#THE MINOR PLANET BULLETIN

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

VOLUME 40, NUMBER 2, A.D. 2013 APRIL-JUNE

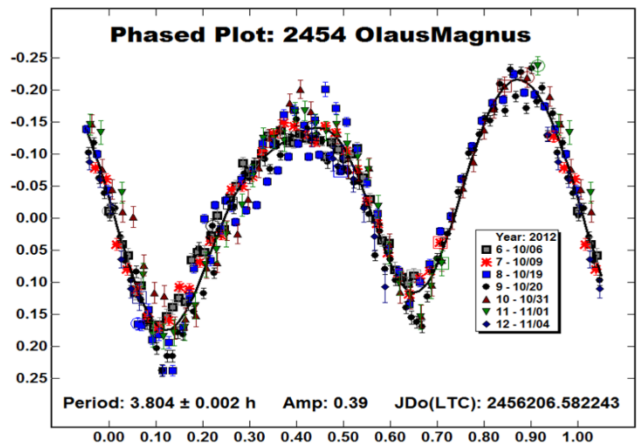
SYNODIC PERIOD FOR 2454 OLAUS MAGNUS FROM FRANK T. ETSCORN OBSERVATORY

Angelica Vargas
Frank T. Etscorn Campus Observatory
New Mexico Tech
101 East Road
Socorro, NM, USA 87801
avargas@nmt.edu

(Received: 2 January)

The main-belt asteroid 2454 Olaus Magnus was observed between 2012 October 6 and November 6 at Etscorn Observatory. Analysis found a synodic period of 3.804 ± 0.002 h and amplitude of 0.39 ± 0.10 mag.

2454 Olaus Magnus is a main belt asteroid with an orbital period of 3.3804 years and was discovered by Y. Vaisla on 1941 September 21 at Turku (JPL, 2012). It has also been known as 1941 SS, 1968 QQ, and 1975 XV. There is no reference in the asteroid lightcurve database (LCDB; Warner *et al.*, 2009). Photometric observations of the asteroid were made from the Frank T. Etscorn Campus Observatory at New Mexico Tech in 2012 October and November. Two telescopes were used, each a 35.6-cm *f*/11 Schmidt-Cassegrain. Both used an SBIG STL-1001E CCD with 1024x1024 24-micron pixels resulting in a plate scale of 1.25 arcsec/pixel. The exposure time was 300 seconds through a clear filter. The CCDs were set to –25ºC. The images were dark subtracted using *CCDSoft* (Software Bisque, 2012), and flat-field corrected using the batch processing tools within *MPO Canopus* (Warner, 2012). *MPO Canopus* was used to measure the processed images and obtain the lightcurve. Analysis of the data found a synodic period of P = 3.804 ± 0.002 h with an amplitude of 0.39 ± 0.10 mag.



Acknowledgements

Thanks to Dr. Daniel A. Klinglesmith and Judy Stanley for inspiring students of all ages to pursue their interests and to Dr. Frank T. Etscorn and everyone who made Etscorn observatory available. Tremendous thanks to my family and friends who motivate and inspire me. Thank you so much Jesse E. Martinez. An infinite amount of thanks to my dad, Ricardo Vargas, who greatly supported my choice to pursue science. The Etscorn Campus Observatory operations are supported by the Research and Economic Development Office of New Mexico Institute of Mining and Technology, NMIMT. Student support at NMIMT is given by a NASA EPScOR grant NNX11AQ35A.

References

JPL Small-body Database Browser (2012). *http://ssd.jpl.nasa.gov/sbdb.cgi#top*

Warner, B.D., Harris, A.W., and Pravec, P. (2009). “The asteroid lightcurve database.” *Icarus* **202**, 134-146. Updates available: *http://www.minorplanet.info/lightcurvedatabase.html*

Software Bisque (2012). *http://bisque.com*

Warner, B.D. (2012). MPO Canopus version 10.4.0.6 Bdw Publishing, Colorado Springs.

LIGHTCURVE AND ROTATIONAL PERIOD DETERMINATION FOR 5275 ZDISLAVA

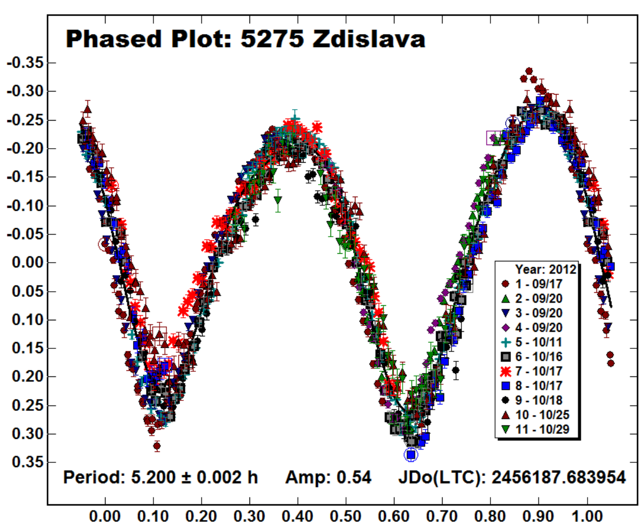
Janek Nathaniel Turk
Etscorn Campus Observatory
New Mexico Institute of Mining and Technology
101 East Road
Socorro, NM 87801 USA
jturk@nmt.edu

(Received: 21 November)

Observations of the minor planet 5275 Zdislava were made between 2012 August 17 and October 29. Analysis of the lightcurve determined that the asteroid has a synodic period of 5.200 ± 0.002 h and lightcurve amplitude of 0.54 ± 0.03 mag.

Named after Czech saint Zdislava Berka, 5275 Zdislava is a Mars-crossing asteroid. This minor planet was discovered on 1986 October 28 by Z. Vavrova at the Kelt Observatory (JPL, 2012). Observations of 5275 were made at Etscorn Campus Observatory on the campus of New Mexico Institute of Mining and Technology. The images were taken through a clear filter with a 0.35-m *f*/11 Schmidt Cassegrain mounted on a Paramount ME and SBIG STL-1001E CCD camera. Exposures were 180 seconds. The image size was 1024x1024 24-micron pixels, providing a scale of 1.25 arcsec per pixel. The CCD was cooled to either –20º C or –25º C, depending on the night-time temperature. Once the images were taken, they were flat-corrected, dark-subtracted, and aligned with *CCDSoft 5* (Software Bisque, 2012). *MPO Canopus* (Warner, 2012) was used to generate the lightcurve and rotational period of the minor planet.

The period determined by *MPO Canopus* was 5.200 ± 0.002 h. Data from the nights of the Sep 20 and Oct 17 had to be split due to weather and focus issues.



Acknowledgements

Special thanks go to Dr. Daniel A. Klinglesmith III for his guidance and help in processing and collecting the data. I would also like to acknowledge my fellow team members: Angelica Vargas, Ethan Risley, and Curtis Warren for the number of nights we've spent at the observatory. I would like to give thanks to Dr. Frank T. Etscorn for providing the Etscorn Observatory. The Research and Economic Development Office of New Mexico Institute of Mining and Technology deserves recognition for the up-keep of the Etscorn Campus Observatory. Lastly, the NASA EPSCOR for grant NNX11AQ35A that allows the students in our team to participate in this research.

References

JPL Small Bodies Database Browser (2012). *http://ssd.jpl.nasa.gov/sbdb.cgi#top*

Software Bisque (2012). *http://www.bisque.com/sc/*

Warner, B.D. (2012). *MPO Canopus* version 10.4.1.0 Bdw Publishing, Colorado Springs.

LIGHTCURVE ANALYSIS OF FOUR ASTEROIDS

Bin Li, Haibin Zhao
Purple Mountain Observatory, Chinese Academy of Sciences
Nanjing 210008. P.R. CHINA
meteorzh@pmo.ac.cn

Xianming L. Han, Lina R. Annable, Eli M. Finkel,
Orry R. Heffner, Adam W. Kidd, Bradley J. Magnetta,
Tiffany M. Ramires, Frederick W. Rastede, Sean G. Sproston
Dept. of Physics and Astronomy
Butler University, Indianapolis IN USA

(Received: 30 August)

From June 2011 through May 2012 May, photometric data for four asteroids were obtained using the Southeastern Association for Research in Astronomy (SARA) telescope located at the Kitt Peak National Observatory. The following synodic periods were found: 4808 Ballaero, P = 8.8976 ± 0.0007 h; 7750 McEwen, P = 27.82 ± 0.01 h; 11941 Archinal, P = 2.717 ±0.006 h; and (47035) 1998WS, P = 7.996 ± 0.001 h.

All observational data reported here were obtained using the 0.91-m SARA telescope located at the Kitt Peak National Observatory. The telescope has a Cassegrain design with an effective focal ratio of f/7.5. Coupled to an Apogee U42 CCD camera, this results in a resolution of 0.77 arcsec/pixel (binned 2×2) and field of view (FOV) = 13.1×13.1 arcminutes. Bessell R or IR blocking (clear) filters were used when taking images. The camera temperatures were set to between –25°C and –35°C. Image acquisition was done with *MaxIm DL*. All images were reduced with master bias, dark, and flat frames. All calibration frames were created using *IDL*. *MPO Canopus* was used for analyzing the processed images and extracting the periods from the lightcurves. The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner *et al.*, 2008)

<u>4808 Ballaero.</u> Observations of this asteroid were made from 2011 Oct 15 to 2012 Jan 14. Our analysis of the lightcurve gives *P* = 8.8976 ± 0.0007 h and *A* = 0.36 ± 0.01 mag.

<u>7750 McEwen.</u> Several groups studied this asteroid during the same observational season and reported their results: Skiff, (2011,

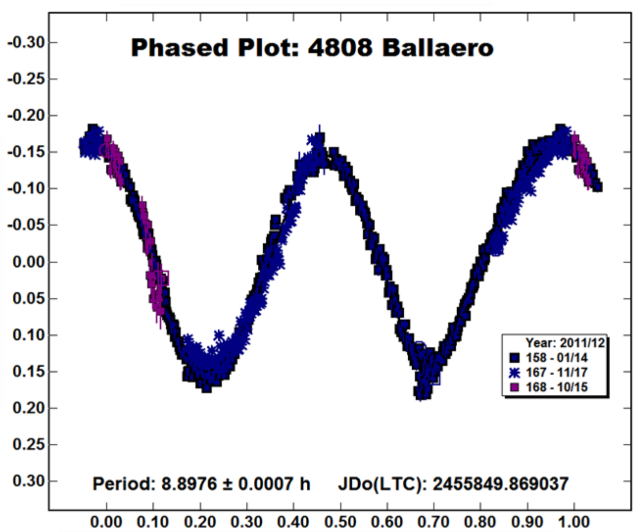
27.807 h), Owings (2012, 27.8182 h), Clark (2012, 27.8124 h), and Ferrero (2012, 27.80 h). We obtained our data from 5 different sessions from 2011 June 26 to Nov 17 and found the period to be $P = 27.82 \pm 0.01$ h and amplitude $A = 0.55 \pm 0.05$ mag. Our results agree with these previously reported periods and amplitudes.

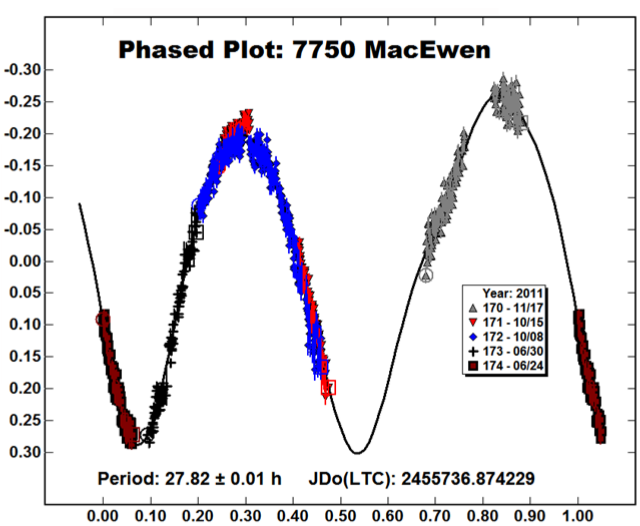
11941 Archinal. Data were collected on the nights of 2012 Apr 27, May 16, 17, and 22. A synodic period of 2.717 ± 0.006 h and amplitude of 0.30 ± 0.01 mag were obtained.

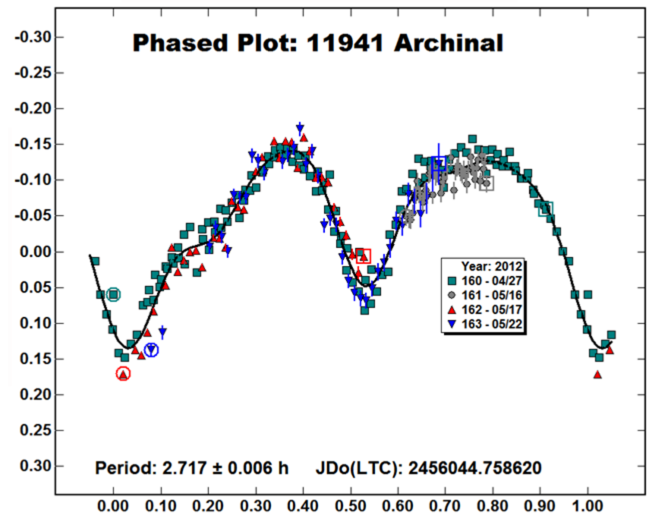
(47035) 1998WS. Data were collected on the nights of 2012 Jan 30, Feb 13 and 21. A synodic period of $P = 7.996 \pm 0.001$ h and amplitude of 0.12 ± 0.01 mag were obtained.

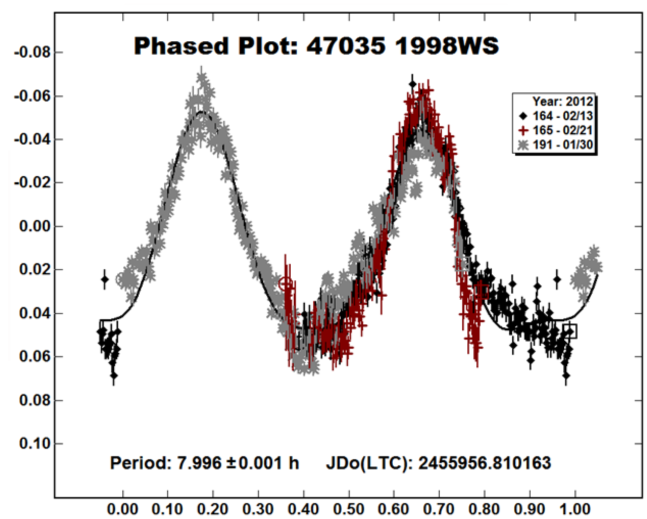
Acknowledgements

We would like to thank F. Levinson for a generous gift enabling Butler University's membership in the SARA consortium. We would also like to thank the support by the National Natural Science Foundation of China (Grant Nos. 11178025 and 10933004), and the Minor Planet Foundation of Purple Mountain Observatory.









References

Clark, M. (2012). "Asteroid Lightcurves from the Preston Gott Observatory." *Minor Planet Bul.* **39**, 63–65.

Ferrero, A. (2012). "Lightcurve Determination at the Bigmuskie Observatory from 2011 July-December." *Minor Planet Bul.* **39**, 65–67.

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

Owings, L.E. (2012). "Lightcurves for 2567 Elba, 2573 Hannu Olavi, 2731 Cucula, 4930 Rephiltim 6952 Niccolo, and 7750 McEwen." *Minor Planet Bul.* **39**, 22–23.

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

Warner, B.D., Harris, A.W., and Pravec, P. (2008). Asteroid Lightcurve Parameters. *http://www.minorplanet.info/call.html*

LIGHTCURVE ANALYSIS OF 774 ARMOR AND 3161 BEADELL

Julian Oey
Kingsgrove Observatory
23 Monaro Ave.
Kingsgrove, NSW AUSTRALIA
julianoey1@optusnet.com.au

Xianming L. Han, Kevin Gipson
Dept. of Physics and Astronomy, Butler University
Indianapolis, IN 46208 USA

(Received: 7 December)

Photometric studies of the asteroids 774 Armor and 3161 Beadell and were carried out by observers from Australia and USA. The data were combined and the following periods were obtained: 774 Armor, 25.107 ± 0.005 h; 3161 Beadell, 36.253 ± 0.004 h.

774 Armor. This main-belt asteroid was favorably placed for a collaborative effort in 2012. Oey approached Han due to wide separation in longitude between the two observatories. The previously published period analysis by Warner *et al.* (2006, 25.162 h) and Behrend (2005, 26.2 h) indicated a rotational period nearly commensurate with an Earth day, making such a collaboration a necessity.

Han observed 774 Armor from Kitt Peak, USA, using the Southeastern Association for Research in Astronomy (SARA) 0.91-m Ritchey-Chretien telescope coupled with an Apogee U42 CCD, providing an image scale of 0.77 arcsec/pixel (binned at 2x2). All images were captured with Bessel R filter at 30 seconds per exposure. Oey observed from Kingsgove Australia with an *f*/7 0.25-m Schmidt-Cassegrain (SCT) using an SBIG ST-402ME giving an image scale of 1.41 arcsec/pixel. All images were taken unfiltered at 300 seconds per exposure.

Raw images were calibrated using a library of bias, dark, and flat-fields. The data were further reduced with *MPO Canopus* v10 using the Comp Star Selector (CSS) method that allows linking the dataset internally to 0.03-0.05m precision (Stephens, 2008). The dataset obtained by Han was reduced by Oey but it was not possible to use the CSS method for the zero-point calibration of the dataset and so the Han data were arbitrarily adjusted to match Oey's. Despite the lack of complete coverage of only two minimums and one maximum for the bimodal lightcurve, we found the synodic period of 25.107 ± 0.005 h and amplitude of 0.16 ± 0.02 mag to be consistent with the results found by Warner *et al*.

3161 Beadell. We found no previously reported results for 3161 Beadell. Han initiated the collaboration after data from his first session showed the characteristics of a long period asteroid. For observing 3161 Beadell, Han used the SARA 0.61-m telescope located at the Cerro Tololo Inter-American Observatory in Chile. It is coupled with a QSI 683s CCD camera, resulting in a resolution of 0.27 arcsec/pixel (binned at 2x2). All images were captured with Bessel R filter at 120 seconds per exposure. Oey used the same equipment as for 774 Armor.

The combined data from both observers formed a nearly complete bimodal lightcurve with the exception of a gap at phase 0.75-0.80. The synodic period is 36.253 ± 0.004 h with amplitude of 0.40 ± 0.05 mag. This period is 1.5 times commensurate with that of the Earth's rotational period, which makes the collaborative effort even more important since a single station would have had great difficulty obtaining a complete lightcurve.

Acknowledgements

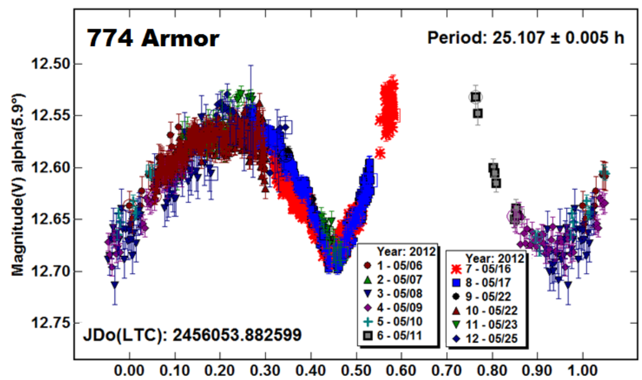
We would like to thank F. Levinson for a generous gift enabling Butler University's membership in the SARA consortium.

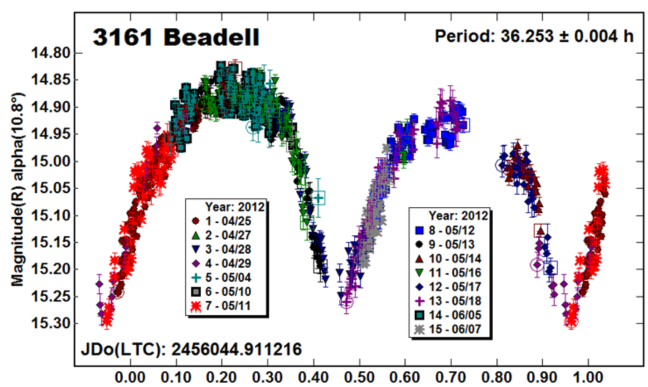
References

Warner, B.D., Higgins, D., Bennett, T., and Fauerbach, T. (2006). "The lightcurve of main belt asteroid 774 Armor." *Minor Planet Bul.* **33**, 95.

Behrend, R. (2005). Observatoire de Genève web site. *http://obswww.unige.ch/~behrend/page3cou.html*

Stephens, R.D. (2008). "Long period asteroids observed from GMARS and SANTANA observatories." *Minor Planet Bul.* **35**, 21-22.





CALL FOR OBSERVATIONS

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

Observers who have made visual, photographic, or CCD measurements of positions of minor planets in calendar year 2012 are encouraged to report them to this author on or before 2013 April 1. This will be the deadline for receipt of reports which can be included in the "General Report of Position Observations for 2012," to be published in *MPB* Vol. 40, No. 3.

ASTEROID SYNODIC PERIODS FROM ETSCORN CAMPUS OBSERVATORY

Daniel A. Klinglesmith III, Jesse Hanowell, Ethan Risley,
Janek Turk, Angelica Vargas, Curtis Alan Warren
Etscorn Campus Observatory, New Mexico Tech
101 East Road
Socorro, NM USA 87801
dklinglesmith@mro.nmt.edu

(Received: 18 December Revised: 28 December)

We report the synodic periods for nine asteroids: 1365 Henyey, 1578 Kirkwood, 1761 Edmondson, 2432 Soomana, 2786 Grinevia, 2933 Amber, 4300 Marg Edmondson, 5096 Luzin, and 5128 Wakabayashi.

The Etscorn Campus Observatory ECO (2012) has three Celestron 0.35-m Schmidt Cassegrain telescopes used for asteroid lightcurve research. Two of the telescopes are equipped with SBIG STL-1001E CCD cameras. The third uses an SBIG ST-10 with an Optec 0.5x focal reducer. The STL-1001E CCDs have unbinned 1024x1024, 24-micron pixels providing 1.25 arcsec/pixel with a field of view of approximately 22x22 arcmin. The ST-10 with the 0.5x focal reducer used 2x2 binned pixels. The image size was 1092x736 with 13.6-micron pixels. This provided a plate scale of 1.28 arcsec/pixel and a field of view approximately 20x16 arcmin. Exposures for all objects were either 180 or 300 seconds, depending on the asteroid brightness. All asteroids were imaged through a clear filter. The CCDs were cooled to –20°C to –30°C depending on the ambient temperature.

The data reduction was done with *MPO Canopus* Warner (2012) batch processing procedures. A series of 11 dome flats were median-combined on a nightly basis. The median flat was used to flat-field correct the asteroid images. The synodic period determination was done using the FALC analysis algorithm (Harris *et. al*., 1989) built into *MPO Canopus*. In most cases there were sufficient catalog stars from either the MPOSC3 or APASS catalogs for night-to-night zero-point calibrations.

Asteroid Summaries

In this section the information about the asteroid discovery and names comes from the JPL Small Bodies Database Browser JPL SB (2012). Table I summarizes the information for each asteroid: number, name, observation date range, number of data points, solar phase angle, phase angle bisector longitude, phase angle bisector latitude, period, period error, amplitude, and amplitude error. The period error has been computed using the formula: Kaasalainen *et al.* (2001)

$$\Delta p = 0.03 * (\text{period})^2/(\text{data interval})$$

where period and data interval are in the same units, e.g., hours.

<u>1365 Henyey</u>. This is a main-belt asteroid discovered on 1928 Aug 9 by M. Wolf at Heidelberg. It has been known as 1928 RK, 1932 WL, 1941 ME, 1973 YG4 1984 BA, and A907 GK. It was observed on 20 nights between 2012 Jul 13 and Sep 3. The synodic period was determined to be 18.986 ± 0.008 h with an amplitude of 0.26 ± 0.05 mag.

<u>1578 Kirkwood</u>. This is an outer main-belt asteroid discovered on 1951 Jan 10 by the Indiana Asteroid Program at Goethe Link Observatory, Brooklyn, Indiana. It has been known as 1951 AT, 1944 DF, 1949 TF, and 1952 FK. It was observed on ten nights between 2012 Sep 16 and Oct 25. This asteroid had a low amplitude, making the period determination difficult. The best result that we obtained was for a synodic period of 12.518 ± 0.005 h with an amplitude of 0.05 ± 0.05 mag. Slyusarev *et al*. (2012) report a period of 17.9 hours with an amplitude of 0.22 mag.

<u>1761 Edmondson</u>. This is a main-belt asteroid discovered on 1952 Mar 30 by the Indiana Asteroid Program at Goethe Link Observatory, Brooklyn, Indiana. It has been known as 1952 FN, 1950 XP, 1952 HT, 1955 US, 1969 JK, and 1978 WY. It was observed on ten nights between 2012 Nov 20 and 30. The synodic period was determined to be 4.208 ± 0.002 h with an amplitude of 0.29 ± 0.05 mag.

<u>2432 Soomana</u>. This is a main-belt asteroid discovered by E. Bowell at Lowell Observatory, Anderson Mesa Station, Flagstaff, Arizona. It is also known as 1981 FA, 1941 BR, 1952 DW, 1961 TK, 1972 TP4, 1972 VN, and A907 VM. It was observed on three nights between 2012 Dec 11 and 13. The synodic period was determined to be 3.206 ± 0.003 h with an amplitude of 0.36 ± 0.04 mag.

<u>2786 Grinevia</u>. This is a main-belt asteroid discovered on 1978 Sep 6 by N. Chernykh at Nauchnyj. It is also known as 1978 RR5, 1972 GZ1, 1976 GP1, 1978 TD, and 1978 UE2. It was observed on six nights between 2012 Dec 9 and 17. The synodic period was determined to be 2.911 ± 0.002 h with an amplitude of 0.34 ± 0.03 mag.

<u>2933 Amber</u>. This is a main-belt asteroid discovered on 1983 Apr 18 by N.G. Thomas at Lowell Observatory, Anderson Mesa Station, Flagstaff, Arizona. It is also known as 1983 HN, 1938 RB, 1940 CE, 1950 NE1, 1951 WT, 1978 EB1, 1980 TE2, and A917 TE. It was observed on four nights between 2012 Mar 5 and 14. The synodic period was determined to be 13.482 ± 0.002 h with an amplitude of 0.29 ± 0.1 mag. It has also been observed by Warner (2012) who determined a period of 13.11 ± 0.03 with an amplitude

#	Name	mm/dd 2012	Data pts	α	L_{PAB}	B_{PAB}	Period (h)	PE	Amp (mag)	AE
1365	Henyey	07/13-09/03	1088	6.6,3.2,19.1	301.6	5.4	18.986	0.008	0.26	0.05
1578	Kirkwood	09/16-10/25	776	11.1,0.3,1.7	26.8	-0.8	12.518	0.005	0.05	0.05
1761	Edmondson	11/20-11/30	236	17.7,14.8	100.1	0.7	4.208	0.002	0.29	0.05
2432	Soomana	12/11-12/13	237	16.5,15.7	106.8	9.3	3.206	0.003	0.36	0.05
2786	Grinevia	12/09-12/17	358	9.5,10.8	72.2	16.5	2.911	0.002	0.34	0.03
2933	Amber	03/05-03/14	523	3.2,6.7	160.7	6.1	13.483	0.002	0.29	0.05
4300	Marg Edmondson	09/14-11/15	327	14.4,17.5	20.1	0.2	9.328	0.002	0.12	0.10
5096	Luzin	10/26-11/04	416	6.6,6.4,7.3	36.0	10.1	3.054	0.001	0.31	0.05
5128	Wakabayashi	03/14-03/15	229	4.5,4.1	179.1	6.2	5.864	0.020	0.13	0.05

Table I. The solar phase angle (α) is given at the start and end for each date range, unless it reached a minimum, which is the middle of the three values. L_{pab} and B_{pab} are the average phase angle bisector longitude and latitude, respectively.

of 0.09 ± 0.01 mag.

4300 Marg Edmondson. This is a main-belt asteroid discovered on 1955 Sep 18 by the Indiana Asteroid Program at Goethe Link Observatory, Brooklyn, Indiana. It is also known as 1955 SG1, 1955 UP, 1955 VG1, 1969 QW, 1985 AG, 1986 LR1, and 1987 SP6. It was observed on five nights between 2012 Sep 14 and Nov 15. The synodic period was determined to be 9.328 ± 0.002 h with an amplitude of 0.12 ± 0.1 mag. Like 1578 Kirkwood, this asteroid has a small amplitude that makes the period determination suspect.

5096 Luzin. This is a main-belt asteroid discovered on 1983 Sep 5 by L.V. Zhuravleva at Nauchnjj. It is also known as 1983 RC5, 1981 CO, 1985 FA1, 1985 GZ1, and 1990 SK16. It was observed on six nights between 2012 Oct 26 and Nov 4. The synodic period was determined to be 3.054 ± 0.001 h with an amplitude of 0.31 ± 0.05 mag.

5128 Wakabayashi. This is a main-belt asteroid discovered on 1989 Mar 30 by M. Koishikawa at Ayashi. It is also known as 1989 FJ, 1970 AK, 1980 KW, and 1982 UA5. It was observed on two nights: 2012 Mar 14 and 15. The synodic period was determined to be 4.864 ± 0.02 h with an amplitude of 0.13 ± 0.05 mag.

Acknowledgements

It was with special pleasure that DAK III was able to determine the periods of 1578 Kirkwood, 1761 Edmondson, and 4300 Marg Edmondson as he was a graduate student at Indiana University Department of Astronomy and spent his first year working for the Indiana Asteroid Program under Dr. Frank Edmondson.

The Etscorn Campus Observatory operations are supported by the Research and Economic Development Office of New Mexico Institute of Mining and Technology (NMIMT). Student support at NMIMT is given by NASA EPSCoR grant NNX11AQ35A, the Department of Physics, and the Title IV of the Higher Education Act from the Department of Education.

References

ECO, Etscorn Campus Observatory (2012). *http://www.mro.nmt.edu/education-outreach/etscorn-campus-observatory/*

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.

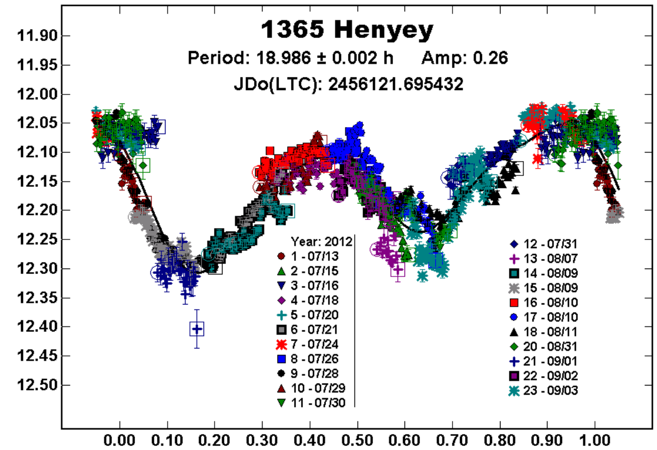
Kaasalainen, M., Torppa, J., and Muinonen, K. (2001). "Optimizations Methods for Asteroid Lightcurve Inversions II. The Complete Inverse Problem." *Icarus* **154**, 37-51.

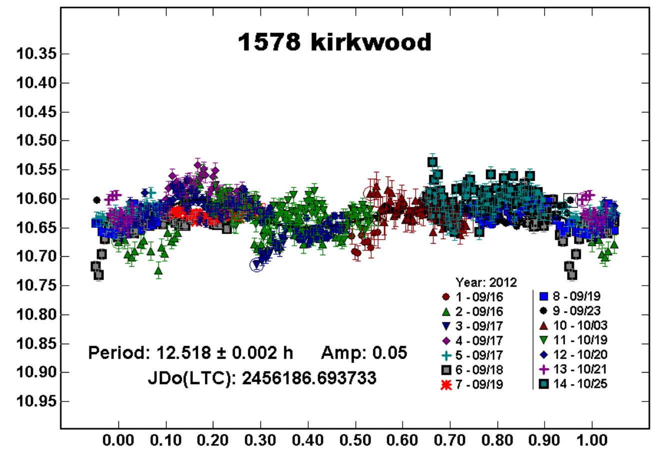
JPL SB (2012). "JPL Small Bodies Database." *http://ssd.jpl.nasa.gov/sbdb.cgi#top*

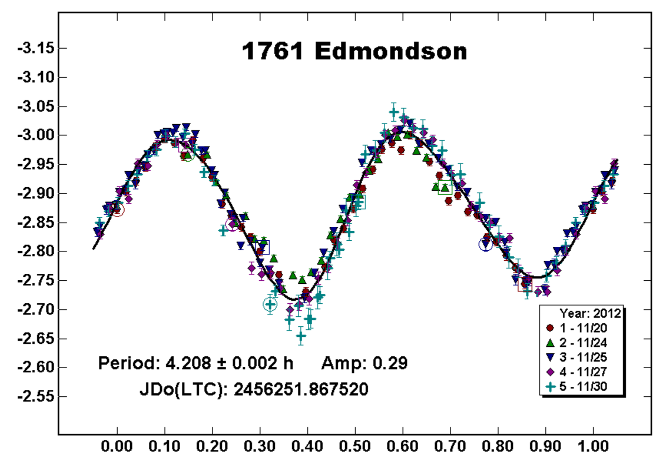
Slyusarev, I.G., Shevchenko, V.G., Belskaya, I.N., Krugly, Yu. N., and Chiorny, V.G. (2012). *ACM 2012*, **#6398**.

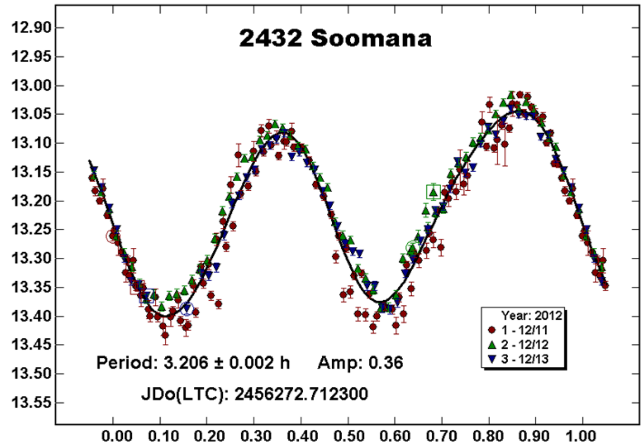
Warner, B.D. (2012a). MPO Software, Canopus version 10.4.1.0 BDW Publishing, Colorado Springs.

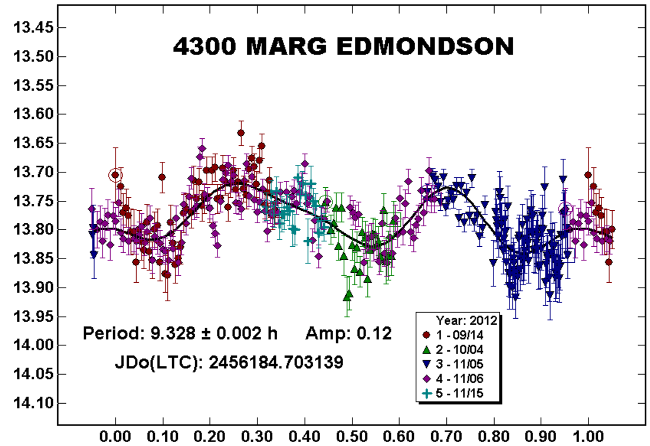
Warner, B.D. (2012b). "Asteroid Lightcurve analysis at the Palmer Divide Observatory: 2011 December – 2012 March." *Minor Planet Bul.* **39**, 158-167.

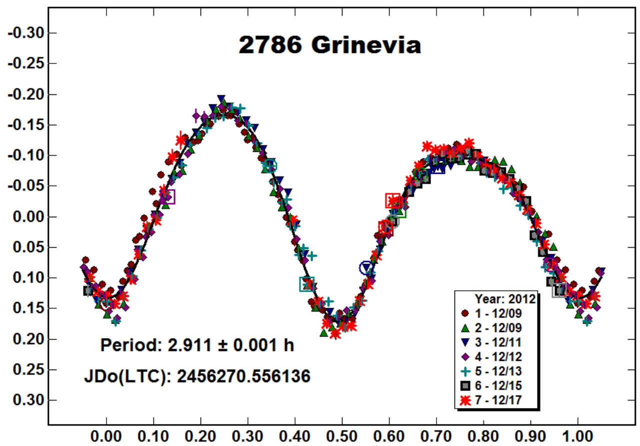


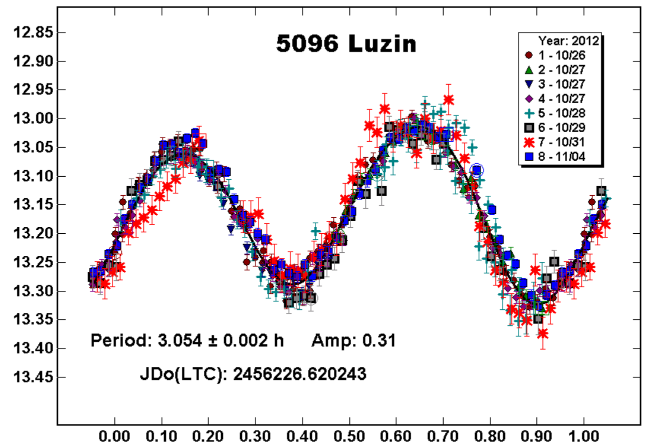


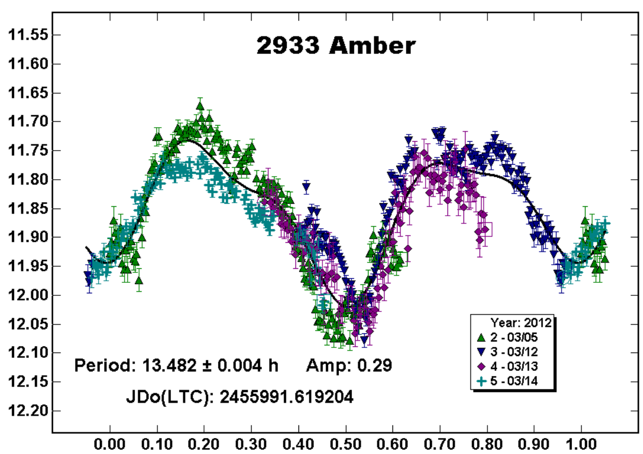


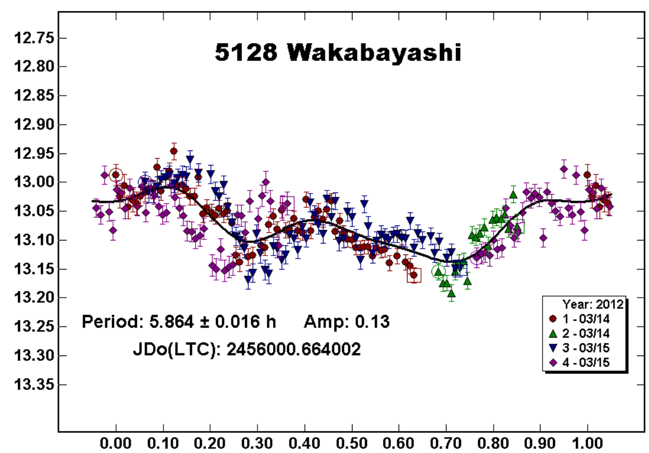

2432 Soomana
Period: 3.206 ± 0.002 h Amp: 0.36
JDo(LTC): 2456272.712300
Year: 2012
1 - 12/11
2 - 12/12
3 - 12/13


4300 MARG EDMONDSON
Period: 9.328 ± 0.002 h Amp: 0.12
JDo(LTC): 2456184.703139
Year: 2012
1 - 09/14
2 - 10/04
3 - 11/05
4 - 11/06
5 - 11/15


2786 Grinevia
Period: 2.911 ± 0.001 h
JDo(LTC): 2456270.556136
Year: 2012
1 - 12/09
2 - 12/09
3 - 12/11
4 - 12/12
5 - 12/13
6 - 12/15
7 - 12/17


5096 Luzin
Period: 3.054 ± 0.002 h Amp: 0.31
JDo(LTC): 2456226.620243
Year: 2012
1 - 10/26
2 - 10/27
3 - 10/27
4 - 10/27
5 - 10/28
6 - 10/29
7 - 10/31
8 - 11/04


2933 Amber
Period: 13.482 ± 0.004 h Amp: 0.29
JDo(LTC): 2455991.619204
Year: 2012
2 - 03/05
3 - 03/12
4 - 03/13
5 - 03/14


5128 Wakabayashi
Period: 5.864 ± 0.016 h Amp: 0.13
JDo(LTC): 2456000.664002
Year: 2012
1 - 03/14
2 - 03/14
3 - 03/15
4 - 03/15

LIGHTCURVE OF 562 SALOME

Michael S. Alkema
Elephant Head Observatory (G35)
17070 S Kolb Rd.
Sahuarita, AZ 85629
msalkema@gmail.com

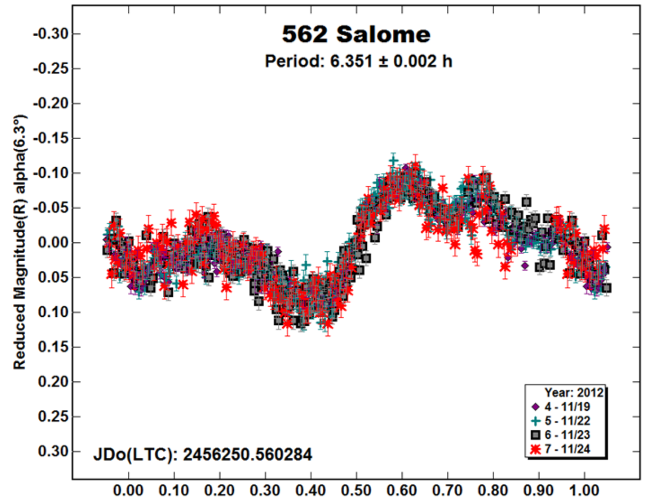
(Received: 28 November)

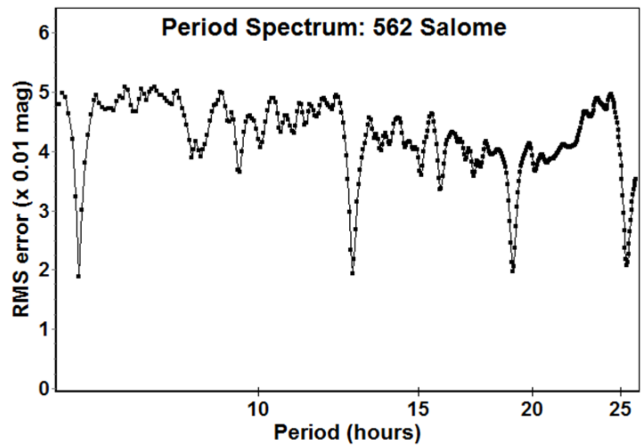
The main-belt asteroid 562 Salome (1905 QH) was observed over a span of four nights in 2012 November. A synodic rotation period of 6.351 ± 0.002 h and an amplitude of 0.17 ± 0.02 mag were obtained.

Asteroid 562 was listed as a lightcurve opportunity target in the *Minor Planet Bulletin* (Warner *et al.*, 2013). Here we report determining this asteroid's synodic rotation rate from the analysis of CCD photometric observations at Elephant Head Observatory. Observations were conducted with a 0.25-m Schmidt-Cassegrain telescope on a German Equatorial mount using an SBIG STT-8300 CCD camera with 5.4-micron pixels binned at 4x4. This provided an image scale of 1.67 arcsec per pixel. A clear filter was used for all exposures. Exposures were 100 seconds each. All images were dark and flat-field corrected.

All images were obtained from an automated image routine using *CCDAutopilot* v5.04.7. Imaging and plate solving were done with *Maxim DL* v5.23 and *TheSkyX* v10.2. Data were reduced in *MPO Canopus* v10.4.1 using differential photometry. Comparison stars were chosen for near-solar color index with the "comp star selector" of *MPO Canopus*. Period analysis was completed using *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (FALC; Harris *et al.*, 1989).

A search for previous period determinations of 562 Salome found Bembrick and Allen (2007; 12.705 h) and Higgins (2011; 6.3505 h). New observations were obtained over four nights in 2012 November. Analysis of the data found a period of 6.351 ± 0.002 h and amplitude 0.17 ± 0.02 mag. The newly-determined period is in good agreement with Higgins (2011) but is inconsistent with the Bembrick and Allen (2007) period, which period appears to be the double-period since the two halves of their lightcurve look nearly identical to each other. Full phase coverage for the double-period was obtained. When the new data were phased to the double-period, the two halves of the lightcurve appeared similar. A plot of the period spectrum shows that the shorter period has a smaller RMS error.





References

Bembrick C. and Allen B. (2007). "The Rotation Period of 562 Salome." *Minor Planet Bul*. **34**, 3.

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

Higgins D.J. (2011). *http://www.davidhiggins.com/Astronomy/asteroid/lightcurves*

Warner, B.D., Harris, A.W., Pravec, P., Durech, J., and Benner, L.A.M. (2013). "Lightcurve Photometry Opportunities: 2013 January-March." *Minor Planet Bul.* **40**, 54-58.

