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LIGHTCURVE ANALYSIS FOR 19848 YEUNGCHUCHIU

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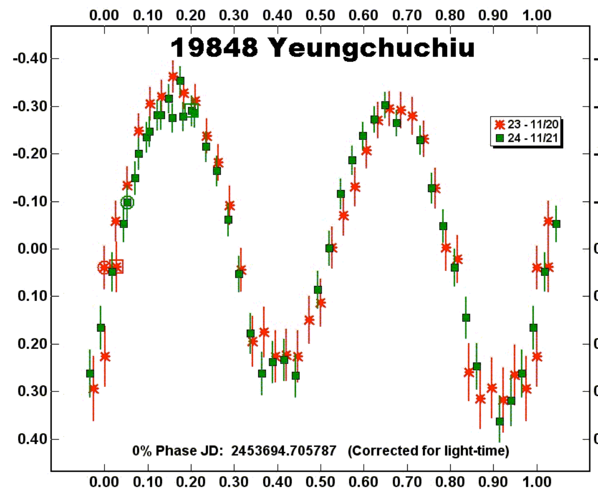
The lightcurve for asteroid 19848 Yeungchuchiu was measured using images taken in November 2005. The lightcurve was found to have a synodic period of 3.450±0.002h and amplitude of 0.70±0.03m.

Asteroid 19848 Yeungchuchiu was discovered in 2000 Oct. by the author at Desert Beaver Observatory, AZ, while it was about one degree away from Jupiter. It is named in honor of my father, Yeung Chu Chiu, who is a businessman in Hong Kong. I hoped to learn the art of photometry by studying the lightcurve of 19848 as my first solo project.

Using a remote 0.46m f/2.8 reflector and Apogee AP9E CCD camera located in New Mexico Skies (MPC code H07), images of the asteroid were obtained on the nights of 2005 Nov. 20 and 21. Exposures were 240 seconds. Dark frames were applied to the images but no flats before they were sent via ftp to my computer located in Benson, AZ.

The images were measured using MPO Canopus, which uses aperture photometry and was developed by Brian D. Warner. The period of the lightcurve data was then analyzed within Canopus, which implements the Fourier analysis algorithm developed by Harris (1989). The synodic period of the lightcurve was found to be 3.450±0.002h and its amplitude 0.70±0.03m. It is very fortunate to have lightcurve with such large amplitude and short period. In view of the fact that the whole cycle was captured on both nights, assuming two maxima and minima, the reported period is believed to be accurate and there is no alias.



The amplitude of 0.7 magnitude indicates that the long axis is about 2 times that of the shorter axis, as seen from the line of sight at that particular moment. Since both the maxima and minima have similar "height", it's likely that the rotational axis was almost perpendicular to the line of sight.

Many amateurs may have the misconception that photometry is a very difficult science. After this learning exercise I found that, at least where differential photometry is used, it is manageable and a fun experience. I am looking forward to doing more lightcurves and working more challenging targets.

Acknowledgements

My thanks to Brian D. Warner for lending a helping hand so that I could master the basics of the MPO Canopus photometry software.

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.

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IN MEMORIAM:
DENISE NYE 1946 - 2006

Subscribers to the *Minor Planet Bulletin* lost a friend on March 13, with the sudden passing of Denise Nye, wife for 33 years to our Distributor, Derald Nye. Derald's soul mate has been his unsung assistant for the management of subscriptions and mailings for the *MPB* for more than two decades. It is no accident that asteroid 3685 Derdenye commemorates Derald and Denise Nye as partners in life and as a team for their service to astronomy. Born in Paris, France, Denise moved with her family to Montreal at the age of 5 where she attended English speaking schools. A graduate of McGill University, she met Derald in 1972 and they married a year later. Denise retired from IBM in 2001, after a 20 year career. Two born travelers, Denise and Derald together visited every continent and more than 90 countries and island groups. In most cases the travel was linked to their common love of solar eclipses, with Denise logging travel in chasing 28 total and annular events. A celebration of Denise and her life was held in Tucson on May 7.

LIGHTCURVE ANALYSIS OF ASTEROIDS 300 GERALDINA, 573 RECHA, 629 BERNARDINA, 721 TABORA, 1547 NELE, AND 1600 VYSSOTSKY

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CCD images recorded in September-December 2005, using a 210mm Dall-Kirkham telescope, yielded lightcurves and periods for six asteroids: 300 Geraldina 6.842 ± 0.001h, 0.18 mag; 573 Recha, 7.164 ± 0.001h, 0.24 mag; 629 Bernardina 3.763± 0.001h, 0.45 mag; 721 Tabora, 7.982 ± 0.001h, 0.28 mag; 1547 Nele, 7.100 ± 0.001h, 0.50 mag; 1600 Vyssotsky, 3.201 ± 0.001h, 0.22 mag.

R.P. Feynman Observatory is located in a very small, but light polluted town in the south of Italy, at about 145m above the sea level. Observations were made using a 210mm f/11.5 Dall-Kirkham telescope and a Starlight SXV-H9 CCD camera. To obtain the maximum S/N ratio, all asteroid photometry data were taken using an IDAS clear filter. Image acquisition and standard calibrations were done using Astroart, published by MSB Software. Photometric measurements and lightcurves were prepared using MPO Canopus, by BDW Publishing. Differential photometry was used in all cases. In general, the complete data set was preserved until the last analysis stage, only deleting badly cloud-affected data after completing the period analysis.

Asteroids were selected using TheSky, published by Software Bisque, to locate those that were at an elevation angle of about 30° at the beginning of the observations. I chose asteroids that had a visible magnitude of 15 or brighter for good signal-to-noise ratio. The target asteroids were cross-checked with Alan Harris' list of lightcurve parameters (Harris, 2005). I tried to observe only those asteroids that had uncertain published results (code 2 in Harris' list). Results are described below.

300 Geraldina. I observed this asteroid over four nights, 2005 September 6, October 27, 31 and November 1. The period found was 6.842 ± 0.001h with an amplitude of 0.18 mag, in good agreement with that reported by Ivanova et al. (2002)

573 Recha. This is an intriguing asteroid. Observations were made on six nights, during the period from November 25, 2005, to December 24, 2005. The best fit of the data suggested a period of 7.164 ± 0.001h and an amplitude of 0.24 mag. This period is different from the lightcurve published by Warner (2002). He found the period to be 6.53h. However, as in the case of Warner's measurements, one session showed a strange behavior and was removed from the analysis as no amount of manipulation of zero points or period could bring it into agreement with the rest of the data. In particular, while the position of the extrema matched quite well, there was a difference in the amplitude of the curve between this anomalous session and the others. Additional observations in the next apparitions will help to resolve the mystery.

629 Bernardina. This object was previously reported to have a period of 4 hours, and classified by Harris (2005) as having an uncertain period. My data, collected over three nights, 2005 October 31, November 3 and 20, suggested a period of 3.763 ± 0.001h with an amplitude of 0.45 mag.

721 Tabora. The asteroid was chosen for study as there was a little ambiguity about the period (Zappalà et al., 1989). This is also an asteroid with a clear shape irregularity. Observations were made on five nights, during the period from November 3, 2005 to November 19, 2005. The data reveal a lightcurve with a 7.982 ± 0.001h period with a 0.28 mag amplitude.

1547 Nele. I observed this asteroid over four nights, 2005 November 10, 11, 12 and 19. The period found was 7.100 ± 0.001h with an amplitude of 0.50 mag, consistent with previously published result (Harris, 2005).

