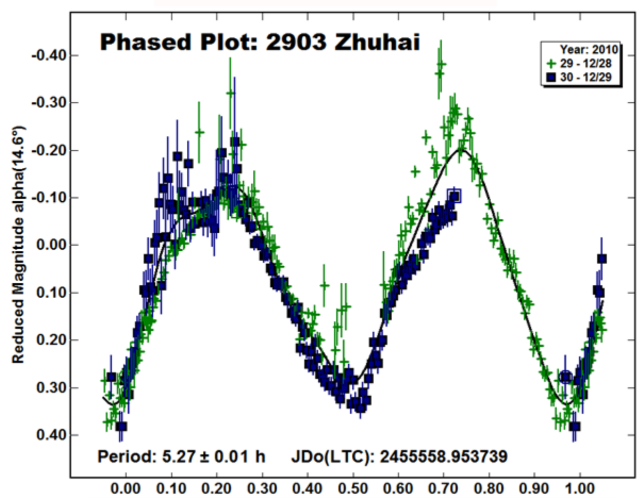
Warner, B.D. (2003). *A Practical Guide to Lightcurve Photometry and Analysis*. Bdw Publishing, Colorado Springs, CO.











PERIOD DETERMINATION FOR 819 BARNARDIANA

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Lightcurve analysis for 819 Barnardiana was performed from observations during its 2011 opposition. The synodic rotation period was found to be 66.70 ± 0.01 h and the lightcurve amplitude was 0.82 ± 0.06 mag.

Edward Emerson Barnard was one of the great observational amateur astronomers. Among many important discoveries, in 1892 he was the first to report Jupiter's fifth moon, Amalthea (the first known after the four Galileans), and in 1916 he discovered the star with the fastest known proper motion and subsequently named “Barnard’s Star.” Barnard was honored by the naming of asteroid 819 Barnardiana, also discovered in 1916, by Max Wolf, the pioneer of the systematic use of photography in astronomy.

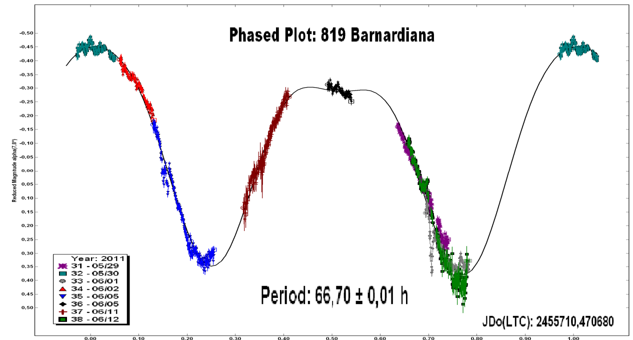
819 Barnardiana was one of the recommended asteroids in the "Potential Lightcurve Targets 2011 April - June" included on the Collaborative Asteroid Lightcurve Link (CALL) web-site (Warner, 2011), where it listed as having no known lightcurve parameters. Unfiltered CCD photometric images were taken at Observatorio Los Algarrobos, Salto, Uruguay (MPC Code I38) from 2011 late-May to mid-June using a 0.3-m Meade LX-200R f/10 working with a 0.63 focal reducer. The CCD imager was a QSI 516wsg NABG with a 1536 x 1024 array of 9-micron pixels. 2x2 binning was used, yielding an image scale of 1.9 arcseconds per pixel. Exposures were 120 s working at –10C. Autoguiding was done by means of a Lodestar camera and *PHD Guiding* software (Stark Labs) version v1.12. All images were dark and flat field corrected and then measured using *MPO Canopus* version 10.2.0.2 (Bdw Publishing) with a differential photometry technique. The data were light-time corrected. Period analysis was also done with *Canopus*, which incorporates the Fourier analysis algorithm developed by Harris et al. (1989).

From nearly 1500 data points obtained during eight sessions (totaling more than 50 h of observation and while the phase angle varied from 7.8º to 14.8º), the rotational period for 819 Barnardiana was determined to be 66.70 ± 0.01 h, along with a peak-to-peak amplitude of 0.82 ± 0.06 mag.

References

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

Warner, B.D. (2011). Collaborative Asteroid Lightcurve Link (CALL) web site. *http://www.minorplanet.info/call.html*



PHOTOMETRY OF ASTEROID 13241 BIYO

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Asteroid 13241 Biyo was observed at Virginio Cesarini Observatory (Italy) on 1 night in March 2011. The resulting lightcurve shows a synodic period of 2.199 ± 0.219 h and amplitude 0.99 ±0.03 mag. in the R band.

The choice of asteroid 13241 Biyo as a target was suggested from related astrometric work: we were analyzing the old DSS plate n° ER653 taken on 20/4/1991 in Siding Spring and we realized that the asteroid Biyo showed a variable width trail on the plate. So we decided to observe photometrically this object. Biyo is a main-belt asteroid discovered 1998 May 22 by the Lincoln Laboratory Near-Earth Asteroid Research Team at Socorro and up to now there are no lightcurve and period value published.

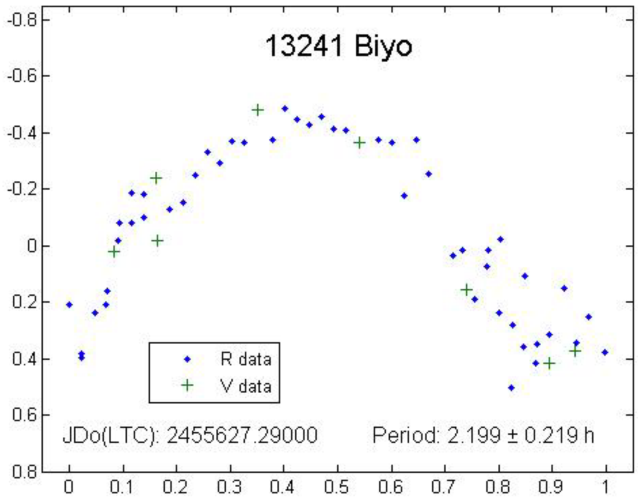
The observations were made at Virginio Cesarini Observatory (157 Frasso Sabino) located in Frasso Sabino village, 60 km north of Rome. The observatory is equipped with a cassegrain telescope 0.37-m diameter f 12 and f 6.8 (with focal reducer), CCD camera (Finger Lakes Proline PL 1301E-1) and classical Bessel B,V,R filters, plus Hα and clear. The images were taken on 6 March 2011 with f 6.8 focal ratio (1.31 arcsec for pixel) exposed for 180s in R and V band and reduced with bias, dark, and flats using Canopus ver.10.0 software. During the observations the camera temperature was set at -40 °C.

We acquired 49 images in the R band and 8 in the V band. In the Table I are indicated the comparison stars used for the differential photometry. The stars are taken from the 2MASS catalog and the conversion from JK magnitudes to BVRI is carried out by the Canopus software. The mean R and V magnitude results were R=17.31± 0.02 and V=17.78± 0.03 and the color indices yield V-R= 0.38±0.03, with no rotational variation detected within this precision.

The photometric data were analyzed by Peranso software version 2.5 and the PDM method; using the R data we found a synodic period P= 2.199 ± 0.219 h. Figure 1 displays the lightcurve data points in both V and R.

	2MASS	RA J2000 (FK5)	DE J2000 (FK5)	V mag	R mag
1	08232616+3134225	08 23 26.160	+31 34 22.59	12.868	12.601
2	08214790+3136569	08 21 47.905	+31 36 56.97	13.704	13.344
3	08215039+3124052	08 21 50.400	+31 24 05.27	13.879	13.427
4	08220147+3122446	08 22 01.472	+31 22 44.69	13.942	13.611
5	08231544+3126362	08 23 15.449	+31 26 36.23	14.170	13.877

Table I. Comparison Stars



References

Harris, A. W. and Lupishko, D. F. (1989). "Photometric lightcurve observations and reduction techniques." In *Asteroids II* (R.P. Binzel, T. Gehrels, M.S. Matthews, eds.) pp 39-53. Univ. of Arizona Press, Tucson.

Stellingwerf, R.F. (1978). "Period determination using phase dispersion minimization". ApJ, **224**,953-960

Vanmunster, T (2009). "Peranso "software *ftp://www.peranso.com*

Warner, B.D. (2008). MPO software , Canopus Version 10.xxx , Bdw Publishing , Colorado Springs, C.O.

THE LONG PERIOD OF 2675 TOLKIEN

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Lightcurve measurements of 2675 Tolkien from the Shed of Science, Via Capote Observatory, and Ondřejov Observatory were taken on twenty-three nights; a period of P = 1058 ± 30 hrs, A = 0.75 ± 0.1 mag were derived.

The Flora member asteroid, 2675 Tolkein, was a target in the Photometric Survey for Asynchronous Binary Asteroids (Pravec, 2006). Twenty-four sessions were recorded on twenty-three nights over three months between 2011 January 5 and March 27. Durkee made observations on eighteen nights, Brinsfield observed on six nights, and Hornoch observed on one night during that period.

All images were dark and flat field corrected and then measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The *MPO Canopus* Comp Star Selector utility was used by Durkee and Brinsfield to link sessions while the observations from Ondřejov were photometrically calibrated. The data were light-time corrected. Period analysis was also done with *MPO Canopus*, which implements the Fourier analysis algorithm developed by Harris (Harris *et al.* 1989). Details about the equipment used at the Shed of Science have been previously described (Durkee 2011). See the introduction in Brinsfield (2011) for a description of equipment and software tools used for observations and measurements at the Via Capote Observatory.

The sessions from Durkee and Brinsfield were linked to one another by using BVRI comparison star magnitudes derived from J-K 2MASS magnitudes (Warner 2006). Durkee and Brinsfield made nearly coincident observations on 2011 March 11, which allowed eliminating any remaining offsets. An absolute magnitude of H_R = 11.93 ± 0.2 mag, assuming G = 0.15, was calculated based on the calibrated session by Hornoch and Kušnirák on January 8.

Our results indicate a period of P = 1058 ± 30 hrs, A = 0.75 ± 0.1 mag. The solution is reasonably secure since we were able to cover the lightcurve twice over three months with good agreement. There are some deviations present in the lightcurve; these could be caused by the phase angle changing from 3 to 25 degrees over the observational interval or, possibly, by tumbling.

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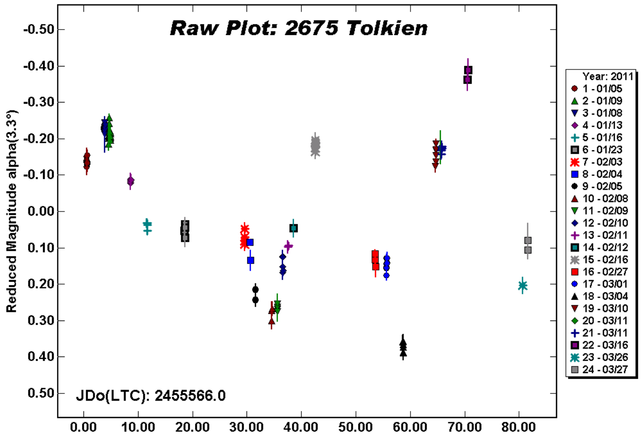
References

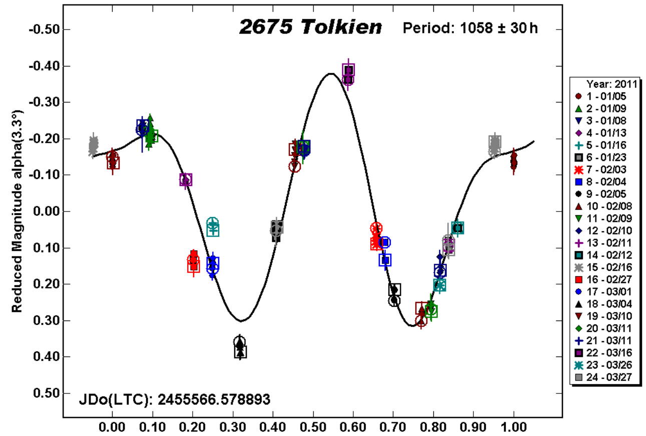
Brinsfield, J.W. (2011). "Asteroid Lightcurve Analysis at the Via Capote Observatory: 4th Quarter 2010." *Minor Planet Bul.* 38, 73-74.

Durkee, R.I. (2011). "Asteroids Observed from the Shed of Science Observatory: 2010 May-October." *Minor Planet Bul*. **38**, 39-40.

Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, Pravec, P. Scheirich, P. Kušnirák, P., Šarounová, L., and 53 coauthors (2006). "Photometric Survey of Binary Near-Earth Asteroids." *Icarus* **181**, 63-93.

Warner, B.D. (2006). "Initial Results of a Dedicated H-G Project" *Minor Planet Bul.* **34**, 113-119.





ROTATION PERIOD DETERMINATIONS FOR 11 PARTHENOPE, 38 LEDA, 99 DIKE, 111 ATE, 194 PROKNE, 217 EUDORA, AND 224 OCEANA

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Synodic rotation periods and amplitudes have been found for these asteroids: 11 Parthenope 13.722 ± 0.001 h, 0.10 ± 0.02 mag with 3 maxima and minima per cycle; 38 Leda 12.834 ± 0.001 h, 0.15 ± 0.01 mag; 99 Dike 18.127 ± 0.002 h, 0.22 ± 0.02 mag; 111 Ate 22.072 ± 0.001 h, 0.12 ± 0.01 mag with an irregular lightcurve; 194 Prokne 15.679 ± 0.001 h, 0.16 ± 0.02 mag; 217 Eudroa 25.253 ± 0.002 h, 0.22 ± 0.04 mag; 224 Oceana 9.401 ± 0.001 h, 0.09 ± 0.01 mag. An alternative 18.8 hour period suggested for 224 Oceana is definitively rejected.

The observations reported here were all obtained at the Organ Mesa Observatory. Equipment consists of a 35.4 cm Meade LX 200 GPS S-C and SBIG STL-1001E CCD, with unguided exposures through an R filter for 11 Parthenope, 111 Ate, and 194 Prokne, and clear filter for other targets, differential photometry only. Image measurement and lightcurve analysis were done with *MPO Canopus*. The lightcurves have been drawn with the large number of data points acquired for each target in this study binned in sets of three with a maximum of five minutes between points.

11 Parthenope. For many years every attempt at rotation period determination produced a different result. All show low amplitude and complex lightcurves, for which alias periods are especially troublesome. In chronological sequence van Houten-Groeneveld and van Houten (1958) obtained an indefinite 10.7 hour period and 0.07 magnitude amplitude. Wood and Kuiper (1963) published an amplitude 0.12 magnitude and no period determination. Zappala (1983) obtained amplitude exceeding 0.07 mag and no period determination. Barucci et al. (1985) found a period 7.83 hours, amplitude 0.08 mag. Melillo (1985) suggested a possible 5 hour period and 0.08 mag amplitude. Lang (1996) found amplitude 0.05 mag and possible period 11.75 hours. Piironen et al. (1998) obtained a bimodal lightcurve of period 9.43 hours, amplitude 0.05 mag. Three recent dense data sets all show compatible periods: Lang and Hansen (1999), 13.720 hours; Stephens (2010), also Stephens et al. (2008), 13.7293 hours; and Pilcher (2010a), 13.722 hours. The period is now considered secure (Harris et. al., 2011), and additional lightcurves were obtained for the purpose of obtaining a spin/shape model by lightcurve inversion.

New observations at the Organ Mesa Observatory on 9 nights 2011 Feb. 16 – May 10 show a period 13.722 ± 0.001 hours, amplitude 0.10 ± 0.02 magnitudes, with three unequal maxima and minima per cycle. This is fully compatible with the dense data sets of Lang and Hansen (1999), Stephens et al. (2008) and Stephens (2010), and Pilcher (2010a). A period near 13.72 hours now seems to be well established.

38 Leda. Harris et al. (2011) state a secure period of 12.838 hours based on several independent and compatible studies. New data obtained to contribute toward a spin/shape model on 5 nights 2011 Mar. 17 – Apr. 26 show a period 12.834 ± 0.001 h, amplitude 0.15 ± 0.01 magnitudes. This result agrees fully with previous studies.

99 Dike. Haupt (1982) based on two consecutive nights degraded by clouds and appulses to stars stated that the period must be at least 18h 20m. Harris et al. (1992) claimed a period > 24 hours based on sparse data. Lagerkvist et al. (1995) found period 10.35 hours; Sheridan (2009) 10.360 hours; Behrend (2011) 10.3811 hours. New lightcurves on 8 nights 2011 March 21 – April 23 show a period 18.127 ± 0.002 hours, amplitude 0.22 ± 0.02 magnitudes. The new results rule out all of these periods except perhaps that by Haupt (1982). The data of Sheridan (2009) which he phased to a period of 10.360 hours are compatible with this new determination. Four rotational cycles corresponds to 72.508 hours. Sheridan's data were obtained on three nights separated by three days or a multiple thereof. Therefore he observed the same segment of the rotational cycle on each night. His data therefore could be phased to near 72.5 hours divided by any of several integers 3, 5, 6, 7 (which he assumed), etc., to obtain a convincing alias period, as well as by 4, the actual value.

111 Ate. Harris and Young (1983) published a somewhat irregular lightcurve with ¾ phase coverage and phased to a suggested period of 22.2 hours. This author (Pilcher, 2010a) obtained a much more dense data set on 9 nights from 2009 Nov. 21 at phase angle 14.2 degrees through a minimum phase angle 2.1 degrees 2009 Dec. 21 to 2010 Jan. 16 at phase angle 13.2 degrees. These showed a period of 22.072 hours, amplitude 0.09 magnitudes, with 3 large maxima somewhat unevenly spaced and a fourth low maximum.

All of the individual lightcurves were in phase with the composite, but some show segments deviating up to 0.03 magnitudes. These may be no greater than is commonly found over a wide range of phase angles, and may also be due in part to unspecified instrumental errors. Before beginning new observations the author examined carefully the period spectrum between 9 hours and 50 hours for these 2009 – 2010 data. For trial periods in this range all except those at 22.072 hours and the double period 44.144 hours showed much higher rms residuals, with at least one or two nights completely out of phase with the others, and can be immediately rejected. New observations were obtained on 18 nights 2011 Apr. 10 – May 28. These show a period of 22.072 ± 0.001 hours, amplitude 0.12 ± 0.01 magnitudes, and an irregular shape very different from that observed in 2009/10. Again periods corresponding to all local minima on the period spectrum between 9 and 50 hours, except 22.072 hours and 44.143 hours, can be rejected immediately. It may be significant that for both the 2009 – 2010 and 2011 data sets the two halves of lightcurve phased to the double period looked the same within reasonable error of observation. The identical periods in 2009/2010 and 2011 may be fortuitous. During the final adjustments after all data were obtained it was found that changing the instrumental magnitudes of individual sessions by a few x .001 magnitudes changed the best fit period by a few x .001 hours. The procedure utilized was that instrumental magnitudes of individual sessions would be adjusted until the rms residual of the Fourier components was a minimum. The period for which this was achieved was 22.072 hours. It should be noted that all period determinations are compatible.

194 Prokne. Previous period determinations are by Scaltriti and Zappala (1979), 15.67 hours with large gaps in a bimodal lightcurve; Pilcher (2010a), 15.677 hours with full phase coverage of a monomodal lightcurve of much smaller amplitude; and Behrend (2011), 16 hours. New observations on 11 nights 2011 May 20 – July 5 show a period 15.679 ± 0.001 hours, maximum amplitude 0.16 ± 0.02 magnitudes. This period is in good agreement with previous determinations.

217 Eudora. Previous period determinations are by Lagerkvist et al. (1998), 12.54 hours based on a sparse lightcurve; Buchheim et al. (2007), 25.253 hours; Pilcher (2010b), 25.470 hours; and Behrend (2011), 25.253 hours. New observations on 20 nights 2011 May 12 – July 11 show a period 25.253 ± 0.002 hours, amplitude 0.22 ± 0.04 magnitudes. This period is in agreement with Behrend (2011), Buchheim et al. (2007), and Pilcher (2010b), and may be compatible with Lagerkvist et al. (1998) if it assumed they found half the actual period.

224 Oceana. Harris and Young (1980) published a period of 18.933 hours, but careful examination of their lightcurve shows that it might be interpreted as half of that period. Warner (2006) published a period of 9.385 hours but some small misfits suggested the period could be twice as great. Shepard et. al. (2008) suggest a period of 9.388 hours. New observations were made with the specific goal of resolving this ambiguity of near 9.4 hours versus near 18.9 hours.

The shorter period 9.401 ± 0.001 hours, amplitude 0.09 ± 0.01 magnitude, and an irregular lightcurve is now found by observations on 10 nights 2001 Mar. 4 – May 1. Of course a lightcurve phased to 18.802 also fits the data with the two halves of the lightcurve appearing nearly identical within reasonable errors of observation. The shorter period is preferred, but photometry alone cannot absolutely rule out the longer one. Tedesco et. al. (2002) derive from IRAS data a diameter 61.82 ± 2.1 km. While the formal error is unrealistically small, a diameter twice as great can be safely rejected. Shepard et. al. (2008) measured a Doppler broadening of 175 ± 15 Hz from 224 Oceana using a 2380 MHz radar beam from Arecibo. The IRAS diameter and 9.4 hour period constrains the reflected bandwidth to <= 180 Hz, the equality for equatorial aspect, and in agreement with observation. The IRAS diameter and 18.8 hour period constrains the bandwidth to <= 90 Hz, in gross disagreement with observation. When the radar data are considered, the longer period near 18.802 hours can be definitively rejected.

References

Barucci, M. A., Fulchignoni, M., Burchi, R., and D'Ambrosio, V. (1985). "Rotational properties of ten main belt asteroids: Analysis of the results obtained by photoelectric photometry." *Icarus* **61,** 152-162.

Behrend, R., Observatoire de Geneve web site: (2011), *http://obswww.unige.ch/~behrend/page_cou.html*

Harris, A. W., Pravec, P., and Warner, B. D., (2011). "Asteroid Lightcurve Data File: Mar. 2011," *http://www.MinorPlanetObserver.com/astlc/default.htm*

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

Harris, A. W. and Young, J. W. (1983). "Asteroid Rotation IV. 1979 Observations." *Icarus* **54**, 59-109.

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

Harris, A. W., Young, J. W., Dockweiler, T., Gibson, J., Poutanen, M., and Bowell, E. (1992). "Asteroid Lightcurve Observations from 1981." *Icarus* **95**, 115-147.

Haupt, H. (1982). "99 Dike ein langsam rotierender Kleinplanet." *Ann. Osterr. Akad. Wiss. Math.-Naturwiss. Kl.* **119**, 47-49.

Lagerkvist, C.-I., and 13 collaborating authors (1995). "Physical studies of asteroids XXIX. Photometry and analysis of 27 asteroids." *Astron. Astrophys. Suppl. Ser.* **113**, 115-129.

Lagerkvist, C.-I., Belskaya, I., Erikson, A., Schevchenko, V., Mottola, S., Chiorny, V., Magnusson, P., Nathues, A., and Piironen, J. (1998). "Physical studies of asteroids XXXIII. The spin rate of M-type asteroids." *Astron. Astrophys. Suppl. Ser.* **131**, 55-62.

Lang, K. (1996). "CCD Photometry of 11 Parthenope in 1995." *Minor Planet Bull.* **23**, 15-16.

Lang, K. and Hansen, A. T. (1999). "The Lightcurve and Rotation Period of 11 Parthenope." *Minor Planet Bull.* **25**, 15-18.

Melillo, F. J. (1994). "Photoelectric photometry of 11 Parthenope." *Minor Planet Bull.* **21**, 15-17.

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

Pilcher, F. (2010a). "Period Determinations for 11 Parthenope, 35 Leukothea, 38 Leda, 111 Ate, 194 Prokne, 262 Valda, 728 Leonisis, and 747 Winchester." *Minor Planet Bull.* **37**, 119-222.

Pilcher, F. (2010b). "Rotation Period Determinations for 80 Sappho, 145 Adeona, 217 Eudora, 274 Philagoria, 567 Eleutheria, and 826 Henrika." *Minor Planet Bull.* **37**, 148-149.

Scaltriti, F. and Zappala, V. (1979). "Photoelectric Photometry and Rotation Periods of the Asteroids 26 Proserpina, 194 Prokne, 287 Nephthys, and 554 Peraga." *Icarus* **39**, 124-130.

Shepard, M. K., and 19 contributing authors (2008). "A radar survey of M- and X- class asteroids." *Icarus* **195**, 184-205.

Sheridan, E. E. (2009). "Lightcurve Results for 99 Dike, 313 Chaldaea, 872 Holda, 1274 Delportia, and 7304 Namiki." *Minor Planet Bull.* **36**, 55-56.

Stephens, R. D., Warner, B. D., Shepard, M. K., and Harris, A. W. (2008) "Lightcurve and Radar Observations and Analysis of 11 Parthenope and 678 Fredegundis," *B. A. A. S.* **40**, 28.16, p. 439.

Stephens, R. (2010). "Asteroid Maven." *Sky and Telescope* **120**, 60-64.

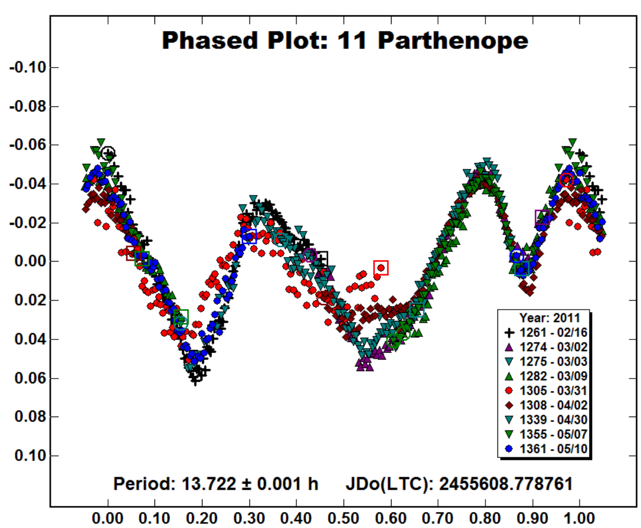
Tedesco, E. F., Noah, P. V., Noah, M., and Price, S. D. (2002). "The Supplemental IRAS Survey." *Astron. J.* **123**, 1056-1085.

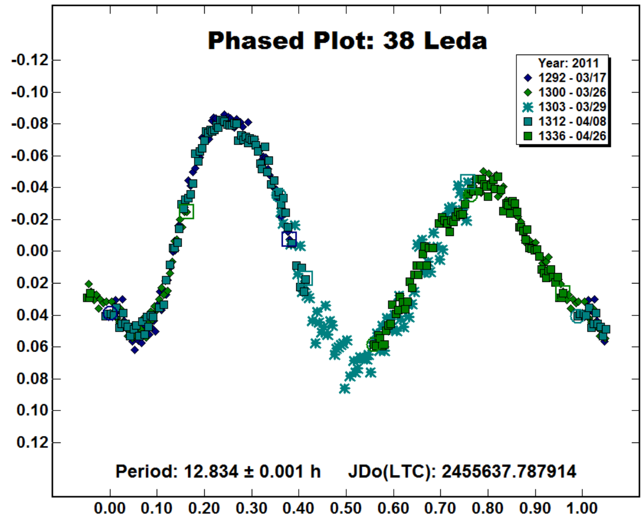
van Houten-Groeneveld, I. and van Houten, C. J. (1958). "Photometric studies of Asteroids. VII." *Astrophys. J.* **127**, 253-273.

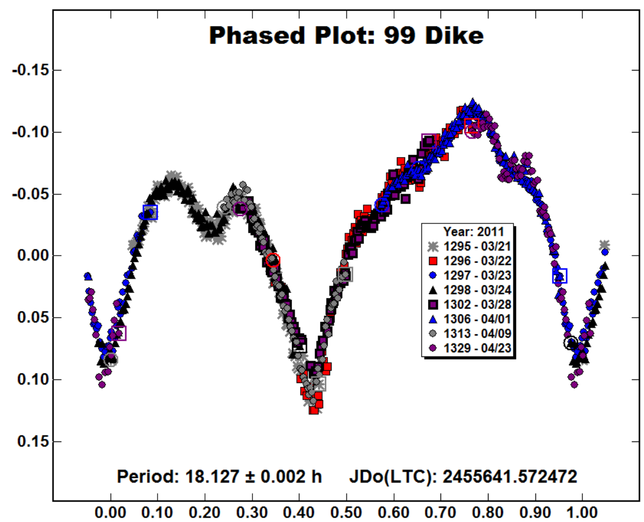
Warner, B. D. (2006). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory – Late 2005 and Early 2006." *Minor Planet Bull.* **33**, 58-62.

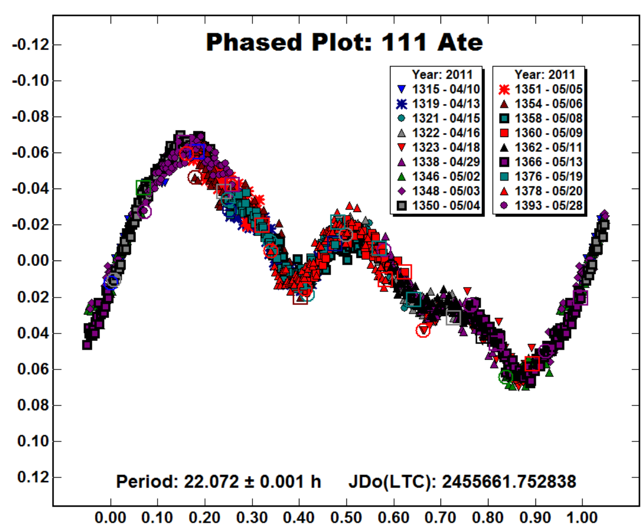
Wood, H. J. and Kuiper, G. P. (1963). "Photometric studies of Asteroids. X." *Astrophys. J.* **137**, 1279-1285.

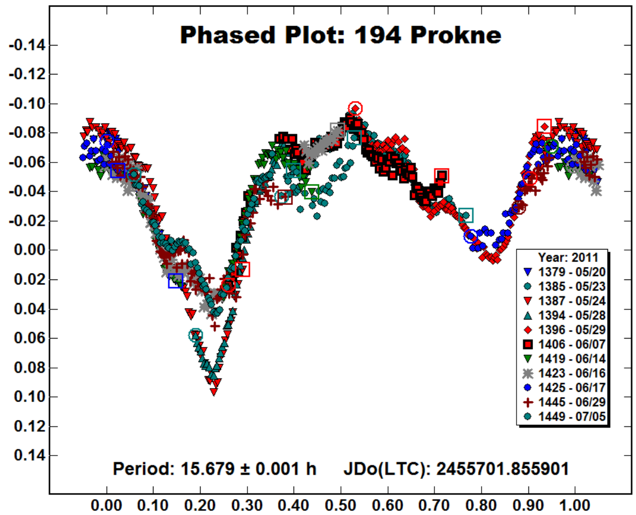
Zappala, V. (1983). "On the ambiguity of rotational periods of asteroids: The peculiar case of 52 Europa." *Icarus* **56**, 325-344.

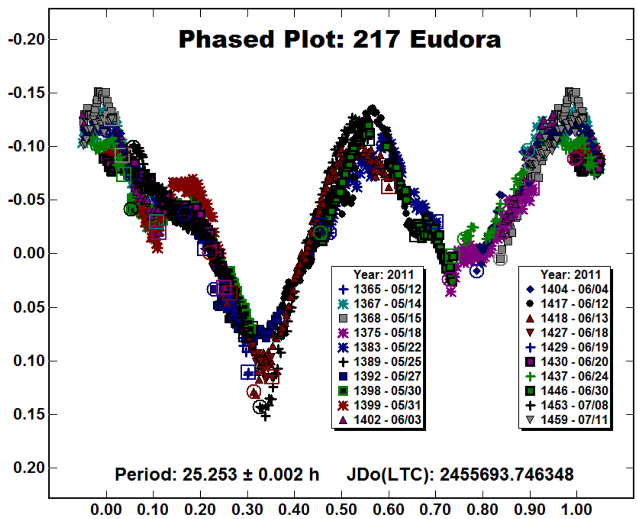


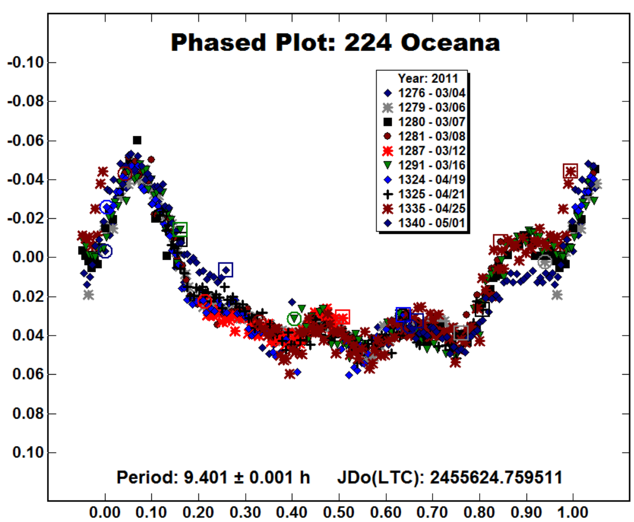












LIGHTCURVE ANALYSIS OF 45073 DOYANROSE

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CCD observations made of main-belt asteroid 45073 Doyanrose during 2011 January led to a lightcurve with a synodic period of 3.16 h ± 0.01 and amplitude of 0.16 ± 0.04 mag.

Main-belt asteroid 45073 Doyanrose was observed during 2011 January over two consecutive nights using a 0.5 meter f/8.1 Ritchey-Chretien reflector and a SBIG STL-6K CCD camera. Each integration was 300 seconds, unfiltered. Camera cooling temperature ranged from -25 to -30 degrees C. Details of the data reduction methods are in Ruthroff (2010).

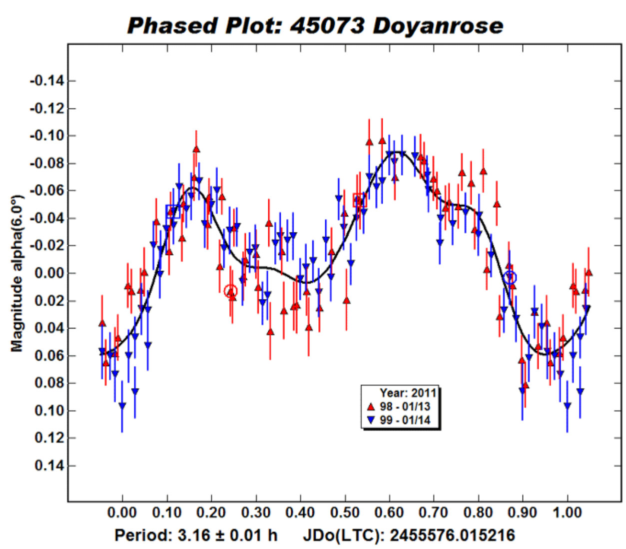
The author was unable to find any previously reported lightcurve data for this object. Two consecutive nights yielded 135 data points. The period found was 3.16 h ± 0.01 h, and amplitude of 0.16 m ± 0.04 mag.

Acknowledgements

This paper makes use of data products from The Third U.S. Naval Observatory CCD Astrograph Catalog (UCAC3). Thanks are offered to the Kitt Peak National Observatory Visitor Center, Mr. Flynn Haase and especially Mr. Steven Peterson, who took the observations of 45073 Doyanrose with the 0.5 meter Ritchey-Chretien reflector at the KPNO Visitors Center. I would like to thank Brian Warner for his years of guidance and support of the community of minor planet observers.

References

Ruthroff, J. C. (2010). “Lightcurve Analysis of Main Belt Asteroids 185 Eunike, 567 Eleutheria, and 2500 Alascattalo” Minor Planet Bul. 37, 158-159.



ASTEROID LIGHTCURVES FROM THE PRESTON GOTT AND MCDONALD OBSERVATORIES

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Asteroid period and amplitude results obtained at the Preston Gott Observatory and at the McDonald Observatory are presented.

The Preston Gott Observatory is the main astronomical facility of the Texas Tech University. Located about 20 km north of Lubbock, the main instrument is a 0.5-m f/6.8 Dall-Kirkam Cassegrain. An SBIG STL-1001E CCD was used with this telescope. All images were unfiltered and were reduced with dark frames and sky flats. The McDonald Observatory is the premier observatory in Texas. It is located in the Davis Mountains in Southern Texas. The instrument used for these observations was a 0.75-m f/3 reflector with an LN_2-cooled CCD mounted at prime focus. All images were unfiltered and reduced with dome flats and bias images.

