THE MINOR PLANET BULLETIN

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

VOLUME 36, NUMBER 1, A.D. 2009 JANUARY-MARCH

NOTES FROM THE ACTING EDITOR

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

Somewhere in this issue, you'll find something new: "In This Issue", which gives the number (if available) and name/designation and page number for every asteroid that appears in this issue of the *Minor Planet Bulletin* for which some physical data was reported, i.e., a lightcurve, color index, *H-G* values, shape model, etc. Astrometric-only observations are not included. This does not replace the annual volume index and it's not a complete cross-reference including authors. Now that issues regularly have such data for well more than 50 asteroids, we hope that this will make life easier for those looking to see if data are available for a given asteroid. The request came from one of many professional astronomers who look to the *MPB* for data needed for their studies.

Also in this issue you'll find Frederick Pilcher's article covering asteroids at favorable elongations. This marks the 35th consecutive year that Professor Pilcher has produced a list of asteroids that will be at a particularly good apparition in a given year. Pilcher's list has been the annual guidebook for observers seeking to add new "notches to their gun" either for visual observing or for taking advantage of physical observations.

Over those 35 years, many changes have occurred on these pages, probably the most amazing is the number of lightcurves that have been published. Even more so has been the way the amateur community (I prefer "backyard astronomers") has taken over the field of asteroid photometry, producing in recent years the vast majority of published asteroid lightcurves. Figure 1 tells the story. The total height of the bar for each year gives the number of lightcurves for which some quality rating (*U*) was assigned in the asteroid Lightcurve Database (LCDB) maintained by Warner *et al.* and a lightcurve was published. The light-shaded portion of the bar shows the total number of *reliable* (U = 2- or better) lightcurves that are entered into the Lightcurve Database (LCDB) maintained by Warner *et al.* that *were not* published in the *Minor Planet Bulletin*. The additional height (dark-shaded area) gives the number of lightcurves published in the *Minor Planet Bulletin*.

Staring in 2000, backyard astronomers started to contribute a substantial portion of all lightcurves entered into the LCDB, reaching nearly 90% in 2008. The year 2000 happens to be right after the first Minor Planet Amateur-Professional Workshop, which was held at Lowell Observatory. At that meeting, amateurs were encouraged to move away from astrometry (discovery) and towards photometry as the "handwriting was on the wall" since LINEAR and LONEOS were then on-line. They obviously listened! Also interesting is that the number of non-*MPB* lightcurves has remained somewhat flat for more than a decade.

To be fair, there is a bit of "apples and oranges" in the plot. The numbers for the *MPB* did not discriminate based on the U rating of the lightcurve. Doing so would lower the numbers a little, but not nearly so much as to change the fact that backyard astronomers have been the primary source for asteroid lightcurve observations for about the past five years, and they're not stopping there. Recent issues of the *MPB* have included shape and spin axis models and detailed analysis for *H* (absolute magnitude) and/or *G* (phase slope parameter). The coming years will see the importance of such modeling rise significantly. Even though even more prolific surveys may soon come on line, they will still take some years to gather enough data for modeling and, even then, it will be the dense-coverage lightcurves from backyard astronomers that will help provide the final element to develop reliable models in many cases.

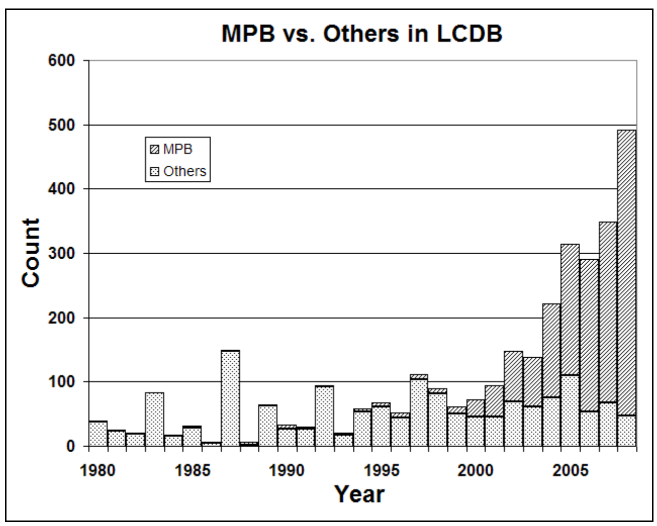


Figure 1. The total height of the bar represents the number of objects with a published and *reliable* lightcurve that were entered into the Lightcurve Database. The light-shaded section represents those curves that were published in a journal *other than the MPB*. The dark-shaded portion of the bar represents curves published in the *Bulletin*.

LIGHTCURVES OF 4135 SVETLANOV, 5614 YAKOVLEV, AND (5985) 1942 RJ

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

(Received: 2008 October 15 Revised: 2008 October 23)

Lightcurves revealed the following periods and amplitudes for three asteroids: 4135 Svetlanov, 10.559 ± 0.003 h, 0.15 ± 0.04 mag; 5614 Yakovlev, 9.713 ± 0.001 h, 0.58 ± 0.05 mag; and (5985) 1942 RJ, 13.835 ± 0.002 h, 0.17 ± 0.03 mag.

Photometric data were collected using a 36-cm Celestron C-14, an SBIG ST-10XME camera, and clear filter at Stonegate Observatory. The camera was binned 2x2 with a resulting image scale of 1.3 arc-seconds per pixel. Image exposures were 120 seconds at –15C. All photometric data were obtained and analyzed using *MPO Canopus* (Warner 2007).

4135 Svetlanov. Data were collected from 2008 September 11 through October 17 resulting in 6 data sets and 252 data points. A period of 10.559 ± 0.003 h was determined. There are no previously reported data on 4135.

5614 Yakovlev. Data were collected from 2008 August 21 through October 21 resulting in 8 data sets and 402 data points. A period of 9.713 ± 0.001 h was determined. There are no previously reported data on 5614.

(5985) 1942 RJ. Data were collected from 2008 September 3 through October 14 resulting in 8 data sets and 279 data points. A period of 13.835 ± 0.002 h was determined. There are no previously reported data on 5985.

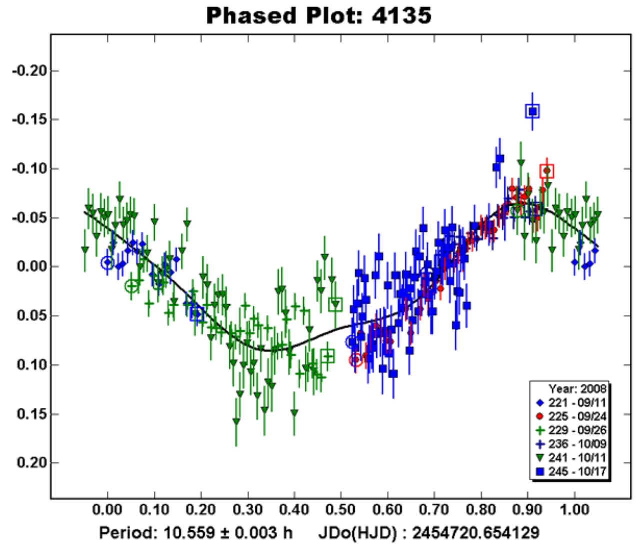
Acknowledgments

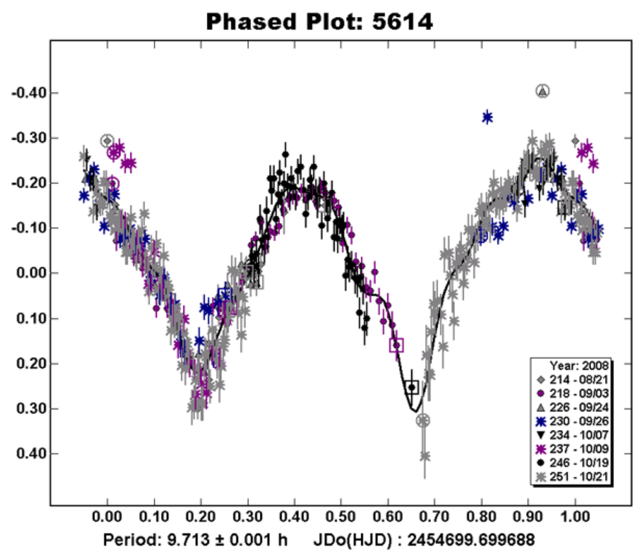
The author appreciates the continuing assistance from Brian Warner and for insight on the relationship between asteroid magnitude and their periods, monomodal vs. bimodal.

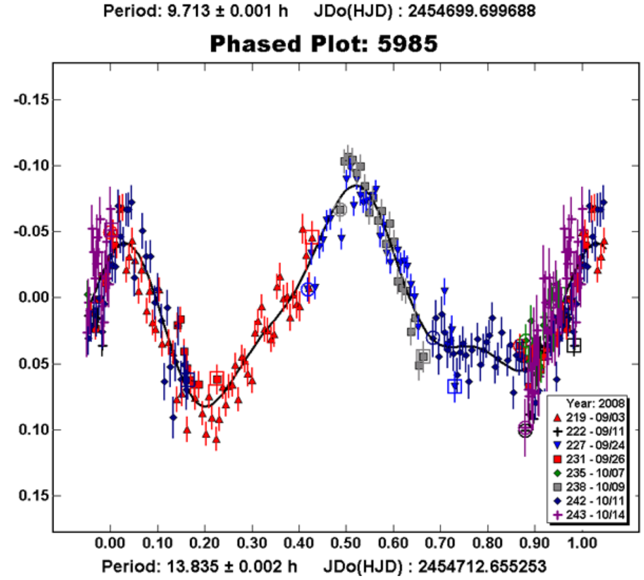
References

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

Warner, B.D. (2007). MPO Software, *Canopus* version 9.4.0.3, Bdw Publishing, http://minorplanetobserver.com/







LIGHTCURVES AND PERIODS FOR ASTEROIDS 1081 RESEDA, 2117 DANMARK, 2315 CZECHOSLOVAKIA, 2871 SCHOBER, 6392 TAKASHIMIZUNO, AND (6409) 1992 VC

Artem Yankov, Richard Ditteon
Rose-Hulman Institute of Technology CM171
5500 Wabash Avenue
Terre Haute, IN 47803
ditteon@rose-hulman.edu

(Received: 2008 August 28)

Ten asteroids were observed at the Oakley Southern Sky Observatory on six nights during the months of 2008 July and August. The asteroids were 1081 Reseda, 1421 Esperanto, 2117 Danmark, 2315 Czechoslovakia, 2871 Schober, 6392 Takashimizuno, (6409) 1992 VC, 7046 Reshetnev, (14276) 2000 CF2, and (32219) 2000 OU20.

During 2008 July and August, photometric data for ten asteroids were collected using the Oakley Southern Sky Observatory in New South Wales, Australia. Out of the ten asteroids, useful lightcurves for six asteroids were produced. The images were captured using a 20-inch Ritchey-Chretien optical tube assembly mounted on a Paramount ME. The CCD camera used was a Santa Barbara Instrument Group STL-1001E with a clear filter. Exposure times were 120 seconds. All images were processed in CCDSoft Version 5 using twilight flats, darks, and bias frames. Lightcurves for processed images were rendered using MPO Canopus.

Asteroids were selected based upon two criteria: convenient southern sky positions and no record of previously published lightcurves according to Harris and Warner (2008). Lightcurves for the asteroids 1421 Esperanto, 7046 Reshetnev, (14276) 2000 CF2, and (32219) 2000 OU20 were omitted from this publication due to a lack of certainty of the derived periods and amplitudes. All of the results are listed in the table below. Comments have been added as necessary. Many of the inconsistencies in the lightcurves can be attributed to the aliasing effect due to the data being taken with long breaks between observing sessions.

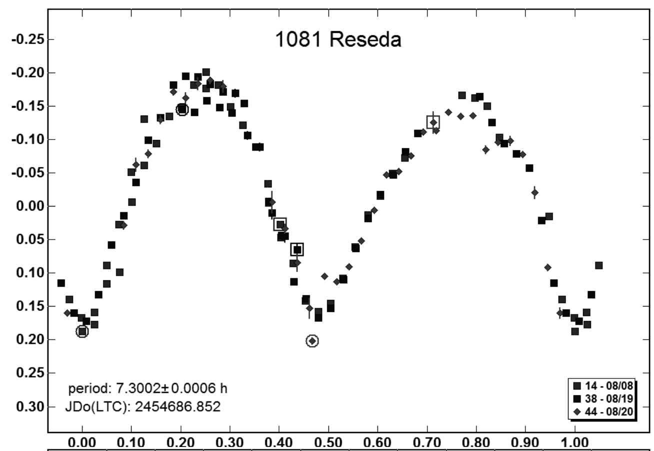
For 1421 Esperanto, we gathered enough data to conclude that the asteroid's period is longer than 20 h and the amplitude is greater than 0.35. However, we did not have enough data to yield precise figures for 1421 Esperanto's period and amplitude. The data for asteroids 7046 Reshetnev and (32219) 2000 OU20 were too inconsistent and scattered to produce a lightcurve. However, our results imply a long period for (32219) 2000 OU20, although we did not have enough data to substantiate this claim. Similarly, our data for asteroid (14276) 2000 CF2 were widely scattered. Although we were unable to determine a period due to the aliasing effect, our data indicates a low amplitude for this asteroid.

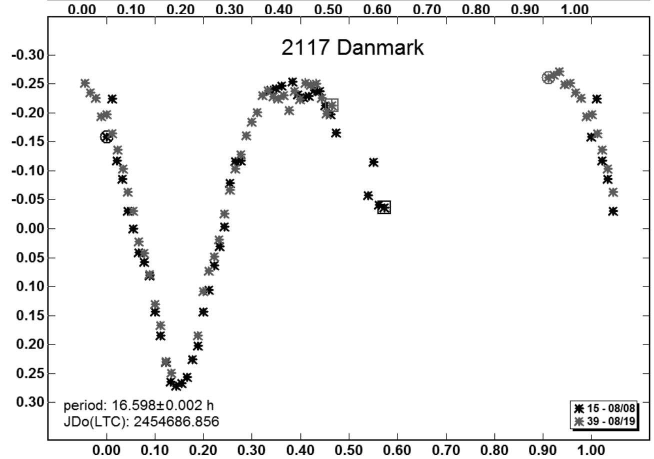
Acknowledgements

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

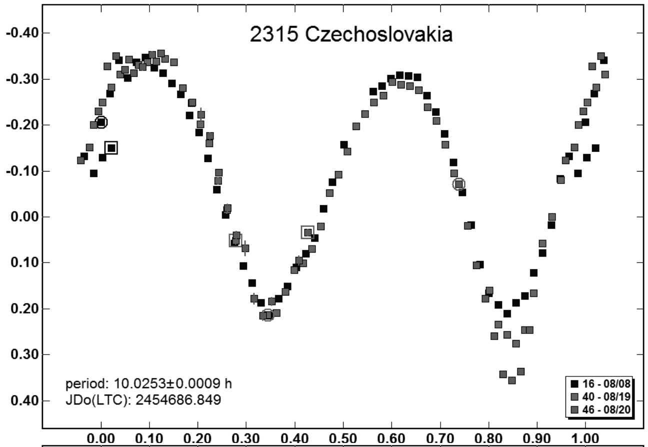
References

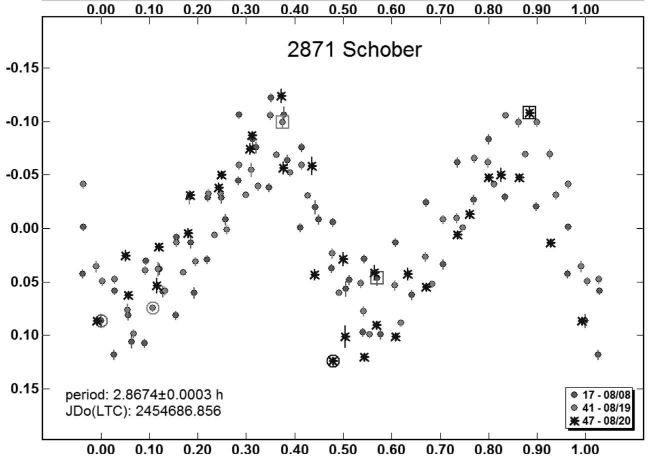
Harris, A. W. and Warner, B. D. (2008). Asteroid Lightcurve List. http://www.minorplanetobserver.com/astlc/LightcurveParameters.htm

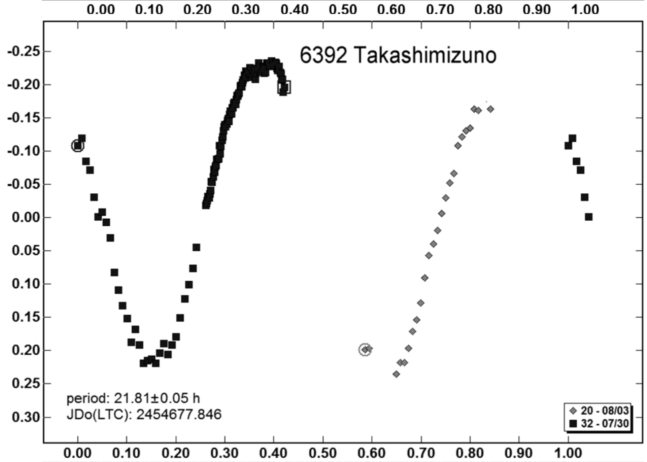


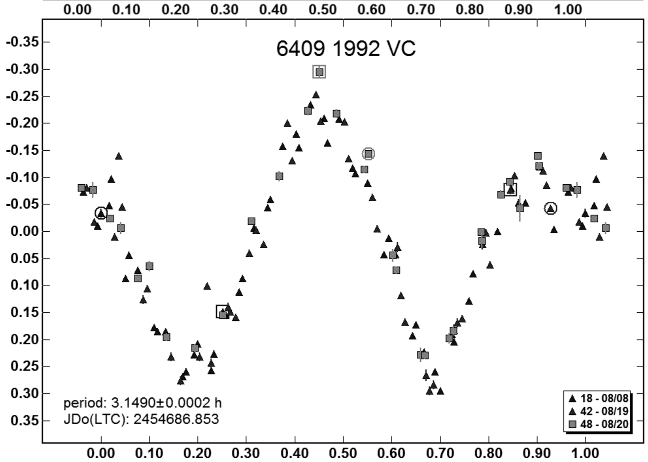


Number	Name	Dates (2008) mm/dd	Data Points	Period (h)	P.E. (h)	Amp. (mag)	A.E. (mag)
1081	Reseda	08/08, 08/19, 08/20	136	7.3002	0.0006	0.36	0.07
1421	Esperanto	07/29, 08/02, 08/03	75	-	-	0.42	0.1
2117	Danmark	08/08, 08/19, 08/20	128	16.598	0.002	0.54	0.05
2315	Czechoslovakia	08/08, 08/19, 08/20	138	10.0253	0.0009	0.58	0.09
2871	Schober	08/08, 08/19, 08/20	135	2.8674	0.0003	0.25	0.12
6392	Takashimizuno	07/29, 08/02, 08/03	178	21.81	0.05	0.48	0.04
(6409)	1992 VC	08/08, 08/19, 08/20	143	3.1490	0.0002	0.54	0.1
7046	Reshetnev	07/29, 08/02, 08/03	76	-	-	0.31	0.15
(14276)	2000 CF2	07/29, 08/02, 08/03	73	-	-	0.12	0.08
(32219)	2000 OU20	07/29, 08/02, 08/03	138	-	-	-	-









LIGHTCURVE ANALYSIS OF ASTEROIDS FROM LEURA AND KINGSGROVE OBSERVATORIES IN THE FIRST HALF OF 2008

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

Leura Observatory, 94 Rawson Pde.
Leura, NSW 2080 AUSTRALIA
julianoey1@optusnet.com.au

(Received: 2008 October 4)

Photometric observations at the Kingsgrove and Leura Observatories resulted in finding the synodic periods for the following asteroids: 315 Constantia, 5.345 h; 552 Sigelinde, 17.156 h; 1563 Noel, 3.550 h; 1638 Ruanda, 4.2397 h; 1785 Wurm, 3.2696 h; 2066 Palala, 9.732 h; 2193 Jackson, 4.7541 h; 5034 Joeharrington, 8.417 h; 5313 Nunes, 2.798 h; (13189) 1997 AF13, 5.9371 h; and (153591) 2001 SN263, 3.42510 h.

Targets observed from Kingsgrove were selected from the CALL Website maintained by Warner (2008). These targets were chosen mainly for their favourable opposition brightness as well as southerly declination due to restrictions to the observatory's northern horizon. Leura observations were dedicated to photometric binary asteroid survey work with all targets selected for the survey by Pravec (2008). Kingsgrove Observatory used a 0.25-m Schmidt-Cassegrain operating at f/5.2 and ST-402 ME SBIG CCD camera operating at 1x1 binning, resulting in a pixel resolution of 1.40 arc seconds/pixel. Images were 60 s and unfiltered. Leura Observatory used a 0.35m Schmidt-Cassegrain and achromatic 0.5x focal reducer for an effective f/ ratio of 6.5. These were combined with an ST-9XE SBIG CCD camera binned 1x1, resulting in a scale of 1.80 arc seconds/pixel. Images were 300 s and unfiltered. The camera was set to between –35°C and –45°C, depending on local ambient temperature. *MPO Canopus* v.9.4.0.1 software was used for period analysis which incorporates the Fourier algorithm developed by Harris (1989).

<u>315 Constantia</u>. Observations were made while the asteroid shared the field with 2066 Palala. The data showed a bimodal lightcurve with a synodic period of 5.345 ± 0.003 h. This agrees well with the previous result by Behrend *et al.* (2008) of 5.37 h, which was based on data obtained in 2005. The 2005 apparition showed an amplitude of 0.11 mag while, in 2008, the amplitude was 0.60 ± 0.02 mag. This is not unexpected for an asteroid that shows a polar orientation during one apparition and a more equatorial orientation at another.

<u>552 Sigelinde</u>. The previously reported period of 12 h (Behrend 2008), was based on a single short night covering only part of the lightcurve. Analysis of the 2008 data found a period of 17.156 ± 0.002 h.

<u>1638 Ruanda</u>. Behrend (2008) reported a period of 8.4 h for this main-belt asteroid. After six nights of observations with photometric errors of 0.02–0.04 mag, no convincing period was found when assuming a bimodal light curve. Data taken on 2008 May 10 showed an apparent dip in the lightcurve, indicating the possibility of a satellite. Peter Kušnirák was contacted (private communications), who suggested obtaining data with higher precision and additional analysis. Four, higher-quality, data sets were obtained in 2008 June. Once reduced, a trimodal light curve

with a period of 4.2397 ± 0.0002 h and amplitude of 0.10 mag was found. The observed dip was concluded to be spurious and appeared to have been caused by automatic target acquisition inherent to the robotic system used in Kingsgrove. Future low amplitude targets will require dedicated, longer-integration imaging, especially when target is relatively dim.

(153591) 2001SN263. This Amor-type asteroid was observed during its close approach in 2008. Radar observations by Nolan *et al.* (2008) showed that the object is ternary. A campaign by the Photometric Survey of Asynchronous Binary Asteroids (Pravec 2008) was started when the target was two weeks from closest approach. Initial observations by the group detected events that were attributed to the presence of the object's satellites. Kingsgrove contributed 11 sets of high-quality data to the campaign after the asteroid moved to southern skies. Analysis of that data found a rotation period of 3.42510 ± 0.00007 h. No events were detected due to the changing geometry of the object.

Acknowledgement

I would like to thank Peter Kušnirák from Ondřejov Observatory for his assistants with 1638 Ruanda.

References

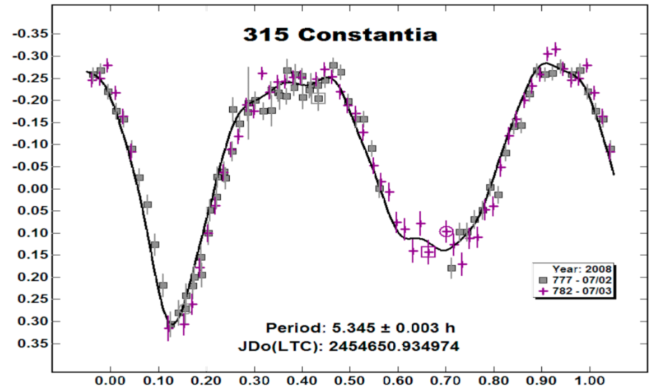
Behrend, R. (2008). Observatoire de Genève web site. http://obswww.unige.ch/~behrend/page_cou.html

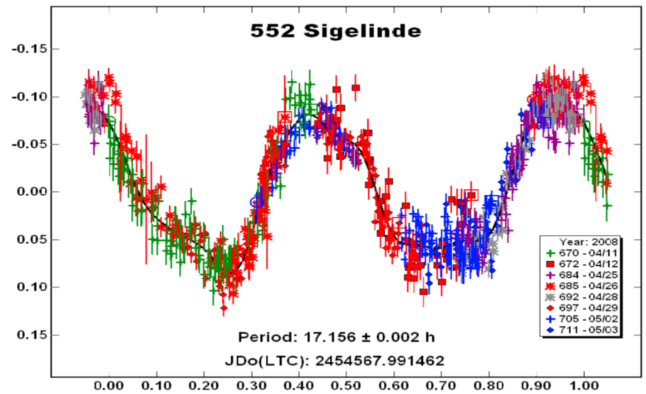
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863". *Icarus* **77**, 171-186.

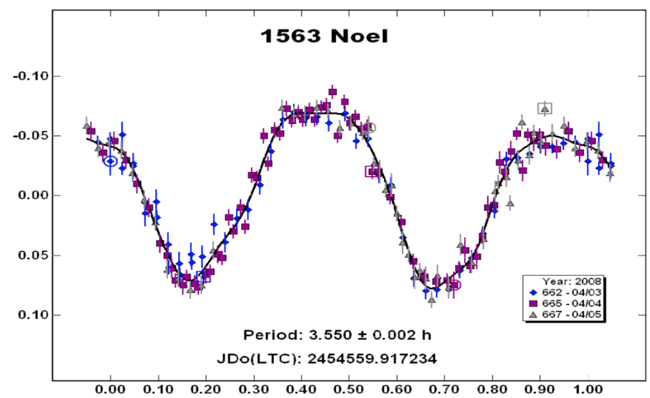
Nolan, M.C., Howell, E.S., Benner, L.A.M., Ostro, S.J., Giorgini, J.D., Busch, M.W., Carter, L.M., Anderson, R.F., Magri, C., Campbell, D.B., Margot, J.L., Vervack, R.J. Jr., and Shepard, M.K. (2008). IAUC 8921. "(153591) 2001 SN_263".

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

Warner, B.D. (2008). "Potential Lightcurve Targets 2008 April – June". http://www.minorplanetobserver.com/astlc/targets_2q_2008.htm

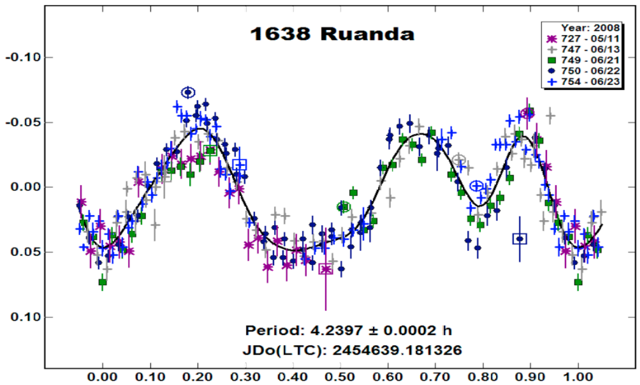


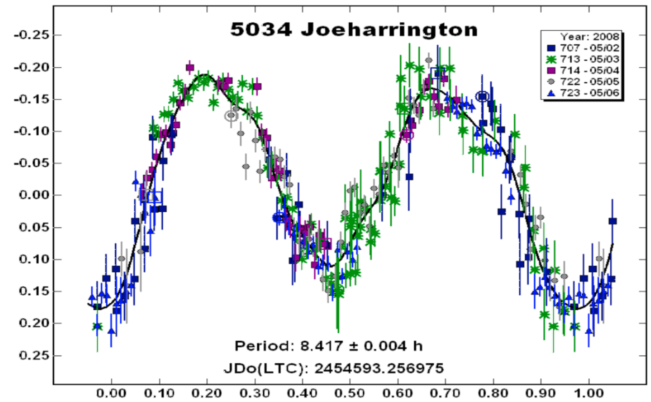


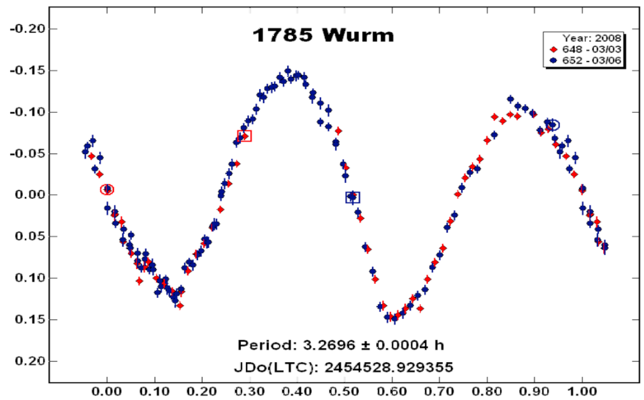


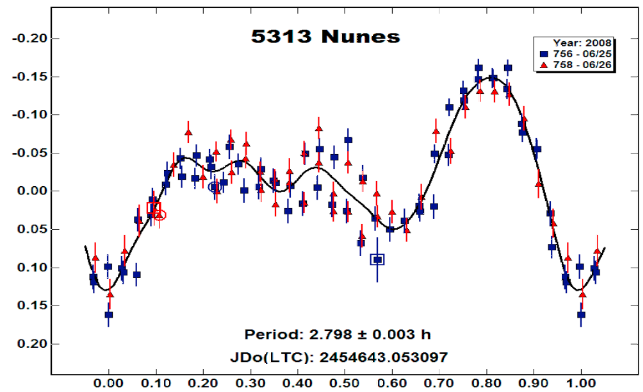
Asteroid	Date (mm/dd) 2008	Period (h)	Amp mag	Phase (α)	LPAB	BPAB
315 Constantia[1]	07/02-07/03	5.345 ± 0.003	0.57 ± 0.02	19.5	246	3
552 Sigelinde[1]	04/11-05/03	17.156 ± 0.002	0.16 ± 0.02	14.2 - 8.9	240	-5
1563 Noel[2]	04/03-04/05	3.550 ± 0.002	0.14 ± 0.02	4.0	198	5
1638 Ruanda[1]	05/11-06/23	4.2397 ± 0.0002	0.10 ± 0.02	11.2-0.2-9.9	253	0
1785 Wurm[2]	03/03-03/06	3.2696 ± 0.0004	0.30 ± 0.01	5.0	171	-5
2066 Palala[1]	06/27-07/03	9.732 ± 0.002	0.62 ± 0.02	17.6-19.8	246	3
2193 Jackson[1]	04/12-04/29	4.7541 ± 0.0005	0.24 ± 0.02	9.8 - 3.3	226	-1
5034 Joeharrington[1]	05/02-05/06	8.417 ± 0.004	0.36 ± 0.04	8.0	233	-6
5313 Nunes[1]	06/25-06/26	2.798 ± 0.003	0.28 ± 0.02	18.0	247	4
(13189) 1997 AF13[2]	06/21-06/26	5.9371 ± 0.0006	1.10 ± 0.06	11.7	243	7
(153591) 2001 SN263[1]	03/13-03/31	3.42510 ± 0.00007	0.10 ± 0.05	26.7 - 24.8	169-185	-16

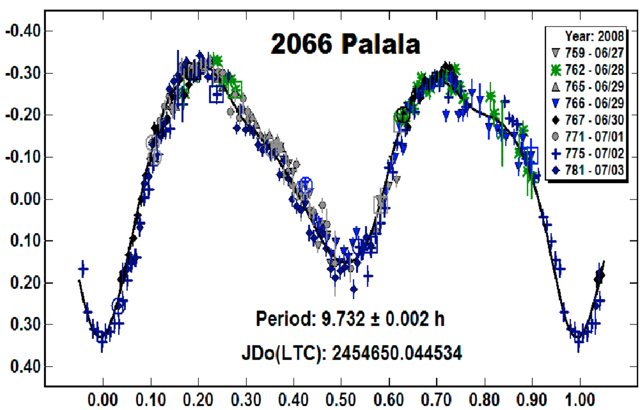
1 = Kingsgrove Observatory; 2 = Leura Observatory .