PHOTOMETRIC OBSERVATION OF 1542 SCHALEN

Bin Li, Haibin Zhao
Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing 210008. P.R. CHINA
libin0129@gmail.com

Xianming L. Han
Dept. of Physics and Astronomy, Butler University
Indianapolis, IN, USA

Daniel A. Klinglesmith III, Jesse Hanowell
Etscorn Campus Observatory, New Mexico Tech
Socorro, NM, USA

(Received: 19 December)

CCD photometric observations of asteroid 1542 Schalen over ten nights in 2012 October and November were used to determine a synodic rotation period of 7.516 ± 0.002 h and an amplitude of 0.49 ± 0.02 mag.

Observations of 1542 Schalen asteroid started independently at the SARA Observatory and the Etscorn Campus Observatory. Once the two sides realized the other's work, we decided to join forces.

Observations at the Southeastern Association for Research in Astronomy (SARA) were obtained with a 0.91-m telescope located at the Kitt Peak National Observatory. The telescope has a Cassegrain design with an effective focal ratio of *f*/7.5. Coupled to an ARC (Astronomical Research Cameras, Inc.) CCD camera, the resulting resolution is 0.86 arcsec/pixel and field-of-view 14.6×14.6 arcmin. A Bessell R filter was used when taking images. The camera temperature was set to –109°C. Observations at the Etscorn Campus Observatory (ECO, 2012) were obtained with Celestron C-14 Schmidt-Cassegrain and SBIG ST-10 CCD resulting in an image scale of 1.05 arcsec/pixel (binned 3×3). The CCD was cooled to –25°C. All images were taken through a clear filter with 180-second exposures. Data from Oct 31, Nov 1, Nov 2, and 27 were obtained with the SARA telescope. Data from Nov 6, 7, 8, 11, 13, and 14 were obtained with the ECO telescope.

Images were reduced with master bias, dark and flat frames. *MPO Canopus* (Warner, 2012) was used for analyzing the processed images and extracting the period from the lightcurves. This asteroid was selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (*http://www.MinorPlanet.info/call.html*).

In the end, we observed this asteroid for a total of ten nights, ranging from 2012 Oct 31 to Nov 27. We obtained a synodic period of $P = 7.516 \pm 0.002$ h and an amplitude of $A = 0.49 \pm 0.02$ mag. No previously published results were found.

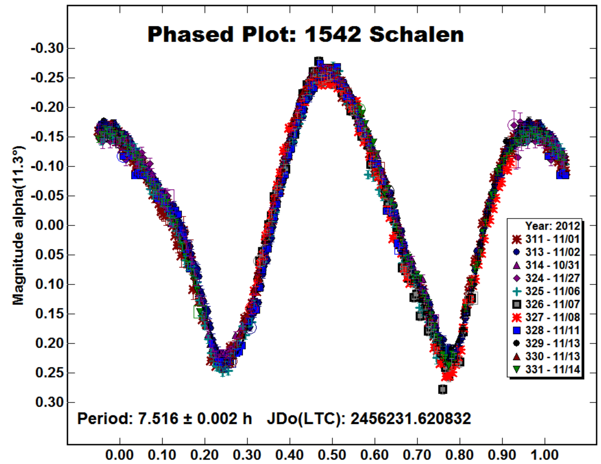
Acknowledgements

We would like to thank F. Levinson for a generous gift enabling Butler University's membership in the SARA consortium. We would also like to thank the support by the National Natural Science Foundation of China (Grant Nos. 11178025, 11273067 and 10933004), and the Minor Planet Foundation of Purple Mountain Observatory. The Etscorn Campus Observatory operations are supported by the Research and Economic Development Office of New Mexico Institute of Mining and Technology (NMIMT). Student support at NMIMT is given by NASA EPSCoR grant NNX11AQ35A, Department of Physics, and the Title IV of the Higher Education Act from the Department of Education.

References

ECO, Etscorn Campus Observatory (2012). *http://www.mro.nmt.edu/education-outreach/etscorn-campus-observatory/*

Warner, B.D. (2012) MPO Software, Canopus version 10.4.1.0 BDW Publishing, Colorado Springs



THE LIGHTCURVE OF 6122 HENRARD

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

(Received: 1 January)

Asteroid 6122 Henrard was observed on three sessions over a four-day period covering approximately 10 rotations. During this apparition, the asteroid exhibited a 9.16 hour lightcurve period with am amplitude of about 0.26 mag.

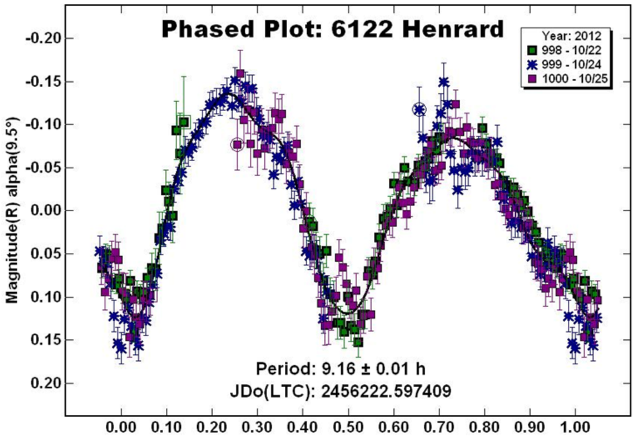
CCD photometric observations made at Via Capote Observatory (VCO) of asteroid 6122 Henrard were made in 2012 October. Prior to this campaign, no other references to photometric lightcurve analysis for 6122 Henrard were found in the literature. Exposures were guided, and obtained through a 0.4-m *f*/10 Schmidt-Cassegrain (SCT) at prime focus. The CCD imager was an Alta U6 featuring a 1024x1024 array of 24-micron pixels. All observations were made unfiltered at 1x binning yielding an image scale of 1.24 arcsec/pixel. All images were dark, flat field, and bias corrected. Images were measured using *MPO Canopus* (Bdw Publishing). Night-to-night zero point calibration was accomplished by selecting up to five comp stars exhibiting 2MASS B-V color indexes similar to the sun. See Warner (2007) and Stephens (2008) for a further discussion of this process. Fourier analysis of the data found a synodic period of 9.16 ± 0.01 h and amplitude of 0.26 ± 0.02 mag.

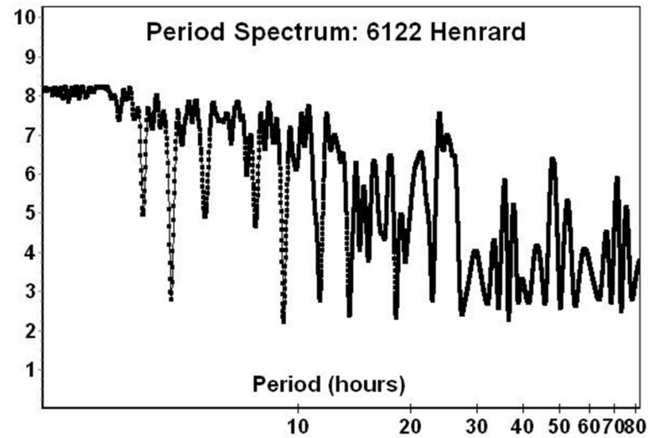
References

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

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

# Name	Date Range (mm/dd) 2012	Data Points	Phase	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (m)	AE
6122 Henrard	10/22 - 10/25	291	10.12	15	4	9.18	0.01	0.26	0.05





PERIOD DETERMINATION FOR (15337) 1993 VT2

Eduardo Manuel Álvarez
OLASU (I38)
Costanera Sur 559, Salto 50.000, URUGUAY
olasu@adinet.com.uy

(Received: 26 December)

Lightcurve analysis for asteroid (15337) 1993 VT2 was performed from observations during its 2012 favorable opposition. The previously unknown synodic rotation period was found to be 3.338 ± 0.001 h and the lightcurve amplitude was 0.27 ± 0.04 mag.

The main-belt asteroid (15337) 1993 VT2 was discovered by the Scottish-Australian astronomer Robert H. McNaught, a prolific discoverer of more than 400 asteroids and 60 comets. The asteroid was chosen from the 2012 October list at the *CALL* web site's *Potential Lightcurve Targets* page because it was within range of the equipment, it had no defined lightcurve parameters, and it was reaching one of its five brightest apparitions between the years 1995-2050.

Unfiltered CCD photometric images were taken at Observatorio Los Algarrobos, Salto, Uruguay (MPC Code I38) from 2012 October 26 through November 3 using a 0.3-m Meade LX-200R reduced to *f*/6.9. The CCD imager was a QSI 516wsg using a non-antiblooming gate (NABG) chip with a 1536 x 1024 array of 9-micron pixels. 2x2 binning was used, yielding an image scale of 1.77 arcsec per pixel. Exposures were 120 seconds. The camera was worked at –10°C and off-axis guided by means of a SX Lodestar camera and *PHD Guiding* (Stark Labs) software.

All images were dark and flat-field corrected and then measured using *MPO Canopus* (Bdw Publishing) version 10.4.0.20 with a differential photometry technique. The data were light-time corrected. Night-to-night zero-point calibration was accomplished by selecting up to five comp stars with near solar colors according to recommendations by Warner (2007) and Stephens (2008). Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989).

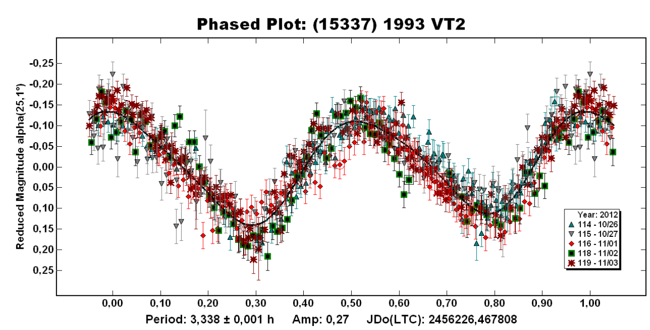
Five nights were devoted to observe this asteroid exclusively over a span of eight days. About 23.5 hours of effective observation time produced more than 650 data points used in the data analysis. The phase angle varied from 25.1º to 25.6º, the phase angle bisector ecliptic longitude from 21.3º to 23.1º, and the phase angle bisector ecliptic latitude from –32.6º to –31.1º. The rotational period for (15337) 1993 VT2 was determined to be 3.338 ± 0.001 h along with a peak-to-peak amplitude of 0.27 ± 0.04 mag. The dual-period tool in *MPO Canopus* was used to check for the possibility that the asteroid is binary; no positive result was obtained.

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.

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

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



ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2012 SEPTEMBER – 2013 JANUARY

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

(Received: 8 January)

Lightcurves for 40 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2012 September to 2013 January: 495 Eulalia, 1694 Kaiser, 2001 Einstein, 3086 Kalbaugh, 3635 Kreutz, 5806 Archieroy, 6310 Jankonke, 6447 Terrycole, 6744 Komoda, 7086 Bopp, 7560 Spudis, 8325 Trigo-Rodriguez, 11149 Tateshina, 11709 Eudoxos, (13245) 1998 MM19, (13573) 1993 FZ18, 14395 Tommorgan, 15434 Mittal, (17657) 1996 VO4, (22013) 1999 XO89, (26916) 1996 RR2, 27776 Cortland, (30878) 1992 GQ, (30981) 1995 SJ4, (31831) 1999 YL, (32626) 2001 RX64, (51371) 2000 XF15, 55844 Bicak, (55854) 1996 VS1, (63440) 2001 MD30, (66832) 1999 UE45, (70927) 1999 VX210, (72675) 2001 FP54, (86388) 2000 AT60, (90988) 1997 XS13, (123937) 2001 EX16, (136017) 2002 VH74, (192683) 1999 SO27, (330825) 2008 XE3, and 2012 TC4. Based on data and analysis in 2012 for 27776 Cortland, the previously reported period from 2009 has been revised.

CCD photometric observations of 40 asteroids were made at the Palmer Divide Observatory (PDO) from 2012 September to 2013 January. See the introduction in Warner (2010c) for a discussion of equipment, analysis software and methods, and overview of the lightcurve plot scaling. The "Reduced Magnitude" in the plots is Johnson V or Cousins R (indicated in the Y-axis title) corrected to unity distance by applying –5*log (rΔ) to the measured sky magnitudes with r and Δ 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.

For the sake of brevity in the following discussions on specific asteroids, only some of the previously reported results may be referenced. For a more complete listing, the reader is referred to the asteroid lightcurve database (LCDB, Warner *et al.*, 2009). The on-line version allows direct queries that can be filtered a number of ways and the results saved to a text file. A set of text files, including the references with bibcodes, is also available for download at *http://www.minorplanet.info/lightcurvedatabase.html*. Readers are strongly encouraged to obtain, when possible, the original references listed in the LCDB for their work.

495 Eulalia. The rotation period for this 40 km Nysa member was first measured by Binzel (1987) at 29.2 h. Behrend (2005) reported a period of 28 hours. It was observed at PDO in 2012 November and December at the request of another researcher.

Almost 1200 data points were obtained using a V filter. The AAVSO Photometric All-Sky Survey (APASS; Henden *et al.*, 2012) catalog was used to fix the magnitudes of comparison stars in each field. Analysis of the data found a synodic period of 28.967 ± 0.002 h and amplitude of 0.14 ± 0.01 mag. The phase angle of the observations ranged from about 2° to 13°. This allowed finding the absolute magnitude (*H*) and phase slope parameter (*G*), i.e., *H* = 10.95 ± 0.02 and *G* = 0.20 ± 0.03.

1694 Kaiser. The author worked this inner main-belt asteroid in 2006, finding a period of 13.23 h (Warner, 2006). Analysis of the 2012 data found *P* = 13.02 ± 0.01 h, *A* = 0.32 ± 0.02 mag. The larger amplitude and higher-quality data in 2012 favor the shorter period. Kaiser was not a planned target in 2012 but appeared in the field with a project asteroid, making it a so-called "target of opportunity," a common trait for a number of other asteroids in this work.

2001 Einstein. This is the fourth apparition at which this Hungaria was worked at PDO. Previous results (Warner, 2005b; 2008c; 2010b) found nearly identical periods. However, the amplitude has ranged from 0.66 mag (2004) to 1.02 mag (2008).

3086 Kalbaugh. Previous results by the author (Warner, 2005b; 2008b; 2010b) agree with the period of *P* = 5.179 ± 0.005 h found in the 2012 analysis. Here, too, a significant range of amplitudes has been seen over the years, 0.47-0.76 mag.

3635 Kreutz. Analysis of the 2012 data found a period of about 280 h with an amplitude of 0.25 mag. An approximate rule of thumb using this period (Pravec *et al.*, 2005) gives a tumbling damping time well in excess of the age of the Solar System for this Hungaria. However, there were no obvious signs of tumbling in the data, e.g., the lightcurve not repeating itself on a second cycle or data from a given night having the "wrong" sense of direction, i.e., trending up when down was expected.

These results do not agree with the *P* = 39 h previously reported by the author (Warner, 2006). The images from that earlier apparition were re-measured using the Comp Star Selector in *MPO Canopus* (as was done in 2012). This allows calibrating night-to-night observations to ± 0.05 mag. The new data showed no definitive period or trend within a given night, save 2005 Dec 8, which seemed to show an increase of about 0.04 mag over about 8 hours. The observing conditions in 2005 were poor on all four nights, which may contribute to the uncertainty of the results. Given the available data, the correct period is likely on the order of 280 hours.

5806 Archieroy. Analysis of the 2012 data found *P* = 12.1602 ± 0.0005 h, *A* = 0.47 ± 0.02 mag. The period agrees with previous results by the author (Warner, 2005a; 2008).

6310 Jankonke. Previous results, all about 3.04 h, are from Warner (2005b; 2011) and Behrend (2008). However, the author found a period of 3.08 h in 2008 (Warner, 2008b). The 2012 PDO analysis found *P* = 3.076 ± 0.002 h, *A* = 0.10 ± 0.01 mag. It should be noted that the data sets from 2008 and 2012 are of much higher quality than the other sets obtained at PDO and that the 2005 data set has two, nearly equal solutions, one of them being 3.074 h.

6447 Terrycole. The author found a period of 10.278 h in 2009 (Warner, 2010) using somewhat noisy data from five nights. The 2012 data set covered three consecutive nights but was of higher quality. Analysis of the 2012 data found *P* = 10.268 h. Observations at future apparitions are needed to resolve the slight discrepancy in results.

6744 Komoda. This was a target of opportunity that was followed on a second night, thus providing a secure result.

7086 Bopp. Warner (2008a) found P = 29.0 h while Behrend (2006) reported P = 3.40 h. The 2012 data analysis found a period of 29.15 ± 0.02 h.

7560 Spudis. This asteroid was observed twice before, in 2004 and 2008 (Warner, 2008b). The results then and in 2012 were in excellent agreement. On the other hand, the amplitude in 2012 was 0.38 mag, significantly larger than in the previous apparitions (0.17 mag, 2004; 0.10 mag, 2008).

8325 Trigo-Rodriguez. This outer main-belt asteroid was a one-night target of opportunity. No period could be found, the data showing only a very slight decrease in magnitude over the span of the observations.

11149 Tateshina. Two nights of follow-up on this target of opportunity, a Vestoid of about 5 km effective diameter, allowed finding a secure solution.

11709 Eudoxos. This middle main-belt object was in the same field as a planned target for two nights. Unfortunately, it was faint and so the data have large errors. The result of P = 2.64 h should not be considered secure.

(13245) 1998 MM19. The long northern winter nights allowed covering the 4.664 h period of this Hungaria member more than once on each of two nights, making for a secure solution.

(13573) 1993 FZ18. Despite three nights of observations in 2012 November, a low amplitude combined with error bars greater than the amplitude prevented finding a unique solution. Two plots are presented, one each for the dominant periods of 3.06 and 6.12 h found during the analysis. This is a Flora member and was a target of opportunity.

(14395) Tommorgan. The plot shows a very confused lightcurve. This is because the asteroid is a "tumbler", i.e., in non-principal axis rotation (see Pravec *et al.*, 2005). The data are phased to the dominant period of 35.5 h. Petr Pravec (private communications) found a second, non-unique period of 40.4 h. A definitive result would require an extended campaign by an extended group of observers.

(15434) Mittal. This Flora member was another target of opportunity. The large error bars, ~0.05 mag, were offset by the amplitude of 0.65 mag and so a secure solution could be found.

(17657) 1996 VO4. A total of 206 data points were used in the analysis for this Hungaria member. The result was a period of 5.507 ± 0.005 h and amplitude of 0.53 ± 0.02 mag.

(22013) 1999 XO89. Data for this outer main-belt asteroid were obtained on a single night, 2012 Nov 12, the asteroid being another target of opportunity. There was no follow-up because of an already busy list of targets, planned and not, and because the solution of 6.5 ± 0.3 h was considered secure enough to be statistically valid for rotation rate studies.

(26916) 1996 RR2. The period of 10.326 ± 0.005 h found with the 2012 data agrees well with earlier results by the author (Warner, 2008b; 2010a).

(27776) Cortland. This Hungaria was first observed at PDO in 2009 (Warner, 2010a). At that time, a period of 20.50 h was reported with an amplitude of 0.09 mag. The 2012 data also showed a low amplitude lightcurve but, with better night-to-night calibrations, a much shorter period of 2.6095 ± 0.0003 h was found. The 2009 were re-examined and found to fit a period of 2.6104 ± 0.0004 h, making the two results statistically the same. The phase angle bisector longitudes (L_{PAB}) of the two apparitions differ by about 70°, and so it appears that this asteroid may always present a low amplitude lightcurve. Follow-up observations are encouraged to confirm this supposition.

(30878) 1992 GQ. There were no previously reported results in the LCDB for this outer main-belt asteroid, yet another target of opportunity. As much as possible, these serendipitous initial observations are followed-up to determine a reasonably secure solution. This helps avoid adding to observational biases against fainter targets. On the other hand, such follow-up is more likely when the initial data indicate a relatively short period and moderate to large amplitude, thus adding to existing biases favoring "easy" targets.

(30981) 1995 SJ4. This outer main-belt asteroid is just such an example of an "easy" target. It was a target of opportunity that was given dedicated follow-up because the period, amplitude and shape of the lightcurve made it a potential small binary candidate. When the initial results fall into the range where a binary is possible, then whenever possible the object is followed for at least three nights to check for evidence of a satellite via eclipse or occultation events. No such evidence was seen in this case.

(31831) 1999 YL. The initial results for this Hungaria made it a binary candidate and so it was observed on four nights. Nothing unusual was seen in 2012 but the asteroid should be observed at future apparitions. Some binary asteroids were found only on second and even third tries at different apparitions.

(32626) 2001 RX64. Since this was a target of opportunity and the analysis of the one night (2012 Nov 7) provided a reasonably secure result of P = 6.23 ± 0.05 h and A = 0.43 ± 0.03 mag, no follow-up was scheduled.

(51371) 2000 XF15. This Hungaria was observed for seven consecutive nights (2012 Nov 19-25). A definitive solution could not be found; two possible results are 54 and 112 h with an amplitude of about 0.10 mag. Plots showing the data phased to each of the periods are included below.

(55844) Bicak. Early observations of this Hungaria showed faint deviations from a lightcurve with a period of 2.8052 ± 0.0002 h. Here again, the period, amplitude, and shape were "binary friendly" and so the asteroid was observed for a total of 10 nights from 2012 Sep 10 to Oct 03. Nothing substantial was seen in the later observations. The asteroid will be a priority target at its next apparition visible from PDO.

(55854) 1996 VS1. Warner (2011) and Skiff (2011) observed this Hungaria asteroid in 2011, finding periods of 3.067 and 3.064 h, respectively. Follow-up observations at PDO in 2012 November confirmed those earlier results within 1-sigma errors.

(63440) 2001 MD30. A result of P = 3.29687 h for this Hungaria was reported by Pravec *et al.* (2010) based on data obtained in 2009. Additional results posted on Pravec's web site (2012) using data from 2012 October showed P = 3.2968 h. The PDO results using data from 2012 November found P = 3.2940 h.

(66832) 1999 UE45. This middle main-belt asteroid was a one-night target of opportunity. The solution is reasonably secure but future follow-up is encouraged.

(70927) 1999 VX210. This was another middle main-belt, one-night target of opportunity. The large amplitude allows some confidence in the period but the incomplete lightcurve argues somewhat against it.

(72675) 2001 FP54. Confidence in the solution of P = 2.50 ± 0.05 h is justified by the 0.38 mag amplitude, which requires a bimodal lightcurve at low phase angles (Harris, 2012). This outer main-belt resident was a one-night target of opportunity.

(86388) 2000 AT60. A member of the Flora group, this target of opportunity was given two additional nights of follow-up with the hope of overriding the noisy data with sufficient data to find a useful solution. That goal was barely achieved, finding a period of 10.23 h.

(90988) 1997 XS13. The solution of P = 8.8 ± 0.5 h for this inner main-belt target of opportunity should be viewed as tentative, with follow-up to be made whenever possible.

(123937) 2001 EX16. Eight nights of observations of this Hungaria asteroid failed to produce a secure solution. A period of 39.82 h and amplitude of 0.07 mag fit the data, but the lightcurve is not complete and the RMS fit to the Fourier curve is poor. The observations covered phase angles ranging from 6° to 22°. Accordingly, the data were used to find H-G parameters of H = 16.04 ± 0.10 and G = 0.51 ± 0.13. The latter is consistent with a high albedo object, as are members of the Hungaria *family*.

(136017) 2002 VH74. The solution of 4.3 h for this outer main-belt target of opportunity is not secure despite the apparent amplitude of 0.35 mag since the error bars are a significant portion of the amplitude.

(192683) 1999 SO27. Two possible solutions were found for this Eunomia asteroid. A monomodal lightcurve has P = 13.17 ± 0.07 h, A = 0.14 ± 0.03 mag while a bimodal solution gives P = 26.45 ± 0.25 h, A = 0.22 ± 0.03 mag.

(330825) 2008 XE3. Using data from 2012 November, Hicks *et al.* (2012) reported P = 4.412 h, A = 0.15 mag at a phase angle of about 22°. The NEA was observed a month earlier at PDO, at phase angle ~39°. Analysis of that data found P = 4.409 h and A = 0.22 mag. The larger amplitude of the PDO data is expected with the larger phase angle.

2012 TC4. This NEA was observed on one night, 2012 Oct 11, during a close fly-by to Earth. The PDO data lead to a period of 0.2038 ± 0.0002 h (about 12.2 minutes) with an amplitude of 0.93 ± 0.05 mag. These results agree well with those reported by Polishook *et al*. (2013).

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX10AL35G, by National Science Foundation grant AST-1032896.

References

Behrend, R. (2005). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

Behrend, R. (2008). 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.

Harris, A.W. (2012). "On the Maximum Amplitude of Harmonics of an Asteroid Lightcurve." in *Proceedings for the 31st Annual Symposium on Telescope Science* (B.D. Warner, R.K. Buchheim, J.L. Foote, D. Mais, eds.) pp 59-63. Society for Astronomical Sciences. Rancho Cucamonga, CA.

Henden, A.A., Smith, T.C., Levine, S.E., and Terrell, D. (2012). "The AAVSO Photometric All-Sky Survey Completes the Sky." AAS Meeting #220, #133.06.

Hicks, M., Dombroski, D., and Brewer, M. (2012). Astronomer's Telegram 4591. *http://www.astronomerstelegram.org*

Polishook, D. (2013). "Fast Rotation of the NEA 2012 TC4 Indicates a Monolithic Structure." *Minor Planet Bul.* **40**, 42-43.

Pravec, P., Harris, A. W., Scheirich, P., Kušnirák, P., Šarounová, L., Hergenrother, C. W., Mottola, S., Hicks, M. D., Masi, G., Krugly, Yu. N., Shevchenko, V. G., Nolan, M. C., Howell, E. S., Kaasalainen, M., Galád, A., Brown, P., Degraff, D. R., Lambert, J. V., Cooney, W. R., and Foglia, S. (2005). "Tumbling Asteroids." *Icarus* **173**, 108-131.

Pravec, P., Vokrouhlický, D., Polishook, D., Scheeres, D.J., Harris, A.W., Galád, A., Vaduvescu, O., Pozo, F., Barr, A., Longa, P., Vachier, F., Colas, F., Pray, D.P., Pollock, J., Reichart, D., Ivarsen, K., Haislip, J., Lacluyze, A., Kušnirák, P., Henych, T., Marchis, F., Macomber, B., Jacobson, S.A., Krugly, Yu.N., Sergeev, A.V., and Leroy, A. (2010). "Formation of asteroid pairs by rotational fission." *Nature* **466**, 1085-1088.

Pravec, P. (2012). NewRes web page. *http://www.asu.cas.cz/~ppravec/newres.txt*

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

Warner, B.D. (2005a). "Asteroid lightcurve analysis at the Palmer Divide Observatory - fall 2004." *Minor Planet Bul.* **32**, 29-32.

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

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. (2008a). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: September-December 2007." *Minor Planet Bul.* **35**, 67-71.

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

Warner, B.D. (2008c). "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.

Number	Name	2012/13 (mm/dd)	Pts	Phase	L_{PAB}	B_{PAB}	Period	P.E.	Amp	A.E.
495	Eulalia	11/08-12/23	1181	13.7,1.7,10.2	71	-3	28.967	0.002	0.14	0.01
1694	Kaiser	11/05-11/07	183	8.6,9.7	33	+7	13.02	0.01	0.32	0.02
2001	Einstein (H)	12/10-12/14	316	18.5,18.4	84	+32	5.4846	0.0004	0.67	0.02
3086	Kalbaugh (H)	11/16-11/18	339	15.8,15.6	59	+25	5.179	0.005	0.76	0.02
3635	Kreutz (H)	10/31-11/14	505	18.2,24.2	18	+13	280.	5.	0.25	0.03
5806	Archieroy (H)	10/02-10/23	469	19.0,22.2	7	+29	12.1602	0.0005	0.47	0.02
6310	Jankonke (H)	11/21-11/24	123	10.1,10.0	58	-14	3.076	0.002	0.10	0.01
6447	Terrycole (H)	11/15-11/17	295	5.4,4.4	59	-3	10.268	0.006	0.24	0.02
6744	Komoda	11/19-11/20	180	2.3,2.0	60	-4	3.110	0.005	0.40	0.02
7086	Bopp (H)	09/18-10/08	430	18.6,22.1	349	+21	29.15	0.02	0.10	0.01
7560	Spudis (H)	09/22-10/08	274	19.6,19.5,20.3	6	+26	3.5440	0.0002	0.38	0.02
8325	Trigo-Rodriguez	11/07	48	2.3	40	+5	long		>0.05	
11149	Tateshina	11/05-11/07	144	2.3,2.8	41	+4	12.85	0.05	0.42	0.02
11709	Eudoxos	11/24-11/25	40	1.5,1.8	60	-3	2.64	0.05	0.24	0.05
13245	1998 MM19 (H)	10/09-10/11	133	4.5,5.6	9	+2	4.664	0.005	0.28	0.02
13573	1993 FZ18	11/18-11/20	154	7.6,8.5	41	-4	3.06/6.12	0.03	0.07	0.01
14395	Tommorgan (H)	11/05-12/07	963	9.2,24.6	40	+15	35.5[1]	0.5	0.61	0.05
15434	Mittal	11/15-11/17	168	11.4,10.3	71	-3	8.52	0.05	0.65	0.03
17657	1996 VO4 (H)	11/14-11/16	206	4.7,5.9	46	-3	5.507	0.005	0.53	0.02
22013	1999 XO89	11/06	70	5.6	32	+8	6.5	0.3	0.20	0.03
26916	1996 RR2 (H)	11/05-11/15	201	18.8,18.5	49	+31	10.326	0.005	0.27	0.02
27776	Cortland (H)	12/12-12/22	536	21.2,21.0	81	+29	2.6095	0.0003	0.07	0.01
27776	Cortland (H)	08/17-08/29*	391	13.6,8.2	342	+7	2.6104	0.0004	0.05	0.01
30878	1992 GQ	12/18-12/22	140	2.5,3.9	81	-3	3.655	0.005	0.22	0.02
30981	1995 SJ4	11/17-11/19	202	9.5,10.0	37	+15	2.951	0.003	0.14	0.02
31831	1999 YL (H)	10/09-10/23	234	14.0,17.0	7	+20	3.36	0.01	0.12	0.02
32626	2001 RX64	11/07	91	3.2	41	+5	6.23	0.05	0.43	0.03
51371	2000 XF15 (H)	11/19-11/25	290	3.1,2.6	60	-3	54/112	5	0.09	0.01
55844	Bicak (H)	09/10-10/03	416	18.8,21.4	352	+27	2.8052	0.0002	0.10	0.01
55854	1996 VS1 (H)	11/17-11/18	187	9.7,10.3	42	-3	3.059	0.005	0.28	0.02
63440	2001 MD30 (H)	11/01-11/06	319	7.3,9.2	33	+7	3.2940	0.0006	0.14	0.01
66832	1999 UE45	11/12	83	8.8	38	+14	6.5	0.3	0.16	0.02
70927	1999 VX210	11/07	57	2.9	41	+5	6.6	0.3	0.60	0.03
72675	2001 FP54	11/12	58	4.7	40	+6	2.50	0.05	0.38	0.03
86388	2000 AT60	12/21-01/02	112	5.3,11.7	82	-3	10.23	0.02	0.26	0.03
90988	1997 XS13	12/18	58	3.6	81	-3	8.8	0.5	0.14	0.02
123937	2001 EX16 (H)	10/09-11/05	332	5.7,22.5	14	+10	39.82	0.04	0.07	0.01
136017	2002 VH74	11/20	79	1.8	60	-4	4.3	0.2	0.35	0.05
192683	1999 SO27	11/18-11/21	244	13.2,14.2	39	+15	13.17[2]	0.07[2]	0.14[2]	0.03
330825	2008 XE3	10/02-10/08	299	39.7,37.5	34	+19	4.409	0.001	0.22	0.02
	2012 TC4	10/11 (7 UT)	211	32.1	2	+2	0.2038	0.0002	0.93	0.05

*2009 [1]Tumbler, dominant period given [2]Alternate solution: P=26.45±0.25h, A=0.22±0.03mag.

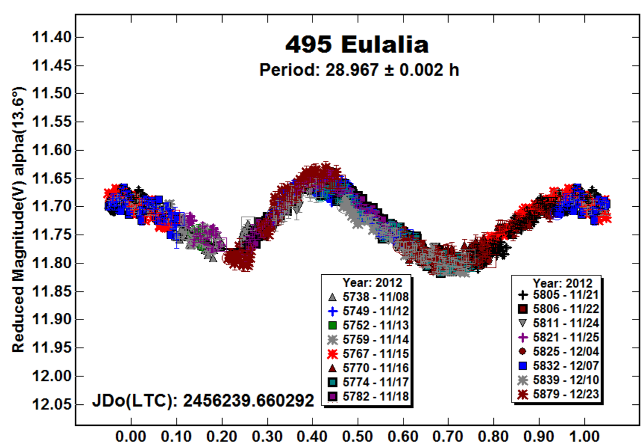
Table I. Observing circumstances. Asteroids with (H) after the name are members of the Hungaria group/family. The phase angle (α) is given at the start and end of each date range, unless it reached a minimum, which is then the second of three values. If a single value is given, the phase angle did not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

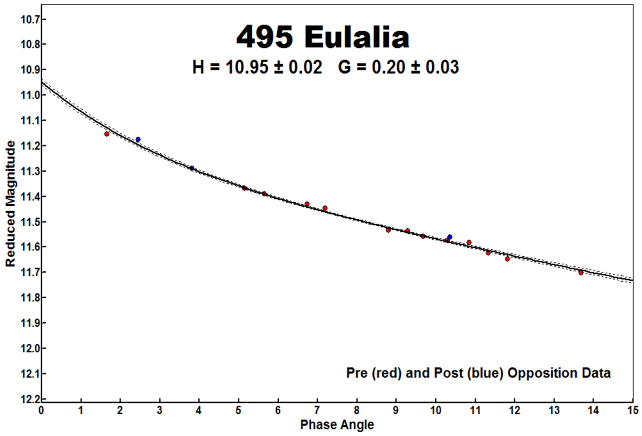
Warner, B.D. (2010b). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 September-December." *Minor Planet Bul.* **37**, 57-64.

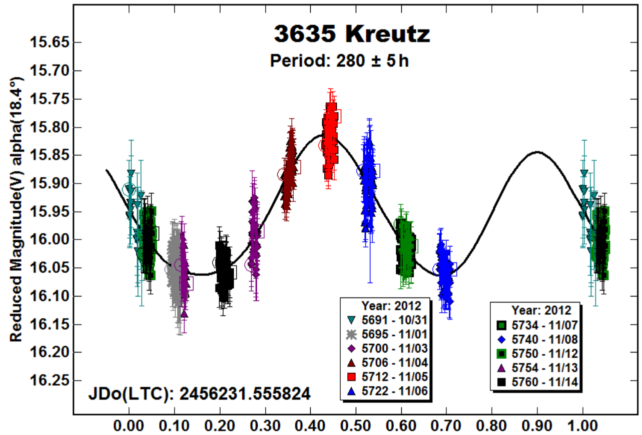
Warner, B.D. (2010c). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2010 March – June." *Minor Planet Bul.* **37**, 161-165.

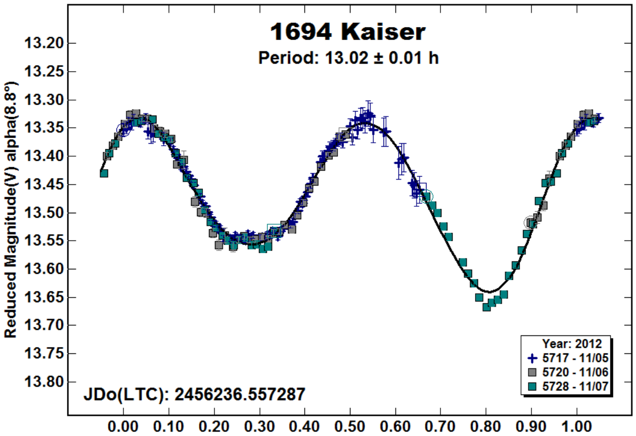
Warner, B.D. (2011). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2011 March – July." *Minor Planet Bul.* **38**, 190-195.

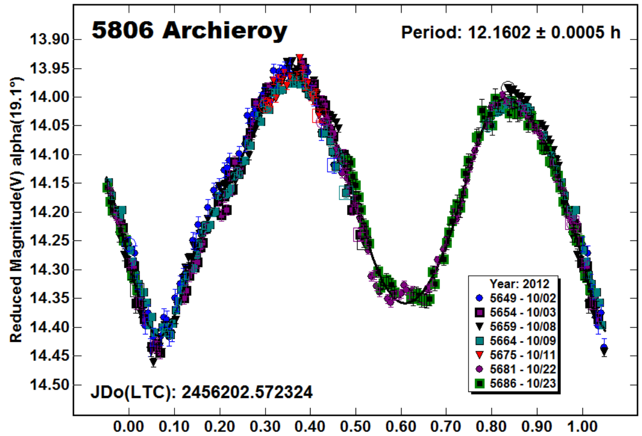
Warner, B.D., Harris, A.W., and Pravec, P. (2009) "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146.

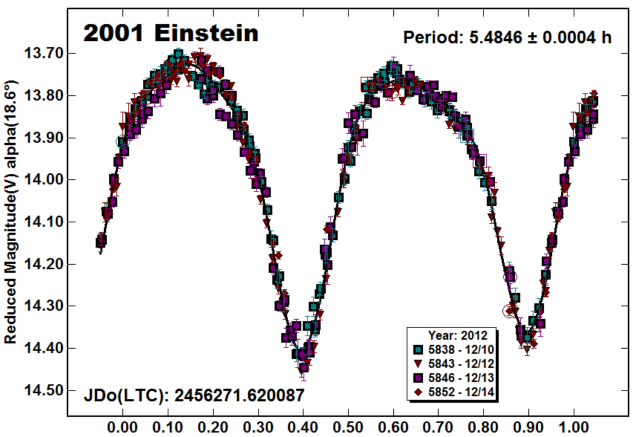


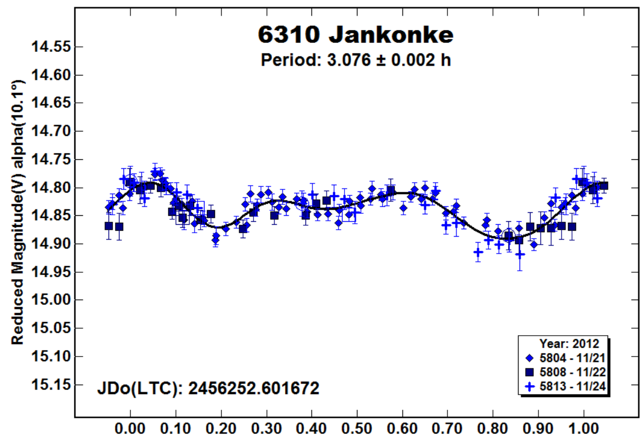

495 Eulalia
H = 10.95 ± 0.02 G = 0.20 ± 0.03
Reduced Magnitude
Pre (red) and Post (blue) Opposition Data
Phase Angle

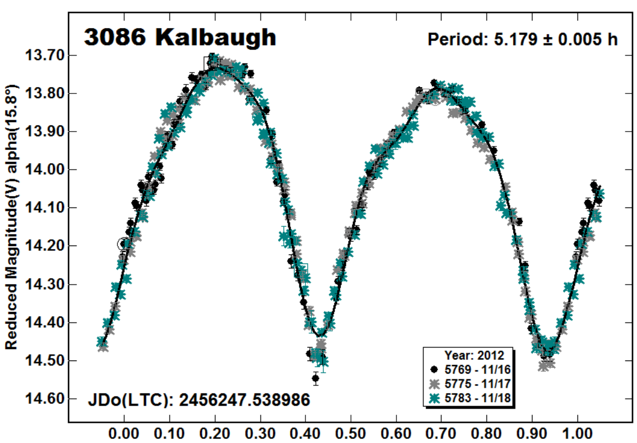

3635 Kreutz
Period: 280 ± 5 h
Reduced Magnitude(V) alpha(18.4°)
Year: 2012
5691 - 10/31
5695 - 11/01
5700 - 11/03
5706 - 11/04
5712 - 11/05
5722 - 11/06
Year: 2012
5734 - 11/07
5740 - 11/08
5750 - 11/12
5754 - 11/13
5760 - 11/14
JDo(LTC): 2456231.555824

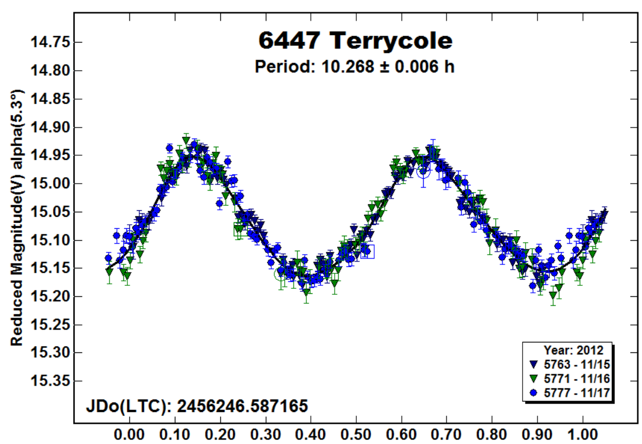

1694 Kaiser
Period: 13.02 ± 0.01 h
Reduced Magnitude(V) alpha(8.8°)
Year: 2012
5717 - 11/05
5720 - 11/06
5728 - 11/07
JDo(LTC): 2456236.557287

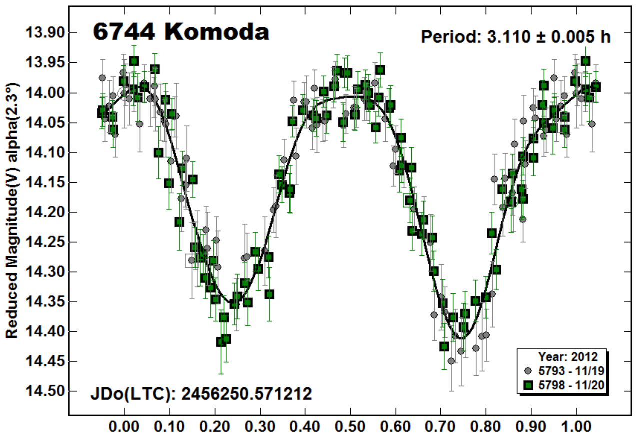

5806 Archieroy
Period: 12.1602 ± 0.0005 h
Reduced Magnitude(V) alpha(19.1°)
Year: 2012
5649 - 10/02
5654 - 10/03
5659 - 10/08
5664 - 10/09
5675 - 10/11
5681 - 10/22
5686 - 10/23
JDo(LTC): 2456202.572324

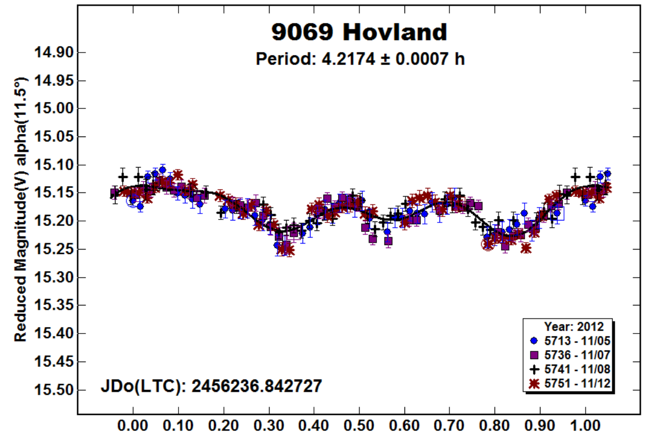

2001 Einstein
Period: 5.4846 ± 0.0004 h
Reduced Magnitude(V) alpha(18.6°)
Year: 2012
5838 - 12/10
5843 - 12/12
5846 - 12/13
5852 - 12/14
JDo(LTC): 2456271.620087

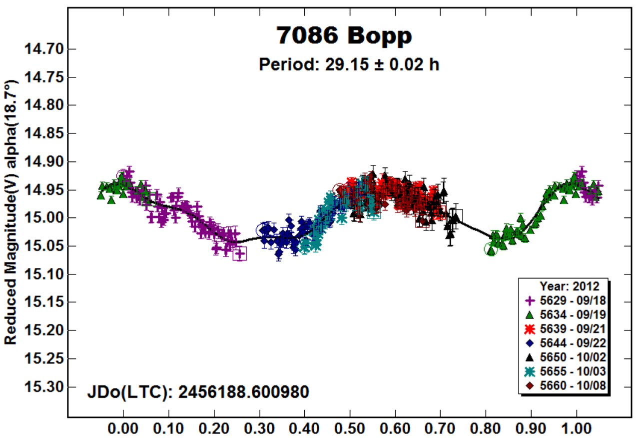

6310 Jankonke
Period: 3.076 ± 0.002 h
Reduced Magnitude(V) alpha(10.1°)
Year: 2012
5804 - 11/21
5808 - 11/22
5813 - 11/24
JDo(LTC): 2456252.601672