1600 Vyssotsky. Five nights from November 4, 2005 to November 19, 2005 were devoted to lightcurve photometry imaging of this asteroid. The period found was 3.201 ± 0.001h in very good agreement with that reported by Warner (1999), and with an amplitude of 0.22 mag.

Acknowledgements

Special thanks are given to Prof. Richard Binzel and Prof. Vincenzo Zappalà for their great kindness and for their ongoing support in my development in this area of research.

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Ivanova, V. G., Apostolovska, G., Borisov, G. B., Bilkina, B.I.: (2002), *Proc. ACM 2002*, ESA SP 500, 505-508.

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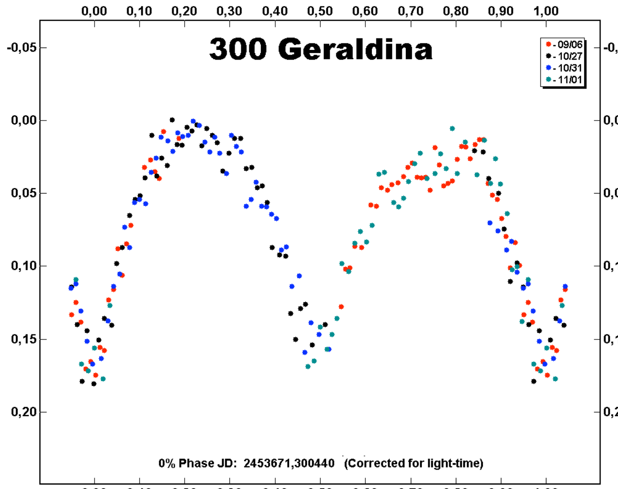
Zappala, V., Di Martino, M., Cellino, A., Farinella, P., De Sanctis, G., Ferreri, W. (1989). *Icarus* **82**, 354-368.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10/27
10/31
11/01
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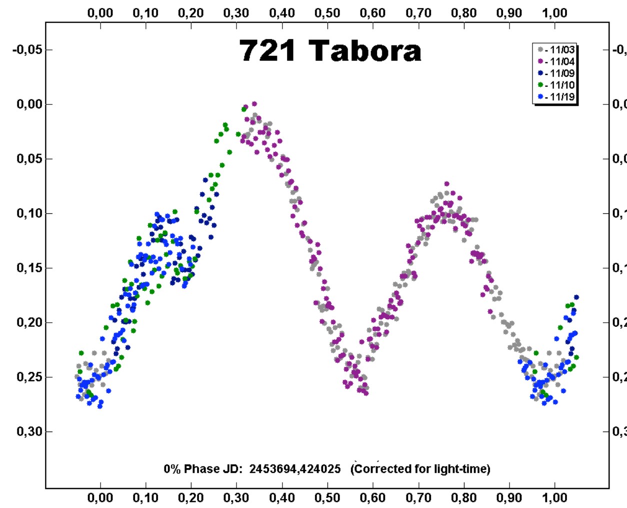
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11/04
11/09
11/10
11/19
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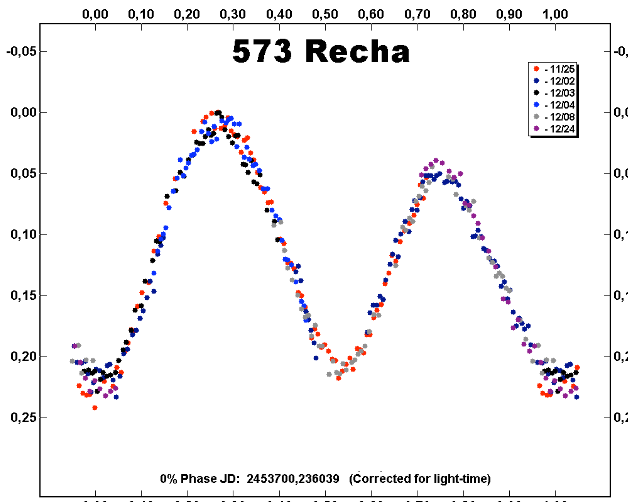
573 Recha
11/25
12/02
12/03
12/04
12/08
12/24
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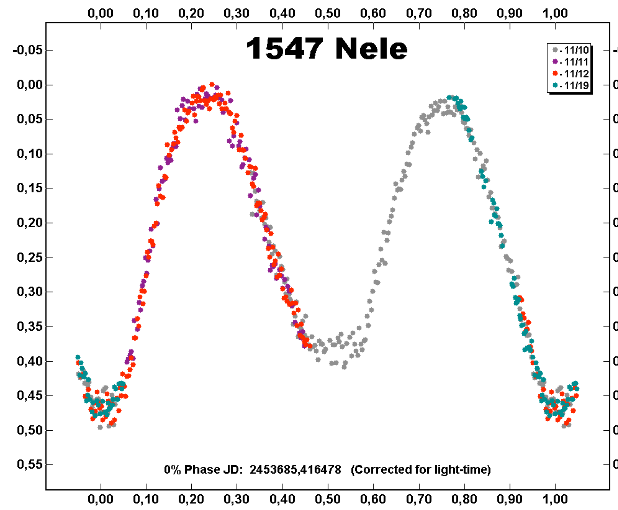
1547 Nele
11/10
11/11
11/12
11/19
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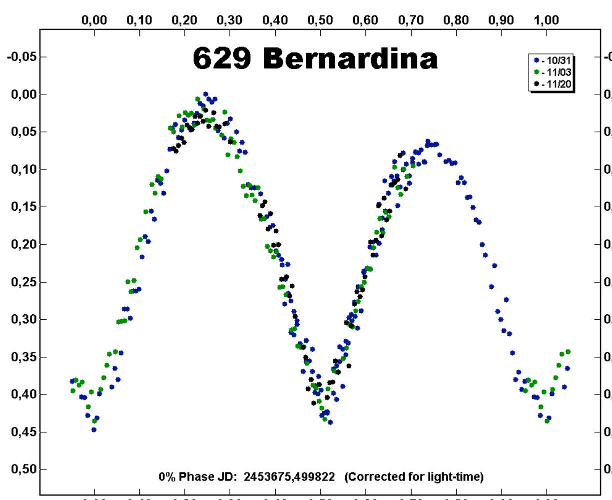
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10/31
11/03
11/20
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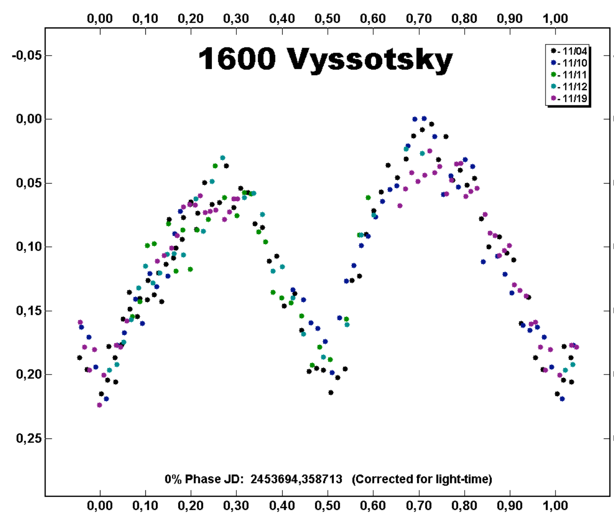
1600 Vyssotsky
11/04
11/10
11/11
11/12
11/19
0% Phase JD: 2453694,358713 (Corrected for light-time)

1857 PARCHOMENKO: A POSSIBLE MAIN-BELT BINARY ASTEROID

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Observations made in late 2005 and early 2006 of the main-belt asteroid, 1857 Parchomenko, show that its lightcurve has a synodic period of 3.1177±0.0001h and amplitude of 0.22±0.02mag. On three occasions, possible occultation or eclipse events were observed, thus suggesting that the asteroid may be binary.