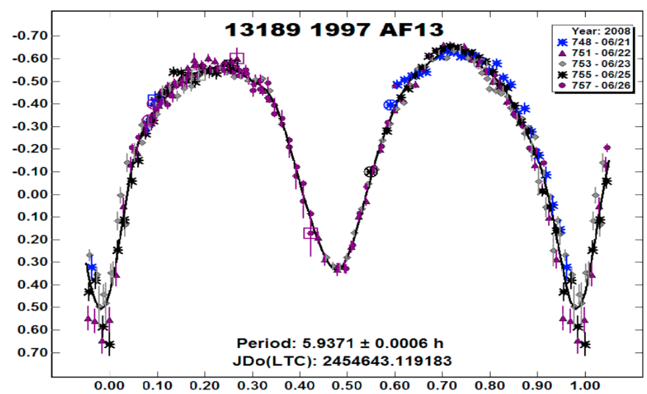

1638 Ruanda
Year: 2008
727 - 05/11
747 - 06/13
749 - 06/21
750 - 06/22
754 - 06/23
Period: 4.2397 ± 0.0002 h
JDo(LTC): 2454639.181326

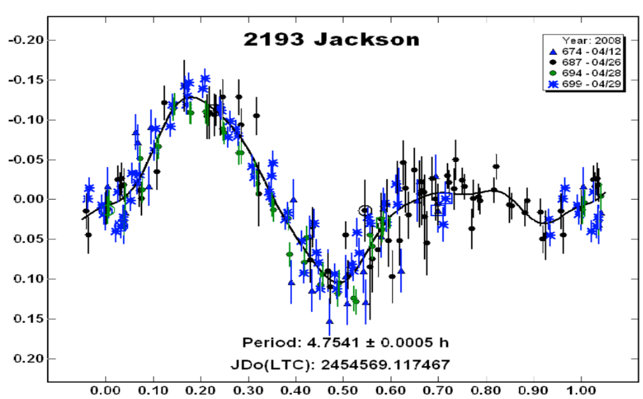

5034 Joeharrington
Year: 2008
707 - 05/02
713 - 05/03
714 - 05/04
722 - 05/05
723 - 05/06
Period: 8.417 ± 0.004 h
JDo(LTC): 2454593.256975

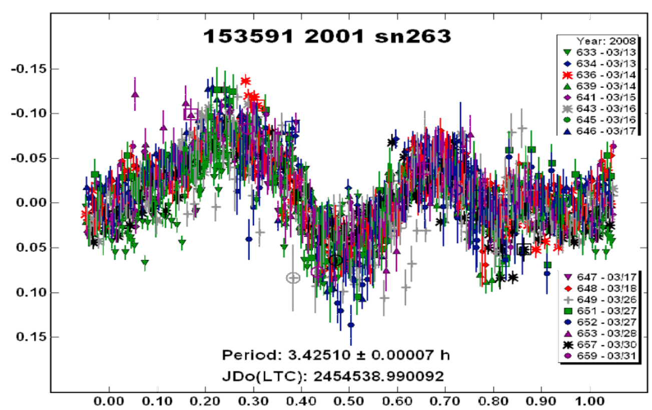

1785 Wurm
Year: 2008
648 - 03/03
652 - 03/06
Period: 3.2696 ± 0.0004 h
JDo(LTC): 2454528.929355


5313 Nunes
Year: 2008
756 - 06/25
758 - 06/26
Period: 2.798 ± 0.003 h
JDo(LTC): 2454643.053097


2066 Palala
Year: 2008
759 - 06/27
762 - 06/28
765 - 06/29
766 - 06/29
767 - 06/30
771 - 07/01
775 - 07/02
781 - 07/03
Period: 9.732 ± 0.002 h
JDo(LTC): 2454650.044534


13189 1997 AF13
Year: 2008
748 - 06/21
751 - 06/22
753 - 06/23
755 - 06/25
757 - 06/26
Period: 5.9371 ± 0.0006 h
JDo(LTC): 2454643.119183


2193 Jackson
Year: 2008
674 - 04/12
687 - 04/26
694 - 04/28
699 - 04/29
Period: 4.7541 ± 0.0005 h
JDo(LTC): 2454569.117467


153591 2001 sn263
Year: 2008
633 - 03/13
634 - 03/13
636 - 03/14
639 - 03/14
641 - 03/15
643 - 03/16
645 - 03/16
646 - 03/17
647 - 03/17
648 - 03/18
649 - 03/26
651 - 03/27
652 - 03/27
653 - 03/28
657 - 03/30
659 - 03/31
Period: 3.42510 ± 0.00007 h
JDo(LTC): 2454538.990092

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY: 2008 MAY - SEPTEMBER

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

(Received: 2008 October 1)

Lightcurves for 32 asteroids were obtained at the Palmer Divide Observatory (PDO) from 2008 May through September: 164 Eva, 568 Cheruskia, 1520 Imatra, 1657 Roemera, 1828 Kashirina, 1951 Lick, 3728 IRAS, 4590 Dimashchegolev, 4770 Lane, 4868 Knushevia, 4937 Lintott, 5427 Jensmartin, 5577 Priestley, 6271 Farmer, 6602 Gilclark, (6618) 1936 SO, 6901 Roybishop, 6911 Nancygreen, 7285 Seggewiss, 7516 Krancj, 7778 Markrobinson, 8021 Walter, (9068) 1993 OD, (9731) 1982 JD1, (9873) 1992 GH, (14465) 1993 NB, (16960) 1998 QS52, (17010) 1999 CQ72, (33896) 2000 KL40, (101430) 1998 VE32, and 2004 FQ5. It is suspected that 6901 Roybishop may be a binary asteroid after at least two possible "mutual events" were observed.

Observations of 32 asteroids were made at the Palmer Divide Observatory from 2008 May through September. One of four telescopes/camera combinations was used: 0.5m Ritchey-Chretien/SBIG STL-1001E, 0.35m SCT/FLI IMG-1001E, 0.35m SCT/ST-9E, or 0.35m SCT/STL-1001E. All images were 1x1 binning, resulting in a scale of approximately 1.2 arcseconds per pixel. All exposure were guided and from 120–240 s. Most observations were made with no filter. On occasion, e.g., when a nearly full moon was present, an R filter was used to decrease the sky background noise. All images were measured using *MPO Canopus* employing differential aperture photometry. Period analysis was also done using *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Alan Harris (Harris et al. 1989).

The results are summarized in the table below, as are individual plots. The data and curves are presented without comment except when warranted. Columns 6 and 7 give the range of values, or average if the range was relatively small, for the Phase Angle Bisector (PAB) longitude and latitude respectively. Columns 8 and 10 give the period and amplitude of the curve while columns 9 and 11 give the respective errors in hours and magnitudes. An "(H)" follows the name of an asteroid in the table if it is a member of the Hungaria group/family, which is a primary target of the PDO observing program.

The plots are "phased", i.e., they range from 0.0 to 1.0 of the stated period. Most of the plots are scaled such that 0.8 mag has the same linear size as the horizontal axis from 0.0 to 1.0. This is done for two reasons: 1) for easier direct comparison of amplitudes and, 2) to avoid the visual impression that the amplitude of variation is greater than it actually is, which can create the impression of a physically implausible lightcurve. There are some cases where the scale has been modified, those being mostly for low amplitude lightcurves, where the above scaling would have resulted in a nearly flat plot void of almost all detail and information. Even so, the vertical scale has been expanded as little as possible to avoid creating misleading interpretations.

164 Eva. The period of 13.672 h found here agrees with that found by Schrober (1982), who reported a period of 13.66 h and 0.36 mag amplitude from observations in 1979 September.

568 Cheruskia. Blanco *et al.* (2000) reported a period of 14.654 h. The data obtained at PDO do not support that, finding instead a synodic period of 13.209 h.

1520 Imatra. The data obtained at PDO do not support the period of 5.23 h reported by De Sanctis (1994).

1657 Roemera. Wisniewski (1997) found a period of 4.5 h. The PDO data suggest a period of 34 h.

1951 Lick. Wisniewski (1997) found a period of 4.424 h while Pravec (2008) observed the asteroid in late 1997 and early 1998 and found an average period of about 5.300 h. The PDO period of 5.2974 h agrees with Pravec's findings.

4937 Lintott. Asteroid Lintott was worked previously at PDO (Warner 2005) when a period of 3.123 h was found. This follow up work for future modeling revises the period to 3.1258 h.

6271 Farmer. This Hungaria member was worked by the author in 2005 (Warner 2006). At that time, an uncertain period of 35.8 h was reported. The data from 2008 give a reasonably secure period of 8.01 h. Forcing the data from 2005 to a solution near this result found 8.30 h. However, that earlier data set is much noisier, due mostly to crowded star fields, and so any period found from the 2005 set is suspect. Thus a period near 8.01 h is preferred.

6901 Roybishop. Two strong attenuation events and one possible weak one were captured during the 2008 apparition. Bad weather conditions and a fading magnitude prevented sufficient follow up to confirm that the asteroid is an asynchronous binary and, if so, the associated periods. Making analysis difficult was the fact that the "primary" amplitude was only 0.04 mag, implying a nearly spheroidal shape. Despite this, a period of 4.682 h was found for the assumed primary (this being one of several possibilities). Using that value in a period search on the attenuation events found a period of 17.16 ± 0.01 h. The weak event was ~0.04 mag. This implies $D_s/D_p = 0.19 \pm 0.02$.

Independent analysis of the PDO data by Petr Pravec at the Astronomical Institute, Czech Republic (private communications), found different primary and secondary periods. Given the limited data set and overall quality, this not surprising. However, it is agreed that, with at least two separate events, there is sufficient reason to suspect that the asteroid is binary. The results given here are just one of several solution sets and should not be taken as absolute. Instead they should serve as a guide for follow up observations at the next good apparition in 2011.

6911 Nancygreen. Previous work at PDO (Warner 2006) found a period of 5.3 h, but that was uncertain. The 2008 data set give an improved solution of 4.33 h. The earlier data set was not available to check if it could be fit to the new solution.

7516 Kranjc. Pravec (2008) reports a period of 3.96769 h and the possibility that the asteroid is binary after two attenuations were seen but not confirmed. The PDO data did not show any events (but that could be due to different viewing geometry) and found a period of 3.982 h.

#	Name	(mm/dd) 2008	Data Pts	Phase	PAB_L	PAB_B	Per (h)	PE	Amp (mag)	AE
164	Eva	05/11-06/03	381	7.9-13.1	218	17	13.672	0.003	0.04	0.01
568	Cheruskia	08/14-09/04	1123	15.2-11.1	351	23	13.209	0.001	0.10	0.01
1520	Imatra	07/15-07/30	539	6.3	299	14	18.635	0.004	0.27	0.03
1657	Roemera	05/09-06/07	529	18.6-21.7	225	27	34.0	0.1	0.15	0.02
1828	Kashirina	07/21-08/02	251	9.9-12.5	276	17	14.838	0.003	0.42	0.02
1951	Lick	06/30-07/11	119	45.4-40.0	292	39	5.2974	0.0004	0.25	0.03
3728	IRAS	08/02-08/13	148	6.8-7.5	311	17	8.323	0.002	0.21	0.02
4590	Dimashchegolev	07/09-07/28	214	11.6-16.9	278	16	25.4	0.2	0.23	0.03
4770	Lane	06/06-06/28	455	14.4-18.4	243	28	34.75	0.02	0.23	0.03
4868	Knushevia (H)	08/28-09/04	184	14.0-10.6	349	13	4.45	0.01	0.09	0.02
4937	Lintott	08/14-08/22	213	9.3-9.2	326	18	3.1258	0.0002	0.24	0.02
5427	Jensmartin (H)	08/31-09/04	179	26.5-25.2	18	16	5.810	0.001	0.44	0.02
5577	Priestley (H)	05/06-06/06	425	19.4-24.9	223	25	51.9	0.1	0.35	0.05
6271	Farmer (H)	09/19-09/26	172	25.5-24.1	33	31	8.01	0.01	0.18	0.02
6602	Gilclark (H)	09/16-09/18	161	28.6	34	21	4.574	0.004	0.54	0.02
6618	1936 SO (H)	09/16-09/18	185	26.8	30	24	8.297	0.006	0.20	0.02
6901	Roybishop (H)	07/31-09/04	397	13.4-21.8	317	21	4.682	0.002	0.04	0.01
6911	Nancygreen (H)	09/16-09/18	166	26.6	32	5	4.33	0.01	0.10	0.02
7285	Seggewiss	08/12-08/13	100	7.5	321	12	3.460	0.002	0.52	0.02
7516	Kranjc	06/08-06/09	109	14.8	240	11	3.982	0.003	0.15	0.02
7778	Markrobinson	06/10-06/12	205	15.2	264	20	7.230	0.002	0.64	0.02
8021	Walter	08/12-08/22	219	20.7-19.9	336	33	4.84/9.68	0.01	0.07	0.02
9068	1993 OD (H)	09/16-09/17	132	34.0	28	30	3.405	0.004	0.20	0.02
9731	1982 JD1	07/21-08/04	152	8.5-13.1	294	12	2.833	0.001	0.16	0.02
9873	1992 GH (H)	09/18-09/22	194	27.0	33	14	2.925	0.001	0.25	0.02
14465	1993 NB	06/07-06/09	214	11.0	247	17	4.972	0.001	0.50	0.02
14923	1994 TU3	06/30-07/13	124	21.9	293	33	7.300	0.002	0.34	0.03
16960	1998 QS52	09/26-09/29	125	35.1-36.9	20	33	2.900	0.001	0.24	0.02
17010	1999 CQ72	06/10-06/28	270	9.4-15.5	255	14	15.781	0.001	0.63	0.03
33896	2000 KL40 (H)	05/06-05/25	114	22.1-23.9	220	31	24	1	>0.1	
101430	1998 VE32	06/30-07/30	386	35.8-44.0	292	43	40.66	0.02	0.22	0.03
	2004 FQ5	07/31-08/01	141	13.7	310	15	5.047	0.004	0.46	0.02

7778 Markrobinson. The period of 7.230 h found at PDO agrees well with the 7.234 h period found by Behrend (2008).

8021 Walter. The period solution is ambiguous. The two plots show the data phased to the periods of 4.84 and 9.68 h. Neither of these agree with the period of 12 h reported by Behrend (2008).

(9873) 1992 GH. This was worked at PDO as follow up for modeling. The period of 2.925 h agrees with that found in the previous work (Warner 2007, 2.9257 h). Sauppe (2007) also reported a similar period of 2.92 h.

(14465) 1993 NB. The PDO data found a period of 4.972 h, which agrees with that found by Pravec (2008, 4.9703 h) and Behrend (2008, 4.9702 h). Pravec worked the asteroid in mid-May and found amplitude of 0.49 mag; the PDO data from early June found 0.50 mag; the Behrend data from early July found 0.69 mag. During that period, the phase angle increased from 10.2° to 19.0°.

(14923) 1994 TU3. Behrend (2008) found a period of 30 h based on data from two nights in 2001. The PDO data give a reasonably secure period of 7.300 h with 0.34 mag amplitude.

(17010) 1999 CQ72. Behrend (2008) reports a period of 11.772 h and a monomodal curve. Given the large amplitude, this is not likely. The PDO data cannot be made to fit that period but do fit a typical bimodal curve with a period of 15.781 h.

(33896) 2000 KL40. The previous work at PDO (Warner 2005) found a period of 23.8 h. Observing circumstances were not favorable this time around, mostly due to bad weather, and so a very limited data set was acquired. The plot shows that data phased to a forced period of 24 h. While the result is plausible, it can hardly be considered conclusive. This is a very good candidate for a collaboration involving sites well-removed in longitude but, if possible, not at intervals of 6, 8, or 12 hours unless long runs are possible.

Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNG06GI32G, by National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society.

References

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

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

De Sanctis, M.C., Barucci, M.A., Angeli, C.A., and Fulchignoni, M., et al. (1994). "Photoelectric and CCD Observations of 10 Asteroids". *Planet. Space Sci.* **42**, 859-864.

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

Pravec, P., Wolf, M., and Sarounova, L. (2008). http://www.asu.cas.cz/~ppravec/neo.htm

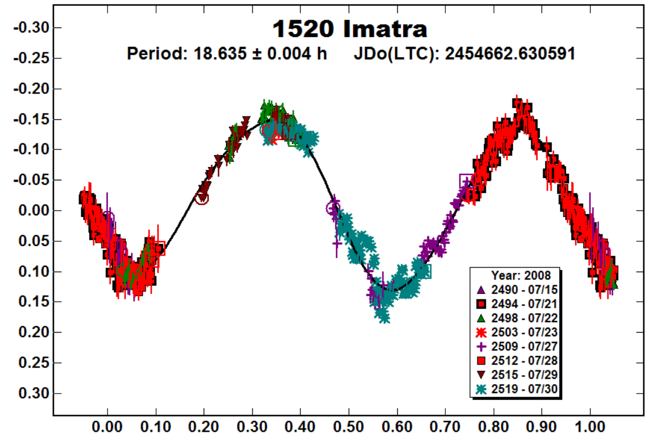
Sauppe, J., Torno, S., Lemke-Oliver, R., and Ditteon, R. (2007). "Asteroid Lightcurve Analysis at the Oakley Observatory: March/April 2007". *Minor Planet Bul.* **34**, 119-122.

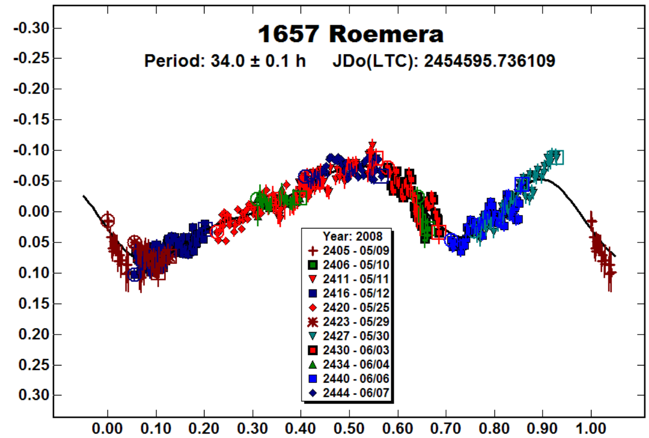
Schober, H.J. (1982). "A Revised rotation period of the Asteroid 164 Eva". *Astron. Astrophys. Suppl. Ser.* **48**, 57-62.

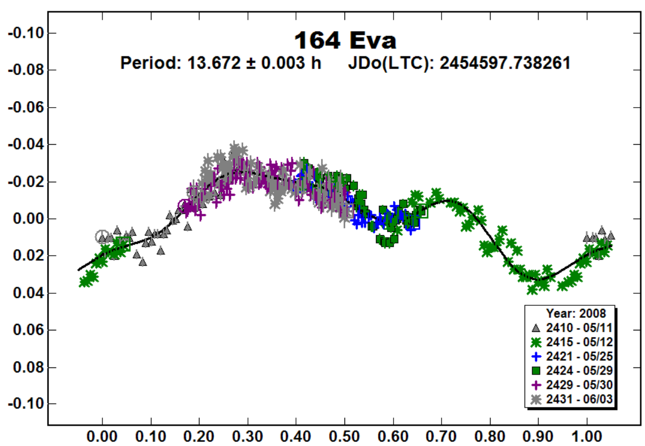
Warner, B.D. (2005). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: Winter 2004-2005". *Minor Planet Bul.* **32**, 54-58.

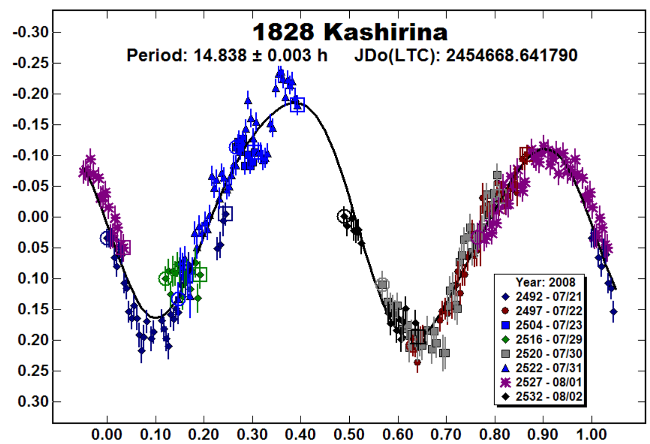
Warner, B.D. (2006). "Asteroid Lightcurve Analysis at the Palmer Divide Observatory: July-September 2005". *Minor Planet Bul.* **33**, 35-39.

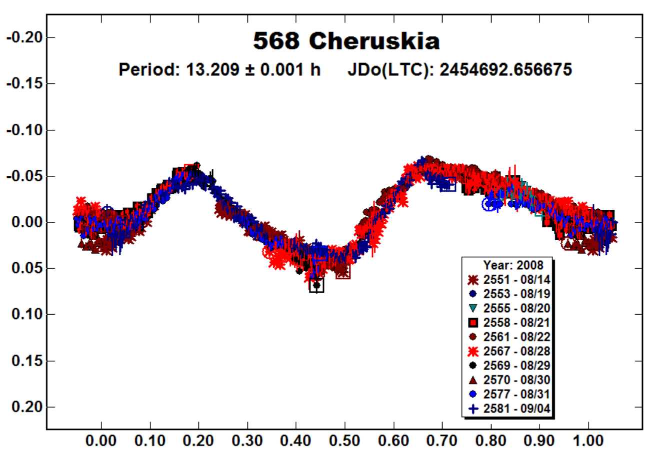
Wisniewski, W.Z., Michalowski, T.M., Harris, A.W., McMillan, R.S. (1997). "Photometric Observations of 125 Asteroids". *Icarus* **126**, 395-449.

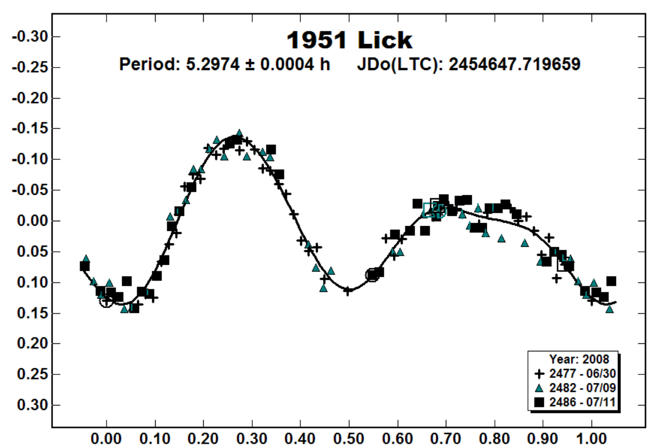


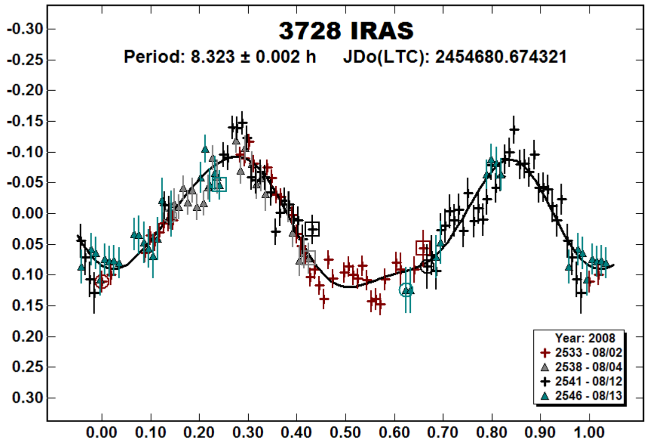


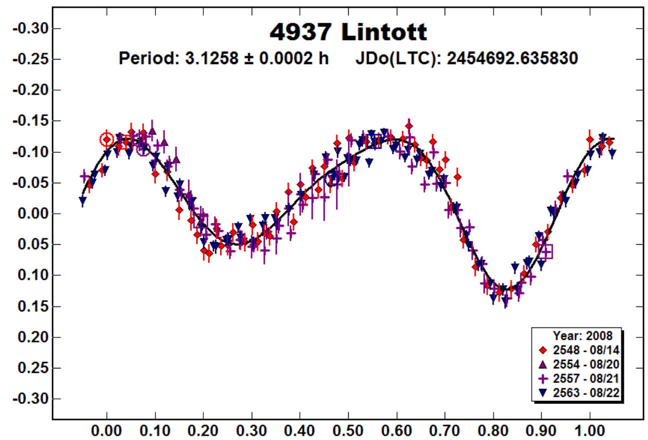


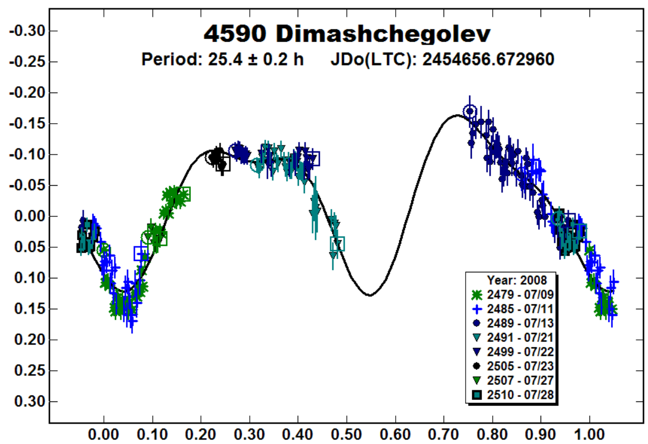


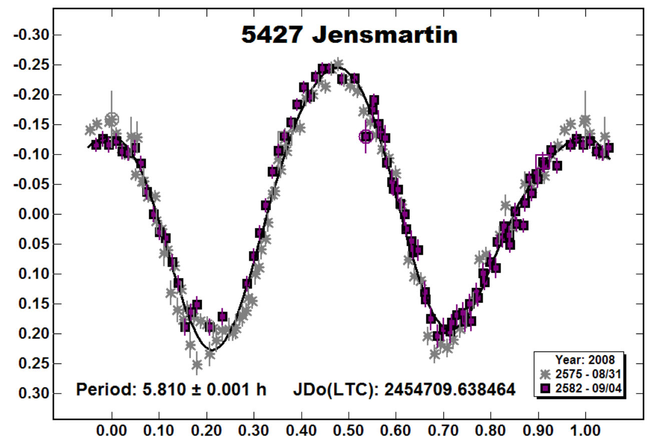


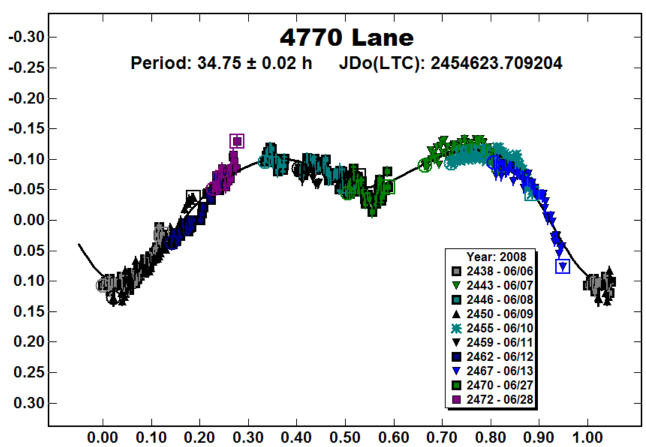


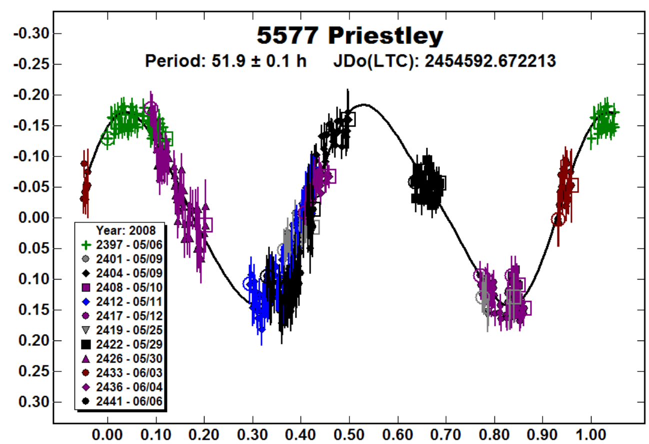

3728 IRAS
Period: 8.323 ± 0.002 h JDo(LTC): 2454680.674321
Year: 2008
2533 - 08/02
2538 - 08/04
2541 - 08/12
2546 - 08/13