The asteroids reported here are mostly those that had been previously observed. The reasons for the repeat observations were either for use in shape modeling or because the previous observations had resulted in a poor determination of the period. Measurements were also made of any other asteroids that happened to be in the field of view. Image analysis was accomplished using differential aperture photometry with *MPO Canopus*. Period analysis was also done in *Canopus*, which implements the algorithm developed by Alan Harris (Harris *et al.* 1989). Differential magnitudes were calculated using reference stars from the USNO-A 2.0 catalog and the UCAC2 catalog.

Results are summarized in the table below and the lightcurve plots are presented at the end of the paper. The data and curves are presented without additional comment except were circumstances warrant. Column 3 gives the range of dates of observations and column 4 gives the number of nights on which observations were undertaken.

1318 Narina Observations of this asteroid were first made in 2004 (Clark, 2007). Those observations indicated a period of 2.536 h with an amplitude of 0.21 mag. The more recent observations confirm this period but show a much smaller amplitude.

1708 Polit Observations of this asteroid made in 2005 yielded a period of 7.507 ± 0.001 h and an amplitude of 0.45 ± 0.02 mag. These results were not previously reported and so are included here. The recent observations confirm the earlier findings.

2036 Sheragul Observations of this asteroid were made in 2003 (Clark, 2004) and indicated a period of 5.4218 h with an amplitude of 0.58 mag. The new observations confirm the period but show an amplitude of about 1.0 mag.

3731 Hancock This was an extremely difficult asteroid to work. Despite observations on six nights, no reasonable bi-modal lightcurve could be derived. The brightness variations were very small, hardly exceeding the scatter in the data. There was some indication of a single-peak period of 6.7 h which is included below. However, the validity of this result is doubtful.

3885 Bogorodskji Observations of this asteroid were made in 2007 and previously reported (Clark, 2008) with a possible period of about 9.901 h and amplitude of 0.36 mag. The recent observations are incompatible with that period, the best result with the new data being a period of 5.803 h with an amplitude of 0.35 mag. A review of the 2007 data indicates that they are compatible with the new period, although the result is still not very satisfactory.

6500 Kodaira Observations of this asteroid were made in 2005 (Clark, 2007) and indicated a period of 5.385 h with an amplitude of 0.7 mag. The 2011 observations closely match both the period and the amplitude.

9566 Rykhlova Observations of this asteroid were made in 2005 (Clark, 2007). Analysis indicated a period of 8.800 h with an amplitude of 0.7 mag. Although the recent observations included only two nights due to weather, the results are similar in both period and amplitude.

In addition to the asteroids listed below, two others were observed: (61330) 2000 OT38 and (63061) 2000 WH118. Observations for each of these were made on two nights. However, the resulting lightcurve for both of them was flat within the scatter of the data and, since the asteroids were extremely faint, observations were discontinued.

Acknowledgments

I would like to thank Brian Warner for all of his work with the program *MPO Canopus*. This paper includes data taken at The McDonald Observatory of The University of Texas at Austin

References

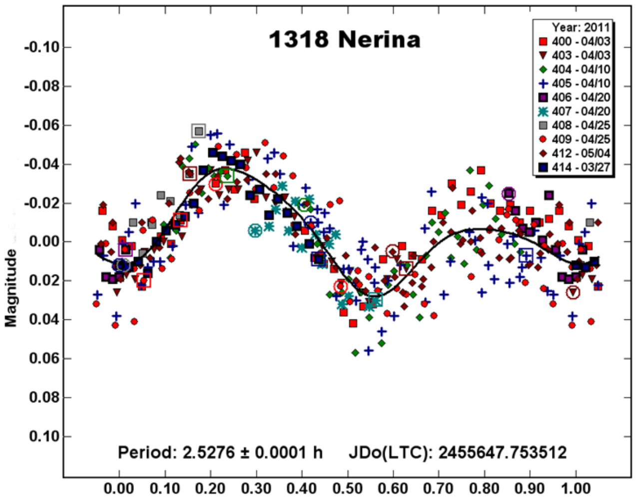
Clark M. L. (2004). "Rosemary Hill Observatory Photometry of Asteroids 2036 Sheragul and (21652) 1999 OQ2." *Minor Planet Bul.* **31**, 15-16.

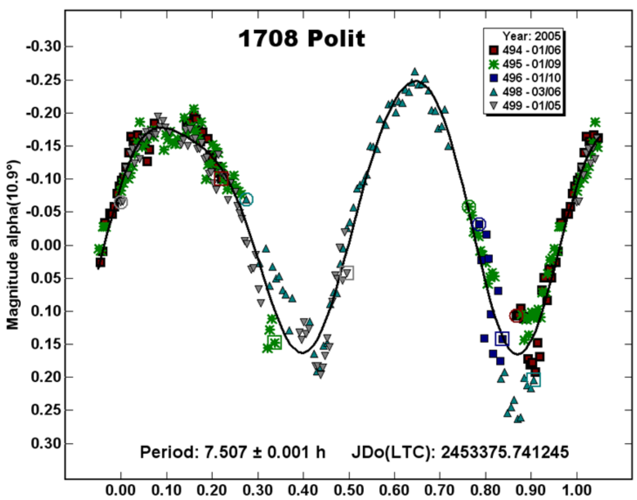
Clark M.L. (2007). "Lightcurve Results for 1318 Nerina, 2222 Lermontov, 3015 Candy, 3089 Oujianquan, 3155 Lee, 6410

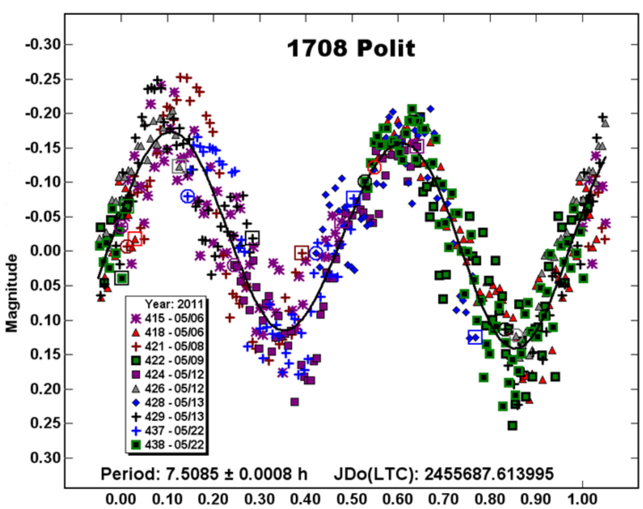
#	Name	Date Range	Sess	Per (h)	Error	Amp	Error
1318	Nerina	Oct 31 - Nov 28, 2010	4	2.5276	0.0001	0.08	0.02
1708	Polit	Jan 05 - Mar 06, 2005	5	7.507	0.001	0.40	0.1
1708	Polit	May 06 - Jun 22, 2011	6	7.5085	0.0008	0.35	0.1
2036	Sheragul	Oct 31 - Nov 28, 2010	4	5.413	0.001	0.95	0.05
3731	Hancock	Aug 05 - Aug 19, 2010	6	6.712	0.003	0.08	0.03
3885	Bogorodski	May 12 - May 24, 2011	6	5.803	0.002	0.35	0.1
6500	Kodaira	Mar 14 - May 04, 2011	5	5.3988	0.0002	0.7	0.05
9566	Rykhlova	Mar 13 - Mar 14, 2011	2	8.567	0.029	0.7	0.1
17302	4610 P-L	May 29 - May 30, 2011	2	5.015	0.008	0.7	0.1
18439	1994 LJ1	Dec 12 - Feb 13, 2010-2011	6	18.291	0.002	0.3	0.05
76437	2000 FD29	May 12 - May 30, 2011	7	8.380	0.002	0.6	0.1

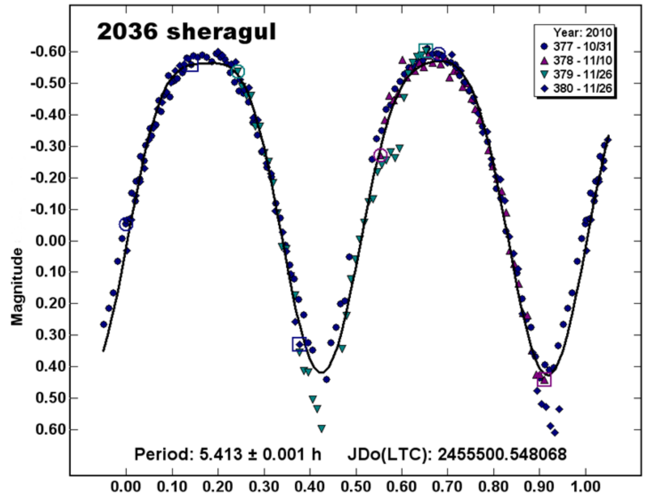
Fujiwara, 6500 Kodaira, (8290) 1992 NP, 9566 Rykhloda, (42923) 1999 SR 18, and 2001 FY." *Minor Planet Bul.* **34**, 19–22.

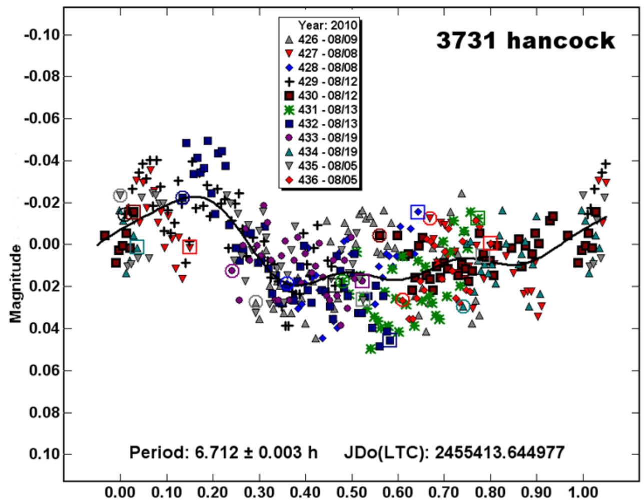
Clark, M. (2008). "Asteroid Lightcurves from the Chiro Observatory." *Minor Planet Bul*. **35**, 42-43.

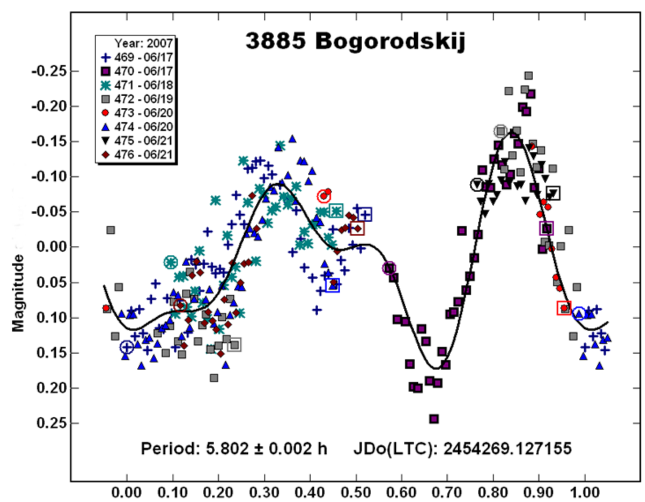


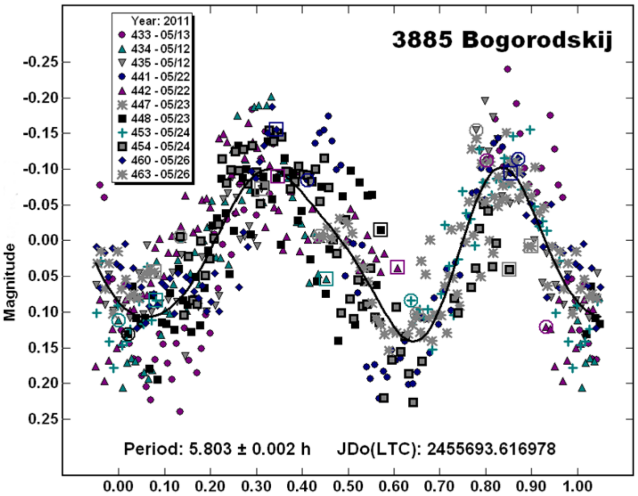


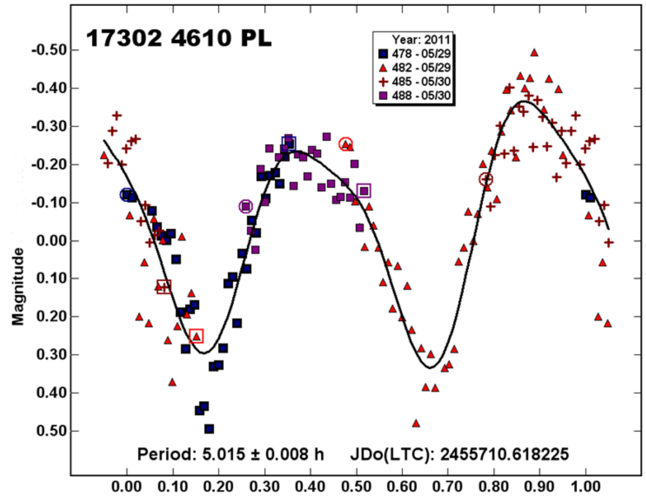


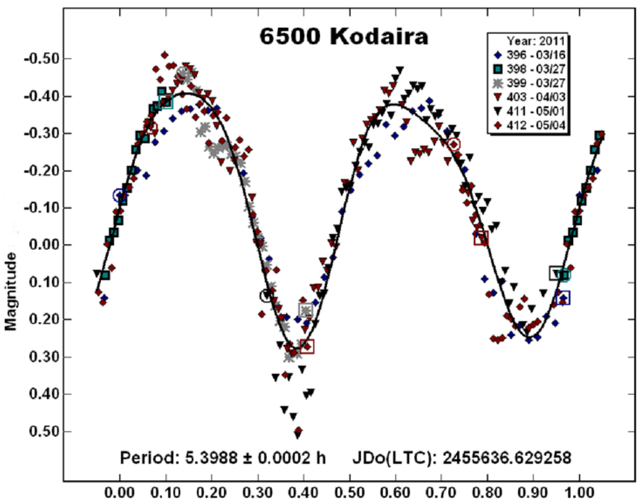


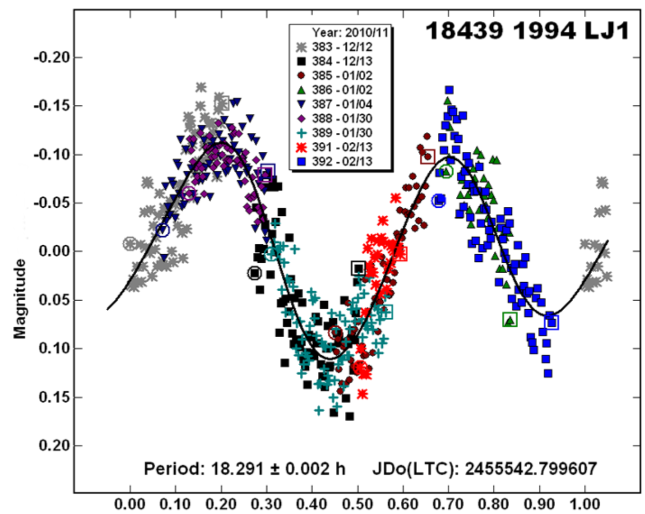


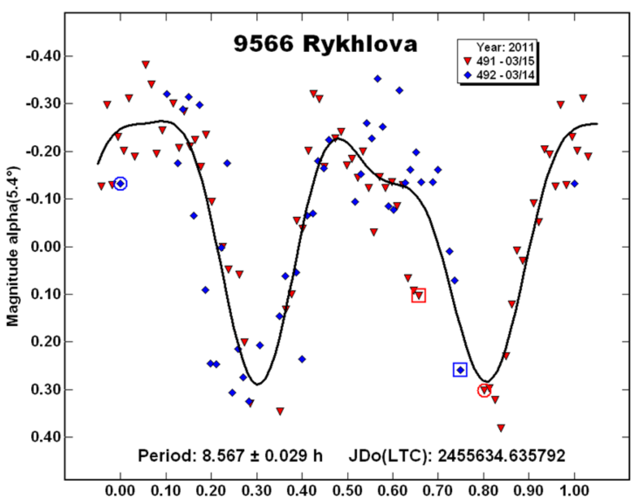


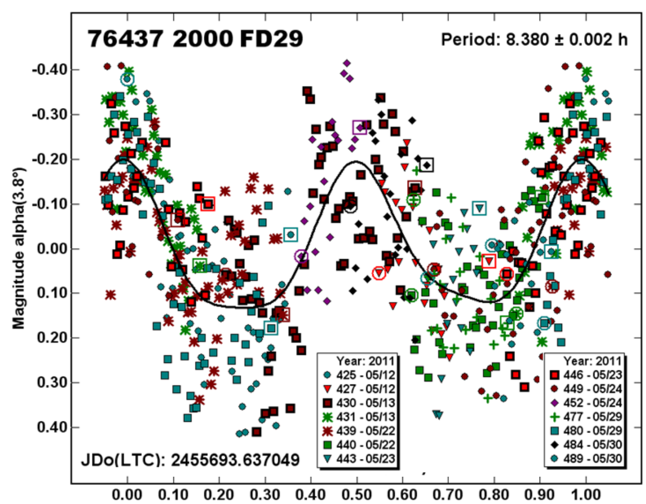

3885 Bogorodskij
Year: 2011
433 - 05/13
434 - 05/12
435 - 05/12
441 - 05/22
442 - 05/22
447 - 05/23
448 - 05/23
453 - 05/24
454 - 05/24
460 - 05/26
463 - 05/26
Magnitude
Period: 5.803 ± 0.002 h JDo(LTC): 2455693.616978


17302 4610 PL
Year: 2011
478 - 05/29
482 - 05/29
485 - 05/30
488 - 05/30
Magnitude
Period: 5.015 ± 0.008 h JDo(LTC): 2455710.618225


6500 Kodaira
Year: 2011
396 - 03/16
398 - 03/27
399 - 03/27
403 - 04/03
411 - 05/01
412 - 05/04
Magnitude
Period: 5.3988 ± 0.0002 h JDo(LTC): 2455636.629258


18439 1994 LJ1
Year: 2010/11
383 - 12/12
384 - 12/13
385 - 01/02
386 - 01/02
387 - 01/04
388 - 01/30
389 - 01/30
391 - 02/13
392 - 02/13
Magnitude
Period: 18.291 ± 0.002 h JDo(LTC): 2455542.799607


9566 Rykhlova
Year: 2011
491 - 03/15
492 - 03/14
Magnitude alpha(5.4°)
Period: 8.567 ± 0.029 h JDo(LTC): 2455634.635792


76437 2000 FD29
Period: 8.380 ± 0.002 h
Magnitude alpha(3.8°)
Year: 2011
425 - 05/12
427 - 05/12
430 - 05/13
431 - 05/13
439 - 05/22
440 - 05/22
443 - 05/23
Year: 2011
446 - 05/23
449 - 05/24
452 - 05/24
477 - 05/29
480 - 05/29
484 - 05/30
489 - 05/30
JDo(LTC): 2455693.637049

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2011 MARCH - JULY

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Lightcurves for 24 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2011 March to July: 1355 Magoeba, 1727 Mette, 2048 Dwornik, 3022 Dobermann, (5639) 1989 PE, 6296 Cleveland, 6310 Jankonke, (6394) 1990 QM2, 6435 Daveross, 6859 Datemasamune, 10159 Tokara, (29242) 1992 HB4, (33324) 1998 QE56, (33679) 1999 JY107, (38047) 1998 TC3, (38048) 1998 UL18, (41424) 2000 CK40, (55854) 1996 VS1, (57784) 2001 VW85, (60335) 2000 AR42, (95147) 2002 AP166, (96327) 1997 EJ50, (97649) 2000 FK1, and (104998) 2000 KT2.

CCD photometric observations of 24 asteroids were made at the Palmer Divide Observatory (PDO) from 2011 March to July. 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 (Rr) with R and r being, respectively, the Sun-asteroid and Earth-asteroid distances in AU. The magnitudes were normalized to the phase angle given in parentheses, e.g., alpha(6.5°), using $G = 0.15$ unless otherwise stated.

1355 Magoeba. This Hungaria was observed previously at PDO in 2006 and 2009 (Warner 2009). The data from 2006 could be best fit to a period of about 32 h. However, this was incompatible with the data from 2009, which gave a very reliable solution of 5.946 h. Yet another examination of the 2006 data does find a solution, albeit weak, at 5.861 h. The 2011 data did nothing to resolve the ambiguities, the amplitude of the lightcurve being 0.06 mag at most. The plot below is the result of confining the period search near the 5.95 h solution found in 2009.

1727 Mette. Several solutions near 2.98 h have been found before (e.g., Behrend 2011, Gandolfi 2009), which contradicted earlier results of 2.63 h (e.g., Wisniewski *et al.* 1987). Analysis of the 2011 data from PDO confirm the 2.981 h period.

2048 Dwornik. Warner (2008b) previously found a period of 8.65 h based on a lightcurves with an amplitude of 0.08 mag. The 2011 data from PDO in early May yield a period of 3.781 h with an amplitude of 0.16 mag. Skiff (2011) observed the asteroid about a month later and found a more reliable solution of 3.677 h, though the amplitude had decreased to 0.12 mag, which was to be expected since the phase angle had decreased by 4° between the two data sets.

3022 Dobermann. A period of 10.32 h was previously reported for this Hungaria by Warner (2005a). The 2011 PDO observations were made to confirm this as well as provided data for future modeling.

(5639) 1989 PE. Observations of this Hungaria were made in 2011 March with the hope of confirming an earlier result of 45.4 h (Warner 2010a). The new data only confused matters. Analysis found a period of 6.215 ± 0.002 h with an amplitude of 0.09 mag. They could not be made to fit any solution that also fit one using the data from 2009. The images from 2009 were re-measured and the resulting data analyzed anew. The result was a period of 23.30 ± 0.02 h with no reasonable solution near 6.2 h. Since the 2009 data set was more extensive, a dual-period search was done to see if by subtracting the 23 h period, something near 6.2 h would stand out. A weak solution was found near 6.54 h but it can hardly be considered reliable. The asteroid remains a mystery.

6296 Cleveland. Two earlier results from PDO (Warner 2006b, 2008a) found a period of 15.38 h and 15.65 h, respectively. These were both lower amplitude lightcurves ($A < 0.2$ mag) and based on somewhat sparse and noisy data sets. The 2011 data showed a lightcurve with an amplitude of 0.7 mag and synodic period of 30.84 h. The large amplitude and relatively low phase angle assure the validity of the longer solution.

6310 Jankonke. The 2011 data from PDO confirmed earlier results of 3.04 h (e.g., Warner 2005b, Behrend 2011).

6435 Daveross. When observed at PDO in 2008 (Warner 2008b), an ambiguous solution of 14.734 h was found, but this was based on a lightcurve with an amplitude of 0.10 mag. The 2011 data gave a period of 51.25 ± 0.05 h and amplitude of 0.67 mag. This longer solution is considered much more likely.

6859 Datemasamune. New data from 2011 did not resolve differences in previous solutions (12.95 h, Warner 2006a; 22.1 h, Warner 2010b). The solution with the lowest RMS fit that appeared to present a reasonable lightcurve shape was 86.1 h with an amplitude of 0.06 mag. However, this could simply be the result of the Fourier algorithm putting data sets "end-to-end", which minimizes overlap and so reduces the RMS error.

(29242) 1992 HB4. The 2011 data analysis confirms an earlier result for the period (Warner 2010b).

(33679) 1999 JY107. This was a "target of opportunity" for one night and could not be followed afterward. The result is the same as reported before (Warner 2005a), only that the period is $P > 12$ h and the amplitude $A > 0.15$ mag.

(38047) 1998 TC3. This Hungaria was observed to provide additional data for modeling. A period of 3.762 h was previously reported based on work on 2009 (Warner 2010b).

(38048) 1998 UL18. The plot is forced to one of several possible solutions. No period stood out significantly in the period spectrum.

(41424) 2000 CK40. A period of 48.0 ± 0.2 h was found. This makes in nearly impossible for a single station to find the true period since every other night is almost an exact repeat of the same part of the lightcurve. A half-period of 24 h was discarded since the amplitude of the lightcurve appears to be at least 0.2 mag and likely $A > 0.3$ mag. This virtually assures a bimodal solution at the relatively low phase angle.

(55854) 1996 VS1. The period of 3.067 h agrees with that found by Skiff (2011), who observed the asteroid about two weeks earlier.

(96327) 1997 EJ50. In addition the period of 7.78 h, another at 11.67 h cannot be formally excluded but it requires a more complex lightcurve.

#	Name	mm/dd 2011	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
1355	Magoeba (H)	06/25-06/29	113	26.4,25.7	302	31	5.99	0.05	0.06	0.01
1727	Mette (H)	04/28-04/29	133	22.0,21.8	237	32	2.981	0.003	0.34	0.01
2048	Dwornik (H)	05/03-05/08	151	26.9,26.2	253	33	3.781	0.005	0.16	0.02
3022	Dobermann (H)	04/01-04/11	213	22.5,25.6	155	-8	10.330	0.003	1.15	0.03
5639	1989 PE (H)	*07/17-08/16*[1]	384	18.0,9.8,11.2	312	15	23.30	0.02	0.15	0.02
5639	1989 PE (H)	03/15-03/26	187	12.7,16.7	172	18	6.215	0.002	0.09	0.01
6296	Cleveland (H)	04/01-04/17	344	26.8,26.1	205	40	30.84	0.03	0.70	0.03
6310	Jankonke (H)	04/01-04/17	162	21.4,18.7	207	29	3.0433	0.0005	0.12	0.02
6394	1990 QM2 (H)	04/17-05/03	216	14.8,17.1	209	25	3.6873	0.0006	0.27	0.02
6435	Daveross (H)	04/28-06/05	392	22.8,22.1,24.1	233	33	51.25	0.05	0.67	0.03
6859	Datemasamune (H)	03/05-03/26	559	9.4,8.5,13.7	172	12	86.1	0.3	0.16	0.01
10159	Tokara	06/07-06/11	116	17.2,18.8	227	8	5.531	0.005	0.58	0.02
29242	1992 HB4 (H)	04/28-04/29	123	5.9,5.5	224	6	3.954	0.005	0.60	0.02
33324	1998 QE56 (H)	06/22-06/24	115	25.3	273	36	6.18	0.02	0.62	0.02
33679	1999 JY107	04/11	33	16.6	166	14	>12.		>0.15	
38047	1998 TC3 (H)	07/02-07/03	93	18.3,17.8	305	9	3.763	0.005	0.65	0.02
38048	1998 UL18 (H)	05/09-06/07	110	18.5,17.2,18.8	237	25	30.0	0.5	0.15	0.02
41424	2000 CK40 (H)	06/25-07/04	203	16.5,17.5	267	23	48.0	0.2	0.35	0.05
55854	1996 VS1 (H)	05/05-05/08	128	7.7,8.8	216	8	3.067	0.003	0.30	0.03
57784	2001 VW85	04/08	38	22.1	155	-7			>0.5	
60335	2000 AR42 (H)	06/22-06/24	123	17.6,17.9	258	19	5.25	0.02	0.69	0.03
95147	2002 AP166	04/11	17	19.3	154	-7	>6.		>0.5	
96327	1997 EJ50	06/12-06/24	157	23.2,24.2	260	34	7.78	0.03	0.20	0.02
97649	2000 FK1 (H)	06/22-06/27	120	17.1,18.1	258	19	7.363	0.005	1.04	0.03
104998	2000 KT2	05/03-05/06	141	14.9,14.8	226	33	16.8	0.5	0.39	0.05

(1)=2009

Table I. Observing circumstances. Asteroids with "(H)" after the name are members of the Hungaria group/family. The phase angle (□) is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not change significantly and the average value is given. LPAB and BPAB are each the average phase angle bisector longitude and latitude, unless two values are given (first/last date in range).

Acknowledgements

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References

Behrend, R. (2011). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

Gandolfi, D., Cigna, M., Fulvio, D., and Blanco, C. (2009). "CCD and photon-counting photometric observations of asteroids carried out at Padova and Catania observatories." *Planet. Space Sci.* **57**, 1-9.

Pravec, P., Wolf, M., and Sarounova, L. (2011). Ondrejov Asteroid Photometry Project web site. *http://www.asu.cas.cz/~ppravec/neo.htm*

Skiff, B.A. (2011). Posting on CALL web site. *http://www.minorplanet.info/call.html*

Warner, B.D. (2005a). "Lightcurve analysis for asteroids 242, 893, 921, 1373, 1853, 2120, 2448 3022, 6490, 6517, 7187, 7757, and 18108." *Minor Planet Bul.* **32**, 4-7.

Warner, B.D. (2005b). "Asteroid lightcurve analysis at the Palmer Divide Observatory - winter 2004-2005." *Minor Planet Bul.* **32**, 54-58.

Warner, B.D. (2006a). "Asteroid lightcurve analysis at the Palmer Divide Observatory - February - March 2006." *Minor Planet Bul.* **33**, 82-84.

Warner, B.D. (2006b). "Asteroid lightcurve analysis at the Palmer Divide Observatory - March - June 2006." *Minor Planet Bul.* **33**, 85-88.

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

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

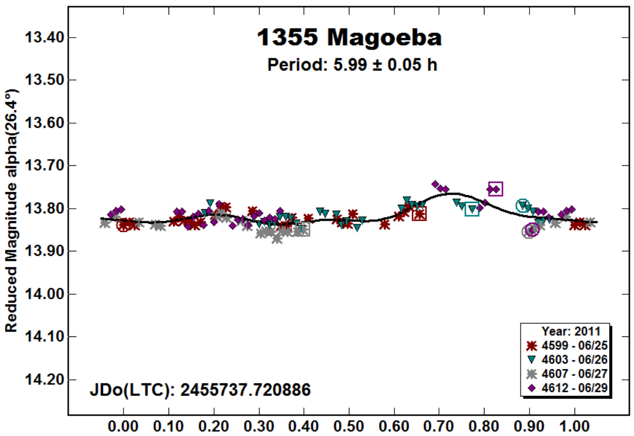
Warner, B.D. (2008b). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: February-May 2008." *Minor Planet Bul.* **35**, 163-167.

Warner, B.D. (2010a). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 June-September." *Minor Planet Bul.* **37**, 24-27.

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

Wisniewski, W.Z. and McMillan, R.S. (1987). "Differential CCD photometry of faint asteroids in crowded star fields and nonphotometric sky conditions." *Astron. J.* **93**, 1264-1267.

Wisniewski, W.A., Michalowski, T.M., Harris, A.W., McMillan, R. S. (1997). "Photometric Observations of 125 Asteroids." *Icarus* **126**, 395-449.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Period: 5.99 ± 0.05 h
Reduced Magnitude alpha(26.4°)
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4607 - 06/27
4612 - 06/29
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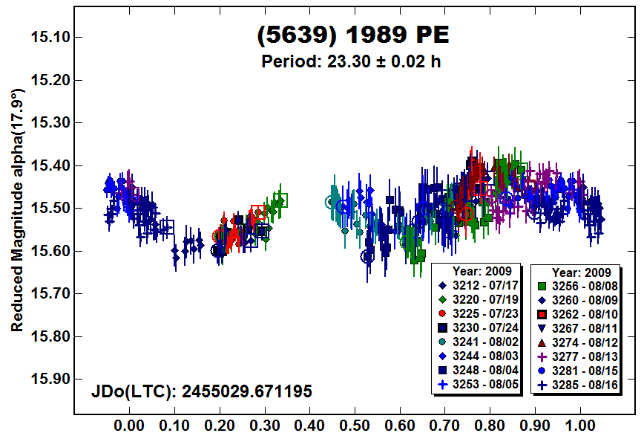
(5639) 1989 PE
Period: 23.30 ± 0.02 h
Reduced Magnitude alpha(17.9°)
Year: 2009
3212 - 07/17
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3225 - 07/23
3230 - 07/24
3241 - 08/02
3244 - 08/03
3248 - 08/04
3253 - 08/05
Year: 2009
3256 - 08/08
3260 - 08/09
3262 - 08/10
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3285 - 08/16
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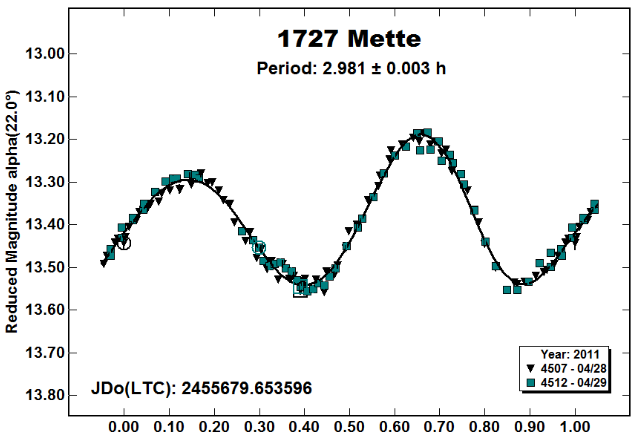
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Period: 2.981 ± 0.003 h
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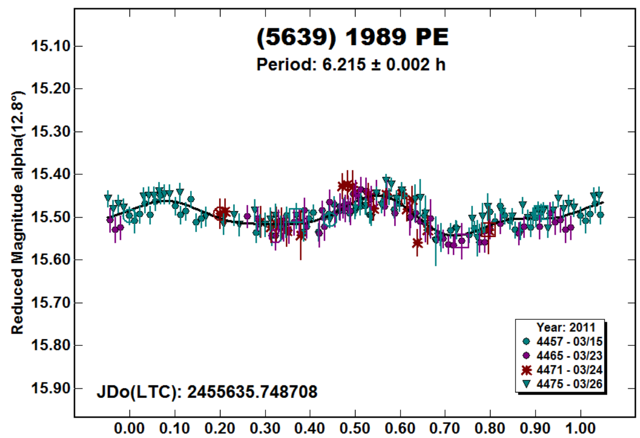
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Reduced Magnitude alpha(12.8°)
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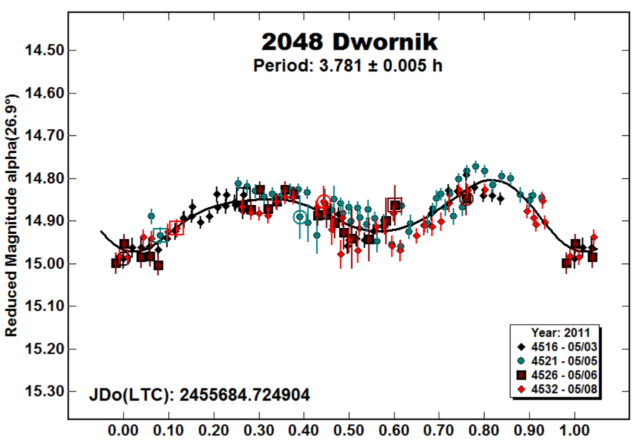
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Period: 3.781 ± 0.005 h
Reduced Magnitude alpha(26.9°)
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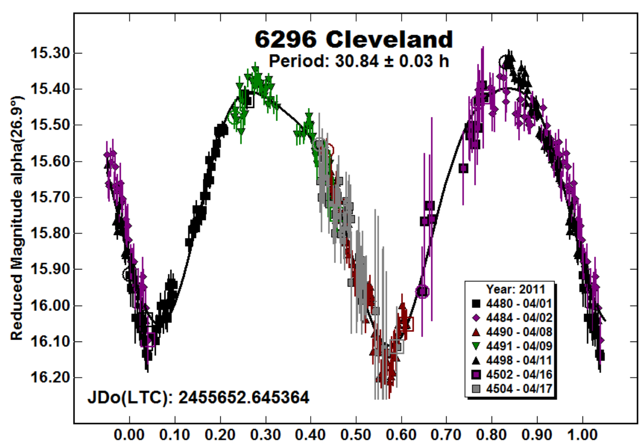
6296 Cleveland
Period: 30.84 ± 0.03 h
Reduced Magnitude alpha(26.9°)
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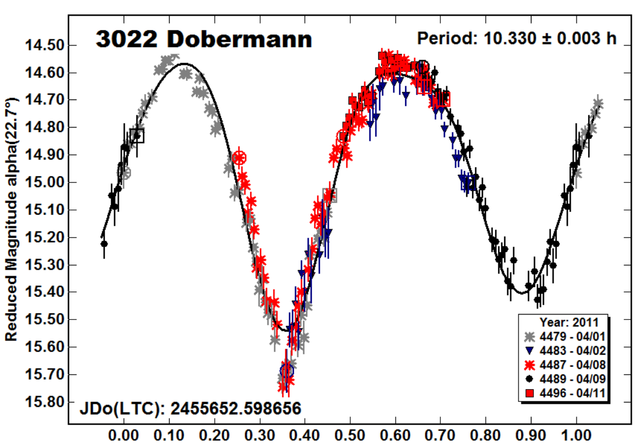
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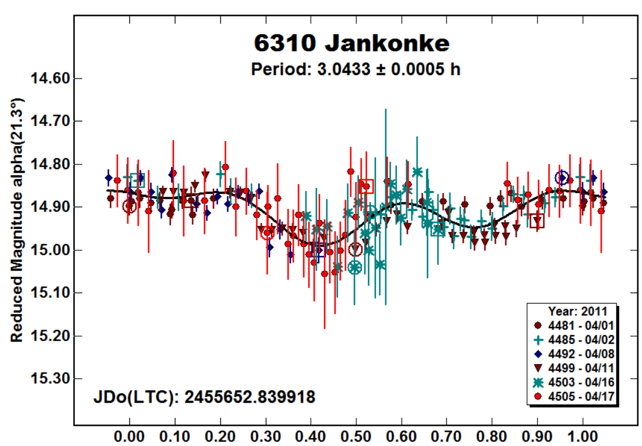
6310 Jankonke
Period: 3.0433 ± 0.0005 h
Reduced Magnitude alpha(21.3°)
Year: 2011
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4505 - 04/17
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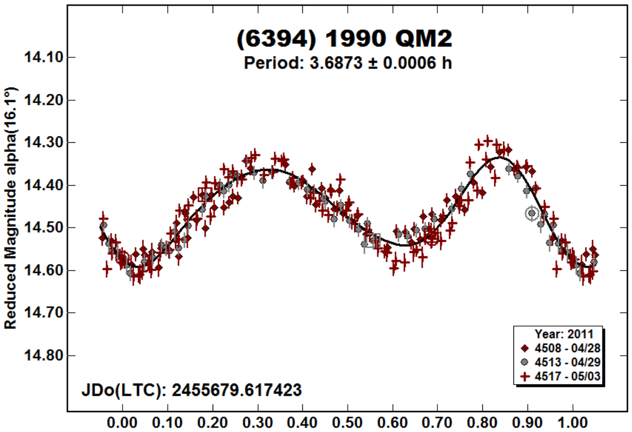
(6394) 1990 QM2
Period: 3.6873 ± 0.0006 h
Reduced Magnitude alpha(16.1°)
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Year: 2011
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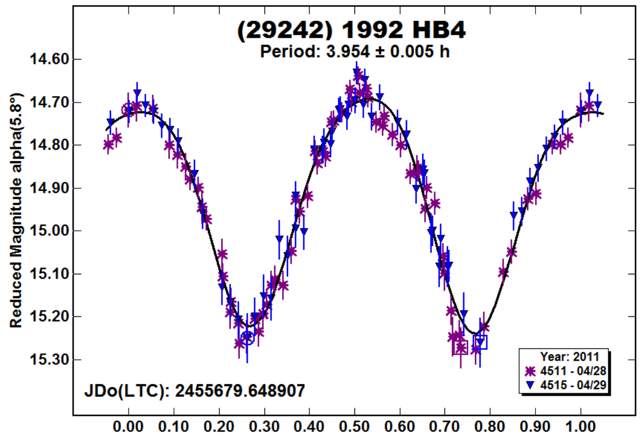
4513 - 04/29
4517 - 05/03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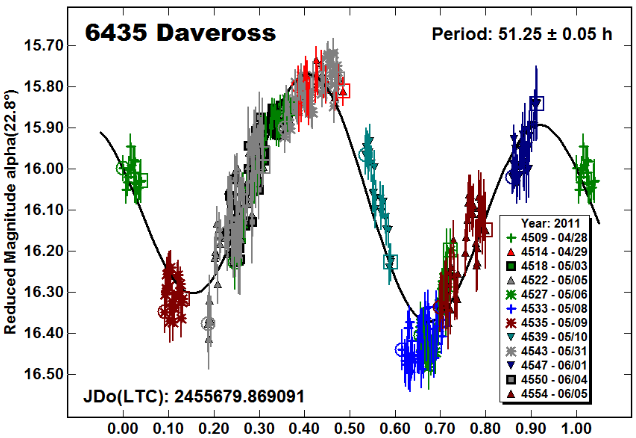
4515 - 04/29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Period: 51.25 ± 0.05 h
Reduced Magnitude alpha(22.8°)
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Year: 2011
4509 - 04/28
4514 - 04/29
4518 - 05/03
4522 - 05/05
4527 - 05/06
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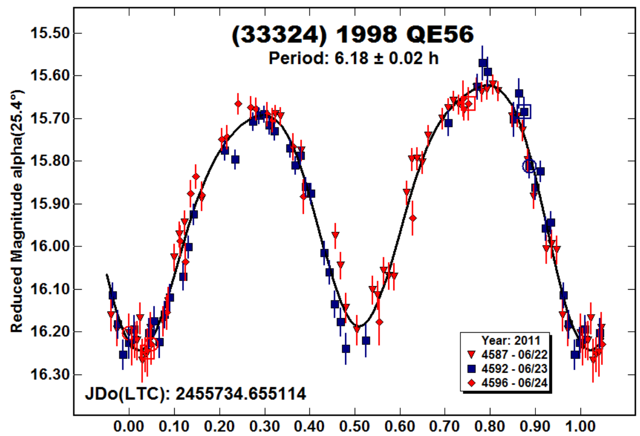
4550 - 06/04
4554 - 06/05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Period: 6.18 ± 0.02 h
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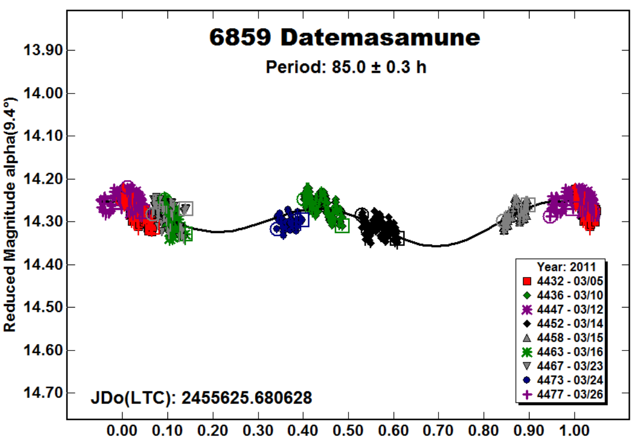
4592 - 06/23
4596 - 06/24