Asteroid 1857 Parchomenko, a member of the Flora dynamical group, was observed over nearly a month in late 2005 and early 2006. Stephens observed from two locations: Santana Observatory in Rancho Cucamonga, CA, and the Goat Mountain Astronomical Research Station in Landers, CA. All images were corrected with flat fields and dark frames. They were measured using MPO Canopus, which employs differential aperture photometry to produce the raw data. Period analysis by Warner was done using Canopus, which incorporates the Fourier analysis algorithm developed by Harris (1989).

Observer	Scope / Camera	Dates
Stephens	0.30m / ST1001E 0.35m / ST1001E	11
Warner	0.35m / FLI1001E	2

Table I. Observer and equipment details

Date	Phase	PAB_L	PAB_B
2005 Dec 07	3.6	79.8	-2.4
2005 Dec 12	1.7	80.1	-2.6
2005 Jan 02	15.6	82.3	-3.4

Table II. Phase and Phase Angle Bisector values for 1857 Parchomenko.

Initial observations by Stephens were made between Dec. 7-24, 2005. During that time, two possible occultation or eclipse events were observed on Dec. 10, Dec. 24. The data were sent to Pravec, who agreed that the two events gave possible indication of events. Warner observed the asteroid on Jan. 2 and 4 and Stephens again on Dec. 25, Dec. 30, Jan. 1, Jan 4 and Jan 8. Stephens' Jan. 1 data also appeared to have caught part of an event. The asteroid soon faded and moved into the Milky Way, preventing further observations.

Assuming that the events were real and not observing artifacts, then using an event drop of 0.2m suggests a value for Ds/Dp of 0.4±0.1. The orbital period could not be reliably derived, but a possible solution is 55.8 h.

The next apparitions for this asteroid occur in May 2007 (15.3m/ –17°) and September 2008 (14.2m/+6°). The authors urge observers to give priority to this asteroid around those times to determine its true nature.

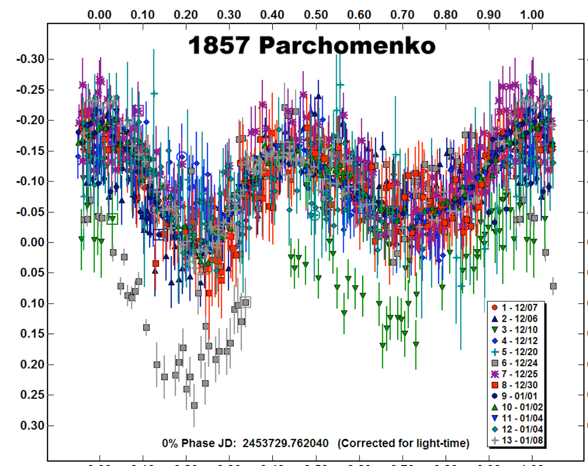

Figure 1. Data for 1857 Parchomenko phased to 3.1177h.

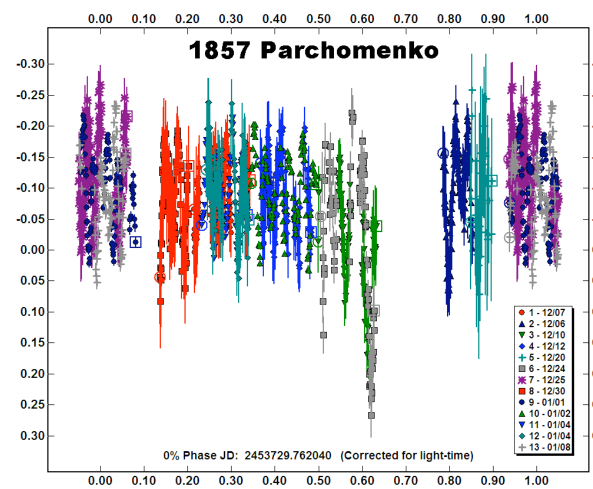

Figure 2. Data for 1857 Parchomenko phased to 55.8h.

Acknowledgements

The work at Ondrejov was supported by the Grant Agency of the Czech Republic, Grant 205/05/0604.

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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.

LIGHTCURVE RESULTS FOR 383 JANINA, 899 JOKASTE, 1825 KLARE, 2525 O'STEEN, 5064 TANCHOZURU, AND (17939) 1999 HH8

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Lightcurve period and amplitude results for six minor planets are reported from Bucknell University Observatory and the Rosemary Hill Observatory. 383 Janina, 4.636±0.001h, 0.13±0.02mag; 899 Jokaste, 6.2475±0.0005h, 0.1±0.03mag; 1825 Klare, 4.7429±0.0003h, 0.9±0.1mag; 2525 O'Steen, 5.538±0.001h, 0.35±0.1mag; 5064 Tanchozuru, 8.13±0.01h, 0.9±0.01 mag; (17939) 1999 HH8, 5.10±0.01h, 0.35±0.03mag. Also reported are indefinite period results for five objects in the hope that they may be useful for future observers: 978 Aidamina, 1007 Pawlowia, 1645 Waterfield, 4497 Taguchi, and (10374) 1996 GN19.

Bucknell Observatory is located on the campus of Bucknell University in Lewisburg, Pennsylvania. Two telescope/camera combinations were used for this study: 1) 20cm SCT with ST-7E CCD camera and, 2) a 35.4cm SCT with SBIG ST-9E. Rosemary Hill Observatory is situated near Bronsen, FL and is owned and operated by the University of Florida, Gainesville. Two telescope/camera setups were used. The first being a 76cm Newtonian with SBIG ST-9E. The second was a 46cm Ritchey-Chretien with SBIG ST-8E. Montgomery College Observatory is situated on the campus of Montgomery Community College in Rockville, Maryland. The main instrument is a 40cm SCT with SBIG ST-9E and f/6.3 focal reducer. ST-7 and ST-9 images were binned 1x1, while the ST-8 images were binned 2x2. All images were unfiltered and were reduced with dark frames and sky flats.

For the most part, the asteroids observed were chosen from the Collaborative Asteroid Lightcurve Link (CALL) home page that is maintained by Brian Warner. Image analysis was accomplished using differential aperture photometry with MPO Canopus. Period analysis was also done in Canopus, which implements the algorithm from Harris et al. (1989). Differential magnitudes were calculated using reference stars from the USNO-A 2.0 catalog and the UCAC2 catalog. Different comparison stars were used on different nights because of the asteroid's movement. Canopus compensates for night-to-night observation by offsetting each night's magnitude scales and then obtaining a best fit.

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

383 Janina. The lightcurve was clearly asymmetric with a derived period of 4.636±0.001h. The amplitude was quite small, only about 0.13 magnitude.

978 Aidamina. Observations were possible on two nights only. This, combined with a relatively large scatter in the data, meant that no clear period with a double peak could be derived. Out of several single peak possibilities, the one presented here of around 9.5 hours appeared to fit the data the best. It is hoped that this result will be of some use to observers at the next opposition.