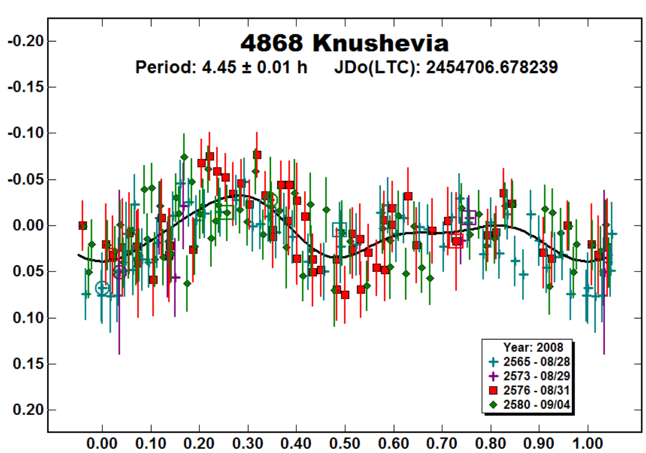

4937 Lintott
Period: 3.1258 ± 0.0002 h JDo(LTC): 2454692.635830
Year: 2008
2548 - 08/14
2554 - 08/20
2557 - 08/21
2563 - 08/22

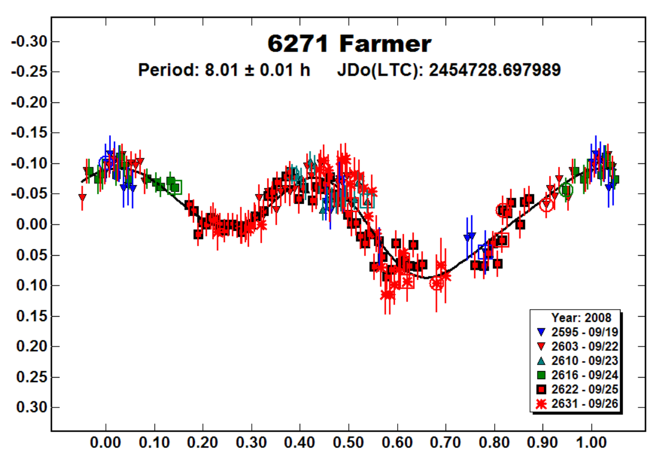

4590 Dimashchegolev
Period: 25.4 ± 0.2 h JDo(LTC): 2454656.672960
Year: 2008
2479 - 07/09
2485 - 07/11
2489 - 07/13
2491 - 07/21
2499 - 07/22
2505 - 07/23
2507 - 07/27
2510 - 07/28

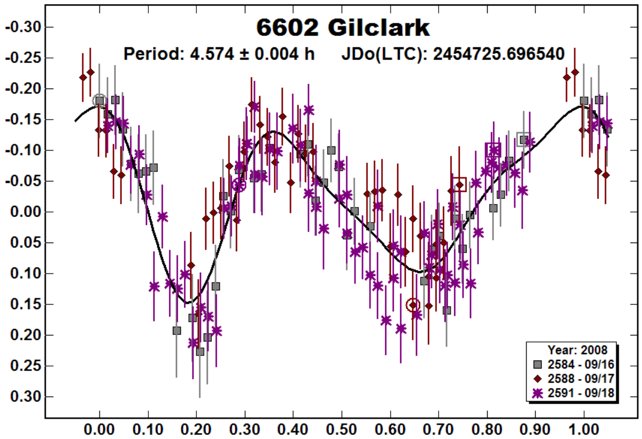

5427 Jensmartin
Period: 5.810 ± 0.001 h JDo(LTC): 2454709.638464
Year: 2008
2575 - 08/31
2582 - 09/04

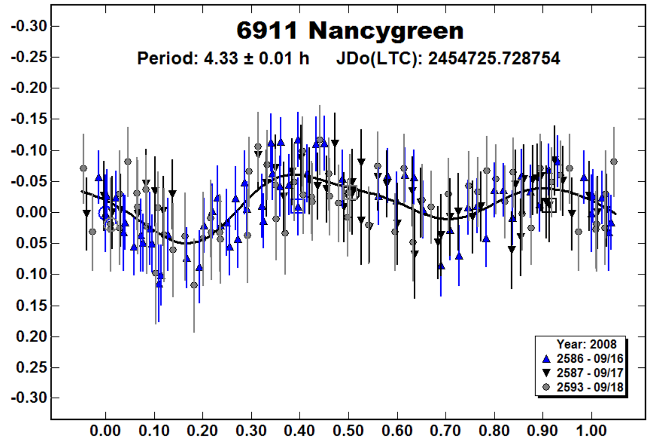

4770 Lane
Period: 34.75 ± 0.02 h JDo(LTC): 2454623.709204
Year: 2008
2438 - 06/06
2443 - 06/07
2446 - 06/08
2450 - 06/09
2455 - 06/10
2459 - 06/11
2462 - 06/12
2467 - 06/13
2470 - 06/27
2472 - 06/28

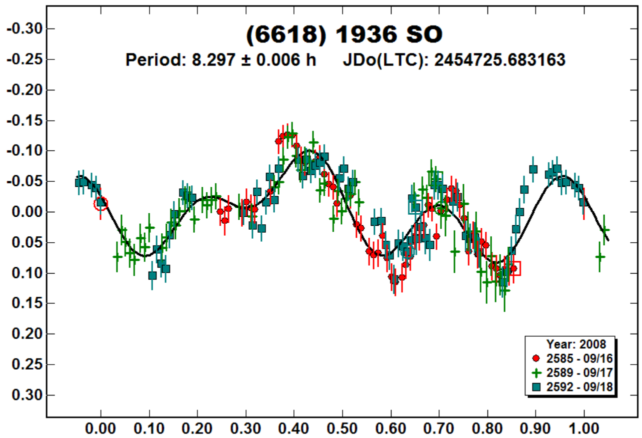

5577 Priestley
Period: 51.9 ± 0.1 h JDo(LTC): 2454592.672213
Year: 2008
2397 - 05/06
2401 - 05/09
2404 - 05/09
2408 - 05/10
2412 - 05/11
2417 - 05/12
2419 - 05/25
2422 - 05/29
2426 - 05/30
2433 - 06/03
2436 - 06/04
2441 - 06/06

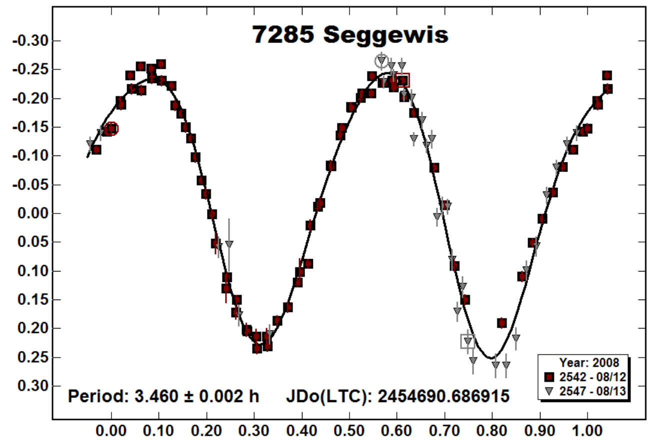

4868 Knushevia
Period: 4.45 ± 0.01 h JDo(LTC): 2454706.678239
Year: 2008
2565 - 08/28
2573 - 08/29
2576 - 08/31
2580 - 09/04

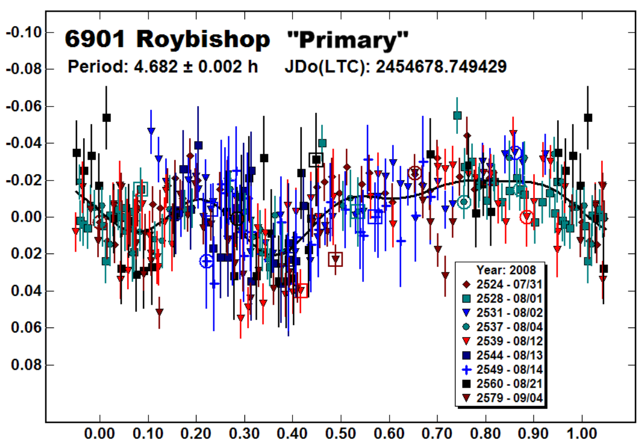

6271 Farmer
Period: 8.01 ± 0.01 h JDo(LTC): 2454728.697989
Year: 2008
2595 - 09/19
2603 - 09/22
2610 - 09/23
2616 - 09/24
2622 - 09/25
2631 - 09/26

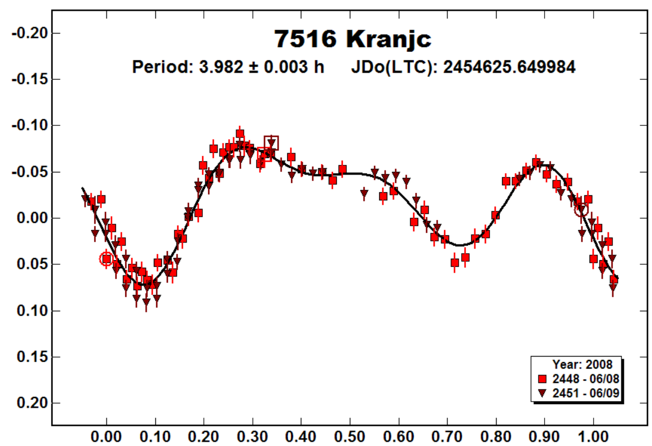

6602 Gilclark
Period: 4.574 ± 0.004 h JDo(LTC): 2454725.696540
Year: 2008
2584 - 09/16
2588 - 09/17
2591 - 09/18

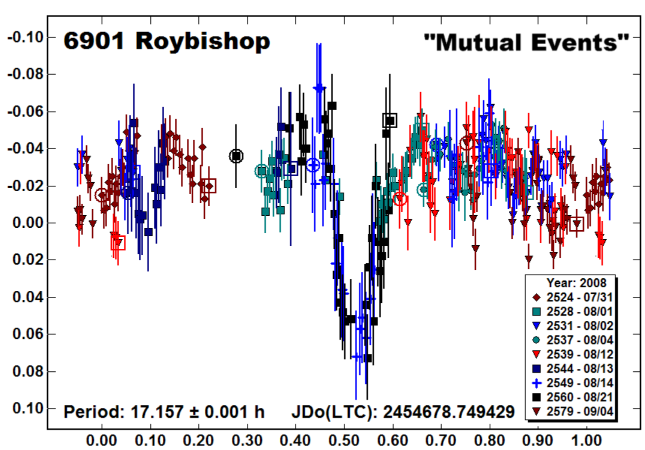

6911 Nancygreen
Period: 4.33 ± 0.01 h JDo(LTC): 2454725.728754
Year: 2008
2586 - 09/16
2587 - 09/17
2593 - 09/18

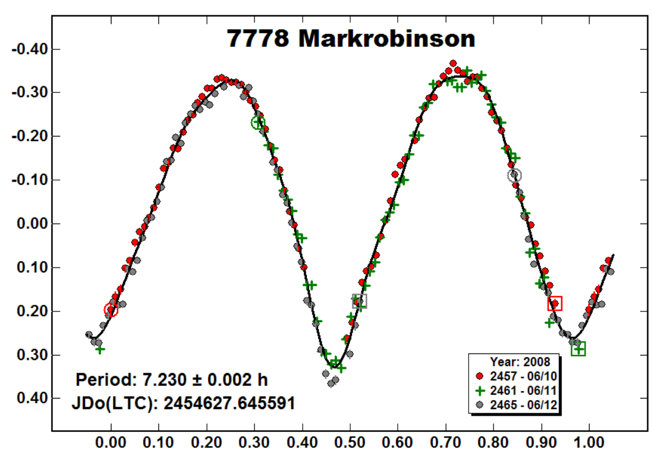

(6618) 1936 SO
Period: 8.297 ± 0.006 h JDo(LTC): 2454725.683163
Year: 2008
2585 - 09/16
2589 - 09/17
2592 - 09/18

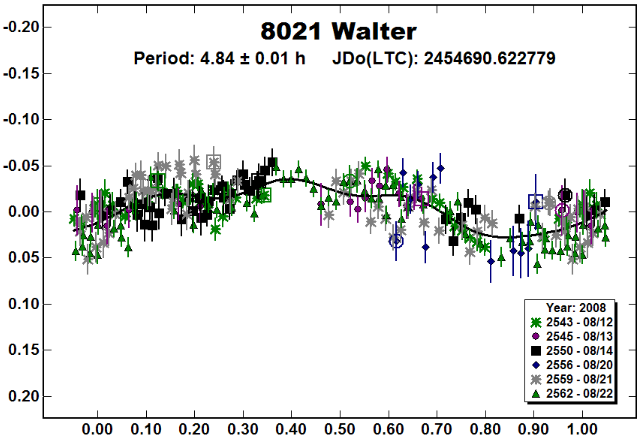

7285 Seggewis
Period: 3.460 ± 0.002 h JDo(LTC): 2454690.686915
Year: 2008
2542 - 08/12
2547 - 08/13

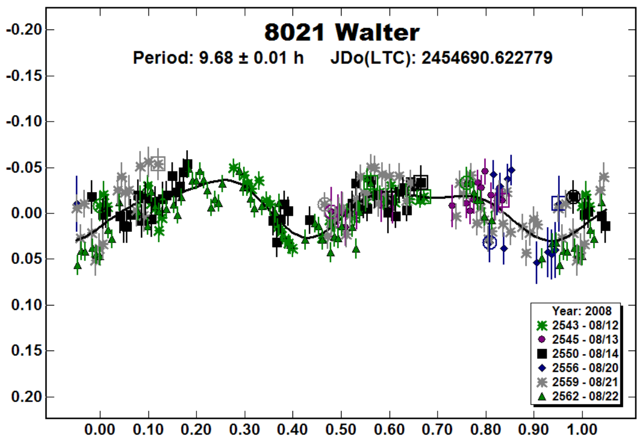

6901 Roybishop "Primary"
Period: 4.682 ± 0.002 h JDo(LTC): 2454678.749429
Year: 2008
2524 - 07/31
2528 - 08/01
2531 - 08/02
2537 - 08/04
2539 - 08/12
2544 - 08/13
2549 - 08/14
2560 - 08/21
2579 - 09/04

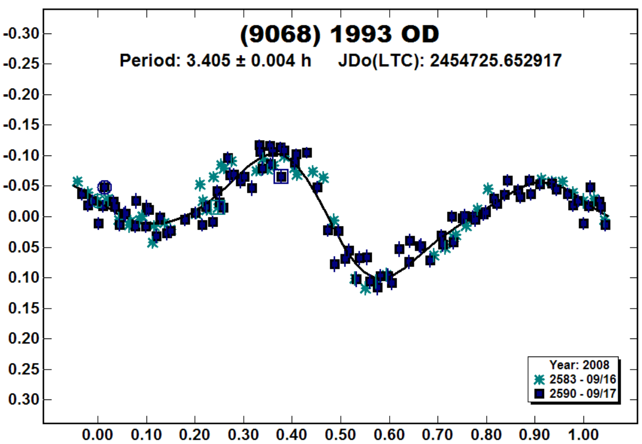

7516 Kranjc
Period: 3.982 ± 0.003 h JDo(LTC): 2454625.649984
Year: 2008
2448 - 06/08
2451 - 06/09

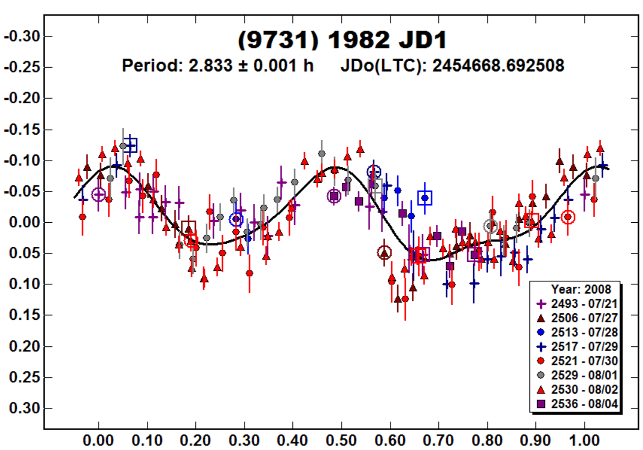

6901 Roybishop "Mutual Events"
Period: 17.157 ± 0.001 h JDo(LTC): 2454678.749429
Year: 2008
2524 - 07/31
2528 - 08/01
2531 - 08/02
2537 - 08/04
2539 - 08/12
2544 - 08/13
2549 - 08/14
2560 - 08/21
2579 - 09/04

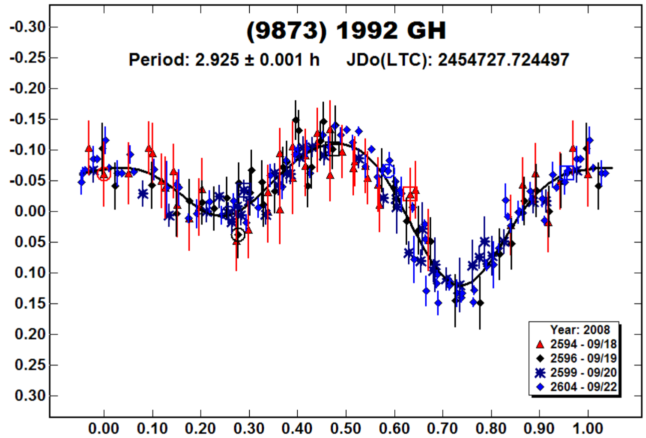

7778 Markrobinson
Period: 7.230 ± 0.002 h
JDo(LTC): 2454627.645591
Year: 2008
2457 - 06/10
2461 - 06/11
2465 - 06/12

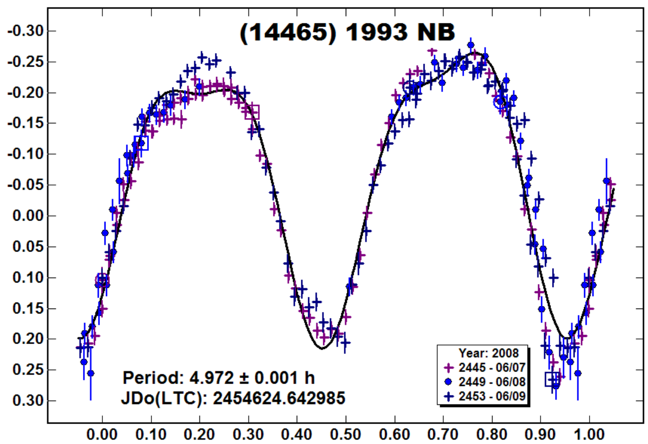

8021 Walter
Period: 4.84 ± 0.01 h JDo(LTC): 2454690.622779
Year: 2008
2543 - 08/12
2545 - 08/13
2550 - 08/14
2556 - 08/20
2559 - 08/21
2562 - 08/22

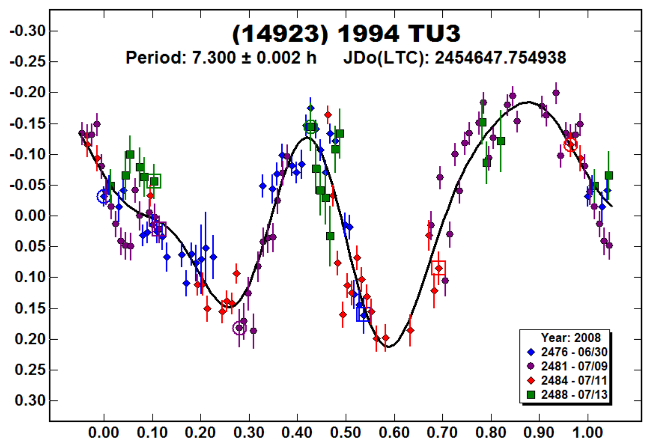

8021 Walter
Period: 9.68 ± 0.01 h JDo(LTC): 2454690.622779
Year: 2008
2543 - 08/12
2545 - 08/13
2550 - 08/14
2556 - 08/20
2559 - 08/21
2562 - 08/22

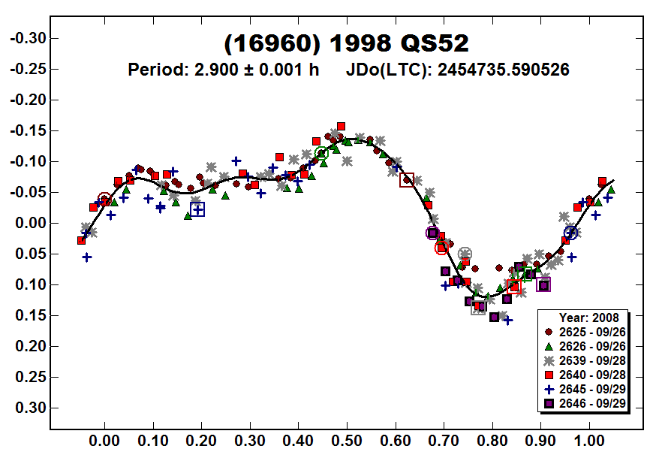

(9068) 1993 OD
Period: 3.405 ± 0.004 h JDo(LTC): 2454725.652917
Year: 2008
2583 - 09/16
2590 - 09/17

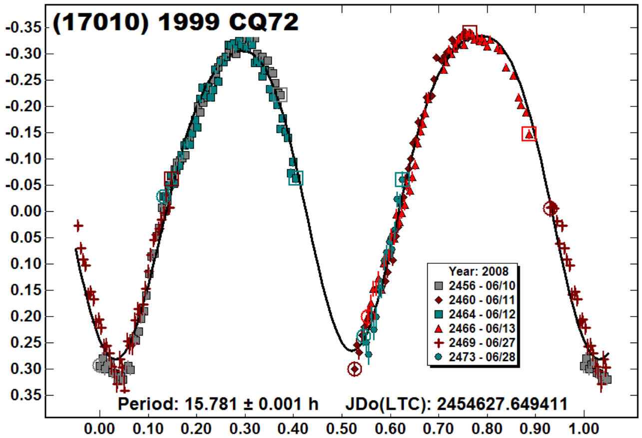

(9731) 1982 JD1
Period: 2.833 ± 0.001 h JDo(LTC): 2454668.692508
Year: 2008
2493 - 07/21
2506 - 07/27
2513 - 07/28
2517 - 07/29
2521 - 07/30
2529 - 08/01
2530 - 08/02
2536 - 08/04

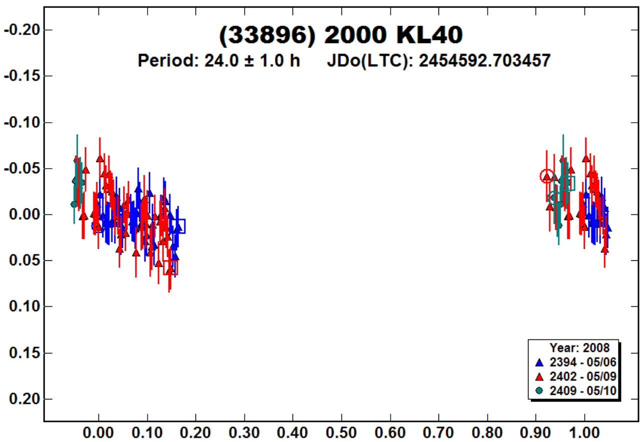

(9873) 1992 GH
Period: 2.925 ± 0.001 h JDo(LTC): 2454727.724497
Year: 2008
2594 - 09/18
2596 - 09/19
2599 - 09/20
2604 - 09/22

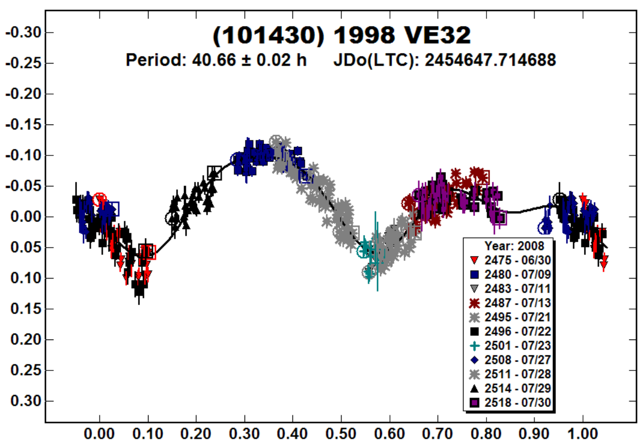

(14465) 1993 NB
Period: 4.972 ± 0.001 h
JDo(LTC): 2454624.642985
Year: 2008
2445 - 06/07
2449 - 06/08
2453 - 06/09

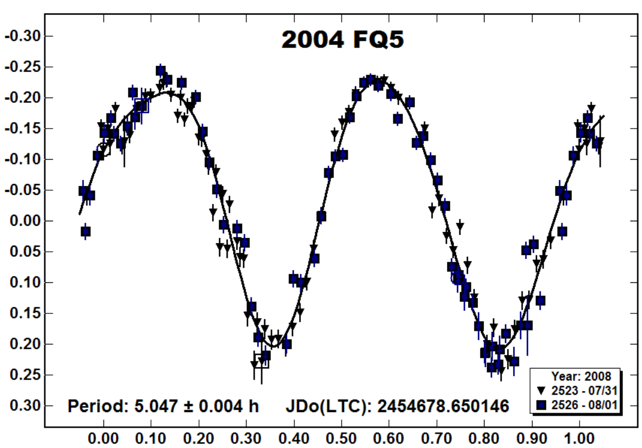

(14923) 1994 TU3
Period: 7.300 ± 0.002 h JDo(LTC): 2454647.754938
Year: 2008
2476 - 06/30
2481 - 07/09
2484 - 07/11
2488 - 07/13


(16960) 1998 QS52
Period: 2.900 ± 0.001 h JDo(LTC): 2454735.590526
Year: 2008
2625 - 09/26
2626 - 09/26
2639 - 09/28
2640 - 09/28
2645 - 09/29
2646 - 09/29









LIGHTCURVES OF EIGHT SELECTED ASTEROIDS FROM MODRA

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

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

(Received: 2008 October 10)

We present lightcurve analysis of asteroids 1989 Tatry, 2696 Magion, (5376) 1990 DD, 10166 Takarajima, 10207 Comeniana, (12798) 1995 WZ4, (14921) 1994 QA, and (50573) 2000 EX39.

Modra observatory with its 0.6-m f/5.5 reflector and AP8p CCD camera have devoted a considerable amount of observing time to relative photometry of asteroids with unknown or poorly known rotation periods. Targeted asteroids of magnitude 16 and fainter are not exceptions. The serious limitations are in exposures. They are 60 s at most (under special circumstances), but 30 s is used more frequently. In the latter case there is a possibility to add two consecutive images. No filter is used. The field of view of 25’ x 25’ is appropriate to link data from consecutive nights for main belt asteroids if needed. Some other asteroids are occasionally projected into the field of view.

1989 Tatry. The only motivation for observation of this target was the fact that it was one of the brightest asteroids discovered in Slovakia and its rotation period was not secure. Many sessions and several consecutive nights were used to link data. The first data indicated that the period could probably be near 35.1 h, though with some apparent deviations. Warner (2005) with his 3 sessions done two apparitions ago also provided the first estimate to be quite close to that value, namely 39.9 h. Our tentative idea was that this asteroid could be a tumbler, having two periods. As this still can be true, our careful analysis of all our data showed that the actual rotation period could be longer than previous estimates. However, we had to use very high value for the slope parameter, *G*, of the order of 1 (in comparison to default 0.15 used in most other cases) to obtain reasonable fit of all data. Despite this, some deviations are still present, but this fit is better than that for 35.1 h. Our imperfect linkages could contain systematic errors so the true value of *G* could be different.

2696 Magion is a slow rotator and probably also a tumbler. Except for the rotation period presented here, we cannot rule out a shorter one near 350 h. Due to the long period, only mean values of magnitudes per session were used.

(5376) 1990 DD. Its unambiguous rotation period was found using short sessions.

10166 Takarajima was observed near its opposition at about 18th magnitude as a byproduct target. Even though this was not a favourable apparition and despite the low precision of the measurements, the large amplitude of its lightcurve, long sessions, and quite rapid rotation led easily to an unambiguous solution.

10207 Comeniana was the first numbered Modra discovery. Though the eccentricity of its orbit is low, its recent apparition was favourable and the object was brighter than magnitude 17. However, since the amplitude of its lightcurve was low, we cannot rule out a few other periods than the one presented. For example, the period half as long also fits the data quite well.

(12798) 1995 WZ4 was also a byproduct target brighter than magnitude 17 in its last favourable apparition. The rotation period and amplitude of the lightcurve could place the object into the category of potential binaries, but our data are too noisy for the study of possible tiny attenuations. We could see no apparent attenuation exceeding 0.06 mag.

(14921) 1994 QA. The rotation period was determined unambiguously close to 12.910 h. Deviations from the smooth lightcurve were present in the data. In order to reduce them as much as possible, we used a very low value for the slope parameter, i.e., $G = -0.25$.