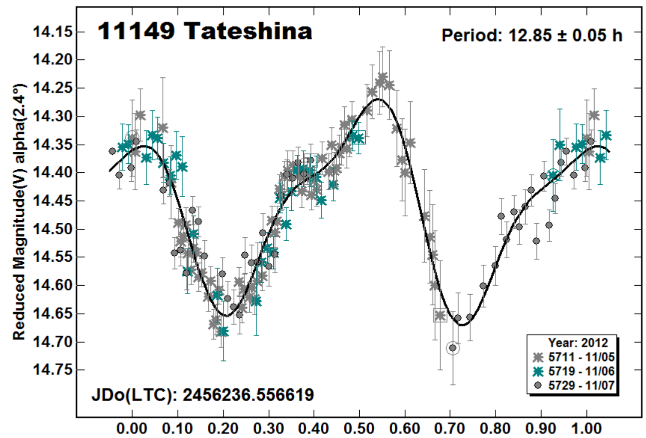

3086 Kalbaugh
Period: 5.179 ± 0.005 h
Reduced Magnitude(V) alpha(15.8°)
Year: 2012
5769 - 11/16
5775 - 11/17
5783 - 11/18
JDo(LTC): 2456247.538986

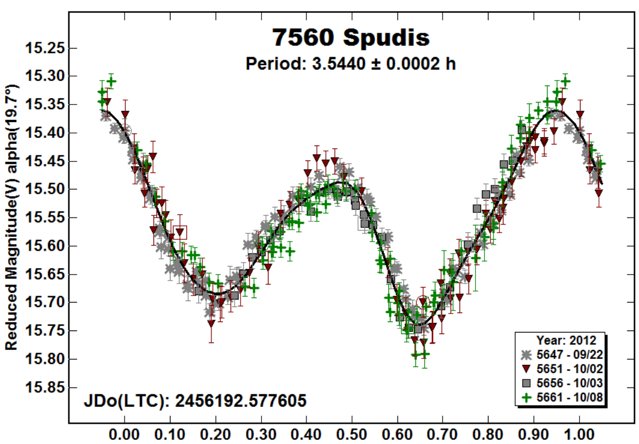

6447 Terrycole
Period: 10.268 ± 0.006 h
Reduced Magnitude(V) alpha(5.3°)
Year: 2012
5763 - 11/15
5771 - 11/16
5777 - 11/17
JDo(LTC): 2456246.587165

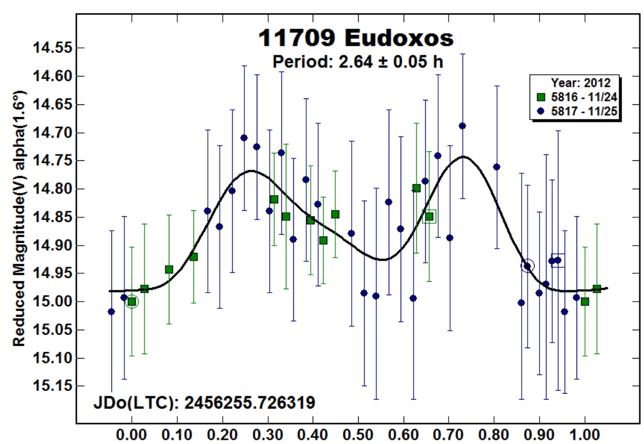

6744 Komoda
Period: 3.110 ± 0.005 h
Reduced Magnitude(V) alpha(2.3°)
Year: 2012
5793 - 11/19
5798 - 11/20
JDo(LTC): 2456250.571212

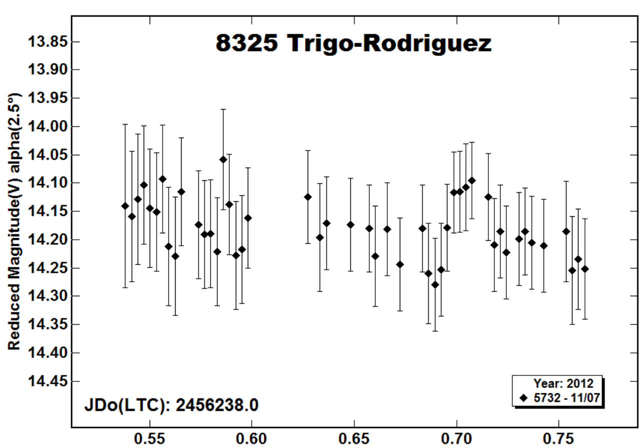

9069 Hovland
Period: 4.2174 ± 0.0007 h
Reduced Magnitude(V) alpha(11.5°)
Year: 2012
5713 - 11/05
5736 - 11/07
5741 - 11/08
5751 - 11/12
JDo(LTC): 2456236.842727

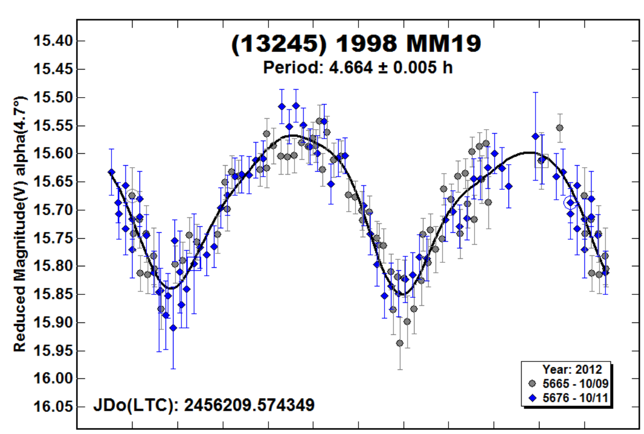

7086 Bopp
Period: 29.15 ± 0.02 h
Reduced Magnitude(V) alpha(18.7°)
Year: 2012
5629 - 09/18
5634 - 09/19
5639 - 09/21
5644 - 09/22
5650 - 10/02
5655 - 10/03
5660 - 10/08
JDo(LTC): 2456188.600980

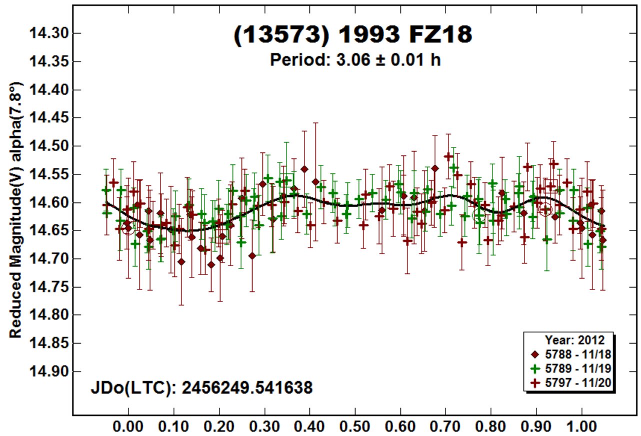

11149 Tateshina
Period: 12.85 ± 0.05 h
Reduced Magnitude(V) alpha(2.4°)
Year: 2012
5711 - 11/05
5719 - 11/06
5729 - 11/07
JDo(LTC): 2456236.556619

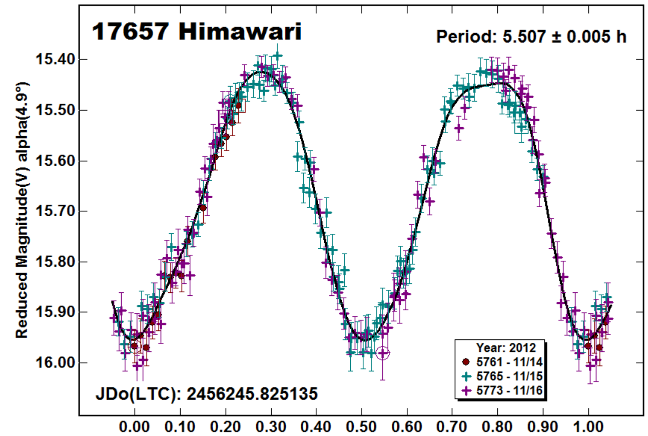

7560 Spudis
Period: 3.5440 ± 0.0002 h
Reduced Magnitude(V) alpha(19.7°)
Year: 2012
5647 - 09/22
5651 - 10/02
5656 - 10/03
5661 - 10/08
JDo(LTC): 2456192.577605

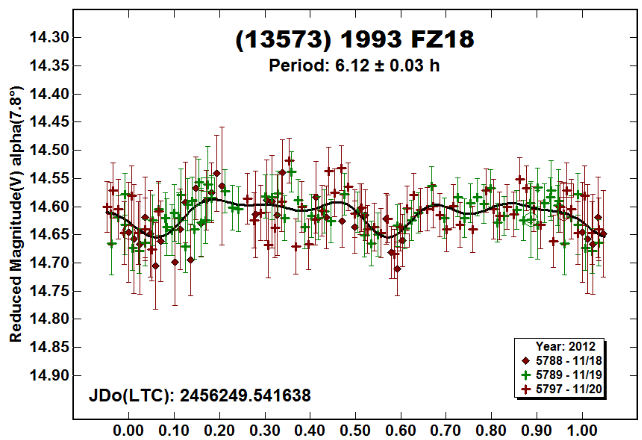

11709 Eudoxos
Period: 2.64 ± 0.05 h
Reduced Magnitude(V) alpha(1.6°)
Year: 2012
5816 - 11/24
5817 - 11/25
JDo(LTC): 2456255.726319

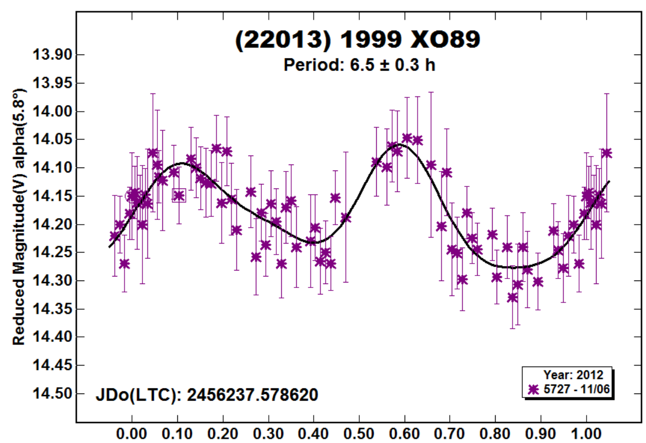

8325 Trigo-Rodriguez
Reduced Magnitude(V) alpha(2.5°)
Year: 2012
5732 - 11/07
JDo(LTC): 2456238.0

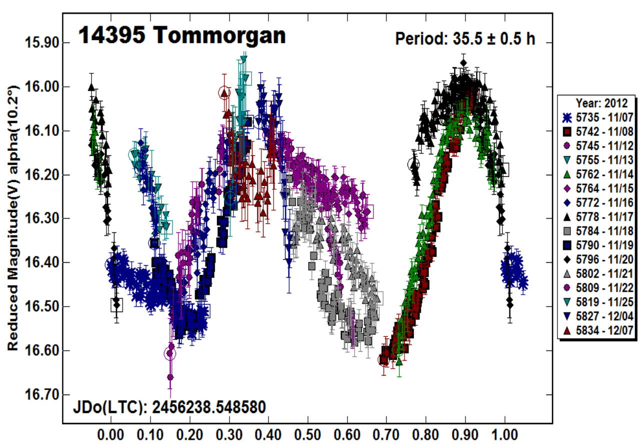

(13245) 1998 MM19
Period: 4.664 ± 0.005 h
Reduced Magnitude(V) alpha(4.7°)
Year: 2012
5665 - 10/09
5676 - 10/11
JDo(LTC): 2456209.574349

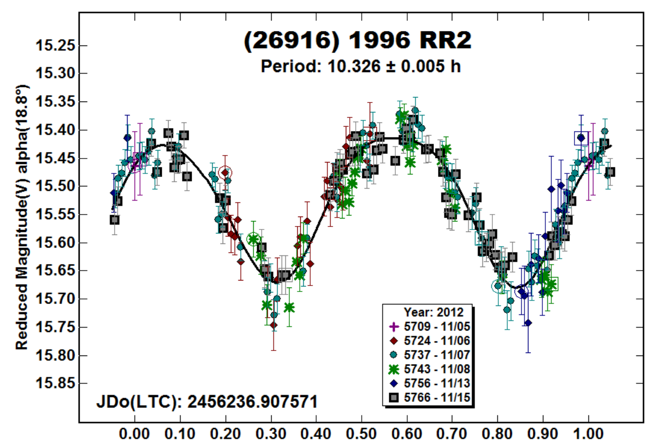

(13573) 1993 FZ18
Period: 3.06 ± 0.01 h
Reduced Magnitude(V) alpha(7.8°)
Year: 2012
5788 - 11/18
5789 - 11/19
5797 - 11/20
JDo(LTC): 2456249.541638

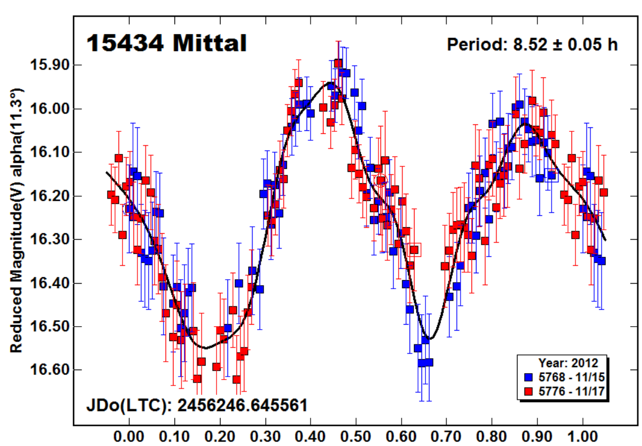

17657 Himawari
Period: 5.507 ± 0.005 h
Reduced Magnitude(V) alpha(4.9°)
Year: 2012
5761 - 11/14
5765 - 11/15
5773 - 11/16
JDo(LTC): 2456245.825135

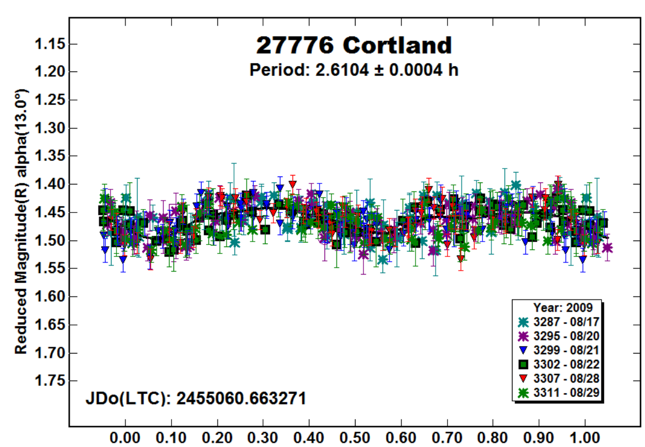

(13573) 1993 FZ18
Period: 6.12 ± 0.03 h
Reduced Magnitude(V) alpha(7.8°)
Year: 2012
5788 - 11/18
5789 - 11/19
5797 - 11/20
JDo(LTC): 2456249.541638

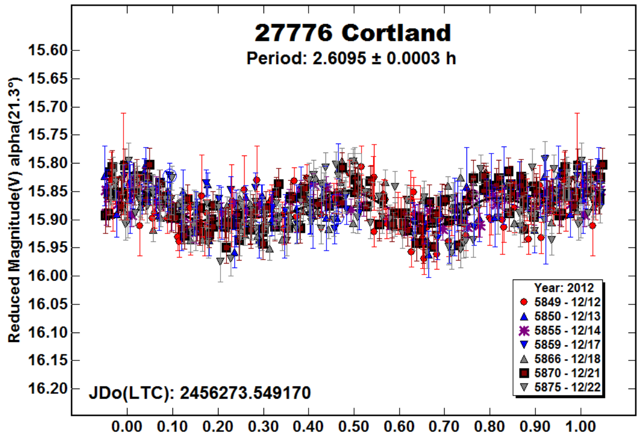

(22013) 1999 XO89
Period: 6.5 ± 0.3 h
Reduced Magnitude(V) alpha(5.8°)
Year: 2012
5727 - 11/06
JDo(LTC): 2456237.578620

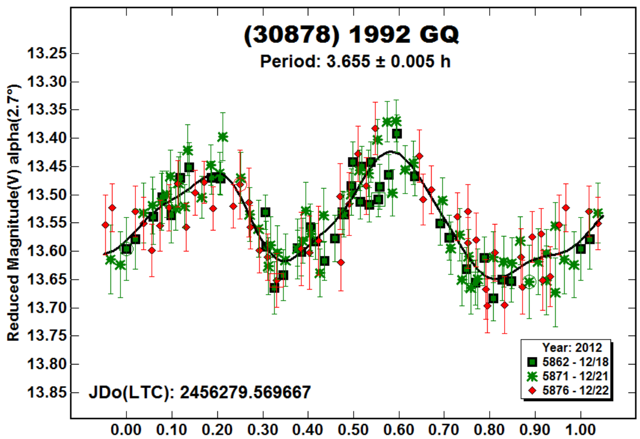

14395 Tommorgan
Period: 35.5 ± 0.5 h
Reduced Magnitude(V) alpha(10.2°)
Year: 2012
5735 - 11/07
5742 - 11/08
5745 - 11/12
5755 - 11/13
5762 - 11/14
5764 - 11/15
5772 - 11/16
5778 - 11/17
5784 - 11/18
5790 - 11/19
5796 - 11/20
5802 - 11/21
5809 - 11/22
5819 - 11/25
5827 - 12/04
5834 - 12/07
JDo(LTC): 2456238.548580

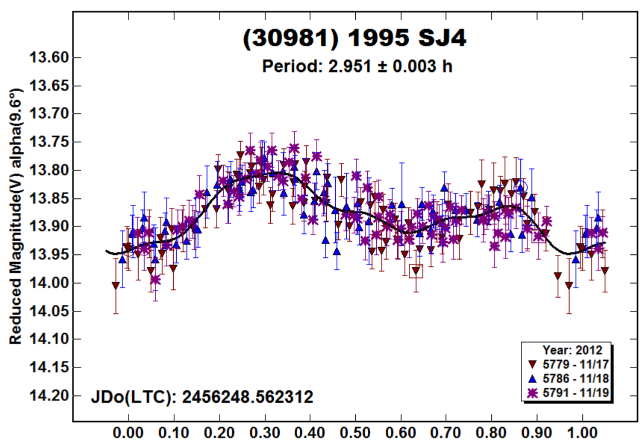

(26916) 1996 RR2
Period: 10.326 ± 0.005 h
Reduced Magnitude(V) alpha(18.8°)
Year: 2012
5709 - 11/05
5724 - 11/06
5737 - 11/07
5743 - 11/08
5756 - 11/13
5766 - 11/15
JDo(LTC): 2456236.907571

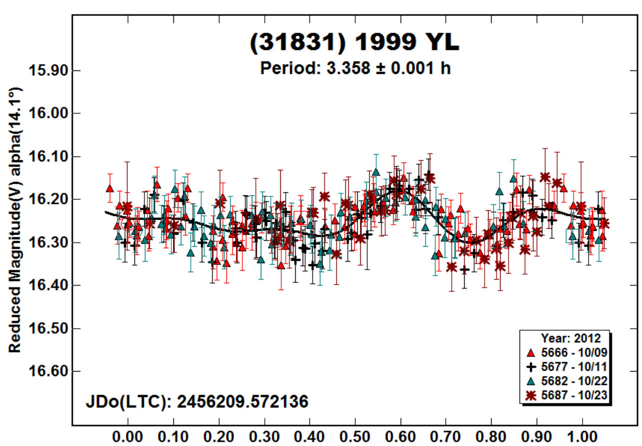

15434 Mittal
Period: 8.52 ± 0.05 h
Reduced Magnitude(V) alpha(11.3°)
Year: 2012
5768 - 11/15
5776 - 11/17
JDo(LTC): 2456246.645561

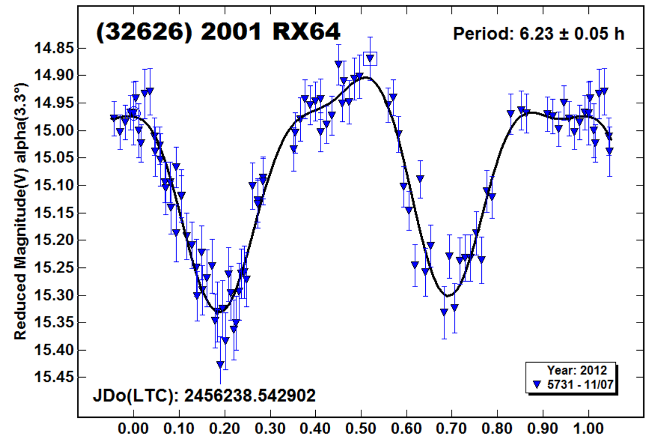

27776 Cortland
Period: 2.6104 ± 0.0004 h
Reduced Magnitude(R) alpha(13.0°)
Year: 2009
3287 - 08/17
3295 - 08/20
3299 - 08/21
3302 - 08/22
3307 - 08/28
3311 - 08/29
JDo(LTC): 2455060.663271

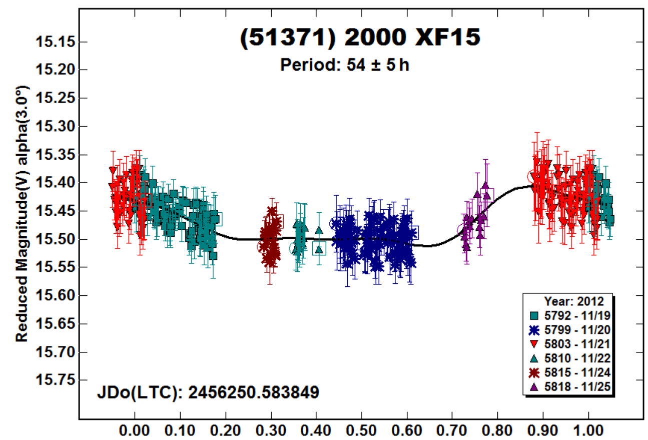

27776 Cortland
Period: 2.6095 ± 0.0003 h
Reduced Magnitude(V) alpha(21.3°)
JDo(LTC): 2456273.549170
Year: 2012
5849 - 12/12
5850 - 12/13
5855 - 12/14
5859 - 12/17
5866 - 12/18
5870 - 12/21
5875 - 12/22

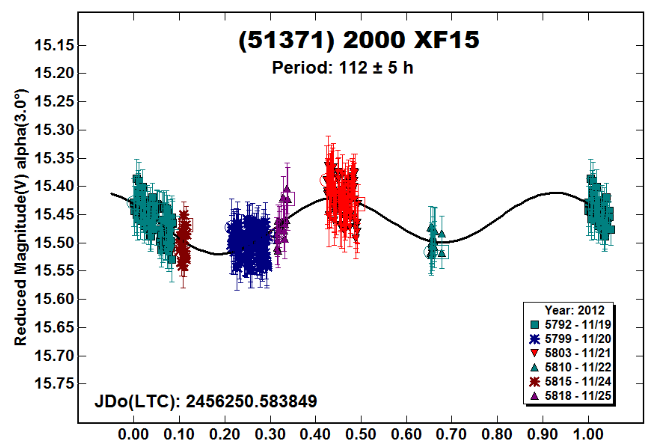

(30878) 1992 GQ
Period: 3.655 ± 0.005 h
Reduced Magnitude(V) alpha(2.7°)
JDo(LTC): 2456279.569667
Year: 2012
5862 - 12/18
5871 - 12/21
5876 - 12/22

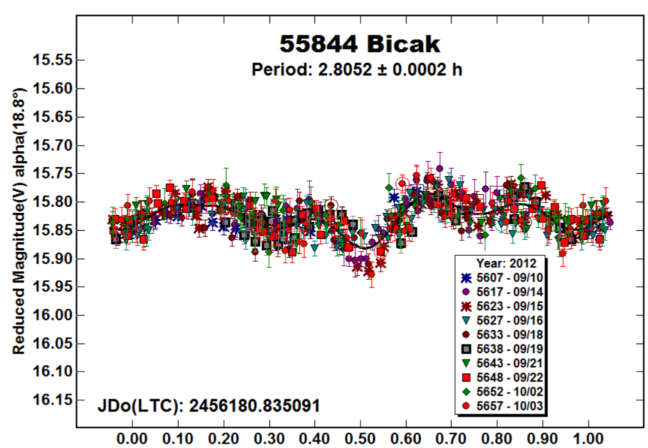

(30981) 1995 SJ4
Period: 2.951 ± 0.003 h
Reduced Magnitude(V) alpha(9.6°)
JDo(LTC): 2456248.562312
Year: 2012
5779 - 11/17
5786 - 11/18
5791 - 11/19

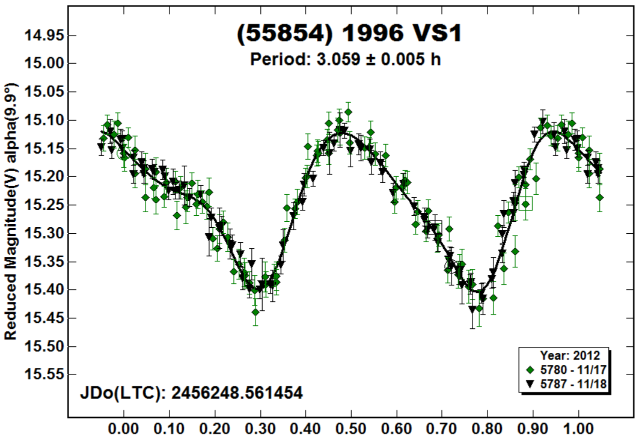

(31831) 1999 YL
Period: 3.358 ± 0.001 h
Reduced Magnitude(V) alpha(14.1°)
JDo(LTC): 2456209.572136
Year: 2012
5666 - 10/09
5677 - 10/11
5682 - 10/22
5687 - 10/23

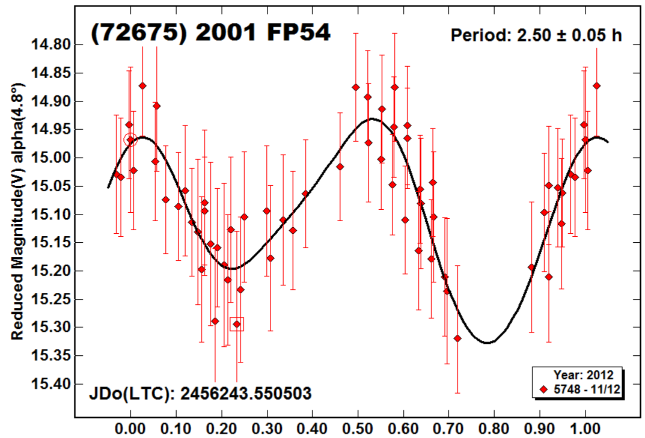

(32626) 2001 RX64
Period: 6.23 ± 0.05 h
Reduced Magnitude(V) alpha(3.3°)
JDo(LTC): 2456238.542902
Year: 2012
5731 - 11/07

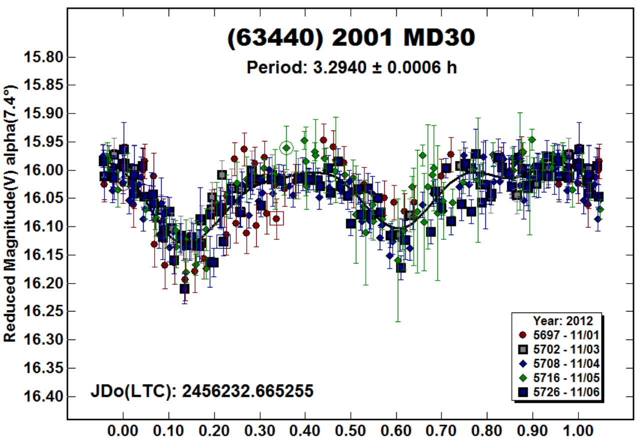

(51371) 2000 XF15
Period: 54 ± 5 h
Reduced Magnitude(V) alpha(3.0°)
JDo(LTC): 2456250.583849
Year: 2012
5792 - 11/19
5799 - 11/20
5803 - 11/21
5810 - 11/22
5815 - 11/24
5818 - 11/25

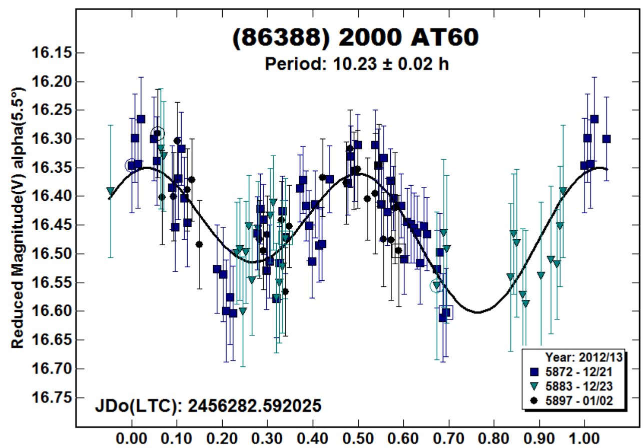

(51371) 2000 XF15
Period: 112 ± 5 h
Reduced Magnitude(V) alpha(3.0°)
JDo(LTC): 2456250.583849
Year: 2012
5792 - 11/19
5799 - 11/20
5803 - 11/21
5810 - 11/22
5815 - 11/24
5818 - 11/25

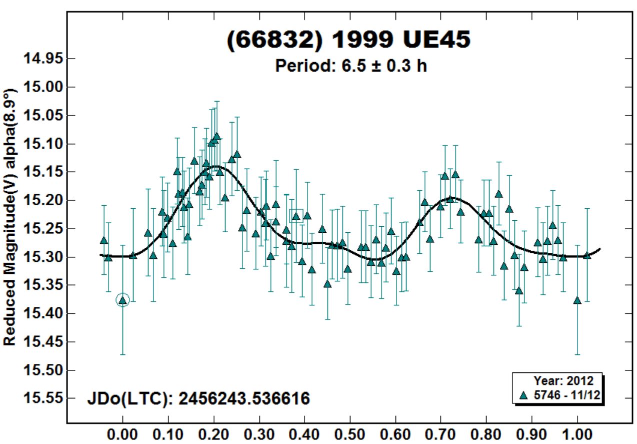

55844 Bicak
Period: 2.8052 ± 0.0002 h
Reduced Magnitude(V) alpha(18.8°)
JDo(LTC): 2456180.835091
Year: 2012
5607 - 09/10
5617 - 09/14
5623 - 09/15
5627 - 09/16
5633 - 09/18
5638 - 09/19
5643 - 09/21
5648 - 09/22
5652 - 10/02
5657 - 10/03

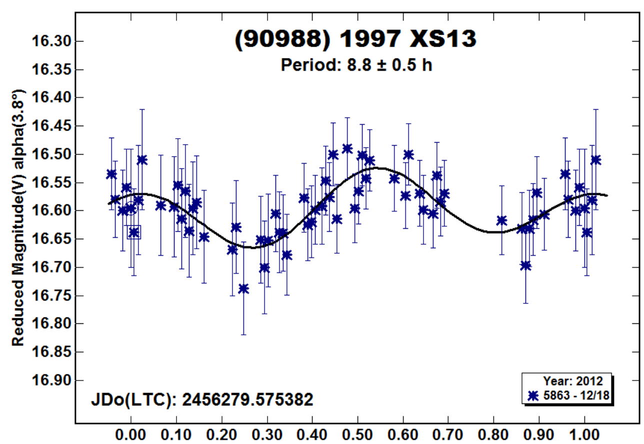

(55854) 1996 VS1
Period: 3.059 ± 0.005 h
Reduced Magnitude(V) alpha(9.9°)
JDo(LTC): 2456248.561454
Year: 2012
5780 - 11/17
5787 - 11/18

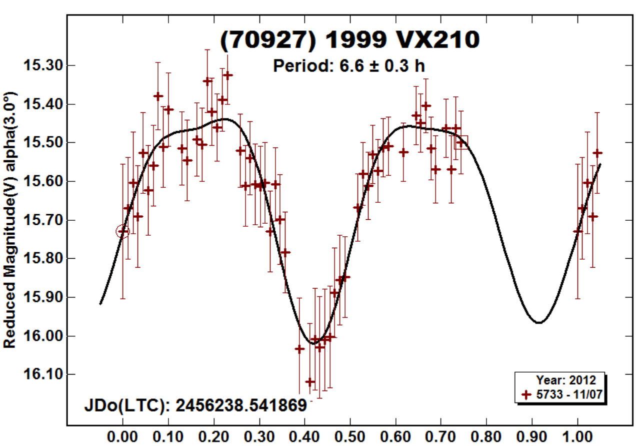

(72675) 2001 FP54
Period: 2.50 ± 0.05 h
Reduced Magnitude(V) alpha(4.8°)
JDo(LTC): 2456243.550503
Year: 2012
5748 - 11/12

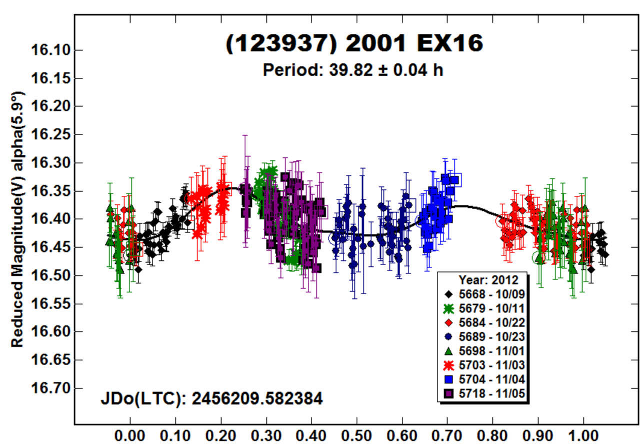

(63440) 2001 MD30
Period: 3.2940 ± 0.0006 h
Reduced Magnitude(V) alpha(7.4°)
JDo(LTC): 2456232.665255
Year: 2012
5697 - 11/01
5702 - 11/03
5708 - 11/04
5716 - 11/05
5726 - 11/06

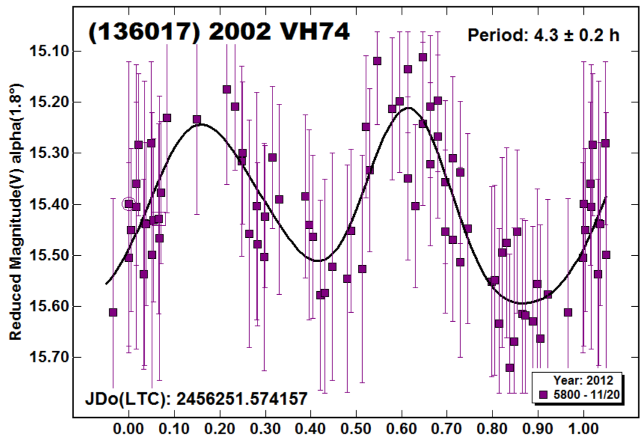

(86388) 2000 AT60
Period: 10.23 ± 0.02 h
Reduced Magnitude(V) alpha(5.5°)
JDo(LTC): 2456282.592025
Year: 2012/13
5872 - 12/21
5883 - 12/23
5897 - 01/02

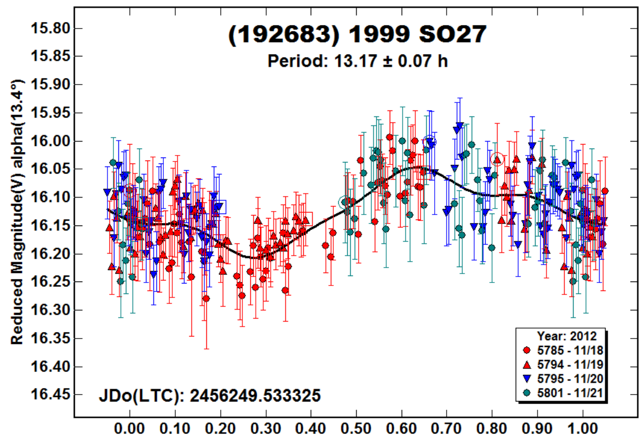

(66832) 1999 UE45
Period: 6.5 ± 0.3 h
Reduced Magnitude(V) alpha(8.9°)
JDo(LTC): 2456243.536616
Year: 2012
5746 - 11/12

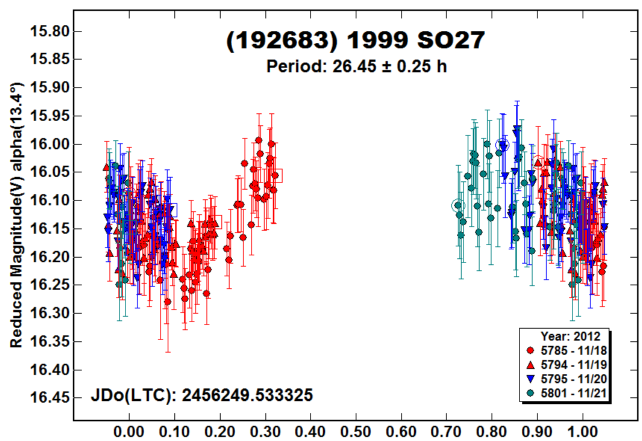

(90988) 1997 XS13
Period: 8.8 ± 0.5 h
Reduced Magnitude(V) alpha(3.8°)
JDo(LTC): 2456279.575382
Year: 2012
5863 - 12/18

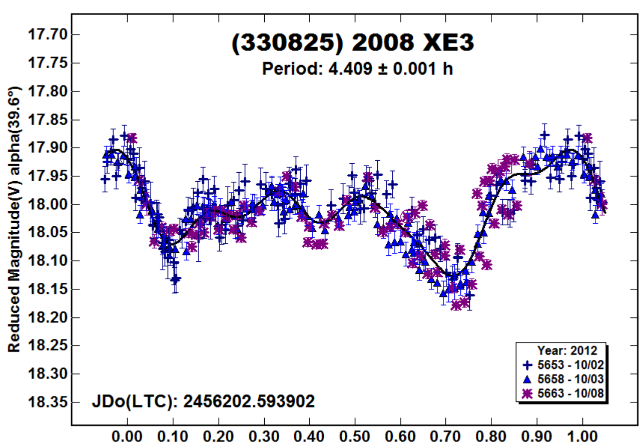

(70927) 1999 VX210
Period: 6.6 ± 0.3 h
Reduced Magnitude(V) alpha(3.0°)
JDo(LTC): 2456238.541869
Year: 2012
5733 - 11/07

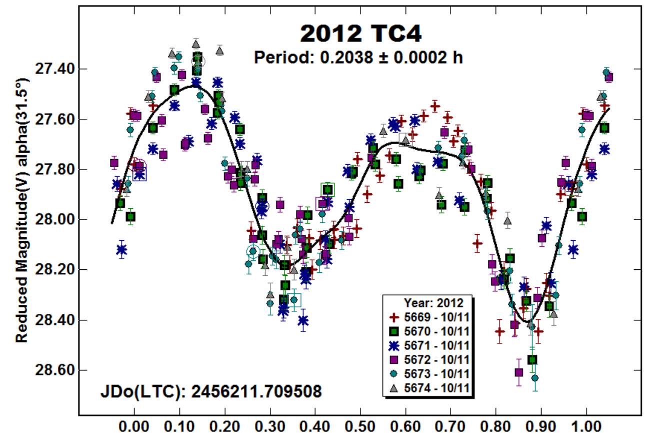

(123937) 2001 EX16
Period: 39.82 ± 0.04 h
Reduced Magnitude(V) alpha(5.9°)
JDo(LTC): 2456209.582384
Year: 2012
5668 - 10/09
5679 - 10/11
5684 - 10/22
5689 - 10/23
5698 - 11/01
5703 - 11/03
5704 - 11/04
5718 - 11/05











3382 CASSIDY: A SHORT PERIOD ASTEROID

Ethan Risley
Etscorn Campus Observatory, New Mexico Tech
101 East Road
Socorro, NM USA 87801
erisley@nmt.edu

(Received: 1 January Revised: 15 February)

The asteroid 3382 Cassidy was observed from the Etscorn Campus Observatory (ECO, 2012) at New Mexico Institute of Mining and Technology in Socorro, NM, on nine nights over a span of 43 days in 2012 September-November. A bimodal synodic period of 4.254 ± 0.002 h and an amplitude of 0.15 ± 0.02 mag were obtained.

3382 Cassidy is a main-belt asteroid discovered by H. L. Giclas at Flagstaff in 1948 (JPL, 2012). The Etscorn observations were made with Celestron C-14 telescopes with SBIG STL-1001E CCDs, unbinned, 1024x1024 24-micron pixels. All exposures were 180 seconds through a clear filter. Image scale was 1.25 arcsec/pixel. The images were dark-subtracted and flat-field corrected using *MPO Canopus* (Warner, 2011). The reduced images were also processed with *MPO Canopus*.

Images were obtained from 2012 Sep 20 through 2012 Nov 2. The asteroid was observed on nine nights during that period. Most nights contained at least 75% of the 4.254 hour period. All nights except one had sufficient MPOSC3 stars such that the *MPO Canopus* Comp Star Selector system could be used. Analysis of the combined data set of 504 data points found a period of 4.254 ± 0.002 h with an amplitude of 0.15 ± 0.02 mag. While there is some scatter in the individual data points, when combined they produce a well-determined period, which was found by using an 8th order fit in the FALC analysis algorithm (Harris *et al.*, 1989). The data from Sep 20 (session 7) seemed to show some deviations from the average curve. A separate plot of that session is included below. There is no obvious explanation for the deviation.

Acknowledgements

The Etscorn Campus Observatory operations are supported by the Research and Economic Development Office of New Mexico

Institute of Mining and Technology (NMIMT). Student support at NMIMT is given by NASA EPScOR grant NNX11AQ35A.

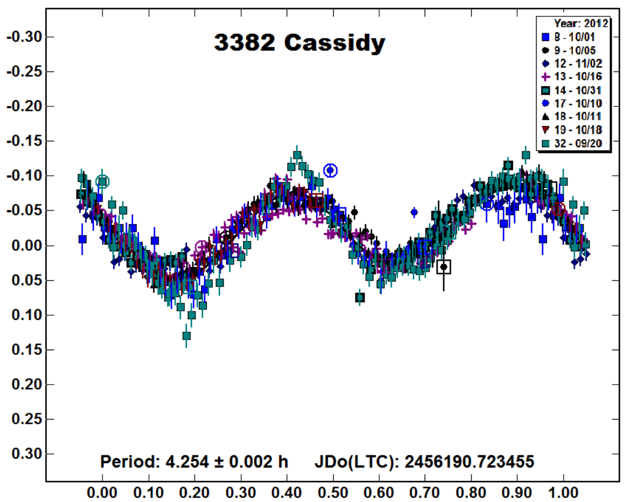
References

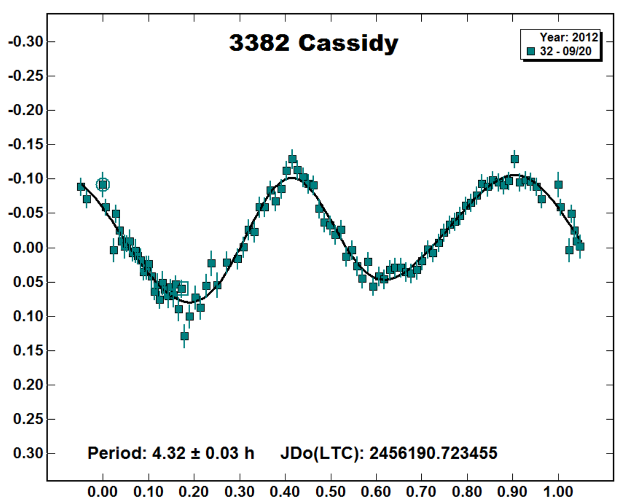
Etscorn Campus Observatory (ECO) (2012). *http://www.mro.nmt.edu/education-outreach/etscorn-campusobservatory/*

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**, 171-183.

JPL Small-Body Browser (2012). *http://ssd.jpl.nasa.gov/sbdb.cgi#top*

Warner, B.D. (2011). MPO Software, *MPO Canopus* version 10.4.0.6





ROTATION PERIOD DETERMINATION FOR 273 ATROPOS: ANOTHER TRIUMPH OF GLOBAL COLLABORATION

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

Eduardo M. Alvarez
Observatorio Los Algarrobos Salto Uruguay
Costanera Sur 559, Salto 50.000 URUGUAY

Andrea Ferrero
Bigmuskie Observatory (B88)
Via Italo Aresca 12, 14047 Mombercelli-Asti ITALY

Raguli Ya. Inasaridze and Otar I. Kvaratskhelia
Abastumani Astrophysical Observatory
Ilia State University
G. Tsereteli Street 3
Tbilisi 0162 GEORGIA REPUBLIC

Yurij N. Krugly
Institute of Astronomy of Kharkiv National University
Sumska str. 35, Kharkiv 61022 UKRAINE

Igor E. Molotov
Keldysh Institute of Applied Mathematics, RAS
Miusskaya sq. 4
Moscow 125047 RUSSIA

Julian Oey
Kingsgrove Observatory
23 Monaro Ave. Kingsgrove, NSW 2208 AUSTRALIA

Luca Pietro Strabla, Ulisse Quadri, Roberto Girelli
Observatory of Bassano Bresciano
via San Michele 4 Bassano Bresciano (BS) ITALY

(Received: 11 January)

Previous observations indicated a rotation period for 273 Atropos which was almost identical to Earth's rotation period, but which showed only partial phase coverage. A consortium of observers widely distributed in longitude collaborated to obtain full phase coverage with a synodic rotation period 23.924 ± 0.001 hours, amplitude 0.52 ± 0.03 magnitudes. Observations with BVRI filters at Simeiz provide B-V = 0.90 ± 0.07, V-R = 0.39 ± 0.035, R-I = 0.32 ± 0.045.