1007 Pawlowia. This was a frustrating asteroid to work. Data from August and September were essentially flat, with an amplitude of less than 0.1 mag, almost as much as the scatter in the data. Later observations were hampered by poor conditions, with a resulting scatter greater than any possible variation. Using the earlier data, we found a possible period of around 8.23 hours.

1645 Waterfield. Observations of this asteroid were made on three nights. However, only one night resulted in usable data. Conditions on the other two nights were poor and resulted in data with such scatter as to be unusable. That one night indicated a single minimum for a period of about 5.6 hours and a small amplitude.

2525 O'Steen. The data for O'Steen was noisy and difficult to reduce. The best period I could derive was 5.538 hours; however the second peak is difficult to discern. There was a suggestion on two nights of a second dip in this region. Whether this is real or just noise I am uncertain.

4497 Taguchi. Two nights of observations resulted in a period of 5.343 hours. However the data are quite noisy. More work is required on this asteroid to confirm this period.

5064 Tanchozuru. Four nights of observations showed that this asteroid has a very asymmetric lightcurve, with the second peak being only about half the amplitude of the first peak.

(10374) 1996 GN19. Considerable difficulty was encountered when trying to determine the period for 10374 since the data are noisy. The best solution found was using a single peak, which resulted in a period of 11.54 hours, with an amplitude of about 0.8 mag. Attempts to fit this period to a double peak of about 23 hours were unsuccessful due to a large gap in the data.

(17939) 1999 HH8. Due to the relatively short duration of observations each night, no set of observations covered the entire lightcurve. The derived result is therefore somewhat uncertain.

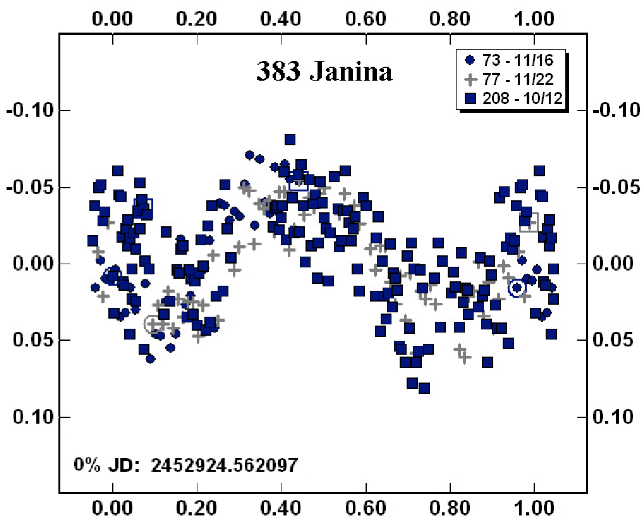
Acknowledgments

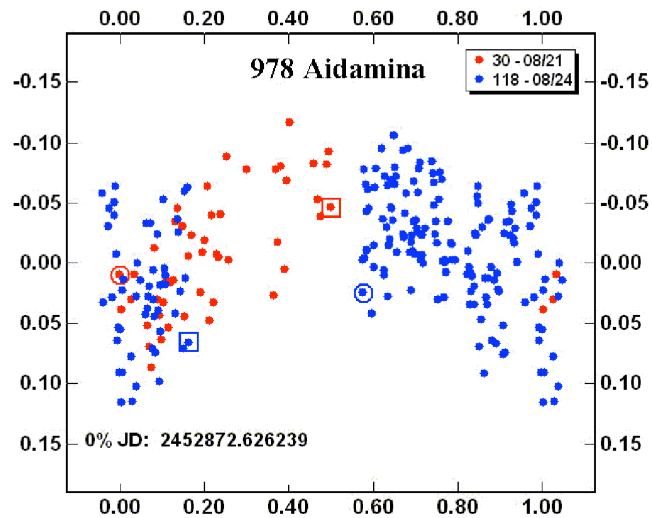
I would like to thank Dr John Oliver at the University of Florida at Gainesville for access to the Rosemary Hill Observatory, and Brian Warner for all of his work with the program "Canopus."

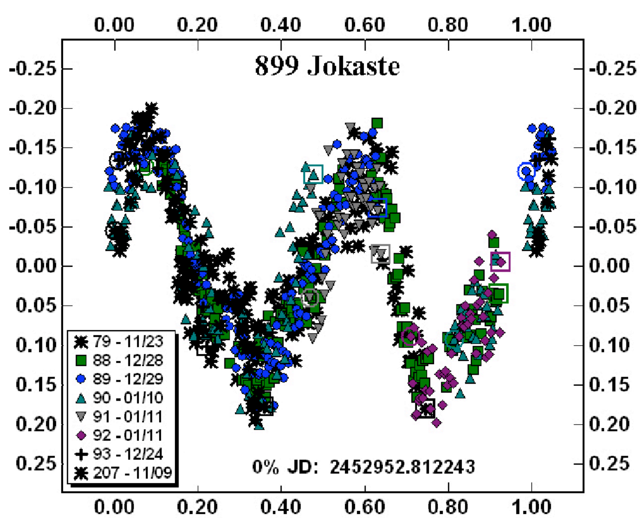
References

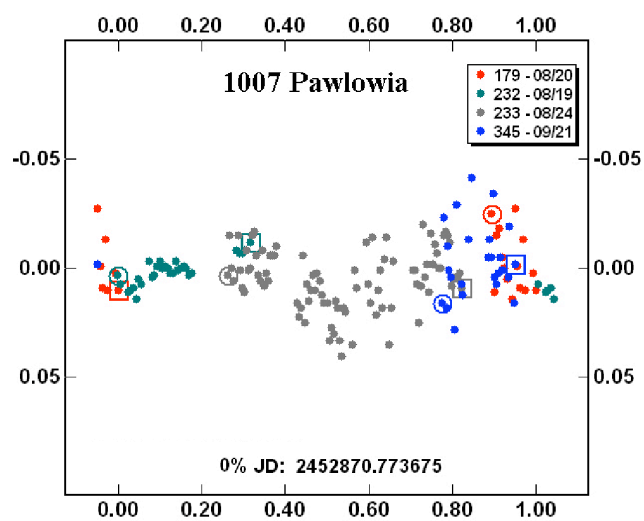
Harris, A. W., et al. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.

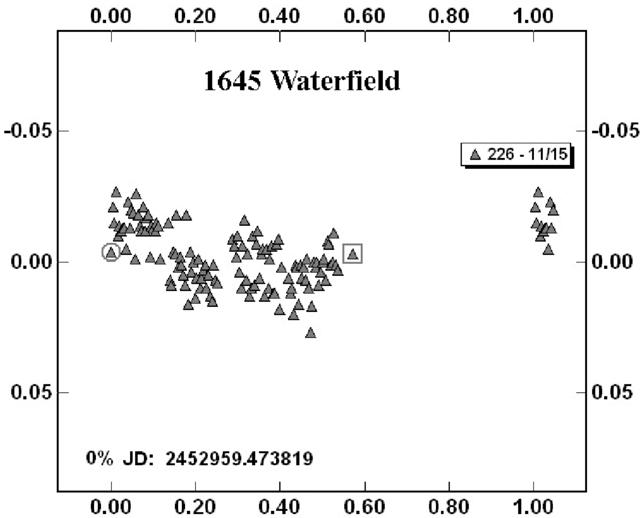
#	Name	Date Range	Sessions	Per (h)	Error (h)	Amplitude	Error
383	Janina	Oct 12 – Nov 23, 2003	4	4.636	0.001	0.13	0.02
899	Jokaste	Nov 9, 2003 – Jan 11, 2004	6	6.2475	0.0001	0.1	0.03
978	Aidamina	Aug 21 – Aug 28, 2003	2	9.5?	-	0.22	0.1
1007	Pawlowia	Aug 19, 2003 – Nov 11, 2003	7	8.23?	-	Flat	0.03
1645	Waterfield	Oct 12 – Nov 22, 2003	3	5.6?	0.1	0.05?	0.01
1825	Klare	Dec 28, 2003 – Jan 11, 2004	3	4.7429	0.0003	0.9	0.02
2525	O'Steen	Oct 12 – Dec 29, 2003	7	5.538	0.001	0.35	0.1
4497	Taguchi	Dec 28 – Dec 29, 2003	2	5.343	0.02	0.2	0.01
5064	Tanchozuru	June 4 – June 28, 2004	4	8.13	0.01	0.9	0.1
10374	1996 GN19	Aug 19 – Oct 14, 2003	5	11.54?	-	0.8	0.3
17939	1999 HH8	Aug 5 – Aug 28, 2003	4	5.10	0.01	0.35	0.03