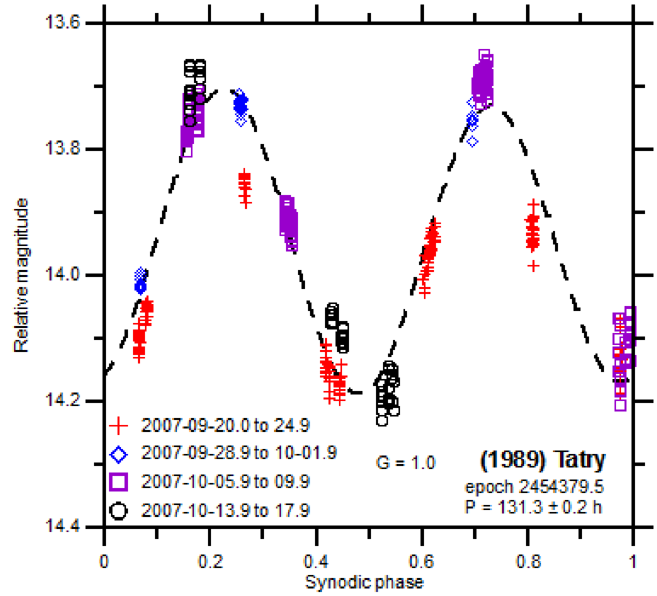
(50573) 2000 EX39. Two long sessions from consecutive nights led to the unambiguous rotation period of 3.99 ± 0.01 h. Later on, when the object was observed again along with another target, we hoped to refine the period. However, two close periods could be made to fit the data. In addition to the one we prefer as the more probable period and given here, there is another one at 4.0015 h. The small ambiguity came from the low amplitude of the lightcurve, scatter of some data, short new sessions, and a long interval between the old and new sessions.

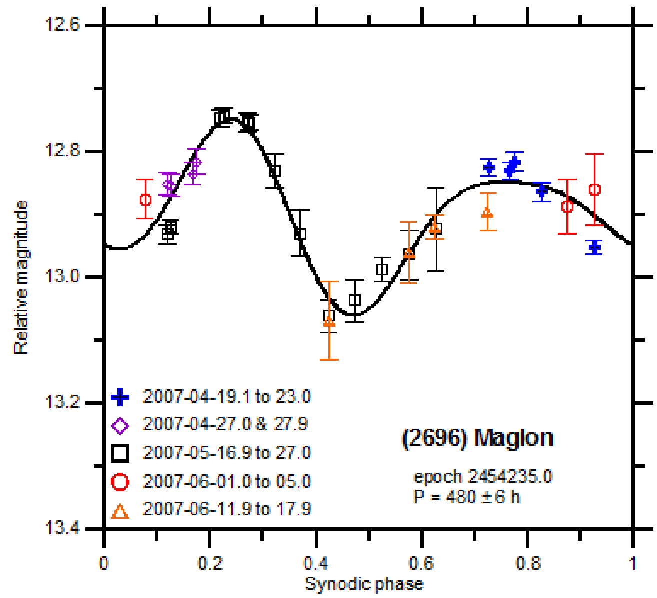
Acknowledgements

We are grateful to Petr Pravec, Ondřejov Observatory, Czech Republic, for his ALC software used in data analysis. The work was supported by the Slovak Grant Agency for Science VEGA, Grant 1/3074/06 and the Grant Agency of the Czech Republic, Grant 205/05/0604.

References

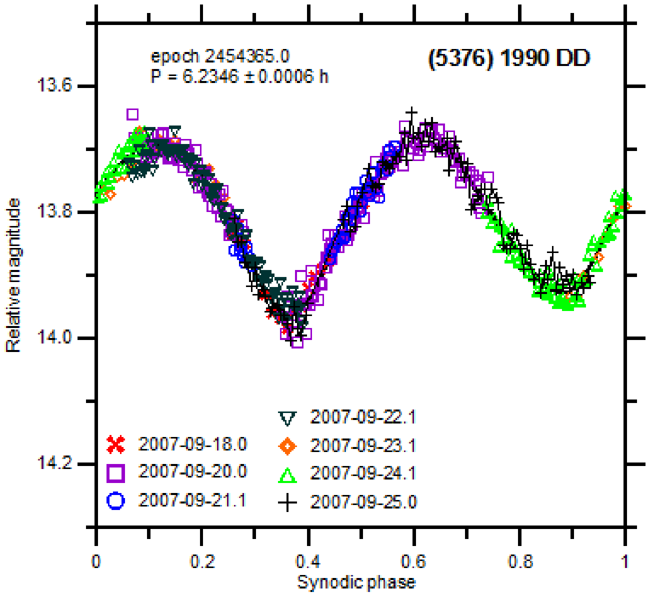
Warner, B. D. (2005). "Asteroid lightcurve analysis at the Palmer Divide Observatory: Winter 2004-2005." *Minor Planet Bulletin* **32**, 54-58.

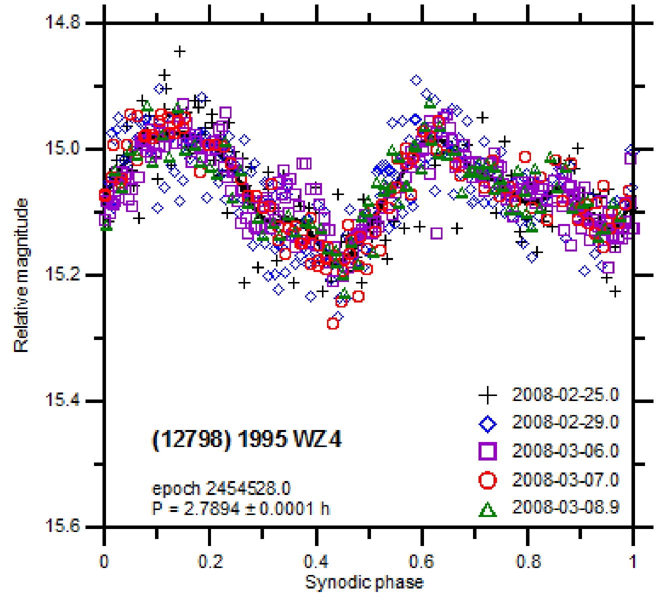


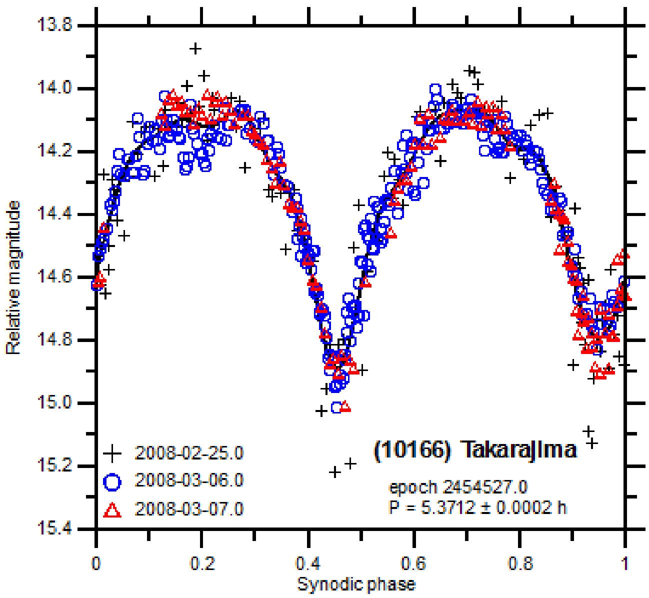


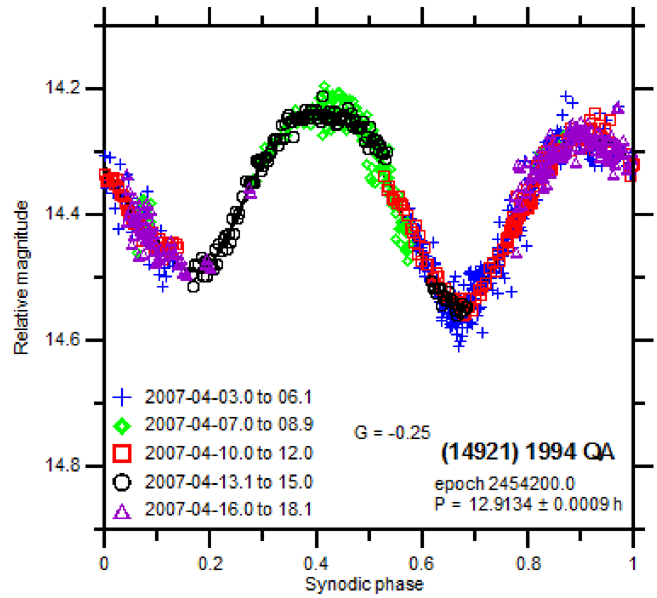
Number	Name	Dates yyyy mm/dd	Phases deg	LPAB deg	BPAB deg	Period [h]	Amp [mag]
1989	Tatry	2007 09/20-10/20	2.5, 13.3	359	-4	131.3 ± 0.2	0.5
2696	Magion	2007 04/19-06/18	7.3, 21.3	211	18	480 ± 6	0.31
(5376)	1990 DD	2007 09/18-25	6.4, 8.6	6	9	6.2346 ± 0.0006	0.28
10166	Takarajima	2008 02/25-03/07	1.9, 5.3	168	5	5.3712 ± 0.0002	0.84
10207	Comeniana	2008 09/04-13	3.2, 6.2	351	5	12.84 ± 0.01	0.10
(12798)	1995 WZ4	2008 02/25-03/09	2.7, 7.2	168	5	2.7894 ± 0.0001	0.21
(14921)	1994 QA	2007 04/03-04/18	18.6, 22.4	210	27	12.9134 ± 0.0009	0.32
(50573)	2000 EX39	2008 03/06-04/06	2.7, 14.5	169	3	3.9789 ± 0.0001	0.19

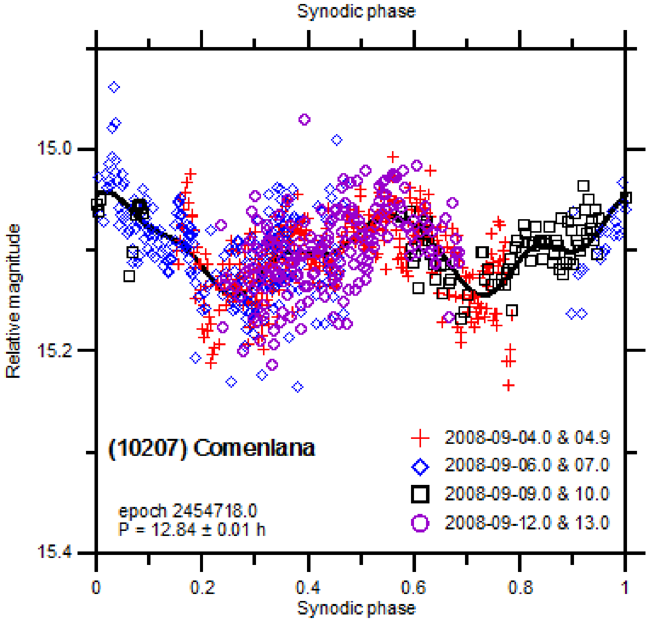
Table I. Asteroids with observation dates, minimum and maximum solar phase angles, phase angle bisector values, derived synodic rotation periods with uncertainties, and lightcurve amplitudes.

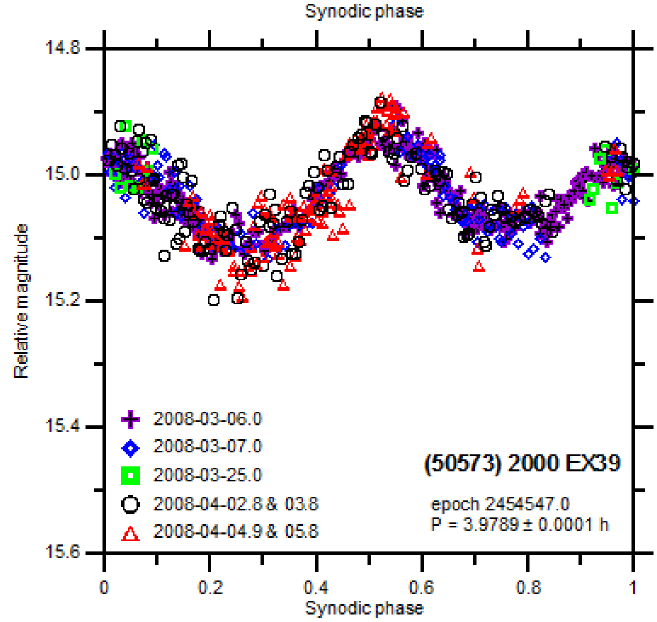

epoch 2454365.0
P = 6.2346 ± 0.0006 h
(5376) 1990 DD
13.6
13.8
14.0
14.2
Relative magnitude
2007-09-18.0
2007-09-20.0
2007-09-21.1
2007-09-22.1
2007-09-23.1
2007-09-24.1
2007-09-25.0
0
0.2
0.4
0.6
0.8
1
Synodic phase


14.8
15.0
15.2
15.4
15.6
Relative magnitude
(12798) 1995 WZ4
epoch 2454528.0
P = 2.7894 ± 0.0001 h
2008-02-25.0
2008-02-29.0
2008-03-06.0
2008-03-07.0
2008-03-08.9
0
0.2
0.4
0.6
0.8
1
Synodic phase


13.8
14.0
14.2
14.4
14.6
14.8
15.0
15.2
15.4
Relative magnitude
2008-02-25.0
2008-03-06.0
2008-03-07.0
(10166) Takarajima
epoch 2454527.0
P = 5.3712 ± 0.0002 h
0
0.2
0.4
0.6
0.8
1
Synodic phase


14.2
14.4
14.6
14.8
Relative magnitude
2007-04-03.0 to 06.1
2007-04-07.0 to 08.9
2007-04-10.0 to 12.0
2007-04-13.1 to 15.0
2007-04-16.0 to 18.1
G = -0.25
(14921) 1994 QA
epoch 2454200.0
P = 12.9134 ± 0.0009 h
0
0.2
0.4
0.6
0.8
1
Synodic phase


15.0
15.2
15.4
Relative magnitude
(10207) Comeniana
epoch 2454718.0
P = 12.84 ± 0.01 h
2008-09-04.0 & 04.9
2008-09-06.0 & 07.0
2008-09-09.0 & 10.0
2008-09-12.0 & 13.0
0
0.2
0.4
0.6
0.8
1
Synodic phase


14.8
15.0
15.2
15.4
15.6
Relative magnitude
2008-03-06.0
2008-03-07.0
2008-03-25.0
2008-04-02.8 & 03.8
2008-04-04.9 & 05.8
(50573) 2000 EX39
epoch 2454547.0
P = 3.9789 ± 0.0001 h
0
0.2
0.4
0.6
0.8
1
Synodic phase

PHOTOMETRIC OBSERVATIONS OF FIVE NEAR-EARTH ASTEROIDS: (31221) 1998 BP26, (96315) 1997 AP10, (164184) 2004 BF68, 2006 VV2, AND 2006 XY

Carl W. Hergenrother and Robert J. Whiteley
Lunar and Planetary Laboratory
University of Arizona
Tucson, AZ 85721
chergen@lpl.arizona.edu

Eric J. Christensen
Association of Universities for Research in Astronomy
950 N. Cherry Ave.
Tucson, AZ 85719

(Received: 2008 August 13)

Lightcurves of five near-Earth asteroids were obtained at several University of Arizona telescopes. *BVRI* broadband photometry was conducted for three of the objects allowing taxonomic classification. One of the five objects, 2006 XY, is a small rapid rotator with a period of 0.0830 ± 0.0007 h.

Several telescopes operated by the University of Arizona were used for near-Earth asteroid lightcurve and color observations. The Kuiper 1.54-m cassegrain reflector on Mount Bigelow was equipped with a Fairchild CCD486 4096x4097 detector with 15 μm pixels. Images were binned 3x3 yielding an effective plate scale of 0.45 arc seconds per pixel. The Vatican Advanced Technology Telescope (VATT) Lennon 1.8-m cassegrain reflector on Mount Graham was equipped with a Loral 2048x2048 CCD with 15μm pixels. As with the Kuiper telescope, 3x3 binning was used resulting in an effective plate scale of 0.56 arc seconds per pixel. The coarser plate scale was used since the seeing on Mounts Bigelow and Graham was routinely in the range of 1-2 arc seconds. The resulting smaller number of pixels per image also allowed a much faster readout time. The two telescopes were tracked to follow the non-sidereal motions of each asteroid. The Mount Lemmon Survey 1.5-m cassegrain reflector on Mount Lemmon is equipped with an ImagerLabs 4096x4096 CCD with 15 μm pixels yielding a plate scale of 0.97 arc seconds per pixel. Pixel binning was not used with this system. The telescope systems used to observe each object is listed in Table I.

Data reduction included the standard procedure of zero subtraction and use of flat field images produced from the data and twilight images. All data reduction was done within the IRAF IMRED package. Filter photometry was conducted on the Kuiper and VATT telescopes with Harris *BVR* and Arizona *I* filters. The Arizona *I* conforms with the Kron-Cousins system. Multiple stars from Landolt (1992) were observed at various airmasses from 1.1 to 2.5 airmasses in each filter. Zero points and extinction coefficients were calculated in individual filters for each night of observation. All photometric observations of the standard stars and asteroids were measured with the IRAF DIGIPHOT package. Variable circular apertures of 2 times the measured FWHM of each image were used. Varying the aperture to fit the FWHM allowed variation in the seeing to be compensated for. Though the seeing was routinely in the 1.0-2.5 arc seconds range, seeing variations from image to image could be substantial. Sky background was measured with a circular ring aperture of radius 20 pixels and width of 5 pixels. The sky aperture was centered on the position of the measured source. Petr Pravec's Asteroid Lightcurve (ALC) software (version 0.96) was used for period determination. Absolute magnitude and orbital information are listed in Table I. Nightly observing circumstances for each object are listed in Table II. Lightcurve and color photometry results are tabulated in table III.

<u>(31221) 1998 BP26.</u> Photometry was conducted on two nights in 2007 February. Lightcurve analysis yielded a rotation period of 2.44 ± 0.01 h and amplitude of 0.07 mag. Derived color indices of *B-V* = +0.87 ± 0.04, *V-R* = +0.48 ± 0.03, and *V-I* = +0.92 ± 0.04 are consistent with an S taxonomy.

<u>(96315) 1997 AP10.</u> Photometry was conducted on two nights in 2006 February and March. A full rotation period was not observed on either night. This fact, combined with a 5-night gap between observations, introduced a large amount of uncertainty in the period. Since the number of rotations between observations on 2006 Feb 27 and Mar 3 is not known, a number of rotation periods are possible. Manual inspection of phased lightcurves identified the following possible periods: 5.38, 5.53, 5.70, 5.87, 6.06, 6.26, and 6.71 h. The most likely period and amplitude based on manual inspection is 5.872 ± 0.002 h and 0.96 mag. These are the values listed in Table III. Further lightcurve observations of this object are desirable.

<u>(164184) 2004 BF68.</u> Photometry conducted over two nights in 2006 June yielded a rotation period of 5.66 ± 0.02 h and amplitude of 0.67 mag. Neither of the two nights covered an entire rotation. The derived period is based on the assumption that the lightcurve possesses two maxima and minima. If the lightcurve possesses more than two maxima or minima then a period greater than ~7 hours is possible. Derived color indices of *B-V* = +0.77 ± 0.04, *V-R* = +0.36 ± 0.02, and *V-I* = +0.62 ± 0.02 are consistent with a C taxonomy.

<u>2006 VV2.</u> Lightcurve and color observations of 2006 VV2 were obtained in support of a ground-based radar campaign (Warner et al. 2007). During the course of the radar observations, an orbiting secondary was observed (Benner et al. 2007). There is no clear evidence of a binary companion in our data.

Photometry conducted during the night of 2007 Mar 30 yielded a rotation period of 2.425 ± 0.019 h and amplitude of 0.43 mag. Over the course of a single night a change in the shape of the lightcurve was observed, this is most evident in the amplitude of the lesser maxima located at a rotational phase of 0.0 and 1.0 (see Fig. 4). The change in lightcurve shape may be due to the rapidly changing aspect angle as the object passed close to the Earth during the night of observation (minimum Δ = 0.023 AU). Our period is consistent with those reported by Benishek (2007) [2.410 ± 0.005 hr], Betzler et al. (2008) [2.359 ± 0.002 h], Klotz and Behrend (2007) [2.454 ± 0.002 h], Masi (2007) [2.4302 h], and Oey (2007) [2.430 ± 0.002 h].

Table I

Object		H	a	e	i	NEO Type
(31121)	1998 BP26	17.3	1.723	0.257	20.2	Amor
(96315)	1997 AP10	17.0	1.443	0.643	17.0	Apollo
(164184)	2004 BF68	19.4	1.627	0.453	4.6	Apollo
	2006 VV2	16.8	2.391	0.603	23.6	Apollo
	2006 XY	24.0	1.498	0.338	24.0	Apollo

Derived color indices of *B-V* = +0.79 ± 0.01, *V-R* = +0.45 ± 0.01, and *V-I* = +0.82 ± 0.01 are consistent with an S taxonomy. Betzler et al. (2008) found a color index of *V-R* = +0.64 ± 0.07. Though the two derived *V-R* indices differ by ~0.19 magnitudes, they are both consistent with an S taxonomy.

<u>2006 XY.</u> The smallest of the five objects reported in this paper, 2006 XY has the shortest rotation period. This H of 24.0 object was observed during the night of 2006 Dec 16 to have a rotation period of 0.0830 ± 0.0005 h or 298.8 ± 1.8 s. Such rapid rotation is common among objects with H ≥ 21.5 and diameters ≤ 200 meters (Pravec et al. 2002, Whiteley et al., 2002).

Acknowledgement

We would like to thank the University of Arizona Observatories, the Vatican Observatory, and the Catalina Sky Survey for allowing the use of their facilities. We are also grateful to Petr Pravec for providing his ALC software. Funding for this research has been provided through a grant from the NASA Planetary Astronomy program.

References

Benishek, V. (2007). “Photometry of Asteroids at Belgrade Astronomical Observatory”. http://beoastrophot.freehostia.com/2006VV2.html

Benner, L.A., Busch, M.W., Nolan, M.C., Ostro, S.J., Giorgini, J.D., Rose, R., Jao, J.S., Black, G.J., Carter, L.M., Slade, M.A., Jurgens, R.F., and Hine, A.A. (2007). “Radar Images of Binary Near-Earth Asteroid 2006 VV2”. *Bull. Amer. Astron. Soc*. **38**, 432.

Betzler, A.S. and Projecto “Descobrindo o Céu” (2008). “Photometric Observations of 2006 VV2 in the State of Bahia-Brazil.” *Minor Planet Bulletin* **35**, 15-16.

Klotz, A. and Behrend, R. (2007) “Courbes de rotation d’astéroïdes et de comètes, CdR”. http://obswww.unige.ch/~behrend/page5cou.html#06v02v

Landolt, A.U. (1992). “*UBVRI* Photometric Standard Stars in the Magnitude Range 11.5 < *V* < 16.0 Around the Celestial Equator.” *Astron. J.* **104**, 340-371.

Masi, G. (2007). “2006 VV2 March 2007 close approach”. http://virtualtelescope.bellatrixobservatory.org/2006vv2.html

Oey, J. (2007). “Lightcurves 2007.” http://minorplanet.haoeydental.com.au/light_curves_2007.htm

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

Whiteley, R.J., Tholen, D.J., and Hergenrother, C.W. (2002). “Lightcurve Analysis of Four New Monolithic Fast-Rotating Asteroids.” *Icarus* **157**, 139-154.

Warner, B.D., Harris, A.W., Pravec, P., Kaasalainen, M., and Benner, L.A.M. (2007). “Lightcurve Photometry Opportunities April-June 2007.” *Minor Planet Bulletin* **34**, 50-51.

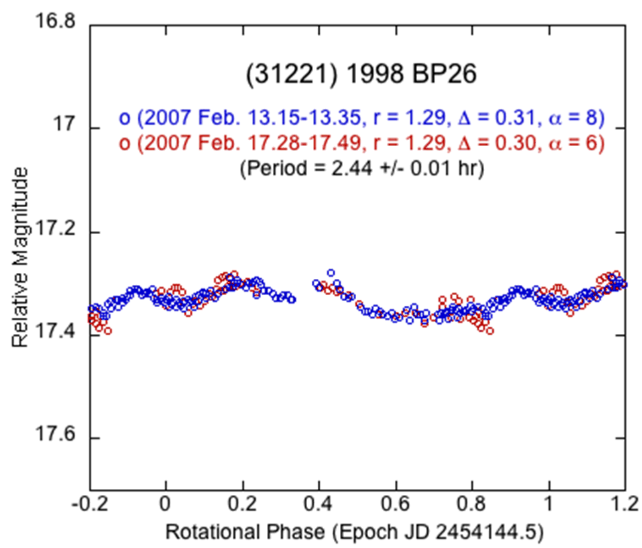


Fig. 1. Relative lightcurve of (31221) 1998 BP26 phased to 2.44 h.

Table II

Object		Date YYYY/MM/DD	r (AU)	Delta (AU)	Phase (Deg)	Bpab	Lpab	Filter	Telescope
(31121)	1998 BP26	2007/02/13	1.288	0.305	8.0	144.90	+6.42	R	Kuiper 1.54-m
(31221)	1998 BP26	2007/02/17	1.285	0.299	5.6	145.75	+3.73	R	Kuiper 1.54-m
(96315)	1997 AP10	2006/02/27	1.542	0.567	10.4	150.99	-8.25	R	VATT 1.8-m
(96315)	1997 AP10	2006/03/03	1.508	0.542	14.5	150.09	-8.66	BVRI	VATT 1.8-m
(164184)	2004 BF68	2006/06/19	1.121	0.189	52.1	298.16	+17.18	BVRI	Kuiper 1.54-m
(164184)	2004 BF68	2006/06/20	1.128	0.193	50.3	298.22	+16.95	R	Kuiper 1.54-m
	2006 VV2	2007/03/30	1.011	0.024	58.8	165.42	+19.84	BVRI	Kuiper 1.54-m
	2006 XY	2006/12/16	0.991	0.014	61.3	55.91	-14.35	clear	Mount Lemmon 1.5-m

Table III

Object		Period (hours)		Amp (mag)	B-V	V-R	V-I	Tax. Class
(31121)	1998 BP26	2.44	±0.01	0.07	+0.87±0.04	+0.48±0.03	+0.92±0.04	S
(96315)	1997 AP10	5.872	±0.002	0.96				
(164184)	2004 BF68	5.568	±0.004	0.67	+0.77±0.04	+0.36±0.02	+0.62±0.02	C
	2006 VV2	2.425	±0.001	0.43	+0.79±0.01	+0.45±0.01	+0.82±0.01	S

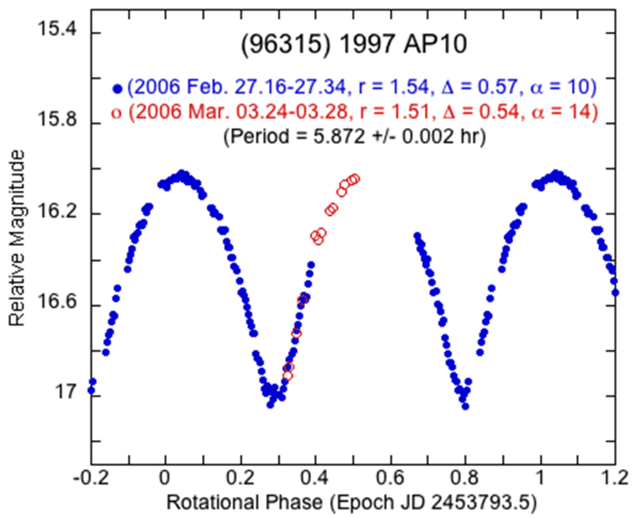


Fig. 2. Relative lightcurve of (96315) 1997 AP10 phased to a period of 5.872 h.

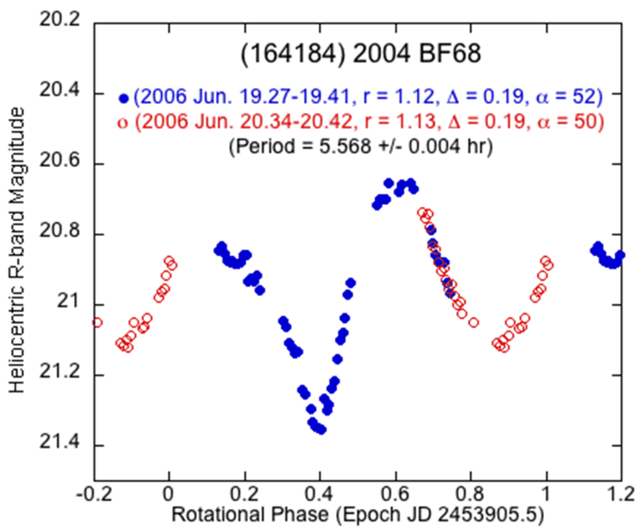


Fig. 3. Heliocentric lightcurve of (164184) 2004 BF68 reduced to heliocentric and geocentric distances of 1 AU. The lightcurve is phased to period of 5.568 h.

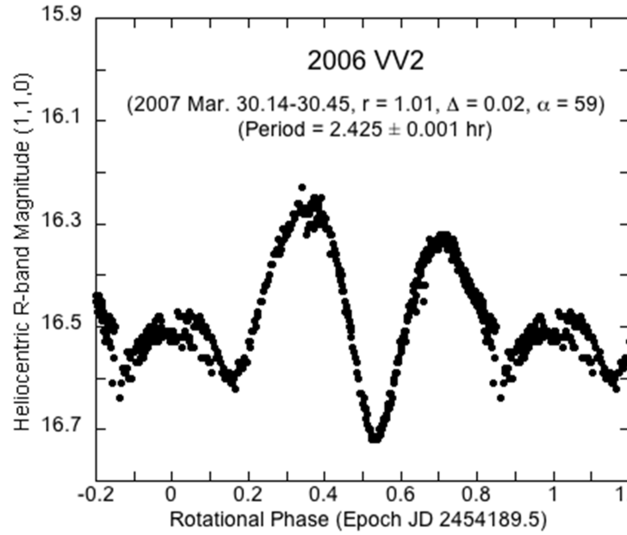


Fig. 4. Heliocentric lightcurve of 2006 VV2 reduced to heliocentric and geocentric distances of 1 AU. The lightcurve is phased to period of 2.425 h.