All previous reports of rotation periods for 273 Atropos were based on lightcurves with only partial phase coverage and the reported periods cannot be considered secure. These are by Tedesco (1979, fragmentary, 20 hours), Warner (2007, 30% phase coverage, 23.852 hours), and Behrend (2007, 75% phase coverage, 23.928 hours), all with amplitude near 0.60 magnitudes. For an object believed to have period almost equal to that of Earth it is necessary to obtain observations from several widely distributed longitudes for full lightcurve coverage because each participating observatory samples the same segment of the lightcurve on all nights. The several authors from Australia, Europe, North America, and South America agreed to participate in this collaboration. Observations from a total of 24 sessions 2012 Sept. 30 – Dec. 24 provide 100%

phase coverage to a somewhat asymmetric bimodal lightcurve with period 23.924 ± 0.001 hours, amplitude 0.52 ± 0.03 magnitudes. A combination of several considerations enables us to claim that our period of 23.924 hours is secure, that there are no feasible alias periods, and that the rotation period of this difficult object is solved definitively. No realistic shape model except an elongated one can produce a lightcurve with an amplitude as large as 0.52 magnitudes, and the lightcurve produced by such a shape is necessarily bimodal. The two minima are distinctly different in shape, and this rules out a monomodal lightcurve with half of our claimed period. There is excellent consistency among separate sessions covering the same part of the lightcurve, including those in the overlap sections covered by two observers. This not only testifies to the reliability of the overall result but also rules out significant tumbling.

Observations by Yu. Krugly with the 1 meter telescope at Simeiz 2012 Nov. 11 – 12 were made with Bessel B, V, R, I filters and provide color indices B-R = 1.29 ± 0.07, V-R = 0.39 ± 0.035, and R-I = 0.32 ± 0.045. From these data we compute B-V = 0.90 ± 0.07.

The observing cadences by EA at Observatorio Los Algarrobos and by FP at Organ Mesa Observatory are such that a much larger number of data points were acquired there than at any of the other collaborating observatories. To make more legible the large number of data points in the segments of the lightcurve included in the Los Algarrobos and Organ Mesa observations, they have been binned in sets of three points with a maximum of five minutes between points.

The following tables provide observer codes, MPC observatory code and equipment, and details of the individual sessions, respectively. The sessions are listed in temporal sequence of observations times, which is not the sequence of sessions numbers representing their receipt by the first author. Column headings refer to: Obs: Observer code; MPC, Minor Planet Center observatory code; Sess, session number; Date in calendar year 2012; UT of first and last observations of the session; Data Pts, number of data points in session.

Observer code

EA	Eduardo Alvarez
AF	Andrea Ferrero
RI	Raguli Inasaridze, Otar Kvaratskhelia
YK	Yurij Krugly
JO	Julian Oey
FP	Frederick Pilcher
LS	Luca Pietro Strabla, U. Quadri, R. Girelli

Observer equipment

Obs.	MPC	Telescope	CCD
EA	I38	0.3m f/6.9 S-C	QSI 516wsg 2x2
AF	B88	0.3m f/8 RC	SBIG ST9
RI	119	0.7m Maksutov	FLI IMG6063E
YK	094	1.0m at Simeiz	FLI PL09000
JO	E19	0.25m f/11 S-C	SBIG ST-9XE
FP	G50	0.35m f/11 S-C	SBIG STL-1001E
LS	565	0.32m f/3.1 S-C	Starlight HX-516

Session Data

Obs	Sess	Date	UT	Data Pts
FP	17	Sep 30	7:52 - 12:22	233
FP	18	Oct 1	7:39 - 12:21	234
FP	19	Oct 2	6:44 - 12:23	284
RI	187	Oct 13-14	22:04 - 1:48	49
JO	80	Oct 14	13:45 - 17:11	39
RI	188	Oct 14-15	22:16 - 1:48	46
LS	70	Oct 16-17	23:56 - 1:58	31
YK	189	Oct 17-18	21:11 - 2:58	109
JO	81	Oct 20	13:37 - 16:50	33
JO	82	Oct 21	12:50 - 18:20	56
LS	85	Oct 23-24	23:44 - 1:34	48
FP	86	Oct 25	5:23 - 12:31	370
JO	162	Nov 1	13:32 - 15:54	27
AF	99	Nov 6-7	23:36 - 4:36	73
FP	98	Nov 7	4:28 - 12:36	408
JO	163	Nov 11	11:10 - 13:21	50
YK	190	Nov 11-12	20:04 - 0:11	51
JO	164	Nov 25	10:35 - 13:31	28
AF	152	Dec 3	20:07 - 23:22	45
JO	165	Dec 4	12:43 - 16:14	44
JO	167	Dec 5	10:06 - 13:06	33
JO	166	Dec 5	16:01 - 17:39	41
EA	170	Dec 9-10	23:53 - 6:45	249
EA	180	Dec 23-24	23:46 - 6:41	236

Acknowledgment

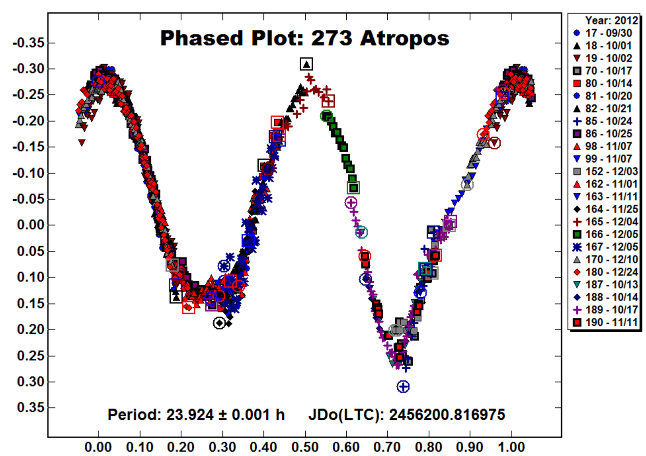
The first author thanks Alan Harris for helpful insights to explain how our 23.924 hour period may be considered secure.

References

Behrend, R. (2007). Observatoire de Geneve web site *http://obswww.unige.ch/~behrend/page_cou.html*

Tedesco, E. R. (1979). PhD Dissertation, New Mexico State University

Warner, B. D. (2007). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory - March - May 2007." *Minor Planet Bull.* **34**, 104-107.



ASTEROID OBSERVED FROM BASSANO BRESCIANO OBSERVATORY 2012 AUGUST-DECEMBER

Luca Strabla, Ulisse Quadri, Roberto Girelli
Bassano Bresciano Observatory
via San Michele 4 Bassano Bresciano (BS) Italy
lucapietro.strabla@fastwebnet.it

(Received: 2 January)

Lightcurves for four minor planets were obtained at Bassano Bresciano Observatory from 2012 August to December: 612 Veronika, 1474 Beira, 1604 Tombaugh, and 1060 Magnolia.

Photometric measurements of four minor planets were obtained at Bassano Bresciano Observatory (565) using the 0.32-m *f*/3.1 Schmidt and Starlight HX-516 CCD camera at prime focus. *Polypus* software v1.8.1 (Bassano Bresciano Observatory, 2010) was used to control the robotic observations. Exposure times for the unfiltered, unguided images were 120 s. Most of exposures were taken when the target's altitude was more than 30°. Due the negative declination of some of the asteroids, some exposures were taken when target's altitude was more than 25°. All raw images were processed with flat field and dark frames. *MPO Canopus* v.10.4.0.20 (Bdw Publishing, 2010) was used to perform differential photometry on the reduced images. Only solar-coloured comparison stars were used in order to minimize colour difference errors by using the Comp Star Selector in *MPO Canopus*. Data were light-time corrected but not reduced to standard magnitudes. The periods reported here were based on those having the lowest RMS error. Night-to-night calibration was done by adjusting the DeltaComp value in MPO *Canopus.* All data have been submitted to the ALCDEF database at *http://minorplanetcenter.net/light_curve.*

612 Veronika. This asteroid was selected in the list by Warner *et al.* (2011a) that indicated that no period had been previously reported. It was observed for eight nights covering a 35-day span. Three sessions were longer than five hours; all these show a very asymmetric but incomplete lightcurve. Period spectrum analysis showed only one deep minimum in the RMS fit, at P = 8.244 ± 0.001 h. The amplitude of the lightcurve is A = 0.14 ± 0.02 mag.

1060 Magnolia was selected from the list in Warner *et al*. (2011a). The asteroid was reported to have a period 2.9017 h, amplitude 0.09-014 mag, and quality code U = 2 (see Behrend, 2009). It was been observed for seven nights covering a 12-day span. Three sessions were longer than 6 hours; these didn't show the 2.917-hour period as expected. The low amplitude of the lightcurve versus the noise in the data made finding a definitive period difficult. The analysis shows a small preference for P = 5.821 h with A = 0.08 ± 0.02 mag. Periods of 2.901 h and 5.821 h were plotted and analysed. The dispersion for P = 5.821 showed the smaller dispersion. When plotting single sessions longer than six hours versus both periods, we saw a better overlap with P = 5.821 h. This leads us to conclude that this is the correct period.

1474 Beira. This asteroid was selected from the list in Warner *et al.* (2011a), which indicated a period of 4.184 h, amplitude 0.18 mag, and quality code U = 3. It was been observed for seven nights over a 19-day span. The sky motion was so large that it was necessary to move the telescope during the night to keep the asteroid within the image. We used two sessions per night and aligned them by changing the zero point of the second session. After that, we used the two sessions as one when doing a period search. Some sessions were longer than 6 hours, all of them clearly showing an asymmetric curve with at least 3 minimums and 3 maximums. This removed all doubt about the period solution. Period spectrum analysis found P = 4.184 ± 0.001 h with A = 0.24 ± 0.02 mag, which confirmed the period reported in Warner *et al*. (2011a; see Koff, 2004). .

1604 Tombaugh. This minor planet is named after Clyde Tombaugh, the man who found Pluto. It was selected from the list in Warner *et al*. (2011b) where it was reported to have P = 7.047 h, A = 0.16-0.20, and quality code U = 2+. It was observed for three nights in 2012 October and, after a long spell of bad weather, again on three nights in December, or a total span of 53 days. The longest session was about 4 hours and showed a bimodal lightcurve. Period spectrum analysis found a best-fit period of 7.056 ± 0.001 h with amplitude A = 0.35 ± 0.02 mag.

Asteroid		Date	Phase Angle	Time h.	Num. Obs.
612	Veronika	2012-09-11	8.1	2.4	62
612	Veronika	2012-09-13	7.8	4.5	117
612	Veronika	2012-09-14	7.7	6.3	152
612	Veronika	2012-09-15	7.6	2.4	67
612	Veronika	2012-09-20	7.5	6.7	116
612	Veronika	2012-09-21	7.6	6.0	135
612	Veronika	2012-09-24	8.0	1.9	52
612	Veronika	2012-10-07	11.5	5.5	139
612	Veronika	2012-10-16	14.3	4.2	118
1060	Magnolia	2012-08-08	7.6	6.0	110
1060	Magnolia	2012-08-10	7.5	4.4	116
1060	Magnolia	2012-08-11	7.6	5.7	105
1060	Magnolia	2012-08-14	8.0	4.3	108
1060	Magnolia	2012-08-17	8.9	6.0	144
1060	Magnolia	2012-08-18	9.3	6.2	154
1060	Magnolia	2012-08-20	10.0	4.5	144
1474	Beira	2012-08-21	20.4	6.8	115
1474	Beira	2012-08-22	20.2	3.0	76
1474	Beira	2012-08-26	19.6	6.9	179
1474	Beira	2012-08-27	19.5	6.8	172
1474	Beira	2012-09-06	19.9	6.4	149
1474	Beira	2012-09-07	20.0	4.6	101
1474	Beira	2012-09-10	20.7	6.5	201
1604	Tombaugh	2012-10-20	6.8	4.0	101
1604	Tombaugh	2012-10-22	7.3	3.0	76
1604	Tombaugh	2012-10-23	7.6	2.0	55
1604	Tombaugh	2012-12-10	19.1	0.9	21
1604	Tombaugh	2012-12-11	19.1	2.5	47
1604	Tombaugh	2012-12-12	19.2	3.9	90

References

Bassano Bresciano Observatory (2010). *Polypus* Software, version 1.8.1. *http://www.osservatoriobassano.org /testi/automazione.htm*

BDW Publishing (2010). *MPO Canopus* software, version 10.4.0.20. *http://minorplanetobserver.com*

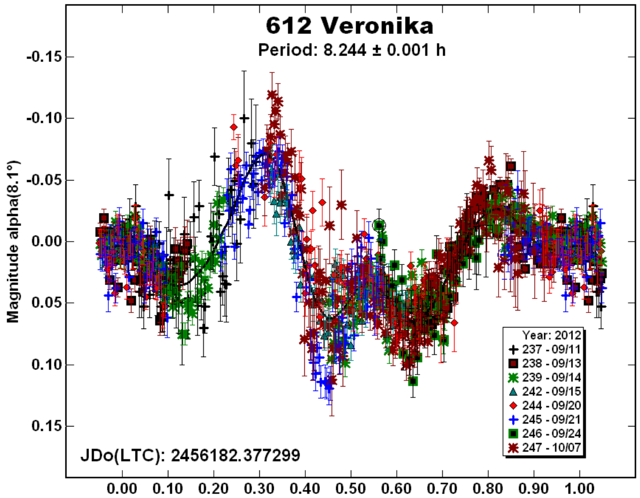
Berend, R. (2009). Observatoire de Genève web site. *http://obswww.unige.ch/~behrend/page_cou.html*

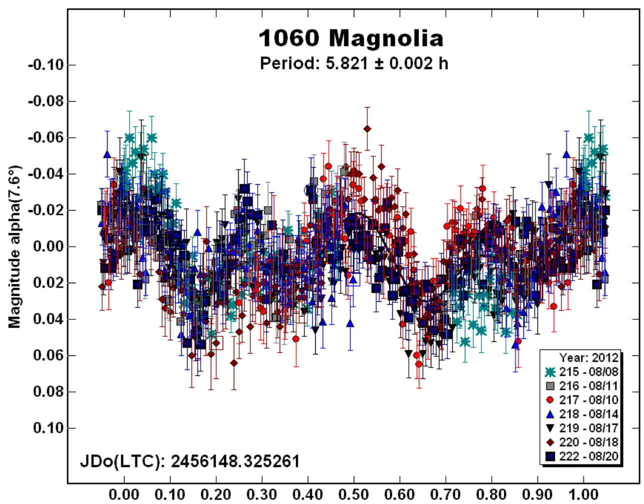
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

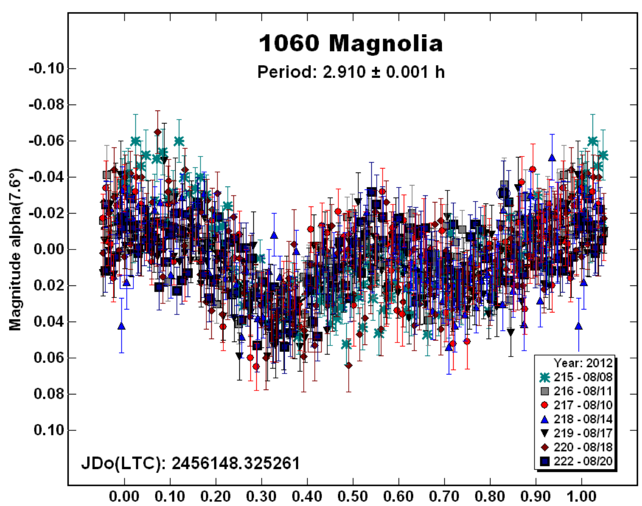
Koff, R.A. (2004). "Lightcurve photometry of Mars-crossing asteroids 1474 Beira and 3674 Erbisbuhl." *Minor Planet Bul.* **31**, 33-34.

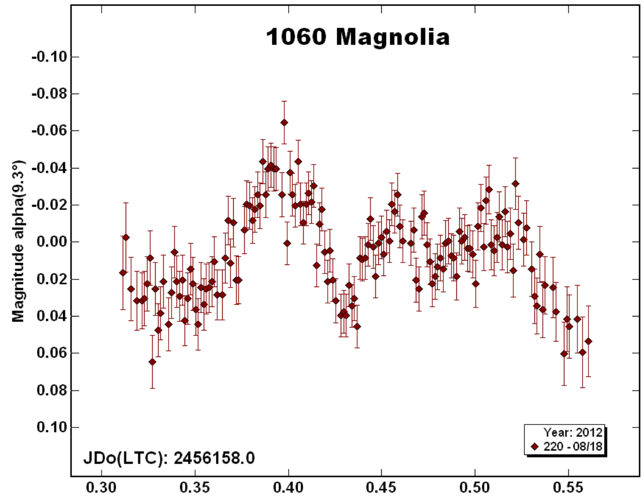
Warner, B.D., Harris, A.W., Pravec, P., Durech, J., and Benner, L.A.M., (2011a). "Lightcurve Photometry Opportunities: 2012 July-September." *Minor Planet Bulletin* **39**, 195-199.

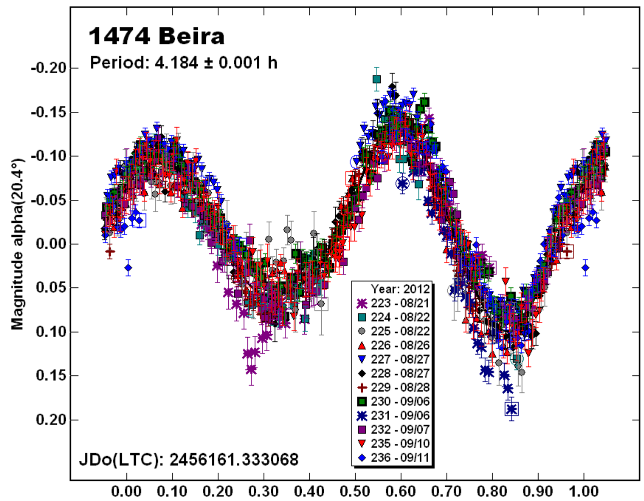
Warner, B.D., Harris, A.W., Pravec, P., Durech, J., and Benner, L.A.M., (2011b). "Lightcurve Photometry Opportunities: 2012 October-December." *Minor Planet Bulletin* **39**, 254-259.

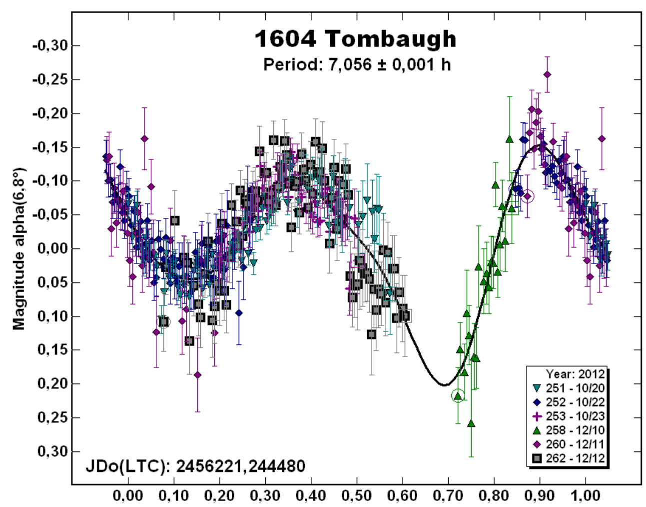












ROTATION PERIOD DETERMINATIONS FOR 24 THEMIS, 159 AEMILIA, 191 KOLGA, 217 EUDORA, 226 WERINGIA, 231 VINDOBONA, AND 538 FRIEDERIKE

Frederick Pilcher
4438 Organ Mesa Loop
Las Cruces, NM 88011-8403 USA
pilcher@ic.edu

(Received: 9 January)

Synodic rotation periods and lightcurve amplitudes have been found for: 24 Themis, P = 8.3743 ± 0.0001 h, A = 0.10 ± 0.01 mag with four unequal maxima and minima per cycle; 159 Aemilia, P = 24.476 ± 0.001 h, A = 0.17 ± 0.02 mag; 191 Kolga, P = 17.604 ± 0.001 h, A = 0.30 ± 0.02 mag; 217 Eudora, P = 25.272 ± 0.002 h, A = 0.31 ± 0.02 mag; 226 Weringia, P=11.147 ± 0.001h, A = 0.38 ± 0.02 mag; 231 Vindobona, P = 14.245 ± 0.001 h, A = 0.20 ± 0.03 mag; and 538 Friederike, P = 46.728 ± 0.004 h, A = 0.25 ± 0.02 mag.

All observations reported here were made at the Organ Mesa Observatory using a Meade 35-cm LX-200 GPS Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD. A Red filter was used for bright targets 24 Themis and 159 Aemilia and Clear filter was used for the other targets. Exposures were unguided. Analysis used differential photometry only. Image measurement and lightcurve analysis were done by *MPO Canopus*. Because of the large number of data points, the data for the lightcurves presented here have been binned in sets of three points with a maximum time interval between points no greater than 5 minutes.

24 Themis. Warner *et al.* (2012) state a secure synodic rotation period of 8.374 hours based on several consistent published values. The motive for obtaining additional lightcurves is to support spin/shape modeling. New observations on six nights 2012 Oct 16 – 2013 Jan 9 provide a good fit to a lightcurve phased to period 8.3743 ± 0.0001 h with amplitude 0.10 ± 0.01 mag and four unequal maxima and minima per cycle. This is in excellent agreement with previous studies.

159 Aemilia. Previous period determinations are by Harris and Young (1989), 25 h; Behrend (2012), 24.44 h; and Ditteon and Hawkins (2007), 16.37 h. New observations on 12 nights from 2012 Oct 26 to 2013 Jan 6 provide a good fit to a lightcurve phased to period 24.476 ± 0.001 h, amplitude 0.17 ± 0.02 mag. For a period slightly longer than Earth-synchronous, the phase of the lightcurve visible at a single location circulates slowly to the left. An interval of approximately 50 days separates successive samplings of a given phase. During this interval, the shape of the lightcurve may change considerably, and in this investigation a significant change did occur. On Oct 26 and 30, near phase angle 15 degrees, the falling portion of the lightcurve near phase 0.25 was smooth. On three consecutive nights, Dec 3-5 near phase angle 3 degrees, a conspicuous bump had appeared at this phase. By the next session, Dec 17 near phase angle 5 degrees, this bump had largely disappeared. From its appearance on three consecutive nights, I consider this feature to be real. Any future lightcurve inversion modeler should try to place a topographic feature on his model which explains this bump. On a trimodal lightcurve drawn to 3/2 of the likely period, this bump looked identical on all three descending branches. On a quadrimodal lightcurve drawn to the double-period, it appeared the same on the two corresponding alternate descending branches. Such symmetry is possible only for a highly symmetric shape model which is extremely unlikely for a real asteroid. The 3/2 and double periods may be safely rejected. The 24.476-hour period is consistent with Behrend (2012) and with Harris and Young (1989). A period near 16.37 h is definitively ruled out.

191 Kolga. Previous period determinations are by Holliday (2001), 27.80 h; Gil-Hutton and Canada (2003), 13.078 h; Behrend (2005), 13.7 h; Behrend (2009), 13.68 h; and Warner (2009), 17.625 hours. New observations on seven nights from 2012 Nov 28 to 2013 Jan 6 provide a good fit to a lightcurve phased to 17.604 ± 0.001 h, amplitude 0.30 ± 0.02 mag. This is consistent with Warner (2009) and rules out all other published periods.

217 Eudora. There have been several previous period determinations. Lagerkvist *et al.* (1998) on the basis of a very fragmentary lightcurve, which showed one minimum and no maximum, assumed a period of 12.54 h. Several more recent determinations show consistent results, with the period, amplitude, and ecliptic longitude, respectively, of each being: Behrend (2007), 25.253 h, 0.24 mag, 245 deg, with the same lightcurve also shown in Buchheim *et al.* (2007); Pilcher (2010), 25.470 h, 0.08 mag, 170 deg; Pilcher (2011), 25.253 h, 0.22 mag, 265 deg. New observations were made on ten nights from 2012 Nov 8 to Dec 10 near ecliptic longitude 75 deg. These provide a good fit to a lightcurve with period 25.272 ± 0.002 h, amplitude 0.31 ± 0.02 mag. The observations near ecliptic longitudes 245 deg, 170 deg, 265 deg, and 75 deg may be combined to provide information about the rotational parameters of 217 Eudora. The 25.470-hour period at longitude 170 degrees may look inconsistent. However it shows an amplitude only 0.08 magnitudes, much smaller than at any other apparitions, and hence was made at nearly polar viewing aspect. Under this circumstance, the difference between synodic and sidereal periods can be fairly large, and the discrepancy from the other reported synodic periods is useful in locating the spin vector. The 25.272-hour period at the current apparition has the largest amplitude and is therefore in near equatorial viewing aspect. From the amplitude-aspect method, the rotational pole probably lies within 20 degrees of longitude 170 deg, or alternatively 350 deg, and the phase angle bisector moved primarily in asteroid latitude. Therefore the 25.272-hour period is closer to the true sidereal period than any of the other published synodic periods.

226 Weringia. Previous period determinations are by Behrend (2012), 15.84 hs; Oey (2008), 11.240 h; and Oey (2009), 11.150 h. New observations on seven nights from 2012 Sep 22 to Nov 2 provide a good fit to a lightcurve phased to period 11.147 ± 0.001 h with amplitude 0.38 ± 0.02 mag. This is in excellent agreement with Oey (2009), slightly less good with Oey (2008), and rules out the 15.84-hour period by Behrend (2012).

231 Vindobona. Previous period determinations are by Blanco *et al.* (2000), 5.547 h; and Behrend (2012) 14.24 h. New observations on eight nights from 2012 Sep 19 to Nov 1 provide a good fit to a lightcurve phased to period 14.245 ± 0.001 h with amplitude 0.20 ± 0.03 mag. This is in good agreement with Behrend (2012).

538 Friederike. The only previous period determination is by Behrend (2012), 27.19 h, based on fragmentary data. New observations on 19 nights from 2012 Oct 17 to Dec 21 provide a good fit to a somewhat asymmetric bimodal lightcurve with period 46.728 ± 0.004 h, amplitude 0.25 ± 0.02 mag.

References

Behrend, R. (2005), (2009), (2012). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

Blanco, C., Di Martino, M., and Riccioli, D. (2000). "New rotational periods of 18 asteroids." *Planet Space Sci.* **48**, 271-284.

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

Ditteon, R. and Hawkins, S. (2007). "Asteroid Lightcurve Analysis at the Oakley Observatory - November 2006." *Minor Planet Bul.* **34**, 59-64.

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

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

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

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

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

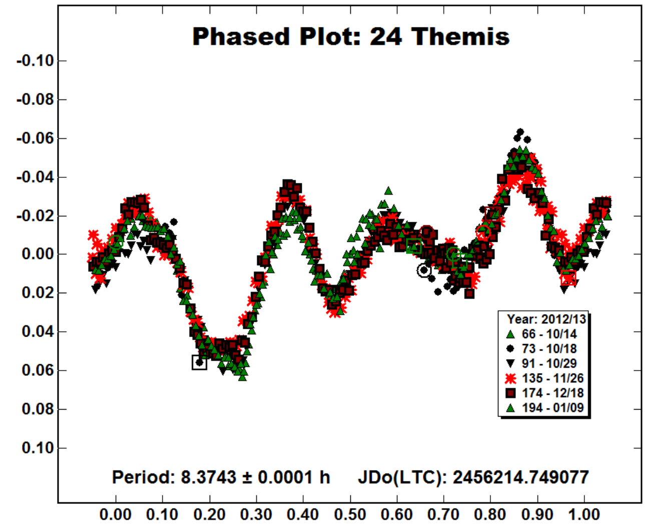
Oey. J. (2009). "Lightcurve Analysis of Asteroids from Leura and Kingsgove Observatory in the second half of 2008." *Minor Planet Bul.* **36**, 162-165.

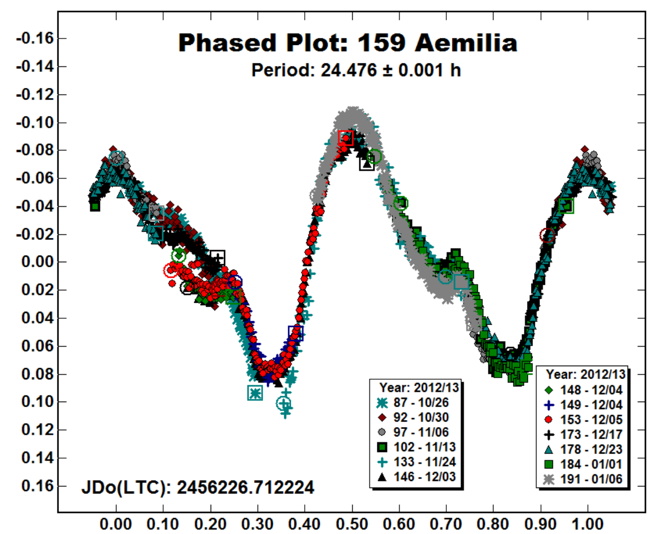
Pilcher, F. (2010). "Rotation Period Determinations for 80 Sappho, 217 Eudora, 274 Philagoria, and 826 Henrika." *Minor Planet Bul.* **37**, 148-149.

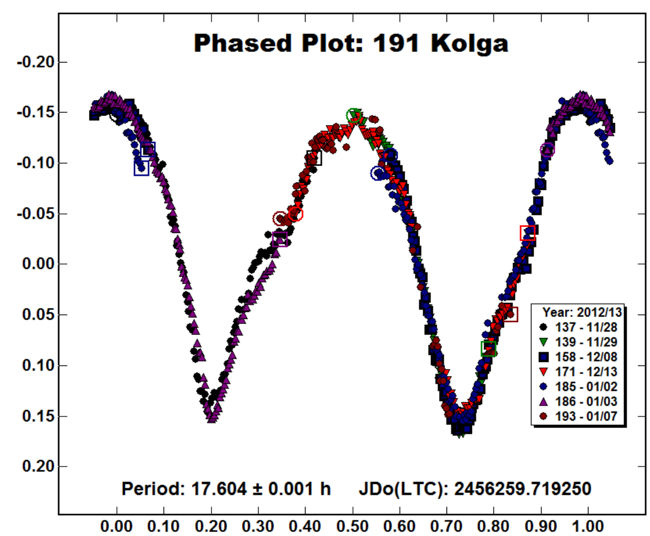
Pilcher, F. (2011). "Rotation Period Determinations for 11 Parthenope, 38 Leda, 99 Dike, 111 Ate, 194 Prokne, 217 Eudora, and 224 Oceana." *Minor Planet Bul.* **38**, 183-185.

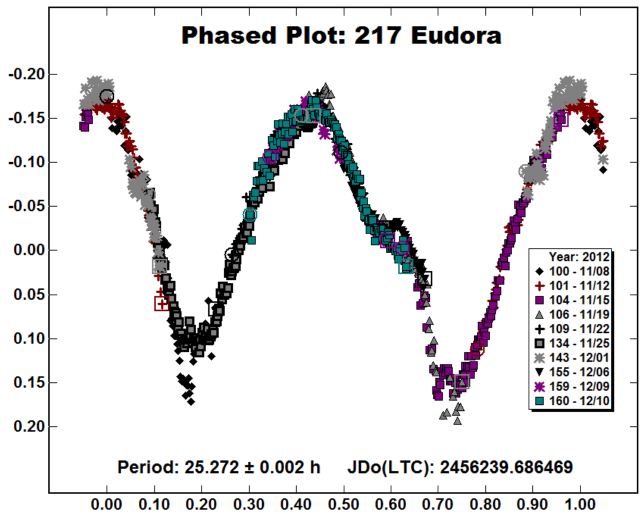
Warner, B.D. (2009). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2009 March - June." *Minor Planet Bul.* **36**, 172-176.

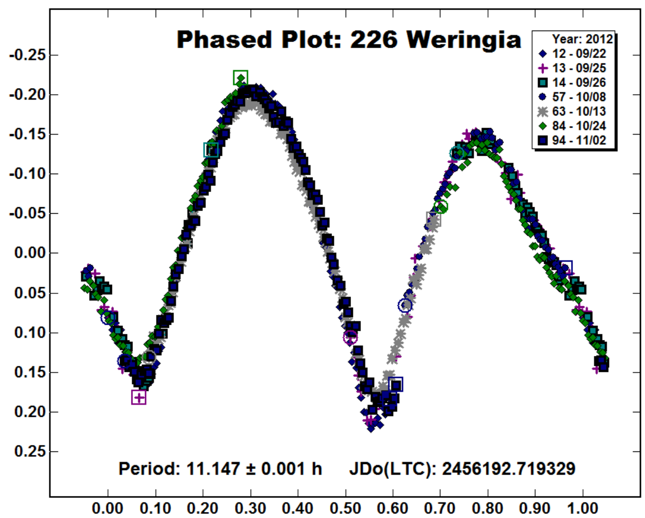
Warner, B.D., Harris, A.W., Pravec, P. (2012). "Asteroid Lightcurve Data File, 2012 June 24." *http://www.minorplanet.info/lightcurvedatabase.html*

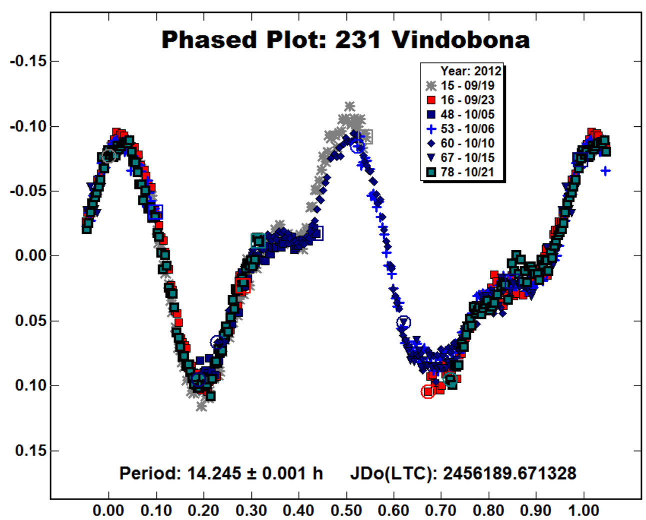




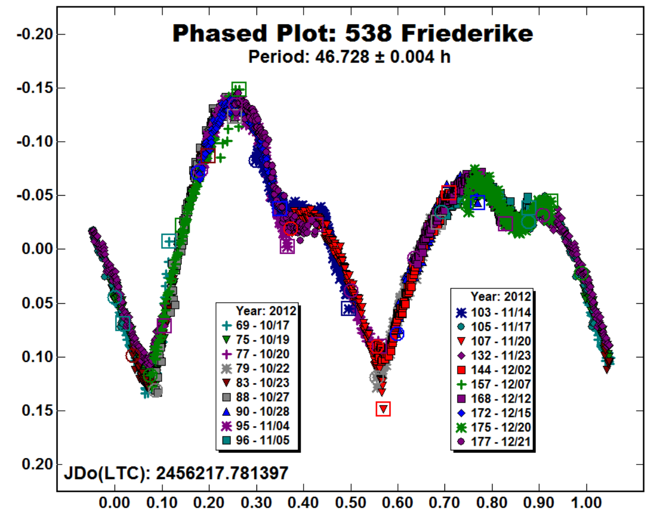








UT Date yyyy/mm/dd	Phase	LPAB	BPAB
2012/11/10 - 11/17	6.6-9.2	35.6-35.8	7.1-6.6



CCD LIGHTCURVE OF 95 ARETHUSA

Kevin B. Alton
UnderOak Observatory
70 Summit Ave.
Cedar Knolls, NJ 07927
mail@underoakobservatory.com

(Received: 3 January Revised: 6 February)

Fourier analysis of CCD-derived Rc-bandpass lightcurves produced a synodic period solution for 95 Arethusa of 8.705 ± 0.005 h.

95 Arethusa is a low albedo ($p_V < 0.07$) carbonaceous main-belt asteroid discovered in 1867 by Robert Luther. Studies over the past three decades (Carlsson and Lagervist, 1981; Harris and Young, 1983; Ďurech *et al*., 2011) indicate a sizeable (D ~140 km) minor planet with a synodic period ranging between 8.688 and 8.702 h. The observations were made with a 0.2-m *f*/10 catadioptric OTA equipped with an SBIG ST8-XME thermoelectrically-cooled CCD. This combination produced a field-of-view of about 14.3×21.5 arcmin, or 1.69 arcsec/pixel. Continuous exposures of 60 s with an Rc filter were made during each of four sessions in the period of 2012 Nov 10-17, producing a total of 893 images. Additional details of the observation and image reduction procedures used at UO can be found in Alton (2010).

The data for analysis were light-time corrected and reduced to instrumental magnitudes with *MPO Canopus* (Warner, 2010). At least four non-varying comparison stars were used to generate lightcurves by differential aperture photometry. Fourier analysis (Harris *et al.*, 1989) yielded a period solution from each folded dataset that was independently verified using *Peranso* (Vannmunster, 2006) as previously described (Alton, 2011). Relevant aspect parameters taken at the mid-point from each observing session are given in the table. Phased data are available upon request.

The Fourier analysis produced a folded lightcurve with a slightly longer period (8.705 h) than published values. The peak-to-peak amplitude of A = 0.35 mag (Rc) was greater than the range (0.24-

0.25 V mag) previously reported for this object (Carlsson and Lagervist, 1981; Harris and Young, 1983).

Acknowledgements

Many thanks to the SAO/NASA Astrophysics Data System and the Asteroid Lightcurve Database (LCDB; Warner *et al.*, 2009), both of which proved indispensable for locating relevant literature references.

References

Alton, K.B. (2010). "A Unified Roche-Model Light Curve Solution for the W UMa Binary AC Bootis." *JAAVSO* **38**, 57.

Alton, K.B. (2011). "CCD Lightcurves for 4 Main Belt Asteroids." *Minor Planet Bulletin* **38**, 8-9.

Carlsson, M. and Lagervist, C.-I. (1981). "Physical studies of asteroids. IV - Photoelectric observations of the asteroids 47, 95, 431." *Astron. Astrophys. Suppl Series* **45**, 1-4.

Ďurech, J., Kaasalainen, M., Herald, D., Dunham, D., Timerson, B., Hanuš, J., Frappa, E., Talbot, J., Hayamizu, T., Warner, B.D., Pilcher, F., and Galád, A. (2011). "Combining asteroid models derived by lightcurve inversion with asteroidal occultation silhouettes." *Icarus* **214**, 652-670.

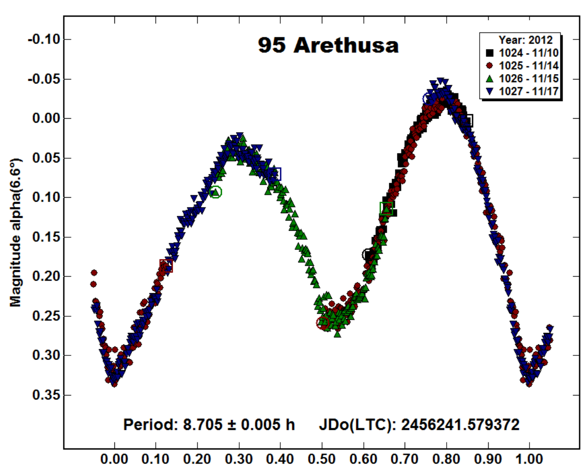
Harris, A.W. and Young, J.W. (1983). "Asteroid rotation. IV." *Icarus* **54**, 59-109.

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.

Vannmunster, T. (2006). *Peranso* Period Analysis Software, Peranso Version 2.31, CBA Belgium Observatory.

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

Warner, B.D. (2010). MPO Software, *MPO Canopus* version 10.3.0.2, Bdw Publishing, Colorado Springs, CO.



LIGHTCURVE OF 2420 CIURLIONIS

Russell I. Durkee, Connor W. Syring
Shed of Science Observatory
Minneapolis, MN, 55410, USA
shedofscience@earthlink.net

(Received: 15 January)

Lightcurve measurements of asteroid 2420 Ciurlionis are reported: $P = 12.84$ h ± 0.02 h, $A = 0.48 \pm 0.08$ mag.

CCD photometry observations of the asteroid 2420 Ciurlionis were made at the Shed of Science using an *f*/8.5 0.35-m Schmidt Cassegrain (SCT) with an SBIG ST10XE CCD camera working at a scale of 0.94 arcsec/pixel. Exposures were taken through a Celestron UHC LPR filter. All images were dark and flat field corrected. Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The data were light-time corrected. Period analysis was also done with *MPO Canopus*, which incorporating the Fourier analysis algorithm developed by Harris (Harris *et al.*, 1989).

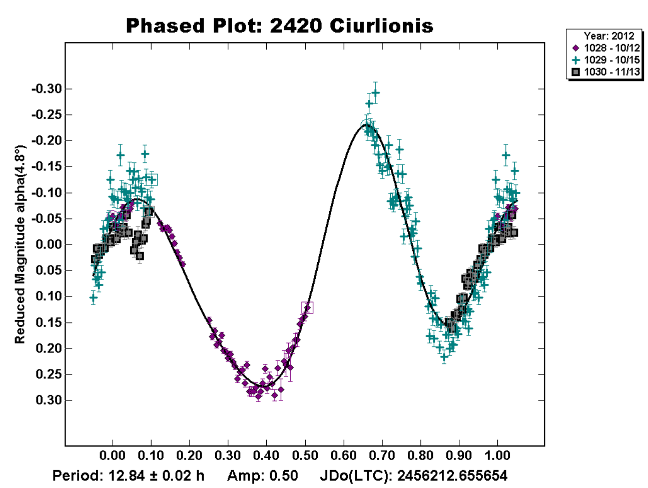
The sessions were not linked from night to night so the results are subject to application of manual offsets to merge the observations. As a result our solution is not conclusive. Solutions of 16.0 h was considered but slightly less favorable due to small deviations at the end of the session on 11/13. Better coverage of this lightcurve is required for a definitive solution.

Acknowledgements

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

References

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



ASTEROID LIGHTCURVE ANALYSIS AT RIVERLAND DINGO OBSERVATORY (RDO): 185 EUNIKE, (17252) 2000 GJ127, AND (152858) 1999 XN35

Kevin Hills
Riverland Dingo Observatory (RDO)
Moorook, 5343, South Australia,
AUSTRALIA
kevinhills@me.com

(Received: 13 January)

Lightcurves for three asteroids selected from the Collaborative Asteroid Lightcurve Link (CALL; Warner 2011) were obtained at Riverland Dingo Observatory (RDO) in the period October 13 through December 5, 2012: 185 Eunike, (17252) 2000 GJ127, and (152858) 1999 XN35.

The observations reported here were obtained using a 0.41-m *f*/9 Ritchey-Chretien telescope, SBIG STL-1001E CCD camera, and either Clear or Johnson Cousins V filter, as indicated. All images were bias, dark and flat field corrected and have an image scale of 1.35 arc seconds per pixel. Differential photometry measurements were made in *MPO Canopus* (Warner, 2008). V magnitudes for comparison stars were extracted from the AAVSO Photometric All-Sky Survey (APASS; Henden, 2012) catalog. The Asteroid Lightcurve Database (LCDB; Warner *et al.*, 2009) does not contain any previously reported results for asteroids (17252) 2000 GJ127 or (152858) 1999 XN35. Previously reported results for 185 Eunike are referred to below.

<u>185 Eunike</u> is a main-belt asteroid discovered by Peters at Clinton in 1878. A total of 1,164 data points were obtained over eight nights using a Johnson Cousins V filter during the period 2012 November 3 to December 5 including solar phase angles between –16.1° to +14.5°. The average magnitude was 11.4 and average SNR was 331. The lightcurve shows a period of 21.7753 ± 0.0001 h and amplitude of 0.23 ± 0.01 mag suggesting that the asteroid rotated 35 times during the period of observation. The LCDB reports six different periods, ranging from 10.83 h to 21.807 h. Only one of these has and uncertainty quality of 3 (Pilcher, 2012), which reports a period of 21.797 h ± 0.001 h, in good agreement with the observations reported here.

<u>(17252) 2000 GJ127</u> is a main-belt asteroid discovered by LINEAR at Socorro in 2000. A total of 437 data points were obtained over four nights using a clear filter during the period 2012 October 13 to November 19 as the solar phase angle increased from +10.23° to +18.12°. The average magnitude was 15.6 and average SNR was 129. The lightcurve shows a period of 8.8237 ± 0.0001 h and amplitude of 0.21 ± 0.02 mag, suggesting that the asteroid rotated 100 times during the period of observation.

<u>(152858) 1999 XN35</u> is a Mars-crossing asteroid discovered by LONEOS at Anderson Mesa in 1999. A total of 501 data points were obtained over seven nights using a clear filter during the period 2012 October 19 to November 22 including solar phase angles between –18.6° to +19.7°. The average magnitude was 16.4 and average SNR was 51. The lightcurve shows a period of 2.990 ± 0.001 h and amplitude of 0.18 ± 0.03 mag, suggesting that the asteroid rotated 272 times during the period of observation.