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226 - 11/15
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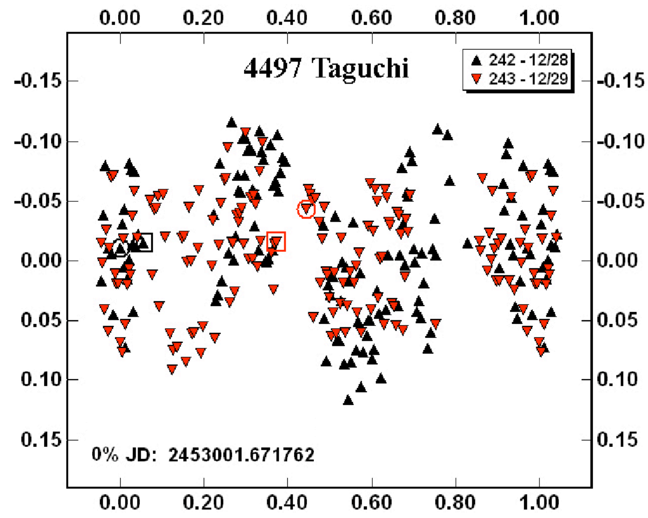
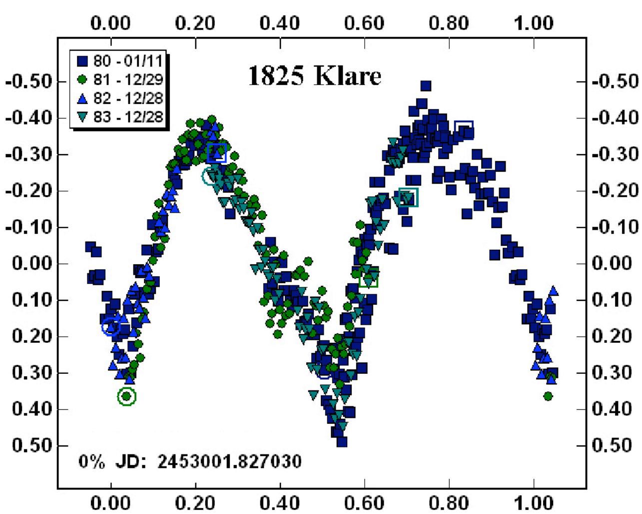

4497 Taguchi
242 - 12/28
243 - 12/29
0% JD: 2453001.671762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80 - 01/11
81 - 12/29
82 - 12/28
83 - 12/28
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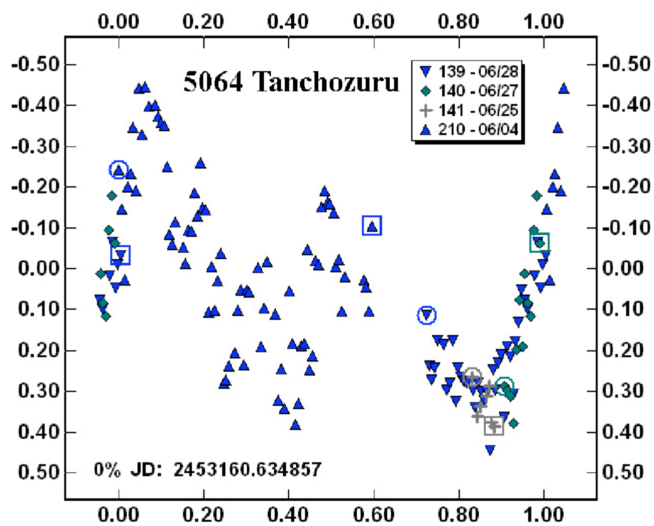
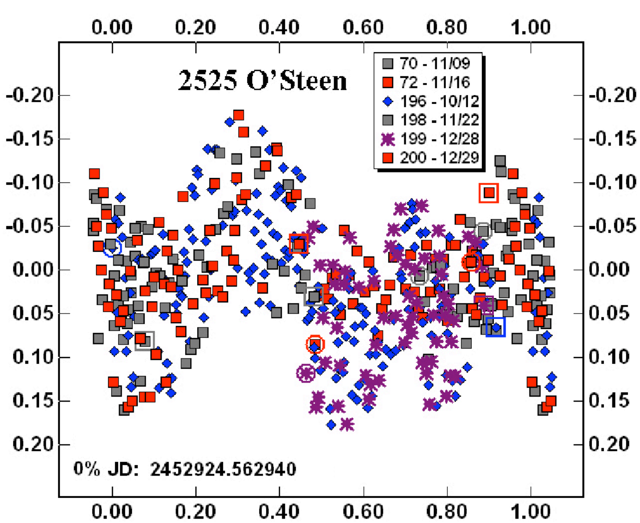

5064 Tanchozuru
139 - 06/28
140 - 06/27
141 - 06/25
210 - 06/04
0% JD: 2453160.634857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70 - 11/09
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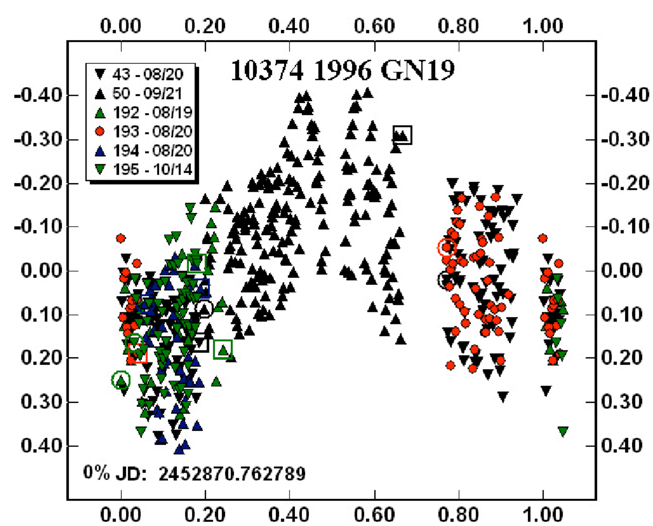
10374 1996 GN19
43 - 08/20
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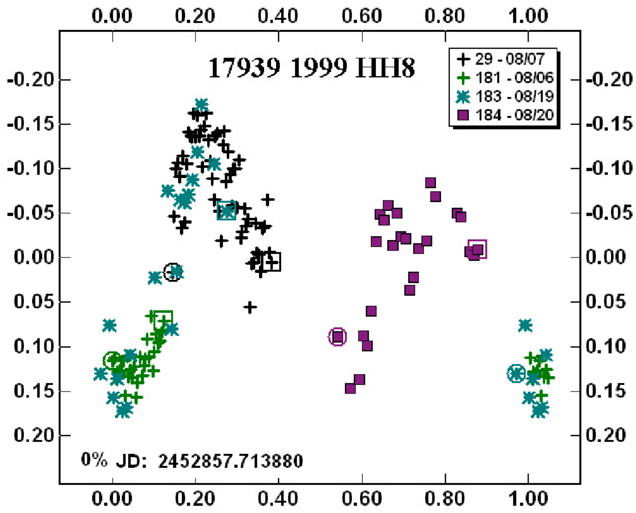