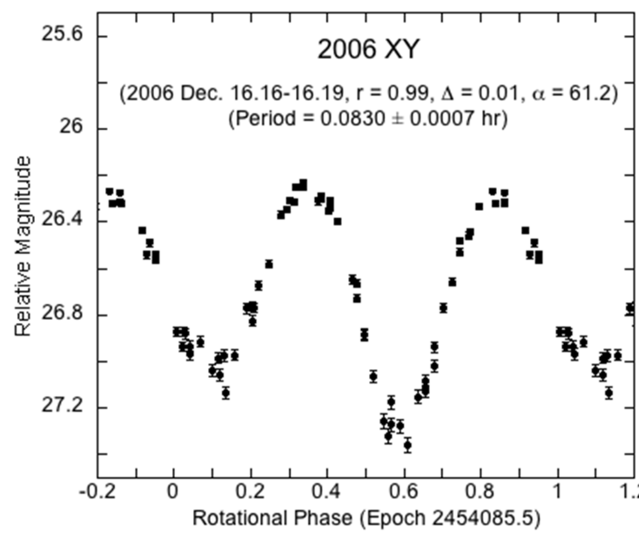


Fig. 5. Relative lightcurve of 2006 XY phased to a period of 0.0830 h.

ASTEROIDS OBSERVED FROM GMARS AND SANTANA OBSERVATORIES

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

(Received: 2008 October 5)

Lightcurve period and amplitude results from Santana and GMARS Observatories are reported for 2008 June to September: 1472 Muonio, 8.706 ± 0.002 h and 0.50 mag; 2845 Franklinken, 114 ± 1 h and 0.8 mag; and 4533 Orth (> 24 hours).

The author operates telescopes at two observatories. Santana Observatory (MPC Code 646) is located in Rancho Cucamonga, California and GMARS (Goat Mountain Astronomical Research Station, MPC G79) located at the Riverside Astronomical Society's observing site. Details of the equipment are in Stephens (2006). All of the targets were chosen from the list of asteroid photometry opportunities published by Brian Warner and Alan Harris on the Collaborative Asteroid Lightcurve Link (CALL) website (Harris 2008). The author measured the images using *MPO Canopus*, which employs differential aperture photometry to produce the raw data. Period analysis was done using *Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (1989).

1472 Muonio. Images were acquired using the 0.30-m SCT at Santana Observatory with a SBIG STL-1001 CCD camera.

2845 Franklinken. Due to the faintness of the target, data could be acquired only by using the 0.35-m SCT at GMARS Observatory with a SBIG STL-1001 CCD camera. The data were linked to an internal standard using a method developed by Warner (2007) and described by Stephens (2008) included in the latest release of *Canopus*.

4533 Orth. All of the data were obtained using a 0.30-m SCT at Santana Observatory with a SBIG STL-1001 CCD camera and were internally linked. No period could be determined from the limited data obtained. However, the gradually declining slope suggests a period of several days.

Acknowledgements

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

References

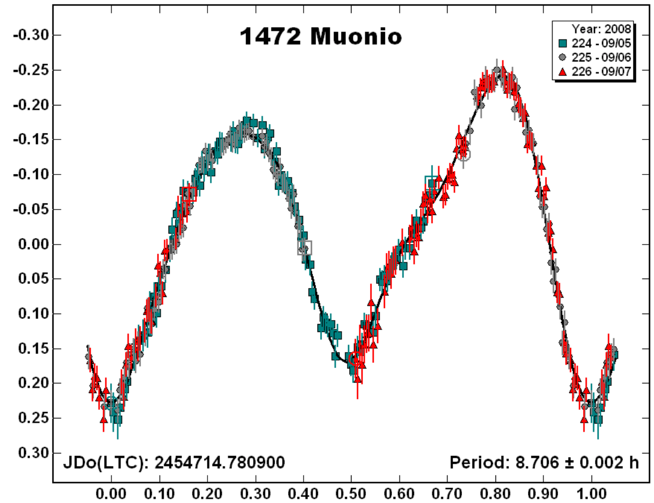
Harris, A.W., Young, J.W., Bowell, E., Martin, L.J., Millis, R.L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H.J., Debehogne, H., and Zeigler, K.W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

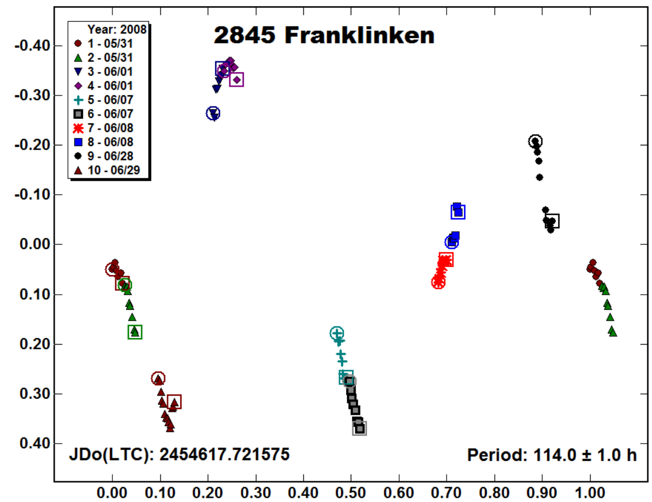
Harris, A.W., Warner, B.D., and Pravec, P. (2008). "Asteroid Lightcurve Parameters." *http://www.MinorPlanetObserver.com/astlc/default.htm.*

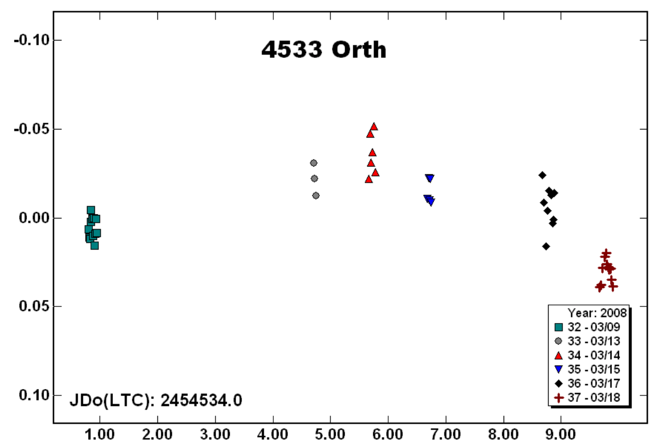
Stephens, R.D. (2006). "Asteroid Lightcurve Photometry from Santana and GMARS Observatories – September to December 2006." *Minor Planet Bulletin* **34**, 31-32.

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

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







Asteroid	Dates (mm/dd) 2008	Sess	Phase	L_{PAB}	B_{PAB}	Per (h)	PE	Amp	AE
1472 Muonio	09/05-09/07	3	20.4, 19.4	10.5, 10.9	-4.9, -4.8	8.706	0.002	0.50	0.02
2845 Franklinken	05/31-06/29	6	6.5, 16.2	252.5, 259.9	8.9, 7.9	114	1	0.80	0.05
4533 Orth	03/09-03/18	6	3.9, 5.8	169.6, 169.8	-5.8, -3.8	> 24			

LIGHTCURVE ANALYSIS OF 7829 JAROFF

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

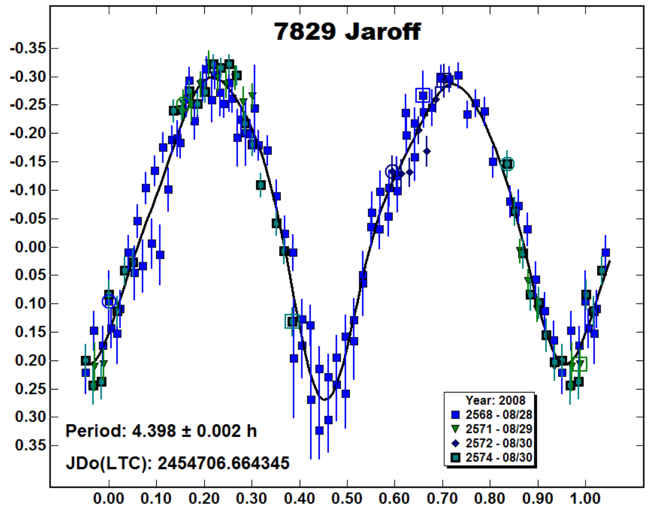
Robert D. Stephens
Goat Mountain Astronomical Research Station (GMARS)
Rancho Cucamonga, CA 91737 USA

(Received: 2008 September 20)

The Hungaria asteroid, 7829 Jarofff, was observed photometrically from Palmer Divide and GMARS Observatories in 2008 August. The synodic period of the lightcurve was found to be 4.398 ± 0.002 h and its amplitude 0.50 ± 0.03 mag.

The authors observed the Hungaria asteroid, 7829 Jaroff, as part of the Palmer Divide Observatory's on-going study of that asteroid group/family. PDO provided observations on 2008 Aug. 28-30 and GMARS added data that extended the Aug. 30 set by another three hours. This assured finding a unique period for the asteroid besides providing complete coverage of the lightcurve.

Images at PDO were taken using a 0.35-m SCT and FLI-1001 camera. Exposures were 90 seconds. GMARS data were collected using a 0.35-m SCT and SBIG STL-1001E. Exposures were 180 seconds. All exposures were unfiltered. Both authors used *MPO Canopus* to measure the dark and flat processed images using aperture photometry. Night-to-night calibration to a common zero point was done using the 2MASS-BVRI conversions developed by Warner (2007) and as described by Stephens (2008). Period analysis was also done in *Canopus*, using the Fourier algorithm (FALC) developed by Alan Harris (Harris *et al.* 1989). That analysis found a synodic period of 4.398 ± 0.002 h and a lightcurve amplitude of 0.50 ± 0.03 mag. We could find no previously reported lightcurve parameters for this asteroid.



Acknowledgements

Funding for observations at the Palmer Divide Observatory is provided by NASA grant NNG06GI32G, National Science Foundation grant AST-0607505, and by a Gene Shoemaker NEO Grant from the Planetary Society.

References

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

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

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

MINOR PLANETS AT UNUSUALLY FAVORABLE ELONGATIONS IN 2009

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

(Received: 2008 September 7)

A list is presented of minor planets which are much brighter than usual at their 2009 apparitions.

[Editor's Note: Congratulations to Professor Pilcher for the 35th consecutive year in which this essential observer's guide has been prepared! On behalf of all readers, we thank you for your multitude of contributions to further asteroid science. –RPB]

The minor planets in the lists which follow will be much brighter at their 2009 apparitions than at their average distances at maximum elongation. Many years may pass before these planets will be again as bright as in 2009. Observers are encouraged to give special attention to those which lie near the limit of their equipment.

There will be approaches closer than 0.03 AU by (68216) 2001 CV26, (136617) 1994 CC, (136849) 1998 CS1, and (152664) 1998 FW4, and closer than 0.2 AU by (17274) 2000 LC16, (143651) 2003 QO104, and (159402) 1999 AP10 in calendar 2009. These events are especially worthy of observational scrutiny.

These lists have been prepared by an examination of the maximum elongation circumstances of minor planets computed by the author for all years through 2060 with a full perturbation program written by Dr. John Reed, and to whom he expresses his thanks. Elements are from EMP 1992, except that for all planets for which new or improved elements have been published subsequently in the Minor Planet Circulars or in electronic form, the newer elements have been used. Planetary positions are from the JPL DE-200 ephemeris, courtesy of Dr. E. Myles Standish. Dr. Reed's ephemeris generating program, a list of minor planet elements, and the JPL planetary ephemeris are freeware which may be obtained from the author by sending a writeable CD ROM and stamped, addressed return mailer. They cannot be downloaded directly over the Internet.

Any planets whose brightest magnitudes near the time of maximum elongation vary by at least 2.0 in this interval and in 2009 will be within 0.3 of the brightest occurring, or vary by at least 3.0 and in 2009 will be within 0.5 of the brightest occurring; and which are visual magnitude 14.5 or brighter, are included. For planets brighter than visual magnitude 13.5, which are within the range of a large number of observers, these standards have been relaxed somewhat to include a larger number of planets. Magnitudes have been computed from the updated magnitude parameters published in MPC28104-28116, on 1996 Nov. 25, or more recently in the Minor Planet Circulars.

Oppositions may be in right ascension or in celestial longitude. Here we use still a third representation, maximum elongation from the Sun, instead of opposition. Though unconventional, it has the advantage that many close approaches do not involve actual opposition to the Sun near the time of minimum distance and greatest brightness and are missed by an opposition-based program. Other data are also provided according to the following tabular

listings: Minor planet number, date of maximum elongation from the Sun in format yyyy/mm/dd, maximum elongation in degrees, right ascension on date of maximum elongation, declination on date of maximum elongation, both in J2000 coordinates, date of brightest magnitude in format yyyy/mm/dd, brightest magnitude, date of minimum distance in format yyyy/mm/dd, and minimum distance in AU.

Users should note that when the maximum elongation is about 177° or greater, the brightest magnitude is sharply peaked due to enhanced brightening near zero phase angle. Even as near as 10 days before or after minimum magnitude the magnitude is generally about 0.4 greater. This effect takes place in greater time interval for smaller maximum elongations. There is some interest in very small minimum phase angles. For maximum elongations E near 180° at Earth distance Δ, an approximate formula for the minimum phase angle (ϕ) is

$$\phi = (180°\text{-}E) / (\Delta+1) \qquad (1)$$

This represents the 35th consecutive annual appearance of my announcement of minor planets becoming unusually bright in the coming year. Its first appearance was in *MPB* **2**, pp. 13-14, under the title "Minor Planets at Highly Favorable Opposition in 1975." In the early years it was entirely prepared by manual inspection of all of the fewer than 2000 asteroids then numbered. More recently the author used increases in computing power, plus an ephemeris program with full perturbations written by Dr. John Reed, to compute the circumstances for each apparition between the years 1950 and 2060 and examine these for favorable events. The author decided to base this on maximum elongation from the Sun rather than opposition, and hence the name of the annual announcement was changed to the current "Minor Planets at Unusually Favorable Elongations." As the rapidly increasing number of numbered minor planets exceeded the author's resources for inspecting them, he decided to restrict his list to minor planets reaching magnitude 14.5 or brighter. By the year 2009 numbering of main belt asteroids ever achieving magnitude 14.5 is complete, although Earth- approachers occasionally becoming this bright continue to be found and numbered.

Table I. Numerical Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
3	2009/09/21	176.4°	23h59m	- 3°	2009/09/21	7.7	2009/09/29	1.199
14	2009/04/21	166.2°	14h12m	+ 1°	2009/04/20	9.0	2009/04/18	1.199
18	2009/10/09	163.5°	1h31m	- 8°	2009/10/09	7.9	2009/10/08	0.814
26	2009/05/18	178.7°	15h41m	-20°	2009/05/18	10.3	2009/05/19	1.414
27	2009/02/04	177.9°	9h13m	+18°	2009/02/04	8.7	2009/01/30	1.035
33	2009/07/29	176.7°	20h39m	-21°	2009/07/30	10.2	2009/08/08	0.990
34	2009/03/23	179.5°	12h 8m	- 1°	2009/03/23	11.3	2009/03/22	1.426
38	2009/12/10	172.7°	5h 7m	+30°	2009/12/11	11.2	2009/12/13	1.372
42	2009/09/08	162.6°	23h38m	-21°	2009/09/06	9.4	2009/09/02	0.941
52	2009/12/18	172.2°	5h45m	+15°	2009/12/18	10.1	2009/12/19	1.817
62	2009/10/05	176.7°	0h51m	+ 1°	2009/10/05	12.1	2009/10/07	1.629
81	2009/11/20	168.3°	3h34m	+31°	2009/11/20	11.2	2009/11/18	1.290
88	2009/08/23	172.5°	22h 1m	- 4°	2009/08/23	9.8	2009/08/20	1.319
98	2009/03/23	175.2°	12h 6m	- 5°	2009/03/23	11.3	2009/03/21	1.233
101	2009/08/15	173.3°	21h48m	-20°	2009/08/15	10.7	2009/08/16	1.210
126	2009/10/08	179.2°	0h56m	+ 5°	2009/10/08	11.5	2009/10/05	1.199
140	2009/07/30	177.9°	20h42m	-20°	2009/07/30	10.4	2009/07/29	1.125
148	2009/09/20	153.6°	0h50m	-23°	2009/09/22	10.8	2009/09/23	1.378
154	2009/05/12	171.4°	15h 8m	-26°	2009/05/11	11.7	2009/05/11	1.977
161	2009/09/25	175.2°	0h16m	- 3°	2009/09/25	11.4	2009/09/20	1.137
163	2009/12/04	170.3°	4h47m	+12°	2009/12/04	11.4	2009/12/07	0.970
164	2009/10/24	136.3°	2h 8m	-31°	2009/10/16	10.9	2009/10/13	0.886
173	2009/10/05	161.5°	1h18m	-11°	2009/10/05	10.4	2009/10/04	1.204
187	2009/04/27	174.5°	14h12m	-19°	2009/04/27	10.2	2009/04/28	1.082
199	2009/06/07	174.5°	17h 2m	-17°	2009/06/07	11.7	2009/06/09	1.627
204	2009/06/14	167.0°	17h37m	-10°	2009/06/14	11.5	2009/06/14	1.211
213	2009/07/10	177.1°	19h18m	-19°	2009/07/10	11.3	2009/07/10	1.338
227	2009/03/16	173.2°	11h33m	- 4°	2009/03/16	12.3	2009/03/22	1.719
244	2009/10/12	178.9°	1h 8m	+ 8°	2009/10/12	13.4	2009/10/10	0.879
383	2009/11/26	177.8°	4h 7m	+18°	2009/11/25	13.2	2009/11/24	1.647
384	2009/11/08	179.7°	2h55m	+16°	2009/11/08	12.1	2009/11/11	1.329
393	2009/06/04	159.5°	17h10m	- 2°	2009/06/09	10.6	2009/06/17	1.017
409	2009/05/05	174.2°	14h43m	-21°	2009/05/06	10.5	2009/05/07	1.391
418	2009/10/20	171.9°	1h26m	+17°	2009/10/20	12.5	2009/10/18	1.301
422	2009/09/17	177.0°	23h44m	- 4°	2009/09/17	11.6	2009/09/14	0.750
428	2009/10/10	179.8°	1h 3m	+ 6°	2009/10/10	12.7	2009/10/11	0.909
435	2009/08/10	176.9°	21h25m	-18°	2009/08/10	12.3	2009/08/14	1.117
455	2009/10/14	159.4°	1h40m	-11°	2009/10/11	10.9	2009/10/05	0.960
457	2009/11/09	171.8°	2h46m	+24°	2009/11/09	14.1	2009/11/05	1.609
458	2009/11/08	158.0°	3h17m	- 4°	2009/11/08	12.7	2009/11/08	1.339
470	2009/03/24	177.4°	12h20m	+ 0°	2009/03/24	12.4	2009/03/28	1.219
479	2009/12/28	170.3°	6h27m	+13°	2009/12/27	12.3	2009/12/22	1.300
506	2009/02/07	177.2°	9h21m	+12°	2009/02/07	12.3	2009/02/04	1.684
510	2009/09/19	172.4°	23h34m	+ 5°	2009/09/18	12.4	2009/09/11	1.297
540	2009/03/27	177.0°	12h18m	- 5°	2009/03/27	12.5	2009/03/27	1.024
577	2009/07/30	176.8°	20h41m	-21°	2009/07/30	12.8	2009/07/29	1.622
578	2009/07/21	168.7°	20h16m	-31°	2009/07/21	11.8	2009/07/20	1.215
598	2009/09/26	157.1°	0h49m	-19°	2009/09/27	12.1	2009/09/29	1.142
634	2009/08/27	172.4°	22h38m	-16°	2009/08/27	12.8	2009/08/29	1.490
654	2009/01/18	164.2°	8h 5m	+ 4°	2009/01/19	9.9	2009/01/21	0.801
663	2009/04/02	160.7°	12h 9m	-22°	2009/04/02	12.9	2009/04/02	1.631
686	2009/08/14	148.2°	21h 0m	+16°	2009/08/15	11.8	2009/08/16	0.957
694	2009/07/29	147.7°	20h12m	+13°	2009/08/05	11.3	2009/08/09	0.927
706	2009/08/28	175.4°	22h21m	- 5°	2009/08/28	12.6	2009/08/30	1.206
712	2009/11/03	175.8°	2h28m	+19°	2009/11/03	10.4	2009/11/04	1.113
769	2009/07/17	168.3°	19h56m	-32°	2009/07/17	12.4	2009/07/16	1.588
770	2009/11/10	179.4°	3h 0m	+17°	2009/11/10	12.2	2009/11/11	0.905
772	2009/05/23	178.5°	16h 1m	-19°	2009/05/23	11.9	2009/05/22	1.758
785	2009/03/23	157.2°	12h47m	+19°	2009/03/25	11.9	2009/03/28	1.093
821	2009/06/19	171.6°	17h55m	-15°	2009/06/19	14.4	2009/06/16	1.228
849	2009/06/02	166.6°	16h53m	- 9°	2009/06/03	11.7	2009/06/07	1.629
928	2009/02/14	172.0°	10h 4m	+20°	2009/02/14	13.7	2009/02/15	1.680
936	2009/09/27	176.8°	0h22m	- 1°	2009/09/27	13.5	2009/09/21	1.696
952	2009/10/28	174.8°	2h 6m	+18°	2009/10/28	11.8	2009/10/23	1.287
966	2009/06/02	179.3°	16h39m	-21°	2009/06/02	12.5	2009/06/02	1.358
978	2009/10/12	168.1°	0h46m	+17°	2009/10/11	13.0	2009/10/07	1.506
985	2009/08/04	176.4°	20h54m	-13°	2009/08/04	13.5	2009/08/13	0.720
994	2009/10/04	175.6°	0h35m	+ 8°	2009/10/04	12.8	2009/10/01	1.263
1003	2009/01/14	178.8°	7h44m	+20°	2009/01/14	13.5	2009/01/13	1.679
1057	2009/10/22	175.1°	1h41m	+15°	2009/10/22	13.3	2009/10/18	1.202
1067	2009/11/18	165.2°	3h16m	+33°	2009/11/18	13.7	2009/11/16	1.367
1093	2009/08/27	138.0°	23h38m	-49°	2009/08/21	12.4	2009/08/19	1.467
1104	2009/12/04	167.9°	4h45m	+10°	2009/12/02	13.8	2009/11/25	0.791
1125	2009/02/01	177.1°	9h 4m	+19°	2009/02/01	14.2	2009/01/29	1.504
1130	2009/10/24	179.4°	1h56m	+12°	2009/10/24	13.5	2009/10/15	0.952
1146	2009/05/30	161.7°	16h50m	- 4°	2009/06/01	12.8	2009/06/05	1.347
1171	2009/11/28	175.8°	4h18m	+17°	2009/11/28	13.2	2009/11/25	1.599
1197	2009/05/03	167.5°	14h23m	-27°	2009/05/02	13.0	2009/04/27	1.359
1239	2009/12/31	178.6°	6h42m	+24°	2009/12/31	13.6	2010/01/01	1.062
1358	2009/07/28	175.8°	20h35m	-22°	2009/07/28	14.1	2009/07/28	1.048
1419	2009/10/25	179.6°	1h58m	+12°	2009/10/25	13.1	2009/10/29	1.071
1431	2009/07/10	175.5°	19h14m	-17°	2009/07/10	14.0	2009/07/16	1.259
1506	2009/05/15	179.9°	15h29m	-18°	2009/05/15	13.3	2009/05/25	1.008
1576	2009/10/19	179.0°	1h38m	+ 9°	2009/10/19	14.3	2009/10/20	1.651
1585	2009/02/07	170.4°	9h 8m	+ 6°	2009/02/06	14.0	2009/01/28	1.551
1625	2009/04/30	155.1°	13h54m	-38°	2009/05/02	14.0	2009/05/05	1.578
1634	2009/07/25	171.4°	20h28m	-27°	2009/07/24	14.5	2009/07/21	0.886
1653	2009/12/15	174.6°	5h30m	+28°	2009/12/14	13.0	2009/12/03	0.944
1659	2009/09/13	172.5°	23h19m	+ 3°	2009/09/14	12.2	2009/09/16	1.092
1671	2009/10/23	175.7°	1h58m	+ 7°	2009/10/23	13.8	2009/10/29	1.012
1700	2009/09/21	179.5°	23h55m	- 0°	2009/09/21	13.5	2009/09/23	0.834
1703	2009/08/09	175.8°	21h22m	-19°	2009/08/09	13.6	2009/08/09	0.825
1934	2009/12/18	179.2°	5h48m	+23°	2009/12/18	14.2	2009/12/07	0.934
1994	2009/08/30	160.8°	22h 6m	+ 8°	2009/08/30	14.1	2009/08/28	1.139
1997	2009/09/17	179.4°	23h41m	- 1°	2009/09/17	14.1	2009/09/16	0.748

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
2031	2009/10/01	176.7°	0h34m	+ 0°	2009/10/01	14.2	2009/10/02	0.857
2035	2009/06/17	162.8°	18h15m	-39°	2009/06/17	13.4	2009/06/18	0.640
2093	2009/09/07	178.0°	23h 7m	- 7°	2009/09/07	14.5	2009/08/29	1.078
2235	2009/12/13	154.7°	5h36m	- 1°	2009/12/15	14.5	2009/12/18	1.692
2379	2009/07/01	179.3°	18h43m	-22°	2009/07/01	13.7	2009/07/10	1.446
2385	2009/08/26	179.7°	22h21m	-10°	2009/08/26	14.3	2009/08/27	0.875
2525	2009/11/29	178.4°	4h20m	+19°	2009/11/29	14.0	2009/11/23	1.758
2532	2009/08/12	176.3°	21h35m	-18°	2009/08/13	14.5	2009/08/16	1.000
2534	2009/10/24	179.1°	1h57m	+11°	2009/10/24	14.1	2009/10/21	1.626
2536	2009/08/07	173.4°	21h 2m	- 9°	2009/08/08	14.5	2009/08/16	0.891
2604	2009/07/20	176.7°	19h53m	-17°	2009/07/19	14.3	2009/07/12	0.889
2672	2009/08/15	173.8°	21h50m	-19°	2009/08/14	14.3	2009/08/10	1.283
2714	2009/07/25	177.0°	20h13m	-16°	2009/07/24	14.4	2009/07/20	0.788
2768	2009/12/02	176.1°	4h34m	+25°	2009/12/02	13.8	2009/11/26	0.938
2784	2009/06/30	177.6°	18h38m	-20°	2009/06/30	14.5	2009/07/02	0.838
2816	2009/09/18	166.1°	0h 6m	-14°	2009/09/18	14.3	2009/09/17	1.222
2834	2009/12/24	169.5°	6h11m	+12°	2009/12/25	14.5	2009/12/28	1.217
3034	2009/08/16	171.9°	21h54m	-21°	2009/08/16	13.6	2009/08/15	0.827
3089	2009/06/02	171.3°	16h42m	-13°	2009/06/02	14.0	2009/06/05	1.418
3279	2009/09/09	176.9°	23h 4m	- 2°	2009/09/09	14.4	2009/09/09	0.819
3552	2009/10/20	90.4°	20h 1m	-24°	2009/09/22	14.8	2009/09/21	0.748
3563	2009/06/19	179.9°	17h51m	-23°	2009/06/19	14.3	2009/06/17	1.295
3728	2009/12/02	140.0°	5h 2m	-17°	2009/12/05	14.5	2009/12/05	1.251
3773	2009/07/31	177.3°	20h45m	-20°	2009/07/31	14.4	2009/08/06	0.822
3901	2009/03/26	178.7°	12h23m	- 1°	2009/03/26	14.4	2009/04/06	1.076
3935	2009/01/11	177.4°	7h32m	+24°	2009/01/11	14.4	2009/01/02	1.203
4080	2009/08/14	171.0°	21h22m	- 5°	2009/08/13	14.2	2009/08/12	0.724
4132	2009/12/28	132.5°	5h58m	-23°	2009/12/18	13.9	2009/12/15	0.924
4324	2009/10/02	165.6°	0h11m	+16°	2009/10/03	14.5	2009/10/06	1.108
4422	2009/10/14	171.9°	1h31m	+ 0°	2009/10/14	14.0	2009/10/10	0.854
4440	2009/01/15	168.8°	7h49m	+ 9°	2009/01/15	13.8	2009/01/17	0.815
5026	2009/08/30	174.7°	22h30m	- 3°	2009/08/30	14.0	2009/08/26	0.804
5817	2009/02/03	158.1°	9h16m	+38°	2009/01/28	14.5	2009/01/19	0.911
5847	2009/09/09	166.3°	22h51m	+ 7°	2009/09/11	14.2	2009/09/16	0.834
5925	2009/06/05	178.7°	16h53m	-23°	2009/06/05	14.5	2009/05/30	1.010
6027	2009/07/24	176.7°	20h20m	-22°	2009/07/24	14.2	2009/07/20	0.867
6560	2009/07/10	177.4°	19h17m	-19°	2009/07/10	13.9	2009/07/08	1.074
6610	2009/11/29	178.1°	4h20m	+23°	2009/11/29	14.3	2009/11/26	0.923
6634	2009/06/18	169.9°	17h55m	-13°	2009/06/20	14.3	2009/06/28	0.817
6792	2009/09/19	171.6°	23h58m	- 9°	2009/09/19	14.2	2009/09/19	0.801
7305	2009/08/23	172.7°	22h 1m	- 4°	2009/08/22	14.1	2009/08/16	1.206
11200	2009/05/08	178.2°	15h 3m	-15°	2009/05/08	14.5	2009/05/15	1.234
13123	2009/07/22	135.2°	22h28m	-56°	2009/07/26	14.4	2009/07/27	0.851
16009	2009/10/30	179.0°	2h17m	+12°	2009/10/30	14.5	2009/10/25	1.188
17274	2009/07/23	176.0°	20h 4m	-23°	2009/08/04	14.2	2009/08/17	0.194
26471	2009/08/15	138.3°	21h18m	+27°	2009/08/15	14.5	2009/08/14	0.719
28610	2009/08/08	179.4°	21h15m	-16°	2009/08/08	13.9	2009/08/03	0.975
29943	2009/01/01	174.2°	6h51m	+28°	2009/01/01	13.9	2009/01/02	1.676
68216	2009/08/18	120.1°	1h48m	-47°	2009/10/04	12.7	2009/10/08	0.025
136617	2009/04/26	160.2°	14h06m	-33°	2009/06/06	12.5	2009/06/10	0.017
136849	2009/01/07	156.0°	8h52m	+15°	2009/01/15	12.5	2009/01/17	0.029
143651	2009/08/18	136.3°	20h56m	-55°	2009/06/13	13.7	2009/06/09	0.095
152664	2009/09/12	176.8°	23h27m	- 6°	2009/09/28	14.0	2009/09/29	0.022
159402	2009/09/01	168.5°	22h53m	-19°	2009/10/14	12.9	2009/10/20	0.076