6859 Datemasamune
Period: 85.0 ± 0.3 h
Reduced Magnitude alpha(9.4°)
JDo(LTC): 2455625.680628
Year: 2011
4432 - 03/05
4436 - 03/10
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4467 - 03/23
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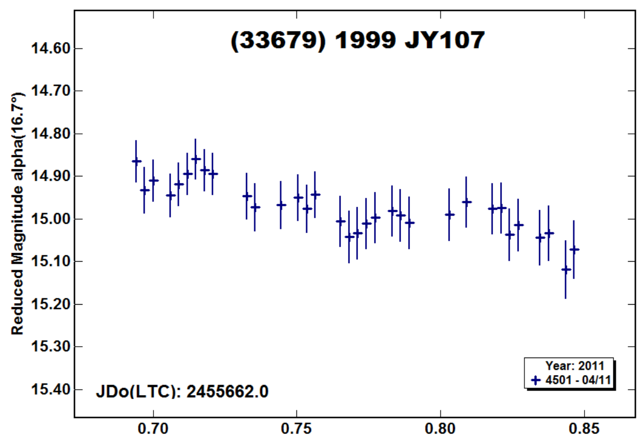
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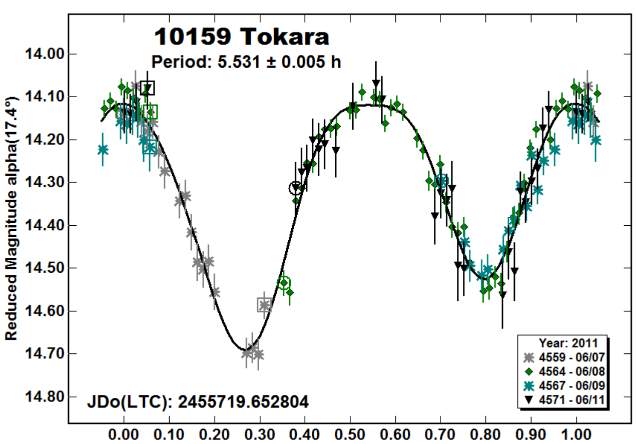
JDo(LTC): 2455662.0
Year: 2011
4501 - 04/11


10159 Tokara
Period: 5.531 ± 0.005 h
Reduced Magnitude alpha(17.4°)
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Year: 2011
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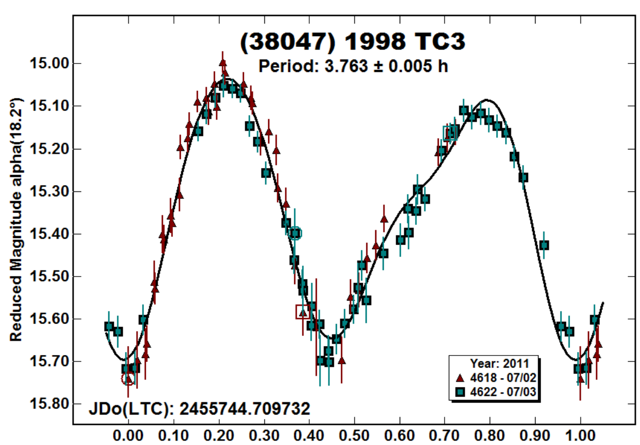
4571 - 06/11


(38047) 1998 TC3
Period: 3.763 ± 0.005 h
Reduced Magnitude alpha(18.2°)
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Year: 2011
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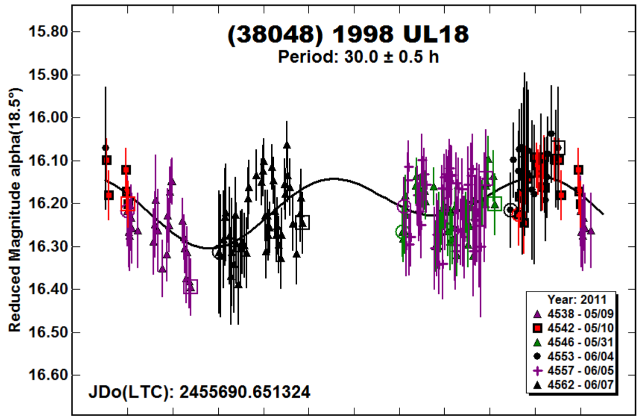
4622 - 07/03


(38048) 1998 UL18
Period: 30.0 ± 0.5 h
Reduced Magnitude alpha(18.5°)
Year: 2011
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4542 - 05/10
4546 - 05/31
4553 - 06/04
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4562 - 06/07
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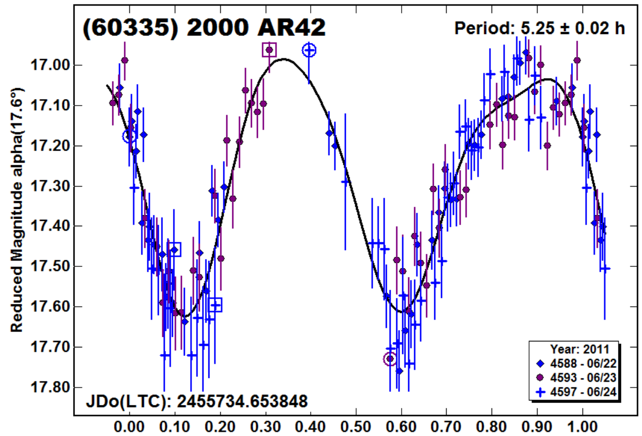
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Period: 5.25 ± 0.02 h
Reduced Magnitude alpha(17.6°)
Year: 2011
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4593 - 06/23
4597 - 06/24
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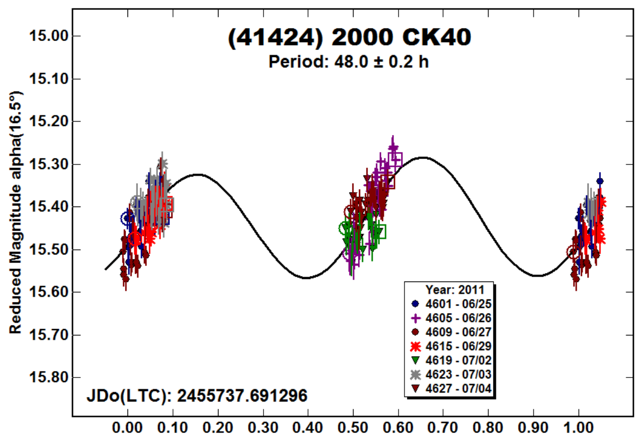
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Period: 48.0 ± 0.2 h
Reduced Magnitude alpha(16.5°)
Year: 2011
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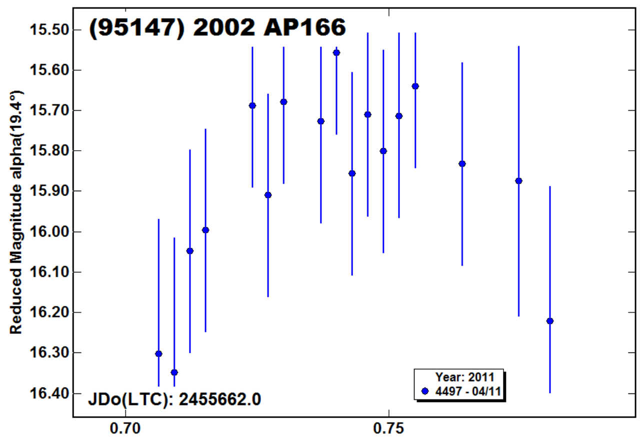
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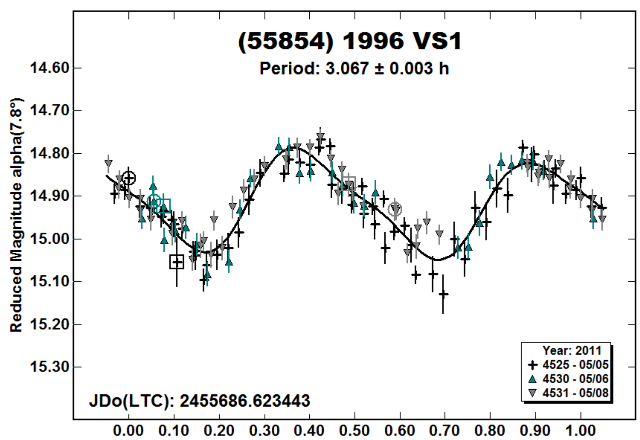
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Period: 3.067 ± 0.003 h
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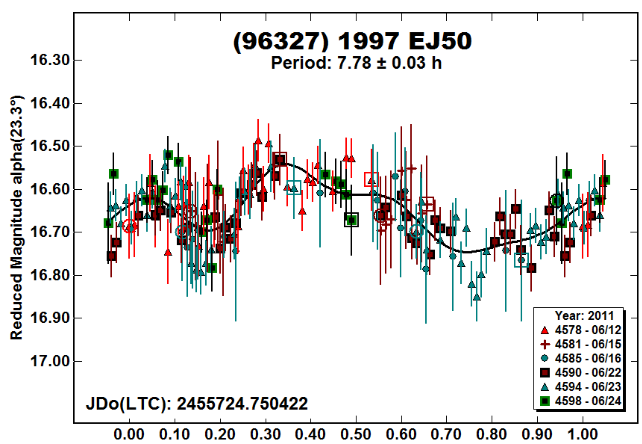
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Reduced Magnitude alpha(23.3°)
Year: 2011
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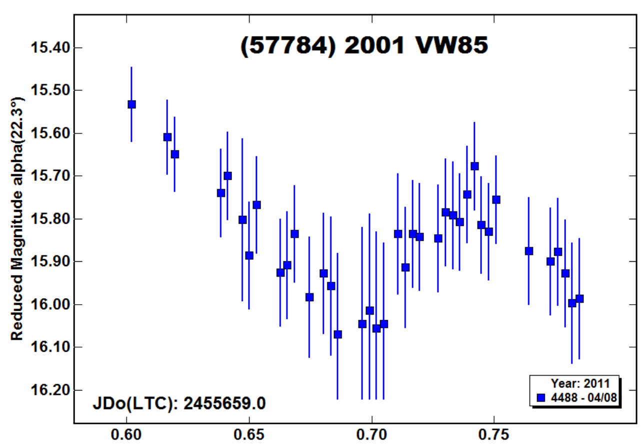
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Year: 2011
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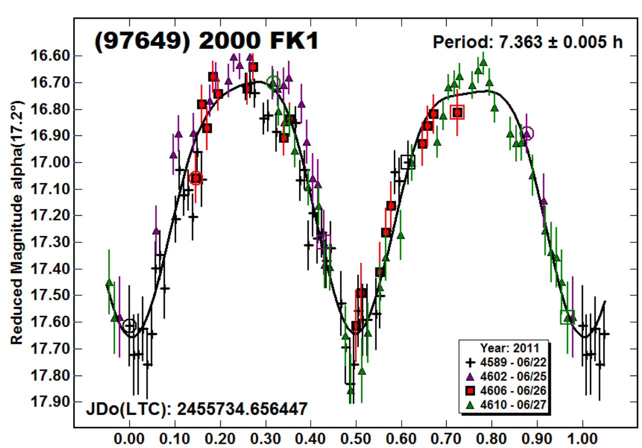
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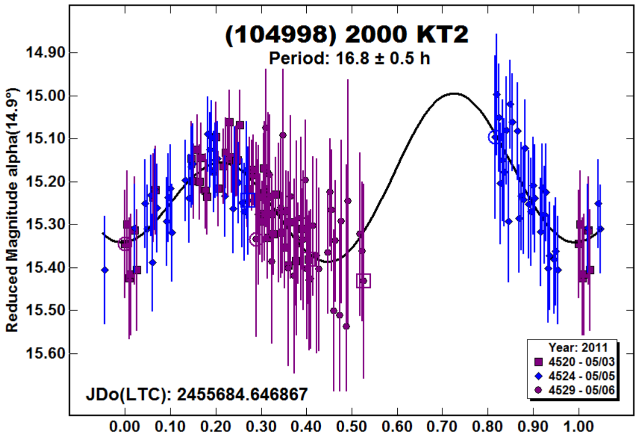

PHOTOMETRIC OBSERVATIONS AND ANALYSIS OF 604 TEKMESSA

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CCD observations of the main-belt asteroid 604 Tekmessa were recorded during the period 2010 September to December. Analysis of the lightcurve found a synodic period of P = 5.5596 ± 0.0001 h and amplitude A = 0.49 ± 0.01 mag. The phase curve referenced to mean magnitude suggests the absolute magnitude and phase slope parameter H = 9.435 ± 0.014 and G = 0.112 ± 0.013. The phase curve referenced to maximum light suggests H = 9.279 ± 0.018 and G = 0.165 ± 0.017.

Observations of 604 Tekmessa were recorded by Baker at Indian Hill Observatory (IHO) using a 0.3-m Schmidt-Cassegrain Telescope (SCT) reduced to f/5.1 coupled with an SBIG ST-402ME CCD. Warner recorded an observation at minimum phase angle at Palmer Divide Observatory (PDO) using a 0.35-m SCT at f/10 coupled with an SBIG STL-1001E CCD. In addition to the instruments at these two observatories, Baker recorded observations with robotic telescopes located at the Tzec Maun Observatory (TMO) near Mayhill, NM, including a 0.4-m Ritchey-Chretien Telescope (RCT) at f/9 coupled with an SBIG STL-6303E CCD, and a 0.35-m Maksutov-Newtonian Telescope (MNT) at f/3.9 coupled with an SBIG ST-10ME CCD. All images recorded during the apparition were calibrated with dark and flat field frames.

Unfiltered observations were recorded at IHO in 6 separate time series sessions (Table I). *MPO Canopus* software (BDW Publishing, 2010) was used to perform differential photometry and period analysis. The bimodal composite lightcurve (L1) suggests period *P* = 5.5596 ± 0.0001 h and amplitude *A* = 0.49 ± 0.01 mag (Figure 1). Since the amplitude changed during the apparition, lightcurves were also constructed using 2 subsets of the observing sessions. Composite lightcurve (L2) is from sessions 1-4, when the phase angle (α) was between 0 and 7 degrees (Figure 2). Composite lightcurve (L3) is from sessions 5-6, when the phase angle was between 15 and 23 degrees (Figure 3).

Phase Curve and H-G Parameters

Individual CCD observations with Bessel V filters were recorded throughout the apparition (Table I) and used to construct the phase curves. Standard V magnitudes of the asteroid were derived from the instrumental magnitudes using differential photometry. Standard V magnitude estimates of the comparison stars were calculated with

$$V = 0.628(J-K) + 0.995r' \qquad (1)$$

where V is the estimated standard V band magnitude, J and K are magnitude bands from the Two-Micron All-Sky Survey, and r' is a magnitude band from the Sloan Digital Sky Survey (Dymock and Miles 2009).

Depending on the star density in the field of view in our images, 4 to 18 stars of the proper color were available for use as comparisons and whose calculated standard V magnitudes were reasonably consistent with their corresponding instrumental magnitudes. The comparison star selection and data reduction were performed with *Astrometrica* software (Raab 2010). The overall error stated for each data point in the table is a combination of the error as a function of the signal to noise ratio and the measure of the uncertainty in the comparison star magnitudes.

The observed magnitude of the asteroid in each observation was corrected for the varying brightness due to rotation by comparing the point on the lightcurve at the time of each observation with both mean magnitude and maximum light. Brightness variance due to changing orbital geometry was also removed by calculating reduced magnitudes with

$$Vr = Vo - 5.0 \log(Rr) \qquad (2)$$

where Vr is the reduced magnitude, Vo is the observed magnitude, *R* is the Sun-asteroid distance, and *r* is the Earth-asteroid distance, both in AU (Warner 2007). The Lightcurve Ephemeris and H-G Calculator utilities in *MPO Canopus* facilitated this process.

The amplitude corrections for all data point observations were referenced to the mean magnitude in lightcurve (L1). The resulting phase curve (P1) indicates the absolute magnitude *H* = 9.435 ± 0.014, and the phase slope parameter *G* = 0.112 ± 0.013 (Figure 4a). However, since the lightcurve data show that the amplitude changed during the apparition, we note that the mean magnitude might not be the best reference for the amplitude corrections. So using the several lightcurves, we referenced the amplitude corrections for all data points to maximum light. In this case, data points recorded when 0 < α < 7 degrees were corrected using lightcurve (L2). Data points recorded when 7 < α < 15 degrees were corrected using lightcurve (L1). Data points recorded when 15 < α < 23 degrees were corrected using lightcurve (L3). The resulting phase curve (P2) indicates the absolute magnitude *H* = 9.279 ± 0.018, and the phase slope parameter *G* = 0.165 ± 0.017 (Figure 4b). We note that the larger amplitude corrections referenced to maximum light at the higher phase angles tend to reduce the slope of the curve, resulting in the corresponding increase in the G value.

The synodic period and amplitude were previously determined to be 5.55959 h and 0.52 (Behrend 2010), and the absolute magnitude to be 9.2 (Warner 2007). According to the Planetary Data System (Neese 2010), 604 Tekmessa is a member of the Xc taxonomic class (Bus and Binzel 2002). The Supplemental IRAS Minor Planet Survey (Tedesco *et al.* 2002) indicates the asteroid's absolute magnitude, albedo and diameter to be 9.2, 0.087 and 65.16 km, respectively. Using the absolute magnitude derived from our observations referenced to mean magnitude and the albedo value from SIMPS, we calculate the diameter of 604 Tekmessa to be 58.65 kilometers using

$$\log D = 3.125 - 0.2H - (0.5\log(pv)) \quad (3)$$

where D is the diameter (km), H is the absolute magnitude and pv is the geometric albedo in the V band (Warner 2007).

The observed amplitude can be used to calculate the equatorial elongation of the asteroid with the relation

$$a/b = 10^{(0.4dm)} \quad (4)$$

where a is the maximum equatorial radius, b is the minimum equatorial radius and dm is the amplitude of variation near minimum phase angle. We estimate dm to be 0.43 mag. Therefore the equatorial elongation is 1.49 using this relation, which must be expressed ≥ 1.49 since we do not know the viewing direction.

Acknowledgements

We wish to thank the Tzec Maun Foundation for the use of their robotic telescopes during this project.

References

BDW Publishing (2010). MPO Canopus Software, version 10.2.0.2. *http://minorplanetobserver.com*

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

Bus, S. J. and Binzel, R. P. (2002). "Phase II of the small main-belt asteroid spectroscopic survey: A feature-based taxonomy." *Icarus* **158**, 146-177.

Dymock, R. and Miles, R. (2009). "A method for determining the V magnitude of asteroids from CCD images." *Journal of the British Astronomical Association* **119**, 149-156.

Raab, H. (2010). Astrometrica Software, version 4.6.5.390 *http://www.astrometrica.at*

Neese, C., Ed., Asteroid Taxonomy V6.0. EAR-A-5-DDR-TAXONOMY-V6.0. NASA Planetary Data System, 2010. *http://sbn.psi.edu/pds/resource/taxonomy.html*

Tedesco, E. F., Noah, P. V., Noah, M., and Price, S. D. (2002). "The Supplemental *IRAS* Minor Planet Survey." *The Astronomical Journal* **123**, 1056-1085.

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

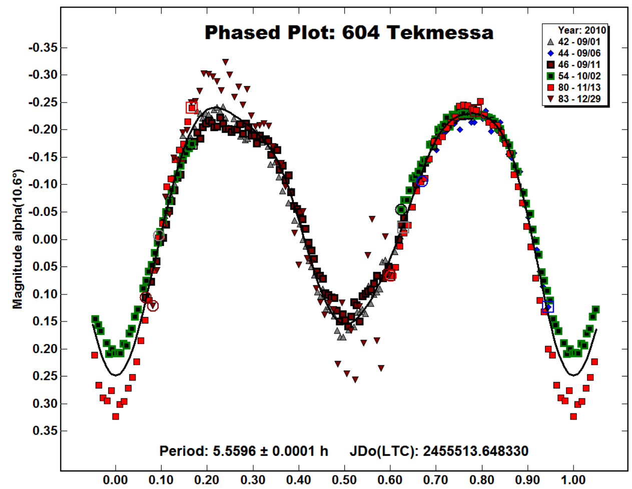

Figure 1. Composite lightcurve L1: 0 < α < 23 degrees.

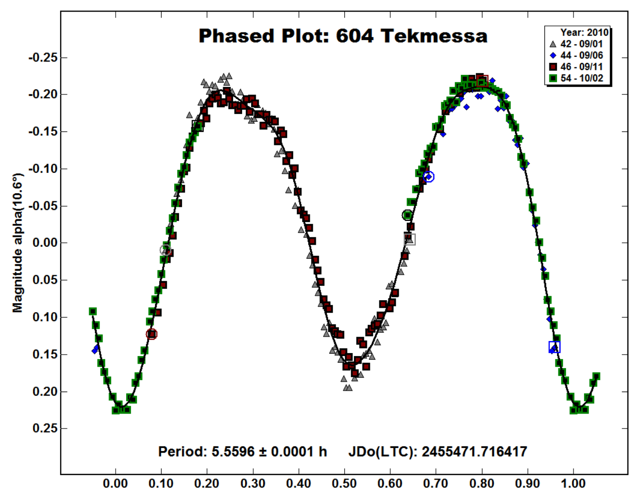

Figure 2. Composite lightcurve L2: 0 < α < 7 degrees.

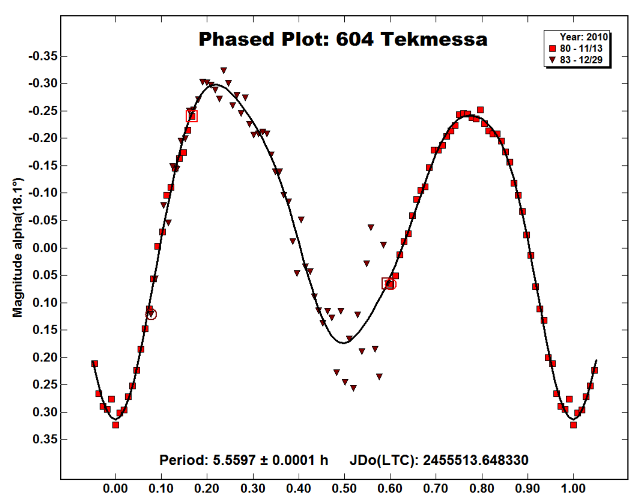

Figure 3. Composite lightcurve L3: 15 < α < 23 degrees.

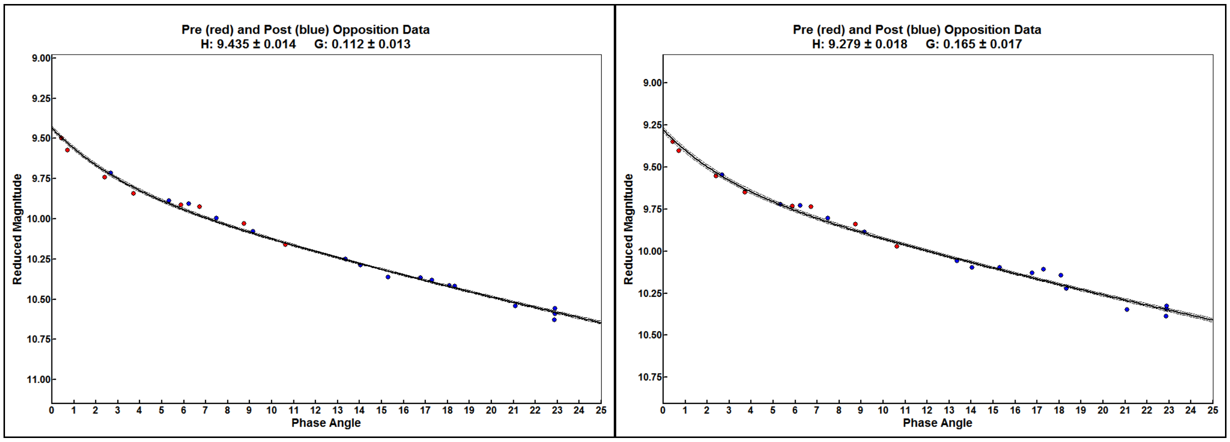

Figure 4. The left-hand plot (4a) shows the 604 Tekmessa phase curve (P1) referenced to mean mag while the right-hand plot (4b) shows the phase curve (P2) referenced to max light.

Date 2010	DptUT hh:mm	Obs	Phase Angle	TS length hrs	Dpt SNR	Observed V mag	Mean mag correction	Max light correction
Sep 01	06:05	IHO	-10.63	3.0	181	13.274 ± 0.035	+0.162 (L1)	-0.029 (L1)
Sep 06	05:54	IHO	- 8.73	2.5	236	13.101 ± 0.046	+0.155 (L1)	-0.036 (L1)
Sep 11	04:30	IHO	- 6.72	4.6	251	12.958 ± 0.050	+0.152 (L1)	-0.038 (L2)
Sep 13	04:28	IHO	- 5.88		257	12.903 ± 0.036	+0.178 (L1)	0.000 (L2)
Sep 18	03:46	IHO	- 3.72		258	12.801 ± 0.044	+0.180 (L1)	-0.011 (L2)
Sep 21	03:34	IHO	- 2.40		246	12.714 ± 0.042	+0.153 (L1)	-0.036 (L2)
Sep 25	03:13	IHO	- 0.71		103	12.625 ± 0.038	+0.057 (L1)	-0.112 (L2)
Sep 26	04:35	PDO	- 0.45			12.754 ± 0.046	-0.149 (L1)	-0.298 (L2)
Oct 02	03:49	IHO	+ 2.69	3.0	312	12.685 ± 0.024	+0.129 (L1)	-0.040 (L2)
Oct 08	03:03	IHO	+ 5.34		243	13.163 ± 0.030	-0.169 (L1)	-0.335 (L2)
Oct 10	03:08	IHO	+ 6.21		245	13.019 ± 0.046	-0.001 (L1)	-0.178 (L2)
Oct 13	02:14	IHO	+ 7.50		245	13.118 ± 0.050	-0.003 (L1)	-0.194 (L1)
Oct 17	01:02	IHO	+ 9.14		157	13.423 ± 0.050	-0.207 (L1)	-0.398 (L1)
Oct 28	04:22	IHO	+13.37		170	13.713 ± 0.031	-0.254 (L1)	-0.445 (L1)
Oct 30	03:59	IHO	+13.99		167	13.601 ± 0.042	-0.085 (L1)	-0.276 (L1)
Nov 03	01:54	IHO	+15.30		169	13.827 ± 0.031	-0.204 (L1)	-0.469 (L3)
Nov 08	01:05	IHO	+16.76		159	13.805 ± 0.031	-0.130 (L1)	-0.365 (L3)
Nov 10	00:57	IHO	+17.30		161	13.895 ± 0.035	-0.183 (L1)	-0.457 (L3)
Nov 13	02:13	IHO	+18.08	3.2	186	13.622 ± 0.029	+0.155 (L1)	-0.115 (L3)
Nov 14	03:11	TMO	+18.32		93	13.602 ± 0.023	+0.190 (L1)	-0.008 (L3)
Nov 28	23:22	IHO	+21.11		151	13.914 ± 0.021	+0.167 (L1)	-0.024 (L3)
Dec 27	03:16	TMO	+22.90		152	14.285 ± 0.015	+0.136 (L1)	-0.093 (L3)
Dec 29	03:10	TMO	+22.88		115	14.652 ± 0.022	-0.175 (L1)	-0.422 (L3)
Dec 29	23:45	IHO	+22.87	2.8	97	14.375 ± 0.028	+0.152 (L1)	-0.089 (L3)

Table I. Summary of observations. Lightcurve used for corrections: (L1) = sessions 1-6, (L2) = sessions 1-4, and (L3) = sessions 5-6.

LIGHTCURVES AND SPIN PERIODS FROM THE WISE OBSERVATORY – 2011

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We consider as targets of opportunity the random asteroids traveling through the field of view of Wise Observatory's telescopes while observing other asteroids. We report here the lightcurves and period analysis of those asteroids with results that we determine to be the most secure.

Photometry of asteroids has been done at the Wise Observatory since 2004. While focusing on a specific target, occasionally random asteroids cross our field of view. These objects are measured along with the prime targets, a lightcurve is drawn, and the spin period is determined if possible. This paper presents photometric results of six asteroids with mostly secure periods. These and other measurements of other asteroids with short coverage of the spin or with low S/N can be obtained from the author by request.

Observations were performed using the 0.46-m Centurion telescope (Brosch et al., 2008) of the Wise Observatory (MPC 097). The telescope was used with an SBIG STL-6303E CCD at the f/2.8 prime focus. This CCD covers a wide field of view of 75'x50' with 3072x2048 pixels, with each pixel subtending 1.47 arcsec, unbinned. Observations were performed in “white light” with no filters (Clear). Exposure times were 180s, all with auto-guider. The asteroids were observed while crossing a single field per night, thus the same comparison stars were used while calibrating the images.

The observational circumstances are summarized in Table I, which lists the asteroid's designation, the telescope and CCD, the filter, the observation date, the time span of the observation during that night, the number of images obtained, the object's heliocentric distance (r), geocentric distance (Δ), phase angle (α), and the Phase Angle Bisector (PAB) ecliptic coordinates (L_{PAB}, B_{PAB} - see Harris et al. (1984) for the definition and ways of calculating these parameters).

The images were reduced in a standard way. We used the IRAF *phot* function for the photometric measurements. After measuring, the photometric values were calibrated to a differential magnitude level using ~270 local comparison stars per field. The brightness of these stars remained constant to ± 0.02 mag. Astrometric solutions were obtained using *PinPoint* (*www.dc3.com*) and the asteroids were identified in the MPC web database. Analysis for the lightcurve period and amplitude was done by Fourier series analysis (Harris and Lupishko 1989). See Polishook and Brosch (2009) for complete description about reduction, measurements, calibration and analysis.

Lightcurves and spin periods of six asteroids, with reliability code of 2 to 3, are reported here. See Warner et al (2009) for a discussion of the “U code” definitions in the Asteroid Lightcurve Database (LCDB). All objects are main belt asteroids. The absolute magnitudes of these asteroids are in the range of 12.7–15.7 mag. None of the asteroids has published photometric measurements. Since these asteroids were not the prime targets of our observing campaign, most of them were observed only for one night. Therefore, the spin results, which are averaged on 4.5 hours, are biased against slow-rotators, tumblers, and potential binaries. The results are listed in Table II, which includes the asteroid name, rotation period, reliability code (*U*), photometric amplitude, and the absolute magnitude *H* as appears in the MPC website (*www.cfa.harvard.edu/iau/mpc.html*). The folded lightcurves are presented afterwards on a relative magnitude scale.