LIGHTCURVE ANALYSIS FOR (15362) 1996 ED

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The main-belt asteroid (15362) 1996 ED was observed in early 2006 at GMARS and Palmer Divide Observatories. The lightcurve was analyzed for its period and amplitude. The synodic period was found to be 31.4±0.1h and the amplitude to be 0.50±0.02mag.

Initial observations of (15362) 1996 ED were made by Stephens on January 28 and 29, 2006, at the Goat Mountain Astronomical Research Station (GMARS), which is owned by the Riverside Astronomical Society and located in Landers, CA. The initial data were sent to Petr Pravec, Ondrejov Observatory, Czech Republic, who confirmed that the period of the asteroid was likely >24h. Warner took over observing from the Palmer Divide Observatory from February 2-7. All images were unfiltered. Table I gives the equipment details.

Observer	Scope / Camera	Exp (s)
Stephens	0.35m / STL-1001E	120
Warner	0.35m / FLI-1001E	210

Table I. Observer and equipment details.

Table II shows the important observation details. Column 2 gives the phase angle for the date in Column 1. Columns 3 and 4 give the Phase Angle Bisector (PAB) longitude and latitude respectively.

Date	Phase	L_{PAB}	B_{PAB}
2006 Jan 28	5.2	127.6	8.1
2006 Feb 07	7.9	128.1	7.9

Table II. The phase and Phase Angle Bisector values for the extreme dates of observations for (15362) 1996 ED.

Images were dark frame and flat field corrected. Both authors used MPO Canopus for measuring reduced images. Canopus generates differential magnitudes from aperture photometry by using up to five comparison stars in the same field as the target. The data sets from each author were merged into a common set. Warner then used Canopus, which implements the Fourier analysis algorithm developed by Harris (1989), to conduct a period search.

Our included figure shows the data phased to the proposed period of 34.1±0.1h. The amplitude of the curve is 0.50±0.02mag.

Acknowledgements

The authors thank Petr Pravec, Ondrejov Observatory, Czech Republic, for his assistance in the data analysis.

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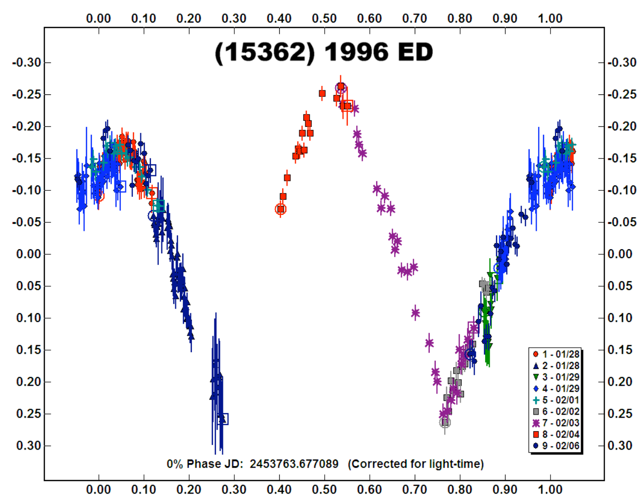

LETTER TO THE EDITOR

I have designed a simple mechanical device for drawing the lightcurves from bodies of all shapes and albedos. The method is shown by simple geometry by Kristensen (1991; *Astron. Nachr.* **312**, 209-220). *Minor Planet Bulletin* readers who may be interested in making a prototype of the device, from drawings I can provide, are encouraged to contact me.

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A NEW MAIN BELT BINARY ASTEROID: (34706) 2001 OP83

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In mid December 2005, observations by Warner and Pray of the main-belt asteroid, (34706) 2001 OP83, indicated it was a synchronous binary. Follow-up observations and analysis showed the primary rotation period to be 2.5944±0.0001h with a lightcurve amplitude of 0.13mag. The orbital period is 20.76±0.01h. Mutual eclipse/occultation events 0.08-0.17mag deep indicate a secondary to primary ratio (Ds/Dp) of 0.28±0.02.

Initial observations of (34706) were made by Warner on December 11 and 12, 2005. Warner sent his data to Pravec who agreed that there was reason to suspect that the asteroid might be binary. Pray independently started work on the asteroid on December 13 and contacted Warner and Pravec after that initial run expressing the same possibility. At that point, notice was put out to the Binary Asteroids group headed by Pravec asking for support for additional observations. More than 1100 data points were acquired from December 11 through 29, 2005. The goal throughout the campaign was to keep observational errors to 0.02m or less by using sufficient aperture and/or exposures.

Observer	Scope / Camera	Dates
Warner	0.50m / FLI-1001E	8
	0.35m / ST-9E	
Pray	0.25m / ST-7ME	6
	0.35m / ST-10XME	
Ku_nirák	0.65m / AP-7p	1
Cooney et al	0.35m / STL-1001E	3

Table I. Observer and equipment details.

Pravec did the primary lightcurve analysis using custom software developed at Ondrejov Observatory, the method has been described in Pravec et al. (2006). Warner did parallel calculations using the Harris Fourier analysis algorithm (Harris 1989). The authors made initial announcement of the discovery via a Central Bureau Electronic Telegram (CBET 341) in late December 2005.

The data analysis showed that the primary's rotation period is 2.5944±0.0001h. The lightcurve amplitude of 0.13mag indicates a nearly spherical shape. The orbital period is 20.76±0.01h. Based on occultation and eclipse events with amplitudes of 0.08-0.17mag, the secondary to primary size ratio is 0.28±0.02.

Date	Phase	L_{PAB}	B_{PAB}
2005 Dec 11	4.5	76.0	3.3
2005 Dec 28	17.5	80.6	6.7

Table II. The phase and Phase Angle Bisector values for the extreme dates of observations for (34706) 2001 OP83.

Figure 1a shows a composite lightcurve. Figure 1b shows the lightcurve with the primary rotation period removed and showing the variations due to the occultation and eclipse events, i.e., the orbital period of the system, and a low-amplitude variation due to secondary's rotation (consistent with being synchronous with the orbital motion). Figure 1c removed the long-term variations and reveals the lightcurve of the primary.

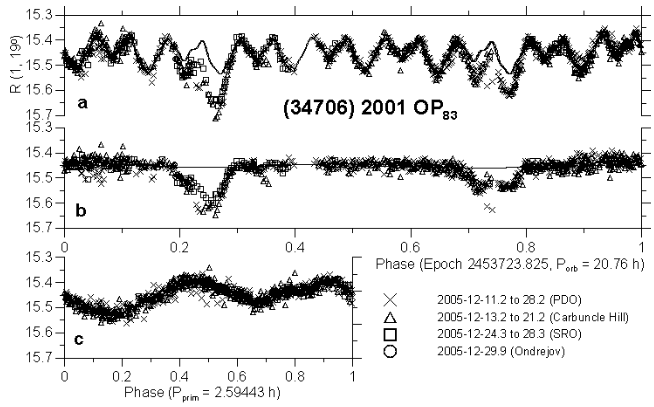

Figure 1. The composite and individual curves for 2001 OP83.