Table II. Temporal Sequence of Favorable Elongations

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
29943	2009/01/01	174.2°	6h51m	+28°	2009/01/01	13.9	2009/01/02	1.676
136849	2009/01/07	156.0°	8h52m	+15°	2009/01/15	12.5	2009/01/17	0.029
3935	2009/01/11	177.4°	7h32m	+24°	2009/01/11	14.4	2009/01/02	1.203
1003	2009/01/14	178.8°	7h44m	+20°	2009/01/14	13.5	2009/01/13	1.679
4440	2009/01/15	168.8°	7h49m	+ 9°	2009/01/15	13.8	2009/01/17	0.815
654	2009/01/18	164.2°	8h 5m	+ 4°	2009/01/19	9.9	2009/01/21	0.801
1125	2009/02/01	177.1°	9h 4m	+19°	2009/02/01	14.2	2009/01/29	1.504
5817	2009/02/03	158.1°	9h16m	+38°	2009/01/28	14.5	2009/01/19	0.911
27	2009/02/04	177.9°	9h13m	+18°	2009/02/04	8.7	2009/01/30	1.035
506	2009/02/07	177.2°	9h21m	+12°	2009/02/07	12.3	2009/02/04	1.684
1585	2009/02/07	170.4°	9h 8m	+ 6°	2009/02/06	14.0	2009/01/28	1.551
928	2009/02/14	172.0°	10h 4m	+20°	2009/02/14	13.7	2009/02/15	1.680
227	2009/03/16	173.2°	11h33m	- 4°	2009/03/16	12.3	2009/03/22	1.719
34	2009/03/23	179.5°	12h 8m	- 1°	2009/03/23	11.3	2009/03/22	1.426
98	2009/03/23	175.2°	12h 6m	- 5°	2009/03/23	11.3	2009/03/21	1.233
785	2009/03/23	157.2°	12h47m	+19°	2009/03/25	11.9	2009/03/28	1.093
470	2009/03/24	177.4°	12h20m	+ 0°	2009/03/24	12.4	2009/03/28	1.219
3901	2009/03/26	178.7°	12h23m	- 1°	2009/03/26	14.4	2009/04/06	1.076
540	2009/03/27	177.0°	12h18m	- 5°	2009/03/27	12.5	2009/03/27	1.024
663	2009/04/02	160.7°	12h 9m	-22°	2009/04/02	12.9	2009/04/02	1.631
14	2009/04/21	166.2°	14h12m	+ 1°	2009/04/20	9.0	2009/04/18	1.199
136617	2009/04/26	160.2°	14h06m	-33°	2009/06/06	12.5	2009/06/10	0.017
187	2009/04/27	174.5°	14h12m	-19°	2009/04/27	10.2	2009/04/28	1.082
1625	2009/04/30	155.1°	13h54m	-38°	2009/05/02	14.0	2009/05/05	1.578
1197	2009/05/03	167.5°	14h23m	-27°	2009/05/02	13.0	2009/04/27	1.359
409	2009/05/05	174.2°	14h43m	-21°	2009/05/06	10.5	2009/05/07	1.391
11200	2009/05/08	178.2°	15h 3m	-15°	2009/05/08	14.5	2009/05/15	1.234
154	2009/05/12	171.4°	15h 8m	-26°	2009/05/11	11.7	2009/05/11	1.977
1506	2009/05/15	179.9°	15h29m	-18°	2009/05/15	13.3	2009/05/25	1.008
26	2009/05/18	178.7°	15h41m	-20°	2009/05/18	10.3	2009/05/19	1.414
772	2009/05/23	178.5°	16h 1m	-19°	2009/05/23	11.9	2009/05/22	1.758
1146	2009/05/30	161.7°	16h50m	- 4°	2009/06/01	12.8	2009/06/05	1.347
849	2009/06/02	166.6°	16h53m	- 9°	2009/06/03	11.7	2009/06/07	1.629
966	2009/06/02	179.3°	16h39m	-21°	2009/06/02	12.5	2009/06/02	1.358
3089	2009/06/02	171.3°	16h42m	-13°	2009/06/02	14.0	2009/06/05	1.418
393	2009/06/04	159.5°	17h10m	- 2°	2009/06/09	10.6	2009/06/17	1.017
5925	2009/06/05	178.7°	16h53m	-23°	2009/06/05	14.5	2009/05/30	1.010
199	2009/06/07	174.5°	17h 2m	-17°	2009/06/07	11.7	2009/06/09	1.627
204	2009/06/14	167.0°	17h37m	-10°	2009/06/14	11.5	2009/06/14	1.211
2035	2009/06/17	162.8°	18h15m	-39°	2009/06/17	13.4	2009/06/18	0.640
6634	2009/06/18	169.9°	17h55m	-13°	2009/06/20	14.3	2009/06/28	0.817
821	2009/06/19	171.6°	17h55m	-15°	2009/06/19	14.4	2009/06/16	1.228
3563	2009/06/19	179.9°	17h51m	-23°	2009/06/19	14.3	2009/06/17	1.295
2784	2009/06/30	177.6°	18h38m	-20°	2009/06/30	14.5	2009/07/02	0.838

Planet	Max Elon D	Max E	RA	Dec	Br Mag D	Br Mag	Min Dist D	Min Dist
2379	2009/07/01	179.3°	18h43m	-22°	2009/07/01	13.7	2009/07/10	1.446
213	2009/07/10	177.1°	19h18m	-19°	2009/07/10	11.3	2009/07/10	1.338
1431	2009/07/10	175.5°	19h14m	-17°	2009/07/10	14.0	2009/07/16	1.259
6560	2009/07/10	177.4°	19h17m	-19°	2009/07/10	13.9	2009/07/08	1.074
769	2009/07/17	168.3°	19h56m	-32°	2009/07/17	12.4	2009/07/16	1.588
2604	2009/07/20	176.7°	19h53m	-17°	2009/07/19	14.3	2009/07/12	0.889
578	2009/07/21	168.7°	20h16m	-31°	2009/07/21	11.8	2009/07/20	1.215
13123	2009/07/22	135.2°	22h28m	-56°	2009/07/26	14.4	2009/07/27	0.851
17274	2009/07/23	176.0°	20h 4m	-23°	2009/08/04	14.2	2009/08/17	0.194
6027	2009/07/24	176.7°	20h20m	-22°	2009/07/24	14.2	2009/07/20	0.867
1634	2009/07/25	171.4°	20h28m	-27°	2009/07/24	14.5	2009/07/21	0.886
2714	2009/07/25	177.0°	20h13m	-16°	2009/07/24	14.4	2009/07/20	0.788
1358	2009/07/28	175.8°	20h35m	-22°	2009/07/28	14.1	2009/07/28	1.048
33	2009/07/29	176.7°	20h39m	-21°	2009/07/30	10.2	2009/08/08	0.990
694	2009/07/29	147.7°	20h12m	+13°	2009/08/05	11.3	2009/08/09	0.927
140	2009/07/30	177.9°	20h42m	-20°	2009/07/30	10.4	2009/07/29	1.125
577	2009/07/30	176.8°	20h41m	-21°	2009/07/30	12.8	2009/07/29	1.622
3773	2009/07/31	177.3°	20h45m	-20°	2009/07/31	14.4	2009/08/06	0.822
985	2009/08/04	176.4°	20h54m	-13°	2009/08/04	13.5	2009/08/13	0.720
2536	2009/08/07	173.4°	21h 2m	- 9°	2009/08/08	14.5	2009/08/16	0.891
28610	2009/08/08	179.4°	21h15m	-16°	2009/08/08	13.9	2009/08/03	0.975
1703	2009/08/09	175.8°	21h22m	-19°	2009/08/09	13.6	2009/08/09	0.825
435	2009/08/10	176.9°	21h25m	-18°	2009/08/10	12.3	2009/08/14	1.117
2532	2009/08/12	176.3°	21h35m	-18°	2009/08/13	14.5	2009/08/16	1.000
686	2009/08/14	148.2°	21h 0m	+16°	2009/08/15	11.8	2009/08/16	0.957
4080	2009/08/14	171.0°	21h22m	- 5°	2009/08/13	14.2	2009/08/12	0.724
101	2009/08/15	173.3°	21h48m	-20°	2009/08/15	10.7	2009/08/16	1.210
2672	2009/08/15	173.8°	21h50m	-19°	2009/08/14	14.3	2009/08/10	1.283
26471	2009/08/15	138.3°	21h18m	+27°	2009/08/15	14.5	2009/08/14	0.719
3034	2009/08/16	171.9°	21h54m	-21°	2009/08/16	13.6	2009/08/15	0.827
68216	2009/08/18	120.1°	1h48m	-47°	2009/10/04	12.7	2009/10/08	0.025
143651	2009/08/18	136.3°	20h56m	-55°	2009/06/13	13.7	2009/06/09	0.095
88	2009/08/23	172.5°	22h 1m	- 4°	2009/08/23	9.8	2009/08/20	1.319
7305	2009/08/23	172.7°	22h 1m	- 4°	2009/08/22	14.1	2009/08/16	1.206
2385	2009/08/26	179.7°	22h21m	-10°	2009/08/26	14.3	2009/08/27	0.875
634	2009/08/27	172.4°	22h38m	-16°	2009/08/27	12.8	2009/08/29	1.490
1093	2009/08/27	138.0°	23h38m	-49°	2009/08/21	12.4	2009/08/19	1.467
706	2009/08/28	175.4°	22h21m	- 5°	2009/08/28	12.6	2009/08/30	1.206
1994	2009/08/30	160.8°	22h 6m	+ 8°	2009/08/30	14.1	2009/08/28	1.139
5026	2009/08/30	174.7°	22h30m	- 3°	2009/08/30	14.0	2009/08/26	0.804
159402	2009/09/01	168.5°	22h53m	-19°	2009/10/14	12.9	2009/10/20	0.076
2093	2009/09/07	178.0°	23h 7m	- 7°	2009/09/07	14.5	2009/08/29	1.078
42	2009/09/08	162.6°	23h38m	-21°	2009/09/06	9.4	2009/09/02	0.941
3279	2009/09/09	176.9°	23h 4m	- 2°	2009/09/09	14.4	2009/09/09	0.819
5847	2009/09/09	166.3°	22h51m	+ 7°	2009/09/11	14.2	2009/09/16	0.834
152664	2009/09/12	176.8°	23h27m	- 6°	2009/09/28	14.0	2009/09/29	0.022
1659	2009/09/13	172.5°	23h19m	+ 3°	2009/09/14	12.2	2009/09/16	1.092
422	2009/09/17	177.0°	23h44m	- 4°	2009/09/17	11.6	2009/09/14	0.750
1997	2009/09/17	179.4°	23h41m	- 1°	2009/09/17	14.1	2009/09/16	0.748
2816	2009/09/18	166.1°	0h 6m	-14°	2009/09/18	14.3	2009/09/17	1.222
510	2009/09/19	172.4°	23h34m	+ 5°	2009/09/18	12.4	2009/09/11	1.297
6792	2009/09/19	171.6°	23h58m	- 9°	2009/09/19	14.2	2009/09/19	0.801
148	2009/09/20	153.6°	0h50m	-23°	2009/09/22	10.8	2009/09/23	1.378
3	2009/09/21	176.4°	23h59m	- 3°	2009/09/21	7.7	2009/09/29	1.199
1700	2009/09/21	179.5°	23h55m	- 0°	2009/09/21	13.5	2009/09/23	0.834
161	2009/09/25	175.2°	0h16m	- 3°	2009/09/25	11.4	2009/09/20	1.137
598	2009/09/26	157.1°	0h49m	-19°	2009/09/27	12.1	2009/09/29	1.142
936	2009/09/27	176.8°	0h22m	- 1°	2009/09/27	13.5	2009/09/21	1.696
2031	2009/10/01	176.7°	0h34m	+ 0°	2009/10/01	14.2	2009/10/02	0.857
4324	2009/10/02	165.6°	0h11m	+16°	2009/10/03	14.5	2009/10/06	1.108
994	2009/10/04	175.6°	0h35m	+ 8°	2009/10/04	12.8	2009/10/01	1.263
62	2009/10/05	176.7°	0h51m	+ 1°	2009/10/05	12.1	2009/10/07	1.629
173	2009/10/05	161.5°	1h18m	-11°	2009/10/05	10.4	2009/10/04	1.204
126	2009/10/08	179.2°	0h56m	+ 5°	2009/10/08	11.5	2009/10/05	1.199
18	2009/10/09	163.5°	1h31m	- 8°	2009/10/09	7.9	2009/10/08	0.814
428	2009/10/10	179.8°	1h 3m	+ 6°	2009/10/10	12.7	2009/10/11	0.909
244	2009/10/12	178.9°	1h 8m	+ 8°	2009/10/12	13.4	2009/10/10	0.879
978	2009/10/12	168.1°	0h46m	+17°	2009/10/11	13.0	2009/10/07	1.506
455	2009/10/14	159.4°	1h40m	-11°	2009/10/11	10.9	2009/10/05	0.960
4422	2009/10/14	171.9°	1h31m	+ 0°	2009/10/14	14.0	2009/10/10	0.854
1576	2009/10/19	179.0°	1h38m	+ 9°	2009/10/19	14.3	2009/10/20	1.651
418	2009/10/20	171.9°	1h26m	+17°	2009/10/20	12.5	2009/10/18	1.301
3552	2009/10/20	90.4°	20h 1m	-24°	2009/09/22	14.8	2009/09/21	0.748
1057	2009/10/22	175.1°	1h41m	+15°	2009/10/22	13.3	2009/10/18	1.202
1671	2009/10/23	175.7°	1h58m	+ 7°	2009/10/23	13.8	2009/10/29	1.012
164	2009/10/24	136.3°	2h 8m	-31°	2009/10/16	10.9	2009/10/13	0.886
1130	2009/10/24	179.4°	1h56m	+12°	2009/10/24	13.5	2009/10/15	0.952
2534	2009/10/24	179.1°	1h57m	+11°	2009/10/24	14.1	2009/10/21	1.626
1419	2009/10/25	179.6°	1h58m	+12°	2009/10/25	13.1	2009/10/29	1.071
952	2009/10/28	174.8°	2h 6m	+18°	2009/10/28	11.8	2009/10/23	1.287
16009	2009/10/30	179.0°	2h17m	+12°	2009/10/30	14.5	2009/10/25	1.188
712	2009/11/03	175.8°	2h28m	+19°	2009/11/03	10.4	2009/11/04	1.113
384	2009/11/08	179.7°	2h55m	+16°	2009/11/08	12.1	2009/11/11	1.329
458	2009/11/08	158.0°	3h17m	- 4°	2009/11/08	12.7	2009/11/08	1.339
457	2009/11/09	171.8°	2h46m	+24°	2009/11/09	14.1	2009/11/05	1.609
770	2009/11/10	179.4°	3h 0m	+17°	2009/11/10	12.2	2009/11/11	0.905
1067	2009/11/18	165.2°	3h16m	+33°	2009/11/18	13.7	2009/11/16	1.367
81	2009/11/20	168.3°	3h34m	+31°	2009/11/20	11.2	2009/11/18	1.290
383	2009/11/26	177.8°	4h 7m	+18°	2009/11/25	13.2	2009/11/24	1.647
1171	2009/11/28	175.8°	4h18m	+17°	2009/11/28	13.2	2009/11/25	1.599
2525	2009/11/29	178.4°	4h20m	+19°	2009/11/29	14.0	2009/11/23	1.758
6610	2009/11/29	178.1°	4h20m	+23°	2009/11/29	14.3	2009/11/26	0.923
2768	2009/12/02	176.1°	4h34m	+25°	2009/12/02	13.8	2009/11/26	0.938
3728	2009/12/02	140.0°	5h 2m	-17°	2009/12/05	14.5	2009/12/05	1.251
163	2009/12/04	170.3°	4h47m	+12°	2009/12/04	11.4	2009/12/07	0.970
1104	2009/12/04	167.9°	4h45m	+10°	2009/12/02	13.8	2009/11/25	0.791
38	2009/12/10	172.7°	5h 7m	+30°	2009/12/11	11.2	2009/12/13	1.372
2235	2009/12/13	154.7°	5h36m	- 1°	2009/12/15	14.5	2009/12/18	1.692
1653	2009/12/15	174.6°	5h30m	+28°	2009/12/14	13.0	2009/12/03	0.944
52	2009/12/18	172.2°	5h45m	+15°	2009/12/18	10.1	2009/12/19	1.817
1934	2009/12/18	179.2°	5h48m	+23°	2009/12/18	14.2	2009/12/07	0.934
2834	2009/12/24	169.5°	6h11m	+12°	2009/12/25	14.5	2009/12/28	1.217
479	2009/12/28	170.3°	6h27m	+13°	2009/12/27	12.3	2009/12/22	1.300
4132	2009/12/28	132.5°	5h58m	-23°	2009/12/18	13.9	2009/12/15	0.924
1239	2009/12/31	178.6°	6h42m	+24°	2009/12/31	13.6	2010/01/01	1.062

ASTEROID-DEEPSKY APPULSES IN 2009

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

Received: 2008 September 2

The following list is a very small subset of the results of a search for asteroid-deepsky appulses for 2009, presenting only the highlights for the year based on close approaches of brighter asteroids to brighter DSOs. The complete set of predictions is available at

http://www.minorplanetobserver.com/Misc/DSOAppulses.htm

For any event not covered, the Minor Planet Center's web site at http://scully.harvard.edu/~cgi/CheckMP allows you to enter the location of a suspected asteroid or supernova and check if there are any known targets in the area.

The table gives the following data:

Date/Time	Universal Date (MM DD) and Time of closest approach
#/Asteroid	The number and name of the asteroid
RA/Dec	The J2000 position of the asteroid
AM	The approximate visual magnitude of the asteroid
Sep/PA	The separation in arcseconds and the position angle from the DSO to the asteroid
DSO	The DSO name or catalog designation
DM	The approximate total magnitude of the DSO
DT	The type of DSO: OC = Open Cluster; GC = Globular Cluster; G = Galaxy
SE/ME	The elongation in degrees from the sun and moon respectively
MP	The phase of the moon: 0 = New, 1.0 = Full. Positive = waxing; Negative = waning

Date	UT	#	Name	RA	Dec	AM	Sep	PA	DSO	DM	DT	SE	ME	MP
01 03	08:41	487	Venetia	6 53.86	+19 20.2	11.4	144	21	UGC 3587	12.8	G	177	104	0.38
01 18	17:57	567	Eleutheria	7 35.06	+32 52.9	13.6	179	14	NGC 2410	13.0	G	166	107	-0.43
01 20	10:00	1585	Union	9 23.47	+ 2 06.3	14.2	152	229	NGC 2861	12.7	G	155	93	-0.28
01 26	00:09	500	Selinur	9 46.30	+ 5 42.7	13.5	44	3	NGC 2990	12.7	G	158	155	0.00
01 31	00:18	602	Marianna	10 01.50	+15 47.5	13.3	29	7	NGC 3094	12.3	G	164	141	0.20
01 31	02:10	908	Buda	11 17.64	+26 37.1	13.7	138	247	NGC 3609	13.1	G	146	144	0.21
02 17	10:05	797	Montana	10 12.71	+ 3 08.6	13.6	38	19	NGC 3156	12.3	G	171	90	-0.45
02 21	14:32	98	Ianthe	12 35.63	- 3 50.1	12.0	218	148	NGC 4546	10.3	G	143	105	-0.11
02 23	19:29	246	Asporina	12 27.19	+ 2 31.6	12.6	196	60	NGC 4420	12.1	G	150	135	-0.01
02 24	04:53	1302	Werra	10 36.39	+12 41.6	14.4	23	203	NGC 3299	12.8	G	176	169	-0.01
03 18	21:00	740	Cantabia	10 13.43	+22 42.0	13.1	129	205	NGC 3162	11.6	G	147	123	-0.48
03 22	07:20	1605	Milankovitch	12 43.31	- 0 37.8	14.3	16	38	NGC 4642	12.9	G	171	120	-0.18
03 24	08:00	29	Amphitrite	12 00.46	- 1 01.5	9.2	218	15	NGC 4030	10.6	G	177	155	-0.06
03 28	11:10	785	Zwetana	12 42.63	+20 00.7	11.9	223	7	NGC 4635	12.6	G	157	140	0.04
03 31	18:58	34	Circe	12 02.46	- 0 11.8	11.6	60	215	NGC 4044	13.0	G	170	103	0.30
04 19	10:17	478	Tergeste	14 45.01	-20 55.9	12.4	137	212	NGC 5743	13.0	G	164	95	-0.32
04 19	12:24	478	Tergeste	14 44.95	-20 55.4	12.4	239	212	NGC 5734	12.7	G	164	96	-0.32
04 22	20:38	248	Lameia	12 44.68	-10 05.4	13.4	26	213	NGC 4658	12.5	G	161	170	-0.06
04 23	09:55	118	Peitho	11 20.07	+13 00.8	13.1	157	315	M66	8.9	G	132	152	-0.04
04 25	22:05	100	Hekate	16 32.47	-13 04.0	12.2	65	201	M107	8.1	GC	146	154	0.01
04 27	08:45	169	Zelia	12 53.09	-10 30.5	13.1	30	197	NGC 4760	11.4	G	159	129	0.07
05 20	14:37	494	Virtus	17 50.66	-30 11.7	13.2	82	340	NGC 6451	8.2	OC	151	101	-0.19
05 22	20:56	103	Hera	14 29.61	- 5 58.6	11.7	26	11	NGC 5634	11.0	GC	154	166	-0.04
05 26	20:42	469	Argentina	17 41.58	-40 03.9	13.1	126	355	Tr 29	7.5	OC	154	161	0.08
06 26	15:50	1128	Astrid	17 17.99	-23 48.8	14.4	167	183	NGC 6325	10.7	GC	165	112	0.20
07 18	16:54	982	Franklina	23 12.90	+ 6 18.4	14.1	184	259	NGC 7518	13.4	G	124	76	-0.16
07 26	23:56	7	Iris	18 29.49	-19 07.9	9.2	112	182	PK 13-3.1	13.0	PN	153	87	0.30
08 20	09:02	623	Chimaera	20 59.02	-12 34.5	14.4	213	4	M73	8.9	OC	166	167	0.00
08 24	06:56	44	Nysa	23 18.96	- 7 36.6	10.5	111	150	NGC 7600	11.9	G	163	144	0.19
08 24	09:22	213	Lilaea	18 55.24	-22 41.5	12.4	119	75	Pal 9	9.2	GC	132	78	0.20
08 25	23:03	623	Chimaera	20 53.52	-12 29.0	14.5	181	4	M72	9.4	GC	159	88	0.35
09 12	15:27	1157	Arabia	23 36.19	+ 2 09.7	14.0	43	351	NGC 7714	12.5	G	173	92	-0.44
09 12	21:55	1547	Nele	23 24.89	+15 17.1	14.2	66	352	NGC 7653	12.7	G	161	92	-0.41
09 16	01:52	160	Una	1 22.81	+ 9 02.6	13.0	23	168	NGC 502	12.8	G	151	114	-0.10
09 21	01:17	210	Isabella	0 27.98	- 1 48.1	12.5	55	345	NGC 124	13.0	G	171	156	0.07
10 15	02:47	164	Eva	2 20.98	-33 44.4	10.9	170	212	NGC 897	11.8	G	135	122	-0.12
10 16	12:56	790	Pretoria	23 14.14	+23 41.9	13.0	241	298	NGC 7539	12.5	G	145	158	-0.04
10 16	21:44	791	Ani	4 36.58	- 0 07.4	14.0	147	312	NGC 1620	12.3	G	132	115	-0.02
10 20	15:14	476	Hedwig	23 12.81	+12 42.2	12.6	107	310	NGC 7515	12.4	G	144	117	0.07
10 23	16:33	1419	Danzig	1 59.95	+12 41.3	13.2	237	326	NGC 781	13.0	G	178	117	0.29
10 24	06:00	335	Roberta	2 49.20	+ 8 09.7	12.4	238	338	NGC 1107	12.2	G	166	120	0.34
11 09	19:44	412	Elisabetha	1 56.20	- 9 01.0	13.4	179	1	NGC 755	12.6	G	150	114	-0.48
11 11	07:46	297	Caecilia	0 43.51	+14 17.2	14.0	192	150	NGC 234	12.5	G	146	145	-0.31
11 11	10:05	412	Elisabetha	1 55.00	- 9 00.3	13.5	43	3	NGC 731	12.1	G	148	133	-0.30
11 13	02:14	237	Coelestina	0 34.25	- 9 41.0	13.8	77	38	NGC 151	11.6	G	132	163	-0.15
11 17	17:14	345	Tercidina	2 39.01	+10 51.9	11.4	139	324	NGC 1024	12.1	G	165	153	0.01
11 19	14:40	652	Jubilatrix	2 52.87	- 1 17.3	14.5	83	199	NGC 1132	12.3	G	156	128	0.08
11 19	22:50	579	Sidonia	0 36.01	-10 08.6	12.8	87	244	NGC 163	12.7	G	126	90	0.10
11 21	19:41	5647	1990 TZ	1 51.25	+22 34.2	13.7	40	289	NGC 695	12.8	G	153	97	0.23
11 22	08:57	51	Nemausa	3 31.36	+ 4 23.7	10.7	105	341	NGC 1349	13.0	G	164	108	0.27
12 12	19:45	373	Melusina	2 38.80	+34 39.1	13.7	146	329	NGC 1002	13.1	G	143	164	-0.13
12 14	07:34	1317	Silvretta	2 26.08	+42 09.3	13.8	26	322	NGC 914	13.0	G	138	157	-0.05

CLOSE MUTUAL APPROACHES OF MINOR PLANETS IN 2009

Edwin Goffin
Aartselaarstraat 14
B-2660 Hoboken (Antwerp), BELGIUM
Edwin.Goffin@skynet.be

(Received: 2008 June 1)

Tabulated are cases where one minor planet comes to within 120 arcseconds of another and both are of magnitude 16 or brighter. A challenge for visual minor planet observers!

Here I present a list of close approaches between numbered minor planets larger than 40 km during 2009 where:

- Solar elongation > 30°
- Both minor planets are brighter than V = 16
- Maximum geocentric separation < 120 arcseconds

The table gives the following data:

1. Date: date and time of closest geocentric approach (in UT). All other information is given for this instant.
2. Closest approach: gives the minimum geocentric distance (in arcseconds) and the position angle (in degrees) of the *nearest* minor planet with respect to the *farthest*.
3. Minor planet 1: information on the *nearest* asteroid:
   - Number, name, and visual magnitude
   - Parallax, in arcseconds
   - Apparent motion, in arcseconds per hour
   - Position angle of the direction of motion, in degrees
4. Minor planet 2: information about the *farthest* of the two. In addition to the J2000 RA and Declination, the same data as for the first asteroid are given.
5. Sun and Moon:
   - Solar elongation, in degrees
   - Lunar elongation, in degrees
   - Illuminated fraction of the moon, percent.