Acknowledgements

The measurements reported make use of the *AAVSO Photometric All-Sky Survey (APASS)* catalog, which is funded by the Robert Martin Ayers Sciences Fund.

Thank you to Darren Wallace of RDO and his collaborators at New Mexico Skies for maintaining the equipment in Australia.

References

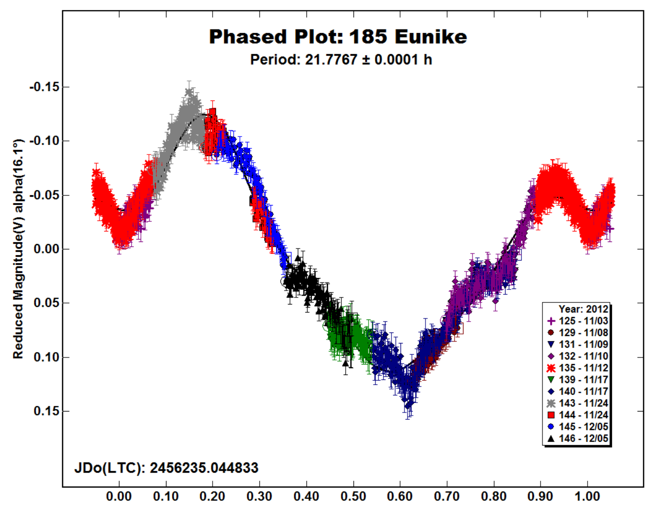
Henden, A. (2012). AAVSO Photometric All-Sky Survey (APASS) catalog. *http://www.aavso.org/download-apass-data*

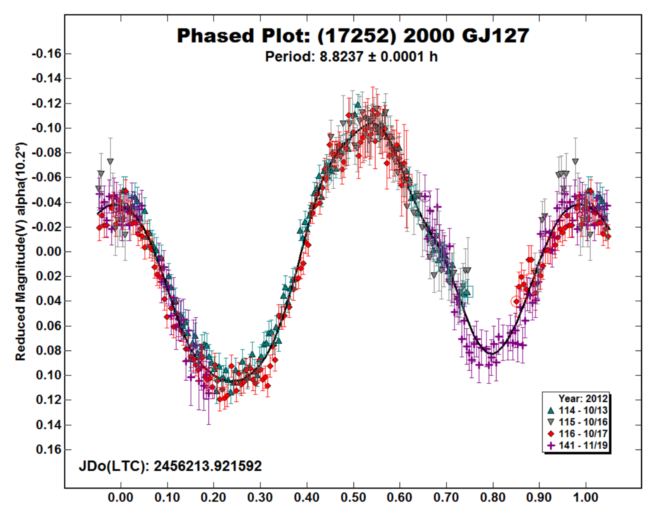
Pilcher, F. and Ruthroff, J.C. (2012). "Rotation Period Determination for 185 Eunike." *Minor Planet Bul.* **39**, 13.

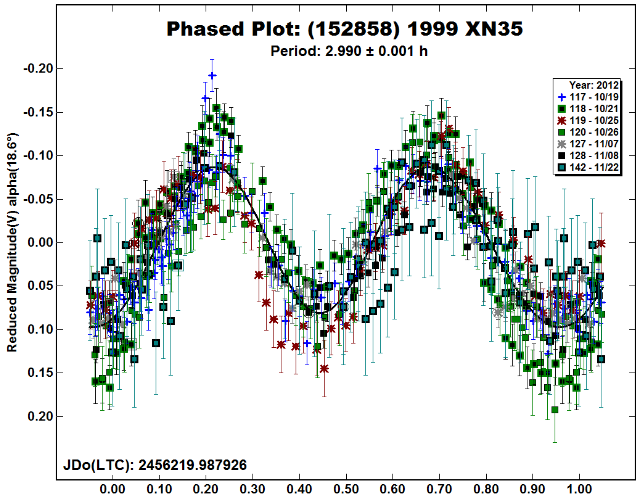
Warner, B.D. (2008). MPO Software, Canopus version 10, Bdw Publishing, Colorado Springs, CO.

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

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







LIGHTCURVE ANALYSIS OF MAIN BELT ASTEROIDS 1115 SABAUDA, 1554 YUGOSLAVIA, 1616 FILIPOFF, 2890 VILYUJSK, (5153) 1940 GO, AND (31179) 1997 YR2

John C. Ruthroff
Shadowbox Observatory
12745 Crescent Drive
Carmel, IN 46032
john@theastroimager.com

(Received: 13 January)

Six asteroids were the subject of the lightcurve program at Shadowbox Observatory during 2012 and early 2013: 1115 Sabauda, 1554 Yugoslavia, 1616 Filipoff, 2890 Vilyujsk, (5153) 1940 GO, and (31179) 1997 YR2.

During the period 2012 May 11 to 2013 January 5, observations and lightcurve analysis were conducted on main-belt asteroids 1115 Sabauda, 1515 Yugoslavia, 1616 Filipoff, 2890 Vilyujsk, (5153) 1940 GO, and (31179) 1997 YR2. All objects were observed using a 0.3-meter Schmidt-Cassegrain (SCT) operating at *f*/6.1 on a German Equatorial mount (GEM). Details of the observing equipment, techniques and data reduction methods are in Ruthroff (2010).

Main-belt asteroids 1115 Sabauda, 1616 Filipoff and 2890 Vilyujsk were chosen for their availability in the author's urban, "horizon challenged" environment. (5153) 1940 GO was the subject of an inconclusive lightcurve study by the author in 2009, while 1554 Yugoslavia and (31179) 1997 YR2 were in the field of another target, i.e., they were "targets of opportunity." Previously reported lightcurve data for 1616 Filipoff and (31179) 1997 YR2 could not be found. Previous lightcurves had been obtained on 1115 Sabauda (Behrend 2005; Warner, 2006), 1554 Yugoslavia (Higgins, 2008), 2890 Vilyujsk (Koff, 2003), and (5153) 1940 GO (Behrend 2008).

1115 Sabauda. A partial lightcurve consisting of 97 data points was obtained over two nights. Lightcurves published by Behrend (2005) and Warner (2006) showed periods of 6.75 ± 0.01 h and 6.72 h respectively. My analysis shows 6.72 ± 0.01 h and an amplitude of 0.15 ± 0.06 mag.

1554 Yugoslavia. One night of observations, resulting in 74 data points, showed a period of 3.887 ± 0.001 h, these results being in good agreement with observations by Higgins (2008).

1616 Filipoff. Five nights of observations showed a period of 5.652 ± 0.001 h. An anomaly in observations from rotation phase 0.80 to 0.90 lowers confidence that this period is correct. Several reexaminations of the images reveal no reason to throw these observations out, yet they are not consistent with the stated period. No previous reported lightcurve results for 1616 Filipoff were found.

2890 Vilyujsk. This main-belt asteroid was observed by Koff (2003) who derived a period of 3.45 ± 0.01 h and an amplitude of 0.22 ± 0.22 mag. My analysis of 406 data points compiled over six nights from 2012 November 6 to 15 give the same results.

(5153) 1940 GO. This asteroid was the subject of a lightcurve study in 2009 that was motivated by an earlier work by Behrend (2008), who reported a period of 4.58 h. The results of my 2009 unpublished study were inconclusive.

My latest observations reveal a period of 9.00 h ± 0.01 h with an estimated amplitude of 0.10 ± 0.04 mag. While this period is nearly twice that offered by Behrend, his result may not be ruled out since my observed amplitude does not meet the threshold amplitude of 0.2 mag that may constrain an object to two minima and two maxima per revolution (Binzel, 1987).

(31179) 1997 YR2 was in the field-of-view (FOV) of another target on 2012 October 11 and was imaged again on October 25. The derived period was 4.829 ± 0.001 h with estimated amplitude of 0.80 ± 0.15 mag.

Acknowledgments

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

References

Behrend, R. (2005), (2008). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

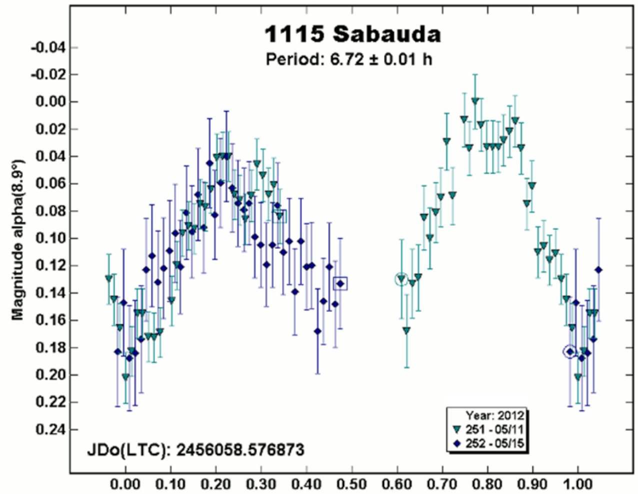
Binzel, R.P. (1987). "A Photoelectric Survey of 130 Asteroids." *Icarus* **72**, 135-208.

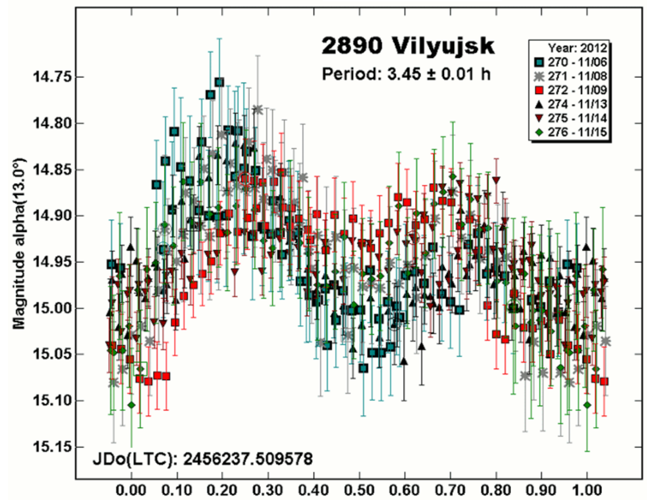
Higgins, D. (2008). "Asteroid Lightcurve Analysis at Hunters Hill Observatory and Collaborating Stations: April 2007-June 2007." *Minor Planet Bul*. **35**, 30-32.

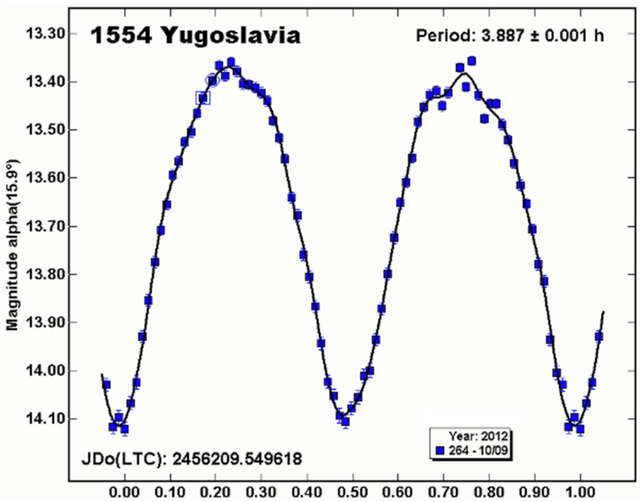
Koff, R.A. (2003). "Lightcurve Photometry of 2890 Vilyujsk, 3106 Morabity, and (4228) 1989 TQ1." *Minor Planet Bul.* **30**, 38-39.

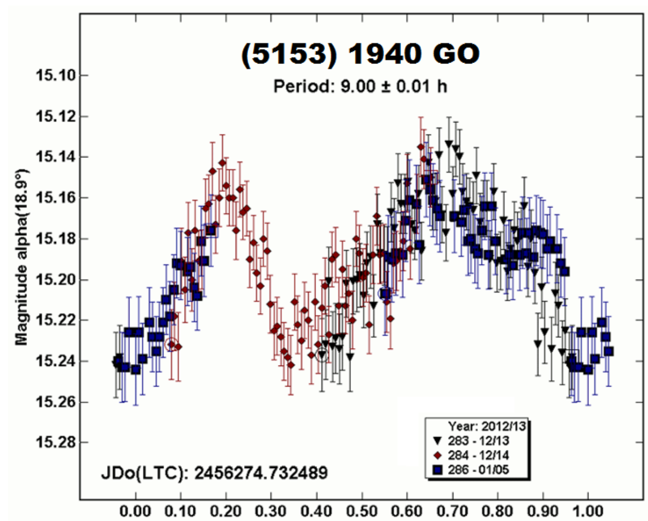
Ruthroff, J.C. (2010). "Lightcurve Analysis of Main Belt Asteroids 185 Eunike, 567 Eleutheria, and 2500 Alascattalo" *Minor Planet Bul.* **37**, 158-159.

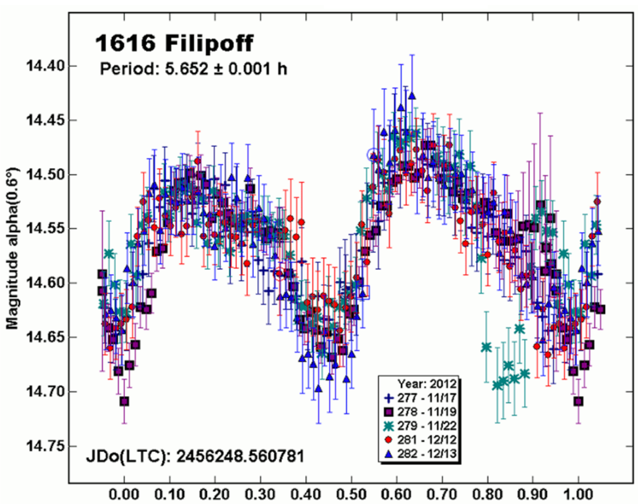
Warner, B.D. (2006). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory – March-June 2006." *Minor Planet Bul.* **33**, 85-88.

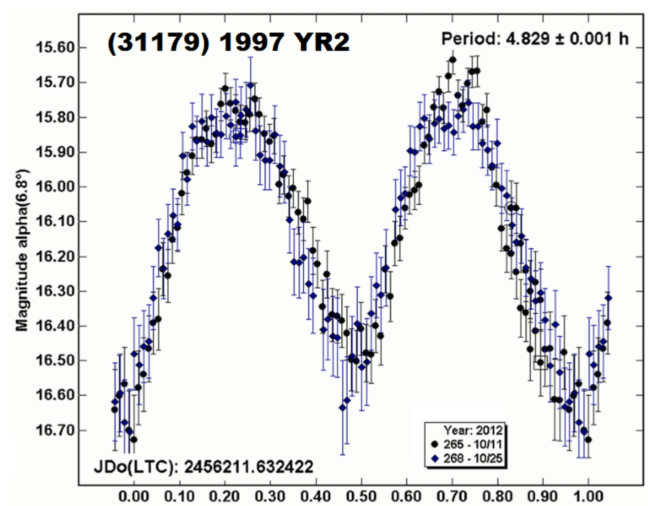

1115 Sabauda
Period: 6.72 ± 0.01 h
Magnitude alpha(8.9°)
JDo(LTC): 2456058.576873
Year: 2012
251 - 05/11
252 - 05/15


2890 Vilyujsk
Period: 3.45 ± 0.01 h
Magnitude alpha(13.0°)
JDo(LTC): 2456237.509578
Year: 2012
270 - 11/06
271 - 11/08
272 - 11/09
274 - 11/13
275 - 11/14
276 - 11/15


1554 Yugoslavia
Period: 3.887 ± 0.001 h
Magnitude alpha(15.9°)
JDo(LTC): 2456209.549618
Year: 2012
264 - 10/09


(5153) 1940 GO
Period: 9.00 ± 0.01 h
Magnitude alpha(18.9°)
JDo(LTC): 2456274.732489
Year: 2012/13
283 - 12/13
284 - 12/14
286 - 01/05


1616 Filipoff
Period: 5.652 ± 0.001 h
Magnitude alpha(0.6°)
JDo(LTC): 2456248.560781
Year: 2012
277 - 11/17
278 - 11/19
279 - 11/22
281 - 12/12
282 - 12/13


(31179) 1997 YR2
Period: 4.829 ± 0.001 h
Magnitude alpha(6.8°)
JDo(LTC): 2456211.632422
Year: 2012
265 - 10/11
268 - 10/25

ASTEROIDS OBSERVED FROM SANTANA AND CS3 OBSERVATORIES: 2012 OCTOBER - DECEMBER

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

(Received: 14 January)

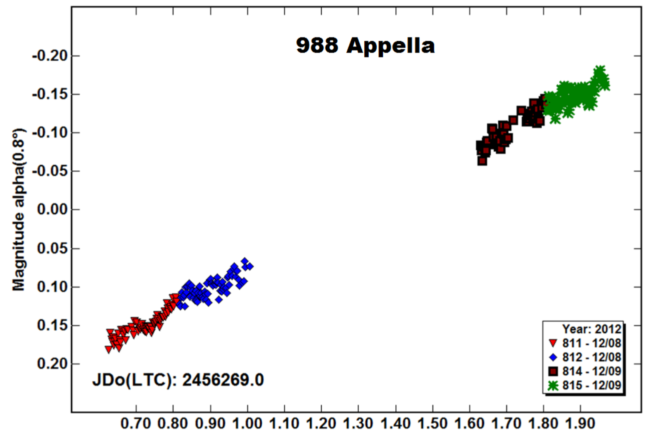
Lightcurves of three asteroids were obtained from Santana Observatory and the Center for Solar System Studies (CS3): 988 Appella, 1606 Jekhovsky, and 3478 Fanale.

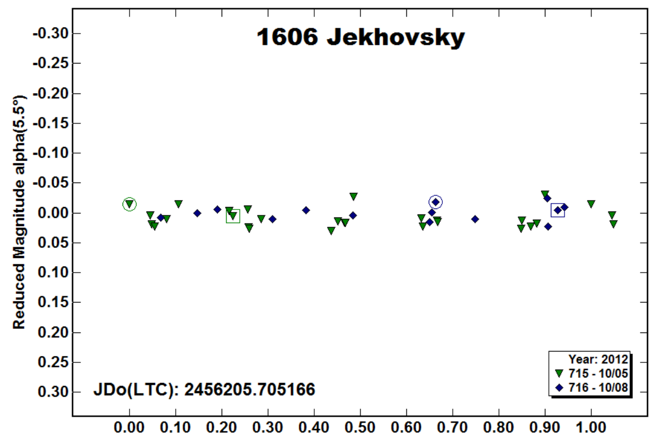
Observations were made at Santana Observatory (MPC Code 646) using a 0.30-m Schmidt-Cassegrain (SCT) with a SBIG STL-9E CCD camera and at CS3 using a 0.40-m with a SBIG STL-1001E CCD camera. All images were unguided and unbinned with no filter. Measurements were made using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris et al., 1989). 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 V magnitudes based on 2MASS J-K colors (Warner 2007 and Stephens 2008).

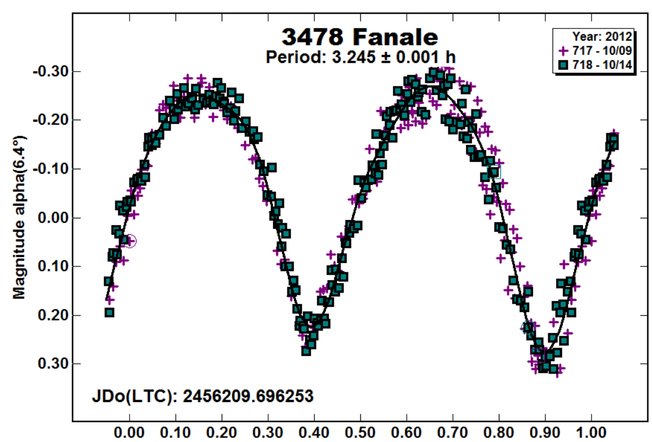
988 Appella. Observations were acquired at CS3. Behrend (2006) reported a period of 7 hours based upon a single night with an amplitude of 0.05 mag. Although Appella could not be followed for longer than two nights during this opposition, it clearly has a long rotational period.

1606 Jekhovsky. All observations were acquired at Santana Observatory. There are no previously reported period results for Jekhovsky, which could not be followed for more than two nights. The plot shows the two nights to be arbitrarily phased to demonstrate that the plots from the two nights are essentially flat showing no features or amplitude within the noise limit.

3478 Fanale. All images were acquired at Santana Observatory.







References

Behrend, R. (2006). 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.

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.

#	Name	mm/dd/12	Data Pts	α	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (mag)	AE
988	Appella	12/08-12/09	248	0.8	77	1	> 120		> 0.3	
1606	Jekhovsky	10/05-10/08	390	5.6,4.4	20	-1				
3478	Fanale	10/09-10/14	386	6.5,4.8	23	-6	3.245	0.001	0.60	0.03

LIGHTCURVES FOR 110 LYDIA AND 1680 PER BRAHE

Robert D. Stephens
Center for Solar System Studies (CS3) / MoreData!
11355 Mount Johnson Ct., Rancho Cucamonga, CA 91737 USA
RStephens@foxandstephens.com

Brian D. Warner
Palmer Divide Observatory (PDO) / MoreData!
Colorado Springs, CO USA

(Received: 10 January)

CCD photometric observations of the main-belt asteroids 110 Lydia and 1680 Per Brahe were obtained from Santana Observatory (MPC 646), the Center for Solar System Studies, and Palmer Divide Observatory (MPC 716).

110 Lydia. Lydia was observed at the request of Michael Shepard (private communication) in support of radar observations at Arecibo Observatory. Observations were obtained at Santana Observatory using a 0.3-m Schmidt-Cassegrain (SCT) with a ST-9E with no filter. Images were reduced using V magnitudes. Observations at Palmer Divide Observatory also used a 0.30-m SCT and ST-9XE, V filter and reduced using V magnitudes. Exposures were 30 seconds. There are 1412 data points in the solution set which resulted in a synodic period of 10.928 ± 0.003 h with an amplitude of 0.14 ± 0.01 mag.

Behrend (2006, 2008) reported a period of 10.61 h. Durech (2007) reported a sidereal period of 10.92580 h developing a shape model. Pray (2004) reported a period of 10.924 h while Taylor (1971) reported a period of 10.927 h. Finally, Warner (2009) reported a shape model from the authors with a sidereal period of 10.925808 h.

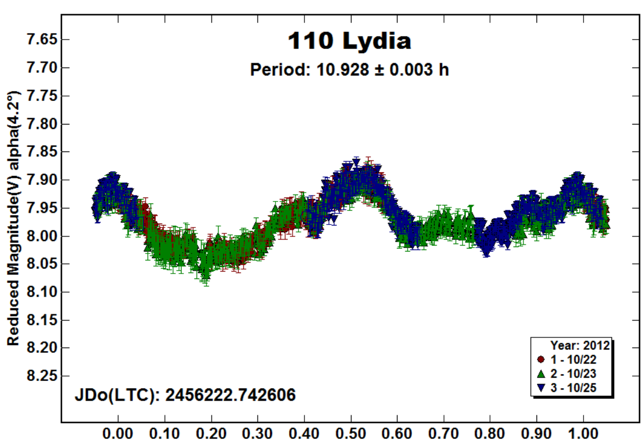


Figure 1: Lightcurve of 110 Lydia using the combined dataset.

1680 Per Brahe. Stephens and Warner independently observed 1680 Per Brahe. Observations at the Center for Solar System Studies were obtained with a 0.4-m SCT and a SBIG STL-1001e CCD camera. Exposures were 180 seconds and unfiltered. Observations at the Palmer Divide Observatory were made using a 0.30-m SCT and SBIG ST-9XE CCD camera. Exposures were 180 seconds and unfiltered. All images were measured and period analysis done also using *MPO Canopus*. Behrend (2005, 2006) reported a period of 3.44h in good agreement with these results. The lightcurve evolved during the three weeks between the two datasets, probably due to the change in phase angle from 0.4° on 2012 Dec 08 to 9° on 2013 Jan 01.

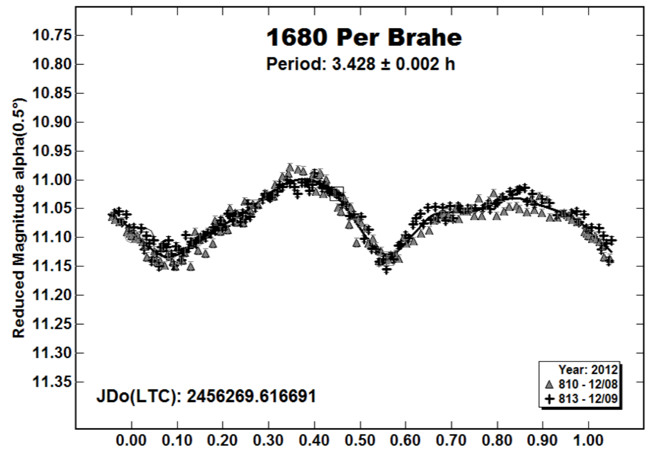


Figure 2: Lightcurve of 1680 Per Brahe using data from the Center for Solar System Studies.

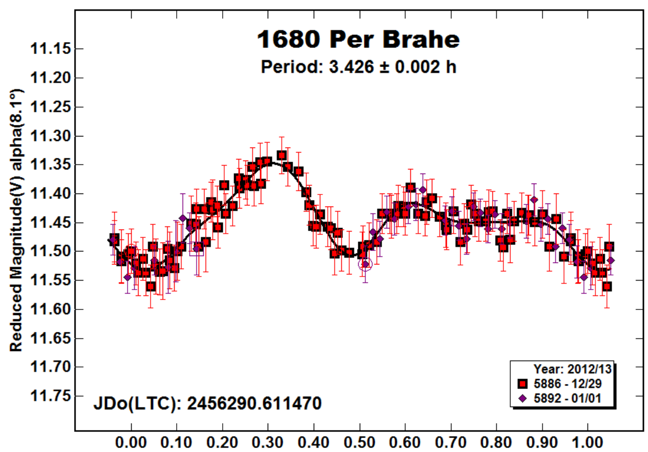


Figure 3: Lightcurve of 1680 Per Brahe using data from Palmer Divide.

References

Behrend, R. (2005, 2006, 2008) Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html.*

Ďurech, J., Kaasalainen, M., Marciniak, A., Allen, W.H., Behrend, R., Bembrick, C., Bennett, T., Bernasconi, L., Berthier, J., Bolt, G., Boroumand, S., Crespo da Silva, L., Crippa, R., Crow, M., Durkee, R., Dymock, R., Fagas, M., Fauerbach, M., Fauvaud, S., Frey, M., Gonçalves, R., Hirsch, R., Jardine, D., Kamiński, K., Koff, R., Kwiatkowski, T., López, A., Manzini, F., Michałowski, T., Pacheco, R., Pan, M., Pilcher, F., Poncy, R., Pray, D., Pych, W., Roy, R., Santacana, G., Slivan, S., Sposetti, S., Stephens, R., Warner, B., and Wolf, M. (2007). "Physical models of ten asteroids from an observers' collaboration network." *Astron. Astrophys.* **465**, 331-337.

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.

Pray, D. (2004). "Lightcurve analysis of asteroids 110, 196, 776, 804, and 1825." *Minor Planet Bul.* **31**, 34-36.

Taylor, R.C., Gehrels, T., and Silvester, A.B. (1971). "Minor Planets and Related Objects. VI. Asteroid (110) Lydia." *Astron. J.* **76**, 141-146.

Warner, B.D., Stephens, R.D., Harris, A.W., and Shepard, M.K. (2009). "Coordinated Lightcurve and Radar Observations of 110 Lydia and 135 Hertha." *Minor Planet Bul.* **36**, 38-39.

SEEING DOUBLE OLD AND NEW: OBSERVATIONS AND LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY OF SIX BINARY ASTEROIDS

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

(Received: 10 January)

Results of the analysis of lightcurves of six binary asteroids obtained at the Palmer Divide Observatory are reported. Of the six, three were previously known to be binary: 9069 Hovland, (26471) 2000 AS152, and 1994 XD. The remaining three are new confirmed or probable binary discoveries made at PDO: 2047 Smetana, (5646) 1990 TR, and (52316) 1992 BD.

As a result of an ongoing CCD asteroid photometry program at the Palmer Divide Observatory near Colorado Springs, CO, more than 40 asteroids were observed from 2012 October to December. Of this number, three were known binary objects. 9069 Hovland, a Hungaria, was first reported as a binary by Warner *et al.* (2004). (26471) 2000 AS152, also a Hungaria, was reported to be binary in 2009 (Warner *et al.*, 2009). The third known binary was 1994 XD, first reported as such in 2005 based on radar observations (Benner *et al.*, 2005)

On the other hand, three other objects were found for the first time to show evidence of a satellite. 2047 Smetana, a Hungaria, had been observed before by the author, in 2006 and 2011, but no evidence of a satellite was seen. (5646) 1990 TR is a near-Earth asteroid (NEA) that was observed as the program at PDO shifts emphasis towards that group. (52316) 1992 BD, another Hungaria, was observed for the first time at PDO in 2012. Details of the observations and analysis for each asteroid are given below.

General Discussion

See the introduction in Warner (2010b) for a discussion of equipment, analysis software and methods, and overview of the lightcurve plot scaling. The "Reduced Magnitude" in the plots is Johnson V or Cousins R (indicated in the Y-axis title) corrected to unity distance by applying –5*log (rΔ) to the measured sky magnitudes with r and Δ 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.

Lightcurve analysis was done using *MPO Canopus*, which implements the FALC algorithm by Harris (Harris *et al.*, 1989). There are several methods for extracting the two periods. The usual procedure at PDO is to find an approximate value for the short period first, presumably due to the primary's rotation, using *all* observations, including any possible events, i.e., occultations or eclipses due to the satellite. This produces a Fourier curve, usually one of 6th order in the initial searches. A second search is then made for a longer period, subtracting the Fourier curve from the raw data before analysis. This usually produces a lightcurve that shows the events more clearly. The results (Fourier curve) from the second search are subtracted from the raw data when searching anew for the shorter period, resulting in a tighter fit of the data. This iterative process continues until the two period solutions stabilize.

Another approach, one that can help avoid misleading initial results, is to use only those data that do not include suspected events when doing the first search for the shorter period. From there, the iterative process can continue with more confidence. To be clear, with each new data set, only those data not suspected of being related to an event are used to refine the short period *before* the search for the orbital period is performed. This alternative method is sometimes used to confirm the solution found from the first method. In either case, as more data are added, the search starts again, although the initial period and range of possibilities can be constrained and found to a higher precision.

As a final check, the two curves are subtracted from the raw data and another period search conducted covering a range from about half the shorter period to 2-3x the longer period. Ideally, this would result in a flat lightcurve with scatter about equally distributed on either side. However, if the secondary (satellite) is not tidally-locked to the orbital period and is sufficiently elongated, a lightcurve with a third period might be found. In this case, the process becomes more involved but does not change substantially, other than keeping track of which two periods are being subtracted before analysis begins.

A thorough discussion of the analysis of lightcurves of binary systems can be found in Pravec *et al.*, 2006. That paper should be among the required reading for those doing asteroid lightcurve photometry.

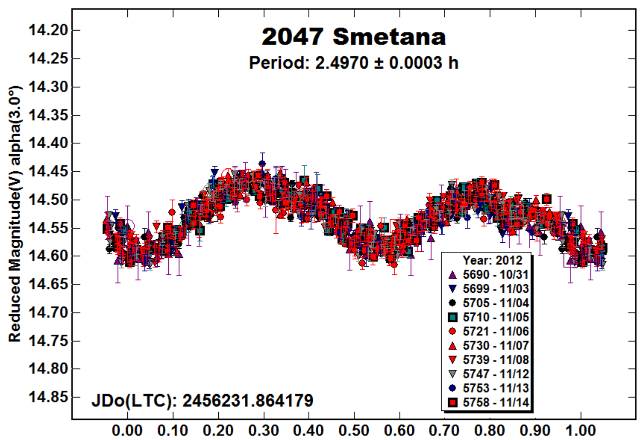
Individual Asteroids

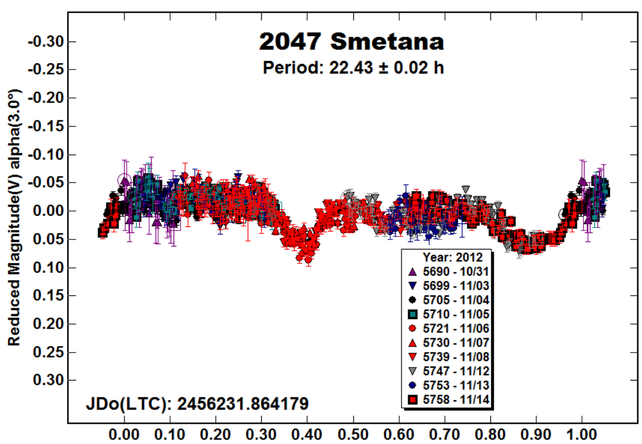
2047 Smetana (new binary). The author observed this Hungaria in 2006 and 2011 (Warner, 2006; 2011). In 2006, a period of P = 2.4969 h was reported and, in 2011, P = 2.4801 h. In the 2006 paper, it was noted that the period and amplitude were "binary friendly," that no evidence of a satellite was seen, and that follow-up observations were recommended. In the 2011 work, a period of about 2.497 h was found in addition to the one adopted. It was noted at that time that a period search routine used for finding the period in lightcurve inversion modeling favored that longer period. Still, the shorter period was adopted. It appears now that this was incorrect.

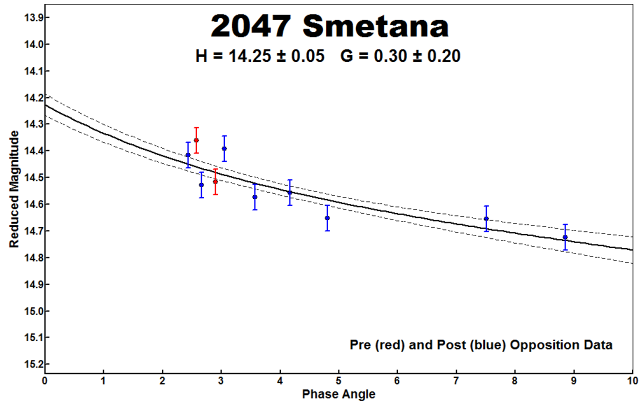
In 2012, observations were made at PDO starting on Oct 31 and continuing through Nov 14. Data from the first three nights seemed to show evidence of a satellite, thus prompting a more extended campaign. In all, 741 data points taken on 10 nights were used in the analysis. The result was a primary period, P_1 = 2.4970 ± 0.0003 h with A_1 = 0.12 ± 0.01 mag. The secondary period, that of the mutual events and, therefore, the orbital period, was P_{Orb} = 22.43 ± 0.02 h with event amplitudes of 0.05 mag.

The event at about 0.9 rotation phase in the lightcurve for the orbital period appears close to, if not total. Assuming that the event is total, this establishes the secondary-to-primary effective diameter ratio as Ds/Dp = 0.21 ± 0.02. If one of the events were not total, then only a lower limit for Ds/Dp could be given.

Maisero *et al.* (2012) reported an albedo p_V = 0.544 ± 0.069 using H = 13.8 and G = 0.15. This is consistent with type E asteroids, the presumed type of the Hungaria parent body. The PDO data gave H = 14.25 ± 0.05 and G = 0.30 ± 0.20. If using a fixed value of G = 0.43 ± 0.08, the average for high albedo objects (see Warner *et al.*, 2009), the value for H changed by only 0.05 mag. The difference in H between the Maisero *et al.* and PDO values is significant and so the albedo and diameter were recalculated by applying the correction method of Harris and Harris (1997) that is required when dealing with original values derived from thermal observations. Masiero *et al.* gave D = 3.13 ± 0.15 km and p_V = 0.544 ± 0.069. The PDO values for H and G give D = 3.07 km and p_V = 0.37 ± 0.04.







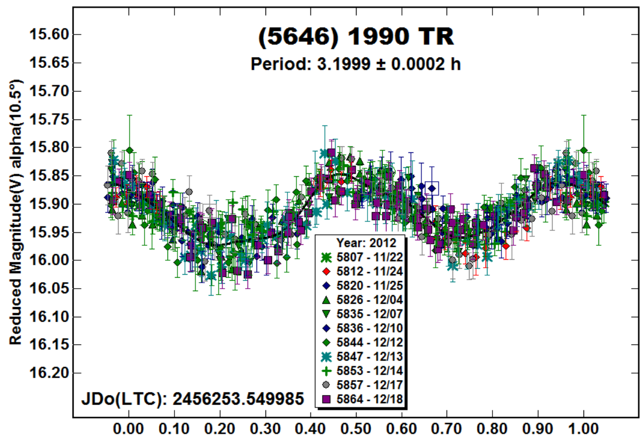
<u>(5646) 1990 TR (probable new binary)</u>. Wisniewski (1992) observed this near-Earth asteroid and reported a period of 6.25 h. While he reported the lightcurve to be "unusual", speculation in the paper about the reasons why did not include a satellite, very likely because, at that time, small satellites of asteroids had yet to be confirmed. Nowadays, those doing asteroid photometry are aware of the potential and so an "unusual" lightcurve is examined more carefully. It's worth some speculation about how many earlier efforts may have overlooked a satellite. Unfortunately, one aspect of those early data sets is that, because the specific need was not known, they were much sparser than would be the case today and so it would be more difficult to confirm a satellite.

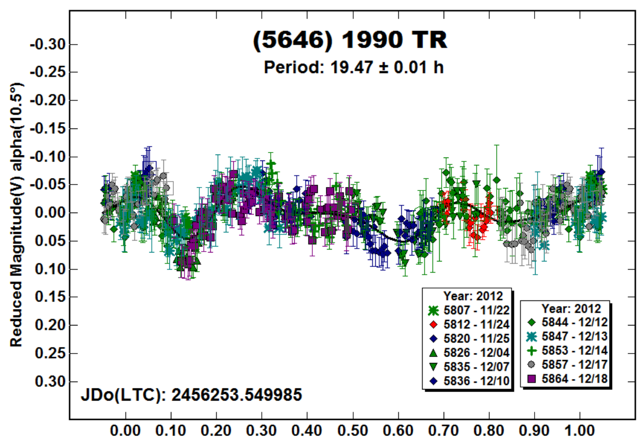
1990 TR is a near-Earth asteroid (NEA). When there are no Hungarias available, NEAs are given next priority. A total of 551 observations were made on 11 nights between 2012 Nov 22 and Dec 18. The initial period and amplitude, along with some suspicious data prompted the longer campaign. Analysis found P_1 = 3.1999 ± 0.0002 h and A_1 = 0.12 ± 0.01 mag. Suspected events of 0.03-0.05 mag were seen in the secondary lightcurve, which has a period of P_{Orb} = 19.47 ± 0.01 h.

It should be noted, however, that P_{Orb} is close to an exact 6:1 ratio of P_1 and so may be the result of the Fourier analysis latching onto harmonics in the data. A test against this was to see if the solution remained the same using orders that were not related to one another, e.g., not all even-numbered. The two periods remained the same within 1-sigma when trying fits of 2, 3, 4, 5, 6, and 7th order. Yet, this is still not conclusive evidence and so this object must be put into the "probable" category with follow-up observations requested at future apparitions.

Keeping the assumption that the asteroid is a binary, neither of the events seems total and so the derived size ratio is a lower limit, i.e., Ds/Dp ≥ 0.18 ± 0.02.

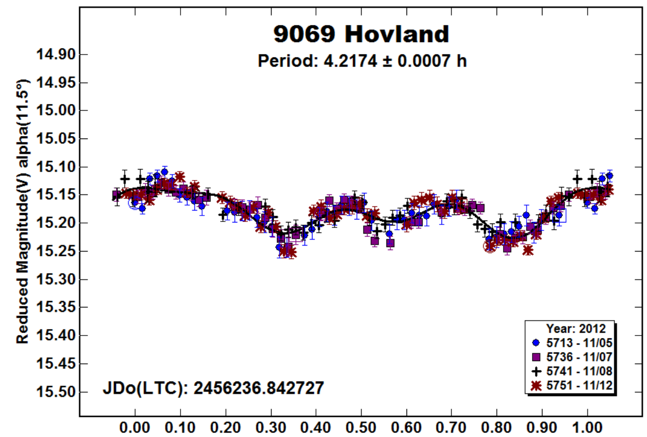
Alan Harris (MoreData!) digitized the Wisniewski plots from the original article to provide uncorrected UT/V sky magnitude data. These were imported into *MPO Canopus* for analysis. Since there were only two nights of data, separated by five nights, it was not possible to confirm even the short primary period, the closest solution being about 3.21 h.





9069 Hovland (known binary). This Hungaria was first reported to be binary in 2004 with P_1 = 4.2174 h and P_{Orb} = 30.35. The phase angle bisector longitude (L_{PAB}) was ~34°. No lightcurve was published at that time. Additional information about the asteroid was given by Harris and Pravec (2006) but still without a lightcurve. The 2004 lightcurve was eventually published by Warner *et al.* (2011) when additional data taken in 2004 were incorporated to refine the results to P_1 = 4.2173 h, A_1 = 0.09 mag, and P_{Orb} = 30.292 h. Marchis *et al.* (2012), using Spitzer IR data from 2008, did not detect the satellite but did find P_1 = 4.217 h, and A_1 = 0.10 mag at L_{PAB} ~ 131°.

The 2012 observations at PDO were made on 4 nights from Nov 5-12. No evidence of a satellite was seen in the lightcurve, which had parameters of P = 4.2174 ± 0.0007 h and A = 0.10 ± 0.01 mag. The approximate L_{PAB} was 51°. Since the 2004 events were somewhat shallow, not much above the ability to detect with photometry alone, the small difference in L_{PAB} could be the reason that no events were seen in 2012. The next apparition is in 2014 June (V ~ 16.5, Dec –15°). The L_{PAB} at that time will be 260° (L_{PAB}–180° = 80°), making it even less likely that mutual events might be seen.

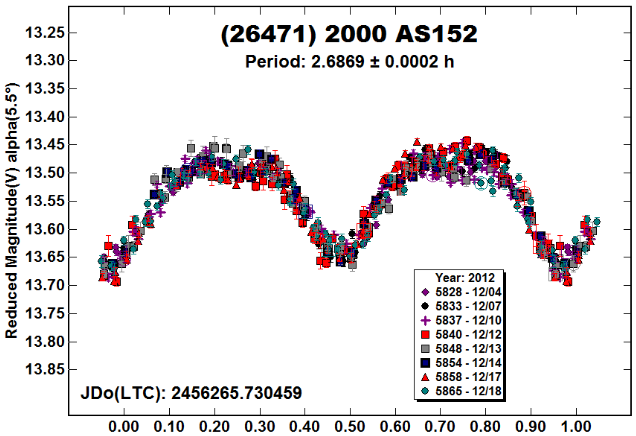


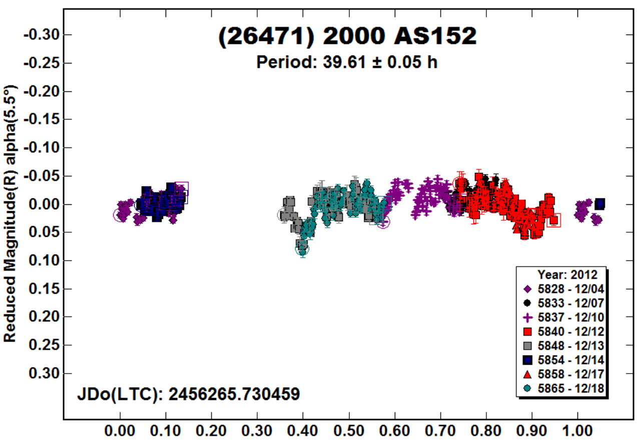
(26471) 2000 AS152 (known binary). This Hungaria was first observed in 2008 at PDO (Warner, 2008). Results were P = 2.687 h and A = 0.20 mag, which agreed with a period reported by Behrend (2001). The 2008 PDO data were somewhat noisy (error bars on the order of 0.02-0.03 mag) and so any low-level events would probably have been lost in the noise. The asteroid was first reported to be binary by Warner *et al.* (2009) in a Central Bureau Electronic Telegram (CBET). A lightcurve and more detailed analysis were later published by Warner *et al.* (2010) with parameters of P_1 = 2.68679 h, A_1 = 0.22 mag, and P_{Orb} = 39.28 h at L_{PAB} = 322°.

The 2012 observations were taken over 8 nights between Dec 4-18 and included 475 data points for analysis. The L_{PAB} was 75°, or about 70° from the line that joined the opposite sides of the orbit of the earlier observations. If the orbital plane of the asteroid is somewhat perpendicular to the orbit of the asteroid, then mutual events would not have been expected in 2012. If the plane is nearly in the plane of the asteroid's orbit, then events would be expected.

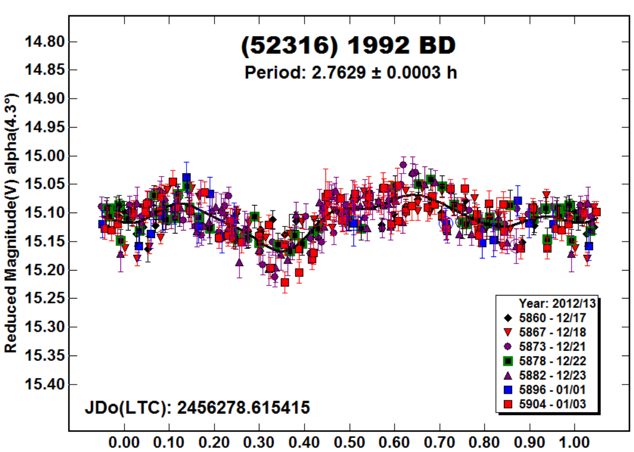
Events were seen, but only just above the observational limits for detecting satellites using only photometry. In fact, if the 2012 data set was the only one available, there would not be sufficient evidence to make an affirmative case for the asteroid being binary, only "probable" at best. The fact the events were seen and so shallow does help constrain the orientation of the satellite's orbit and the approximate longitude of the orbit's pole.