The observations made at Ondrejov Observatory used the Rc filter and were calibrated in the Cousins R system. Assuming a value of G=0.15±0.20, the derived H_R=14.48±0.20. Assuming a V-R value of 0.42, this gives H_V=14.90. This is slightly fainter than the current listing in the MPCORB file (MPC 2006) of H_V=14.7 but within the stated error.

Acknowledgements

The work at Ondrejov was supported by the Grant Agency of the Czech Republic, Grant 205/05/0604.

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ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY – LATE 2005 AND EARLY 2006

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(Received: 14 Feb)

Lightcurves for 23 of 24 asteroids were obtained at the Palmer Divide Observatory from November 2005 through early February 2006: 224 Oceana, 332 Siri, 494 Virtus, 549 Jessonda, 573 Recha, 596 Scheila, 773 Irmintraud, 840 Zenobia, 1207 Ostenia, 1238 Predappia, 1613 Smiley, 1694 Kaiser, 2839 Annette, 2856 Roser, 3511 Tsvetaeva, 3635 Kreutz, 3873 Roddy, 4283 Stoffler, 4547 Massachusetts, (5877) 1990 FP, (18582) 1997 XK9, and (21056) 1991 CA1. In addition, a revised period for 1582 Martir based on data obtained in 2000 is presented.

Observations of 23 asteroids were made at the Palmer Divide Observatory from late 2005 to early 2006. One of three telescopes/camera combinations was used: 0.5m Ritchey-Chretien/FLI-100E, 0.35m SCT/FLI-1001E, or 0.35m SCT/ST-9E. The scale for each was about 2.4 arcseconds/pixel. Exposure times were 120–240s, all unguided. The operating temperature for the FLI cameras was –30°C while the ST-9E was run between –15° to –30°C, depending on ambient conditions. The observations for 1582 Martir used the 0.5m R-C, ST-8, and focal reducer.

When selecting targets, first priority was given to members of the Hungaria group, those being part of an ongoing study at the Palmer Divide Observatory. When no suitable Hungarias were available, other targets were chosen by comparing the list of known lightcurve periods maintained by Harris and Warner (Harris 2006) against a list of well placed asteroids. Asteroids were often selected with the intent of removing the observational biases against faint objects (due to size and/or distance) as well as those with lightcurves of small amplitudes, long periods, or a complex nature. All images were measured using MPO Canopus, which employs differential aperture photometry to determine the values used for analysis. The period analysis was also done within Canopus, which incorporates the Fourier analysis algorithm developed by Harris (1989).

The results are summarized in the table below. The individual plots are presented afterwards. The data and curves are presented without comment except when additional details are warranted. Column 3 gives the full range of dates of observations while column 4 gives the number of data points used in the analysis. Column 5 is the range of phase angles over the full date range. If there are three values in the column, this means the phase angle reached a minimum with the middle value being the minimum. 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 hour and magnitudes.

<u>224 Oceana</u>. This asteroid was worked in support of radar observations being made by Dr. Michael Shepard of Bloomsburg University (PA). After several nights, there were indications of some unusual behavior and speculation that the asteroid might be in non-principal axis (NPA) rotation. Alan Harris of Space Science Institute and Petr Pravec of Ondrejov Observatory, Czech Republic, joined in the analysis from early on (Harris and Pravec –

#	Name	Date Range (mm/dd) 2005/06	Data Pts	Phase	L_{PAB}	B_{PAB}	Per (h)	PE	Amp (m)	AE
224	Oceana	01/19-01/25	1064	3.0,4.8	115.3	6.1	9.385	0.003	0.10	0.02
332	Siri	01/13-01/23	213	19.4,20.3	52.7-54.4	1.6	6.003	0.001	0.10	0.02
494	Virtus	12/15-12/22	90	18.0,18.4	15.2-16.3	-1.7	5.57	0.01	0.12	0.02
549	Jessonda	01/14-01/23	223	28.0,29.0	53.4-56.4	3.1	5.938	0.002	0.10	0.02
573	Recha	12/08–12/10	250	8.0,8.6	61.0	12.2	7.165	0.002	0.22	0.02
596	Scheila	01/10-01/24	303	10.7,8.0	135.6	15.7	15.848	0.007	0.09	0.02
773	Irmintraud	12/08-12/11	176	8.1,7.4	90.0	16.8	6.750	0.002	0.15	0.02
840	Zenobia	12/14-12-16	165	15.3,15.6	29.7	9.2	5.565	0.005	0.20	0.02
1207	Ostenia	01/31-02/02	134	5.7,6.1	124.2	12.5	9.073	0.004	0.60	0.02
1238	Predappia	01/30-02/02	99	8.7,9.2	125.5	15.9	8.94	0.02	0.03	0.01
1582	Martir	05/05-21 2000	182	7.3,11.9	214.0	12.3	15.668	0.004	0.36	0.02
1613	Smiley	01/13-01/30	502	11.9,6.0	133.7	2.1	81.0	0.1	0.30	0.02
1694	Kaiser	01/25-01/29	265	8.5,9.6	115.0	14.2	13.23	0.02	0.13	0.02
2839	Annette	12/15-12/22	154	24.7,26.7	43.1	1.2	10.457	0.003	0.92	0.03
2856	Roser	01/27-01/29	201	5.9,6.4	116.3	11.9	13.73	0.01	0.49	0.02
3511	Tsvetaeva	12/28-01/02	231	9.4,11.7	80.9	-7.0	6.2279	0.0004	0.87	0.02
3635	Kreutz	12/08-12/12	114	9.4,12.0	68.9	-9.8	39	2	0.20	0.02
3873	Roddy	11/30-12/11	105	29.7,27.3	114.0	-17.0	2.4782	0.0002	0.09	0.02
4283	Stoffler	12/30-01/08	232	17.9,19.2	87.7	28.4	98	5	0.46	0.02
4547	Massachusetts	01/30-01/31	133	9.2,9.3	122.6	19.0	7.703	0.005	0.29	0.02
5877	1990 FP	01/27-02/01	126	6.1,6.8	126.5	12.5	8.91	0.01	0.09	0.02
18582	1997 XK9	11/21-12/01	175	1.2,0.8,6.0	60.2	-1.8	114	10	0.94	0.02
19164	1991 AU1	12/24-01/24	480	24.7,14.7	119.6,122.2	24.2,19.6	32.492	0.006	0.25	0.02
21056	1991 CA1	01/04-01/08	163	13.3,10.3	117.1	-9.1	5.584	0.004	0.10	0.02

private communications). After the data were linked to a standard magnitude system, Pravec found that much of the behavior could be accounted for by assuming a value of –0.12 for the slope parameter (G) instead of the assumed value of 0.15. It is now considered highly unlikely that the asteroid is "tumbling".

The period reported here differs from that previously published by Harris (1980) of 18.933h. However, that longer period agrees closely with an alternate solution of 18.785h found by Pravec using the PDO data. Therefore, there remains some ambiguity in the solution, though Harris and Pravec agree that the shorter period is more likely. Shepard will publish further analysis in light of these and the original radar observations at a later date.