	Date (U.T.)	h m	Min. dist. "	Pos. ang. °	Minor planet 1 Name		Vis. mag. "	Hor. par. "/h	Motion per hour "	Motion pos. ang. °	Minor planet 2 Name		Vis. mag. "	Hor. par. "/h	Motion per hour °	Motion pos. ang.	Right ascens. (2000.0) h m	Decli- nation (2000.0) ° '	Elon- gation Sun °	Elon- gation Moon °	Ill. frac. Moon %
	2009 jan 11	2 57.6	26.95	265	1384	Kniertje	15.06	2.75	62.35	74	2525	O'Steen	15.95	2.69	63.72	68	22 16.97	-12 59.1	40	135	97
	jan 14	18 29.1	111.11	241	169	Zelia	14.60	3.67	33.28	119	184	Dejopeja	13.84	3.20	29.51	114	13 25.22	- 9 38.3	91	38	81
	jan 20	14 24.6	66.19	181	470	Kilia	14.13	5.14	24.25	99	76	Freia	13.45	3.27	8.63	113	12 31.30	- 4 49.7	111	50	28
	jan 21	12 17.4	34.14	131	849	Ara	13.80	2.76	51.32	92	77	Frigga	14.41	2.61	44.84	104	15 55.26	-21 52.4	60	20	21
	jan 30	9 22.6	80.73	298	192	Nausikaa	10.42	5.65	40.91	278	1548	Palomaa	15.09	5.11	39.29	308	8 57.62	+23 32.6	173	131	17
	feb 8	12 42.4	41.57	354	140	Siwa	13.38	3.12	71.11	91	488	Kreusa	13.96	2.36	46.28	95	17 59.15	-21 53.5	49	140	96
	feb 19	14 42.7	114.08	275	752	Sulamitis	13.27	6.43	26.74	286	1548	Palomaa	15.51	4.98	30.38	305	8 40.33	+26 25.7	153	136	27
	feb 23	1 2.0	13.89	163	61	Danaë	13.51	2.75	45.79	103	31	Euphrosyne	13.48	2.17	33.02	117	17 45.20	-40 17.7	68	58	5
	feb 24	13 49.8	88.33	2	213	Lilaea	13.74	3.30	60.62	89	655	Briseïs	15.75	2.50	40.33	88	18 05.51	-18 32.5	64	61	1
	mar 7	14 51.4	84.75	147	145	Adeona	12.76	4.11	44.63	76	382	Dodona	14.97	2.62	22.84	97	4 47.23	+27 37.1	86	54	84
	mar 13	7 35.3	16.24	336	1277	Dolores	15.70	3.60	77.58	75	275	Sapientia	14.57	2.72	49.38	80	19 47.53	-18 38.4	57	94	94
?	mar 14	9 1.2	6.85	346	1277	Dolores	15.69	3.62	77.42	75	675	Ludmilla	13.95	2.50	45.44	73	19 49.74	-18 29.6	57	82	88
	mar 15	2 26.7	53.86	141	402	Chloë	13.49	4.42	38.43	70	1251	Hedera	15.80	3.46	27.30	78	5 59.87	+20 04.0	95	133	83
	mar 16	19 36.1	72.64	70	2025	Nortia	15.65	3.70	11.10	150	643	Scheherezade	15.40	3.17	2.18	99	15 34.49	-27 51.3	117	26	68
	mar 17	16 51.7	27.06	315	1157	Arabia	15.64	2.47	61.73	67	116	Sirona	13.89	2.24	52.09	71	21 56.35	-15 25.6	31	73	60
	mar 21	15 49.8	23.81	192	3	Juno	10.77	2.57	60.64	73	466	Tisiphone	14.87	2.04	45.01	62	21 37.30	- 7 21.5	37	23	24
	mar 26	11 27.9	45.73	85	25	Phocaea	11.25	5.78	41.63	314	1780	Kippes	15.02	4.40	29.12	285	12 46.18	-19 23.3	161	163	0
?	apr 19	10 46.6	17.91	64	26	Proserpina	11.12	5.75	16.63	266	551	Ortrud	14.72	3.63	19.10	280	16 04.49	-21 12.0	146	80	31
?	may 1	5 40.7	17.93	179	8	Flora	9.92	5.62	37.03	285	1283	Komsomolia	15.96	3.02	26.33	292	13 50.65	- 1 17.9	162	85	45
	may 7	9 39.5	72.68	107	2091	Sampo	14.83	4.02	30.18	281	451	Patientia	11.41	3.85	30.88	273	15 02.61	- 0 56.4	164	20	96
	may 11	17 54.4	88.39	48	1092	Lilium	14.98	4.83	22.31	301	678	Fredegundis	13.82	3.99	25.62	304	13 09.86	-16 11.9	150	63	91
	may 18	8 51.6	86.31	334	19	Fortuna	11.93	3.11	80.10	69	872	Holda	15.79	2.38	54.28	71	1 19.64	+ 8 55.2	35	41	38
	may 31	22 8.7	53.84	263	327	Columbia	15.19	3.64	37.18	67	559	Nanon	14.53	3.55	35.80	82	22 59.44	-11 24.4	88	164	60
	jun 20	9 48.1	81.01	176	962	Aslög	15.45	4.58	31.36	269	2357	Phereclos	15.53	2.22	19.66	271	17 54.70	-20 04.8	176	144	10
	jun 26	23 44.2	22.92	115	519	Sylvania	13.86	4.23	9.51	259	643	Scheherezade	15.29	3.29	11.46	343	14 45.73	-20 30.8	129	68	26
	jun 28	4 36.3	101.29	42	1001	Gaussia	15.42	2.97	43.07	61	778	Theobalda	15.50	2.82	41.47	53	1 07.73	+16 41.7	74	151	38
	jul 12	7 5.1	23.41	90	311	Claudia	15.08	3.66	14.02	121	957	Camelia	15.17	3.37	12.40	75	14 31.14	-13 19.2	109	126	77
	jul 14	3 31.4	93.08	310	442	Eichsfeldia	15.38	2.75	62.35	84	968	Petunia	15.75	2.51	57.38	89	4 45.63	+17 38.6	39	65	62
	jul 14	4 6.2	27.64	66	1062	Ljuba	15.62	2.49	56.90	80	859	Bouzaréah	15.44	2.45	55.84	75	4 40.49	+26 35.7	39	64	62
	jul 17	6 58.1	59.33	168	740	Cantabia	14.58	2.76	55.45	116	680	Genoveva	15.34	2.49	45.62	126	11 32.18	+12 30.7	54	122	31
	jul 23	4 59.0	11.04	285	448	Natalie	15.78	3.34	15.80	114	1189	Terentia	15.62	3.21	17.55	78	14 34.94	-21 46.9	102	83	5
	aug 3	20 10.8	75.73	306	957	Camelia	15.47	3.01	25.77	96	692	Hippodamia	15.50	2.57	22.54	137	14 43.02	-13 19.4	90	67	93
	aug 3	23 42.2	105.33	93	971	Alsatia	15.73	2.99	36.91	127	276	Adelheid	14.54	2.75	31.31	102	14 08.92	- 5 12.8	80	77	94
	aug 8	15 52.7	71.40	183	53	Kalypso	13.60	3.77	59.28	83	423	Diotima	13.23	2.70	34.92	76	4 02.26	+15 47.1	74	75	92
	aug 11	5 54.1	104.37	153	1057	Wanda	14.92	5.35	33.97	64	153	Hilda	14.14	2.40	5.71	66	1 48.51	+16 00.7	107	14	75
	aug 12	3 7.0	107.63	67	572	Rebekka	13.72	7.37	25.39	239	665	Sabine	12.56	4.38	28.74	275	22 36.52	+ 5 18.9	153	50	68
?	aug 26	0 0.1	10.45	233	3	Juno	8.37	6.53	24.96	203	708	Raphaela	15.04	4.47	23.11	253	0 13.11	+ 1 13.3	149	138	35
	aug 31	12 8.2	91.20	168	390	Alma	15.44	3.72	33.10	60	516	Amherstia	14.36	2.76	19.23	45	3 54.43	+34 11.4	94	120	83
	aug 31	20 24.7	11.96	206	336	Lacadiera	14.55	3.01	76.41	110	392	Wilhelmina	15.97	2.15	48.63	107	12 34.50	- 5 59.6	31	108	86
	sep 4	16 11.5	119.86	204	686	Gersuind	12.00	8.89	22.82	207	132	Aethra	15.02	3.18	27.73	239	20 48.72	+14 35.2	142	32	99
	sep 9	15 52.6	23.42	352	4	Vesta	8.40	2.76	61.26	100	465	Alekto	15.91	2.26	48.40	106	8 29.47	+19 33.8	42	80	76
?	sep 19	8 18.8	4.79	192	206	Hersilia	14.43	2.70	50.34	107	758	Mancunia	14.83	2.14	36.73	108	15 28.11	-15 35.5	57	48	1
	sep 19	12 60.0	85.92	170	427	Galene	15.24	3.10	47.22	94	77	Frigga	14.32	2.81	39.10	97	16 25.36	-23 59.7	71	60	1
	oct 9	20 44.8	33.79	304	179	Klytaemnestra	13.43	3.42	35.14	88	417	Suevia	14.91	3.15	32.56	94	19 00.48	-15 57.3	88	158	66
	oct 25	0 16.1	101.65	62	1210	Morosovia	15.68	2.42	58.72	105	957	Camelia	15.81	2.24	51.58	96	16 15.89	-16 39.6	33	49	42
	oct 25	13 51.5	36.43	160	751	Faïna	13.91	3.40	47.08	91	1467	Mashona	15.28	2.23	25.10	111	9 30.97	+24 13.6	75	145	48
	oct 28	18 46.6	31.51	187	221	Eos	13.37	2.73	53.35	97	134340	Pluto	14.55	0.27	3.55	99	18 04.58	-18 09.7	55	67	77
	nov 12	1 55.2	33.22	110	2244	Tesla	15.73	5.50	6.17	306	3139	Shantou	15.83	3.61	18.64	219	6 30.51	+17 52.5	132	76	22
	nov 21	6 20.8	54.89	46	642	Clara	15.94	2.88	14.88	50	65	Cybele	12.82	2.83	16.17	69	22 49.80	- 8 59.1	101	53	22
	nov 26	15 38.2	20.85	205	310	Margarita	15.51	3.16	58.56	114	168	Sibylla	14.49	2.23	35.94	114	12 04.50	- 3 19.9	62	173	68
	nov 28	0 41.8	74.83	184	877	Walkure	14.98	4.62	50.62	66	1735	ITA	14.95	3.16	33.75	48	22 33.13	-13 46.4	89	38	80
	nov 29	21 22.9	103.13	150	916	America	15.97	3.01	76.79	81	471	Papagena	12.43	2.34	54.67	90	18 38.71	-28 06.7	31	115	92

THE ROTATION PERIOD OF 244 SITA

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

David Higgins
Hunters Hill Observatory (E14)
7 Mawalan Street
Ngunnawal ACT 2913 AUSTRALIA

(Received: 2008 July 22)

Data were acquired at both the Via Capote observatory in southern California, USA, and the Hunters Hill Observatory in Australia. A rotation period of 129.51 ± 0.03 h with a magnitude of 0.82 ± 0.25 mag was obtained in this collaborative effort.

The observations at the Via Capote Observatory were made using a Meade LX200 14-inch (356 mm) SCT working at f/10. The CCD imager was an Alta U6 featuring a 1024x1024 array of 24-micron pixels, working at 1x binning (1.44”/pixel). The observations at Hunters Hill Observatory were made using a 0.35-m Meade LX200GPS SCT working at f/10. The CCD imager was an SBIG ST-8E with 9-micron pixels, yielding an image scale of 1.31"/pixel. Download times were reduced by downloading sub-frames of 1148 x 765 pixels. The CCD was operating at a temperature of -15° C. Images at both observatories were dark and flat-field corrected. The table shows which sessions are due to each observer.

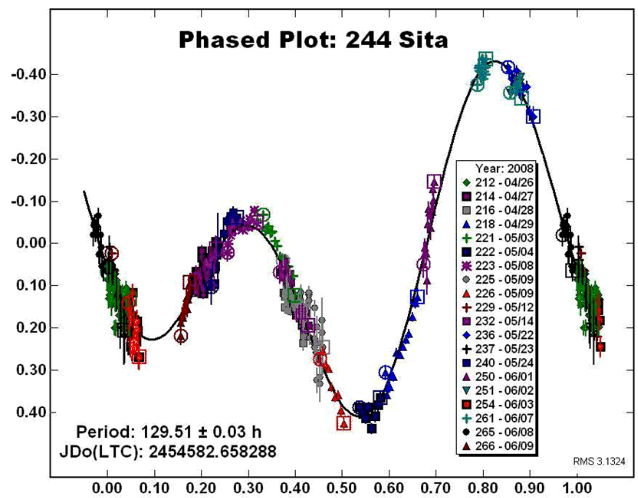
Images were measured using *MPO Canopus* (Bdw Publishing). All observations were made using unfiltered differential photometry and all data were light-time corrected. Period analysis was also done with *Canopus*, incorporating the Fourier analysis algorithm developed by Harris (1989). To make the lightcurve plot more readable, the original 1370 measurements were binned in sets of 5 with a maximum separation between individual data points of 7 min.

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.

	Date Range (mm/dd/2008)	Data Points	Phase	L_{PAB}	B_{PAB}
244 Sita	04/26 -06/09	421	12.7	208.35	0.3

Observer	Plot Sessions
Brinsfield	212, 214, 216, 225, 237, 250, 251, 254, 261, 265, 266
Higgins	218, 221, 222, 223, 226, 229, 232, 236, 240



PERIOD DETERMINATIONS FOR 33 POLYHYMNIA, 38 LEDA, 50 VIRGINIA, 189 PHTHIA, AND 290 BRUNA

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

(Received: 2008 October 15)

Synodic rotation periods and amplitudes have been found for: 33 Polyhymnia 18.609 ± 0.002 h, 0.15 ± 0.02 mag; 38 Leda 12.838 ± 0.001 h, 0.05 ± 0.01 mag; 50 Virginia 14.315 ± 0.001 h, 0.19 ± 0.02 mag; 189 Phthia 22.346 ± 0.001 h, 0.26 ± 0.02 mag; 290 Bruna 13.807 ± 0.001 h, 0.54 ± 0.04 mag.

The lightcurve periods and amplitudes for five asteroids were found following observations made at the Organ Mesa Observatory. The equipment consisted of a Meade 35-cm LX200 GPS Schmidt-Cassegrain, SBIG STL 1001-E CCD camera, and clear filter. Unguided exposures of 60 seconds were used for all objects, except 50 Virginia. Due to its brightness, exposures were limited to 15 seconds. Image measurements using differential photometry and the subsequent lightcurve analysis were done with *MPO Canopus*. Due to the large number of data points acquired for each target in this study, the lightcurves have been binned in sets of three data points with a maximum of five minutes between points.

33 Polyhymnia. The only previous published lightcurve is by Zappala *et al.* (1982), who observed on 12 nights, 1980 Aug. 15 - Sept. 14, and obtained a period 18.601 ± 0.004 h. The amplitude was 0.14 mag at opposition and increased to 0.17 mag at phase angle 10 degrees. This result was assigned a reliability value of U = 3 (secure) by Harris *et al.* (2008). The rationale for the new observations reported here is to provide data leading to a spin/shape model. Observations on seven nights, 2008 Apr. 1-29, show a period of 18.609 ± 0.002 h and amplitude of 0.15 ± 0.02 mag, in good agreement with the 1980 observations.

38 Leda. De Young and Schmidt (1996) observed 38 Leda on 8 nights, 1995 Nov. 16 – Dec. 10, near longitude 20 degrees, and obtained a bimodal lightcurve of period 12.84 h and amplitude of 0.16 mag. At that time, the lightcurve showed one minimum nearly twice as deep as the other. Observations at Organ Mesa on 8 nights, 2008 July 29 – Sept. 30, at longitudes 335-325 degrees, show a period of 12.838 ± 0.001 h with an amplitude of 0.05 ± 0.01 mag, which are consistent with De Young and Schmidt. The smaller amplitude shows that this object was closer to a polar aspect at the longitude of the new observations. Several other minima also appeared in the period spectrum, but lightcurves phased to these periods all had higher RMS residuals and showed appreciable misfits for some individual sessions. Hence I claim the 12.838 h period is the correct one.

50 Virginia. Harris *et al.* (2008) list different periods of >24h, 17.88 h, 14.31 h, 9.25 h, and 7.167 h for each of five references. This investigation was able to find a unique and reliable rotation period and eliminate all aliases. Observations on 9 nights, 2008 Sept. 4 - Oct. 17, show a period of 14.315 ± 0.001 h and amplitude of 0.19 ± 0.02 mag. The shape of the broad maximum at phases 0.10–0.50 changed considerably with changing phase angle through the interval of observation.

189 Phthia. Harris *et al.* (2008) state a period >15 h, amplitude >0.2, and U = 1 (most likely wrong). Observations on 13 nights, 2008 July 31 – Sept. 18, show a period of 22.346 ± 0.001 h and amplitude of 0.26 ± 0.02 mag, with complete multiple phase coverage. The shape and depth of the minimum near phase 0.65 changed considerably between the observations of Aug. 6-7 and Sept. 5-18, which is attributed to shadowing by topographic features at larger phase angles in September.

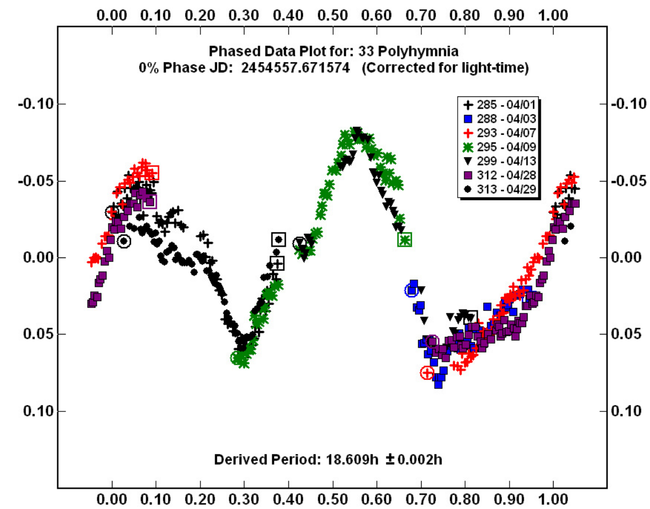
290 Bruna. Harris *et al.* (2008) list no previous photometric measurements. Observations on 9 nights, 2008 Mar. 13 – Apr. 24, show a period of 13.807 ± 0.001 h with complete phase coverage and an amplitude of 0.54 ± 0.04 mag. The minimum near phase 0.04 on Mar. 13 and 14 was about 0.07 mag deeper than those that followed. Just as for 189 Phthia, this is attributed to increased shadowing at larger phase angles and so the amplitude from Mar. 15 forward is 0.47 ± 0.03 mag.

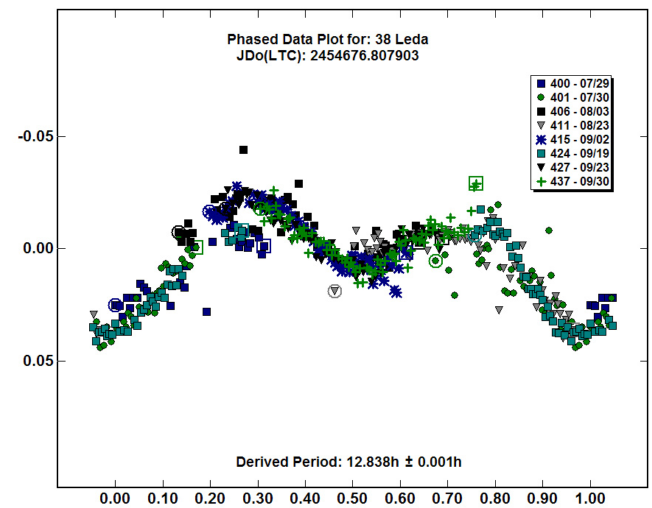
References

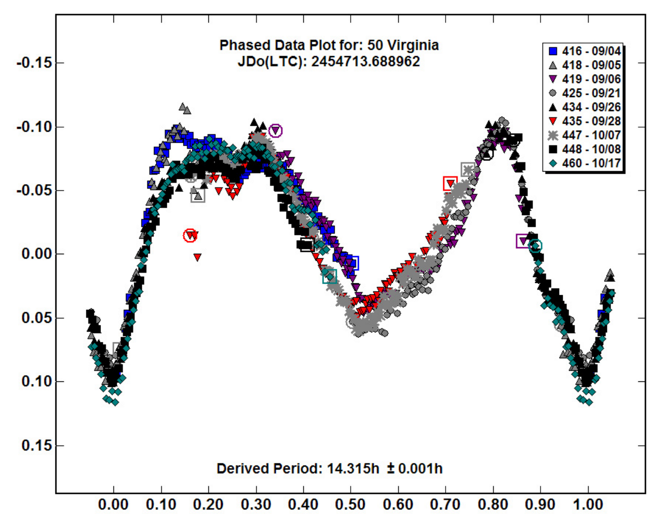
DeYoung, J.A. and Schmidt, R.E. (1996). "The Lightcurve and Period of the Minor Planet 38 Leda". *Minor Planet Bull.* **23**, 44.

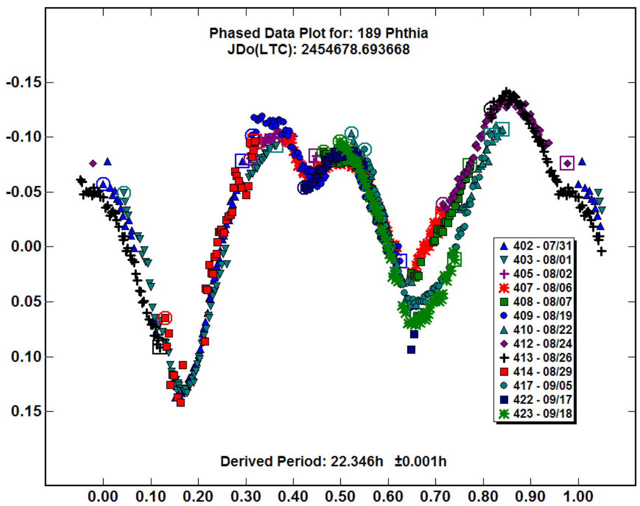
Harris, A.W., Warner, B.D., and Pravec, P. (2008). "Asteroid Lightcurve Data File, Revised Mar. 10, 2008." http://www.MinorPlanetObserver.com/astlc/default.htm.

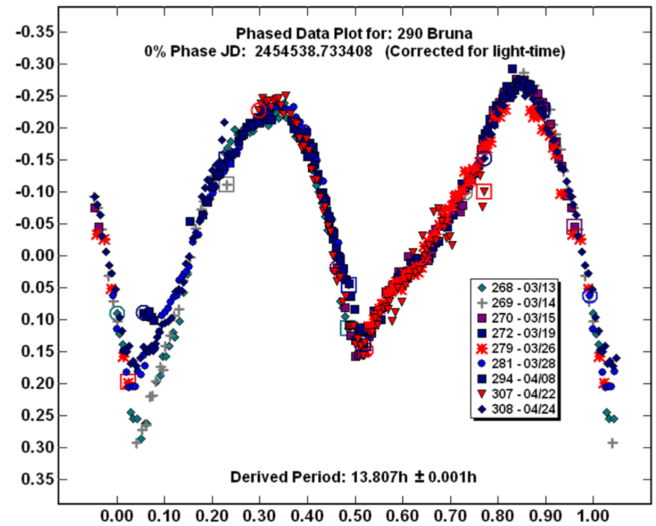
Zappala, V., Scaltriti, F., Lagerkvist, C.-I., Rickman, H., and Harris, A.W. (1982). "Photoeletric Photometry of Asteroids 33 Polyhymnia and 386 Siegena". *Icarus* **52,** 196-201.











CCD PHOTOMETRY OF 967 HELIONAPE, 3415 DANBY, (85275) 1994 LY, 2007 DT103, AND 2007 TU24

Gordana Apostolovska
Institute of Physics, Faculty of Science, Ss. Cyril and Methodius University, PO Box 162, 1000 Skopje, Republic of Macedonia
gordanaa@on.net.mk

Violeta Ivanova, Andon Kostov, Institute of Astronomy
Bulgarian Academy of Sciences, Sofia, Bulgaria

(Received: 2008 August 30)

The R-band lightcurves of asteroids 967 Helionape, 3415 Danby, (85275) 1994 LY, 2007 DT103 and 2007 TU24 are presented. The observations were obtained at the Bulgarian National Astronomical Observatory Rozhen (MPC Code 071) from 2007 August through 2008 February.

In the frame of the scientific project between the Institute of Astronomy, Bulgarian Academy of Science, and the Institute of Physics, Ss. Cyril and Methodius University, photometric observations of chosen minor planets were performed in order to investigate their rotational and physical characteristics. Here we present lightcurves of objects observed during one opposition and the calculated synodic periods.

The observations were made with the 50/70-cm Schmidt telescope at NAO Rozhen. The data for Helionape, Danby, 85275, and 2007 DT103 were obtained with an SBIG ST-8E (Kodak KAF-1602E, 1536 x 1024, 1 px = 9 microns square) CCD camera and data for 2007 TU24 were obtained with an ST11 000 (KAI-11000M, 4008 x 2672, 1 px = 9 microns square). All frames were dark subtracted and flat fielded. The R-band lightcurves were derived from the differential magnitudes between the asteroid and comparison stars. Aperture photometry was performed using the software program CCDPHOT (Buie, 1998). For lightcurve analysis, Asteroid Catalog Software (APC) was used (Magnuson *et al.* 1990). Composite lightcurves are presented in relative magnitudes. The amplitude of each lightcurve was measured using the highest and the lowest minima from the Fourier fit.

967 Helionape. This asteroid was observed as part of studies of the interrelations among Flora family asteroids (Kryszczynska *et al.* 2005). Its diameter is about 12 km and it has an albedo of 0.178. At the time of observation, the asteroid was at 17.^{m}4 and the solar phase was 21 degrees. On 2007 October 16 and 17, Helionape was observed for about 4 hours, an interval that covered the full lightcurve more than once. The obtained composite lightcurve has maxima with different amplitudes. The estimated synodic period of the object is 3.234 ± 0.002 h. The amplitude of the composite lightcurve, Fourier fitted of order 4, is 0.058 ± 0.005 mag. We found no other lightcurves for this asteroid in the literature.

3415 Danby. IRAS observations of this main belt asteroid give a diameter of 32.33 km and albedo of 0.08. At the time of observation, the asteroid was at 16.^{m}0 and the solar phase was 17.6 degrees. Danby was observed for about 3.5 hours on the nights 2007 August 15 and 16, making each run longer that than published period of 2.851 h. An additional run on August 17 covered less than two hours. Applying 2.851 h as the synodic period did not fit a composite lightcurve to our three nights of data. Construction of a composite lightcurve with a period 5.667 h and Fourier fit of order = 5 reveals the same shape (four minima and four maxima) as published and explained by Warner and Higgins (2008). The presence of the gap in our data probably lead to a slight difference in the obtained period 5.689 ± 0.006 h and amplitude 0.184 ± 0.015 mag.

(85275) 1994LY. This NEO belongs to the group of Amors. It was observed on 2007 August 13 for about 3.5 hours and on August 15 for less than 3 hours. Each night's observations covered more than one cycle of the asteroid. At the time of observation, the asteroid was at 14.^{m}3 and the solar phase angle was 55.6 degrees. This asteroid was observed by Brinsfield (2008), who obtained a period of 2.70 h and amplitude of 0.07 mag. Our composite lightcurve Fourier fitted (order 4) confirms this with a period of 2.6960 ± 0.0003 h. The difference in the shape of the two composite lightcurves and twice bigger amplitude, 0.16 ± 0.02 mag, is probably due to the high phase angle during our observations.

2007 DT103. This Apollo object has an estimated size of 390-870 m. Its quick fly-by in 2007 late July and early August at only 9.3 lunar distances from Earth classified it as a potentially hazardous asteroid. Radar observations at Goldstone on 2007 July showed evidence of a binary asteroid. At NAO Rozhen, 2007 DT103 was observed on 2007 August 12 for about 3 hours when the asteroid was at $15.^{m}6$ and the solar phase angle was 32.3 degrees. The lightcurve reveals the presence of two symmetrical extrema. However, the observing time-span is short and the obtained amplitude is only 0.07 ± 0.01 mag. We found a period of 2.703 ± 0.040 h, but we cannot exclude the existence of a different period.

<u>2007 TU24</u>. Radar data indicate this asteroid is somewhat asymmetrical in shape with a diameter roughly 250 meters in size. With its pass within 1.4 lunar distances from Earth on 2008 July 29, 2007 TU24 had the closest approach by a known potentially hazardous asteroid of its size or larger until 2027. We observed it on 2008 February 1 when the asteroid was at $13.^{m}4$ and the solar phase angle was 42.9 degrees. One night of observations covered 9 hours of the lightcurve, which reveals only one maximum. We constructed the lightcurve applying 26 hours as rotational period, as pre-published by Pravec (2008).

References

Brinsfield, J. (2008). "The Rotation Periods of 1465 Autonoma, 1656 Suomi, 4483 Petofi, 4853 Marielukac, and (85275) 1994 LY." *Minor Planet Bulletin* **35**, 23-24.

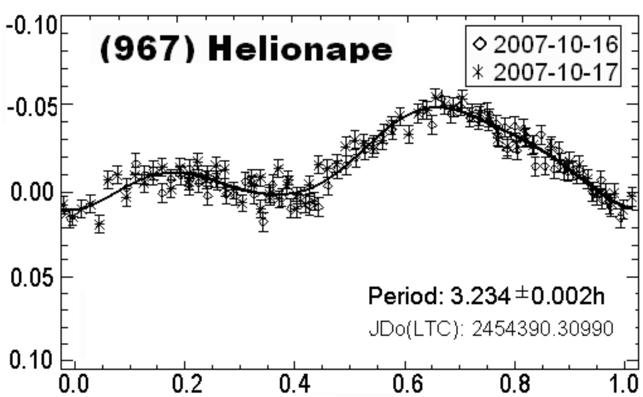
Buie, M. W. (1998). http://www.lowell.edu/users/buie/idl/ccdphot.html

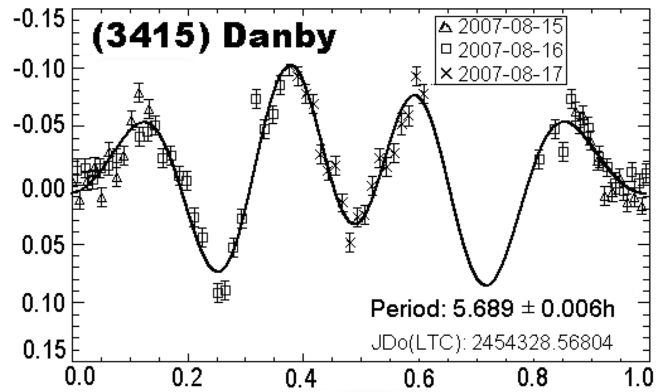
Kryszczynska, A., Colas, F., Ivanova, V., Velichko, F., Apostolovska, G., Michalowski, T., Marciniak, A., and Bilkina, B. (2005). "Photometry of the Flora family asteroids." *IAUS 229, ACM 2005*, *Abstract Book,* p. 80.

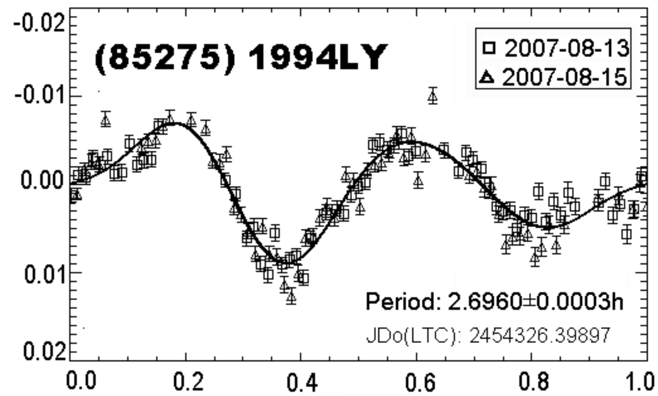
Magnuson, P. and Lagerkvist, C. I. (1990). "Analyses of Asteroid Lightcurves. I. Database and Basic Reduction." *Astron. Astrophys. Suppl. Ser.* **86**, 45-51.