Reference

Brosch, N., Polishook, D., Shporer, A., Kaspi, S., Berwald, A. and Manulis, I. (2008). “The Centurion 18 telescope of the Wise Observatory.” *Astrophys. Space Sci.* **314**, 163-176.

Harris, A.W., Young, J.W., Scaltriti, F. and Zappalà, V. (1984). “Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis.” *Icarus* **57**, 251-258.

Harris, A.W. and Lupishko, D.F. (1989). “Photometric lightcurve observations and reduction techniques.” In *Asteroids II* (R. P. Binzel, T. Gehrels, M. S. Matthews, eds.), pp. 39-53. Univ. of Arizona Press, Tucson.

Polishook, D. and Brosch, N. (2009). “Photometry and Spin Rate Distribution of Small Main Belt Asteroids.” *Icarus* **199**, 319-332.

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

Acknowledgement

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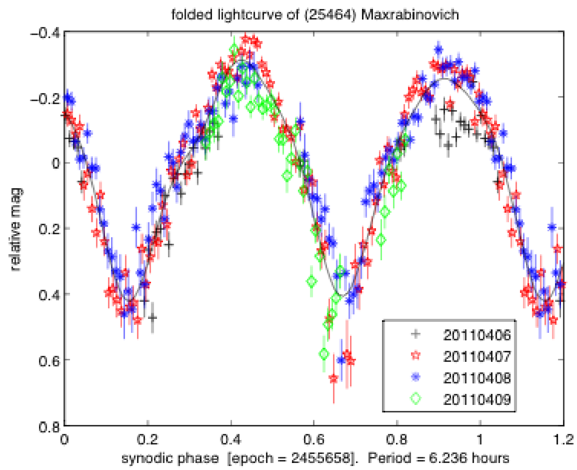
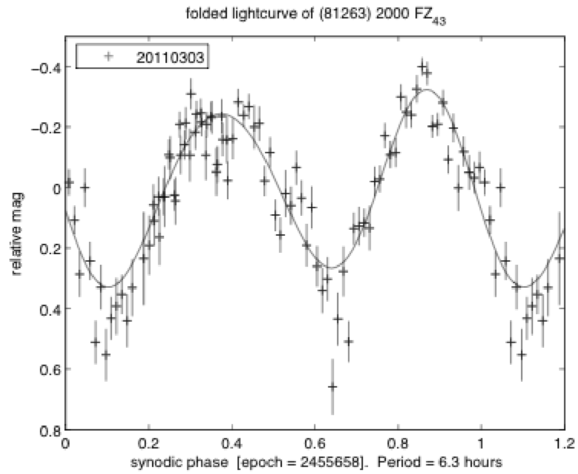
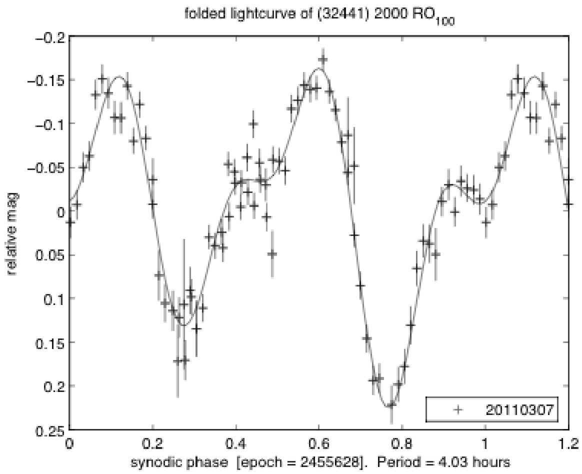
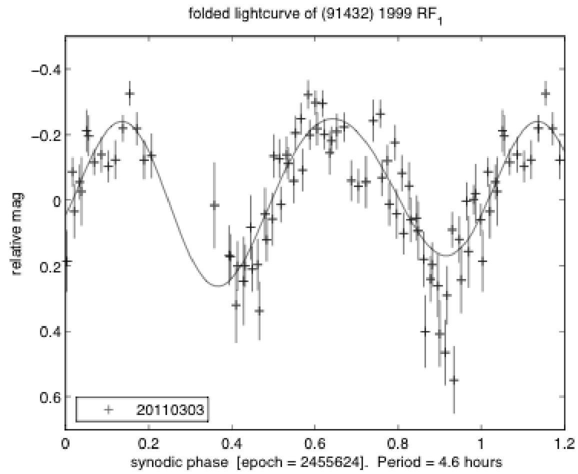
Asteroid	Date	Time span [hours]	N	r [AU]	Δ [AU]	α [Deg]	L_{PAB} [Deg]	B_{PAB} [Deg]
25464 Maxrabinovich	Apr 6, 2011	7.6	93	2.35	1.36	2.33	160.4	3.2
	Apr 6, 2011	7.84	82	2.76	1.77	2.19	159.9	3.8
	Apr 6, 2011	7.92	96	2.85	1.87	1.83	160.3	3.3
	Apr 6, 2011	7.6	93	2.35	1.36	2.33	160.4	3.2
(32441) 2000 RO_{100}	Mar 7, 2011	7.84	82	2.76	1.77	2.19	159.9	3.8
(54591) 2000 QC_{202}	Mar 3, 2011	7.92	96	2.85	1.87	1.83	160.3	3.3
(81263) 2000 FZ_{43}	Mar 3, 2011	7.6	93	2.35	1.36	2.33	160.4	3.2
(91432) 1999 RF_1	Mar 3, 2011	7.84	82	2.76	1.77	2.19	159.9	3.8
(108528) 2001 LQ_2	Mar 3, 2011	7.92	96	2.85	1.87	1.83	160.3	3.3

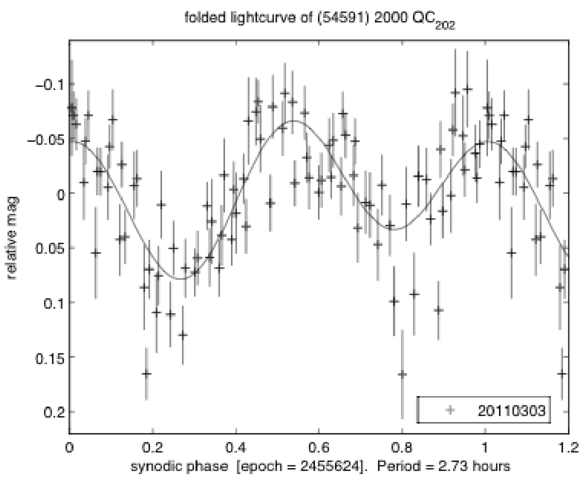
Table I. Observing circumstances. See the text for an explanation of the columns.

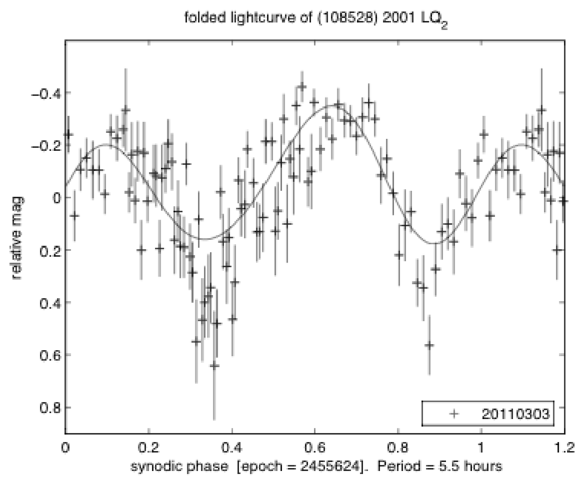












Asteroid name	Period [hours]	U	Amplitude [mag]	H by MPC [mag]
25464 Maxrabinovich	6.236 ± 0.005	3	0.9 ± 0.1	14.4
(32441) 2000 RO_{100}	4.03 ± 0.06	+2	0.36 ± 0.04	12.7
(54591) 2000 QC_{202}	2.73 ± 0.06	+2	0.20 ± 0.05	14.6
(81263) 2000 FZ_{43}	6.3 ± 0.2	3	0.8 ± 0.1	15.7
(91432) 1999 RF_1	4.6 ± 0.1	+2	0.6 ± 0.1	14.9
(108528) 2001 LQ_2	5.5 ± 0.2	+2	0.7 ± 0.2	15.4

Table II. Derived periods and amplitudes. The *U* code (reliability) is the suggested value. The value in the Asteroid Lightcurve Database (LCDB, Warner et al., 2009) may differ.

SEVERAL WELL-OBSERVED ASTEROIDAL OCCULTATIONS IN 2010

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(Received: 11 July)

During 2010 IOTA observers in North America reported about 190 positive observations for 106 asteroid occultation events. For several asteroids, this included observations with multiple chords. For two events, an inversion model was available. An occultation by 16 Psyche on 2010 August 21 yielded a best-fit ellipse of 235.4 x 230.4 km. On 2010 December 24, an occultation by 93 Minerva produced a best-fit ellipse of 179.4 x 133.4 km. An occultation by 96 Aegle on 2010 October 29 yielded a best-fit ellipse of 124.9 x 88.0 km. An occultation by 105 Artemis on 2010 June 24 showed a best-fit ellipse of 125.0 x 92.0 km. An occultation by 375 Ursula on 2010 December 4 produced a best-fit ellipse of 125.0 km x 135.0 km. Of note are two events not summarized in this article. On 2010 August 31, an occultation by 695 Bella yielded a new double star. That event will be summarized in the JDSO. Finally, on 2010 April 6, an occultation of zeta Ophiuchi by 824 Anastasia was observed by 65 observers at 69 locations. Unfortunately a large shift in the path yielded only 4 chords. Results of that event, and all the events mentioned here, can be found on the North American Asteroidal Occultation Results webpage.

The history of asteroidal occultation observations was previously reviewed by Timerson *et al.* (2009). Successful predictions (Preston 2009) and observations have increased dramatically, especially since 1997, aided by high-accuracy star catalogs and asteroid ephemerides (Dunham *et al.* 2002). Other prediction information is available Timerson *et al.* (2009).

The techniques and equipment needed to make these observations are outlined in the IOTA manual (Nugent 2007). Observations are reported to a regional coordinator who gathers these observations and uses a program called *Occult4* (Herald 2008) to produce a profile of the asteroid at the time of the event. These asteroidal occultation data are officially deposited, archived, and made available to the astronomical community through the NASA Planetary Data System (Dunham *et. al.* 2010). Additional tools such as asteroid lightcurves (e.g., Pilcher, Warner) and asteroid models derived from inversion techniques (Durech) can be combined with occultation results to yield high resolution profiles.

The asteroid lightcurve inversion method was developed by Kaasalainen and Torppa (2001) and Kaasalainen *et al.* (2001). It enables one to derive shape, spin axis direction, and rotation period from an asteroid's lightcurves observed over several apparitions. The shape is usually modeled as a convex polyhedron. When the shape model and its spin state are known, its orientation with respect to an observer (sky plane projection) can be easily computed. Such a predicted silhouette can then be compared with the occultation chords and scaled to give the best fit. Finally, planning software called *OccultWatcher* allows observers to space themselves across the predicted path of the occultation to gather as many unique chords as conditions allow (Pavlov 2008).

Occultation Results

16 Psyche On 2010 August 21 at 9:52 UT, 16 Psyche occulted the V = 8.5 star HIP 22112 in Taurus over a long path that passed from the central Baja peninsula to the central Atlantic coast. Maximum duration was predicted to be 10.3 seconds. For this event, 12 observers at 17 sites recorded 14 chords across the profile of the asteroid. Fifteen sites used video to record the event while one station used visual techniques and one station used drift scan. Three stations reported no occultation. D. Dunham set up five stations and P. Maley set up two stations, all of which recorded positive events.

The resulting chords and least squares ellipse from *Occult4* are shown in Figure 1. These chords produce a smooth ellipse with dimensions of 235.4 ± 3.9 x 230.4 ± 2.4 km. The maximum occultation duration of 10.12 seconds occurred at station nine and is just 2% shorter than predicted. The observed path was just 32 km north of the prediction.

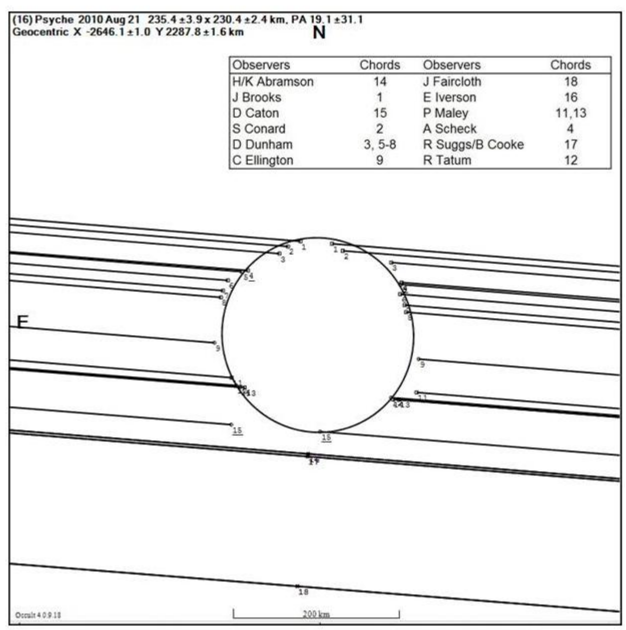

Figure 1. Observed occultation outline for 16 Psyche on 2010 August 21 with least-squares ellipse.

Fitting the irregular shape model provided by Durech to the observations gives a least-squares equivalent diameter of 225 ± 20 km for the asteroid. That result is shown in Figure 2.

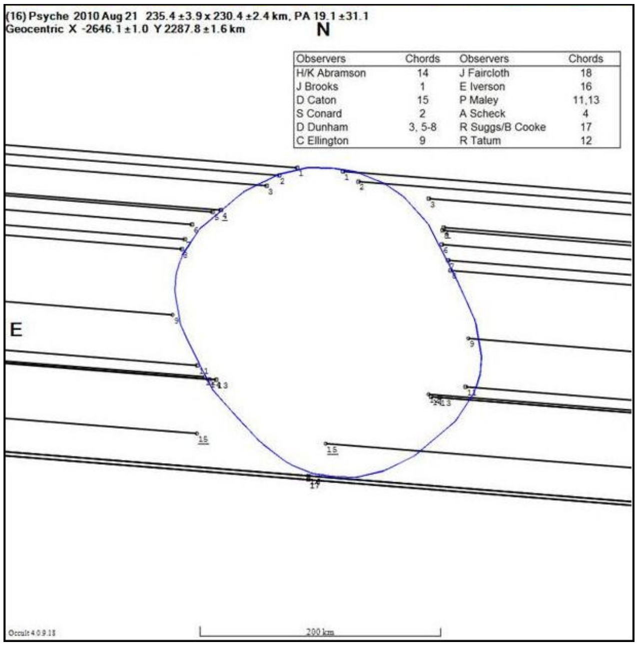

Figure 2. Observed occultation profile for 16 Psyche on 2010 August 21 with lightcurve inversion model.

Only two other occultations by Psyche have been observed: a single-chord event on 2002 March 22 and a five-chord occultation on 2004 May 16 (RASNZ, 2004). The four useable chords for the 2004 event were spaced well across the asteroid, being fit by an ellipse with axes of 214 ± 6 km by 181 ± 7 km.

93 Minerva On 2010 December 24 at 5:06 UT, 93 Minerva occulted the V = 11.2 star TYC 2445-01074-1 in Gemini over a path that crossed the USA from the central mid-Atlantic coast to southern California. Maximum duration was predicted to be 11.9 seconds. For this event, 10 observers at 13 sites recorded 13 chords across the profile of the asteroid. All sites used video techniques to make observations.

The resulting chords and least squares ellipse from *Occult4* are shown in Figure 3. These chords produce a smooth ellipse with dimensions of 179.4 ± 2.0 x 133.4 ± 1.3 km. The maximum occultation duration of 12.26 seconds occurred at station six and is just 4% shorter than predicted. The observed path was 31 km south of the prediction.

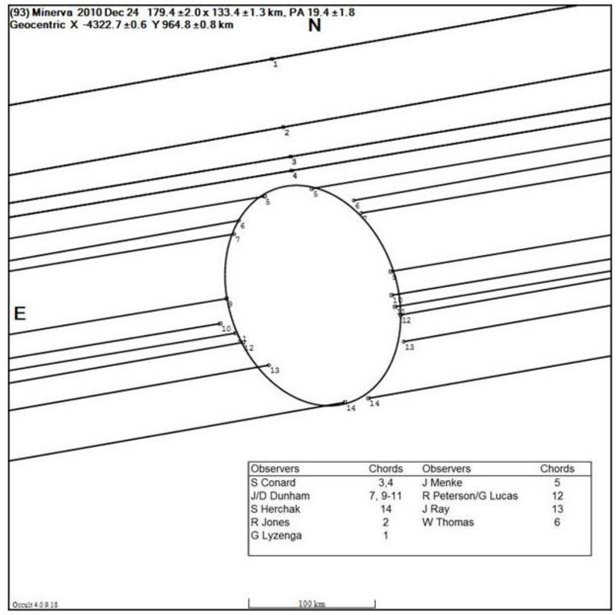

Figure 3. Observed occultation profile for 93 Minerva on 2010 December 24 with least-squares ellipse.

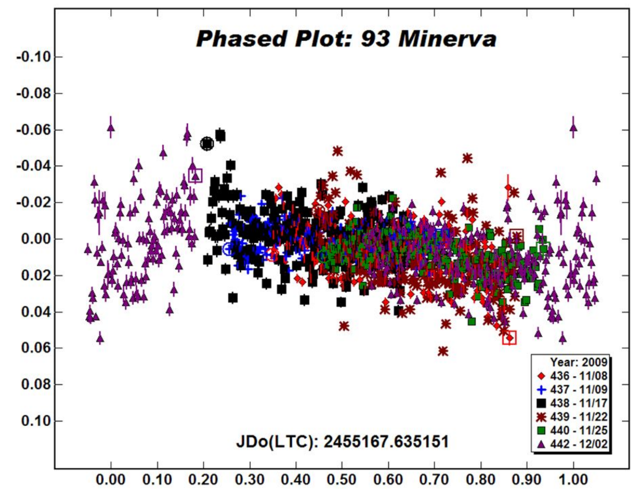

Figure 4. Lightcurve for 93 Minerva obtained in November and December, 2009 (Alton, 2011).

This asteroid was recently discovered to be a triple system (Marchis 2009). The lightcurve in Figure 4 (Alton, 2011) is largely featureless and no meaningful period solution could be derived. Shape modeling by Torppa *et al.* (2008) revealed remarkable axial symmetry (b/a = 0.99 and c/b = 0.97). These results appear to be contrary to the profile obtained during this occultation event (b/a = 0.74).

An occultation by Minerva was observed from ten stations on 1982 Nov 22; the data were fit by a circle of diameter 170.8 ± 1.4 km (Millis *et al.* 1985). An occultation was observed from two stations on 1996 Nov 25, but four chords were determined since the star was a close binary. An occultation was observed from two stations on 2008 May 17 and another was observed from four stations on 2011 Jan. 28. However, for the 1996, 2008, and 2011 events, the chords were all on one side of center and not spaced widely enough to make a good elliptical fit. Single-chord occultations by Minerva were observed on 1986 Oct. 27, 2008 May 12, 2008 July 30, and 2010 Jan. 17.

96 Aegle On 2010 October 29 at 9:54 UT, 96 Aegle occulted the V = 9.7 star TYC 2549-00615-1 in Perseus over a path that passed from the Texas Gulf coast to southern California. Maximum duration was predicted to be 12.8 seconds. For this event, 12 observers at 12 sites recorded nine chords across the profile of the asteroid. Nine sites used video to record the event while three stations used visual techniques. Three stations reported no occultation.

The resulting chords and least squares ellipse from *Occult4* are shown in Figure 5. These chords produce a smooth ellipse with dimensions of 172.5 ± 1.4 x 157.5 ± 1.5 km. The maximum occultation duration of 12.26 seconds occurred at station six and is just 4% shorter than predicted. The observed path was 11 km north of the prediction.

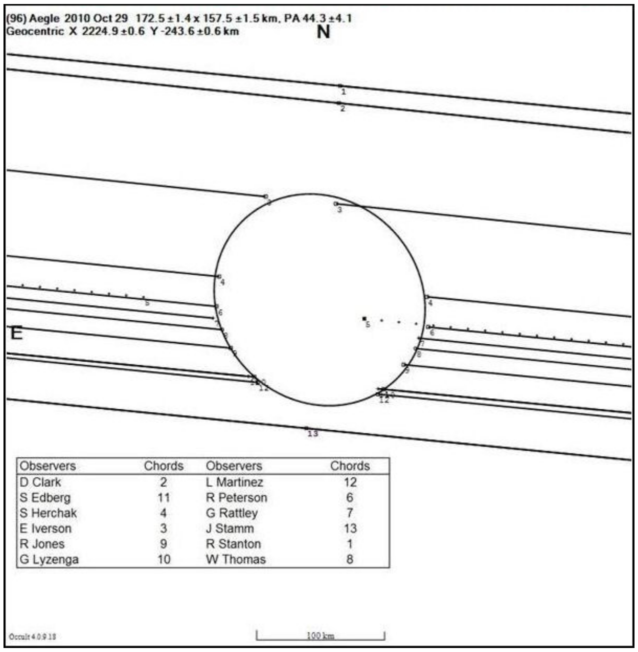

Figure 5. Observed occultation profile for 96 Aegle on 2010 October 29 with least-squares ellipse.

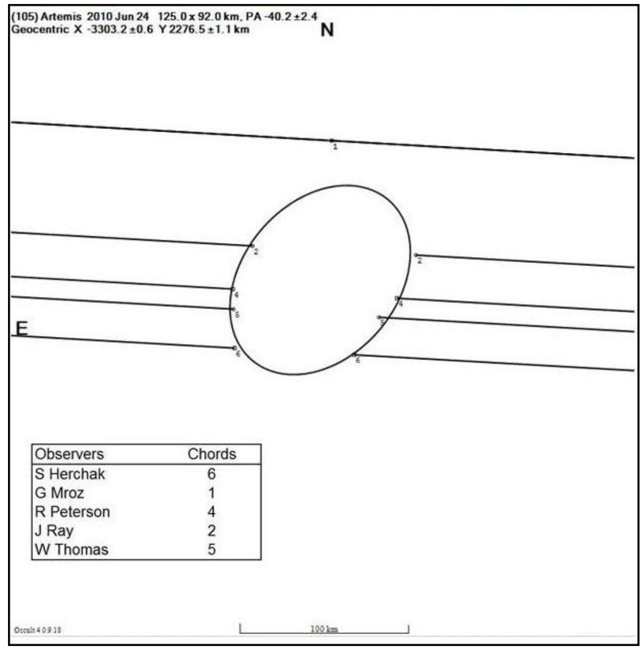

Figure 7. Observed occultation profile for 105 Artemis on 2010 June 24 with least-squares ellipse.

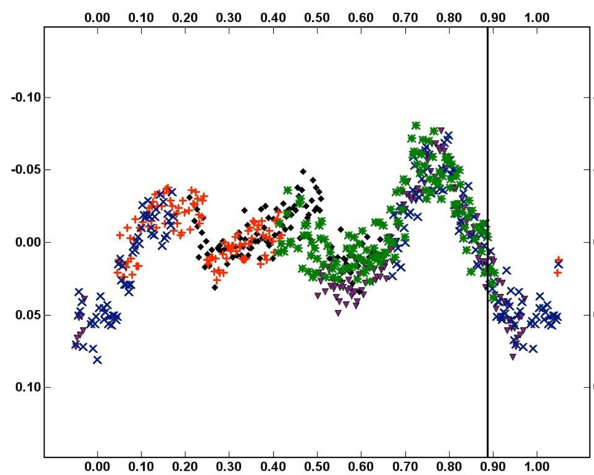

Figure 6. Light curve for 96 Aegle with phase of event time shown. A period of 13.82 ± 0.01 hours was found (Stephens, 2005).

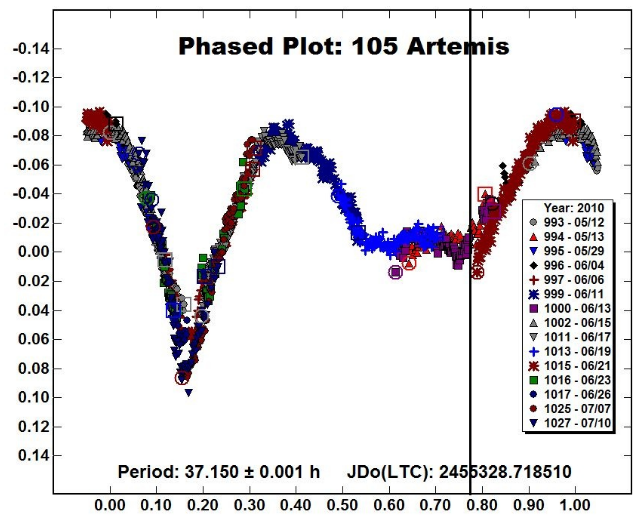

Figure 8. Light curve for 105 Artemis with event time shown (Pilcher, 2010).

No inversion model is available for this asteroid. A lightcurve from 2004 for 96 Aegle is shown in Figure 6. While a possible phase position along the curve is shown for this event, the length of time between the acquisition of this light curve and the time of the event limits its accuracy.

Five previous occultations by 96 Aegle have been observed. All of them involved observations that had few chords across the entire profile of the asteroid. These include 2002 Feb 18 (1 chord), 2002 Aug 10 (3 chords), 2003 Aug 3 (1 chord), 2009 Sep 8 (4 chords), and 2010 Jan 5 (14 chords, 10 misses). This last event, with three of the four chords near one pole, gave an ellipse of 183.0 ± 16.3 x 157.7 ± 12.0 km.

105 Artemis. On 2010 June 24 at 3:52 UT, 105 Artemis occulted the V = 12.6 star UCAC2 37917435 in Hercules along a path across the USA from the mid-Atlantic to southern California. Maximum duration was predicted to be 18.5 seconds. For this event, five observers at five sites recorded four chords across the profile of the asteroid. All sites used video to record the event. One observer reported a miss.

The resulting chords and least squares ellipse from *Occult4* are shown in Figure 7. These chords produce a smooth ellipse with dimensions of 125.0 ± 6.3 x 92.0 ± 1.9 km. The maximum occultation duration of 14.24 seconds occurred at station four and is 9% shorter than predicted. The observed occultation was just 8 km south of the predicted path.

A lightcurve is available for this asteroid (Pilcher 2010) and is shown in Figure 8. The phase position along the curve of the event is indicated by a vertical line.

In addition, a model is available for 105 Artemis (Figure 9). It appears to confirm the elongated results obtained during the occultation.

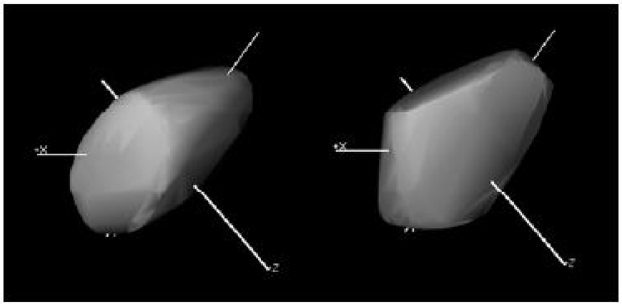

Figure 9. Shape model for 105 Artemis. The left-hand model is Z= 0°; the right-hand is Z = +90° (Higley, 2008).

Eight other occultations involving Artemis have been observed with three providing enough chords for a size determination. On 1997 Dec 4, 8 chords gave a size of 116 ± 3 x 92 ± 2 km. (Dunham, 1999). On 1998 Feb 12, three chords gave a size of 105.0 ± 42.6 x 84.6 ± 4.5 km. On 2010 Aug 18, five chords yielded an ellipse with 124.4 ± 2.9 x 84.7 ± 6.0 km dimensions.

<u>375 Ursula</u> On 2010 December 4 at 12:06 UT, 375 Ursula occulted the V = 10.0 star TYC 3358-02411-1 in Auriga along a path from southern Texas to Oregon. Maximum duration was predicted to be 15.6 seconds. For this event, five observers at seven sites recorded six chords across the profile of the asteroid. Six sites used video to record the event while one observer used visual techniques. One station reported a miss.

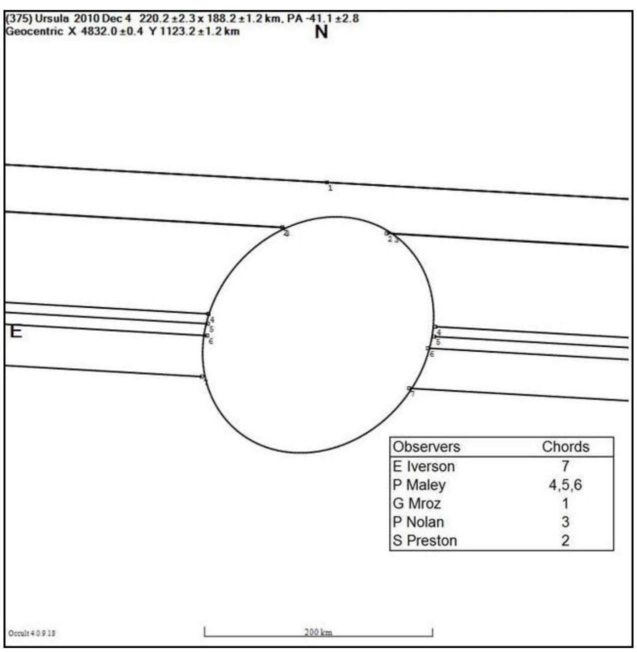

Figure 10. Observed occultation profile for 375 Ursula on 2010 December 24 with least-squares ellipse.

The resulting chords and least-squares ellipse from *Occult4* are shown in Figure 10. These chords produce a smooth ellipse with dimensions of 220.2 ± 2.3 x 188.2 ± 1.2 km. The maximum occultation duration of 14.24 seconds occurred at station four and is 9% shorter than predicted. The observed occultation path was 4 km north of the prediction.

No inversion models or lightcurves are available for this asteroid.

An occultation by Ursula was observed from six sites on 1982 Nov. 15; the data were fit by a circle of diameter 216 ±10 km (Millis *et al.*, 1984). An occultation was seen from three sites on 1999 Sept. 21, but the star was double and it has not been possible to derive a coherent solution from the visual observations. An ellipse with axes 216 ± 9 km by 186 ± 2 km was fit to 15 observations of an occultation on 2003 Oct. 19. Single-chord occultations were observed on 2004 Dec. 5, 2008 May 27, and 2010 Dec.28. Occultations of Ursula were observed on 2011 Jan. 2 and April 6, from two stations in each case, but on the same side of center and without enough separation to make an elliptical fit or determine a new circular diameter.

<u>695 Bella</u> On 2010 August 31, asteroid 695 Bella occulted V = 7.7 star TYC 2332-01054-1 in Triangulum along a path from south-central California to Nevada. Analysis of this event showed the star to be double. Full results of this event will be available in a future JDSO article.

<u>824 Anastasia</u> On 2010 April 6, asteroid 824 Anastasia was predicted to occult V = 2.5 HIP 81377 (zeta Ophiuchi) along a path from southern California to Montana. An alert went out to get as many observers as possible to try to determine a profile for this 34 km diameter asteroid. 65 observers at 69 observing sites answered the call. Unfortunately a large path shift on the order of 91 km prevented all but four observers from recording the event. These limited results yielded a best-fit ellipse of 41.6 ± 2.4 x 22.3 ± 0.5 km.

Conclusions

Combining observations from a variety of independent sources provides evidence for the shape of asteroids and their orientation during the time of these observations. This can be seen by the excellent agreement between occultation results and inversion models in the cases of Psyche and Artemis. However, conflicting observations such as those for Minerva point to the need for more observations. The need for better astrometry is illustrated by the Anastasia event. Only through the acquisition of additional data can high quality occultation results be obtained and then used to verify indirect techniques. Future articles will continue to include occultation results in which multiple chords are observed. Preference will be given to those events for which lightcurves and/or inversion models are available.

Acknowledgements

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References

Alton, K. (2010). “CCD Lightcurves for 4 Main Belt Asteroids.” *Minor Planet Bulletin* **38**,, 8-9.

Blow, G. (2004). “Occultation of TYC 5783-01228-1 by (16) Pysche 2004 May 16.” *http://occsec.wellington.net.nz/planet/2004/results/04056_psyche.htm*

Degenhardt, S. (2009). “Effects of Optical Miniaturization on Occultations.” In *The Alt-Az Initiative: Lightweight Telescope*

Developments and Scientific Research Programs (R. Genet, ed.). Collins Foundation Press.

Dunham, D.W. (1999). *Sky and Telescope* **97**, 106-109

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

Dunham, D.W., Herald, D., and Neese, C. (2010). Asteroid Occultations V8.0. EAR-A-3-RDR- OCCULTATIONS-V6.0. NASA Planetary Data System.
http://sbn.psi.edu/pds/resource/occ.html

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

Durech, J., Sidorin, V., and Kaasalainen M. (2010) "DAMIT: a database of asteroid models." *Astron. Astrophys.* **513**, A46.

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

Higley, S., Hardersen, P., and Dyvig, R. (2008). "Shape and Spin Axis Models for 2 Pallas (revisited), 5 Astraea, 24 Themis, and 105 Artemis." *Minor Planet Bulletin* **35**, 63-68.

Kaasalainen, M. and Torppa, J. (2001). "Optimization methods for asteroid light curve inversion. I. Shape determination." *Icarus* **153**, 24-36.

Kaasalainen, M., Torppa, J., and Muinonen, K. (2001). "Optimization methods for asteroid light curve inversion. II. The complete inverse problem." *Icarus* **153**, 37-51.

Marchis, F. (2009). "The discovery of a new triple asteroid - (93) Minerva." Cosmic Diary Blog.
http://www.cosmicdiary.org/blogs/nasa/franck_marchis/?p=465.

Millis, R.L., Wasserman, L.H., Bowell, E., Franz, O.G., Klemola, A., and Dunham, D.W. (1984). "The diameter of 375 Ursula from its occultation of AG + 39 deg 303." *Astron. J.* **89**, 592-596.

Millis, R.L., Wasserman, L.H., Bowell, E., Franz, O.G., Nye, R., Osborn, W., and Klemola, A. (1985). "The occultation of AG+29° 398 by 93 Minerva." *Icarus* **61**, 124-131.

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

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

Pilcher, F. (2010). "New Lightcurves of 40 Harmonia and 105 Artemis." *Minor Planet Bulletin* **37**, 167.

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

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

Timerson, B. (2010). "Asteroid Occultation Results for North America."
http://www.asteroidoccultation.com/observations/Results/index2010.html

Timerson, B., Durech, J., Aguirre, S., Benner, L., Blacnhette, D., Breit, D., Campbell, S., Campbell, R., Carlisle, R., Castro, E., and 36 coauthors. (2009). "A Trio of Well-Observed Asteroid Occultations in 2008." *Minor Planet Bulletin* **36**, 98-100.

Torppa, J., Hentunen, V.-P., Pääkkönen, P., Kehusmaa, P., Muinonen, K. (2008). "Asteroid shape and spin statistics from convex models." *Icarus* **198**, 91-107.

Torppa, J., Kaasalainen, M., Michalowski, T., Kwiatkowski, T., Kryszczyńska, A., Denchev, P., Kowalski, R. (2003). "Shapes and Rotational Properties of Thirty Asteroids from Photometric Data." *Icarus* **164**, 364-383 .

Warner, B.D. (2011). Minor Planet Lightcurve Data.
http://www.minorplanetobserver.com/PDO/PDOLightcurves.htm

LIGHTCURVES FOR 1965 VAN DE KAMP AND 4971 HOSHINOHIROBA

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Asteroids 1965 van de Kamp and 4971 Hoshinohiroba were observed in 2011 February in order to create lightcurves. We found no discernible rotation period for 1965 van de Kamp with some suggestion it may be longer than 36 hours. We find a synodic rotation period of 7.7 ± 0.1 h for 4971 Hoshinohiroba.

Observations of asteroids 1965 van de Kamp and 4971 Hoshinohiroba were taken from the Tzec Maun Foundation's New Mexico Skies observatory using the 14-in Maksutov-Newtonian f/3.8 reflector telescope. The ST-10XME CCD camera was used to take the images with a clear filter and guided exposures. Observing occurred 2011 February 16 – 22. Cloudy weather during the second session and windy weather during the third made the data for 1965 van de Kamp less reliable. Each observing session went from 9:00pm EDT until 5:00am. *Sky Image Processor* (Simonetti 1999) was used for image reduction. *Aperture Photometry Tool* (Laher 2007-2011) software was used to measure instrumental magnitudes. Two comparison stars were used for each. We constructed and examined phase plots for the asteroids using spreadsheet software.