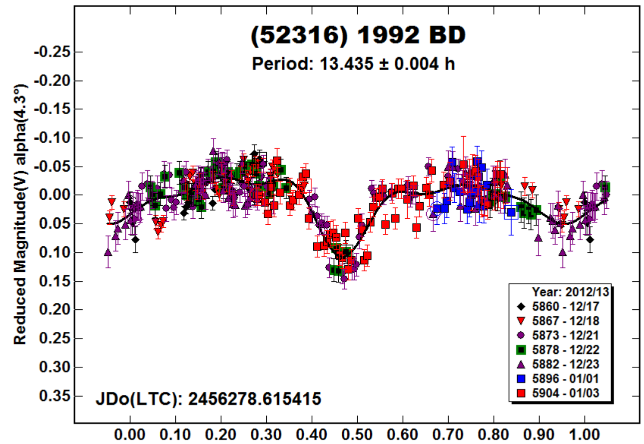
Despite the low amplitude, it was possible to look for the orbital period by restricting the primary period to a small range about the earlier results. This lead to finding P_{Orb} = 39.61 ± 0.05 h. In the lightcurve for the events, the apparent "bowing" due to a tidally-locked and slightly elongated satellite can been seen, almost more so than the mutual events. The value for P_{Orb} from 2012 is significantly different from the earlier result. If not the result of a lack of data, then the change may be due to different shadowing effects with different phase angles. In 2009, the phase angle was about 29° but only 5° in 2012. When more data become available, this information may prove useful for modeling.





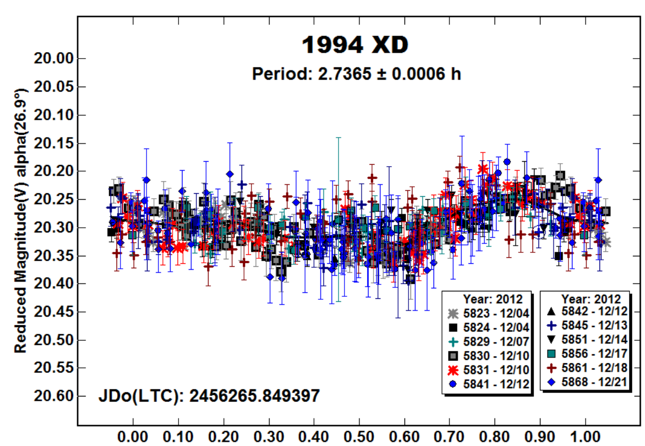
(52316) 1992 BD (new binary). Observations of 1992 BD occurred on 7 nights between 2012 Dec 17 and 2013 Jan 3. A total of 341 data points were obtained. This is a little less than often required but the very deep primary event (~0.12 mag) made the case for a satellite much stronger and easier to prove. The results of analysis were P_1 = 2.7629 ± 0.0003 h, A_1 = 0.10 ± 0.01 mag, and P_{Orb} = 13.435 ± 0.004 h. The secondary event, used to estimate the size of the satellite, was only 0.03 mag. This gives Ds/Dp = 0.16 ± 0.02. Since neither event is total, this must be taken as a lower limit. The lightcurve showing the events gives strong indications of a tidally-locked, elongated satellite by virtue of the overall "bowing" in the shape.

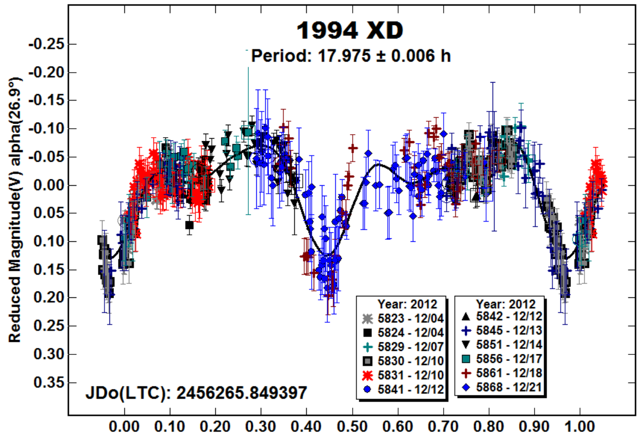




1994 XD (known binary). This NEA was reported to be binary following radar observations in 2005 (Benner *et al.*, 2005). Observations were made at PDO from 2012 Dec 4-21 on 9 nights. On some nights, the measurements had to be split into two "sessions" as the sky motion of the asteroid required using different sets of comparison stars. The split sessions were matched to one another by measuring a set of five images twice, first as the last five observations in the first session and then as the first five observations in the second session. If required, the zero point of the combined set was then adjusted to fit the other sessions.

Using only PDO data, the results were P_1 = 2.7365 ± 0.0006 h, A_1 = 0.08 ± 0.01 mag, and P_{Orb} = 17.975 ± 0.006 h. Pravec *et al.* (private communications), using a subset of the PDO data along with data from other observers, found different results, the primary period being about 0.04 h and orbital period about 0.07 h less than then PDO results. Attempts to reconcile the differences by forcing the PDO-only data set to periods near those from Pravec *et al.* were unconvincing. The PDO data set extended a week longer than the last reported set from Pravec. It's possible that the lightcurve, especially for the mutual events, underwent significant changes over the additional time, which leads to the discrepancies. With luck, when combined with the radar data analysis, a more definitive solution will be found, including actual sizes of the two bodies.





Hungaria Binary Status

This count of *known* Hungaria binary found at PDO now stands at 13. Five others have been discovered at other locations. Another 7 Hungarias (all but one found at PDO) are considered *probable* binaries but need additional confirmation. There are still 4 others that are suspicious but not sufficiently so to make them even probable discoveries. There are currently 278 Hungarias in the LCDB with statistically valid rotation rates. The 18 known binaries accounts for about 6% of that total. Making some assumptions about distribution of orbit pole orientations, the true number may be more on the order of 12%. If the 7 probable discoveries are included, the percentage increases to about 18%, which is in line with the estimated population among near-Earth asteroids of about 15% (Pravec *et al.*, 2006).

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX10AL35G and by National Science Foundation grant AST-1032896.

References

Behrend, R. (2001). Observatoire de Geneve web site, *http://obswww.unige.ch/~behrend/page_cou.html*

Benner, L.A.M., Nolan, M.C., Ostro, S.J., Giorgini, J.D., Margot, J.L, and Magri, C. (2005). "1994 XD." *IAUC* **8563**

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

Harris, A.W. (DLR), Harris, A.W. (JPL) (1997). "On the Revision of Radiometric Albedos and Diameters of Asteroids." *Icarus* **126**, 450-454.

Harris, A.W. and Pravec, P. (2006). "Rotational properties of asteroids, comets and TNOs" in Asteroids, Comets, Meteors, Proceedings of the 229th Symposium of the International Astronomical Union held in Búzios, Rio de Janeiro, Brasil August 7-12. (Daniela, L., Sylvio Ferraz, M., Angel, F. Julio, eds.) pp 439-447. Cambridge University Press, Cambridge.

Masiero, J., Mainzer, A.K., Grav, T., Bauer, J.M., Cutri, R.M., Nugent, C., and Cabrera, M.S. (2012). "Preliminary Analysis of WISE/NEOWISE 3-Band Cryogenic and Post-cryogenic Observations of Main Belt Asteroids." *Astrophys. J. Letters* **759**, L8.

Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, L., Mottola, S., Hahn, G., Brown, P., Esquerdo, G., Kaiser, N., Krzeminski, Z., Pray, D.P., Warner, B.D., Harris, A.W., Nolan, M.C., Howell, E.S., Benner, L.A.M., Margot, J.-L., Galád, A., Holliday, W., Hicks, M.D., Krugly, Yu.N., Tholen, D., Whiteley, R., Marchis, F., Degraff, D.R., Grauer, A., Larson, S., Velichko, F.P., Cooney, W.R., Stephens, R., Zhu, J., Kirsch, K., Dyvig, R., Snyder, L., Reddy, V., Moore, S., Gajdoš, Š., Világi, J., Masi, G., Higgins, D., Funkhouser, G., Knight, B., Slivan, S., Behrend, R., Grenon, M., Burki, G., Roy, R., Demeautis, C., Matter, D., Waelchli, N., Revaz, Y., Klotz, A., Rieugné, M., Thierry, P., Cotrez, V., Brunetto, L., and Kober, G. (2006). "Photometric survey of binary near-Earth asteroids." *Icarus* **181**, 63-93.

Marchis, F., Enriquez, J.E., Emery, J.P., Mueller, M., Baek, M., Pollock, J., Assafin, M., Vieira Martins, R., Berthier, J., Vachier, F., Cruikshank, D.P., Lim, L.F., Reichart, D.E., Ivarsen, K.M., Haislip, J.B., and LaCluyze, A.P. (2012). "Multiple asteroid systems: Dimensions and thermal properties from Spitzer Space Telescope and ground-based observations." *Icarus* **221**, 1130-1161.

Warner, B.D., Pravec, P., Harris, A.W., Pray, D., Kanupuru, V., and Dyvig R. (2004). MPML, msg #13545.

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

Warner, B.D., Harris, A.W., and Pray, D. (2009). "(26471) 2000 AS152." *CBET* **1881**.

Warner, B.D., Pravec, P., Kusnirak, P., Hornoch, K., Harris, A., Stephens, R.D., Casulli, S., Cooney, W.R., Jr., Gross, J., Terrell, D., Durkee, R., Gajdos, S., Galad, A., Kornos, L., Toth, J.,Vilagi, J., Husarik, M., Marchis, F., Reiss, A.E., Polishook, D., Roy, R., Behrend, R., Pollock, J., Reichart, D., Ivarsen, K., Haislip, J., Lacluyze, A., Nysewander, M., Pray, D.P., and Vachier, F. (2010a). "A Trio of Binary Asteroids." *Minor Planet Bul.* **37**, 70-73.

Warner, B.D. (2010b). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: 2010 March – June." *Minor Planet Bul.* **37**, 161-165.

Warner, B.D., Pravec, P., Kusnirak, P., Harris, A.W., Cooney, W.R., Jr., Gross, J., Terrell, D., Nudds, S., Vilagi, J., Gajdos, S., Masi, G., Pray, D.P., Dyvig, R., and Reddy, V. (2011). "Lightcurves from the Initial Discovery of Four Hungaria Binary Asteroids." *Minor Planet Bul.* **38**, 107-109.

Wisniewski, W.Z. (1992). "The unusual lightcurve of 1990 TR" in *Asteroids, Comets, Meteors 1991.* pp. 653-656 (A.W. Harris, E. Bowell, eds.) Lunar and Planetary Institute, Houston.

PHOTOMETRIC OBSERVATIONS OF 782 MONTEFIORE, 3842 HARLANSMITH, 5542 MOFFATT, 6720 GIFU, AND (19979) 1989 VJ

Xianming L. Han
Dept. of Physics and Astronomy, Butler University, Indianapolis, IN 46208, USA
xhan@butler.edu

Bin Li, Haibin Zhao
Purple Mountain Observatory, Chinese Academy of Sciences, Nanjing. P.R. China

Wenjuan Liu, Luming Sun, Jingjing Shi, Shan Gao, Shufen Wang, Xiang Pan, Peng Jiang, Hongyan Zhou
Dept. of Astronomy, University of Science and Technology of China, Hefei, China
and
Polar Research Institute of China, Shanghai, China

(Received: 15 January)

Five solar system minor planets were measured photometrically between 2012 October and December using the SARA (Southeastern Association for Research in Astronomy) telescopes located in Kitt Peak National Observatory in USA and Cerro Tololo Inter-American Observatory in Chile. The following synodic periods were found: 782 Montefiore P = 4.0728 ± 0.0006 h; 3842 Harlansmith, P = 2.7938 ± 0.0005 h; 5542 Moffatt P = 5.187 ± 0.001 h; 6720 Gifu, P = 4.231 ± 0.001 h; and (19979) 1989 VJ, P = 7.568 ± 0.005 h.

All observational data reported here were obtained using the two Southeastern Association for Research in Astronomy telescopes (SARA North and SARA South). The SARA North telescope has an aperture of 0.91 m and is located at the Kitt Peak National Observatory in USA. This telescope has an effective focal ratio of *f*/7.5. When coupled to an ARC (Astronomical Research Cameras, Inc) CCD camera, this results in a resolution of 0.86 arcsec/pixel (binned 2×2) and FOV = 14.6×14.6 arcmin. A Bessell R filter was used when taking images. The camera was cooled to –109°C. Image acquisition was done with *DS9*. The SARA South telescope has an aperture of 0.61 m and is located at the Cerro Tololo Inter-American Observatory in Chile. This telescope has an effective focal ratio of *f*/13.5. When coupled to a QSI 683s CCD camera, this results in a resolution of 0.27 arcsec/pixel (binned 2×2) and FOV = 7.51×5.70 arcmin. An SDSS r filter was used when taking images. The camera temperature was set at –25°C. Image acquisition was done with *MaxIm DL*. Both telescopes were operated remotely. All images were reduced with master bias, dark and flat frames with calibration frames created using *IDL*. Period analysis was performed using *MPO Canopus,* which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris *et al.*, 1989). The asteroids were selected from the list of asteroid photometry opportunities published on the Collaborative Asteroid Lightcurve Link (CALL) website (Warner *et al.*, 2008), and the lightcurve opportunities published in the *Minor Planet Bulletin* (Warner *et al.*, 2012).

782 Montefiore. This asteroid was selected based on its potential for shape modeling (Warner *et al.*, 2012). Five observation sessions were made between 2012 November 8 and December 2. We obtained a period of P = 4.0728 ± 0.0006 h and an amplitude of 0.43 ± 0.01 mag. Behrend (2007) studied this asteroid previously and obtained P = 4.0730 h with an amplitude of 0.45 mag. Our period is consistent with that obtained by Behrend.

3842 Harlansmith. We observed this asteroid on three nights: 2012 November 28, 29, and December 10. We obtained a synodic period of 2.7938 ± 0.0005 h and an amplitude of 0.34 ± 0.03 mag. No previously published results were found.

5542 Moffatt. Alvarez-Candal *et al*. (2004) observed this asteroid and obtained a period of 5.195 h, but with less than 100% lightcurve coverage, and the CALL website assigned it a quality index U = 1. We made five observation sessions between 2012 November 15 and December 9 and obtained a synodic period of P = 5.187 ± 0.001 h and an amplitude of 0.10 ±0.01 mag. Our period is consistent with that obtained by Alvarez-Candal *et al*.

6720 Gifu. We made three observation sessions of this asteroid between 2012 October 31 and December 9. We obtained a synodic period of 4.231 ± 0.001 h and an amplitude of 0.39 ± 0.01 mag. No previously published results were found.

(19979) 1989 VJ. Behrend *et al*. (2006) observed this asteroid previously and obtained a period of 1.3 hours, and the CALL website assigned it a quality index U = 1. We observed this asteroid for three nights: 2012 November 28, 29, and December 9. We obtained a synodic period of 7.568 ± 0.005 h and an amplitude of 0.29 ± 0.03 mag. Our period does not agree with that obtained by Behrend.

Acknowledgements

We would like to thank F. Levinson for a generous gift enabling Butler University's membership in the SARA consortium. We would also like to thank the support by the National Natural Science Foundation of China (Grant Nos. 11178025, 11273067 and 10933004) and the Minor Planet Foundation of Purple Mountain Observatory.

References

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

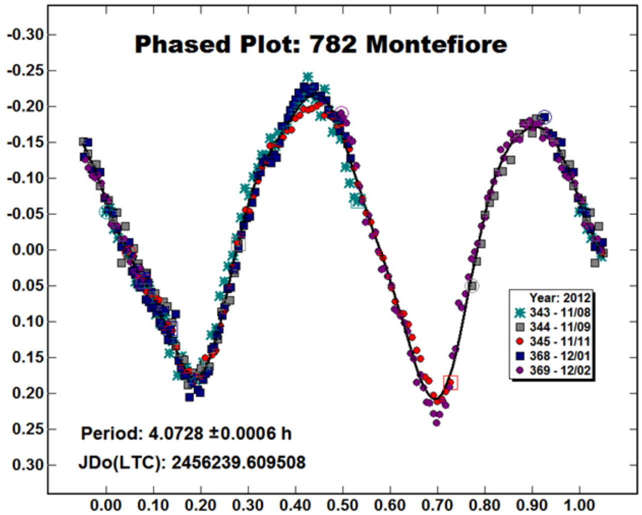
Behrend, R. (2006). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

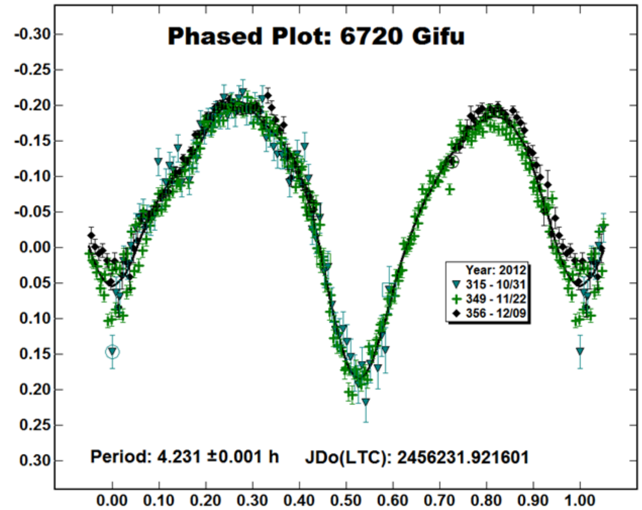
Behrend, R. (2007). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

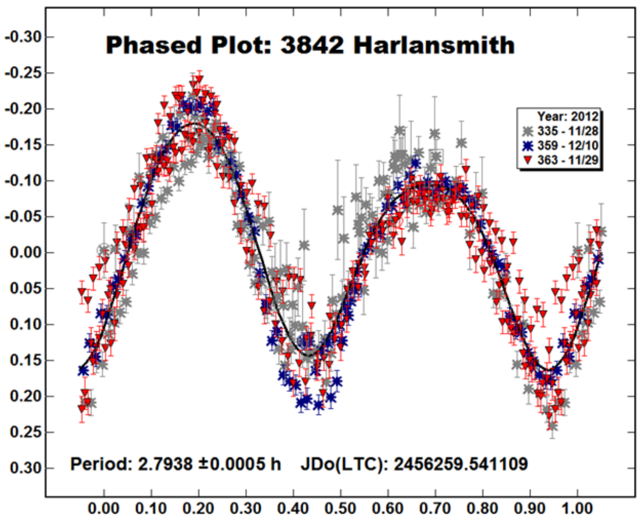
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186

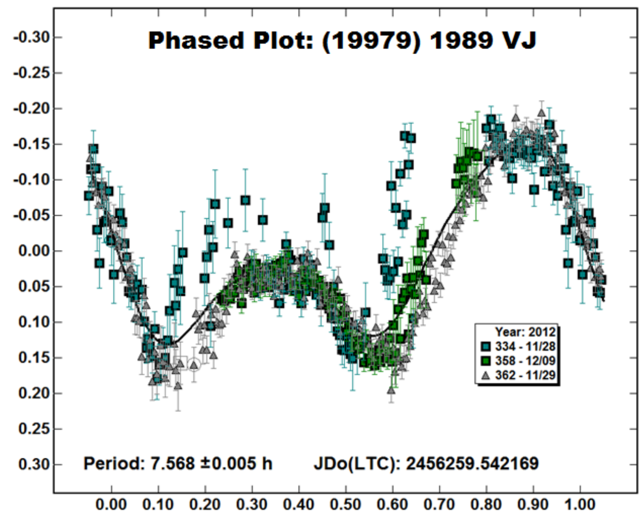
Warner, B.D., Harris, A.W., and Pravec, P. (2008). Asteroid Lightcurve Parameters. *http://www.minorplanet.info/call.html*

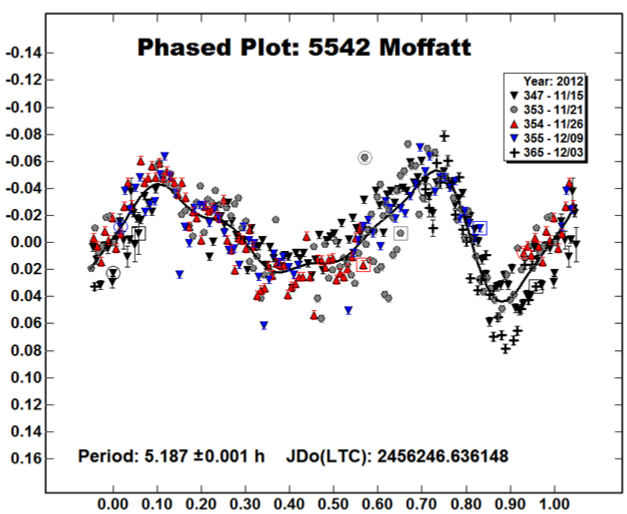
Warner, B.D., Harris, A.W., Pravec, P., Ďurech, J., and Benner, L.A.M. (2012). "Lightcurve Photometry Opportunities: 2012 October-December." **39,** 254-259.











LIGHTCURVES FOR 366 VINCENTINA, 592 BATHSEBA, AND 1554 YUGOSLAVIA FROM BELGRADE ASTRONOMICAL OBSERVATORY

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

(Received: 15 January)

Lightcurves for the asteroids 366 Vincentina, 592 Bathseba, and 1554 Yugoslavia were obtained from 2012 May to October at the Belgrade Astronomical Observatory using differential aperture photometry. The results found for the synodic periods and amplitudes are reported.

CCD photometric observations of 366 Vincentina, 592 Bathseba, and 1554 Yugoslavia were carried out using a 0.4 m *f*/10 Schmidt-Cassegrain telescope with an SBIG ST-10XME CCD camera operating at 2x2 binning with a 0.69 arcsec/pixel resolution. Exposures were unguided. The usual exposure times were fairly short (between 20 and 45 seconds depending on target brightness) due to telescope tracking problems. Bessel R and V photometric filters were used only in the case of three sessions of 366 Vincentina. All photometric measurements using differential photometry technique and period analysis were done in *MPO Canopus*. Only the instrumental magnitudes were used. The observing targets were selected from the list of asteroid photometry opportunities on the Collaborative Asteroid Lightcurve Link website (CALL, Warner, 2012).

366 Vincentina. Robinson (2002) reported an unreliable period (U=1) of 15.5 ± 0.1 h for this main-belt asteroid (MBA). In order to determine a secure value for the period, photometric observations were made on seven nights between 2012 September 11 and October 23. The data analysis produced a bimodal lightcurve with a period of 12.7365 ± 0.0005 h and an amplitude of 0.06 ± 0.01 mag. The newly obtained period result based on full rotational phase coverage differs significantly from that previously found by Robinson.

592 Bathseba. Clark and Joyce (2003) published a period of 6.571 ± 0.008 h for this MBA based on less than full rotational phase coverage. This result has an uncertainty flag U=2 on the CALL website (Warner, 2012). In order to test the reliability of the previously determined period, observations were made on eight nights from 2012 May 1-28. Analysis of the 1268 data points, which covered the complete lightcurve, found a secure synodic period of 7.7456 ± 0.0004 h with an amplitude of 0.23 ± 0.02 mag. It is interesting to note that Pierre Antonini (Behrend, 2012) also conducted new observations of this asteroid and found a period of value of 7.7464 h, which is fully consistent with the results presented here.

1554 Yugoslavia. This main-belt minor planet was discovered at the Belgrade Observatory on 1940 September 6 by M. B. Protitch. A secure period of 3.8879 ± 0.0003 h (U=3) was previously found by Higgins (2008). New photometric data were collected at the Belgrade Observatory over three nights from 2012 August 28 until September 9 resulting in 501 data points. The synodic period of 3.8876 ± 0.0001 h that was found is consistent with the value determined by Higgins. The amplitude of the 2012 lightcurve is 0.77 ± 0.03 mag.

References

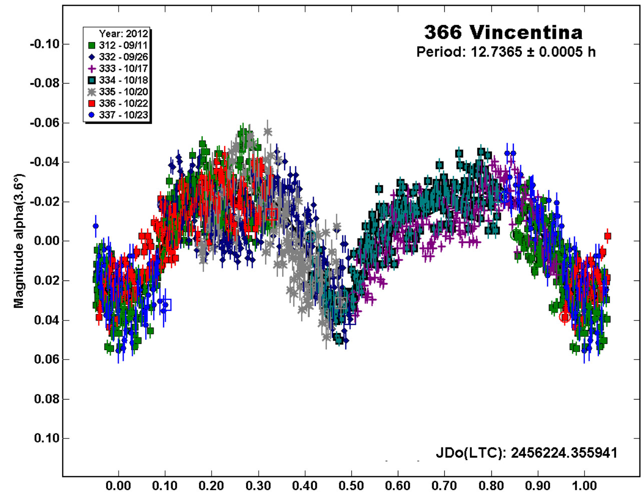
Behrend, R. (2012). Observatoire de Geneve web site. *http://obswww.unige.ch/~behrend/page_cou.html*

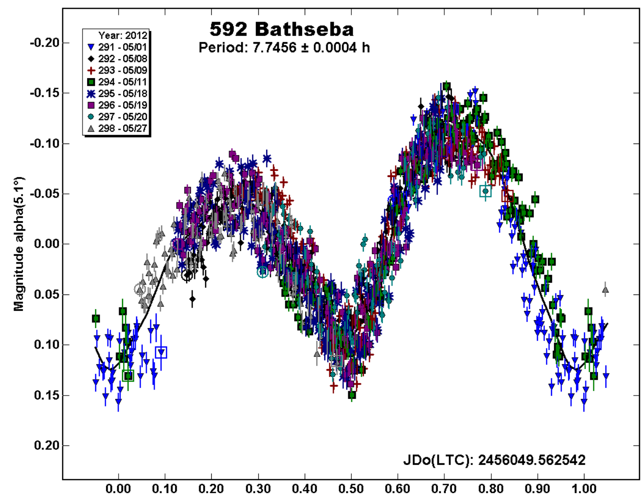
Clark, M. and Joyce, B. (2003). "Asteroid Lightcurve Photometry from Goodsell Observatory (741)." *Minor Planet Bulletin* **30**, 4-7.

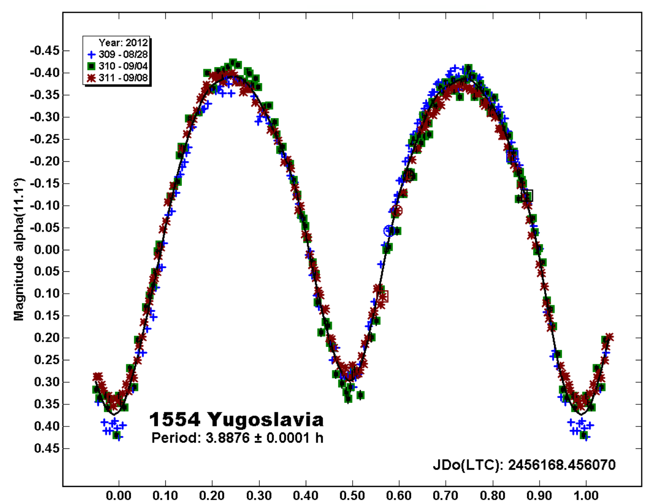
Higgins, D. (2008). "Asteroid Lightcurve Analysis at Hunters Hill Observatory and Collaborating Stations: April 2007 – June 2007." *Minor Planet Bulletin* **35**, 30-32.

Robinson, L.E. (2002). "Photometry of Five Difficult Asteroids: 309 Fraternitas, 366 Vincentina 421 Zahringia, 578 Happelia, 959 Anne." *Minor Planet Bulletin* **29**, 30-31.

Warner, B.D (2012). Collaborative Asteroid Lightcurve Link (CALL) web site. *http://www.minorplanet.info/call.html*







LIGHTCURVE ANALYSIS FOR ASTEROIDS 2855 BASTIAN AND (17722) 1997 YT1

Caroline Odden, John French, John Little, Ryan Brigden
Phillips Academy Observatory (I12)
180 Main Street
Andover, MA USA 01810
ceodden@andover.edu

John W. Briggs
HUT Observatory, H16
P.O. Box 5320
Eagle, CO 81631 USA

(Received: 15 January)

Lightcurves for asteroids 2855 Bastian and (17722) 1997 YT1 were obtained at Phillips Academy Observatory (PAO) and HUT Observatory from 2012 October to 2013 January.

The Phillips Academy and HUT Observatories have twin 0.40-m *f*/8 Ritchey-Chrétien reflectors by DFM Engineering. Phillips Academy Observatory used an SBIG 1301-E CCD camera with a 1280x1024 array of 16-micron pixels working at –25° C. The resulting image scale was 1.0 arcsec/pixel. Exposures were usually 450 seconds and unfiltered. All images were dark and flat field corrected, guided, and unbinned. HUT observations were made with an Apogee Alta model U47 CCD binned 2x2 for an effective image scale of 1.65 arcsec/pixel working at –40° C. Exposures were 180 seconds through a Cousins R filter. All images were dark and flat field corrected.

Images were measured using *MPO Canopus* (Warner, 2010) with a differential photometry technique. All comparison stars were selected to have approximately solar color by using the "comp star selector" tool of *MPO Canopus*. Data merging and period analysis was also done with *MPO Canopus,* the latter process using an implementation of the Fourier analysis algorithm (FALC) of Harris *et al.* (1989).

2855 Bastian. The lightcurve for 2855 Bastian was a combined effort between the Phillips Academy Observatory and HUT and consists of 598 data points. An examination of the period spectrum indicates a best-fit period of P = 3.5161 ± 0.0001 h and results in a lightcurve with amplitude A = 0.15 ± 0.02 mag. The adopted period and its double yielded the lowest RMS values. Given the multimodal nature of the curve, the 1/2P solution was also examined. That resulting curve exhibited considerable misfit and was not favored by the period spectrum. When the data are phased to the double period (13.752 hours), full coverage is achieved and the two halves of the curve look the same within reasonable error. This result agrees with the period of 3.5160 h reported by Pravec *et al.* (2012).

(17722) 1997 YT1. The lightcurve for asteroid (17722) 1997 YT1 was obtained exclusively from Phillips Academy Observatory and consists of 400 data points. Examination of the period spectrum indicates a period of P = 8.6387 ± 0.0005 h with a lightcurve amplitude A = 0.36 ± 0.02 mag. The adopted period yielded the lowest RMS value. The double-period and higher order multiples also yielded low RMS values. When the data are phased to the double-period, full coverage is achieved and the two halves of the curve look the same within reasonable error.

Acknowledgments

Thanks to Brian Warner and Petr Pravec for their timely and helpful advice regarding 2855 Bastian. Research at the Phillips Academy Observatory is supported by the Israel Family Foundation. Work at the HUT Observatory is supported by the Mittelman Family Foundation.

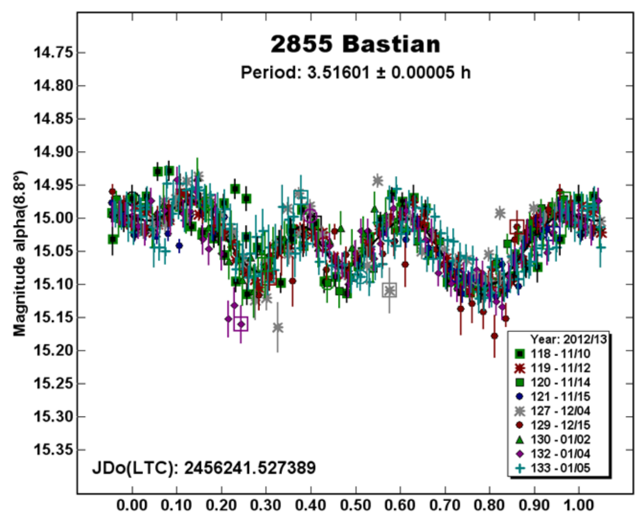
References

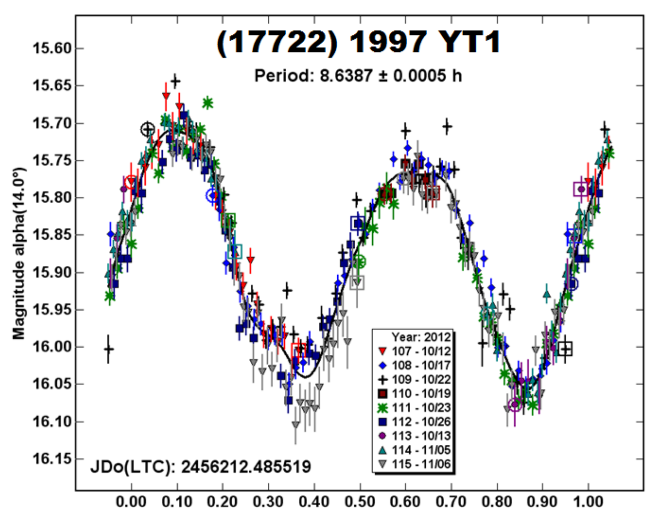
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

Pravec, P., Wolf, M., and Sarounova, L. (2012). Ondrejov Asteroid Photometry Project web site. *http://www.asu.cas.cz/~ppravec/neo.htm*

Warner, B.D. (2010). *The MPO Users Guide: A Companion Guide to the MPO Canopus/PhotoRed Reference Manuals*. BDW Publishing, Colorado Springs, CO.

Warner, B.D. (2012) "Potential Lightcurve Targets". *http://www.MinorPlanet.info/PHP/call_OppLCDBQuery.php*





(51356) 2000 RY76: A NEW HUNGARIA BINARY

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

Donald P. Pray
Sugarloaf Mountain Observatory
South Deerfield, MA USA

(Received: 9 January)

Analysis of CCD photometric observations of the Hungaria asteroid (51356) 2000 RY76 made in 2012 October and November shows that the asteroid is a binary system. A monomodal lightcurve for the primary has a period 2.5572 ± 0.0001 h with an amplitude of 0.09 ± 0.01 mag while a bimodal solution has a period of 5.1143 ± 0.0003 h. The shorter solution is considered the more likely. The orbital period of the presumed satellite is 62.05 ± 0.05 h using either primary period. Based on the depth of the mutual events, the satellite-primary diameter ratio is estimated to be $D_s/D_p \geq 0.21 \pm 0.02$.

As part of the regular observations of the Hungaria asteroids conducted at the Palmer Divide Observatory since 2005, CCD photometric observations of (51356) 2000 RY76 were started in 2012 October. No previous rotation period was found in the asteroid lightcurve database (LCDB; Warner *et al.*, 2009). Assuming a compromise albedo of 0.3, the estimated diameter of the asteroid is 2.5 km. The compromise value lies between that for type S asteroids (p_V ~0.2), commonly found among members of the Hungaria group, and that for type E asteroids (p_V ~0.4), which is expected for members of the Hungaria family.

During the course of the observations, what appeared to be deviations from a 2.55 hour lightcurve were noticed. The duration and depth of the "events" were consistent with a satellite with an orbit on the order of 24-72 hours. Weather and a full moon prevented continuous coverage in October and so the observations were continued into November with Pray at Sugarloaf Mountain providing data on several nights.

The observations at PDO were made using 0.5-m Ritchey-Chretien and Finger Lakes Instruments CCD camera with KAF-1001E chip. Exposures were 240 seconds and unfiltered. Observations at Sugarloaf Mountain were made with a 0.5-m Newtonian and SBIG ST-10XME. Exposures were 180 seconds, also unfiltered. All images were measured in *MPO Canopus*. The dual-period feature in that program, based on the FALC algorithm developed by Harris (Harris *et al.*, 1989) was used to subtract one of the periods from the data set in an iterative process until both periods remained stable. Night-to-night calibration of the data was done using the Comp Star Selector feature in *MPO Canopus*. Catalog magnitudes for the comparison stars were derived from J-K to BVRI formulae developed by Warner (2007) using stars from the 2MASS catalog (Skrutskie *et al.*, 2006). A description of this method was described by Stephens (2008).

The results of the analysis are shown in the three figures. The rotation periods for small binary asteroids can range from 2-5 hours, with 2-3 hours being more common. On that basis, a monomodal solution for the primary lightcurve (Figure 1) has a period of 2.5572 ± 0.0001 h and amplitude of 0.09 ± 0.01 mag. However, a bimodal solution, with P = 5.1143 ± 0.0003 h, cannot be formally excluded. Deciding which is the more likely solution can be left to circumstantial evidence, so-called "Bayesian probability", where shorter periods are statistically favored. Also favoring the shorter period is the work done by Pravec *et al.* (2010) that showed, for a small binary with a primary having a period of about 5 hours, the satellite will have a mass about 0.1 the primary, or a diameter of about 0.5 the primary. To agree with the lightcurve for the mutual events shown below, this would require very grazing events with even greater slope than observed.

As pointed out by Harris (2012), lightcurves with amplitudes less than about 0.15 mag can be anywhere from monomodal, bimodal, trimodal, and beyond. Therefore, enforcing a restriction of even the more common mono- and bimodal shapes cannot be easily justified, although in this case, there is no indication that the true solution goes beyond a bimodal lightcurve. In the end, we adopted the shorter solution as the more likely but also say that the longer period cannot be formally excluded.

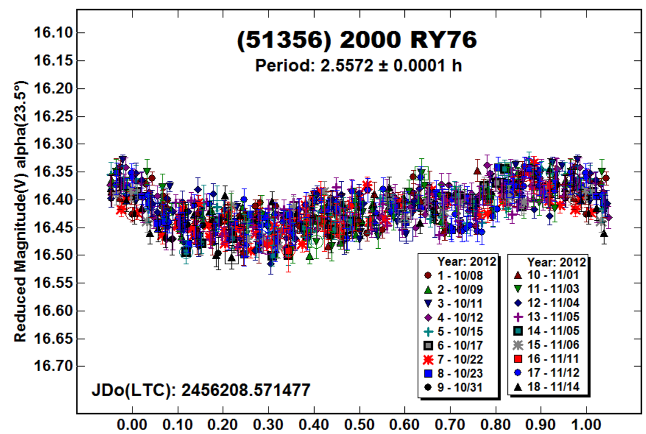


Figure 1. The lightcurve of the primary body of 2000 RY76 for a period of 2.5572 h.

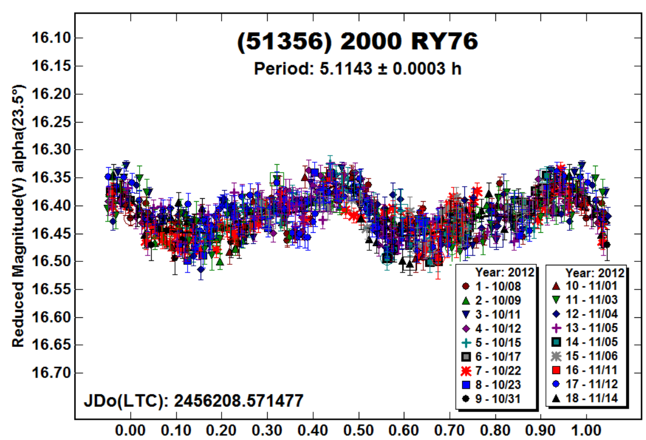


Figure 2. The lightcurve for 2000 RY76 of 5.1143 h, which assumes the shape is bimodal and the viewing aspect more equatorial.

Figure 3 shows the lightcurve of the mutual events (eclipses and/or occultations). The period is 62.05 ± 0.05 h. This did not change when using either of the primary period solutions. The more shallow event at about 0.8 rotation phase gives a secondary/primary effective size ratio of D_s/D_p = 0.21 ± 0.02. Since the events do not appear total, this ratio should be considered a lower limit.

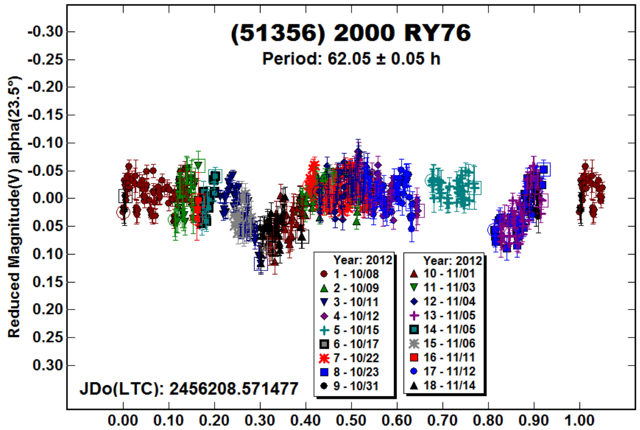


Figure 3. The lightcurve of 2000 RY76 showing the mutual events due to a suspected satellite.

Acknowledgements

The authors thank Dr. Alan Harris for his comments and suggestions regarding the analysis of the periods.

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNX10AL35G and by National Science Foundation grant AST-1032896. Research at Sugarloaf Mountain Observatory is funded in part by a Eugene Shoemaker grant from the Planetary Society.

References

Harris, A.W. (2012). "On the Maximum Amplitude of Harmonics of an Asteroid Lightcurve." in *Proceedings for the 31st Annual Symposium on Telescope Science* (B.D. Warner, R.K. Buchheim, J.L. Foote, D. Mais, eds.) pp 59-63. Society for Astronomical Sciences, Rancho Cucamonga, CA.

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., Vokrouhlický, D., Polishook, D., Scheeres, D. J., Harris, A. W., Galád, A., Vaduvescu, O., Pozo, F., Barr, A., Longa, P., Vachier, F., Colas, F., Pray, D. P., Pollock, J., Reichart, D., Ivarsen, K., Haislip, J., Lacluyze, A., Kušnirák, P., Henych, T., Marchis, F., Macomber, B., Jacobson, S. A., Krugly, Yu. N., Sergeev, A. V., and Leroy, A. (2010). "Formation of asteroid pairs by rotational fission." *Nature* **466**, 1085-1088.

Skrutskie, M.F., Cutri, R.M., Stiening, R., Weinberg, M.D., Schneider, S., Carpenter, J.M., Beichman, C., Capps, R., Chester, T., Elias, J., Huchra, J., Liebert, J., Lonsdale, C., Monet, D.G., Price, S., Seitzer, P., Jarrett, T., Kirkpatrick, J.D., Gizis, J.E., Howard, E., Evans, T., Fowler, J., Fullmer, L., Hurt, R., Light, R., Kopan, E.L., Marsh, K.A., McCallon, H.L., Tam, R., Van Dyk, S., and Wheelock, S. (2006). "The Two Micron All Sky Survey (2MASS)." *Astron. J.* **131**, 1163-1183.

Stephens, R.D. (2008). "Long Period Asteroids Observed from GMARS and Santana Observatories." *Minor Planet Bul*. **37**, 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. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146.

LIGHTCURVES FOR 1560 STRATTONIA, 1928 SUMMA, 2763 JEANS, 3478 FANALE, 3948 BOHR, 5275 ZDISLAVA, AND 5369 VIRGIUGUM

Larry E. Owings
Barnes Ridge Observatory
23220 Barnes Lane
Colfax, CA 95713 USA
lowings@foothill.net

(Received: 14 Nov 2012 Revised: 28 Jan 2013)

Lightcurve observations have yielded period determinations for the following asteroids: 1560 Strattonia, 1928 Summa, 2763 Jeans, 3478 Fanale, 3948 Bohr, 5275 Zdislava, and 5369 Viriugum. In addition, H-G values were found for 3948 Bohr and 5369 Viriugum.

Photometric data for seven asteroids were obtained at Barnes Ridge Observatory located in northern California, USA, using a 0.43-m PlaneWave f/6.8 corrected Dall-Kirkham astrograph and Apogee U9 camera. The camera was binned 2x2 with a resulting image scale of 1.26 arcsec per pixel. All image exposures were 210 seconds taken through a photometric C filter. All images were obtained with *MaxIm DL* V5 driven by *ACP* V6 and analyzed using *MPO Canopus* v10.4 (Warner, 2011). The *MPO Canopus* Comp Star Selector feature was used to select comparison stars. All comparison stars and asteroid targets had an SNR at least 100.

<u>1560 Strattonia.</u> Data were collected from 2012 September 3 through September 23 resulting in eleven data sets totaling 902 data points. 1560 Strattonia was tracked through 26.11 revolutions from phase angles of –6.2 through 7.9 deg. A period of 18.4311 ± 0.0015 h was calculated with a peak-to-peak amplitude of 0.20 mag. The average phase angle bisector longitude and latitude were 349.1 and 7.8 deg., respectfully. No previous lightcurve data were found for 1560 Strattonia.