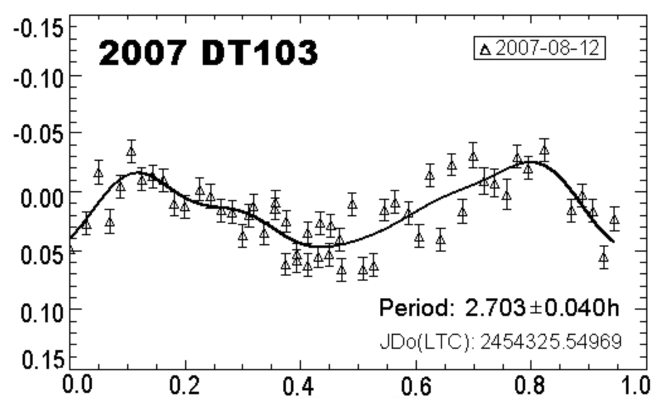
Pravec, P. (2008). http://www.asu.cas.cz/~ppravec/newres.htm

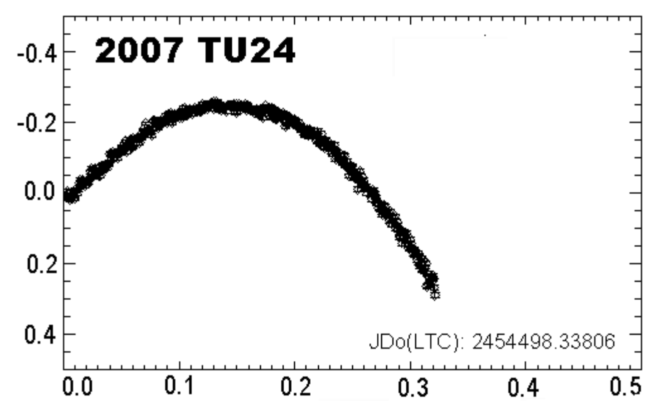
Warner, B. D. and Higgins, D. (2008). "Lightcurve Analysis of 3415 Danby." *Minor Planet Bulletin* **35**, 103.











THE LIGHTCURVE OF MINOR PLANET 3014 HUANGSUSHU

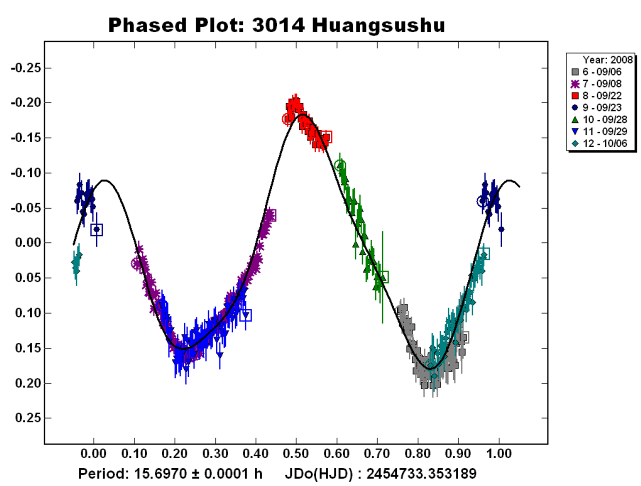
Stefano Moretti, Salvatore Tomaselli, and Alessandro Maitan
Bastia Obs. (MPC 197) – ARAR – Ravenna
Via dell'Osso, Bastia (Ravenna), ITALY
Stefanomoretti_001@fastwebnet.it

(Received: 2008 October 12)

Lightcurves of 3014 Huangsushu obtained in 2008 September reveal a rotation period of 15.6970 ± 0.0001 h and amplitude of about 0.35 mag.

Our lightcurve of 3014 Huangsushu is the second attempt of asteroid photometry observations from Osservatorio (ARAR) Don Molesi, Bastia, Ravenna, Italy (MPC 197). The target was selected from the list of asteroid photometry opportunities published by Warner *et al.* (2008). This list didn't show any available information about 3014 Huangsushu. In addition, no information was found on the Minor Planet Center "Minor Planet Lightcurve Parameters" web page, which is based on Harris and Warner (2006).

The observations were obtained with a Newton telescope D = 0.42 m and F = 2.250 m. The CCD camera was an Apogee Alta U260e with 60 s exposure times (S/N >100) and Schuler Clear filter. The observations were performed on the nights of 2008 Sept. 6, 8, 22, 23, 28, 29, and Oct. 6. All the measurements are compatible with a bimodal modulation. A total of 1015 measurements were made with the mean error for any single measurement varying from about 0.01 to 0.03 mag. The data were binned 3x3 before analysis and plotting in the lightcurve. Analysis of the combined data sets was made using *MPO Canopus*. The derived synodic rotation period is 15.697 ± 0.0001 h; the measured amplitude is about 0.35 mag.



UT Date	R.A.	Dec.	V
2008 Sept 06	23 26 12.6	-04 40 01	+14.4
2008 Sept 08	23 24 38.8	-04 51 53	+14.3
2008 Sept 22	23 13 59.7	-06 10 04	+14.6
2008 Sept 23	23 13 19.1	-06 14 55	+14.6
2008 Sept 28	23 10 14.2	-06 36 46	+14.8
2008 Sept 29	23 09 41.4	-06 40 36	+14.9
2008 Oct 06	23 06 37.6	-07 02 00	+15.1

References

Harris, A.W. and Warner, B.D. (2006). "Minor Planet Lightcurve Parameters. Updated March 14, 2006". http://cfa-www.harvard.edu/iau/lists/LightcurveDat.html

Warner, B.D. (2006). MPO Software, *Canopus* version 9.3.1.0. Bdw Publishing, http://minorplanetobserver.com/

Warner, B.D., Harris A.W., Pravec, P., Benner, L.A.M, and Durech, J. (2008). "Lightcurve Photometry Opportunities: September-October 2008". http://minorplanetobserver.com/

PERIOD DETERMINATIONS FOR 634 UTE AND 805 HORMUTHIA

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

Vladimir Benishek
Belgrade Astronomical Observatory
Volgina 7, 11060 Belgrade 38, Serbia

(Received: 2008 September 21)

Synodic rotation periods and amplitudes have been found for 634 Ute 11.7554 ± 0.0003 h, 0.17 ± 0.02 mag; and for 805 Hormuthia 9.510 ± 0.001 h, 0.05 ± 0.02 mag.

634 Ute. The only previous lightcurve is by Rene Roy and presented by Behrend (2008), which shows a period of 11.8 h and amplitude 0.13 ± 0.01 mag but with only 75% phase coverage. New observations on 22 nights by Pilcher were made from 2008 Apr. 17 through July 1 at the Organ Mesa Observatory. The equipment consisted of a Meade 35-cm LX200 GPS S-C, SBIG STL 1001-E CCD, and clear filter. Exposures were 60-s unguided. Image measurement using differential photometry and lightcurve analysis were done with *MPO Canopus*. Additional observations by Benishek on five nights, 2008 May 27 through June 2, were made at the Belgrade Observatory, about 127 degrees east in longitude from Organ Mesa, with a Meade 16" LX200 GPS f/10 S-C and Apogee AP47p CCD.

The first observations made by Pilcher on 2008 Apr. 17-19, a month before opposition, showed corresponding phases about 23.5 h apart, slightly less than an Earth commensurability. Subsequent observations were made at intervals of 3 to 7 days, each showing a phase slightly farther to the right on the lightcurve. The shape of any lightcurve changes slowly with phase angle, and can be appreciable during the interval of three weeks between sampling of the same portion of the lightcurve for a hypothetical 11.75 h period. This can make the 11.75 h period masquerade as a quadrimodal lightcurve with a 23.5 h period. Although Pilcher continued to obtain frequent lightcurves, the ambiguity between periods of 11.7554 h and 23.5111 h could not be resolved.

With a presumed 11.75 hour period, Benishek's five lightcurves show the same phase (position in the lightcurve) as Pilcher's on June 2-9 and overlapping in time should look identical. With a presumed 23.5 h period, these lightcurves would be of separated by one-half cycle. If the two sets of lightcurves are distinctly different, this is strong evidence for the quadrimodal longer period. Actually they look identical within observational error, which is evidence in favor of the shorter period but not conclusive. The two halves of the lightcurve phased to the longer period look almost the same, which again is evidence in favor of the shorter period with the usual bimodal lightcurve. The shorter period lightcurve, 11.7554 ± 0.0003 h and amplitude 0.17 ± 0.02 mag, binned in sets of five data points separated by no more than ten minutes to make it more readable, is included here.

P. Pravec (private communications) kindly evaluated the complete observation set and stated that "It [the period of 634 Ute] is 11.7554 ± 0.0002 h, U = 3. A period twice as long has low signal in odd harmonics and is therefore physically unlikely." The authors also noted that for the longer period the coefficients of the odd harmonics were much smaller than for the even harmonics.

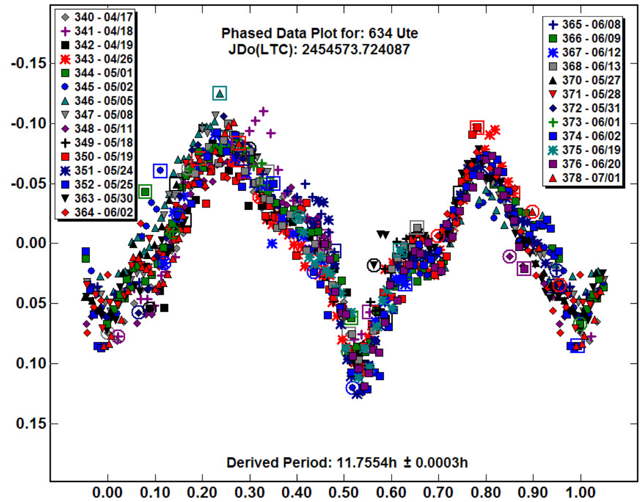
805 Hormuthia. Behrend (2008) states a period > 8 h and amplitude > 0.1 mag. Benishek obtained lightcurves on 13 nights, 2008 June 23 through July 11. Period determination was rendered difficult by a commensurability, and Pilcher at Organ Mesa Observatory obtained three additional lightcurves July 15-29 in an attempt to resolve the ambiguity. The period spectrum between 9.2 and 19.2 h shows four minima, of which we favor a solution of 9.510 ± 0.001 h, amplitude 0.05 ± 0.02 mag, and whose lightcurve binned in sets of three data points separated by no more than five minutes is included here. The minima are evenly spaced and the maxima look sufficiently different to rule out a monomodal solution of half this period. An 11.815 h period shows minima unevenly spaced at phases 0.0 and 0.6, respectively, in which the data points are more spread out in the better-observed broad maximum. However subsets of lightcurves including the data within the broad maxima show only 4.75 h between minima. The broad maximum is an artifact and we reject this solution. A 14.266 h period shows three maxima, two of which have identical shapes within observational error, and a 19.012 h period shows a quadrimodal lightcurve with the two halves appearing nearly identical to each other and to the 9.510 h lightcurve. These both imply shape models sufficiently symmetric that we consider them unrealistic for real asteroids. Hence we claim the 9.510 h period is the correct one.

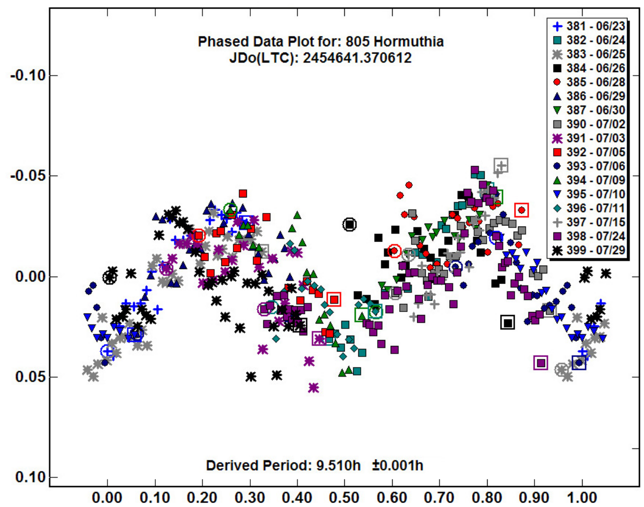
Acknowledgments

The authors thank P. Pravec for his independent period analysis of 634 Ute.

References

Behrend, R. (2008) http://obswww.unige.ch/~behrend/page_cou.html





LIGHTCURVE PHOTOMETRY OPPORTUNITIES: JANUARY – MARCH 2009

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

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

Petr Pravec
Astronomical Institute
CZ-25165 Ondřejov, CZECH REPUBLIC

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

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

We present here four lists of "targets of opportunity" for the period 2009 January – March. The first list is those asteroids reaching a favorable apparition during this period, are <15m at brightest, and have either no or poorly constrained lightcurve parameters. By "favorable" we mean the asteroid is unusually brighter than at other times and, in many cases, may not be so for many years. The goal for these asteroids is to find a well-determined rotation rate. Don't hesitate to solicit help from other observers at widely spread longitudes should the initial findings show that a single station may not be able to finish the job.

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

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Some asteroids have been on the list for some time, so work on them is strongly encouraged so that models can be completed. For modeling work, absolute photometry is recommended, meaning that data not differential magnitudes but absolute values put onto a standard system such as Johnson V. If this is not possible or practical, good relative photometry, where all differential values are based on a calibrated internal or standard zero point, is just as acceptable. When working any asteroid, keep in mind that the best results for shape and spin axis modeling come when lightcurves are obtained over a large range of phase angles within an apparition. If at all possible, try to get lightcurves not only close to opposition, but before and after, e.g., when the phase angle is 15° or more. This can be difficult at times but the extra effort can and will pay off.

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

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

Once you have data and have analyzed them, it's important that you publish your results, if not part of a pro-am collaboration, then in the *Minor Planet Bulletin.* It's also important to make the data available at least on a personal website or upon request. Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing as a guide and double-check your work. Those doing modeling should refer to the Database of Asteroid Models from Inversion Techniques (DAMIT) project at the Astronomical Institute of the Charles University, Czech Republic (*http://astro.troja.mff.cuni.cz/projects/asteroids3D*). Results and the original data for a large number of asteroid models can be browsed and downloaded at this location.

Funding for Warner and Harris in support of this article is provided by NASA grant NNG06GI32G and by National Science Foundation grant AST-0607505.

Lightcurve Opportunities

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
5732	1988 WC	1 03.1	14.8	-31	2	3.1	0.3
487	Venetia	1 03.2	11.3	+19	2	13.28	0.05-0.30
5079	Brubeck	1 05.6	15.0	+17			
3562	Ignatius	1 07.1	15.0	+25			
2678	Aavasaksa	1 08.5	14.4	+27			
5450	Sokrates	1 11.0	15.0	+17			
1003	Lilofee	1 14.5	13.5	+20	2+	8.23	0.56
1826	Miller	1 15.4	14.6	+16	1	6.77	0.06
946	Poesia	1 15.9	13.8	+23	?		
3566	Levitan	1 19.2	14.6	+20			
654	Zelinda	1 19.4	9.8	+ 5	2	31.9	0.3
3162	Nostalgia	1 20.7	14.9	+16			
5822	Masakichi	1 23.8	14.9	+26			
1548	Palomaa	1 30.0	15.0	+23			
1125	China	2 01.4	14.2	+20			
2296	Kugultinov	2 05.2	14.6	+18			
506	Marion	2 07.4	12.2	+12	2	10.59	0.23-0.70
	2006 AS2	2 08.5	14.8	+41			
	2008 EE5	2 11.1	14.7	+47			
630	Euphemia	2 15.9	14.0	+27	2	79.18	0.20
	1999 AQ10	2 17.1	13.1	-24			
4606	Saheki	2 17.3	14.5	+ 7			
2857	NOT	2 18.7	14.8	+12	2	5.63	0.28
807	Ceraskia	2 18.8	14.4	+16	2	7.4	0.25
6619	Kolya	2 19.4	14.4	+33			
740	Cantabia	2 20.6	12.6	+20	1	>24.	
4719	Burnaby	2 23.5	14.6	+15			
1678	Hveen	2 24.3	14.7	+13			

Lightcurve Opportunities (continued)

#	Name	Brightest Date	Mag	Dec	U	LCDB Data Period	Amp
318	Magdalena	2 24.7	13.4	+ 8	1	59.5	0.11
4640	Hara	2 24.8	14.8	+11			
4148	McCartney	2 25.2	14.7	+ 7			
1254	Erfordia	2 25.7	15.0	+ 2			
1755	Lorbach	2 28.0	14.6	+ 9			
34036	2000 OX27	3 01.3	14.5	+ 4			
4904	Makio	3 02.2	15.0	- 9			
2396	Kochi	3 03.1	14.8	+ 8			
52768	1998 OR2	3 04.2	14.7	+ 3			
2679	Kittisvaara	3 07.0	14.9	- 5			
5318	Dientzenhofer	3 07.1	15.0	+10			
5070	Arai	3 07.9	14.8	+ 4			
4457	van Gogh	3 12.0	14.9	- 3	2	7.60	0.12
46992	1998 TZ17	3 13.3	15.0	- 1			
6398	Timhunter	3 15.1	14.7	+34			
1344	Caubeta	3 17.9	14.7	+11			
1446	Sillanpaa	3 20.6	14.5	+ 3			
738	Alagasta	3 20.9	13.9	+ 4	2	17.83	0.20
671	Carnegia	3 22.1	14.0	- 1			
5604	1992 FE	3 24.6	14.5	-25	2	6.02	0.10
470	Kilia	3 24.9	12.3	+ 1	1		<0.2
3901	Nanjingdaxue	3 26.7	14.4	- 1			
2827	Vellamo	3 28.8	14.5	- 9			
992	Swasey	3 29.7	14.4	-10	2	13.30	0.17
2450	Ioannisiani	3 29.9	14.9	+ 0	?		

Low Phase Angle Opportunities

#	Name	Date	PhA	V	Dec	Period	AMin	AMax	U
462	Eriphyla	01 08.7	0.16	13.1	+22	8.64	0.14	0.25	2
507	Laodica	01 09.2	0.38	13.2	+23	4.705		0.22	3
537	Pauly	01 09.6	0.69	14.0	+19	16.250		0.17	2
1074	Beljawskya	01 11.0	0.43	13.5	+23	6.284	0.28	0.37	3
445	Edna	01 11.7	0.21	13.6	+22	19.97		0.21	2
40	Harmonia	01 12.2	0.97	9.5	+24	8.910	0.15	0.36	4
222	Lucia	01 12.9	0.46	13.9	+23	7.		0.33	2
1245	Calvinia	01 14.0	0.88	13.9	+19	4.84		0.63	3
1003	Lilofee	01 14.5	0.47	13.6	+20	8.230		0.56	2
656	Beagle	01 15.2	0.27	13.6	+20	7.035	0.9	1.2	3
946	Poesia	01 15.9	0.60	13.8	+23				
295	Theresia	01 29.6	0.96	13.3	+15	10.70		0.15	2
271	Penthesilea	01 31.2	0.71	13.9	+19				
288	Glauke	01 31.2	0.54	12.8	+19	1200.		0.9	3
744	Aguntina	02 01.0	0.75	14.0	+15	17.47		0.50	3
600	Musa	02 03.6	0.50	13.6	+15	5.8856		0.28	3
208	Lacrimosa	02 03.9	0.70	12.7	+18	14.085	0.31	0.35	3
27	Euterpe	02 04.1	0.98	8.8	+18	10.410	0.15	0.21	3
167	Urda	02 05.7	0.55	13.1	+14	13.07	0.36	0.39	3
301	Bavaria	02 08.8	0.15	13.7	+15	12.24		0.24	3
755	Quintilla	02 09.8	0.93	13.9	+12	4.551	0.08	0.38	3
602	Marianna	02 13.0	0.82	13.0	+16	30.		0.3	1
30	Urania	02 18.9	0.54	10.5	+10	13.686	0.11	0.45	3
318	Magdalena	02 24.7	0.51	13.5	+08	59.5		0.11	2
90	Antiope	02 27.4	0.85	13.3	+11	16.509	0.08	0.73	3
733	Mocia	03 02.3	0.15	13.3	+07	11.35		0.29	2
201	Penelope	03 06.6	0.42	12.7	+07	3.7474	0.15	0.73	4
112	Iphigenia	03 07.3	0.58	13.4	+04	31.466	0.30	0.50	3
973	Aralia	03 11.2	0.27	13.9	+03	7.29		0.25	2
291	Alice	03 13.2	0.35	13.2	+04	4.32	0.14	0.25	4
75	Eurydike	03 15.4	0.20	13.6	+03	5.357		0.12	3
29	Amphitrite	03 21.8	0.31	9.1	-01	5.390	0.01	0.15	4
34	Circe	03 23.2	0.17	11.3	-01	12.15		0.24	3
76	Freia	03 23.7	0.34	12.3	-02	9.972	0.10	0.33	4
388	Charybdis	03 27.1	0.62	12.8	-04	9.516		0.18	3

Shape/Spin Modeling Opportunities

#	Name	Brightest Date	Mag	Dec	Per (h)	Amp. (min)	Amp. (max)	U
50	Virginia	1 01.	13.0	+04	14.315	0.07	0.20	2
85	Io	1 01.	12.0	+07	6.875		0.15	3
114	Kassandra	1 01.	12.3	+13	10.758		0.25	3
137	Meliboea	1 01.	13.4	+06	15.13	0.11	0.20	2
145	Adeona	1 01.	11.6	+23	8.1		0.08	2
225	Henrietta	1 01.	14.6	+00	7.360	0.16	0.29	3
270	Anahita	1 01.	11.6	+22	15.06		0.32	3
281	Lucretia	1 01.	13.8	+33	4.348		0.38	3
376	Geometria	1 01.	13.2	+28	7.74	0.14	0.18	3
804	Hispania	1 01.	12.6	+30	14.845	0.19	0.24	3
852	Wladilena	1 01.	14.2	+53	4.6134	0.30	0.32	3

Shape/Spin Modeling Opportunities (continued)

#	Name	Brightest Date	Mag	Dec	Per (h)	Amp. (min)	Amp. (max)	U
487	Venetia	1 03.2	11.3	+19	13.28	0.05	0.30	2
537	Pauly	1 09.5	13.9	+19	16.250		0.17	2
40	Harmonia	1 12.1	9.5	+24	8.910	0.15	0.36	3
12	Victoria	1 23.6	11.2	+08	8.6599	0.08	0.35	3
1604	Tombaugh	1 25.7	14.9	+20	7.04		0.20	2
558	Carmen	1 30.4	12.7	+15	11.387	0.2	0.31	3
288	Glauke	1 31.3	12.7	+19	1200.		0.9	3
80	Sappho	2 03.0	11.5	+03	14.030	0.1	0.40	3
30	Urania	2 18.8	10.4	+10	13.686	0.11	0.45	3
704	Interamnia	3 01.7	11.1	-13	8.727	0.03	0.11	3
338	Budrosa	3 07.1	12.5	-02	4.6084	0.06	0.47	3
291	Alice	3 13.1	13.2	+04	4.313	0.14	0.25	3
34	Circe	3 23.1	11.2	-01	12.15		0.24	3
76	Freia	3 23.7	12.3	-02	9.969	0.10	0.33	3
83	Beatrix	3 29.7	11.0	-01	10.16	0.18	0.27	3

Radar-Optical Opportunities

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

2004 LV3

The observing window on this is very tight; larger instruments may be able to follow the asteroid for a few days before or after the ephemeris dates. There are no known lightcurve parameters. Note the ephemeris interval of 2 days.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
12/26	23 19.89	+26 14.8	0.071	0.983	16.03	87.9
12/28	0 23.37	+13 26.5	0.070	0.991	15.75	81.8
12/30	1 16.93	+ 0 35.1	0.076	0.998	15.76	76.3
01/01	1 58.59	- 9 31.8	0.088	1.006	15.98	72.5
01/03	2 30.14	-16 36.4	0.105	1.014	16.29	70.0

(136849) 1998 CS1

There are no known lightcurve parameters for this asteroid.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
12/25	8 18.08	+12 29.5	0.267	1.220	16.50	24.7
12/30	8 26.05	+13 02.9	0.208	1.172	15.83	23.0
01/04	8 38.07	+14 13.6	0.152	1.123	15.02	21.6
01/09	9 01.63	+16 50.6	0.099	1.074	13.99	22.1
01/14	10 16.15	+24 04.2	0.050	1.024	12.74	33.8
01/19	16 05.55	+22 04.8	0.032	0.975	14.22	106.1

2006 AS2

There are no known lightcurve parameters for this asteroid. Note the ephemeris interval of 2 days.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
01/30	7 54.18	+22 03.0	0.107	1.090	16.39	12.5
02/01	7 45.15	+23 41.7	0.090	1.071	16.11	16.8
02/03	7 31.56	+26 03.8	0.072	1.052	15.77	22.4
02/05	7 08.78	+29 41.8	0.055	1.033	15.39	30.3
02/07	6 23.49	+35 34.7	0.040	1.015	15.00	43.1
02/09	4 31.26	+43 25.6	0.027	0.997	14.86	67.5
02/11	0 57.69	+37 34.9	0.024	0.979	16.25	109.0

1999 AQ10

There are no known lightcurve parameters for this asteroid. Note the ephemeris interval of 3 days.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/01	11 54.27	+19 50.3	0.086	1.051	16.62	38.6
02/04	11 58.65	+18 26.6	0.071	1.041	16.17	37.6
02/07	12 04.05	+16 20.3	0.057	1.031	15.64	36.8
02/10	12 11.71	+12 49.7	0.043	1.021	14.99	36.7
02/13	12 24.91	+ 5 58.7	0.029	1.010	14.19	38.7
02/16	12 56.70	-11 34.0	0.017	0.999	13.29	49.6

2008 EE5

There are no known lightcurve parameters for this asteroid. Note the ephemeris interval of 2 days.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/05	16 44.42	+72 22.7	0.091	1.004	16.56	76.2
02/07	16 24.31	+83 17.6	0.070	1.005	15.87	72.6
02/09	5 14.42	+77 40.3	0.053	1.006	15.12	67.3
02/11	5 01.64	+48 26.6	0.046	1.007	14.70	63.4
02/13	4 59.01	+19 04.4	0.053	1.008	15.07	65.9
02/15	4 58.05	- 0 00.9	0.070	1.009	15.81	70.6
02/17	4 57.67	-11 03.5	0.091	1.009	16.49	73.9

1991 DB

There is a chance this asteroid is a binary. Using data from Ondřejov, Kharkiv, and IfA Hawaii, Pravec has reported deviations from the primary period of 2.266 h on two nights that might be due to a secondary (*http://www.asu.cas.cz/~ppravec/newres.htm*). While radar observations may resolve the question, independent lightcurve photometry with higher precision data, 0.01-0.03 mag, and – if possible – all data linked to an internal or standard system, will be a great help.

DATE	RA(2000)	DC(2000)	E.D.	S.D.	Mag	α
02/20	11 44.74	-02 09.0	0.192	1.164	16.21	22.0
03/02	12 37.05	+06 30.8	0.142	1.120	15.50	23.0
03/12	14 02.39	+20 25.5	0.115	1.083	15.39	37.1
03/22	15 55.71	+32 45.5	0.118	1.054	15.96	57.8
04/01	17 33.96	+37 05.6	0.142	1.035	16.75	71.6

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.

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

Nonmembers are invited to join ALPO by communicating with: Matthew L. Will, A.L.P.O. Membership Secretary, P.O. Box 13456, Springfield, IL 62791-3456 (will008@attglobal.net). The Minor Planets Section is directed by its Coordinator, Prof. Frederick Pilcher, 4438 Organ Mesa Loop, Las Cruces, NM 88011 USA (pilcher@ic.edu), assisted by Lawrence Garrett, 206 River Road, Fairfax, VT 05454 USA (LSGasteroid@msn.com). Steve Larson, Lunar and Planetary Laboratory, 1629 E. University Blvd., University of Arizona, Tucson, AZ 85721 USA (slarson@lpl.arizona.edu) is Scientific Advisor. The Asteroid Photometry Coordinator is Brian D. Warner, Palmer Divide Observatory, 17995 Bakers Farm Rd., Colorado Springs, CO 80908 USA (brian@MinorPlanetObserver.com).

Brian D. Warner (address above) is the *MPB* Acting Editor while Dr. Richard P. Binzel is on sabbatical (*MPB* **35**, p. 141***)***. The *MPB* is produced by Dr. Robert A. Werner, JPL MS 301-150, 4800 Oak Grove Drive, Pasadena, CA 91109 USA (robert.a.werner@jpl.nasa.gov) and distributed by Derald D. Nye.

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

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

Annual subscription rates for the *Minor Planet Bulletin* by postal delivery (North America):

Payment by check: $24.00
Payment by credit card: $25.00
Outside N.A.: $34.00/$35.00

To minimize our administrative time, please consider subscribing for two years. Users of the on-line *MPB* who are not paid subscribers are encouraged to make a voluntary contribution of $5 or more per year. Checks or money orders should be in US dollars, drawn on a US bank, and made payable to the “Minor Planet Bulletin.” To pay by credit card, (Visa, Mastercard, or Discover) please send by mail your credit card number, your name exactly as it appears on the card, and the expiration date. Be sure to specify the desired length of your subscription. Credit card charges will be made through “Roadrunner Mkt, Corona AZ.” When sending your subscription order, be sure to include your full mailing address and an email address, if available. The numbers in the upper-right corner of your mailing label indicate the volume and issue number with which your current subscription expires.

Authors are strongly encouraged to submit their manuscripts by electronic mail (brian@MinorPlanetObserver.com). Electronic submissions can be formatted either using a Microsoft Word template document available at the web page given above, or else as text-only. A printed version of the file and figures must also be sent. 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 (36-2) is January 15, 2009. The deadline for issue 36-3 is April 15, 2009.