<u>1965 van de Kamp.</u> Though we had the most images and data compiled for 1965 van de Kamp (118 data points), our attempt to determine a rotation period was inconclusive. We began our search with shorter rotation periods: 5 – 10 h. When this produced no results, we examined longer rotation periods: up to 36 h. Seeing no identifiable lightcurve, we concluded that we had insufficient data to determine a rotation period. Because the asteroid had ten nearly identical measurements on 2011 February 20 and twenty-eight nearly identical measurements on 2011

February 22, we conclude the rotation period is probably rather long, at least 36 h.

4971 Hoshinohiroba. A search of the Asteroid Lightcurve Database did not reveal any reported lightcurve results for 4971 Hoshinohiroba. We collected 51 good images and data points. We began phasing the data with short rotation periods (5 – 10 h). When promising results appeared around 7 – 8 h, we narrowed the rotation period down to 7.7 ± 0.1 h.

Acknowledgement

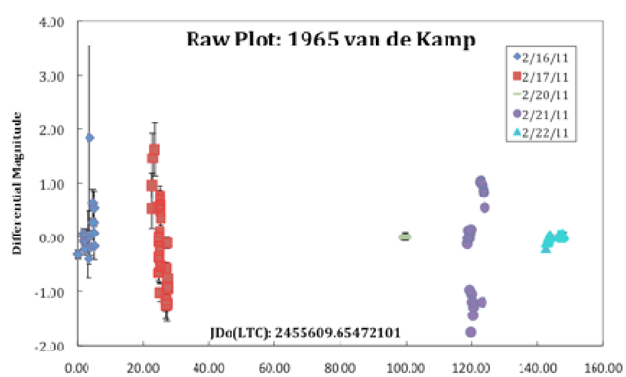
We would like to thank the Tzec Maun Foundation for the use of their New Mexico Skies observatory in New Mexico, USA. Information on this foundation and its support may be found at http://blog.tzecmaun.org/.

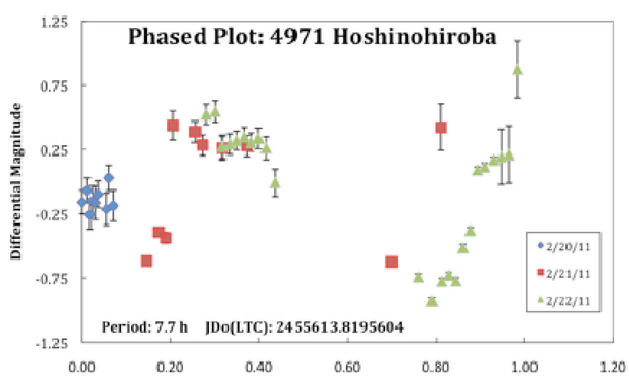
References

Laher, R. (2007-2011). *APT*, Aperture Photometry Tool software, version 1.1.1. Spitzer Science Center, California Institute of Technology, Pasadena, CA. *http://spider.ipac.caltech.edu/staff/laher/apt/*

Simonetti, J. (1999). *SIP*, Sky Image Processor software. *http://www.phys.vt.edu/~jhs/SIP/*

Warner, B.D., Harris, A.W., and Pravec (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updates available at: *http://www.MinorPlanetObserver.com/astlc/default.htm*





LIGHTCURVE PHOTOMETRY OF 6670 WALLACH

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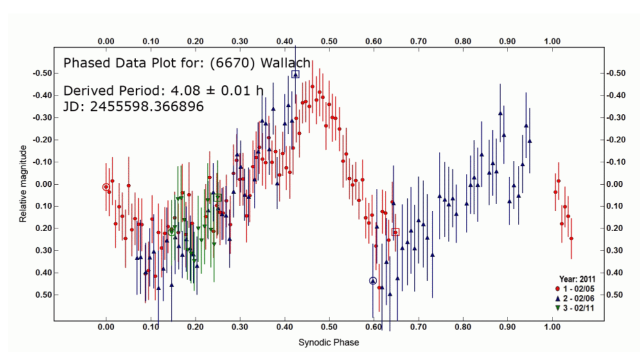
The main-belt asteroid 6670 Wallach was observed over 3 nights between February 05, 2011 and February 11, 2011 at the Observatorio Astronomico de Mallorca (620). From the collected data we determined a synodic rotation period of 4.08 ± 0.01 h and lightcurve amplitude of about 0.80 ± 0.15 mag.

6670 Wallach was tracked over 3 nights between February 05 and February 11, 2011 with PIRATE (http://pirate.open.ac.uk) a Planewave CDK17 0.43-m f/6.8 Dall-Kirkham Telescope equipped with an SBIG STL-1001E CCD camera located at the Observatorio Astronomico de Mallorca in Spain. Image acquisition and calibration were performed using *Maxim DL*. All 174 images were unfiltered and had exposures of 90 seconds. Image analysis was accomplished using differential aperture photometry with *MPO Canopus*. Period analysis was also done in *Canopus*, which implements the algorithm developed by Harris et al. (1989). From the data we determined a synodic period of 4.08 ± 0.01 h and a lightcurve amplitude of 0.80 ± 0.15 mag.

References

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



ROTATION PERIOD DETERMINATION FOR 531 ZERLINA

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The synodic rotation period of 531 Zerlina is found to be 16.706 ± 0.001 hours with lightcurve amplitude varying from 0.70 ± 0.05 to 0.55 ± 0.04 magnitudes.

Observations by Pilcher at the Organ Mesa Observatory were obtained with a 35.4 cm Meade LX 200 GPS S-C and SBIG STL-1001E CCD, unguided exposures through a clear filter, differential photometry only. Observations by Brinsfield at Via Capote Observatory were made using a guided 0.40 m SCT and Alta U6 CCD resulting in an image scale of 1.25” per pixel. Data Mar. 5 – Apr. 22 and May 26 are by Pilcher. Data on dates Apr. 29 – May 5, May 27, June 14 are by Brinsfield. Image measurement, data sharing, and lightcurve analysis were done using *MPO Canopus*. The lightcurve has been drawn with the large number of acquired data points binned in sets of three with a maximum of five minutes between points.

Minor planet 531 Zerlina has an unusual orbit with i = 33 deg, e = 0.199, a = 2.78, resembling that of Pallas. Bus and Binzel in (2002a) find a spectral slope very similar to that of Pallas and in (2002b) that Zerlina has the same rarely encountered taxonomic class B as Pallas. It is suggested that Zerlina and several other small asteroids with very similar orbits and spectra may be chips from a major cratering event on Pallas. Zerlina passes the ascending node at the start of the 2011 observation window with perihelion passage soon afterward. Being brighter than usual, and moving through a large arc, the year 2011 offers an unusually good opportunity for a long observation interval to provide a precise rotation period and contribute toward a lightcurve inversion model. Brinsfield (2008) has obtained the most dense lightcurve prior to the current study showing period 16.716 hours, amplitude 0.40 magnitudes, and which to a cursory examination looks convincing. Szekely et al. (2005) found a period > 12 hours. New data on 19 nights 2011 Mar. 5 – June 14 show a period 16.706 ± 0.001 hours, compatible with Brinsfield (2008). The amplitude decreased from 0.70 ± 0.05 magnitudes at 19 degrees phase angle in early March to 0.57 ± 0.04 magnitudes at 6 degrees phase angle in mid April, as usually occurs with decreasing phase angle. But from mid April to the final observations June 14 at phase angle 24 degrees the amplitude remained steady near 0.55 ± 0.05 magnitudes. During this interval the object moved from longitude 218 degrees, latitude +1 degree March 5 to longitude 200 degrees, latitude +21 degrees June 14. We explain the lack of amplitude increase late in the observing interval as being due to a decrease in the aspect angle between the line of sight and the rotational pole.

The ratio of maximum to minimum equatorial diameter a/b is related to the amplitude A at zero phase angle and equatorial aspect by the relationship a/b=10^(0.4A). While the minimum phase angle achieved at the current apparition is 6 degrees, not zero, the value A = 0.57 is likely close to the zero phase amplitude. However the aspect angle at the current apparition is not known. Therefore we should present a/b >= 1.69, with the equality if at equatorial aspect and the inequality if not at equatorial aspect.

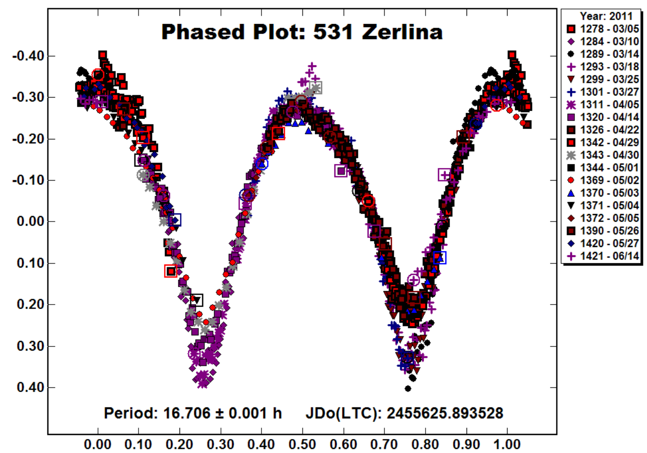
References:

Brinsfield, J. W. (2008). “The Rotation Periods of 531 Zerlina, 1194 Aletta, 1352 Wawel, 2005 Hencke, 2648 Owa, and 2509 Sanshui.” *Minor Planet Bull.* **35**, 86-87.

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

Bus, S. J. and Binzel, R. P. (2002b). “Phase II of the Small Main-Belt Asteroid Spectroscopic Survey: A Feature-Based Taxonomy.” *Icarus* **158**, 146-177.

Szekely, P., Kiss, L. L., Szabo, Gy. M., Sarneczky, K., Csak, B., Varadi, M., and Meszaros, Sz., (2005). “CCD photometry of 23 minor planets.” *Planet. Space Sci.* **53**, 925-936.



53 KALYPSO, A DIFFICULT ASTEROID

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Previous observations of 53 Kalypso have not resolved a rotation period ambiguity between near 9.035 hours and twice that value. New observations very strongly support the 9.035 hour period, with amplitude 0.10 magnitudes and 3 unequal maxima and minima per cycle in the interval 2011 April – July.

The observations reported here were obtained at the Organ Mesa Observatory. Equipment consists of a 35.4 cm Meade LX 200 GPS S-C and SBIG STL-1001E CCD, with unguided exposures, clear filter, differential photometry only. Image measurement and lightcurve analysis were done with *MPO Canopus*. The lightcurves have been drawn with the large number of data points binned in sets of three with a maximum of five minutes between points.

A lightcurve phased to twice the real period will show a fit as good as one phased to the real period, and the two halves will look the same. Conversely if the period is initially unknown a lightcurve phased to a trial period may show two halves which look the same. This might mean that the real period is half of the trial period, or it might mean that the asteroid has a shape symmetric about a 180 degree rotation. Particularly if the lightcurve is otherwise irregular the chance of a sufficiently symmetric shape is extremely small, and the smaller period has a very high probability of being the correct one. But the larger period can be absolutely ruled out only if the amplitude is 0.3 magnitudes or greater in which case there is no feasible shape model except an elongated body producing a bimodal lightcurve. It should be noted, however, that the shape of a lightcurve changes with phase and aspect angles through an apparition. The two halves of a lightcurve phased to twice the real period will look the same only if they include the same range of phase and aspect angles. Additionally, small differences in the two halves of a lightcurve may be caused by a variety of external factors and do not verify the longer period.

53 Kalypso. Debehogne et al. (1982) obtained a very sparse lightcurve for which they claimed a period near 27 hours. Surdej et al. (1983) obtained additional observations later in the same opposition and linking the results obtained a possible period of 26.55 hours, but a reexamination suggests alias periods are likely. Harris and Young (1989) obtained additional lightcurves and suggested their own results and those by Debehogne et al. (1982) and Surdej et al. (1983) more likely indicate a period 16 – 20 hours. Pray et al. (2006) found a period 18.075 ± 0.005 hours, amplitude 0.14 magnitudes. Pilcher and Pray (2010) found a period 9.036 ± 0.001 hours, amplitude 0.14 magnitudes, with two unequal maxima and minima per cycle. In a subset of data from 6 nights 2009 Nov. 2 – 18 the two halves of a trial lightcurve phased to 18.075 hours looked almost exactly the same. In this paper Pray reevalutated his 2006 data and found a good fit to 9.029 hours. This object was observed again to provide additional evidence to resolve the 9.036 versus 18.075 hours ambiguity. New observations were made on 14 nights 2011 Apr. 1 – July 6 and show an amplitude 0.10 ± 0.02 magnitudes. When phased to 9.035 hours they show three unequal maxima and minima per cycle; for 18.07 hours there are six maxima and minima. Two data sets were examined separately for periods of both 9.035 and 18.07 hours.

For observations on 6 nights 2011 Apr. 1 – 12 an examination of the 9.036 hour lightcurve shows that for overlapping segments near phase 0.75 a magnitude about 0.01 brighter on April 11 than on Apr 4 appears. These are separated by ½ cycle on the 18.071 hour lightcurve. Re-examination of the original images shows that April 11 at the time of this magnitude discrepancy the target approached within 1.5 FWHM of a field star about 2 magnitudes fainter. It appears likely that the April 11 discrepancy is due to contamination from the star. The only lightcurve evidence favoring the 18.071 hour period must be considered unreliable.

Additional observations were obtained on 8 nights 2011 June 9 – July 6, and phased to periods of both 9.034 and 18.067 hours. Near phase 0.20 on the 9 hour lightcurve and the corresponding phase 0.60 on the 18 hour lightcurve the start of the June 23 session is about 0.02 magnitudes higher than the end of the June 10 session. As this appears in the same place on both lightcurves it does not constitute evidence favoring either the shorter or longer period. The June 23 session started 45 minutes before the end of astronomical twilight and the end of the June 10 session was at low altitude 25 degrees. Under both of these circumstances photometric accuracy is reduced, and I consider them to be the most likely causes of the misfit. Otherwise the two halves of the 18 hour lightcurve are indistinguishable.

For one data set in 2009 and two data sets in 2011 the two halves of the lightcurve phased to near 18.07 hours are strongly asymmetric but nearly identical to each other. I consider the probability of an irregular shape sufficiently symmetric over a 180 degree rotation to account for the plotted 18.07 hour lightcurves at 3 separate phase/aspect angle sets to be very small. The statistical confidence level for the favored 9.035 ± 0.001 hour period is probably large, but not feasible to evaluate numerically.

Five lightcurves representing the 2011 observations are presented to allow readers to make independent assessments. These are for the April and June/July observations, separately, each phased to near 9.035 hours and 18.07 hours, respectively, and a single lightcurve representing all observations and phased to 9.035 hours.

References

Debehogne, H., De Sanctis, G., and Zappala, V. (1982). "Photoelectric Photometry of Three Dark Asteroids." *Astron. Astrophys.* **108**, 197-200.

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

Pilcher, F., and Pray, D. P. (2010). "Rotation Period Determination for 53 Kalypso." *Minor Planet Bull.* **37**, 75-76.

Pray, D. P., Galad, A., Gajdos, S., Vilagi, J., Cooney, W., Gross, J., Terrell, D., Higgins, D., Husarik, M., and Kusnirak, P. (2006). "Lightcurve analysis of asteroids 53, 698, 1016, 1523, 1950, 4608, 5080, 6170, 7760, 8213, 11271, 14257, 15350, and 17509." *Minor Plan. Bull.* **33**, 92-95.

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

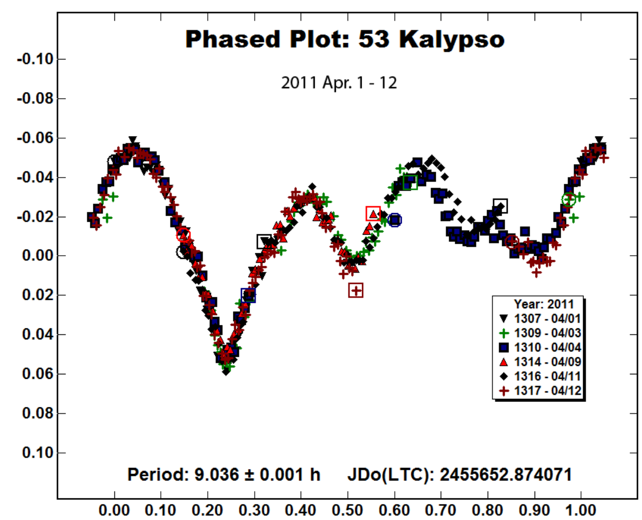

Fig. 1 Lightcurve of 53 Kalypso based on data 2011 Apr. 1 - 12 and phased to 9.036 hours.

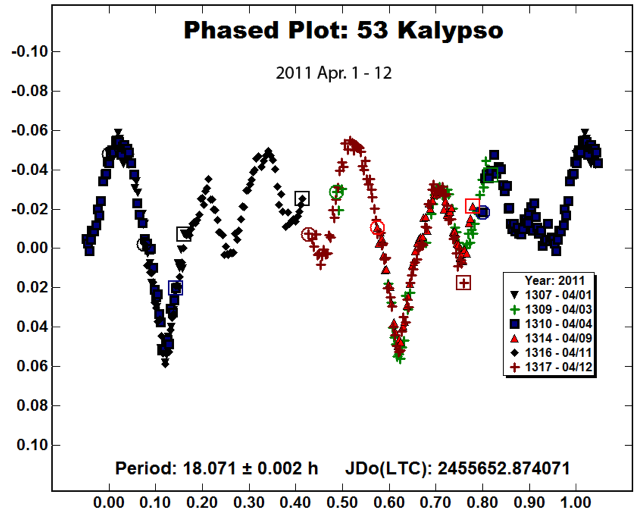

Fig. 2 Lightcurve of 53 Kalypso based on data 2011 Apr. 1 - 12 and phased to 18.071 hours.

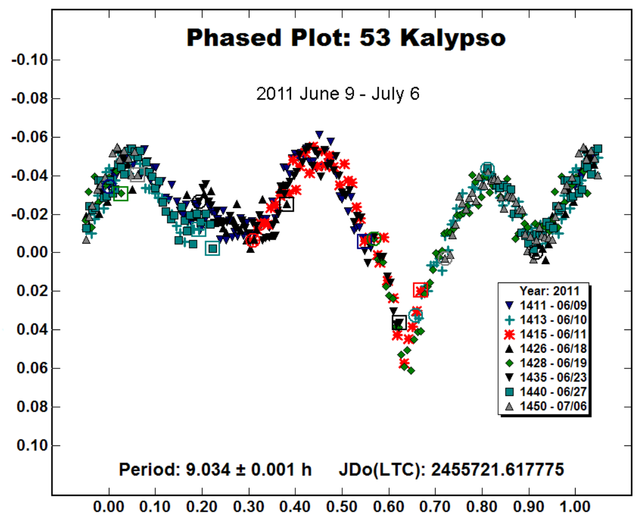

Fig. 3 Lightcurve of 53 Kalypso based on data 2011 June 9 - July 6 and phased to 9.034 hours.

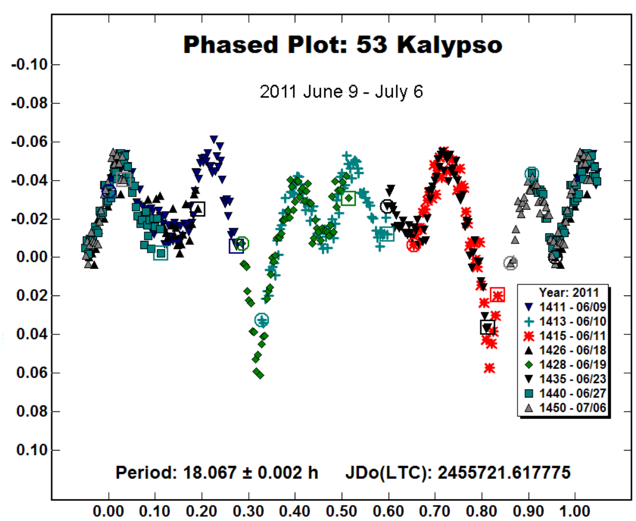

Fig. 4 Lightcurve of 53 Kalypso based on data 2011 June 9 - July 6 and phased to 18.067 hours.

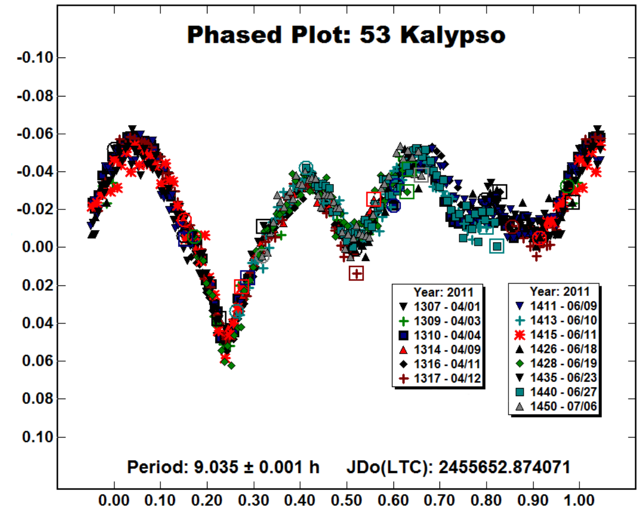

Fig. 5 Lightcurve of 53 Kalypso based on all data 2011 April 1 - July 6 and phased to the likely 9.035 hour period.

THE LIGHTCURVE FOR 202 CHRYSEIS

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The main-belt asteroid 202 Chryseis was observed 2011 January – February by four observers with widely separated longitudes. The derived lightcurve has a synodic period of 23.670 ± 0.001 h and amplitude of 0.20 ± 0.02 mag.

Observations of the main-belt asteroid 202 Chryseis were made by the authors from 2011 January 19 through February 28. The combined data set consists of 3,173 data points. Most images were unbinned with no filter. Details of the equipment used are in Table 1. 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).

Stephens and Pilcher selected Chryseis from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2010). It immediately became apparent that the period was nearly synchronized with the Earth's rotation resulting in the same features being observed each night. Stephens contacted Ferrero and Hamanowa whose observatories are located at widely different longitudes to obtain observations filling in the missing gaps of the lightcurve. Pilcher obtained another session on 2011 March 20 (not plotted here) which increased the amplitude by 0.07 magnitudes.

202 Chryseis was previously observed by Slivan (2002) who obtained sparse data on six sessions from 2000 February 8 – March 25. He found a period of 15.74 h, which appears to be an alias of our period. His observed amplitude did not exceed 0.1 magnitudes. Behrend (2011) observed Chryseis over some of the same period as our observations and reported a period of 11.856 h based upon a partial lightcurve obtained over 10 nights, which also appears to be an alias of our period.

References

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

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

Minor Planet Center (2011). Lightcurve Database, *http://minorplanetcenter.net/light_curve*.

Slivan, S. M. and Krco, M. (2002). "Rotation Period and Solar Phase Coefficients of (202) Chryseis." *Minor Planet Bul.* **29**, 70-71.

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

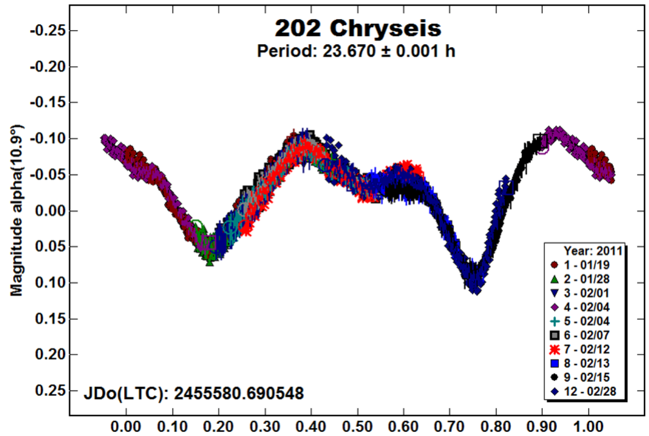

Figure 1: Lightcurve of 202 Chryseus. P.A. 10.9 to 0.7 to 5.6, Avg. L_{PAB} = 145°, Avg. B_{PAB} = 2°.

Observer	Telescope	CCD	# Sess.
Stephens	0.30 m SCT	SBIG STL-1001E	5
Pilcher	0.35 m SCT	SBIG STL-1001E	4
Hamanowa	0.40 m SCT	SBIG ST-8	2
Ferrero	0.30 m RC	FLI CM9	1

Table 1: Details of Equipment.

Observer	Dates observed
Stephens	01/28, 02/01, 02/04, 02/07, 02/28 (not plotted)
Pilcher	01/19, 02/12, 02/28, 03/20 (not plotted)
Hamanowa	02/13, 02/16, 3/30 (not plotted)
Ferrero	02/03

Table 2: Dates Observed.

LIGHTCURVE ANALYSIS OF (8369) 1991 GR

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CCD photometry observations of the Eunomia member asteroid (8369) 1991 GR were made at the Palmer Divide Observatory and Center for Solar System Studies in 2011 March. Analysis using a single period search found a synodic period of 2.7368 ± 0.0001 h and lightcurve amplitude of 0.24 ± 0.02 mag. A dual-period search found a weak secondary period (assuming a bimodal lightcurve) of 49.24 ± 0.16 h. Subtracting this period noticeably improved the RMS fit of the short-period component.

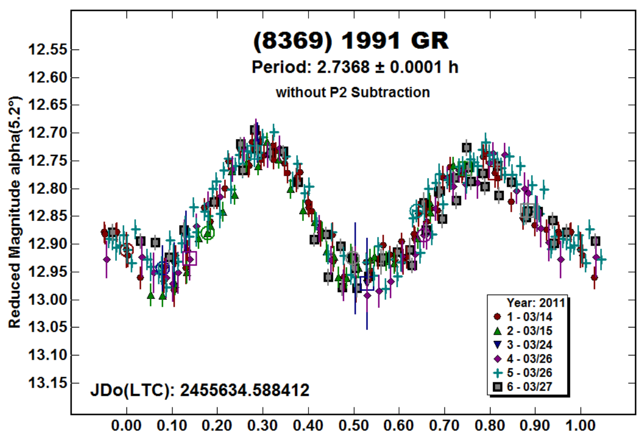
The Eunomia member asteroid (8369) 1991 GR was first observed on 2011 March 14 at the Palmer Divide Observatory as a "target of opportunity," meaning it happened to be in the same field as a planned target. The equipment used was a 0.35-m Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD camera. Exposures were unfiltered and 240 s. All frames were dark and flat field corrected. The initial analysis showed the period to be approximately 2.7 h with an amplitude of 0.24 mag. As such, this made the object a good candidate for being a binary and so additional observations were made to follow-up. Coley at the Center for Solar System Studies (CS3) contributed observations on March 26 and 27 using a 0.35-m telescope and SBIG ST-9XE CCD camera. Exposures were unfiltered and 240 s. All frames were dark and flat field corrected. Since both observatories observed on March 26, this allowed a check of each other's observations and provided a zero point calibration to match the two systems.

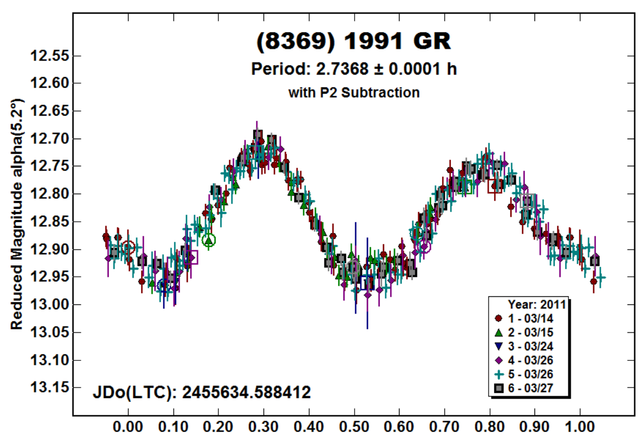
MPO Canopus was used to measure all images and then do the period analysis. When searching for a single period with the entire data set, *Canopus* found a synodic period of 2.7368 ± 0.0001 h and lightcurve amplitude of 0.24 ± 0.02 mag. However, there were weak signs of a secondary period in the resulting lightcurve. This prompted a dual-period search in which the modeled Fourier curve for one period was subtracted from the data set and then a search done on the resulting data. The process iterated between the two periods until both stabilized. This search found a weak secondary period of 49.24 ± 0.16 h with an amplitude of 0.05 ± 0.01 mag. Subtracting this period did not change the "primary" period but noticeably improved the RMS fit from 0.024 mag to 0.018 mag.

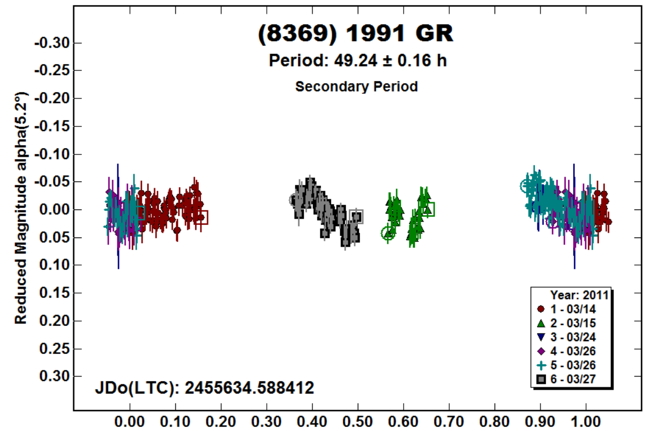
If not the result of systematic or observational errors, the cause for the secondary period is a matter for speculation. There were no *mutual events*, the result of occultations and/or eclipses by a satellite. However, known binaries have shown similar behavior outside event seasons, with the secondary lightcurve being the result of the rotation of the satellite that is tidally-locked to its orbital period. If nothing else, the possible presence of a secondary period along with the period and amplitude of the main lightcurve warrant high-precision observations at future apparitions, the most immediate being 2012 June (V ~ 15.5, Dec –42°) and 2013 October (V ~ 14.1, Dec +16°).

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. 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.







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Minor Planet Bulletin

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ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES: 2011 APRIL - JUNE

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(Received: 13 July)

Lightcurves of four asteroids were obtained from Santana Observatory and Goat Mountain Astronomical Research Station (GMARS) from 2011 April to June: 948 Jucunda, 1183 Jutta, 1775 Zimmerwald and 3492 Petra-Pepi.

Observations at Santana Observatory (MPC Code 646) were made with a 0.30-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. All images were unguided and unbinned with no filter. Observations at GMARS were made with either a 0.35-m or a 0.4-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. Measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (1989). The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner et al., 2011).

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

948 Jucunda. All images were acquired at GMARS. There is no previously reported rotational period in the latest public release of the Asteroid Lightcurve Database (LCDB) maintained by Warner et al (2010). Since Jucundas period is similar to the Earth's rotation, observations had to be obtained over two months to fill in the complete phased lightcurve. Over that period of time, phase effects started to become apparent as the solar phase angle changed from 1 to 18 degrees.

1183 Jutta. Observations on March 5, 13, 27, April 3 and 10 were acquired at GMARS with the 0.4-m SCT. All others were acquired at Santana Observatory. There is no previously reported period in the LCDB (Warner 2010). Every night's observations produced an essentially flat plot, with small shifts in magnitude from night to night. The amplitude of the plotted curve is twice the errors of the night-to-night calibration data using converted 2MASS stars. However, a repeatable lightcurve was obtained over the six week observing run. Given the low amplitude, it cannot be certain if the lightcurve should be bimodal or only have a single extrema with a period half of that shown here.

1175 Zimmerwald. Observations on May 1 were acquired at GMARS with the 0.4-m SCT. All others were acquired at Santana Observatory. Zimmerwald does not have a previously reported period in the LCDB (Warner 2010). Monson (2004) observed it for three nights in August 2003 but could not determine a period. For this opposition, observations could only be obtained over a twelve night span. Observations on the last two nights were 0.2 magnitudes fainter than the rest, well outside of the normal calibration errors. These two sessions might be indicative of nonprincipal axis rotation.

3492 Petra-Pepi. Behrend (2011) reported a period was 9 h based upon a single night's observations on July 12, 2007 with scatter in the data of about 0.50 magnitudes.

The data for each of these asteroids was uploaded to The Minor Planet Center's Lightcurve database MPC (2011).

References

Behrend, R. (2011). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html.*

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

Minor Planet Center (2011). Lightcurve Database,*http://minorplanetcenter.net/light_curve*.

Monson, A. and Kipps, S. (2004). "Rotational Periods of Asteroids 1165 Imprinetta, 1299 Mertona, 1645 Waterfield, 1833 Shmakova, 2313 Arura, and (13856) 1999 SX105." *Minor Planet Bul*. **31**, 71-73.

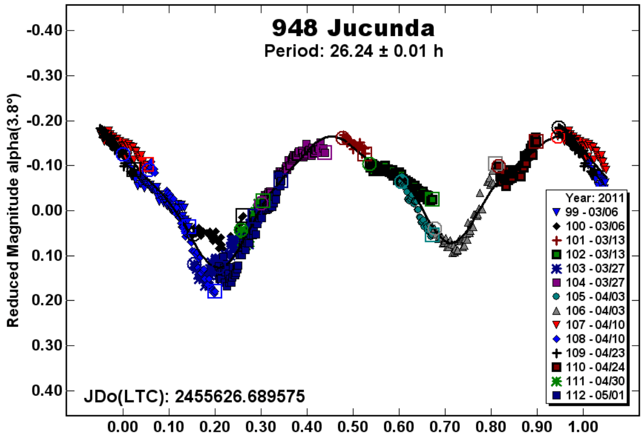
Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul*. **35**, 31-32.

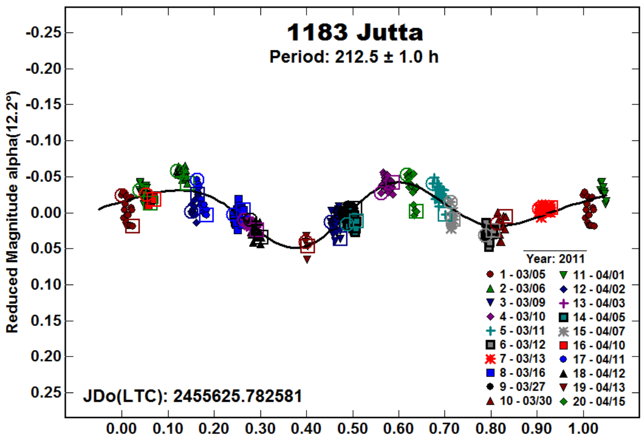
Warner, B.D. (2007). "Initial Results from a Dedicated H-G Project." *Minor Planet Bul.* **34**, 113-119.

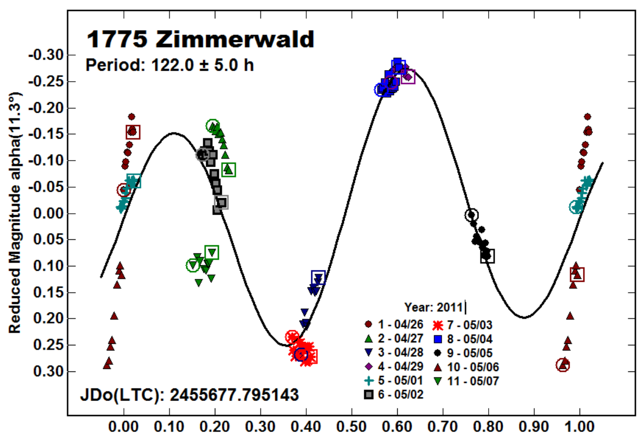
Warner, B.D., Harris, A.W., and Pravec, P. (2011). Lightcurve Targets. *http://www.minorplanet.info/call.html.*

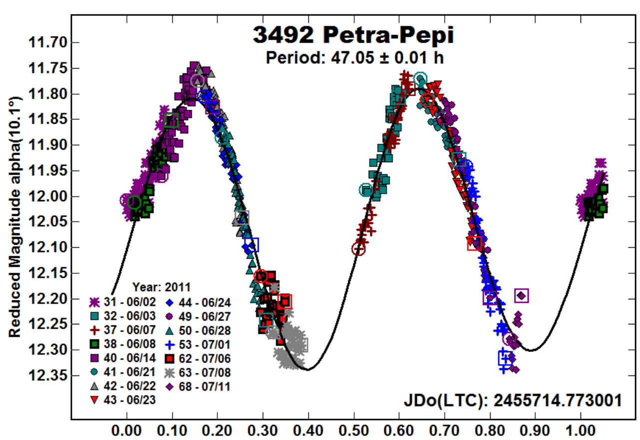
Warner, B.D., Harris, A.W., and Pravec, P. (2010). Asteroid Lightcurve Database. *http://www.minorplanet.info/lightcurve database.html.*

#	Name	mm/dd 2011	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
948	Jucunda	03/06 - 05/01	657	3.9, 0.8, 18.0	175	0	26.24	0.01	0.30	0.03
1183	Jutta	03/05 – 04/15	1,757	12.3, 0.4, 14.6	186	1	212.5	1	0.10	0.02
1175	Zimmerwald	04/26 – 05/07	597	7.1, 9.0	13	11	122	5	0.6	
3492	Petra-Pepi	06/02 – 07/11	664	10.1, 9.5, 17.?	257	17	47.05	0.01	0.55	0.02









THE CURSE OF SISYPHUS

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(Received: 15 July)

Analysis of CCD photometry observations in mid-2011 of the suspected binary asteroid 1866 Sisyphus made at Lowell Observatory, Goat Mountain Astronomical Research Station (GMARS), and Palmer Divide Observatory (PDO) found two low amplitude periods of 2.40 h and 25.25 h. The shorter period is similar to that previously reported. The longer period may be due to the suspected satellite but, given the lack of mutual events (occultations and/or eclipses), the evidence is not conclusive.