<u>1928 Summa.</u> Data were collected from 2012 August 20 through September 9 resulting in twelve data sets totaling 931 data points. 1928 Summa was tracked through 70.61 or 80.73 revolutions depending on which period is used. The phase angle varied from 2.6 to 11.8 deg. Initially, the analysis resulted in the period spectrum shown in Figure 2. Using a period of 6.8551 h, the lightcurve of Figure 3 resulted. Due to the poor correlation of curves between sessions, Brian Warner (private communications) and Petr Pravec (private communications) reviewed the data and suggested a dual period solution. A better fit to the data resulted in using a primary period of 6.8544 ± 0.0003 h (Figure 4) and a secondary period of 5.9869 ± 0.0015 h (Figure 5). Therefore the solution is not unique. It has the character of a rotational lightcurve, not mutual events as in an eclipsing binary. It may be a binary, but the interpretation is not unique. Also suspicious is a strong peak in the period spectrum of 8.00 h, which is commensurate with an Earth day. The phase angle bisector longitude and latitude were 328.1 and 3.4 deg., respectfully. No previous lightcurve data were found for 1928 Summa.

2763 Jeans. Data were collected from 2012 October 8 through October 17 resulting in four data sets totaling 479 data points. 2763 Jeans was tracked through 28.64 revolutions from phase angles of 3.4 to 6.6 deg. A period of 7.8014 ± 0.0004 h was calculated with a peak-to-peak amplitude of 0.14 mag. The average phase angle bisector longitude and latitude were 15.4 and 5.0 deg., respectfully. Data were previously submitted to the Minor Planet Center Lightcurve Database by Stephens (2012). The reported period was 7.805 ± 0.005 h.

3478 Fanale. Data were collected from 2012 October 18 through October 26 resulting in three data sets totaling 323 data points. 3478 Fanale was tracked through 61.15 revolutions from phase angles of 4.3 through 7.4 deg. A period of 3.24497 ± 0.00006 h was calculated with a peak-to-peak amplitude of 0.57 mag. The average phase angle bisector longitude and latitude were 24.1 and –5.8 deg., respectfully. No previous lightcurve data were found for 3478 Fanale.

3948 Bohr. Data were collected from 2012 July 16 through September 3 resulting in 21 data sets totaling 1256 data points. 3948 Bohr was tracked through 47.22 revolutions from phase angles of –5.39 through 23.12 deg. A period of 24.9053 ± 0.0006 h was calculated with a peak-to-peak amplitude of 0.95 mag. Given the good range of phase angles, the H and G parameters were calculated: H = 13.545 ± 0.046 and G = 0.292 ± 0.085 (Figure 9). The average phase angle bisector longitude and latitude were 301.7 and 3.9 deg., respectfully. No previous lightcurve data were found for 3948 Bohr.

5275 Zdislava. Data were collected from 2012 September 25 through October 5 resulting in seven data sets totaling 771 data points. 5275 Zdislava was tracked through 47.56 revolutions from phase angles of 7.5 through 8.4 deg. A period of 5.2008 ± 0.0002 h was calculated with a peak-to-peak amplitude of 0.50 mag. The average phase angle bisector longitude and latitude were 5.3 and 8.0 deg., respectfully. No previous lightcurve data were found for 5275 Zdislava.

5369 Viriugum. Data were collected from 2012 August 12 through September 19 resulting in ten data sets totaling 563 data points. 5369 Viriugum was tracked through 156.14 revolutions from phase angles of –5.65 through 18.68 deg. A period of 5.8422 ± 0.0002 h was calculated with a peak-to-peak amplitude of 0.18 mag. The range of phase angles allowed finding the H-G parameters: H = 14.482 ± 0.034 and G = 0.309 ± 0.066 (Figure 12). The average phase angle bisector longitude and latitude were 328.0 and 2.2 deg. respectfully. No previous lightcurve data were found for 5369 Viriugum.

Acknowledgements

The author wishes to thank Brian Warner and Petr Pravec for reviewing and offering suggestions on the analysis of data on 1928 Summa, 3948 Bohr, and 5369 Virgiugum.

References

Stephens, R. D. (2012). Posting on CALL web site. *http://www.minorplanet.info/call.html*

Warner, B. D. (2011). *MPO Canopus* software Version 10.4.04 Bdw Publishing. *http://www.MinorPlanetObserver.com/.*

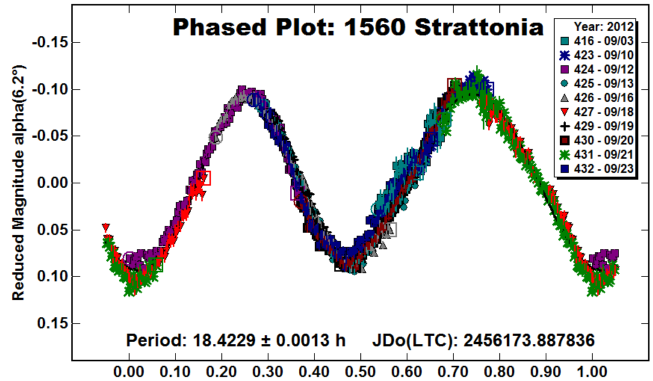


Figure 1. Lightcurve for 1560 Strattonia.

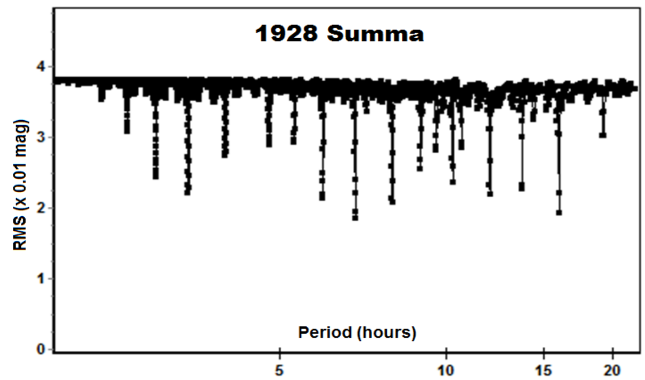


Figure 2. Period spectrum for 1928 Summa.

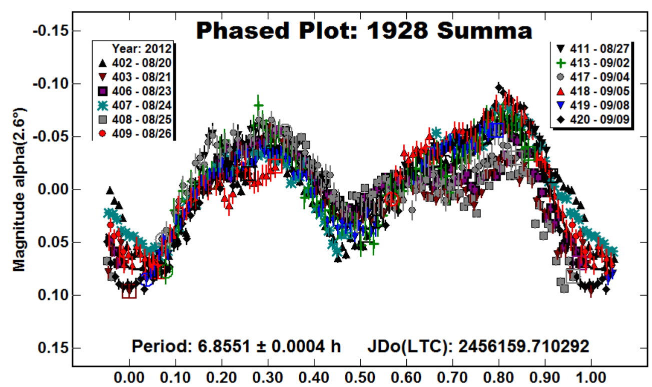


Figure 3. The initial lightcurve for 1928 Summa assuming a single period.

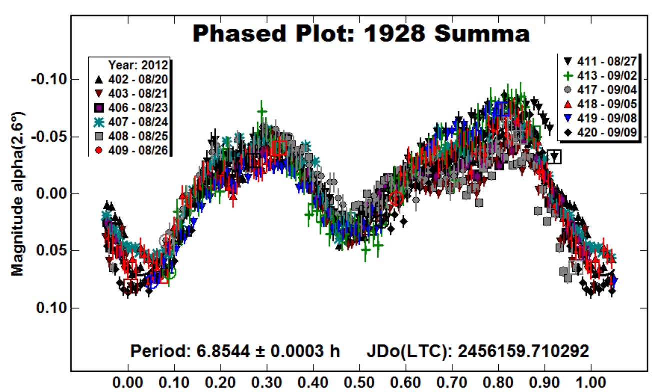


Figure 4. The lightcurve of 1928 Summa using one of two periods in a dual period search. See the text for additional information.

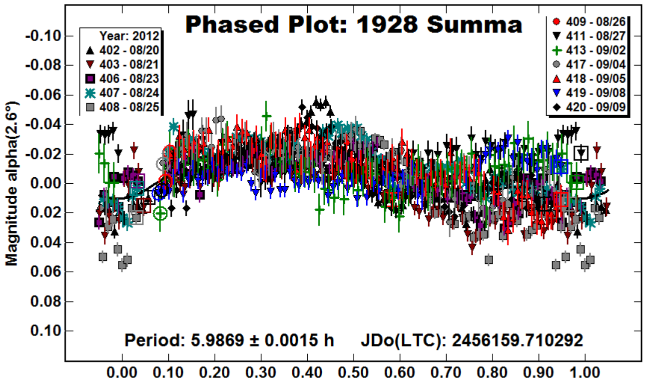


Figure 5. The lightcurve of 1928 Summa phased to a secondary period in a dual-period solution.

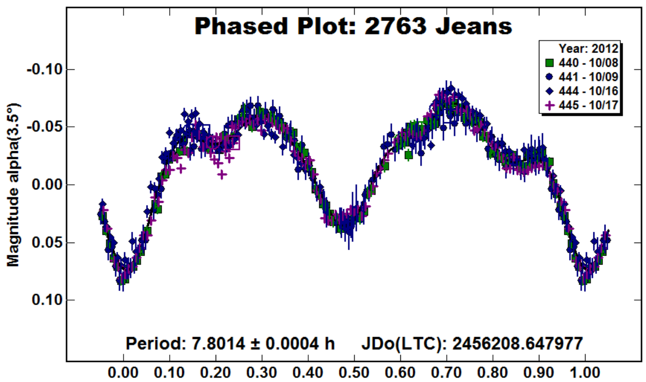


Figure 6. The lightcurve of 2763 Jeans.

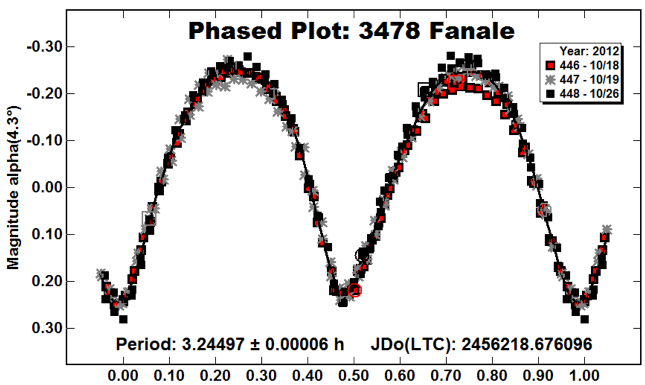


Figure 7. The lightcurve of 3478 Fanale.

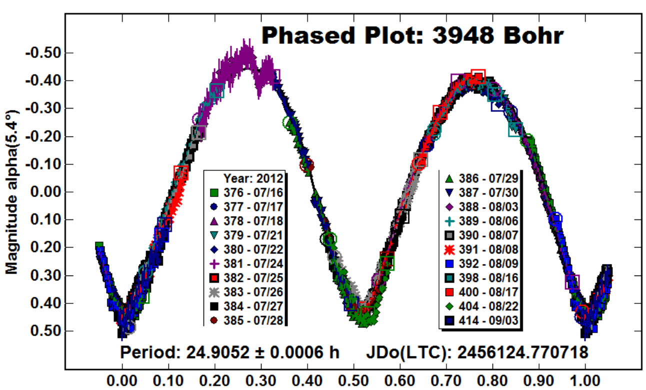


Figure 8. The lightcurve of 3948 Bohr.

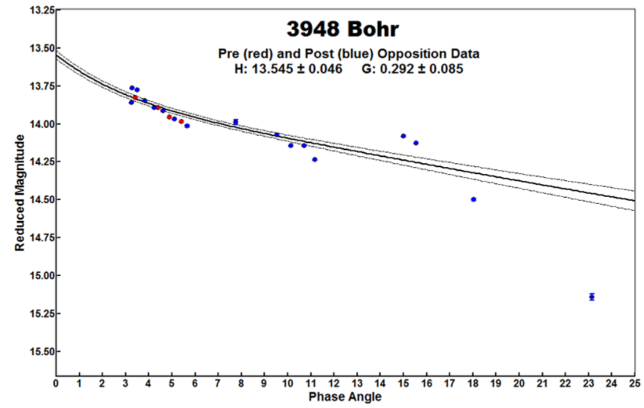


Figure 9. The H-G curve of 3948 Bohr.

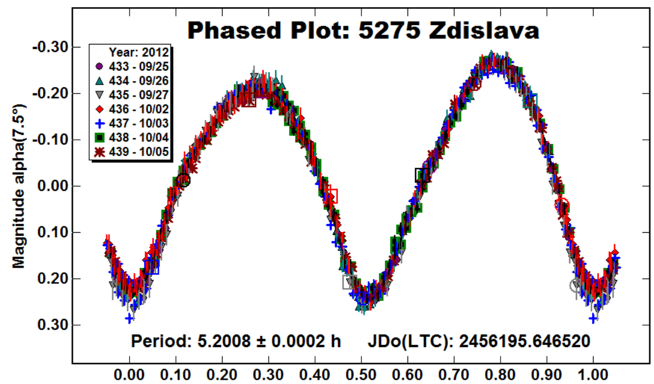


Figure 10. The lightcurve of 5275 Zdislava.

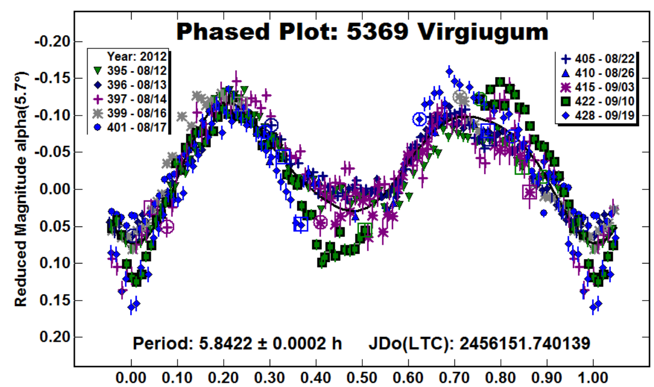


Figure 11. The lightcurve of 5369 Virgiugum.

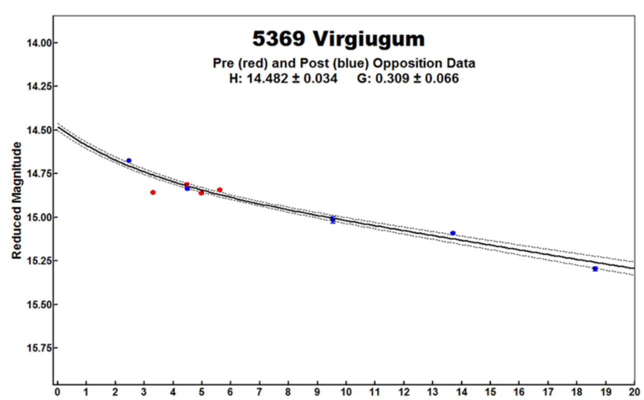


Figure 12. The H-G curve of 5369 Virgiugum.

PHOTOMETRIC OBSERVATIONS OF ASTEROID 433 EROS DURING 2012 APPARITION

Frank J. Melillo
Holtsville Observatory
14 Glen-Hollow Dr., E-16
Holtsville, NY 11742

(Received: 3 November)

A total of 55 clear-filtered photometric observations of the near-Earth asteroid 433 Eros were made on four nights from Holtsville Observatory during the 2012 apparition. The lightcurves were plotted using data from these observations to detect the amplitudes. The amplitudes and also the synodic rotation period of the 2012 apparition in clear-filtered photometry are discussed here.

433 Eros was discovered in 1898 by Carl Gustav Witt as the first near-earth asteroid. It is a type-S minor planet and belongs to the Amor group. It has an elongated shape with dimensions of 34.4x11.2x11.2 km measured by the NEAR spacecraft. When Eros is close to earth, it can shine as bright as 7th magnitude.

As Eros spins on its axis, it is often seen with two maxima and two minima over the 5 hour and 16 minute rotation period. The amplitude of the variations can be as much as 1.5 magnitudes in some cases and, at other times, there is little or no variation at all. This is due to the alignment of the asteroid's polar axis to the line-of-sight from Earth. When we are looking nearly at one of the poles of Eros, the amplitude of the lightcurve is near a minimum. When the view is more "equatorial", the amplitude is near maximum.

Eros is observable infrequently since it never spends much time near Earth. Roughly every 81 years, it makes a close approach to Earth, as it did 1975 and it will do again in 2056. Other years, such as 1901 and 1931, were also favorable. In 1894, it was missed at the closest approach before it was discovered. It was in those latter years when Eros was close to Earth that it was observed by many amateur astronomers and the ground-based professional observatories. The author observed Eros as a 7th magnitude object during the extremely favorable apparition in 1974-75. All observations were done visually through the eyepiece of an 11.5-cm reflector telescope and were able to catch the dramatic brightness changes of nearly 1.5 magnitude within a few hours, especially on one night due to the 5.16 rotation period. On 1975 January 23, Eros came to opposition in Gemini and its movement was striking each time it was seen. The author continued to observe Eros well into 1975 February. That was the last time it was seen until 37 years later, in 2012.

New Observations

Holtsville Observatory is located in a moderately light-polluted sky 50 miles east of New York City. Eros was visible in high power binoculars but easily imaged with a 200-mm telephoto lens. CCD photometry was the only method this author used to monitor Eros during the 2012 apparition. The unfiltered observations were taken using a Starlight Xpress MX-5 camera through a 200-mm telephoto lens piggybacked on a Meade 0.25-m *f*/10 telescope. Star 2000 MX5 USB photometry software was used to determine the brightness. The 200-mm telephoto was chosen because Eros was bright enough and it was easy to find the comparison stars in the field. A dark field was applied to each image and one comparison star was chosen for each night to determine the amplitude for Eros.

The 2012 observing season began when Eros came closest to earth on 31 January at almost 17 million miles. It was located in constellations Sextans and later on in Hydra in the southern hemisphere during the four nights runs on 2012 February 6, 18, 21 and 27 (UT). Since Eros was visible in the southern hemisphere of the sky, it could not be followed longer than 2-½ hrs due to the lower altitude. This period was about half of the rotation period. Furthermore, most of the eastern sky was blocked and only the sky near meridian could be observed. Each night, Eros clearly showed one minimum and one maximum.

Eros was exposed 10 seconds for each frame to give enough signal for the photometric readings. It was imaged every 10 minutes for more than 2.5 hrs each night. The Star 2000 MX5 USB software provided a good photometry system with background, comparison, and target. The photometric aperture contained 9 square pixels. The readings between the comparison star and Eros automatically calculated the ratio to give the magnitude difference. Many factors must also be considered, such as the seeing conditions, wind, periodic clock drive error, polar alignment and the temperature of the CCD chip, as they all can affect the readings. During most nights, the seeing conditions were above average with no wind. The periodic clock drive error was very small due to the wider telephoto lens. Being that it is a portable observatory, the polar axis was aligned as close as possible to the celestial north pole. Therefore, in spite of a small drift, the motion was corrected before each image taken. The Starlight Xpress MX-5 camera was turned on at least 30 minutes before the start of the first image. This 'cool-down' routine stayed on until the temperature of the chip stabilized. The first night on 6 February, 14 readings were taken every 10 minutes for more than 2 hrs. Eros showed amplitude of 0.30 magnitude. On 18 February, 14 readings showed an amplitude of 0.28 magnitude during 2.3 hrs. By the third night on 21 February, with 13 readings over 2.2 hrs, it showed an amplitude of 0.25 magnitude. Finally, on 27 February with 14 readings during 2.5 hrs, it showed an amplitude of 0.20 magnitude. It seemed that Eros' amplitude decreased from 0.30 to 0.20 magnitude during the month of February.

According to Alan Harris (personal communication; Bowell *et al.*, 1999) he observed Eros at about the same amplitude of 0.3 magnitude in December 1981. That result was taken about 44 degrees from the published north pole. Frederick Pilcher (personal communication) indicated that the north pole of Eros is located at 0h 45m of RA and +17 degrees Declination. The 2012 observations of Eros were in nearly the opposite direction of the sky, about 50 degrees away from the south pole, which is located at 12h 45m RA and –17 degrees Declination. This might explain the decreasing amplitude from early to late February, i.e., Eros was between edge-on and pole-on while it was heading toward the polar aspect position with the minimum amplitude.

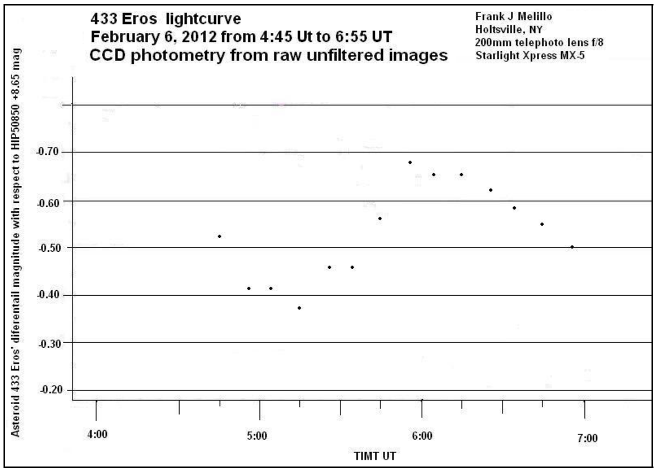
Conclusion

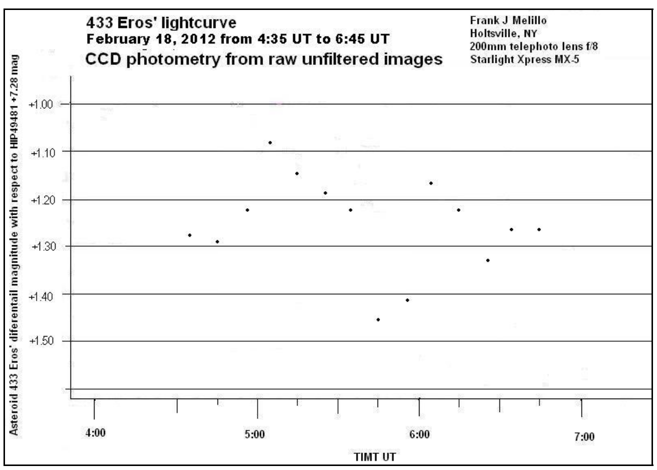
All CCD photometry results were taken from Holtsville Observatory in New York. Only the unfiltered images were used to determine the best shape of the lightcurve. The result is similar to the December 1981 results reported by Harris but a closer look might detect some differences, especially the phase angle.

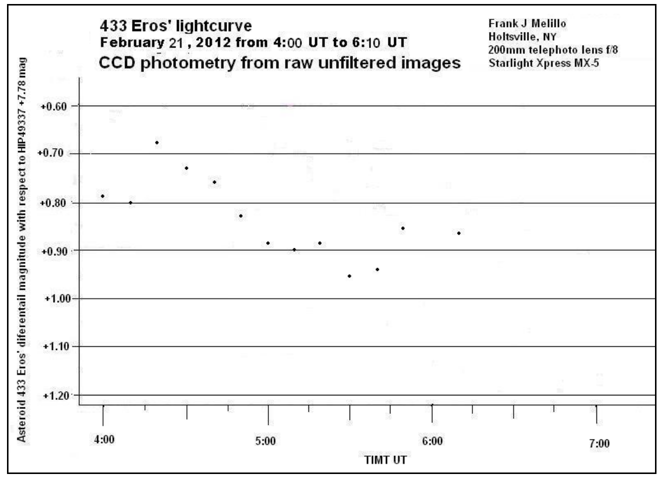
References

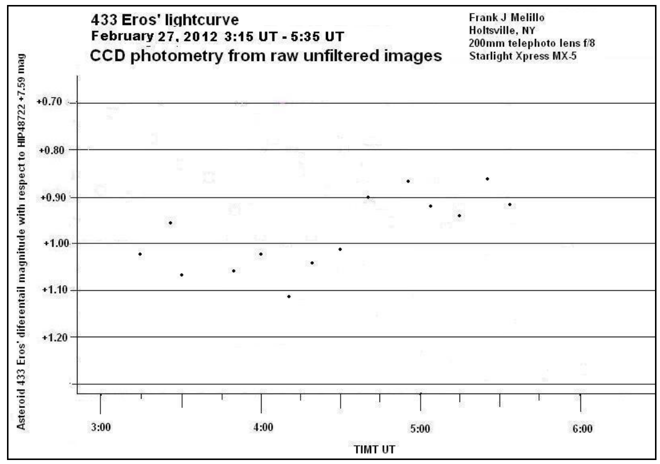
Bowell, E., Harris, A.H., Tholan, D. J. and Young, J. W. (1999). "Asteroid Lightcurves Observations from 1981 to 1983." *Icarus* **142**, 173-201.

DATE (UT)	JD	TIME (UT)		Amp (mag)
2012 Feb 6	+2455963	4:45	6:55	0.30
2012 Feb 18	+2455975	4:35	6:45	0.28
2012 Feb 21	+2455978	4:00	5:50	0.25
2012 Feb 27	+2455984	3:15	5:35	0.20









LIGHTCURVE OF 2717 TELLERVO

Angelo Tomassini, Maurizio Scardella, Gianni La Caprara
Associazione Tuscolana di Astronomia (D06)
Osservatorio Astronomico F. Fuligni
Via Lazio, 14 - località Pratoni del Vivaro - 00040
Rocca di Papa (RM) – ITALY
nikkor5@gmail.com

(Received: 6 November)

Photometric data of the asteroid 2717 Tellervo were collected over 17 nights between 2012 June and August. A synodic rotation period of P = 8.428 ± 0.003 h and amplitude A = 0.43 mag have been determined. In addition, the phase curve parameters have been also computed: H = 12.486 ± 0.071, G = 0.252 ± 0.057.

2717 Tellervo is a main-belt asteroid with a well-known orbit but no reliable photometric data that we could find. Observations were made at the F. Fuligni Observatory, 30 km from Rome (Italy), during a two-month campaign. The equipment used included a 0.35-m *f*/10 Ritchey-Chrétien telescope on a GM2000 German equatorial mount and SBIG ST8-XE CCD camera. All images were taken through a Bessel V filter with different exposure times depending on the visibility conditions. The images were flat-corrected, dark-subtracted, and aligned using *Maxim DL5*.

Photometric data were then extracted by means of *Astrometrica* software (Raab, 2011). The following lightcurve generation and period analysis were executed using *MPO Canopus* (MPO Software).

Analysis of the data found a synodic period of 8.428 ± 0.003 h and amplitude of 0.43 mag. We were also able to use the data set of 17 sessions, covering phase angles between 3.6 and 31 degrees, to calculate phase curve parameters. The results were H = 12.486 ± 0.071 and G = 0.252 ± 0.057. The value for G is consistent with taxonomic class S (stony).

From our value for absolute magnitude, and assuming a geometric albedo p_V = 0.20 – an average value for type S asteroids, we estimated a diameter of

$$D = (1329 \cdot 10^{-0.2H}) / p_v^{1/2} = 9.4 \text{ km}.$$

From the amplitude of the lightcurve and assuming an equatorial view of the asteroid, it is possible infer the minimum value for principal axes ratio (Warner, 2006)

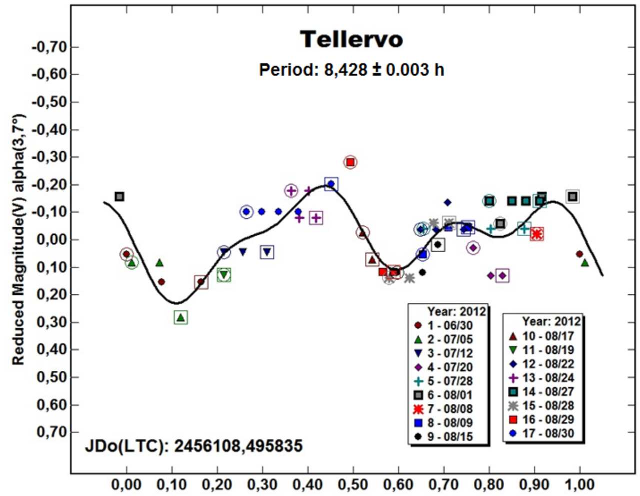
$$a/b = 10^{(A(0)/2.5)} = 1.49$$

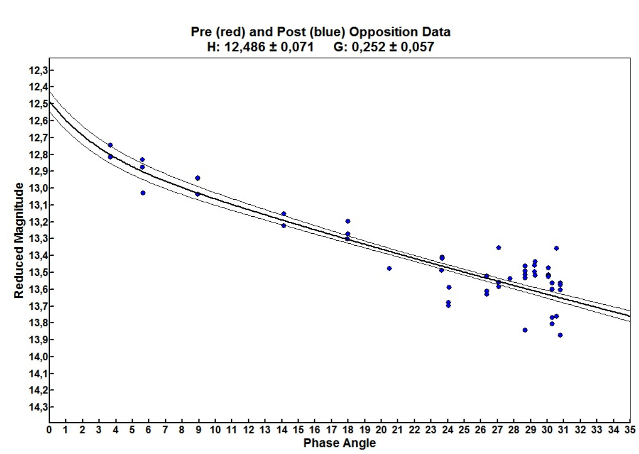
References

BDW Publishing. MPO Canopus Software, version 10.4.1.2. *http://minorplanetobserver.com*

Raab, H. *Astrometrica* software, version 4.6.6.394. *http://www.astrometrica.at/*

Warner, B.D. (2006). *A Practical Guide to Lightcurve Photometry and Analysis*. pp 266. Springer, New York.





LIGHTCURVE PHOTOMETRY AND ROTATIONAL PERIODS OF 2890 VILYUJSK AND 6223 DAHL

E. Brett Waller
857 Cedar Green Road
Staunton, VA 24401
CedarGreenObservatory@gmail.com

(Received: 15 January Revised: 17 February)

Photometric measurements at Cedar Green Observatory and analysis of the resulting lightcurves yield the following synodic periods and amplitude results: 2890 Vilyujsk, 3.42 ± 0.01 h, amplitude 0.10 mag; 6223 Dahl, 3.33 ± 0.01 h, amplitude 0.47 mag.

Cedar Green Observatory is located in Augusta County, Virginia, at an elevation of 545 meters. The equipment and instrumentation used in this study consist of a 0.20-m Schmidt-Cassegrain (SCT) on a Losmandy G-11 mount operating at *f*/6.82 with an SBIG ST-8 CCD camera and CFW-8 filter wheel. Images were guided during acquisition and obtained with a clear filter. All images were corrected using matching dark frames and flat fields. Measurements were obtained by differential aperture photometry and data were reduced using *MPO Canopus*. Lightcurve periods were determined by Fourier analysis using the FALC algorithm (Harris *et al.*, 1989) and incorporated in *MPO Canopus*.

2890 Vilyujsk. Asteroid 2890 Vilyujsk was selected for study from a list of targets with poorly defined lightcurve parameters provided by Warner *et al.* (2012). Photometric observations were conducted on 2012 October 12 and November 9-11 during which time the phase angle increased from 3.82° to 15.72°. The combined set of 334 measurements yielded a bimodal lightcurve with a derived synodic period P = 3.42 ± 0.01 h and amplitude A = 0.10 mag. These results compare favorably with the lightcurve determined by Koff (2003) of P = 3.45 ± 0.01 h and amplitude A = 0.22 mag.

6223 Dahl. A search of the Asteroid Lightcurve Database (Warner *et al.*, 2009) does not reveal any previously reported results for asteroid 6223 Dahl. Photometric observations were conducted on 2012 October 22 and November 12, 14, and 17 during which time the phase angle increased from 3.82° to 13.91°. The combined set of 203 measurements yielded a bimodal lightcurve with a derived synodic period of P = 3.33 ± 0.001 h and amplitude of 0.47 mag.

Acknowledgements

The author would like to thank Brian Warner for his assistance with *MPO Canopus,* insightful suggestions to improve data reduction, his useful book, and the CALL website.

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.

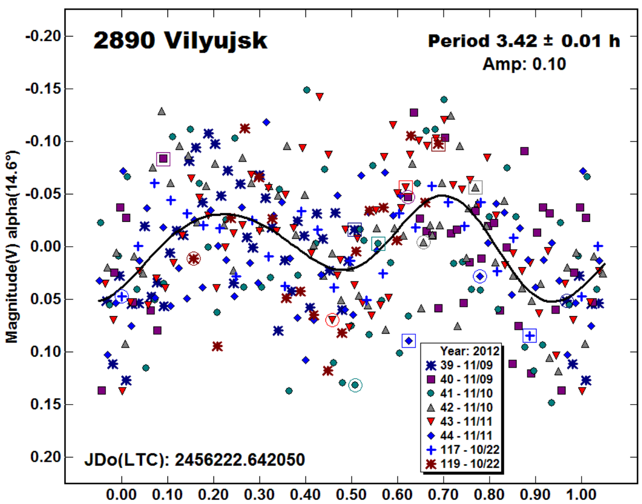
Koff, R.A. (2003). "Lightcurve Photometry of 2890 Vilyujsk, 3016 Morabito, (4288) 1989 TQ1." *Minor Planet Bul*. **30**, 38-39.

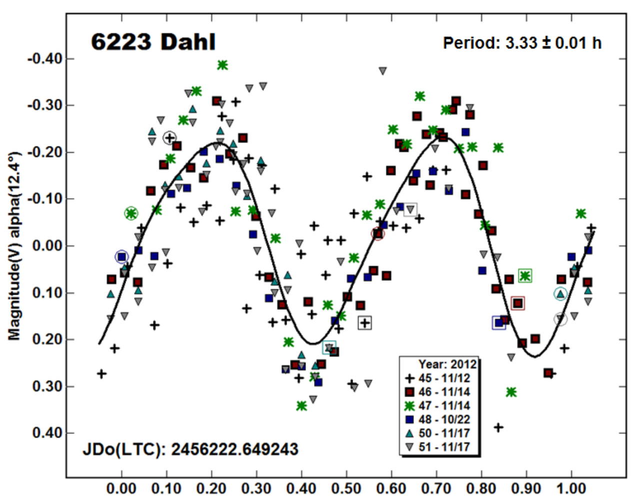
Warner, B.D. (2003). *A Practical Guide to Lightcurve Photometry and Analysis*. Bdw Publishing, Colorado Springs, CO.

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

Warner, B.D. (2012). "Collaborative Asteroid Lightcurve Link." *http://www.minorplanet.info/call.html*

Warner, B.D., Harris, A.W., Pravec, P., Ďurech, J., and Benner, L.A.M. (2012). "Lightcurve Photometry Opportunities: 2012 October-December." *Minor Planet Bul*. **39**, 254-259.





LIGHTCURVE ANALYSIS FOR 15499 CLOYD

Caroline Odden and John French
Phillips Academy Observatory (I12)
180 Main Street
Andover, MA 01810 USA
ceodden@andover.edu

John W. Briggs
HUT Observatory, H16
P.O. Box 5320
Eagle, CO 81631 USA

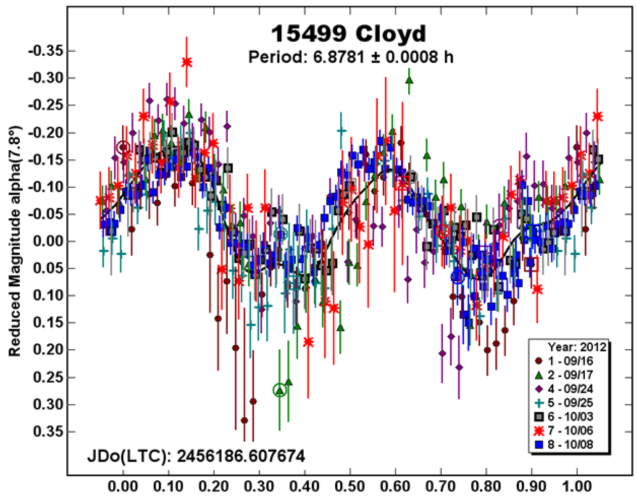
(Received: 15 January)

A lightcurve for asteroid 15499 Cloyd was obtained using images from Phillips Academy Observatory (PAO) and HUT Observatory. Observations were made between 2012 September and October.

Asteroid 15499 Cloyd was named for Marshall P. Cloyd (b. 1939), a businessman, philanthropist, and astronomy enthusiast. The asteroid name was suggested by Everett K. Gibson and Faith Vilas. The lightcurve for asteroid 15499 Cloyd was obtained with images from Phillips Academy Observatory and HUT Observatory taken between 2012 September and October. HUT and Phillips Academy Observatory have twin 0.40-m *f*/8 Ritchey-Chrétien reflectors by DFM Engineering. Phillips Academy Observatory used an SBIG 1301-E CCD camera with a 1280x1024 array of 16-micron pixels. The resulting image scale was 1.0 arcsecond per pixel. Exposures were primarily 450 seconds working at –25° C and unfiltered. All images were dark and flat field corrected, guided, and unbinned. HUT observations were made with an Apogee Alta model U47 CCD. Exposures were 300 seconds working at –40° C through a Cousins R filter. All images were dark and flat field corrected and binned 2x2 for an effective image scale of 1.65 arcsec/pixel.

Images were measured using *MPO Canopus* (Warner, 2010) with a differential photometry technique. All comparison stars were selected to have approximately solar color by using the "comp star selector" tool of *MPO Canopus*. Data merging and period analysis was also done with *MPO Canopus,* the latter process using an implementation of the Fourier analysis algorithm of Harris (FALC; Harris *et al.*, 1989). The combined data sets from both observatories were analyzed by Odden and French. A search of the Asteroid Lightcurve Database (LCDB; Warner *et al*., 2009) and other sources did not reveal previously reported lightcurve results for this asteroid.

The resulting lightcurve consists of 381 data points. An examination of the period spectrum indicates a period of P = 6.8781 ± 0.0008 h and results in a lightcurve with amplitude 0.24 ± 0.05 mag. For trial periods in this range, P (the adopted period), 3/2P, and 2P (the double-period) yielded the lowest RMS values. The 3/2P alias exhibits considerable misfit and is trimodal. As such, it is unlikely to be the true period. When the data are phased to the double-period (13.752 h), full coverage is achieved and the two halves of the curve look the same within reasonable error. The reader will notice that several data points have large error bars and a discordantly worse fit to the curve. These were obtained under variable atmospheric conditions in Andover, Massachusetts. The data were retained because the associated images were not measurably worse than images for "better" data points. It is worth noting that inclusion of these data improves both the period spectrum and the uncertainty of the period. Supplementary observations from HUT Observatory (October 3 and 8) were made from Colorado's Rocky Mountains at an altitude of approximately 2640 meters.



Acknowledgments

Research at the Phillips Academy Observatory is supported by the Israel Family Foundation. Work at the HUT Observatory is supported by the Mittelman Family Foundation. Thanks to Marshall Cloyd, who has provided significant assistance and encouragement for student research opportunities at the Phillips Academy Observatory. It is fitting that this submission is authored by John French (PA '13), John Briggs (PA '77), and Caroline Odden (current faculty member).

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

Warner, B.D. (2010). *The MPO Users Guide: A Companion Guide to the MPO Canopus/PhotoRed Reference Manuals*. BDW Publishing, Colorado Springs, CO.

UPDATED AUTHORS GUIDE AND MS WORD TEMPLATE

The *Minor Planet Bulletin* Authors Guide and Microsoft Word® template have been updated to include new information about formatting and referencing web site URLs. Some outdated instructions and inconsistencies between the two have also been removed. Authors should download both the *Authors Guide* and the *template* files, even if they are not using the template directly, since each file contains some information not found in the other.

The files are available at MPB page on the MinorPlanet.info site: *http://www.minorplanet.info/minorplanetbulletin.html*

CORRIGENDUM MPB VOLUME 40, LIGHTCURVE OPPORTUNITIES

The tables for Lightcurve Opportunities and Shape/Spin Modeling Opportunities in *Minor Planet Bulletin* 40, pg. 55-56, contained the wrong list of targets. A corrected version of those tables is given here.