The near-Earth asteroid 1866 Sisyphus is an Apollo asteroid with a favorable opposition in 2011. Sisyphus was previously reported to have a period of 2.400 h by Schober, 1993. As part of that study, Hahn observed it on four nights in 1985 November and December, producing a bimodal lightcurve with an amplitude of 0.1 magnitudes. Their plot indicated a magnitude shift of approximately 0.03 magnitudes each night in order to bring the individual plots into alignment. Szabo (2001) reported a period of 2.7 h with an amplitude of 0.12 magnitudes from 42 observations obtained on 2000 June 30. Pravec (2011) reports a period of 2.4 hours from observations obtained in 1998 and 1999 with amplitudes varying from 0.05 to 0.11 mag.

Our observations with the 72-inch (1.8-m) Perkins telescope at Lowell Observatory's Anderson Mesa Station (MPC 688) in 2011 May used the PRISM camera through a Cousins R filter. Observations were continued at GMARS (MPC G79) and eventually, PDO (MPC 716). Observations at GMARS were unfiltered and made with a 0.35-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. Unfiltered observations at PDO were made with a 0.5-m or a 0.35-m Schmidt-Cassegrain (SCT) with a SBIG STL-1001E. All measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data.

Night-to-night calibration of the data was done by taking images of all of the fields on a photometric night along with a standard field. Applying first and second order extinction and transforms for the individual telescopes, reduced magnitudes for each of the comparison stars used were determined.

Useful observations of the asteroid with obtained with the 72-inch Perkins telescope during three sessions spanning four nights. These initial observations, obtained when the asteroid was near a solar phase angle of 10 degrees, did not reveal a short period but, instead, suggested a much longer period. Observations were continued at GMARS, and a short 2.4 hr period began to reveal itself when the solar phase angle reached 14 degrees. Hahn's data from 1985 November and December were obtained when the asteroid was at a 60 degree solar phase angle. Szabo's observations were obtained at a phase angle of 22 degrees. The Pravec observations in 1998 and 1999 also showed the amplitude was correlated with solar phase angle. Their observations had a 0.03 mag amplitude at phase angles less than 20 degrees and an amplitude of 0.05 to 0.11 magnitudes at phase angles of 23 and 39 degrees. It is possible that the asteroid is so close to spherical that it doesn't show a prominent amplitude unless scattering from surface features is enhanced at higher solar phase (Pravec private communication).

Pravec also suggested the zero point offsets in the Hahn data might be indicative of a secondary period, or to their using the wrong value for the phase slope parameter (G). In Schober *et al.* (1993), a value of $G = 0.22$ was used to derive an absolute magnitude of $H = 12.5$. We downloaded the original data from the SAPC web site (*http://asteroid.astro.helsinki.fi/apc*) but could not replicate their plot using either $G = 0.15$ or 0.22.

Since a longer period seemed to be present, we inquired about previous radar data. Steve Ostro obtained radar data in 1985 on Sisyphus. Lance Benner took another look at them and reported that Ostro got Doppler-only echoes of Sisyphus on several days but was unable to get delay-Doppler images. The spectra show a broad echo with a narrow spike superimposed on it, the signature we now recognize as that of a binary system. The bandwidth (aka Doppler broadening, caused by the object's spin) of the echo is nearly 100 Hz, a large amount for a near-Earth asteroid but consistent with an object about 9 km in diameter with a rotation period of about 2.4 hours. Ostro's data are too sparse to pin down the orbital period, but 25 hours is reasonable and within the realm of orbital periods seen for the satellites of other binary systems. (Benner, private communication).

With a hint of a longer period contained within our data, and evidence of Sisyphus being a binary from the 1985 radar data, we attempted to solve for two periods using the dual period search feature in *MPO Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (1989). Since the 2.4 h period did not present itself at low solar phase angles, we initially limited our search for the shorter period (P1) to those observations where the phase angle exceeded 14 degrees. After finding a period P1 = 2.401 ± 0.001 h, we subtracted it from the dataset and found a weak secondary period of P2 = 25.25 ± 0.01 h. This secondary period, which might be indicative the orbital period of a satellite, has an amplitude of 0.06 mag. The lack of *mutual events* (occultations and/or eclipses due to a satellite), leaves the issue of binarity still unresolved.

Although this secondary period is within the realm of orbital periods seen for satellites of other binary systems, due to the noisiness of the data, we cannot consider it to be definitive. It would be appropriate to have future studies of this suspected binary system. It is time for others to take up the task of pushing this boulder up the mountain.

The data for each of these asteroids was uploaded to The Minor Planet Center's Lightcurve database MPC (2011).

Acknowledgements

This research was supported by Cottrell College Science Award grants from the Research Corporation and support from the Faculty Development Fund of Illinois Wesleyan University.

References

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

Pravec, P., Wolf, M., and Sarounova, L. (2011). *http://www.asu.cas.cz/~ppravec/neo.htm*

Schober, H.J., Erikson, A., Hahn, G., and Lagerkvist, C.-I. (1993). "Physical Studies of Asteroids. Part XXVI. Rotation and Photoelectric Photometry of Asteroids 323, 350, 582, 1021 and 1866." *Astron. Astrophys. Suppl. Ser.* **101**, 499-505.

Szabo, Gy.M., Csak, B., Sarneczky, K., and Kiss, L.L. (2001). "Photometric observations of 9 Near-Earth Objects." *Astron. Astrophys*. **375**, 285-292.

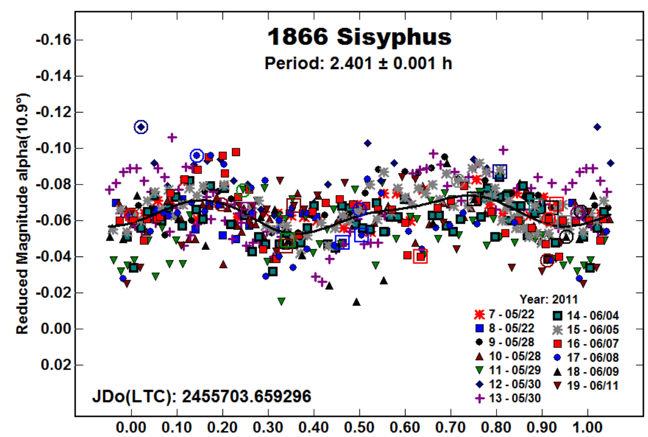

Figure 1. The primary period (P1) after subtracting the secondary period (P2) from the dataset obtained after Sisyphus reached solar phase angle of 14 degrees.

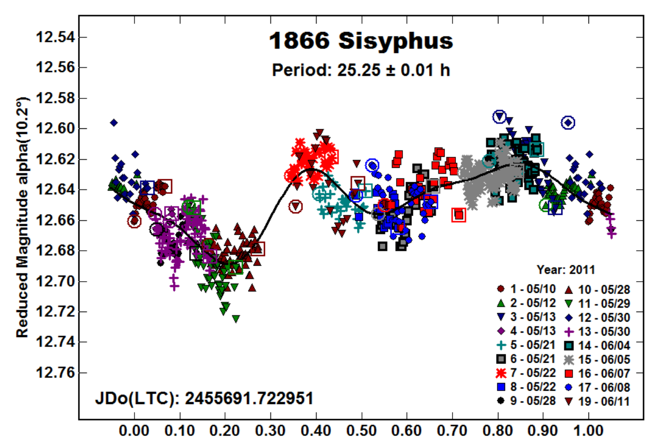

Figure 2. The secondary period (P2) after subtracting the primary period (P1) from the entire dataset.

ASTEROID LIGHTCURVE ANALYSIS AT THE OAKLEY SOUTHERN SKY OBSERVATORY: 2011 JANUARY THRU APRIL

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(Received: 15 July)

Photometric data for 23 asteroids were collected over 26 nights of observing during 2011 January thru 2011 April at the Oakley Southern Sky Observatory. The asteroids were: 437 Rhodia, 930 Westphalia, 948 Jucunda, 1129 Neujmina, 1315 Bronislawa, 1377 Roberbauxa, 1598 Paloque, 1716 Peter, 2107 Ilmari, 2108 Otto Schmidt, 2233 Kuznetsov, 2290 Helffrich, 3001 Michelangelo, 3065 Sarahill, 4175 Billbaum, 4493 Naitomitsu, 6505 Muzzio, 6511 Furmanov, 7145 Linzexu, (7151) 1971 SX3, (17129) 1999 JM78, (18835) 1999 NK56, and 52266 Van Flandern.

Twenty three asteroids were observed from the Oakley Observatory in Terre Haute, Indiana, on the nights of 2011 January 26 – 31, February 23 – 27, March 14, 24, 25, 27, 29, April 2 – 9, 11 and 12. From the data, we were able to find lightcurves for 16 asteroids. Out of those 16, 12 were previously unrecorded results. Of the 4 asteroids with previously published results, two were reasonably close to previously published periods. The 7 remaining asteroids produced no repeatable data.

Selection of asteroids for observation was based on their sky position about one hour after sunset. Asteroids without previously published lightcurves were given higher priority than asteroids with known periods, but asteroids with uncertain periods were also selected with the hopes that we would be able to improve previous results. The Oakley Southern Sky Observatory houses a 20-inch Ritchey-Chretien optical tube assembly mounted on a Paramount ME. The attached camera is a Santa Barbara Instrument Group STL-1001E CCD camera and a clear filter. The image scale was 1.2 arcseconds per pixel at f/8.4. Exposure times varied between 90 and 180 seconds. Calibration of the images was done using master dome flats, darks, and bias frames. All calibration frames were created using *CCDSoft*. *MPO Canopus* was used to measure the processed images.

As far as we are aware, these are the first reported observations for the period of the following asteroids: 1377 Roberbauxa, 1598 Paloque, 1716 Peter, 2233 Kuznetsov, 3001 Michelangelo, 3065 Sarahill, 6505 Muzzio, 6511 Furmanov, 7145 Linzexu, (7151) 1971 SX3, (17129) 1999 JM78, and (18835) 1999 NK56. Our data for 437 Rhodia, 930 Westphalia, 948 Jucunda, 2107 Ilmari, 2108 Otto Schmidt, 2290 Helffrich, and 4493 Naitomitsu were too noisy for us to determine periods or we didn't have enough data, so we are reporting the magnitude variations only. Results from all of the asteroids are listed in the table below.

Additional comments have been included as needed.

1129 Neujmina. Our data are inconsistent with the period of 7.61 ± 0.10 h found by Binzel (1987) but are consistent with the period of 5.089 ± 0.004 h found by Carbo, et al. (2009).

1315 Bronislawa. Our data are inconsistent with the period of 9 ± 1 h found by Behrend (2011).

4175 Billbaum. Our calculated rotational period is close to the period of 2.730 ± 0.002 h found by Megna (2011), but not within stated uncertainty ranges.

52266 Van Flandern. Our data are inconsistent with the period of 9.65 ± 0.06 h found by Behrend (2011).

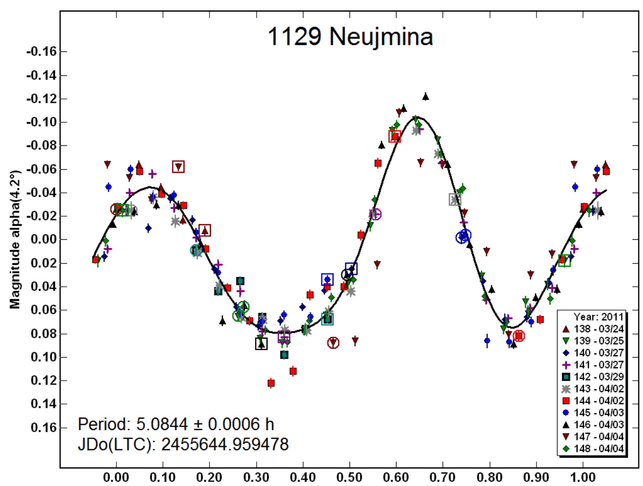
References

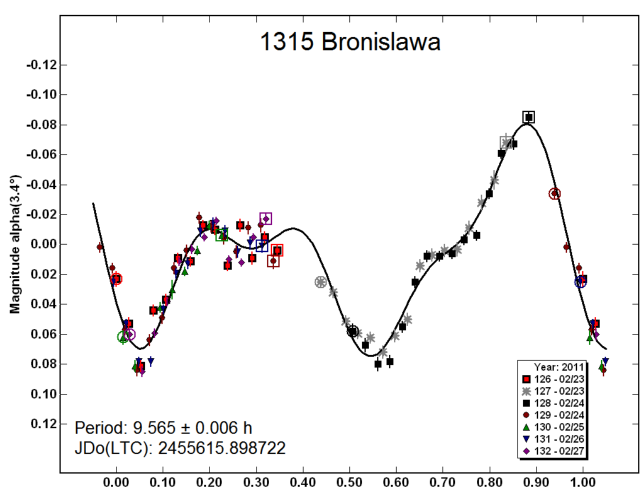
Behrend, R. (2011). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

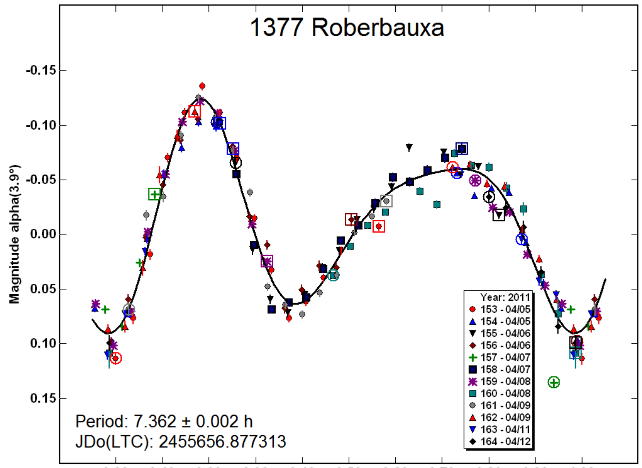
Binzel, R.P. (1987). "A Photoelectric Survey of 130 Asteroids," *Icarus* **72**, 135-208.

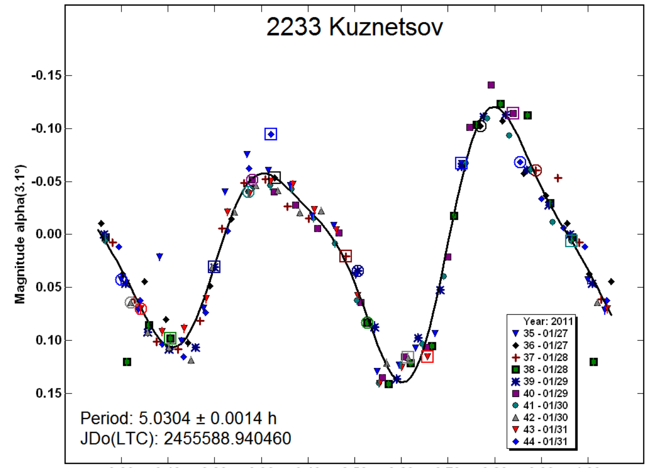
Carbo, L., et al. (2009). "Asteroid Lightcurve Analysis at the Oakley Southern Sky Observatory and Oakley Observatory: 2008 September and October," *Minor Planet Bul*. **36**, 91-94.

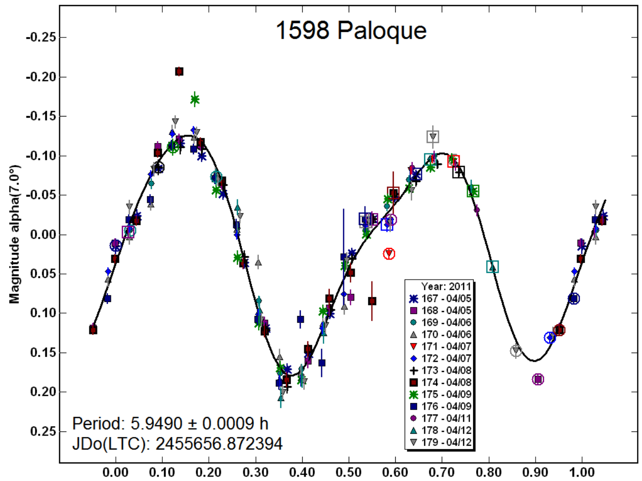
Megna, R. (2011). MacAstronomy web site, *http://www.macastronomy.com/MacAstronomy.com/Asteroids.html*

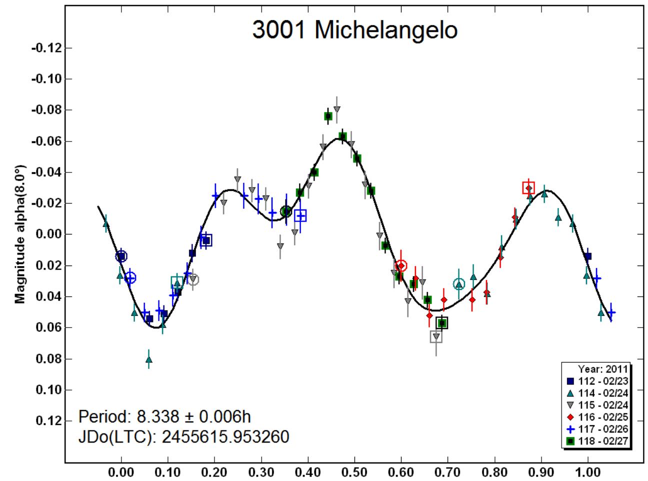


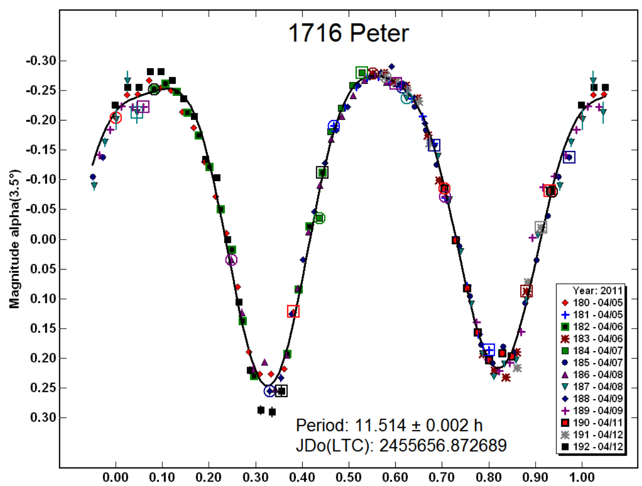


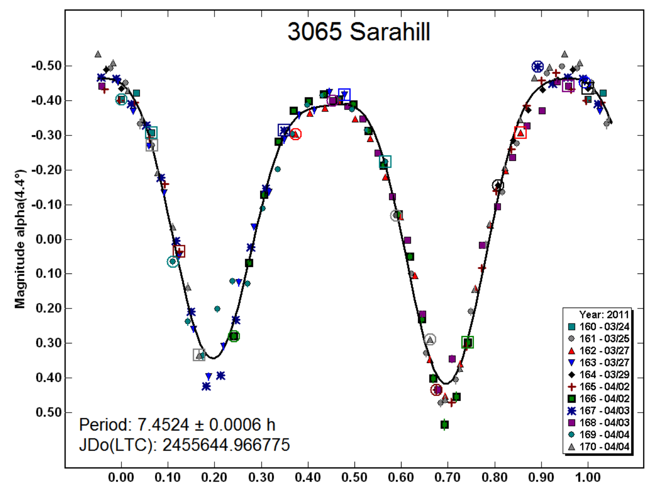

1377 Roberbauxa
Magnitude alpha(3.9°)
Period: 7.362 ± 0.002 h
JDo(LTC): 2455656.877313

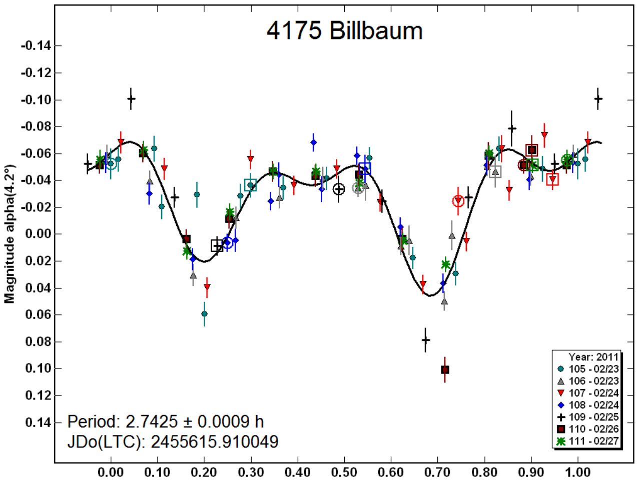

2233 Kuznetsov
Magnitude alpha(3.1°)
Period: 5.0304 ± 0.0014 h
JDo(LTC): 2455588.940460

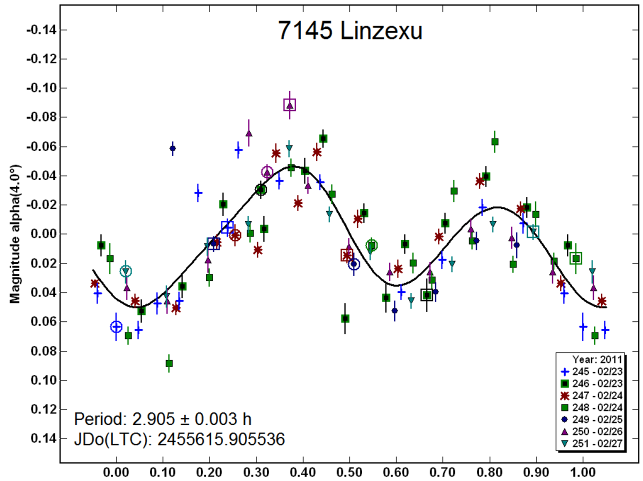

1598 Paloque
Magnitude alpha(7.0°)
Period: 5.9490 ± 0.0009 h
JDo(LTC): 2455656.872394

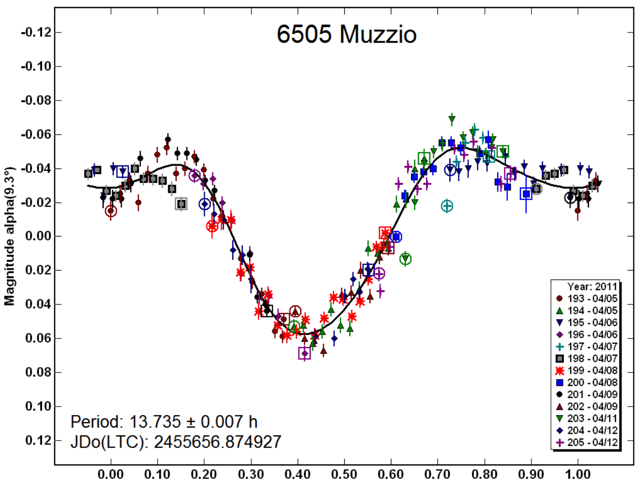

3001 Michelangelo
Magnitude alpha(8.0°)
Period: 8.338 ± 0.006h
JDo(LTC): 2455615.953260

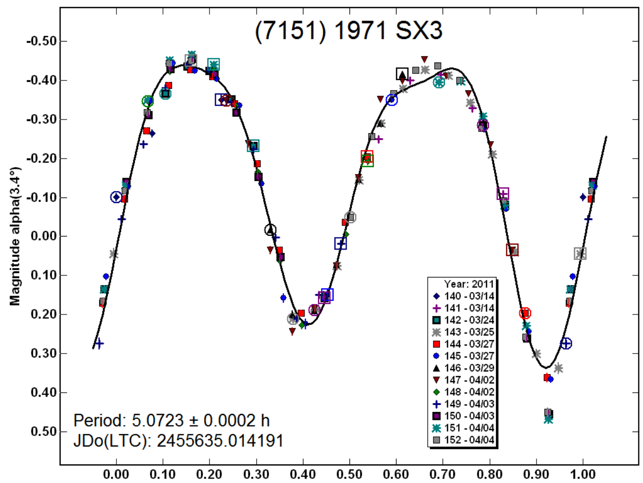

1716 Peter
Magnitude alpha(3.5°)
Period: 11.514 ± 0.002 h
JDo(LTC): 2455656.872689


3065 Sarahill
Magnitude alpha(4.4°)
Period: 7.4524 ± 0.0006 h
JDo(LTC): 2455644.966775


4175 Billbaum
Magnitude alpha(4.2°)
Period: 2.7425 ± 0.0009 h
JDo(LTC): 2455615.910049
Year: 2011
105 - 02/23
106 - 02/23
107 - 02/24
108 - 02/24
109 - 02/25
110 - 02/26
111 - 02/27


7145 Linzexu
Magnitude alpha(4.0°)
Period: 2.905 ± 0.003 h
JDo(LTC): 2455615.905536
Year: 2011
245 - 02/23
246 - 02/23
247 - 02/24
248 - 02/24
249 - 02/25
250 - 02/26
251 - 02/27


6505 Muzzio
Magnitude alpha(9.3°)
Period: 13.735 ± 0.007 h
JDo(LTC): 2455656.874927
Year: 2011
193 - 04/05
194 - 04/05
195 - 04/06
196 - 04/06
197 - 04/07
198 - 04/07
199 - 04/08
200 - 04/08
201 - 04/09
202 - 04/09
203 - 04/11
204 - 04/12
205 - 04/12


(7151) 1971 SX3
Magnitude alpha(3.4°)
Period: 5.0723 ± 0.0002 h
JDo(LTC): 2455635.014191
Year: 2011
140 - 03/14
141 - 03/14
142 - 03/24
143 - 03/25
144 - 03/27
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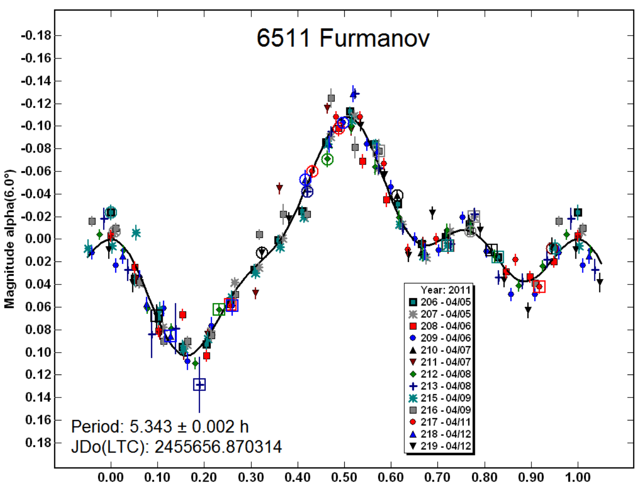
151 - 04/04
152 - 04/04


6511 Furmanov
Magnitude alpha(6.0°)
Period: 5.343 ± 0.002 h
JDo(LTC): 2455656.870314
Year: 2011
206 - 04/05
207 - 04/05
208 - 04/06
209 - 04/06
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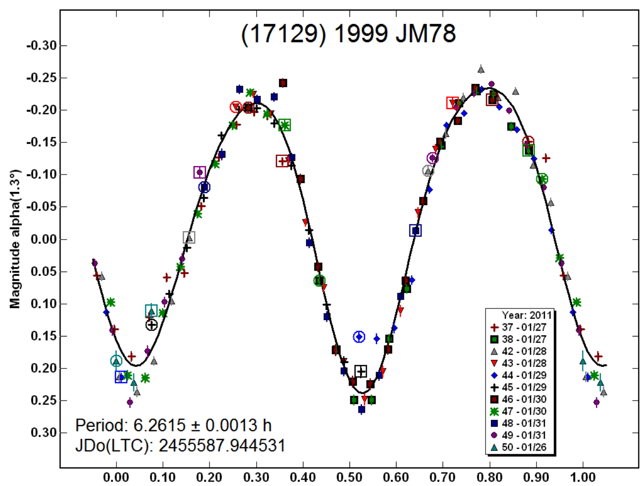
218 - 04/12
219 - 04/12


(17129) 1999 JM78
Magnitude alpha(1.3°)
Period: 6.2615 ± 0.0013 h
JDo(LTC): 2455587.944531
Year: 2011
37 - 01/27
38 - 01/27
42 - 01/28
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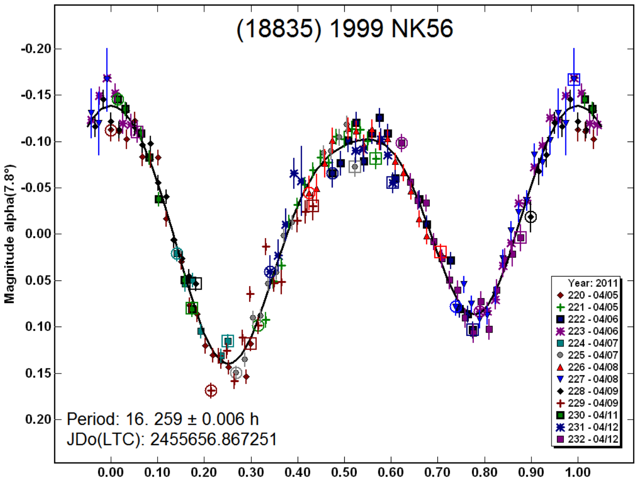
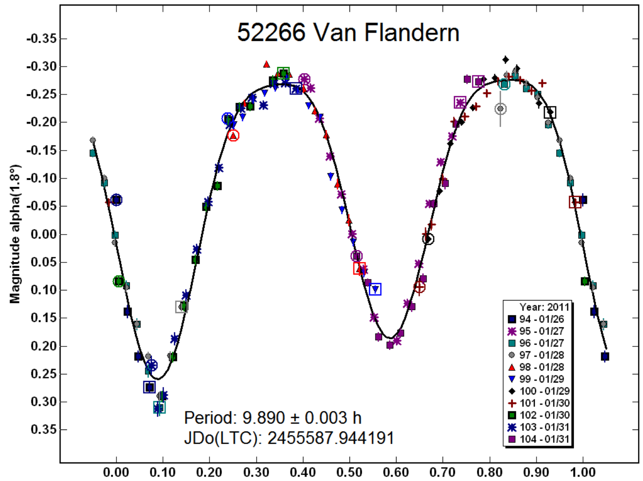
49 - 01/31
50 - 01/26





Number	Name	Dates 2011 mm/dd	Data Points	Period (h)	P.E (h)	Amp (mag)	A.E. (mag)
437	Rhodia	2/23-2/27	85	-	-	0.02	0.02
930	Westphalia	3/24, 3/25, 3/27, 3/29, 4/2-4/4	153	-	-	0.10	0.06
948	Jucunda	3/24, 3/25, 3/27, 3/29, 4/2-4/4	133	-	-	0.10	0.05
1129	Neujmina	3/24, 3/25, 3/27, 3/29, 4/2-4/4	162	5.0844	0.0006	0.20	0.04
1315	Bronislawa	2/23-2/27	94	9.565	0.006	0.16	0.02
1377	Roberbauxa	4/5-4/9, 4/11, 4/12	153	7.362	0.002	0.22	0.04
1598	Paloque	4/5-4/9, 4/11, 4/12	163	5.949	0.0009	0.33	0.05
1716	Peter	4/5-4/9, 4/11, 4/12	175	11.514	0.002	0.52	0.05
2107	Ilmari	2/23-2/27	83	-	-	0.06	0.04
2108	Otto Schmidt	3/24, 3/25, 3/27, 3/29, 4/2-4/4	167	-	-	0.08	0.04
2233	Kuznetsov	1/27-1/31	138	5.0304	0.0014	0.24	0.02
2290	Helffrich	1/26-1/31	155	-	-	0.10	0.08
3001	Michelangelo	2/23-2/27	78	8.338	0.006	0.14	0.02
3065	Sarahill	3/24, 3/25, 3/27, 3/29, 4/2-4/4	152	7.4525	0.0006	0.95	0.06
4175	Billbaum	2/23-2/27	91	2.7425	0.0009	0.14	0.02
4493	Naitomitsu	1/26-1/31	137	-	-	0.10	0.04
6505	Muzzio	4/5-4/9, 4/11, 4/12	178	13.735	0.007	0.10	0.03
6511	Furmanov	4/5-4/9, 4/11, 4/12	170	5.343	0.002	0.20	0.03
7145	Linzexu	2/23-2/27	92	2.905	0.003	0.10	0.03
7151	1971 SX3	3/14, 3/24, 3/25, 3/27, 3/29, 4/2-4/4	143	5.0723	0.0002	0.84	0.05
17129	1999 JM78	1/26-1/31	137	6.2615	0.0013	0.44	0.04
18835	1999 NK56	4/5-4/9, 4/11, 4/12	181	16.259	0.006	0.30	0.04
52266	Van Flandern	1/26-1/31	136	9.89	0.003	0.52	0.04

LIGHTCURVE ANALYSIS OF FIVE TAXONOMIC A-CLASS ASTEROIDS

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We report lightcurve rotational periods for five taxonomic A-class asteroids observed at the Evelyn L. Egan Observatory: 246 Asporina, 289 Nenetta, 446 Aeternitas, 1600 Vyssotsky, and the Mars-crosser 1951 Lick.

Taxonomic A-class asteroids are interpreted to be olivine-rich in mineralogy based on their strong infrared absorption feature at ~1.05 µm (Reddy et al., 2005). Photometric observations of five A-class objects were undertaken as part of a larger study (Lucas et al., 2010) to characterize the physical and geochemical properties of the rare A-class asteroids. Observations were collected at the Evelyn L. Egan Observatory (MPC code H72) on the campus of Florida Gulf Coast University (FGCU) in Fort Myers, Florida. Further details regarding the equipment and experimental methods can be found in Fauerbach and Bennett (2005). Data were analyzed with MPO Canopus Version 9, which employs synthetic aperture differential photometry to determine the values used for lightcurve analysis.

Our lightcurve rotational periods for the five objects are in reasonable agreement with previously derived rotational periods found and referenced from the Asteroid Lightcurve Database (LCDB). Observations collected at the Egan Observatory since 2006 October of 446 Aeternitas, which is one of the first spectrally recognized A-class objects, are being utilized to develop a shape model of this asteroid.

246 Asporina. The main-belt asteroid 246 Asporina was discovered 1885 March 06 by A. Borrelly at Marseilles. Asporina was observed during seven nights in 2009 April for a duration of ~27 hours (Table I). Twenty-three CCD exposures collected on the night of 2009 April 24 were removed from the lightvcurve solution due to cloud cover. 246 Asporina has a previously reported rotational period of 16.222 h with an amplitude of 0.44 mag (Harris and Young, 1983). Our result is in reasonable agreement to this period and with results from two other authors (Durech, 2006; Behrend, 2011). Our lightcurve of 246 Asporina has a best-fit period of 16.234 ± 0.001 h with an amplitude of ~0.25 mag.

289 Nenetta. The main-belt asteroid 289 Nenetta was discovered 1890 March 10 by A. Charlois at Nice. Nenetta was observed for two nights in 2010 December for a duration of ~10 hours (Table I). 289 Nenetta has a previously reported rotational period of 6.902 ± 0.001 h with an amplitude of 0.18 mag (Barucci et al., 1992). We derived a slightly longer period of 6.914 ± 0.003 h although the result is in reasonable agreement with results from Behrend (2011). Figure 1 shows the lightcurve of 289 Nenetta with a best-fit period of 6.914 ± 0.003 h with an amplitude of ~0.18 mag.