Lightcurve Opportunities

#	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
191	Kolga	01 01.5	13.0	+8	17.625	0.21-0.40	2+
478	Tergeste	01 02.1	11.9	+8	16.104	0.23	2+
895	Helio *	01 02.2	12.0	+9	9.396	0.10-0.23	2
4611	Vulkaneifel	01 02.3	14.6	+17			
1283	Komsomolia	01 04.4	14.3	+12	96.	1.03	1+
1105	Fragaria	01 04.6	14.4	+19	10.88	0.12	1
4162	SAF	01 04.6	15.0	+10	7.5	0.16	2-
1004	Belopolskya	01 05.4	14.7	+19	9.44	0.14	2
1255	Schilowa	01 06.1	14.6	+13	29.536	0.09-0.15	2
2762	Fowler *	01 07.4	14.4	+25			
3731	Hancock *	01 08.2	14.8	+9	6.712	0.04	1
2432	Soomana *	01 09.0	14.8	+34			
1415	Malautra	01 09.5	14.6	+26	>12.	0.03	1
1591	Baize	01 09.9	15.0	+35	10.	0.26	2
1232	Cortusa	01 10.0	15.0	+15	25.16	0.10	2
1285	Julietta	01 11.8	14.8	+25	20.3	0.07-0.23	1
1040	Klumpkea *	01 12.4	13.7	+16	59.2	0.77	2
2273	Yarilo *	01 12.6	14.9	+22			
772	Tanete	01 14.1	12.9	+54	11.8	0.10	2
662	Newtonia	01 14.4	14.5	+19	16.46	0.42	2
1175	Margo	01 15.7	14.9	+1	6.015	0.22-0.40	2
1504	Lappeenranta *	01 17.8	13.9	+29	10.44	0.29	2
2005	Hencke	01 18.3	15.0	+18	10.186	0.08	2
2091	Sampo *	01 19.9	14.1	+22	71.3	0.38	2
2266	Tchaikovsky	01 20.0	15.0	+1	37.7	0.04-0.09	2
3025	Higson *	01 20.6	14.4	+16	10.8	0.12	2
5747	1991 CO3 *	01 20.8	14.2	-2	38.6	0.30	2
5153	1940 GO *	01 21.5	14.5	+31	4.58	0.07-0.12	1
1265	Schweikarda *	01 26.5	14.9	+21	18.13	0.07	1
4695	1985 RU3 *	01 26.7	14.8	+2			
953	Painleva	01 27.3	14.7	+30	10.	0.03-0.10	1
52762	1998 MT24 *	01 27.7	13.5	-28	12.066	0.4	2
1353	Maartje	01 28.0	14.5	+6	22.98	0.40	2
2056	Nancy	01 28.9	14.9	+11	>15.	0.08	1
2661	Bydzovsky *	01 29.4	15.0	+21			
716	Berkeley	01 31.1	14.3	+14	15.55	0.25	2+
1068	Nofretete	02 01.5	14.3	+18	6.15	0.04	2
1031	Arctica	02 01.8	13.9	-8	51.	0.09-0.22	2
2566	Kirghizia *	02 02.3	14.9	+25			
1143	Odysseus	02 02.4	14.4	+13	10.111	0.11-0.22	2+
4002	Shinagawa	02 02.6	14.9	+23			
781	Kartvelia	02 03.5	14.4	+15	19.06	0.22-0.28	2
1510	Charlois *	02 05.7	14.0	+21	6.653	0.23	2
1329	Eliane	02 06.7	14.9	+18	106.	0.18-0.30	2-
735	Marghanna	02 07.3	14.6	+36	15.95	0.11	2
1170	Siva	02 07.3	14.8	+40	5.	0.1	1
108	Hecuba	02 11.3	12.3	+17	17.859	0.05- 0.2	2
3099	Hergenrother	02 12.8	14.6	+38	24.266	0.28	2
2545	Verbiest	02 13.1	14.4	+13	10.	0.06	1+
613	Ginevra	02 19.2	13.6	+16	13.024	0.20-0.63	2
1237	Genevieve	02 19.7	14.7	+25	16.37	0.17-0.23	2-
551	Ortrud	02 20.7	13.2	+11	13.05	0.09-0.18	2
5262	Brucegoldberg	02 20.7	14.9	+32	16.43	0.12-0.75	2+
2500	Alascattalo	02 21.0	14.8	+23			
494	Virtus	02 22.0	13.2	+19	5.57	0.03-0.12	2+
1707	Chantal	02 23.0	15.0	+13	>10.	0.2	1
3569	Kumon *	02 23.7	14.9	+7			
2947	Kippenhahn	02 24.4	14.8	+5	10.5	0.42	2
1343	Nicole	02 24.8	14.5	+18	70.	0.29	1
729	Watsonia	02 25.3	12.9	+24	16.71	0.18	2
926	Imhilde	02 26.5	14.5	+33	26.8	0.27	2
1783	Albitskij *	02 27.1	14.7	-1	>12.	0.4	2
255	Oppavia	02 28.3	13.7	+16	14.3	0.14-0.15	2
2007	McCuskey	03 01.0	14.2	+11			
2068	Dangreen	03 01.1	15.0	+24		0.04	
1110	Jaroslawa	03 04.1	15.0	-2	94.432	0.44-0.80	2+
215	Oenone	03 06.0	13.1	+7	>20.	0.1	2
1243	Pamela	03 08.9	14.4	-12	26.017	0.42-0.71	2
2556	Louise	03 09.0	15.0	+8			
3237	Victorplatt	03 09.8	14.8	-7	10.36	0.12-0.24	2
4512	Sinuhe	03 10.8	14.6	+16	18.	0.80	2
426	Hippo	03 10.9	12.1	-16	34.3	0.15-0.22	2
4293	Masumi	03 12.0	15.0	+16		0.1	
7132	Casulli *	03 13.1	14.9	-2	4.13	0.14-0.28	2+
857	Glasenappia	03 14.6	14.2	+11	8.23	0.27-0.75	2

Lightcurve Opportunities (cont'd)

#	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
2283	Bunke *	03 15.3	14.2	-2	3.96	0.04-0.06	2
1651	Behrens *	03 16.4	13.8	+0	34.34	0.16	2
777	Gutemberga	03 17.4	13.9	-16	12.88	0.25	2
982	Franklina	03 17.8	14.6	-13	>16.	0.05	2-
927	Ratisbona *	03 21.5	13.4	+2	12.994	0.12	2
965	Angelica	03 21.7	14.5	+17	17.772	0.06	2
393	Lampetia	03 23.1	12.7	-11	38.7	0.12-0.14	2-
2591	Dworetsky	03 25.0	15.0	-2	12.77	0.45	2
814	Tauris	03 25.8	14.7	+23	35.8	0.20	2
1284	Latvia	03 25.9	14.3	-16	9.644	0.10-0.21	2
269	Justitia	03 28.1	12.6	+2	16.545	0.14-0.25	2
622	Esther	03 28.1	14.1	+5	47.5	0.57	2
7888	1993 UC *	03 28.1	14.2	+86	2.34	0.10	2
1341	Edmee	03 28.7	14.3	+16	23.745	0.22-0.60	2+
3376	Armandhammer	03 29.3	14.9	-12	7.918	0.03-0.04	2
1199	Geldonia	03 29.7	14.4	-12	28.3	0.11	2-

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
704	Interamnia	01 01.	10.7	+30	8.727	0.05 0.11	3
914	Palisana	01 01.	13.1	+24	15.922	0.04 0.18	3
154	Bertha	01 01.	12.6	+45	25.224	0.04 0.20	3
308	Polyxo	01 01.	12.3	+17	12.032	0.08-0.15	2+
234	Barbara	01 01.	13.2	-15	26.468	0.19	3-
102	Miriam	01 15.7	13.1	+13	23.613	0.04-0.14	3
976	Benjamina	02 06.3	13.5	+05	9.746	0.18	3-
420	Bertholda	02 11.1	13.0	+05	11.04	0.24-0.29	3
153	Hilda	02 16.5	13.3	+03	5.9587	0.05-0.20	3
105	Artemis	02 16.9	12.0	-10	37.15506	0.09-0.17	3
200	Dynamene	03 04.2	12.0	+03	37.394	0.10	3
230	Athamantis	03 07.0	10.6	-08	24.0055	0.1 -0.26	3
790	Pretoria	03 11.9	13.4	-21	10.37	0.05-0.18	3
466	Tisiphone	03 22.7	13.0	-25	8.824	0.12-0.16	3
40	Harmonia	03 31.4	9.8	+03	8.910	0.13-0.36	3

Inversion Modeling Candidates

#	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
3998	Tezuka	01 01.	14.8	+33	3.0789	0.46	3
343	Ostara	01 01.	13.4	+29	109.87	0.23-0.52	3-
1274	Delportia	01 01.	15.0	+29	5.615	0.04	3
670	Ottegebe	01 01.	13.1	+12	10.045	0.35	3
1135	Colchis	01 01.	14.7	+24	23.47	0.45	2
1309	Hyperborea	01 01.	14.2	+09	13.88	0.4	3
402	Chloe	01 01.	12.4	+09	10.664	0.07-0.33	3
1251	Hedera	01 01.	14.9	+04	19.9000	0.50	3-
430	Hybris	01 01.	14.1	+17	7.205	0.54	3
1294	Antwerpia	01 01.	14.9	-08	6.63	0.40	3
2209	Tianjin	01 01.	14.9	+19	9.47	0.42	3
4179	Toutatis	01 01.	12.0	+22	176.	0.5 -1.1	3
2378	Pannekoek	01 01.	14.6	+00	11.8806	0.08-0.14	2
882	Swetlana	01 01.	14.5	+20	20.	0.17	2-
60	Echo	01 01.	12.2	+03	25.208	0.07-0.22	3
782	Montefiore	01 01.	14.8	+15	4.08	0.45	3
191	Kolga	01 01.5	13.0	+08	17.625	0.21-0.40	2+
1667	Pels	01 09.5	15.0	+26	3.268	0.20-0.42	3
1232	Cortusa	01 10.0	15.0	+15	25.16	0.10	2
14257	2000 AR97	01 10.0	14.6	+30	13.584	0.67	3
986	Amelia	01 11.0	13.9	+29	9.52	0.25-0.43	3
1633	Chimay	01 11.7	14.4	+22	6.5911	0.41-0.58	3
662	Newtonia	01 14.4	14.5	+19	16.46	0.42	2
1175	Margo	01 15.7	14.9	+01	6.015	0.22-0.40	2
199	Byblis	01 17.7	13.7	+31	5.2201	0.05-0.15	3
1011	Laodamia	01 27.2	12.6	+17	5.1725	0.44	3

Inversion Modeling Candidates (cont'd)

#	Name	Brightest Date	Mag	Dec	LCDB Data Period	Amp	U
1353	Maartje	01 28.0	14.5	+06	22.98	0.40	2
1847	Stobbe	02 02.8	14.6	+24	5.617	0.27-0.35	3
446	Aeternitas	02 05.9	13.4	+30	15.7413	0.36-0.51	3
472	Roma	02 06.4	11.9	+20	9.8007	0.27-0.45	3
1825	Klare	02 06.9	14.7	+12	4.744	0.75	3
679	Pax	02 07.4	13.1	+31	8.452	0.02-0.32	3
100	Hekate	02 11.4	12.6	+16	27.066	0.11-0.23	3
1282	Utopia	02 12.2	14.3	+14	13.623	0.28-0.36	3
3332	Raksha	02 20.4	14.6	+16	4.8065	0.31	3
175	Andromache	03 02.2	13.7	+10	8.324	0.21-0.30	3
3786	Yamada	03 04.0	14.7	-14	4.034	0.40-0.65	3
251	Sophia	03 09.3	13.9	+07	20.216	0.30-0.61	3
172	Baucis	03 09.8	12.1	+00	27.417	0.23-0.35	3
4512	Sinuhe	03 10.8	14.6	+16	18.00	0.80	2
1127	Mimi	03 12.2	15.0	+17	12.749	0.72-0.95	3
1275	Cimbria	03 14.7	14.8	-02	5.65	0.40-0.57	3
2283	Bunke	03 15.3	14.2	-02	3.96	0.04-0.06	2
270	Anahita	03 15.3	11.8	-01	15.06	0.25-0.34	3
1000	Piazzia	03 18.7	14.4	-15	9.47	0.18-0.45	3
177	Irma	03 20.0	13.9	+00	13.856	0.30-0.37	3-
742	Edisona	03 20.8	14.4	+13	18.52	0.24-0.30	3
1735	ITA	03 21.9	14.2	+03	12.599	0.26	2
112	Iphigenia	03 26.5	13.3	-05	31.466	0.30	3
966	Muschi	03 28.0	13.5	+18	5.355	0.31	3
1396	Outeniqua	03 28.5	13.8	-04	3.08158	0.42	3
604	Tekmessa	03 31.7	14.3	-04	5.5596	0.49-0.52	3

LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2013 APRIL-JUNE

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

Alan W. Harris
MoreData!
La Cañada, CA 91011-3364 USA

Petr Pravec
Astronomical Institute
CZ-25165 Ondřejov, CZECH REPUBLIC

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

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

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 lists of "targets of opportunity" for the period 2013 April-June. 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 and "U" is the quality code of the lightcurve. 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 over those rated U = 2 or 2+ but not necessarily over those with no period. On the other hand, d*o not overlook asteroids with* U = 2/2+ *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 < 14.5 at brightest during the period and have either no or poorly-constrained lightcurve parameters.

The goal for these asteroids is to find a well-determined rotation rate. The target list generator on the CALL web site allows you to create custom lists for objects reaching V ≤ 18.0 during any month in the current year, e.g., limiting the results by magnitude and declination.

http://www.minorplanet.info/PHP/call_OppLCDBQuery.php

In a general note, small objects with periods up to 4 hours or even longer are possible binaries. For longer periods (4-6 hours or so), the odds of a binary may be less, but the bonus is that the size of the secondary, if it exists, is likely larger (see Pravec *et al.* (2010), *Nature* **466**, 1085-1088), thus eclipses, if they occur, will be deeper and easier to detect.

The Low Phase Angle list includes asteroids that reach very low phase angles. The "α" column is the minimum solar phase angle for the asteroid. 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." You will have the best chance of success working objects with low amplitude and periods that allow covering, e.g., a maximum, every night. Objects with large amplitudes and/or long periods are much more difficult for phase angle studies since, for proper analysis, the data have to be reduced to the average magnitude of the asteroid for each night. Without knowing the period and/or the amplitude at the time, that reduction becomes highly uncertain. As an aside, some use the maximum light to find the phase slope parameter (*G*). However, this can produce a significantly different value for both *H* and *G* versus using average light, which is the method used for values listed by the Minor Planet Center.

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
http://www.naic.edu/~pradar

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.

Funding for Warner and Harris in support of this article is provided by NASA grant NNX10AL35G and by National Science Foundation grant AST-1032896.

Lightcurve Opportunities

		Brightest			LCDB Data		
#	Name	Date	Mag	Dec	Period	Amp	U
3748	Tatum	04 01.3	14.8	-1	58.21	0.54	2+
530	Turandot	04 01.8	14.4	+5	19.947	0.10-0.16	2+
1128	Astrid	04 04.9	14.4	-5	10.228	0.29	2+
739	Mandeville	04 06.0	11.9	+21	11.931	0.14	2
2896	Preiss	04 06.2	14.8	-2	24.	0.3	2
1418	Fayeta	04 06.5	14.9	-11	63.641	0.15-0.24	2+
1425	Tuorla	04 06.9	14.1	-3	6.97	0.40	2
5468	Hamatonbetsu	04 08.0	15.0	+10	42.02	0.43	2
2038	Bistro	04 08.3	15.0	+14	7.88	0.24	1
1075	Helina	04 09.0	15.0	+8			
1279	Uganda	04 09.4	14.7	-14	23.2	0.16	1
871	Amneris	04 09.6	14.2	-2			
1242	Zambesia	04 10.7	14.8	-15	17.305	0.24-1.36	2
936	Kunigunde	04 11.5	14.8	-6	8.8	0.25	2
838	Seraphina	04 15.8	14.6	-18	15.67	0.07-0.30	2
3260	Vizbor	04 18.8	14.7	-17	72.12	0.64	2+
5073	Junttura	04 19.1	14.8	-14			
978	Aidamina	04 19.6	14.8	-15	10.099	0.10-0.13	2
1594	Danjon	04 19.9	14.2	+0	>12.	0.03	1
2678	Aavasaksa	04 19.9	14.9	-9	>24.	0.4	1
375	Ursula	04 20.7	12.1	-29	16.83	0.04-0.17	2
924	Toni	04 20.8	14.1	-1	21.1	0.1-0.14	1
555	Norma	04 21.0	14.8	-8	19.55	0.06-0.20	2+
1654	Bojeva	04 21.3	14.9	-13		0.1	
806	Gyldenia	04 21.6	14.2	-7	14.45	0.10-0.27	2
331	Etheridgea	04 22.4	14.0	-14		0.05	1
605	Juvisia	04 22.5	14.9	-32	15.93	0.24-0.26	2
4710	Wade	04 22.6	15.0	-20			
795	Fini	04 22.8	13.0	-21	9.292	0.02-0.06	1+
1989	Tatry	04 23.0	15.0	-14	131.3	0.22- 0.5	2
1366	Piccolo	04 23.1	14.1	-15	16.57	0.24-0.33	2
309	Fraternitas	04 23.7	13.9	-16	13.2	0.10-0.12	2
1506	Xosa	04 23.8	14.3	-20	292.	0.70	2+
248	Lameia	04 24.0	12.9	-16	12.	0.10	2
4904	Makio	04 24.0	14.9	-17	7.83	0.08	2
681	Gorgo	04 24.4	14.9	-2			
2830	Greenwich	04 24.8	14.4	+3	>24.	0.5	2
764	Gedania	04 25.5	14.5	-22	24.975	0.09-0.35	2
645	Agrippina	04 26.1	14.8	-19	32.6	0.11-0.18	2
3761	Romanskaya	04 26.3	14.7	-10	15.32	0.34	2
705	Erminia	04 29.4	12.8	-38	53.96	0.05-0.17	2
1926	Demiddelaer	05 02.0	14.2	+2	18.5	0.15	2
242643	2005 NZ6	05 02.0	14.6	+17			

Lightcurve Opportunities (cont'd)

		Brightest			LCDB Data		
#	Name	Date	Mag	Dec	Period	Amp	U
3115	Baily	05 02.8	15.0	-24	16.22	0.08-0.14	2+
2448	Sholokhov	05 03.6	14.3	+12	10.065	0.63	2+
498	Tokio	05 04.5	12.8	-4	30.	0.10-0.18	1
1322	Coppernicus	05 04.5	14.9	-37	3.967	0.04-0.22	2
5247	Krylov	05 06.9	13.8	-12	81.5	1.5	2
395	Delia	05 07.6	13.6	-20	19.71	0.25	2
2880	Nihondaira	05 08.4	14.1	-19	17.97	0.22-0.75	2
548	Kressida	05 09.0	14.7	-12	11.940	0.44	2
1661	Granule	05 09.0	14.5	-21	>24.	0.15	2
470	Kilia	05 10.2	12.5	-7	290.	0.26	2
4437	Yaroshenko	05 11.5	14.5	-17	30.	0.3	1+
879	Ricarda	05 16.0	14.7	-31	82.9	0.37	2
3109	Machin	05 16.6	14.6	-26	20.3	0.46	2
3152	Jones	05 16.6	14.9	-36		0.09	
2862	Vavilov	05 18.1	14.7	-18	>800.	0.4	2
609	Fulvia	05 18.6	14.3	-14	>12.	0.05	1+
3760	Poutanen	05 18.9	14.7	-4			
2145	Blaauw	05 20.7	15.0	-29	12.141	0.18	2+
3738	Ots	05 20.8	14.0	-22			
784	Pickeringia	05 21.3	12.2	-35	13.17	0.20-0.40	2
1558	Jarnefelt	05 21.4	14.9	-9	18.22	0.40	2
1269	Rollandia	05 23.3	14.1	-17	15.4	0.02-0.08	2
1354	Botha	05 23.4	14.1	-26	4.	0.21	1+
275	Sapientia	05 23.9	12.1	-14	14.766	0.05-0.06	2
2906	Caltech	05 28.8	14.9	-6	11.442	0.17	2
746	Marlu	05 28.9	13.8	-45	7.787	0.23	2
254	Augusta	05 29.9	13.6	-28	6.	0.56	2
14425	Fujimimachi	05 30.2	14.9	-25			
791	Ani	05 30.3	13.6	+1	16.72	0.17-0.38	2
1001	Gaussia	05 30.3	14.6	-24	9.17	0.04-0.16	2-
3224	Irkutsk	05 31.6	14.0	-19	19.9	0.49	2
1458	Mineura	06 01.2	14.0	-1	36.	0.04	1
1114	Lorraine	06 01.4	14.7	-9	33.	0.16	1
952	Caia	06 01.6	13.9	-33	7.51	0.03-0.13	2
730	Athanasia	06 02.3	14.9	-19			
285263	1998 QE2	06 02.3	10.5	-15			
379	Huenna	06 02.5	13.1	-20	14.14	0.07-0.09	2
3973	Ogilvie	06 02.8	14.5	-22			
1609	Brenda	06 03.0	13.7	-2	19.46	0.16-0.26	2
2942	Cordie	06 06.8	14.3	-13	80.	1.1	2
70410	1999 SE3	06 06.8	15.0	-15			
314	Rosalia	06 06.9	14.6	-4	20.43	0.21-0.40	2
2728	Yatskiv	06 07.6	14.6	-19			
5405	Neverland	06 08.2	14.6	-41			
1057	Wanda	06 10.1	14.8	-23	28.8	0.14-0.41	2
407	Arachne	06 10.3	12.4	-30	22.62	0.31-0.45	2
3527	McCord	06 15.6	14.7	-16	321.	0.10-0.44	2
619	Triberga	06 17.0	13.5	-1	29.412	0.30-0.45	2
14668	1999 CB67	06 17.9	15.0	-20	2.89	0.06	2
2933	Amber	06 18.4	14.9	-17	13.11	0.32	2
1424	Sundmania	06 18.5	14.2	-33	93.73	0.42	2+
2639	Planman	06 19.2	14.6	-27	89.5	0.40	2+
3716	Petzval	06 19.4	14.7	-19			
7021	1992 JN1	06 19.4	14.5	-22			
2505	Hebei	06 20.0	14.6	-25			
450	Brigitta	06 23.9	14.4	-38	10.75	0.18	2
1182	Ilona	06 24.3	14.6	-38	29.8	0.98- 1.2	2
3783	Morris	06 24.9	14.5	-30			
3578	Carestia	06 25.0	13.8	-31	9.93	0.13-0.25	2
1367	Nongoma	06 25.6	13.8	-20		0.3	1
3839	Bogaevskij	06 25.6	14.6	-20			
249	Ilse	06 26.3	14.4	-38	85.24	0.27-0.33	1
439	Ohio	06 26.7	14.8	+3	19.2	0.24	2
1551	Argelander	06 26.7	14.6	-22			
5248	Scardia	06 27.1	14.7	-24			
1029	La Plata	06 28.2	14.7	-27	15.31	0.26-0.58	2
10902	1997 WB22	06 28.7	15.0	-23			
1032	Pafuri	06 29.3	13.5	-29	>24.	0.15- 0.3	1+
4157	Izu	06 29.3	14.8	-35			
2816	Pien	06 29.4	14.8	-24			

Low Phase Angle Opportunities

#	Name	Date	α	V	Dec	Period	Amp	U
490	Veritas	04 01.4	0.87	13.1	-02	7.930	0.33-0.58	3
203	Pompeja	04 01.5	0.69	12.5	-06	24.052	0.10	3
158	Koronis	04 03.8	0.51	13.2	-07	14.218	0.28-0.43	3
119	Althaea	04 10.3	0.22	12.0	-09	11.484	0.23-0.36	3
340	Eduarda	04 11.5	0.27	13.8	-08	8.0062	0.17-0.32	3
417	Suevia	04 12.6	0.29	12.1	-08	7.034	0.10-0.22	3
204	Kallisto	04 13.2	0.23	11.5	-10	19.489	0.09-0.26	3
33	Polyhymnia	04 21.4	0.32	13.1	-13	18.608	0.13-0.20	3
578	Happelia	04 21.8	0.19	12.4	-12	10.061	0.11-0.16	3

Low Phase Angle Opportunities (cont'd)

#	Name	Date	α	V	Dec	Period	Amp	U
331	Etheridgea	04 22.3	0.48	14.0	-14		0.05	1
912	Maritima	04 23.3	0.19	13.2	-12	1332.	0.18	3-
240	Vanadis	04 25.5	0.97	13.3	-10	10.64	0.34	3
223	Rosa	04 27.1	0.18	13.9	-13	20.283	0.06-0.14	3
77	Frigga	04 28.7	0.75	12.5	-16	9.012	0.07-0.20	3
83	Beatrix	05 02.0	0.97	11.0	-17	10.16	0.06-0.27	3
586	Thekla	05 05.3	0.13	13.3	-16	13.670	0.24-0.30	3
147	Protogeneia	05 11.0	0.28	13.0	-19	7.853	0.28	3
82	Alkmene	05 11.6	0.74	11.8	-20	12.999	0.18-0.54	3
106	Dione	05 12.2	0.33	12.4	-17	16.26	0.08	3
49	Pales	05 16.3	0.91	13.0	-22	10.42	0.18	3
243	Ida	05 17.9	0.58	13.9	-21	4.634	0.40-0.86	3
1909	Alekhin	05 21.0	0.45	13.8	-19	148.6	0.45	3
1277	Dolores	05 23.8	0.49	13.3	-22	17.19	0.45	3
121	Hermione	05 25.5	0.45	12.4	-19	5.551	0.04-0.70	3
62	Erato	05 28.7	0.75	13.7	-19	9.2213	0.12-0.17	3
937	Bethgea	05 29.5	0.36	13.3	-21	7.5390	0.12-0.19	3
379	Huenna	06 02.3	0.79	13.1	-20	14.14	0.09	2
675	Ludmilla	06 09.8	0.34	12.3	-24	7.717	0.16-0.38	3
4353	Onizaki	06 10.0	0.03	14.0	-23			
150	Nuwa	06 13.8	0.95	12.2	-20	8.1347	0.08-0.31	3
563	Suleika	06 14.5	0.20	12.9	-23	5.69	0.13-0.28	3
683	Lanzia	06 14.7	0.66	12.8	-21	8.630	0.12-0.20	3
1699	Honkasalo	06 15.8	0.35	13.8	-24	11.159	0.17	3-
348	May	06 19.8	0.17	13.6	-23	7.3812	0.16	3
364	Isara	06 25.2	0.87	12.8	-21	9.156	0.30-0.40	3
598	Octavia	06 28.6	0.64	13.1	-25	10.8903	0.28-0.35	3

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

		Brightest			LCDB DATA		
#	Name	Date	Mag	Dec	Period	Amp	U
490	Veritas	04 01.4	13.1	-02	7.930	0.33-0.58	3
530	Turandot	04 01.8	14.4	+05	19.947	0.10-0.16	2+
70	Panopaea	04 09.7	11.6	+01	15.797	0.06-0.12	3
27	Euterpe	04 10.6	9.8	-06	10.4082	0.13-0.21	3
204	Kallisto	04 13.2	11.4	-10	19.489	0.09-0.26	3
386	Siegena	04 19.4	12.4	+07	9.763	0.11-0.18	3
978	Aidamina	04 19.6	14.8	-15	10.099	0.13	2
375	Ursula	04 20.7	12.1	-29	16.83	0.17	2
578	Happelia	04 21.9	12.4	-12	10.061	0.11-0.16	3
498	Tokio	05 04.5	12.8	-04	30.	0.18	1
144	Vibilia	05 04.6	12.1	-12	13.819	0.13-0.20	3
106	Dione	05 12.2	12.4	-17	16.26	0.08	3
49	Pales	05 16.5	12.9	-22	10.42	0.18	3
25	Phocaea	05 16.7	10.0	-03	9.9341	0.03-0.25	3
334	Chicago	05 18.3	12.9	-14	7.361	0.15-0.67	3
757	Portlandia	05 28.4	13.6	-31	6.5837	0.24-0.45	3
791	Ani	05 30.3	13.6	+01	16.72	0.17-0.38	2

Inversion Modeling Candidates

		Brightest			LCDB Data		
#	Name	Date	Mag	Dec	Period	Amp	U
158	Koronis	04 03.8	13.2	-07	14.218	0.28 0.43	3
391	Ingeborg	04 04.9	15.0	-16	26.391	0.22 0.79	3
2896	Preiss	04 06.2	14.8	-02	24.	0.3	2
1307	Cimmeria	04 06.7	14.9	-10	2.820	0.31	3
1860	Barbarossa	04 07.8	15.0	+07	3.255	0.28	3
1378	Leonce	04 09.9	14.1	-05	4.3250	0.49 0.50	3
936	Kunigunde	04 11.5	14.8	-06	8.80	0.25	2
2678	Aavasaksa	04 19.9	14.9	-09	24.	0.4	1
1366	Piccolo	04 23.1	14.1	-15	16.57	0.24 0.33	2
1023	Thomana	04 25.5	14.6	-08	17.56	0.27 0.36	3-
3761	Romanskaya	04 26.3	14.7	-10	15.32	0.34	2
2276	Warck	04 28.0	14.5	-14	4.054	0.20	3

Inversion Modeling Candidates (cont'd)

		Brightest			LCDB Data		
#	Name	Date	Mag	Dec	Period	Amp	U
7360	Moberg	04 30.7	14.6	-25	4.5842	0.38 0.41	3
586	Thekla	05 05.3	13.2	-16	13.670	0.22 0.30	3
5247	Krylov	05 06.9	13.8	-12	81.5	1.5	2
461	Saskia	05 10.9	15.0	-16	7.348	0.25 0.36	3
2911	Miahelena	05 11.6	14.9	-03	4.19	0.56	3-
247	Eukrate	05 13.1	13.2	-46	12.093	0.10 0.14	3
1277	Dolores	05 23.9	13.2	-22	17.19	0.45	3
254	Augusta	05 29.9	13.6	-28	6.0	0.56	2
1013	Tombecka	06 03.6	14.3	-36	6.053	0.44 0.50	3
373	Melusina	06 08.6	13.7	-44	12.97	0.20 0.25	3
407	Arachne	06 10.3	12.4	-30	22.62	0.31 0.45	2
1505	Koranna	06 13.4	14.0	-17	4.451	0.55	3
698	Ernestina	06 13.7	15.0	-35	5.0363	0.30 0.69	3
1150	Achaia	06 15.5	14.4	-19	60.99	0.72	3
523	Ada	06 15.6	14.5	-23	10.03	0.52 0.70	3
5754	1992 FR2	06 16.6	14.8	-20	8.898	0.97	3
706	Hirundo	06 18.9	14.6	-44	22.027	0.39 0.9	3
361	Bononia	06 23.4	14.8	-39	13.83	0.25	3
1182	Ilona	06 24.3	14.6	-38	29.8	0.98 1.2	2
364	Isara	06 25.3	12.7	-21	9.156	0.30 0.40	3
480	Hansa	06 25.8	12.3	-02	16.19	0.20 0.58	3
553	Kundry	06 29.1	15.0	-27	12.605	0.41 0.61	3

Radar-Optical Opportunities

Use the ephemerides below as a guide to your best chances for observing, but remember that photometry may be possible before and/or after the ephemerides given below. 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.

Some of the objects below are repeats from the previous issue of the *Minor Planet Bulletin* and those with opportunities extending into the next quarter may be featured again in the next .

2062 Aten (Mar-May, H = 16.8)
The orbits of the Aten asteroids lie mostly within Earth's and so are never very far from the Sun in the sky. Therefore, it should be no surprise that the rotation period for the namesake of the group is not well-known. Mottola *et al.* (1995) reported a period of 40.77 h, but that is the only entry with a period in the Lightcurve Database (Warner *et al.*, 2009; U = 2). Despite the difficulties, a successful campaign would be of enormous benefit to radar and modeling efforts.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
03/20	04 18.8	+43 17	0.57	0.99	18.1	74.0	72	33	+0.53	-5
03/30	04 43.6	+47 16	0.58	0.96	18.2	77.0	69	140	-0.91	+1
04/09	05 10.0	+50 48	0.57	0.92	18.2	80.6	65	78	-0.02	+6
04/19	05 37.2	+53 51	0.55	0.89	18.2	85.0	62	51	+0.55	+12
04/29	06 03.0	+56 24	0.51	0.86	18.2	90.6	59	143	-0.86	+16
05/09	06 24.3	+58 20	0.47	0.83	18.3	97.8	55	63	-0.01	+19
05/19	06 35.4	+59 27	0.41	0.81	18.4	106.9	50	71	+0.58	+21
05/29	06 28.8	+59 03	0.35	0.80	18.8	118.7	44	132	-0.80	+20

1685 Toro (February-April, H = 14.2)

The rotation period of this NEA is well established at 10.195 h. However, it is a good candidate for YORP spin-up/down, meaning that data from each succeeding apparition can be used to determine if the period is changing slowly over time.

It's important to note that the shape and amplitude of the curve can change significantly over an apparition, e.g., see Warner, *http://www.minorplanetobserver.com/pdolc/A1685_2012.HTM,* which also shows that the synodic period can change over a relatively short time. If you plan a protracted campaign, it would be good to subdivide data into blocks of dates, each having a relatively small range of phase angles and treating them as stand-alone sets. Putting all the data into a single set may not only affect the final solution but hide critical data about the lightcurve shape and amplitude vital to good modeling.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	12 16.2	-24 21	0.82	1.79	15.8	11.5	159	62	-0.74	+38
04/11	11 58.8	-21 38	0.86	1.82	15.9	12.6	157	154	+0.00	+40
04/21	11 46.2	-18 48	0.92	1.85	16.3	16.6	148	37	+0.74	+41
05/01	11 38.8	-16 14	1.00	1.88	16.6	21.0	138	110	-0.66	+43
05/11	11 36.2	-14 10	1.10	1.90	17.0	24.7	128	118	+0.01	+45
05/21	11 37.8	-12 38	1.21	1.92	17.3	27.4	119	11	+0.78	+46
05/31	11 42.7	-11 37	1.33	1.93	17.6	29.4	111	149	-0.59	+48
06/10	11 50.3	-11 03	1.45	1.95	17.8	30.6	103	88	+0.02	+49

14 Irene (Apr-Jun, H = 6.30)

Despite its low number, the rotation period for this inner main-belt asteroid wasn't firmly established until the work by Pilcher (2009) found 15.028 h. A shape model has been developed (Hanus *et al.*, 2011) but additional observations at this apparition and beyond will serve to refine that model. In any event, having a lightcurve from around the same time as radar observations helps with analysis of the radar data.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	12 14.5	+16 24	1.20	2.16	9.0	9.9	158	76	-0.74	+76
04/11	12 06.8	+16 33	1.23	2.16	9.2	13.6	150	143	+0.00	+75
04/21	12 01.1	+16 12	1.29	2.16	9.4	17.3	140	31	+0.74	+74
05/01	11 58.2	+15 24	1.36	2.16	9.7	20.5	131	116	-0.66	+73
05/11	11 58.1	+14 13	1.45	2.16	9.9	23.1	123	112	+0.01	+72
05/21	12 00.9	+12 44	1.54	2.17	10.1	25.1	115	18	+0.78	+71
05/31	12 06.2	+11 01	1.65	2.17	10.3	26.5	107	149	-0.59	+71
06/10	12 13.7	+09 09	1.76	2.18	10.4	27.3	100	86	+0.02	+70

2002 TR190 (Apr-May, H = 19.4)

There is no rotation period given in the LCDB for this near-Earth asteroid (NEA). The estimated size is about 400 meters. As with many objects during the middle of a year, observers in the Southern Hemisphere will have the best observing circumstances.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	19 09.9	+01 01	0.13	0.99	18.2	89.6	83	41	-0.74	-4
04/06	19 13.8	-15 50	0.12	1.00	17.7	85.0	88	35	-0.20	-12
04/11	19 19.3	-36 01	0.11	1.02	17.4	79.2	95	102	+0.00	-21
04/16	19 27.2	-55 30	0.12	1.03	17.4	73.8	100	140	+0.27	-27
04/21	19 39.9	-70 56	0.14	1.04	17.7	70.1	102	112	+0.74	-29
04/26	20 09.9	-81 57	0.17	1.06	18.0	67.8	103	75	-1.00	-30
05/01	01 20.7	-88 30	0.20	1.07	18.3	66.2	104	73	-0.66	-29
05/06	06 38.4	-84 15	0.23	1.08	18.7	65.0	103	95	-0.15	-27

(7888) 1993 UC (Apr-Jun, H = 15.2)

Pravec *et al.* (1996) found a period of 2.340 h for this asteroid along with an amplitude of 0.10 mag. This makes it a good candidate for being a binary asteroid, so extended higher-precision observations should be made over at least three nights to look for signs of eclipse or occultation events. The estimated diameter of the NEA is 2.7 km.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	14 09.9	+82 06	0.19	1.03	14.4	76.3	93	104	-0.74	+35
04/11	14 14.1	+65 44	0.29	1.12	14.9	60.0	105	102	+0.00	+49
04/21	14 12.7	+56 51	0.40	1.21	15.5	50.6	111	70	+0.74	+57
05/01	14 11.7	+50 32	0.52	1.31	16.1	44.6	114	97	-0.66	+62
05/11	14 11.9	+45 14	0.64	1.41	16.5	40.4	116	111	+0.01	+66
05/21	14 13.8	+40 26	0.76	1.50	17.0	37.5	115	54	+0.78	+68
05/31	14 17.4	+35 57	0.89	1.60	17.4	35.4	114	115	-0.59	+70
06/10	14 22.7	+31 45	1.03	1.69	17.8	33.8	112	104	+0.02	+70

4034 Vishnu (Apr-May, H = 18.3)

The diameter is about 650 meters for this NEA. The period is about 13.5 hours Mottola (2011).

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	20 47.1	+31 39	0.15	0.93	18.3	110.7	61	78	-0.74	-7
04/08	19 26.8	+38 47	0.16	0.99	17.4	89.2	82	65	-0.06	+10
04/15	18 06.9	+41 49	0.17	1.04	17.1	71.5	99	116	+0.19	+26
04/22	16 59.1	+41 22	0.20	1.10	17.1	58.0	112	90	+0.82	+38
04/29	16 07.7	+38 51	0.23	1.14	17.2	48.5	122	62	-0.86	+48
05/06	15 30.7	+35 24	0.27	1.19	17.5	42.4	127	116	-0.15	+55
05/13	15 04.9	+31 37	0.31	1.23	17.8	38.9	130	116	+0.08	+61
05/20	14 47.5	+27 49	0.36	1.27	18.1	37.4	130	57	+0.68	+64

(242643) 2005 NZ6 (May, H = 17.6, PHA)

The JPL NEO site gives a close approach of about 25 lunar distances (LD) on April 29. There is no rotation period in the LCDB for the 900 meter NEA. Given the size, it's unlikely this is a superfast rotator, i.e., $P < 2$ h.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/30	08 09.9	+28 21	0.06	1.00	15.1	97.3	79	155	-0.77	+29
05/01	09 13.3	+22 32	0.07	1.01	14.8	82.7	93	155	-0.66	+41
05/02	10 00.5	+16 45	0.08	1.03	14.7	70.9	105	157	-0.55	+49
05/03	10 34.3	+11 56	0.09	1.05	14.7	62.2	113	162	-0.44	+54
05/04	10 58.8	+08 09	0.11	1.06	14.9	55.7	119	168	-0.33	+57
05/05	11 17.0	+05 14	0.12	1.08	15.1	51.0	124	175	-0.24	+59
05/06	11 31.0	+02 58	0.14	1.10	15.3	47.5	127	172	-0.15	+59
05/07	11 41.9	+01 10	0.16	1.11	15.5	44.8	129	163	-0.09	+59

(163364) 2002 OD20 (May-Jun, H = 18.8, PHA)

This NEA has an estimated diameter of about 500 meters. A close approach of about 15 LD comes on May 23. The closest approach through 2200 is in 2131 May at about 10 LD. The rotation rate is not known.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
05/15	06 55.3	-09 51	0.06	0.98	17.5	118.0	59	28	+0.21	-4
05/20	08 21.9	-22 28	0.04	1.00	15.6	98.1	79	48	+0.68	+8
05/25	11 20.2	-34 53	0.04	1.03	14.1	61.6	116	63	+1.00	+24
05/30	13 55.4	-31 42	0.05	1.06	14.0	33.4	145	99	-0.69	+29
06/04	15 04.4	-26 03	0.08	1.09	14.5	22.1	156	150	-0.19	+28
06/09	15 37.6	-22 26	0.11	1.12	15.1	19.0	159	155	+0.00	+26
06/14	15 56.8	-20 12	0.14	1.14	15.7	19.1	158	100	+0.24	+25
06/19	16 09.8	-18 47	0.17	1.17	16.3	20.4	156	38	+0.74	+24

(285263) 1998 QE2 (Apr-Jun, H = 16.4, PHA)
Of three close approaches through 2200, this is the closest, but it's hardly a near-miss. On May 31 it will be about 15 LD from Earth. The rotation period for the 1.5 km NEA is not known.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
04/01	09 04.5	-34 17	0.33	1.21	16.2	44.9	122	98	-0.74	+8
04/11	08 55.1	-34 43	0.28	1.15	16.0	52.5	115	112	+0.00	+7
04/21	08 52.5	-34 59	0.23	1.10	15.7	59.9	108	45	+0.74	+6
05/01	08 58.7	-35 28	0.18	1.07	15.3	66.5	104	123	-0.66	+7
05/11	09 19.5	-36 25	0.13	1.05	14.7	70.9	102	94	+0.01	+9
05/21	10 22.7	-37 56	0.08	1.04	13.4	67.7	108	41	+0.78	+16
05/31	14 17.1	-24 36	0.04	1.05	10.9	29.8	149	110	-0.59	+34
06/10	17 45.2	+11 32	0.07	1.07	12.2	33.3	145	148	+0.02	+20

(152756) 1999 JV3 (May-Jun, H = 18.8)
There is no rotation period in the LCDB for this 500 meter NEA. The next close approach is not until 2088 and even then at the safe distance of 34 LD. Others before 2200 are 25 LD or more.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
05/10	17 08.2	-15 21	0.27	1.25	17.5	23.1	151	151	+0.00	+15
05/15	17 15.0	-09 22	0.23	1.22	17.1	22.8	152	149	+0.21	+17
05/20	17 22.4	-01 19	0.19	1.18	16.8	25.2	150	91	+0.68	+19
05/25	17 31.2	+09 20	0.17	1.15	16.6	31.6	143	37	+1.00	+22
05/30	17 42.1	+22 43	0.15	1.12	16.6	42.3	132	60	-0.69	+25
06/04	17 57.1	+37 55	0.14	1.09	16.8	55.8	118	99	-0.19	+26
06/09	18 19.6	+52 55	0.15	1.06	17.2	69.6	103	106	+0.00	+26
06/14	18 57.8	+65 42	0.16	1.03	17.7	81.7	89	100	+0.24	+24

(17188) 1999 WC2 (May-Jul, H = 16.4)
To repeat a common refrain, there is no period in the LCDB for this asteroid, a 1.6 km NEA that comes no closer than about 30 LD through 2200.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
05/15	04 35.5	-32 42	0.34	0.86	17.7	107.2	54	64	+0.21	-42
05/25	04 00.8	-38 53	0.24	0.92	17.1	107.3	60	122	+1.00	-49
06/04	02 15.8	-46 45	0.14	0.99	15.5	94.7	77	59	-0.19	-64
06/14	21 34.1	-32 50	0.10	1.08	13.5	49.7	126	157	+0.24	-47
06/24	19 15.6	-02 24	0.17	1.17	14.0	22.6	154	18	-0.99	-6
07/04	18 33.1	+07 42	0.28	1.26	15.3	24.4	149	129	-0.16	+8
07/14	18 15.8	+10 50	0.41	1.36	16.3	27.2	142	99	+0.28	+13
07/24	18 09.0	+11 30	0.54	1.45	17.1	28.9	136	52	-0.98	+15

(163249) 2002 GT (May-Jul, H = 18.5)
In 2172 October, this NEA will be about 8 LD from Earth. That's the closest approach through 2200. Remember that establishing YORP spin up/down requires having good lightcurves over many apparitions, so use this opportunity to start building the data set for some future modeler. The estimated size is 600 meters. No period has been recorded in the LCDB.

DATE	RA	Dec	ED	SD	V	α	SE	ME	MP	GB
05/01	17 12.5	-11 05	0.37	1.32	18.2	28.8	141	34	-0.66	+16
05/11	17 22.9	-05 51	0.30	1.27	17.6	26.7	146	155	+0.01	+17
05/21	17 31.9	+01 47	0.23	1.21	17.0	27.0	147	81	+0.78	+18
05/31	17 40.7	+12 51	0.18	1.16	16.5	33.0	141	67	-0.59	+21
06/10	17 51.7	+28 36	0.14	1.11	16.3	46.5	128	131	+0.02	+25
06/20	18 12.6	+49 20	0.12	1.06	16.4	66.4	107	81	+0.83	+26
06/30	19 22.6	+71 51	0.12	1.01	17.1	88.5	85	80	-0.52	+23
07/10	01 50.9	+79 38	0.14	0.97	18.0	106.0	67	78	+0.03	+17

IN THIS ISSUE

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

Number	Name	EP	Page
24	Themis	25	85
95	Arethusa	27	87
110	Lydia	33	93
159	Aemilia	25	85
185	Eunike	29	89
191	Kolga	25	85
217	Eudora	25	85
226	Weringia	25	85
231	Vindobona	25	85
273	Atropos	21	81
366	Vincentina	40	100
433	Eros	47	107
495	Eulalia	11	71
538	Friederike	25	85
562	Salome	8	68
592	Bathseba	40	100
612	Veronika	23	83
774	Amor	4	64
782	Montefiore	39	99
988	Appella	32	92
1060	Magnolia	23	83
1115	Sabauda	30	90
1365	Henyey	5	65
1474	Beira	23	83
1542	Schalen	8	68
1554	Yugoslavia	30	90
1554	Yugoslavia	40	100
1560	Strattonia	44	104
1578	Kirkwood	5	65
1604	Tombaugh	23	83
1606	Jekhovsky	32	92
1616	Filipoff	30	90
1680	Per Brahe	33	93
1694	Kaiser	11	71
1761	Edmondson	5	65
1928	Summa	44	104
2001	Einstein	11	71
2047	Smetana	34	94
2420	Ciurlionis	28	88
2432	Soomana	5	65
2454	Olaus Magnus	1	61
2717	Tellervo	48	108
2763	Jeans	44	104
2786	Grinevia	5	65
2855	Bastian	42	102
2890	Vilyujsk	30	90
2890	Vilyujsk	49	109
2933	Amber	5	65
3086	Kalbaugh	11	71
3161	Beadell	4	64
3382	Cassidy	20	80
3478	Fanale	32	92
3478	Fanale	44	104
3635	Kreutz	11	71
3842	Harlansmith	39	99
3948	Bohr	44	104
4300	Marg Edmondson	5	65
4808	Ballaero	2	62
5096	Luzin	5	65
5128	Wakabayashi	5	65
5153	1940 GO	30	90
5275	Zdislava	2	62
5275	Zdislava	44	104
5369	Virgiugum	44	104
5542	Moffatt	39	99
5646	1990 TR	34	94
5806	Archieroy	11	71
6122	Henrard	9	69
6223	Dahl	49	109
6310	Jankonke	11	71
6447	Terrycole	11	71
6720	Gifu	39	99
6744	Komoda	11	71
7086	Bopp	11	71
7560	Spudis	11	71
7750	McEwen	2	62
8325	Trigo-Rodriguez	11	71
9069	Hovland	34	94
11149	Tateshina	11	71
11709	Eudoxos	11	71
11941	Archinal	2	62
13245	1998 MM19	11	71
13573	1993 FZ18	11	71
14395	Tommorgan	11	71
15337	1993 VT2	10	70
15434	Mittal	11	71
15499	Cloyd	50	110
17252	2000 GJ127	29	89
17657	1996 VO4	11	71
17722	1997 YT1	42	102
19979	1989 VJ	39	99
22013	1999 XO89	11	71
26471	2000 AS152	34	94
26916	1996 RR2	11	71

Number	Name	EP	Page
27776	Cortland	11	71
27776	Cortland	11	71
30878	1992 GQ	11	71
30981	1995 SJ4	11	71
31179	1997 YR2	30	90
31831	1999 YL	11	71
32626	2001 RX64	11	71
47035	1998 WS	2	62
51356	2000 RY76	43	103
51371	2000 XF15	11	71
52316	1992 BD	34	94
55844	Bicak	11	71
55854	1996 VS1	11	71
63440	2001 MD30	11	71
66832	1999 UE45	11	71
70927	1999 VX210	11	71
72675	2001 FP54	11	71
86388	2000 AT60	11	71
90988	1997 XS13	11	71
123937	2001 EX16	11	71
136017	2002 VH74	11	71
152858	1999 XN35	29	89
192683	1999 SO27	11	71
330825	2008 XE3	11	71
	1994 XD	34	94
	2012 TC4	11	71

THE MINOR PLANET BULLETIN (ISSN 1052-8091) is the quarterly journal of the Minor Planets Section of the Association of Lunar and Planetary Observers (ALPO). Current and most recent issues of the *MPB* are available on line, free of charge from:

http://www.minorplanet.info/mpbdownloads.html

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

The Minor Planet Bulletin is edited by Professor Richard P. Binzel, MIT 54-410, Cambridge, MA 02139 USA (rpb@mit.edu). Brian D. Warner (address above) is Assistant Editor. The *MPB* is produced by Dr. Robert A. Werner, 3937 Blanche St., Pasadena, CA 91107 USA (bwernerca1@att.net) and distributed by Derald D. Nye. Direct all subscriptions, contributions, address changes, etc. to:

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

Effective with Volume 38, the *Minor Planet Bulletin* is a limited print journal, where print subscriptions are available only to libraries and major institutions for long-term archival purposes. In addition to the free electronic download of the *MPB* noted above, electronic retrieval of all *Minor Planet Bulletin* articles (back to Volume 1, Issue Number 1) is available through the Astrophysical Data System *http://www.adsabs.harvard.edu/*. Library and institution rates for print subscriptions (four issues) of Volume 40 are:

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

For readers of the free electronic version online, a voluntary contribution of $5 or more per year is most welcome (in support of the library archives). Checks or money orders should be in US dollars, drawn on a US bank, and made payable to the "Minor Planet Bulletin." To contribute by credit card, (Visa, Mastercard, or Discover) please send by mail your credit card number, your name exactly as it appears on the card, and the expiration date. Credit card charges will be made through "Roadrunner Mkt, Corona AZ." For libraries: when sending your subscription order, be sure to include your full mailing address and an email address. The upper-right corner of your mailing label indicates the volume and issue number with which your current subscription expires.

Authors should submit their manuscripts by electronic mail (rpb@mit.edu). Author instructions and a Microsoft Word template document are available at the web page given above. All materials must arrive by the deadline for each issue. Visual photometry observations, positional observations, any type of observation not covered above, and general information requests should be sent to the Coordinator.

* * * * *

The deadline for the next issue (40-3) is April 15, 2013. The deadline for issue 40-4 is July 15, 2013.