446 Aeternitas. The main-belt asteroid 446 Aeternitas was discovered on 1899 October 27 by M.F. Wolf and A. Schwassmann at Heidelberg. Aeternitas was observed during six nights in 2009 April for a duration of ~25 hours (Table 1). 446 Aeternitas has previously reported rotational periods of 15.85 ± 0.01 h (Florczak et al., 1997), 15.736 ± 0.001 h (Fauerbach et al., 2008), and 15.7413 ± 0.0004 h (Behrend, 2011). Our result is in excellent agreement with the latter two periods and we present the lightcurve of 446 Aeternitas with the best-fit period of 15.740 ± 0.003 h with an amplitude of ~ 0.40 mag. We have collected photometric data for 446 Aeternitas over three oppositions beginning in 2006 and shape modeling of this asteroid using lightcurve inversion techniques is forthcoming.

1600 Vyssotsky. The inner main-belt asteroid 1600 Vyssotsky was discovered 1947 October 22 by C. A. Wirtanen at Mount Hamilton. Vyssotsky was observed on the night of 2010 November 08 for a duration of ~4 hours (Table I) during which we were able to obtain coverage of slightly more than one rotational period. Because Vyssotsky has a relatively short rotational period, it has been a well studied object. Our derived period of 3.201 ± 0.005 h with an amplitude of ~0.21 mag is in excellent agreement with the period of 3.2011 ± 0.0004 h found by Warner et al. (2006) and also in excellent agreement with Warner (2011).

1951 Lick. The Mars-crossing asteroid 1951 Lick was discovered 1949 July 26 by C. A. Wirtanen at Mount Hamilton. Lick was observed over two nights in 2011 February for a duration of ~11 hours (Table I). 1951 Lick has a previously reported rotational periods of 5.3016 ± 0.0001 h (Pravec et al., 2011), and 5.2974 ± 0.0004 h (Warner, 2009). We derived a slightly longer period of 5.317 ± 0.001 h with an amplitude of ~0.33 mag.

#	Name	Date Range (yyyy-mm-dd)	Data Points	Phase Angle	L_{PAB}	B_{PAB}	Period (h)	PE (h)
246	Asporina	2009-04-23 to 2009-04-29	433	14.7 - 16.6	180.5 - 181.0	8.5 - 8.9	16.234	0.001
289	Nenetta	2010-12-10 to 2010-12-12	164	4.1 - 4.0	79.7 - 79.8	-8.5	6.914	0.003
446	Aeternitas	2009-04-23 to 2009-04-29	402	10.3 - 12.1	186.4 - 186.5	6.6 - 6.3	15.740	0.003
1600	Vyssotsky	2010-11-08	101	7.7	53.7	-6.1	3.201	0.005
1951	Lick	2011-02-26 to 2011-02-27	144	35.3 - 35.8	116.9 - 117.1	5.1 - 5.7	5.317	0.001

Table I – Observational circumstances for five A-class asteroids.

Acknowledgements

The authors would like to acknowledge the Florida Space Grant Consortium (FSGC) for a Space Grant Fellowship (M.S.) to Lucas and undergraduate internship funding to Grasso. The authors would also like to acknowledge the Geological Society of America (GSA) for a Graduate Student Research Grant (2010-2011) to Lucas.

References

Barucci, M.A.; Di Martino, M.; Fulchignoni, M. (1992). "Rotational Properties of Small Asteroids: Photometric Observations." *The Astronomical Journal* v. 103, pp. 1679-1686.

Behrend, R. (2011). Observatoire de Genève website, *http://obswww.unige.ch/~behrend/page_cou.html*

Durech, J. (2006). "Asteroid brightness and geometry." *International Astronomical Union (IAU)* poster paper.

Fauerbach, M. and Bennett, T. (2005). "First Photometric Lightcurve Observations from the Evelyn L. Egan Observatory." *The Minor Planet Bulletin* v. 32, no. 2, pp. 34-35.

Fauerbach, M., Marks, S.A., and Lucas, M.P. (2008). "Lightcurve Analysis of Ten Main Belt Asteroids." *The Minor Planet Bulletin* v. 35, no. 2, pp. 44-46

Florczak, M., Dotto, E., Barucci, M.A., Birlan, M., Erikson, A., Fulchignoni, M., Nathues, A., Perret, L., and Thebault, P. (1997). "Rotational Properties of main belt asteroids: photoelectric and CCD observations of 15 objects." *Planet. Space Sci.* v. 45, no. 11, pp. 1423-1435

Harris, A.W. and Young, J.W. (1983). "Asteroid Rotation IV. 1979 Observations." *Icarus* v. 54, pp. 51-109

Lucas, M.P., Ryan, J., and Fauerbach, M. (2010). "The Missing Mantle of the Asteroid Belt: Physical and Geochemical Properties of Taxonomic A-class Asteroids." (182405). *GSA Abstracts with Programs* v. 42, no. 5, pp. 601

Pravec, P., Wolf, M., and Sarounova, L. (2011) Ondrejov Asteroid Photometry Project website,
http://www.asu.cas.cz/~ppravec/neo.htm

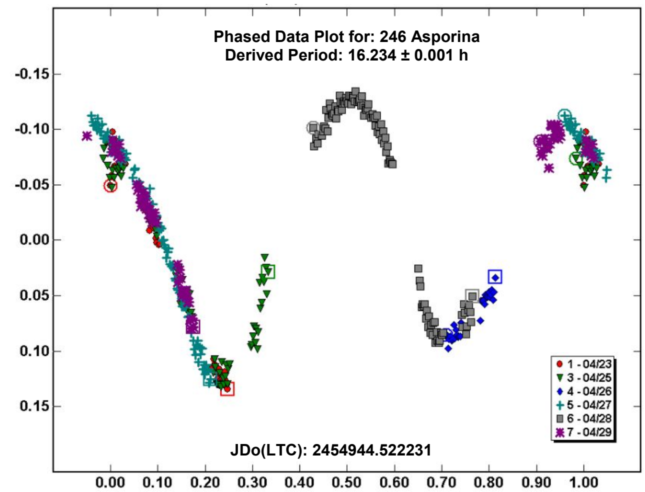
Reddy, V., Hardersen, P.S., Gaffey, M.J., and Abell, P.A. (2005.) "Mineralogic and Temperature-Induced Spectral Investigations of A-type Asteroids 246 Asporina and 446 Aeternitas." *Lunar and Planetary Science XXXVI*, Abstract no. 1375

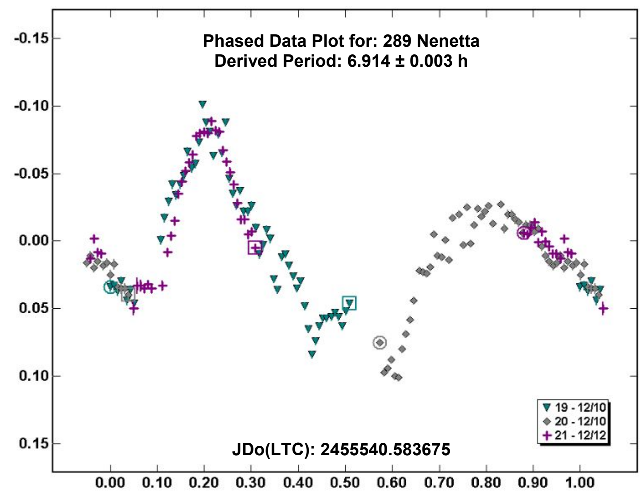
Warner, B.D. (2011). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2010 September–December." *The Minor Planet Bulletin* v. 38, no. 2, pp. 82-86

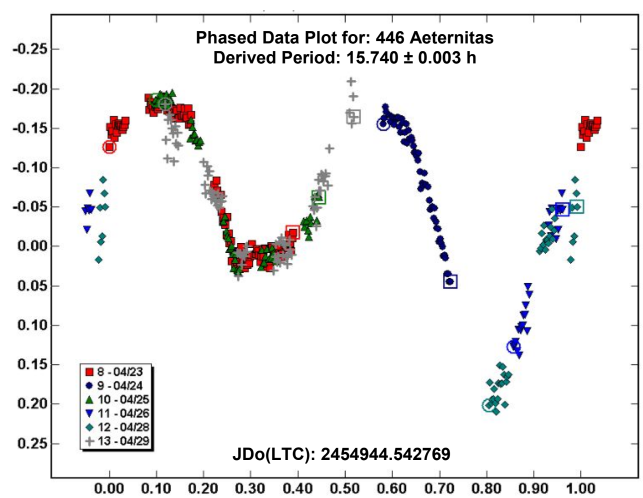
Warner, B.D., Harris, A.W., and Pravec, P. (2011) Asteroid Lightcurve Database, 2011 March
http://www.minorplanet.info/lightcurvedatabase.html)

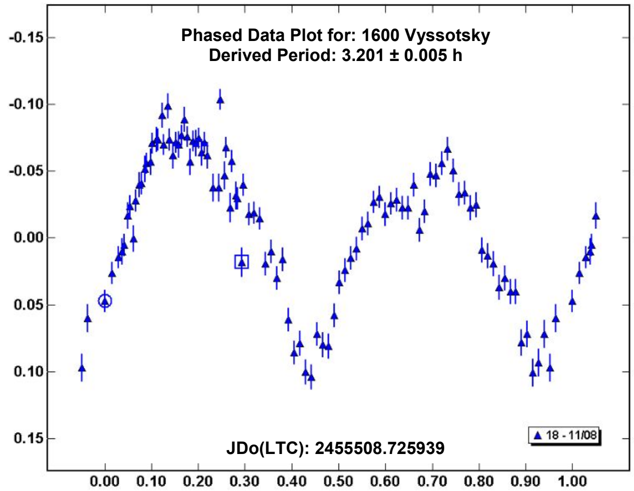
Warner, B.D. (2009) "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2008 May – September." *The Minor Planet Bulletin* v. 36, no. 1, pp. 7-13

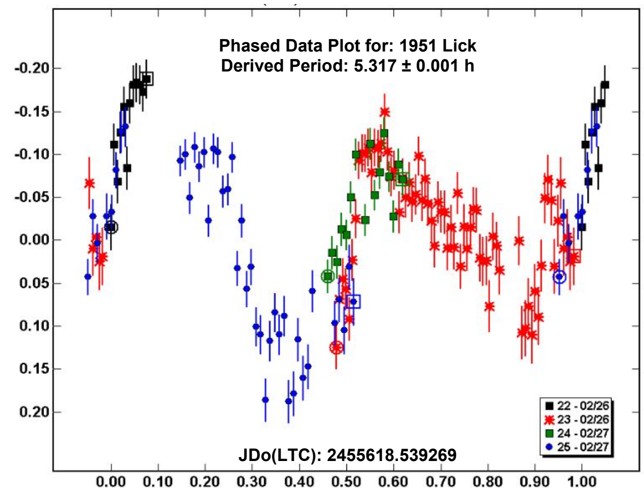
Warner, B.D., Pray, D.P., Dyvig, R., and Reddy, V. (2006). "Lightcurve for Hungaria Asteroid 1600 Vyssotsky Over Several Apparitions." *The Minor Planet Bulletin* v. 33, no. 2, pp. 45-46.











CALL FOR LIGHTCURVES: FAST FLYBY OF NEAR-EARTH ASTEROID 2005 YU55

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As noted in the Photometry Opportunities article (this issue), on November 8, 2011 at 23:28 UT the approximately 400-meter C-type asteroid 2005 YU55 will pass inside the Moon's orbit at 0.0022 AU (85% of the Earth-Moon distance) and reach a brightness of V~11. Such an encounter for an asteroid of this size occurs but once every few decades and thus enables a host of exciting and novel scientific investigations. To capitalize upon this opportunity, the professional community will employ a suite of visible through mid-infrared (0.5 - 26 μm) spectrographs at observatories in Arizona, California and Hawaii. The aims of this project include an improved understanding of the relationship between interpreted mineralogy and observing geometry, the first ever detailed study of a primitive C-type asteroid <5 km in size, and an investigation into rotational variability of surface properties such as thermal inertia and composition. Co-investigators in this campaign are Lucy Lim (NASA/GSFC), Bin Yang (Univ. Hawaii), Scott Sheppard (Carnegie DTM), Mark Willman (Univ. Hawaii), Josh Emery (Univ. Tennessee) and Ed Cloutis (Univ. Winnipeg).

Though the focus of this campaign is spectroscopic in nature, its success will depend on complementary visible-wavelength observations. Knowledge of the visible magnitudes will be essential for constraining the albedo and thermophysical properties of the asteroid's surface. Furthermore, an optical lightcurve will help to determine 2005 YU55's rotational phase for all measurements – critical for revealing longitudinal variations in surface properties. As the rotation period is currently believed to be approximately 18 hours, complete lightcurve coverage will require a nearly global network during the few days of closest encounter. In addition to photometry, astrometry uploaded to the Minor Planet Center as soon as the asteroid becomes accessible will be critical for constraining the asteroid ephemeris a few hours later at the time of closest encounter. Many of the planned experiments critically depend on the most accurate up-to-the-moment ephemeris available. Therefore, we encourage contributions from the community that will help constrain the absolute magnitude, light curve amplitude, rotation period, as well as astrometry of 2005 YU55.

The greatest challenge of these observations will be the fast non-sidereal motion of 2005 YU55. At closest approach the asteroid will be moving at nearly 9 arcseconds/sec. Twenty-four hours later, it will still be moving at almost 1 arcsecond/sec. At such rates differential photometry using background field stars is unlikely to be a feasible observing strategy. After approximately 19:00 UT on November 8, the asteroid will pass into regions covered by the Sloan Digital Sky Survey, thereby allowing photometric calibration through intermittent, sidereal observations of SDSS field stars.

Observers interested in contributing to this campaign for the composite of a complete lightcurve may contact Brian Warner at the email address above. The goal of the campaign is to provide the most complete composite lightcurve possible that will be extensively referenced by the research community in their detailed scientific analysis. The science goals of this project will require photometric precision of roughly 0.03 magnitudes or better. Observers willing to contribute to this campaign will be free to use or post their data elsewhere, as they may wish.

LIGHTCURVE ANALYSIS OF ASTEROIDS FROM LEURA AND KINGSGROVE OBSERVATORY FOR THE SECOND HALF OF 2009 AND 2010

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Photometric observations of the following asteroids were made from both Kingsgrove and Leura Observatories for the remaining half of 2009 and 2010: 1194 Aletta (20.390 ± 0.007 h); 1685 Toro (10.203 ± 0.003 h); 2897 Ole Romer (2.6004 ± 0.0002 h); 4283 Stoffler (133 ± 1 h); 6961 Ashitaka (3.1461 ± 0.0002 h); (10357) 1993 SL3 (2.763 ± 0.002 h); (14133) 1998 RJ17 (5.24009 ± 0.00008 h); (55760) 1992 BL1 (8.0813 ± 0.0004 h); (131702) 2001 YZ3 (4.920 ± 0.004 h); and 2001 FE90 (0.47713 ± 0.00009 h).

CCD photometric observations of ten asteroids were made at the Kingsgrove and Leura Observatories in Australia in 2009 and 2010. Kingsgrove used a 0.25-m f/11 Schmidt-Cassegrain (SCT) with a self-guiding ST-9XE SBIG CCD camera operating at 1x1 binning. This gave a resolution of 1.45 arcsec/pixel. Unless otherwise noted, exposures were 300 seconds unfiltered. The selection of targets was mainly from the lists on the the CALL website (Warner, 2008) with the criteria being an average magnitude during closest approach of V 13-14 and a relatively southerly declination. Leura observatory used a 0.35-m SCT and SBIG CCD camera operating at 1x1 binning. The resolution was 0.77 arcsec/pixel. All images were unfiltered at 300 seconds. This telescope was used mainly on fainter targets selected from Photometric Survey for Asynchronous Binary Asteroid (PSABA) for follow-up and detection work coordinated by Pravec (2011). Additional information about the instruments and operations at the two observatories can be found on the author's web site (Oey, 2011). *MPO Canopus* V.10.2.0.1, which incorporates the Fourier algorithm developed by Harris (1989), was used to measure the images and do period analysis.

1685 Toro. This asteroid has been observed in the past, most recently by Higgins (2011), where he derived a period of 10.199 h. This closely matches the period of 10.203 ± 0.003 h found here.

1194 Aletta. Brinsfield (2008) obtained a period of 19.7 ± 0.1 for this asteroid. The current observations found a different period of 20.390 ± 0.007 h, which is statistically different from the earlier result.

2897 Ole Romer. This asteroid was selected through the binary asteroids program (Pravec, 2011) as one member of an asteroid pair, two asteroids possibly derived from the same parent object and in very similar heliocentric orbits but not around one another. Observations were made 2010 May and June. The data were of lower quality and the amplitude was low, ~0.06 mag, making for a less than certain period result.

4283 Stoffler was selected from the list on the CALL website. Initially the data were reduced by using differential photometry without the use of Comp Star Selector (CSS) method in *MPO Canopus* software. However due to the scarcity and quality of data, it was not easy to identify a unique lightcurve. The best that could be obtained was a long period bimodal lightcurve with a period of 154h. At the time, the CSS method was just introduced in the version of *MPO Canopus* that was used. Subsequent re-reduction using the CSS method eliminated the possibility of a large-amplitude, long-period nature. Instead a very low amplitude monomodal lightcurve that indicated a polar aspect was found. The period was found to be 14.59 ± 0.01 h with an amplitude of 0.10 ± 0.05mag. The observations by Warner (2006) differ in both period and amplitude. With such differences in the results, Warner was contacted and his data were re-analyzed with the CSS method. The revision resulted in a period of 136 ± 1h for the Warner (2006) data. Presented with this latest revelation, a search of Oey's recent data provided 2 possible solutions of near 88h and 133h where the latter being close to the revision result above. The PAB longitude for both observations were nearly 90 degrees different hence the reason for such difference in amplitude suggesting a nearly perpendicular to orbit polar orientation. The shorter period of 14.59h was therefore discarded in favor of the long period. The final analysis shows that when sparse low quality data were used, fourier analysis tends to latch on to noise (Warner, private communication). None of the available data are able to show that the asteroid is a tumbler which is common among slow rotators. Future more thorough observations will be needed to determine the true nature of 4283 Stoffler.

(10357) 1993 SL3. The CSS utility in *MPO Canopus* was not available due to the loss of data. Therefore, it's possible that this could be a long period asteroid.

(14133) 1998 RJ17. This was a binary asteroid candidate target selected for PSABA. The lightcurve show large 1.15 magnitude amplitude with no signs of deviations that could have indicated it was a binary.

Name	Date (20yy/mm/dd)	Obs	Period (h)	Amp (mag)	PA	LPAB	BPAB
1194 Aletta	10/08/03-10/19/03	K	20.390 ± 0.007	0.28 ± 0.03	6	169	-12
1685 Toro	10/04/20-10/05/10	K	10.203 ± 0.003	0.60 ± 0.05	12,8,9	222	-11
2897 OleRomer	10/05/06-10/06/10	L	2.6004 ± 0.0002	0.07 ± 0.02	7,1,11	238	-1
4283 Stoffler	10/03/08-10/03/25	K	133. ± 1	0.10 ± 0.05	8,14	167	-14
6961 Ashitaka	10/03/15-10/04/14	K	3.1461 ± 0.0002	0.15 ± 0.02	16,2,3	199	-3
(10357) 1997 SL3	10/09/11-10/09/17	K	2.762 ± 0.002	0.05 ± 0.04	12	353	-16
(14133) 1998 RJ17	10/12/31-11/01/29	L	5.24008 ± 0.00007	1.15 ± 0.02	13,10,12	113	-14
(55760) 1992 BL1	09/11/21-09/12/16	K	8.0813 ± 0.0004	0.32 ± 0.03	32	50	-36
(131702) 2001 YZ3	10/01/09-10/01/22	L	4.92 ± 0.01	0.10 ± 0.05	20	126	-18
2001 FE 90	09/07/01	K	0.47713 ± 0.00009	0.80 ± 0.03	10,13	278	-4

Table 1. Observatory Code: K= Kingsgrove Observatory, L= Leura Observatory

References

Brinsfield J. W. (2008). “The Rotation Periods of 531 Zerlina, 1194 Aleta, 1352 Wawel, 2005 Hencke, 2648 Owa, and 3509 Sanshut”. *Minor Planet Bulletin* ***35***, 86-87.

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

Higgins D. (2011). “Period Determination of Asteroid Targets Observed at Hunters Hill Observatory: May 2009 – September 2010.” *Minor Planet Bulletin* ***38***, 41-46.

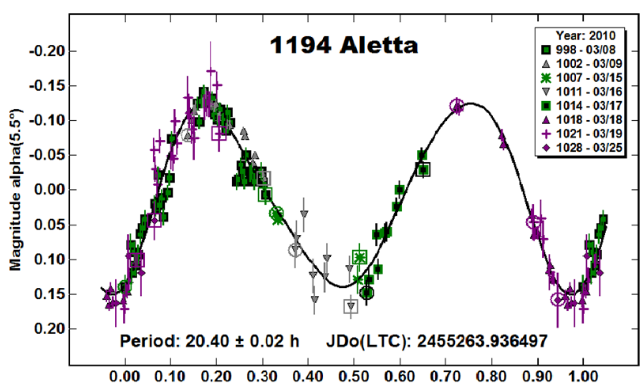
Oey, J. (2008). “Lightcurve Analysis of Asteroids from Kingsgrove and Leura Observatories in the 2nd half of 2007.” *Minor Planet Bul.* ***35,*** 132 – 135.

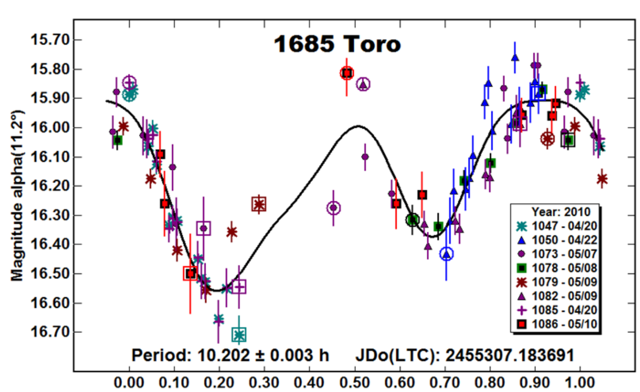
Oey, J. (2011). Leura Observatory Minor Planet website *http://minorplanet.haoeydental.com.au/index.htm*

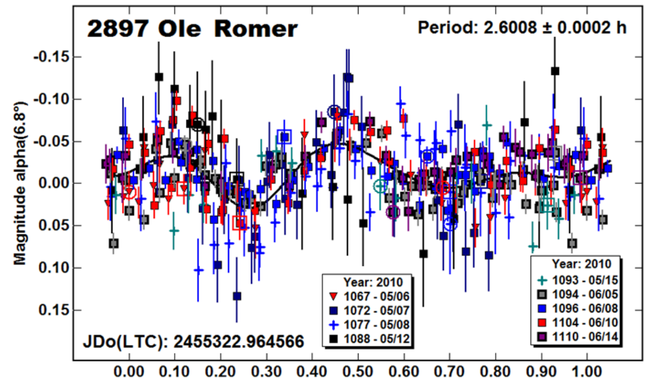
Pravec, P. (2011). Photometric Survey of Asynchronous Binary Asteroids website. *http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm*

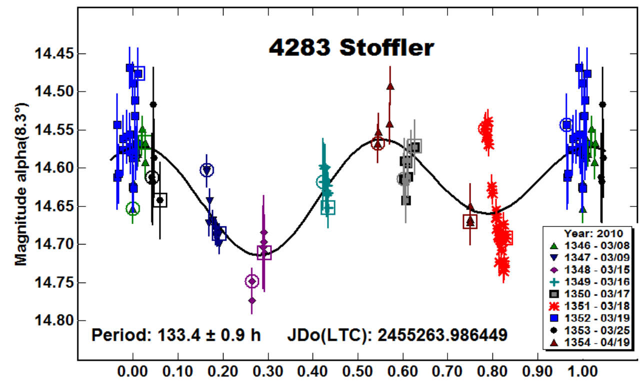
Warner, B.D. (2006). “Asteroid Lightcurve Analysis at the Palmer Divide Observatory – Late 2005 and Early 2006.” *Minor Planet Bul.* **33**, 58-62.

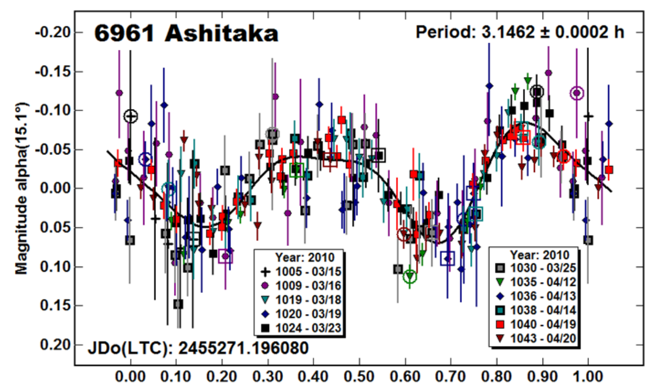
Warner, B.D. (2008). “Potential Lightcurve Targets 2008 July–September.” *http://www.minorplanetobserver.com/astlc/targets_4q_2008.htm*

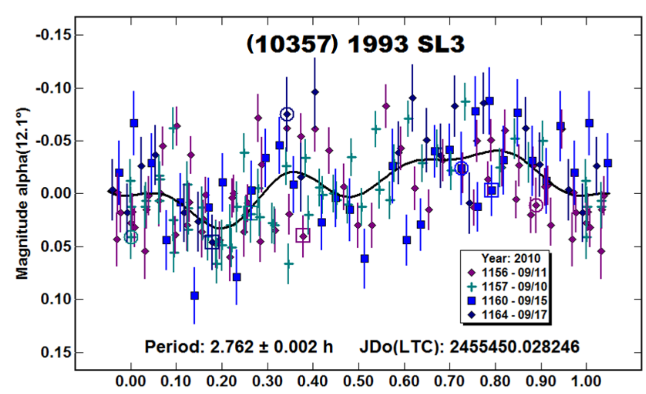


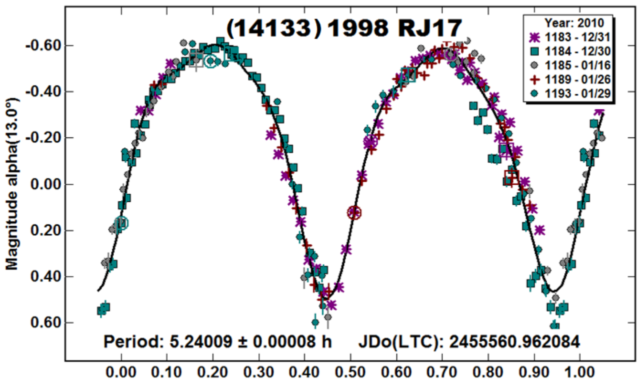


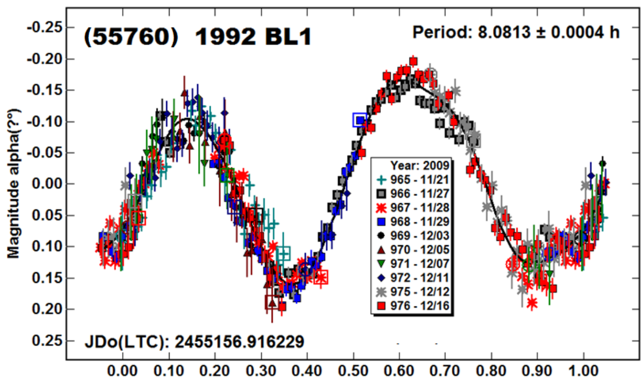


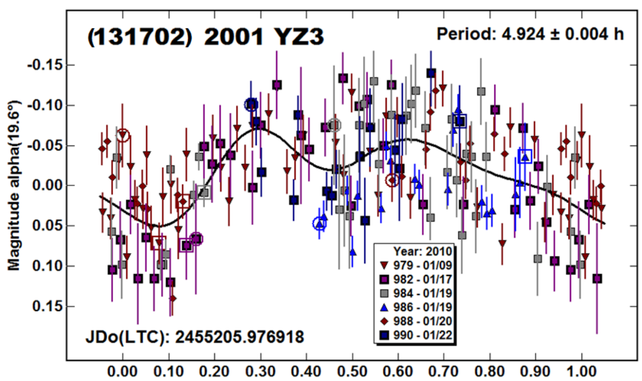


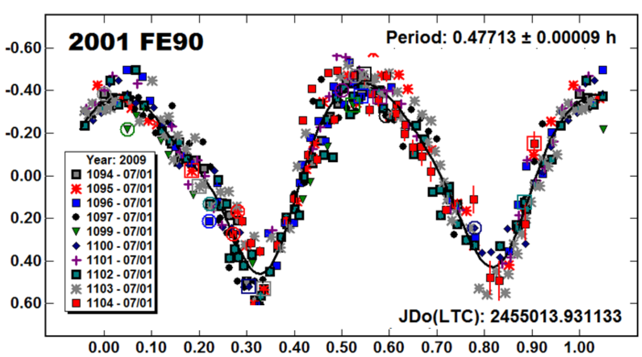












LIGHTCURVE DETERMINATION OF 3151 TALBOT AND 4666 DIETZ

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CCD photometry observations of 3151 Talbot and 4666 Dietz were obtained at the Bigmuskie Observatory, Italy, during 2011 June and July. Analysis found a rotation period of 19.49 ± 0.01 h for 3151 Talbot and a period of 2.953 ± 0.003 h for 4666 Dietz.

During 2011 June and July, the Bigmuskie Observatory worked to obtain the lightcurve for two asteroids, 3151 Talbot and 4666 Dietz. Both targets were chosen from the potential lightcurve targets listed in the *Minor Planet Bulletin* (Warner *et al.* 2011) because no previous period was reported. Due to equipment failure, observations did not start until late June, by which time both asteroids were rather faint and so the data were noisier than hoped.

Both asteroids were observed with the same equipment: a Marcon 0.3m f/8 Ritchey-Chretien reflector with an SBIG ST-9 CCD. This provided a field of about 15x15 arcmin and a resolution of 1.7 arcsec/pixel. Exposure times were 240 sec with an Rc filter. No external guiding was used. However, tracking was under the control of the Telescope Drive Master (TDM), a very precise encoder that maintains the sidereal tracking error to about 1 arcsec. *CCDsoft* V5 was used to control the CCD camera. All images were calibrated and measured with *MPO Canopus*. The Comp Star Selector utility in *MPO Canopus* was used to link the sessions to a common zero point, with the largest error being on the order of ± 0.05 mag.

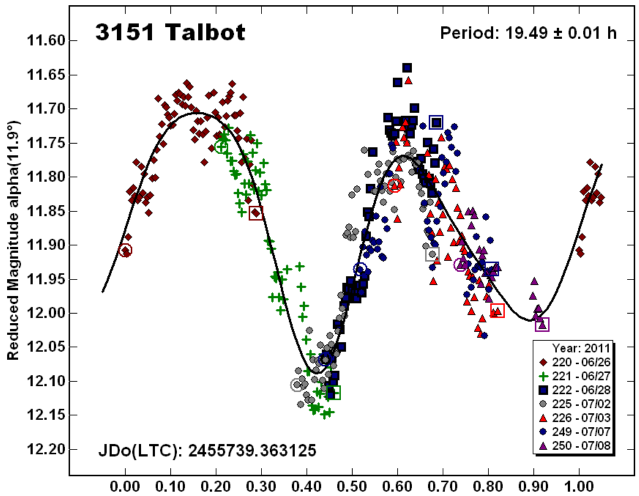
3151 Talbot Seven sessions were necessary to reach the final period of 19.49 ± 0.01 h. The amplitude was 0.4 mag. The portion of the lightcurve between phase 0.80 and 1.00 was affected by some clouds, leaving a small gap in the curve. From this session on, sky conditions and the very low brightness of the target led to the decision that was useless to continue observing the asteroid for the sole purpose of filling in the missing portion of the lightcurve.

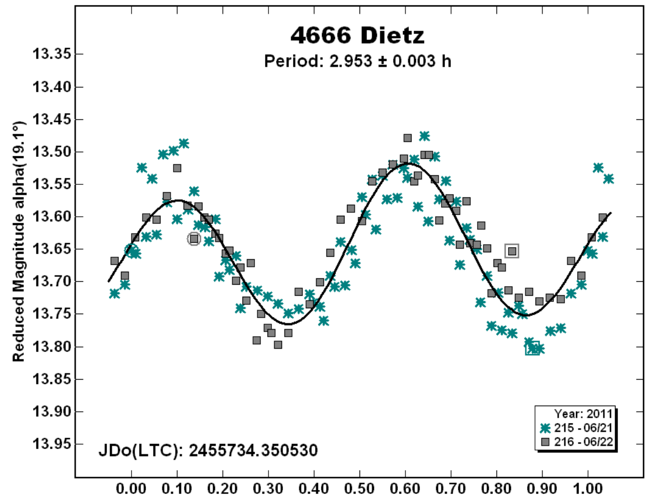
4666 Dietz Due to the fast rotation of this asteroid, evident from the first night of observations, the period was determined using only two consecutive sessions. The result was a classical bimodal curve with a period of 2.953 ± 0.003 h and an amplitude of 0.25 mag.

References

Warner, B.D. (2008). MPO Software, Canopus version 10.1.0.6. Bdw Publishing, Colorado Springs, CO.

Warner, B.D., Harris A. W., Pravec, P., Durech J., and Benner L. A.M. (2011). "Lightcurve Photometry Opportunities: 2011 April – June." *Minor Planet Bul.* **38**, 121-125.





LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2011 OCTOBER-DECEMBER

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We present lists of asteroid photometry opportunities for objects reaching a favorable apparition and have 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 October-December. 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_Q4.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 8000. 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.

The ephemeris listings for the optical-radar listings 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. 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

		Brightest				LCDB Data	
#	Name	Date	Mag	Dec	U	Period	Amp
6528	Boden	10 01.8	15.0	+05			
3366	Godel	10 01.3	14.9	+01			
1913	Sekanina	10 01.8	14.8	+04			
2913	Horta	10 04.8	14.8	-06			
1786	Raahe	10 04.8	14.7	+03			
16959	1998 QE17	10 04.0	14.7	+14	1+	6.31	0.30
18488	1996 AY3	10 05.6	15.0	-18			
1896	Beer	10 07.3	14.7	+05			
2237	Melnikov	10 07.3	14.8	+02			
20932	2258 T-1	10 08.1	14.5	+02			
2574	Ladoga	10 09.0	14.6	+06			
59402	1999 FR32	10 09.3	14.6	+01			
2783	Chernyshevskij	10 10.6	15.0	+07			
1285	Julietta	10 10.1	14.6	+13	1	20.3	0.07-0.23
1536	Pielinen	10 10.7	13.3	+07			
10400	Hakkaisan	10 11.9	14.7	+03			
24694	1990 SZ2	10 11.8	15.0	+06			
4274	Karamanov	10 13.8	14.6	+11			
3032	Evans	10 14.6	14.8	+04			
23276	2000 YT101	10 16.0	15.0	-09			
1599	Giomus	10 16.7	14.4	+ 6	1	6.46	0.40
9006	Voytkevych	10 16.6	14.8	-09			
1123	Shapleya	10 16.7	13.3	-02	2	> 20.	>0.28
13923	Peterhof	10 16.2	15.0	-09			
2978	Roudebush	10 17.4	14.8	+10			
7143	Haramura	10 17.0	14.9	+13			
2423	Ibarruri	10 17.7	13.8	+18			
2870	Haupt	10 17.4	14.2	+02			
1573	Vaisala	10 18.3	13.2	+08			
4339	Almamater	10 18.9	14.7	+14			
4962	Vecherka	10 19.1	14.5	+11			
18595	1998 BR1	10 19.6	14.5	+06			
5425	Vojtech	10 20.7	15.0	+16			
1136	Mercedes	10 21.0	12.4	+11	2	24.64	0.05-0.15
724	Hapag	10 21.1	14.3	+09			
1577	Reiss	10 21.7	14.5	+02			
957	Camelia	10 22.4	13.5	+20	1+	150.	>0.30
2428	Kamenyar	10 22.8	14.9	+16			
4804	Pasteur	10 23.3	14.9	-02			
3990	Heimdal	10 24.6	14.8	+08			
1201	Strenua	10 24.9	14.6	+10	2	14.77	0.30
5682	Beresford	10 25.4	13.8	+13	2	7.53	0.20
735	Marghanna	10 25.9	11.2	+06	2	15.95	0.11
622	Esther	10 27.2	11.8	-04	2	47.5	0.57
2162	Anhui	10 28.7	14.7	+07			
4438	Sykes	10 28.8	14.7	+05			
3080	Moisseiev	10 29.9	13.8	+08			
12808	1996 AF1	10 30.3	15.0	-04			
14495	1995 AK1	10 30.2	14.5	-02	2+	8.8	0.27
15070	1999 BK8	10 31.3	14.9	+10			
965	Angelica	10 31.9	12.7	+11	2	17.77	0.06
2027	Shen Guo	11 01.5	14.5	+09			
2819	Ensor	11 02.4	14.6	+16			
3811	Karma	11 02.5	14.4	+30	2	11.52	0.20
3384	Daliya	11 02.0	15.0	+09			
1237	Genevieve	11 03.7	13.6	+10	2-	16.37	0.23
200	Dynamene	11 04.4	11.2	+26	2	19.	0.10
4312	Knacke	11 06.5	15.0	+10			
4363	Sergej	11 07.9	14.7	+05			
3672	Stevedberg	11 07.3	14.7	+23			
1175	Margo	11 07.7	14.2	+21	2	6.01	0.22-0.40
9877	1993 ST3	11 08.9	15.0	+17			
14379	1989 UM4	11 09.4	14.6	+14			
24260	Krivan	11 11.2	14.9	+20			
6200	Hachinohe	11 11.2	14.6	+16			
2538	Vanderlinden	11 13.1	14.5	+18			
613	Ginevra	11 13.7	13.4	+28	1	16.45	0.63
1438	Wendeline	11 14.9	14.4	+19			
1665	Gaby	11 16.5	13.9	+05	2	66.	0.27
8487	1989 SQ	11 16.4	14.7	+27			
2909	Hoshi-no-ie	11 17.6	14.7	+10			
696	Leonora	11 20.8	12.2	+39	2	17.98	0.10
1284	Latvia	11 21.9	12.9	+37	2	9.64	0.21
10940	1999 CE52	11 21.9	15.0	+19			
6887	Hasuo	11 22.8	15.0	+22			
16666	Liroma	11 24.8	13.6	+19			
26514	2000 CH48	11 25.9	14.8	+09			
5287	Heishu	11 25.1	14.9	+09			
6311	Porubcan	11 26.3	14.8	+32			
1045	Michela	11 26.0	14.4	+21			
1479	Inkeri	11 26.4	13.9	+30	1	5.	0.05
5143	Heracles	12 01.1	12.8	+47			
1028	Lydina	12 02.2	13.5	+24	2	15.69	0.7
170502	2003 WM7	12 04.7	14.8	+40			
548	Kressida	12 04.8	12.5	+17	2	11.94	0.44
2757	Crisser	12 05.8	14.3	+23			
12738	Satoshimiki	12 07.0	15.0	-03			
2828	Iku-Turso	12 07.0	15.0	+22			
6823	1988 ED1	12 07.3	14.5	+16	2+	2.54	0.10
9851	Sakamoto	12 07.8	14.4	+27			
1940	Whipple	12 08.0	14.7	+24	2	5.78	0.15
5352	Fujita	12 10.8	14.5	+23			
96487	1998 JU1	12 11.9	15.0	-18			
2087	Kochera	12 11.0	15.0	+22			
6306	Nishimura	12 12.5	14.3	+21			
9033	Kawane	12 12.4	15.0	+13			
24475	2000 VN2	12 13.2	14.5	+14			
2439	Ulugbek	12 13.7	14.9	+23			
1814	Bach	12 13.8	14.7	+31			
3899	Wichterle	12 16.0	14.5	+23			
10363	1994 UP11	12 16.0	15.0	+24			
3550	Link	12 16.7	14.9	+25	2	81.	0.39
9083	Ramboehm	12 18.4	14.9	+25			
4808	Ballaero	12 22.8	14.6	+34			
2774	Tenojoki	12 23.3	15.0	+28	2+	11.2	0.30
15243	1989 TU1	12 23.2	14.9	+21			

Lightcurve Opportunities (cont'd)

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
8609	Shuvalov	12 23.5	14.7	+12			
16058	1999 JP75	12 24.8	14.7	+27			
2496	Fernandus	12 24.5	15.0	+22			
1143	Odysseus	12 26.3	14.3	+20	2	10.12	0.11-0.16
8345	Ulmerspatz	12 29.0	13.5	+24			
2564	Kayala	12 30.1	14.8	+20			

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp	U
1188	Gothlandia	10 01.9	0.30	12.3	+04	3.493	0.68	3
388	Charybdis	10 03.0	0.88	12.4	+06	9.516	0.14-0.25	3
34	Circe	10 10.7	0.63	12.3	+05	12.15	0.17-0.24	3
1536	Pielinen	10 10.7	0.21	13.4	+07			
1046	Edwin	10 10.9	0.47	13.9	+08	5.2906	0.16-0.27	3
904	Rockefellia	10 12.0	0.04	13.6	+07	4.93	0.18	3
300	Geraldina	10 15.5	0.19	13.6	+08	6.8423	0.15-0.32	3
453	Tea	10 16.8	0.78	13.3	+11	6.812	0.30	3
1518	Rovaniemi	10 17.8	0.49	13.8	+08	5.249	0.25	3
1136	Mercedes	10 21.1	0.40	12.5	+11	24.64	0.05-0.15	2
180	Garumna	10 22.6	0.50	13.8	+12	23.859	0.56	2
1072	Malva	10 24.0	0.68	13.4	+10	10.080	0.17-0.3	3
23200	2000 SH3	10 25.2	0.23	13.6	+12	16.22	0.42	3
5682	Beresford	10 25.5	0.36	13.9	+12	7.536	0.20	2
680	Genoveva	10 28.5	0.59	13.7	+11	11.0905	0.27	2+
551	Ortrud	11 01.6	0.19	12.8	+15	13.05	0.16	3
797	Montana	11 04.7	0.76	13.8	+17	4.5463	0.32-0.50	3
1071	Brita	11 09.9	0.35	13.4	+16	5.8169	0.20-0.38	3
311	Claudia	11 10.6	0.92	13.7	+14	7.532	0.16-0.89	3
68	Leto	11 11.1	0.40	9.6	+18	14.848	0.15-0.53	3
270	Anahita	11 12.2	0.93	10.6	+19	15.06	0.25-0.34	3
701	Oriola	11 22.1	0.27	13.4	+21	9.090	0.20	3
16666	Liroma	11 24.8	0.86	13.7	+19			
976	Benjamina	11 26.7	0.12	13.9	+21	9.746	0.18	3-
1028	Lydina	12 02.2	0.53	13.5	+24	15.69	0.7	2
131	Vala	12 02.6	0.27	13.2	+23	5.1812	0.09-0.28	3
420	Bertholda	12 02.8	0.37	12.9	+21	11.04	0.29	3
215	Oenone	12 04.4	0.69	13.2	+24	>20.	0.1	2
380	Fiducia	12 11.2	1.00	12.9	+20	13.69	0.20-0.32	3
261	Prymno	12 12.5	0.80	11.9	+21	8.002	0.20	3
198	Ampella	12 13.7	0.93	10.8	+25	20.778	0.03-0.22	3
177	Irma	12 23.2	0.96	12.2	+26	14.208	0.37	2
678	Fredegundis	12 23.7	0.92	11.2	+25	11.61624	0.27	3
259	Aletheia	12 26.0	0.51	12.6	+25	8.143	0.12	3
8345	Ulmerspatz	12 29.1	0.29	13.5	+24			

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 Date	Mag	Dec	LCDB DATA Period	Amp	U
27	Euterpe	10 04.3	9.3	+01	10.410	0.15-0.21	3
154	Bertha	10 14.3	12.5	-01	22.30	0.04-0.20	2
230	Athamantis	10 23.8	9.8	+19	24.0055	0.1 -0.26	3
105	Artemis	11 03.3	12.5	-02	37.15506	0.09-0.17	3
200	Dynamene	11 04.4	11.2	+26	19.	0.10	2
40	Harmonia	11 12.1	9.3	+12	8.910	0.13-0.36	3
976	Benjamina	11 26.7	13.8	+21	9.746	0.18	3-
420	Bertholda	12 02.8	12.8	+21	11.04	0.29	3
70	Panopaea	12 31.	12.8	+35	15.797	0.06-0.12	3
153	Hilda	12 31.	13.7	+14	5.9587	0.05-0.20	3
204	Kallisto	12 31.	13.3	+11	19.489	0.09-0.26	3
466	Tisiphone	12 31.	12.9	+28	8.824	0.16	3
757	Portlandia	12 31.	13.4	+30	6.5837	0.24-0.45	3

Inversion Modeling Candidates

#	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
1188	Gothlandia	10 01.9	12.3	+04	3.493	0.68	3
1495	Helsinki	10 13.2	14.9	+10	5.33116	0.61-0.83	3
351	Yrsa	10 13.4	13.0	-06	13.29	0.42	3
622	Esther	10 27.2	11.7	-04	47.5	0.57	2
272	Antonia	10 31.2	14.1	+14	3.8548	0.43	3
281	Lucretia	11 04.2	13.3	+17	4.348	0.38	3
700	Auravictrix	11 07.6	14.2	+07	6.075	0.42	3
1282	Utopia	11 09.5	14.0	+43	13.623	0.28-0.36	3
270	Anahita	11 12.0	10.6	+19	15.06	0.25-0.34	3
564	Dudu	11 12.1	14.6	+08	8.882	0.43-0.55	3
187	Lamberta	11 14.5	12.9	+25	10.670	0.23-0.32	3
1665	Gaby	11 16.5	13.9	+05	66.	0.27	2
446	Aeternitas	11 18.0	12.5	+23	15.7413	0.48	3
915	Cosette	11 30.4	13.4	+31	4.445	0.37	3
1214	Richilde	12 07.8	14.7	+30	9.860	0.32	3
966	Muschi	12 22.5	14.1	+30	5.355	0.31	3
1243	Pamela	12 25.8	14.2	+14	26.017	0.42-0.71	2
233	Asterope	12 31.	12.4	+09	19.70	0.25-0.55	3
235	Carolina	12 31.	13.4	+29	17.610	0.38	3
336	Lacadiera	12 31.	12.8	+17	13.70	0.27-0.34	3
391	Ingeborg	12 31.	13.6	-15	26.391	0.22-0.79	3
399	Persephone	12 31.	13.6	+31	9.136	0.40	3
540	Rosamunde	12 31.	13.7	+08	9.336	0.40-0.66	3-
629	Bernardina	12 31.	13.8	+26	3.763	0.23-0.39	3
753	Tiflis	12 31.	14.5	+27	9.85	0.35-0.8	3
784	Pickeringia	12 31.	14.4	+28	13.17	0.20-0.40	2
1013	Tombecka	12 31.	13.0	+39	6.053	0.44	3
1185	Nikko	12 31.	14.5	+26	3.79	0.27-0.50	3
1301	Yvonne	12 31.	14.2	-17	7.320	0.52-0.90	3
1687	Glarona	12 31.	15.0	+16	6.3	0.75	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://www.minorplanetcenter.org/iau/MPEph/MPEph.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.

1036 Ganymed (2011 Oct-Nov, H = 9.5)
This asteroid is repeated from the last issue since it remains within easy reach for several weeks into the last quarter of 2011. 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 longer 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 not to saturate the asteroid on CCD images.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	01 40.4	+48 44	0.38	1.28	9.1	35.7	132	144	+0.18	-13
10/06	01 48.5	+43 19	0.37	1.30	8.9	30.3	139	94	+0.69	-18
10/11	01 54.6	+37 13	0.36	1.32	8.8	24.2	147	38	+0.99	-24
10/16	01 59.2	+30 41	0.36	1.33	8.6	17.5	156	31	-0.87	-30
10/21	02 02.6	+24 03	0.37	1.36	8.5	10.7	165	92	-0.41	-36
10/26	02 05.2	+17 42	0.39	1.38	8.4	4.1	174	165	-0.01	-42
10/31	02 07.3	+11 55	0.41	1.40	8.5	2.4	177	119	+0.23	-47
11/05	02 09.2	+06 54	0.44	1.43	8.9	7.7	169	55	+0.72	-51

1998 SC15 (2011 Oct, H = 19.4, PHA)
There are no known lightcurve parameters for this asteroid, which has an estimated effective diameter of 400 m. The size makes it a candidate for fast rotation and possibly tumbling. Given that it is also a potentially hazardous asteroid, high-quality astrometry will be particularly helpful, beyond the usual immediate help for radar observers to aim their instruments.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	02 44.5	+39 10	0.20	1.15	16.7	40.3	132	159	+0.18	-19
10/06	02 31.9	+34 20	0.20	1.16	16.5	32.4	141	100	+0.69	-24
10/11	02 19.0	+29 00	0.20	1.18	16.3	23.9	151	37	+0.99	-30
10/16	02 06.4	+23 22	0.20	1.19	16.0	15.2	162	29	-0.87	-36
10/21	01 54.8	+17 47	0.21	1.20	15.8	6.7	172	95	-0.41	-43
10/26	01 44.6	+12 34	0.22	1.22	15.8	3.0	176	171	-0.01	-48
10/31	01 36.3	+07 58	0.24	1.23	16.3	9.7	168	111	+0.23	-53
11/05	01 29.9	+04 08	0.26	1.24	16.7	16.1	160	45	+0.72	-57

(163081) 2002 AG29 (2011 Oct, H = 18.2)
There are no known lightcurve parameters for 2002 AG29. The effective diameter is about 650 m when assuming a typical albedo of $p_V = 0.2$ for near-Earth asteroids.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	02 44.5	+39 10	0.20	1.15	16.7	40.3	132	159	+0.18	-19
10/06	02 31.9	+34 20	0.20	1.16	16.5	32.4	141	100	+0.69	-24
10/11	02 19.0	+29 00	0.20	1.18	16.3	23.9	151	37	+0.99	-30
10/16	02 06.4	+23 22	0.20	1.19	16.0	15.2	162	29	-0.87	-36
10/21	01 54.8	+17 47	0.21	1.20	15.8	6.7	172	95	-0.41	-43
10/26	01 44.6	+12 34	0.22	1.22	15.8	3.0	176	171	-0.01	-48
10/31	01 36.3	+07 58	0.24	1.23	16.3	9.7	168	111	+0.23	-53
11/05	01 29.9	+04 08	0.26	1.24	16.7	16.1	160	45	+0.72	-57

(138524) 2000 OJ8 (2011 Oct, H = 16.2, PHA)
The estimated diameter of this NEA is 1.4 km. There are no known lightcurve parameters.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	02 45.4	+44 40	0.15	1.10	14.5	45.6	128	154	+0.18	-14
10/06	03 52.3	+45 56	0.13	1.08	14.4	51.6	122	116	+0.69	-6
10/11	05 06.1	+44 10	0.13	1.06	14.5	58.2	116	74	+0.99	+2
10/16	06 12.8	+39 23	0.13	1.05	14.6	64.5	109	31	-0.87	+10
10/21	07 04.8	+32 59	0.14	1.03	14.9	69.6	103	28	-0.41	+17
10/26	07 42.8	+26 27	0.15	1.03	15.1	72.8	99	88	-0.01	+22
10/31	08 10.2	+20 34	0.16	1.02	15.4	74.2	97	154	+0.23	+26
11/05	08 30.4	+15 34	0.18	1.03	15.6	74.1	96	148	+0.72	+29

(7341) 1991 VK (2011 Oct-Nov, H = 16.7, PHA)
Pravec *et al.* (1998) found a synodic period of 4.2096 h. Additional data can help with modeling.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	00 20.4	+19 17	0.50	1.49	16.8	11.0	164	134	+0.18	-43
10/11	00 00.5	+19 17	0.44	1.42	16.4	13.8	160	13	+0.99	-42
10/21	23 37.9	+18 31	0.39	1.34	16.3	22.3	149	124	-0.41	-41
10/31	23 16.0	+17 06	0.35	1.27	16.3	33.0	136	83	+0.23	-40
11/10	22 58.3	+15 22	0.32	1.20	16.3	44.3	123	48	+0.99	-39
11/20	22 46.3	+13 37	0.30	1.13	16.3	55.6	110	165	-0.35	-39

(5143) Heracles (2011 Oct-Dec, H = 14.0)
Photometry work by Pravec *et al.* (1998) indicates that the rotation period of this NEA could be long (at least > 12 h). The estimated diameter is between 3.5 and 5 km, depending on the albedo value used.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	03 56.2	+35 55	1.10	1.83	16.6	27.7	122	165	+0.18	-13
10/11	03 57.4	+38 08	0.91	1.73	16.0	26.3	130	60	+0.99	-12
10/21	03 52.6	+40 46	0.74	1.63	15.3	24.2	138	66	-0.41	-10
10/31	03 37.6	+43 54	0.59	1.51	14.6	21.8	146	140	+0.23	-9
11/10	03 04.4	+47 28	0.45	1.39	13.8	21.2	149	32	+0.99	-10
11/20	01 56.5	+50 21	0.33	1.27	13.1	28.0	143	116	-0.35	-11
11/30	23 56.8	+47 38	0.24	1.13	12.8	47.9	122	75	+0.27	-14
12/10	21 43.6	+31 14	0.21	0.99	13.2	82.3	86	89	+1.00	-16

4183 Cuno (2011 Oct-Dec, H = 14.4)
This asteroid was observed with radar in 1998 and 2000. The latter observations indicated an elongated shape, somewhat angular at one end, and a significant concavity. A synodic period of 3.559 h was found by Pravec *et al.* based on data taken in 1997, 1998, and 2000. No pole solution has been reported. Additional lightcurves in 2011 could help constrain the pole direction.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	03 05.1	+28 19	1.42	2.24	17.9	18.6	135	170	+0.18	-26
10/11	02 57.6	+28 38	1.27	2.17	17.5	15.2	145	45	+0.99	-27
10/21	02 45.5	+28 34	1.15	2.10	17.0	11.0	156	81	-0.41	-28
10/31	02 28.9	+27 57	1.05	2.03	16.5	6.9	166	128	+0.23	-30
11/10	02 09.5	+26 41	0.97	1.95	16.3	7.5	165	10	+0.99	-33
11/20	01 49.5	+24 49	0.93	1.87	16.4	13.4	154	131	-0.35	-36
11/30	01 31.8	+22 35	0.91	1.78	16.5	20.5	141	80	+0.27	-39
12/10	01 18.6	+20 20	0.91	1.70	16.6	27.4	128	46	+1.00	-42
12/20	01 10.9	+18 20	0.92	1.61	16.6	33.6	115	174	-0.28	-44
12/30	01 08.6	+16 47	0.93	1.51	16.7	39.0	104	39	+0.29	-46

2003 FH (2011 Nov, H = 18.9, PHA)
This 500 m NEA has no known lightcurve parameters. The solar elongation is well under "opposition" (180°) during the time of the ephemeris. The best chances to observe it in terms of moon phase, solar elongation, and magnitude will be very late October and early November.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/31	21 16.9	+28 58	0.11	1.04	16.5	64.9	109	66	+0.23	-14
11/01	21 31.4	+30 44	0.12	1.04	16.7	61.9	112	60	+0.33	-15
11/02	21 44.0	+32 08	0.13	1.05	16.8	59.4	114	53	+0.43	-16
11/03	21 55.0	+33 15	0.15	1.06	16.9	57.3	116	47	+0.53	-17
11/04	22 04.7	+34 09	0.16	1.07	17.1	55.5	117	42	+0.63	-17
11/05	22 13.3	+34 53	0.17	1.08	17.2	54.0	118	39	+0.72	-18
11/06	22 21.0	+35 30	0.18	1.09	17.3	52.7	119	37	+0.80	-18
11/07	22 27.8	+36 00	0.19	1.10	17.4	51.5	120	37	+0.87	-18

2005 YU55 (2011 Nov, H = 22.0, PHA)
This NEA will come within one lunar distance of Earth in early November, reaching about 12th magnitude, and then rapidly move away and fade. However, moderate-sized instruments may be able to follow it until the end of the month. Previous Arecibo observations determined an approximately round shape and diameter of about 400 meters as well as being optically dark and having a rotation period of about 18 h. This means a single station might have trouble getting sufficient photometry data in the short time available to find the actual period. A coordinated observing campaign will have much better chances for success. More information on the planned radar campaign is available at:

http://echo.jpl.nasa.gov/asteroids/2005YU55/2005YU55_planning.html

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/09	20 42.5	+11 28	0.00	0.99	11.7	89.4	90	70	+0.97	-18
11/11	02 06.4	+17 35	0.02	1.01	13.7	13.2	167	15	-1.00	-42
11/13	02 22.5	+16 59	0.03	1.02	15.1	11.1	169	35	-0.96	-41
11/15	02 28.0	+16 46	0.05	1.04	16.1	11.6	168	59	-0.84	-40
11/17	02 30.9	+16 39	0.06	1.05	16.8	12.7	166	84	-0.67	-40
11/19	02 32.7	+16 35	0.08	1.07	17.3	14.0	165	110	-0.46	-40
11/21	02 34.0	+16 33	0.10	1.08	17.8	15.3	163	138	-0.24	-40
11/23	02 35.1	+16 32	0.11	1.09	18.2	16.7	161	167	-0.07	-40
11/25	02 36.2	+16 32	0.13	1.11	18.6	18.0	160	163	+0.00	-39
11/27	02 37.1	+16 33	0.15	1.12	18.9	19.3	158	134	+0.04	-39

(8567) 1996 HW1 (2011 Nov, H = 15.4)

The rotation period for this NEA is known to be 8.762 h. A model published by Magri *et al.* (2011) shows this to be the most bifurcated NEA known and also one of the most elongated: it's a "peanut" with a long axis of about 3.8 km. The geometry at this apparition is at latitudes around 40°. Lightcurves at this apparition will help improve constraints on the polar regions. This is the last chance to obtain lightcurves with modest telescopes until 2046.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	06 27.1	+05 20	0.57	1.37	16.4	39.3	119	162	+0.33	-3
11/11	06 23.9	+03 37	0.57	1.42	16.3	32.9	129	50	-1.00	-4
11/21	06 15.0	+02 27	0.58	1.48	16.3	25.9	139	84	-0.24	-7
12/01	06 01.9	+01 57	0.61	1.54	16.2	19.0	149	127	+0.36	-10
12/11	05 47.1	+02 10	0.64	1.60	16.3	13.7	157	21	-1.00	-13
12/21	05 33.2	+03 01	0.70	1.66	16.5	12.3	159	130	-0.18	-16
12/31	05 22.3	+04 19	0.78	1.72	16.9	14.7	154	87	+0.38	-18
01/10	05 15.5	+05 53	0.88	1.78	17.3	18.3	145	41	-0.99	-18
01/20	05 13.0	+07 33	1.00	1.84	17.8	21.6	136	165	-0.13	-18
01/30	05 14.4	+09 11	1.13	1.90	18.2	24.2	128	54	+0.39	-17

2004 JO2 (2011 Oct-Nov, H = 17.4)

There are no known lightcurve parameters for this NEA. The estimated diameter is about 1 km. Given the moon phase and asteroid magnitude, the better opportunities look to be the latter half of November.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/26	19 53.3	+11 52	0.25	1.03	17.1	75.0	91	103	-0.01	-8
10/31	20 41.5	+09 01	0.23	1.05	16.8	69.6	98	47	+0.23	-20
11/05	21 34.0	+05 33	0.23	1.07	16.6	63.2	105	17	+0.72	-32
11/10	22 26.3	+01 58	0.24	1.10	16.6	56.8	112	59	+0.99	-45
11/15	23 14.3	-01 12	0.26	1.13	16.6	51.3	117	110	-0.84	-55
11/20	23 55.6	-03 36	0.29	1.16	16.8	47.2	120	165	-0.35	-63
11/25	00 29.8	-05 14	0.33	1.19	17.1	44.3	122	125	+0.00	-68
11/30	00 58.0	-06 13	0.37	1.23	17.4	42.3	123	63	+0.27	-69

(138852) 2000 WN10 (2011 Nov, H = 20.0)

To repeat a common refrain: there are no known lightcurve parameters. The estimated diameter for the NEA is only 300 m. You'll have to fight the moon until the middle part of the ephemeris. Those with larger instruments can try extending the ephemeris at the end by a few days.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/15	04 19.3	-05 24	0.13	1.11	17.1	24.8	152	43	-0.84	-36
11/16	04 10.2	-03 05	0.13	1.11	17.0	21.7	155	54	-0.76	-37
11/17	04 01.3	-00 48	0.14	1.12	17.0	18.8	159	66	-0.67	-37
11/18	03 52.7	+01 25	0.14	1.12	16.9	16.2	162	80	-0.57	-38
11/19	03 44.4	+03 34	0.14	1.13	16.9	13.9	164	95	-0.46	-38
11/20	03 36.4	+05 38	0.15	1.13	16.9	12.1	166	110	-0.35	-38
11/21	03 28.7	+07 36	0.15	1.13	16.9	11.0	167	125	-0.24	-38
11/22	03 21.4	+09 29	0.15	1.14	17.0	10.6	168	141	-0.15	-38

(2201) Oljato (2011 Nov, H = 15.3, PHA)

Several attempts to find the rotation period for this NEA indicated that the period is on the order of 1 day or longer. Fortunately, the 2 km asteroid is within reach for several weeks. Given the possible period, it will take a coordinated campaign of observers at well-spaced longitudes to find a good solution, if one is possible. Those able to work below 18th magnitude (0.5-m or larger aperture) can try working the asteroid during those times in the latter half of October when the moon does not interfere. Arecibo observations in 1983 indicate a pronounced concavity on the asteroid.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/31	03 19.1	+15 37	0.97	1.94	17.2	7.4	165	137	+0.23	-34
11/05	03 10.5	+15 04	0.91	1.90	16.8	4.0	172	71	+0.72	-36
11/10	03 00.8	+14 27	0.86	1.85	16.4	1.4	177	11	+0.99	-38
11/15	02 50.0	+13 44	0.82	1.80	16.5	4.5	172	54	-0.84	-40
11/20	02 38.4	+12 57	0.78	1.75	16.5	9.0	164	123	-0.35	-42
11/25	02 26.3	+12 07	0.75	1.70	16.6	13.7	156	159	+0.00	-44
11/30	02 14.3	+11 17	0.73	1.65	16.6	18.5	148	86	+0.27	-47
12/05	02 02.6	+10 28	0.71	1.60	16.6	23.4	140	22	+0.74	-49

(2062) Aten (2011 Oct-Dec, H = 16.8)

As might be expected for the asteroid that is the prototype for a group that spends most of its time inside the Earth's orbit, Aten is never very far from the Sun in the sky. This will make getting photometry difficult, especially given 40.8 h period found by Mottola *et al.* (1995). Here is where another well-coordinated campaign of observers around the world will have a better chance of success than one station alone.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
10/01	15 07.2	-71 35	0.37	0.96	17.5	85.3	73	51	+0.18	-12
10/11	17 13.7	-78 45	0.38	0.99	17.5	79.7	78	99	+0.99	-22
10/21	20 41.1	-78 45	0.39	1.02	17.4	74.9	83	116	-0.41	-32
10/31	22 39.9	-72 29	0.41	1.05	17.4	70.7	87	62	+0.23	-41
11/10	23 33.0	-64 16	0.42	1.07	17.4	67.1	90	87	+0.99	-51
11/20	00 03.6	-55 23	0.44	1.10	17.5	64.3	92	124	-0.35	-60
11/30	00 25.8	-46 10	0.45	1.11	17.5	62.1	94	57	+0.27	-70
12/10	00 44.7	-36 51	0.48	1.13	17.6	60.6	94	81	+1.00	-80

2011 LC19 (2011 Nov-Dec, H = 18.2, PHA)

There are no known lightcurve parameters for this recently discovered NEA. The estimated diameter is about 700 m. This is case where accurate astrometry through early October will be extremely helpful since, as of 2011 mid-July, the plane-of-sky pointing uncertainties are several thousand arcseconds at the time of closest approach in late October.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/10	07 07.9	+00 03	0.11	1.04	15.6	58.3	116	73	+0.99	+4
11/15	06 31.7	-01 26	0.15	1.09	15.9	45.4	129	22	-0.84	-5
11/20	06 08.8	-02 07	0.19	1.13	16.3	36.2	137	72	-0.35	-10
11/25	05 52.5	-02 19	0.23	1.18	16.6	29.3	144	141	+0.00	-14
11/30	05 40.2	-02 11	0.27	1.23	16.9	24.1	150	132	+0.27	-17
12/05	05 30.6	-01 49	0.32	1.28	17.2	20.3	153	75	+0.74	-19
12/10	05 23.0	-01 17	0.37	1.33	17.6	17.9	155	26	+1.00	-20
12/15	05 17.1	-00 38	0.42	1.38	17.9	16.9	156	57	-0.81	-21

(10145) 1994 CK1 (2011 Nov-Dec, H = 17.3)

There are no known lightcurve parameters for 1994 CK1, a 1 km NEA. It should still be within reach of 0.3-0.4 meter instruments during the last part of December, after the waning moon moves away.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/20	12 02.6	+26 44	0.18	0.94	17.0	99.8	70	30	-0.35	+79
11/25	11 15.6	+31 30	0.19	0.99	16.5	83.5	86	83	+0.00	+69
11/30	10 29.3	+34 48	0.20	1.04	16.3	68.6	101	148	+0.27	+59
12/05	09 45.3	+36 46	0.21	1.09	16.2	55.3	114	120	+0.74	+50
12/10	09 05.0	+37 38	0.24	1.14	16.1	43.5	127	59	+1.00	+42
12/15	08 29.2	+37 40	0.26	1.19	16.2	33.0	139	27	-0.81	+35
12/20	07 58.4	+37 07	0.29	1.24	16.2	23.9	149	91	-0.28	+29
12/25	07 32.7	+36 13	0.33	1.29	16.3	16.3	158	159	+0.00	+23

(170502) 2003 WM7 (2011 Nov-Dec, H = 17.2)

This 1 km NEA has no known lightcurve parameters.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/10	04 59.0	+27 05	0.53	1.48	17.8	19.4	150	38	+0.99	-10
11/15	04 50.3	+28 32	0.44	1.41	17.1	16.2	157	25	-0.84	-10
11/20	04 35.4	+30 33	0.35	1.33	16.4	12.4	163	94	-0.35	-11
11/25	04 08.7	+33 25	0.27	1.25	15.6	10.2	167	167	+0.00	-13
11/30	03 16.5	+37 17	0.20	1.17	15.1	17.7	159	105	+0.27	-17
12/05	01 26.3	+39 57	0.14	1.09	14.8	39.8	135	33	+0.74	-22
12/10	22 36.6	+30 27	0.12	1.00	15.5	77.4	96	79	+1.00	-24

(24475) 2000 VN2 (2011 Nov-2012 Jan, H = 16.5)

2002 VN2 is a 1.6 km NEA. There are no known lightcurve parameters. It will linger around for the final two months of 2011 and be within relatively easy reach for modest instruments the entire time. Well-linked observations (those on a common system with only small adjustments to nightly zero points required) over the entire span of the ephemeris could show how the amplitude varies with phase angle. Because the asteroid never reaches below 7° phase angle, let alone close to 0°, finding an accurate value for the absolute magnitude (*H*) and phase slope parameter (*G*) won't be likely.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/01	03 52.2	-09 05	0.42	1.36	16.2	22.8	148	122	+0.33	-44
11/11	03 46.0	-07 41	0.35	1.31	15.6	20.2	153	29	-1.00	-44
11/21	03 34.7	-04 17	0.29	1.26	15.1	18.7	156	123	-0.24	-45
12/01	03 19.3	+02 03	0.25	1.21	14.7	20.5	155	87	+0.36	-44
12/11	03 02.4	+11 49	0.22	1.17	14.5	26.6	148	37	-1.00	-40
12/21	02 47.2	+24 24	0.20	1.14	14.6	35.6	138	170	-0.18	-31
12/31	02 37.7	+37 57	0.20	1.12	14.8	44.5	127	55	+0.38	-20
01/10	02 38.2	+50 30	0.22	1.11	15.1	51.2	119	70	-0.99	-9

2000 YA (2011 Dec, H = 23.8)

Radar observations by Benner *et al.* (2001) indicated a period of <1.3 h. This was partly confirmed with photometry by Pravec *et al.* based on observations in late 2000. They found a solution of 0.06658 h, but a solution near 1.3 h could not be formally excluded. High-quality observations this time around may remove the ambiguity. The estimated diameter is about 120 meters, based on Arecibo observations in 2000.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/20	04 37.1	+23 52	0.05	1.03	18.0	15.8	163	133	-0.28	-15
12/21	04 36.4	+25 30	0.04	1.02	17.6	17.0	162	147	-0.18	-14
12/22	04 35.4	+27 53	0.03	1.02	17.2	18.5	161	161	-0.10	-13
12/23	04 33.8	+31 41	0.03	1.01	16.7	20.8	159	170	-0.04	-11
12/24	04 30.7	+38 35	0.02	1.00	16.1	25.0	155	160	-0.01	-7
12/25	04 21.0	+53 56	0.01	0.99	15.4	36.5	143	140	+0.00	+3
12/26	19 12.3	+83 04	0.01	0.99	15.5	72.9	107	102	+0.02	+26
12/27	16 54.7	+32 34	0.01	0.98	18.4	119.9	60	69	+0.06	+38

(175706) 1996 FG3 (2011 Nov-Dec, H = 18.2, PHA/Binary)

Interest in this object is very high because it's a target of the proposed ESA Marco Polo-R mission, which has advanced to the second round in ESA's Cosmic Visions spacecraft mission competition. Previous work by Mottola (2000) and Pravec *et al.* (2000, 2006, 2009) established the synodic period for this 700 m NEA at 3.594 h. It is also a known binary with the satellite's orbital period being 16.14 h. If the mutual events (occultations and/or eclipses) are visible this time around, you'll need 0.01-0.02 mag precision to record them with sufficient accuracy. These data can help refine the system parameters and model the orbital plane and primary spin axis orientations and, possibly, look for evidence of Binary YORP (BYORP), which affects the size of the orbit of a satellite.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
11/25	09 59.2	+29 12	0.10	1.01	15.8	74.2	100	97	+0.00	+52
12/05	08 02.2	+33 40	0.11	1.07	15.2	40.6	135	103	+0.74	+29
12/15	06 31.6	+32 11	0.15	1.13	15.1	14.6	163	40	-0.81	+10
12/25	05 38.6	+29 03	0.20	1.18	15.6	7.8	171	167	+0.00	-1
01/04	05 12.1	+26 30	0.26	1.22	16.7	18.9	156	37	+0.75	-8
01/14	05 01.7	+24 49	0.33	1.27	17.5	27.4	144	95	-0.76	-10

2003 AK18 (2011 Dec-2012 Jan, H = 19.6)

Based on observations obtained in early 2003, Pravec *et al.* found a period of 5.3 h with an amplitude of 0.19 mag. However, this solution is rated at U = 2 in the LCBD, and so needs confirmation. Unfortunately, the asteroid is brightest when the moon is near full. The estimated diameter is about 350 m.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/25	17 37.6	+55 08	0.06	0.97	17.1	97.5	79	77	+0.00	+32
12/30	21 58.1	+82 26	0.06	1.00	15.9	68.5	108	85	+0.29	+22
01/04	03 58.9	+62 41	0.07	1.03	15.8	46.6	130	47	+0.75	+7
01/09	04 27.6	+46 11	0.10	1.06	16.3	38.4	138	41	+1.00	-2
01/14	04 38.9	+36 39	0.13	1.08	16.9	37.4	138	100	-0.76	-7
01/19	04 46.5	+30 49	0.16	1.10	17.5	38.9	135	166	-0.22	-9
01/24	04 53.0	+27 00	0.19	1.12	18.0	40.9	132	123	+0.01	-11

2001 YE4 (2011 Dec-2012 Jan, H = 20.6, PHA)

There are no known lightcurve parameters for this NEA coming in at only 200 m diameter. Fast rotation and/or tumbling are a possibility, so try to get as high-precision data as possible.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
12/25	07 33.9	+68 40	0.07	1.03	16.7	44.3	133	132	+0.00	+29
12/26	06 37.3	+70 38	0.06	1.03	16.7	44.8	133	128	+0.02	+24
12/27	05 28.2	+71 16	0.06	1.02	16.6	46.0	131	119	+0.06	+19
12/28	04 17.1	+70 12	0.06	1.02	16.6	47.9	130	106	+0.13	+14
12/29	03 16.1	+67 29	0.06	1.02	16.7	50.6	127	92	+0.20	+8
12/30	02 29.7	+63 38	0.06	1.02	16.8	53.8	123	77	+0.29	+3
12/31	01 55.9	+59 09	0.06	1.01	16.9	57.4	120	63	+0.38	-3
01/01	01 31.2	+54 25	0.06	1.01	17.0	61.3	116	49	+0.48	-8

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.

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The deadline for the next issue (39-1) is October 15, 2011. The deadline for issue 39-2 is January 15, 2012.