332 Siri. Lagerkvist (1978) and Cieza (1999) have both reported a period of 7.0h, The data from PDO was tested against this period and did not provide a reasonable fit.

549 Jessonda. Only one previously reported period could be found, that being 4.5h posted on the CALL site by Stephen Brincat (CALL 2006). That lightcurve does not seem to have been published. Behrend (2006) indicated an amplitude of 0.03mag but no period while Szekely (2005) also gave only an amplitude, >0.15mag.

573 Recha. Originally worked in 2001 by Warner (2002), the data was somewhat sparse and the solution fit to a period of 6.53h was not ideal. The asteroid presented itself again in 2005 and so the opportunity was taken to work it again in hopes of checking and/or refining the previous results. The 2005 data showed that a new period of 7.165h should be adopted, a solution that worked well using the 2001 data.

596 Scheila. Behrend (2006) has reported a period of 19.081h. However, it was given a U=1 rating in the Harris lightcurve list (Harris 2006). The data obtained at PDO shows that a period of 15.848h is a more likely solution.

773 Irmintraud. Holliday (2001) had previously found a precise period of 6.7514h. The PDO work was mainly in support of shape modeling but provided confirmation of the previous period.

1207 Ostenia. Lagerkvist worked this asteroid twice before. In 1978 (Lagerkvist 1978) a period of 7.7h was reported. A year later (Lagerkvist 1979), a period of 8.4h was assigned. Both of these were tested with the 2006 data and did not yield a reasonable fit. The period of 9.073h reported here is more likely correct.

1238 Predappia. The period of 8.94h is based on a monomodal solution. A bimodal solution, with a poorer fit and standard deviation, of 17.89h remains a possibility. One explanation that might favor the shorter solution is if the viewing aspect in 2005 was nearly pole-on. Given this assumption and the low amplitude, this seems to be a reasonable possibility and would parallel the interpretation presented by Warner et al (2005) for 6249 Jennifer.

1582 Martir. Warner (2000) previously reported a period of 15.757h. During a re-examination of the original data for several asteroids including Martir, it was found that a slightly shorter period of 15.668h was required to provide an acceptable fit of the data.

1694 Kaiser. R.A. Koff posted a result of 9.0h on the CALL site (CALL 2006) but noted coverage was incomplete and the solution uncertain. The data from PDO in 2005 show an unusual curve that is almost monomodal. Attempts to find a bimodal solution found no acceptable fit of the data.

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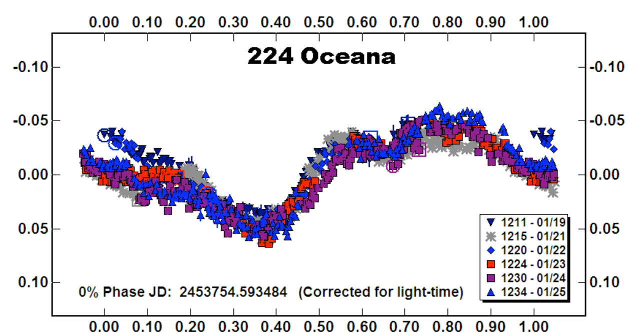

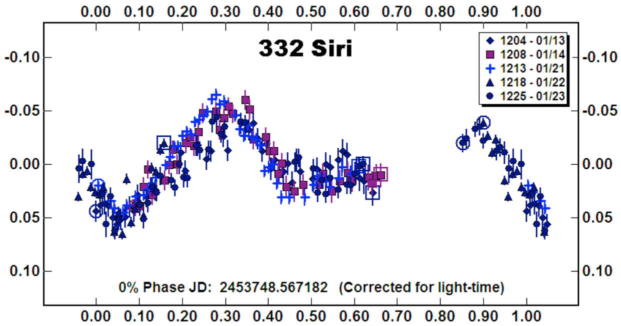
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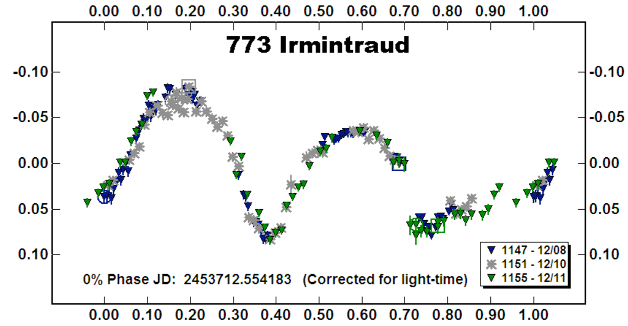
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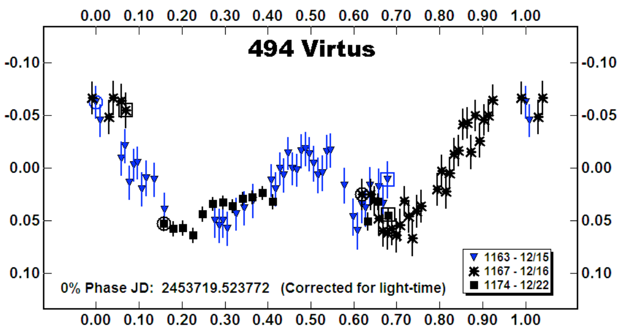
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1167 - 12/16
1174 - 12/22
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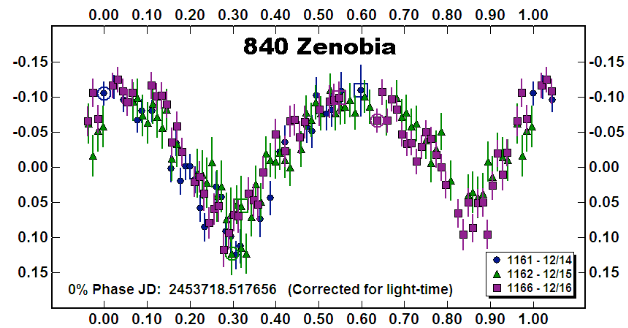
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1166 - 12/16
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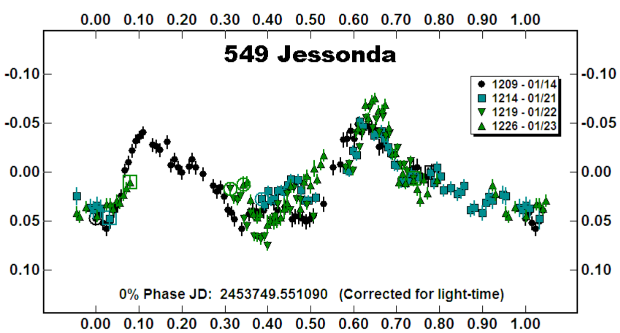
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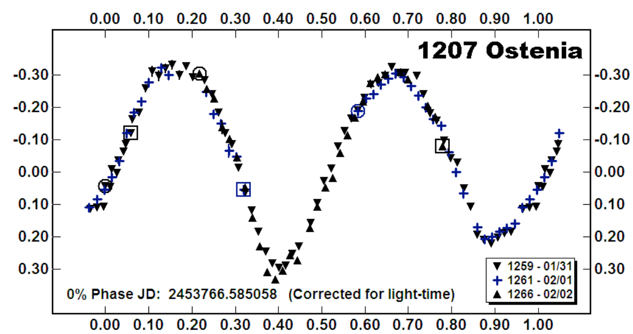
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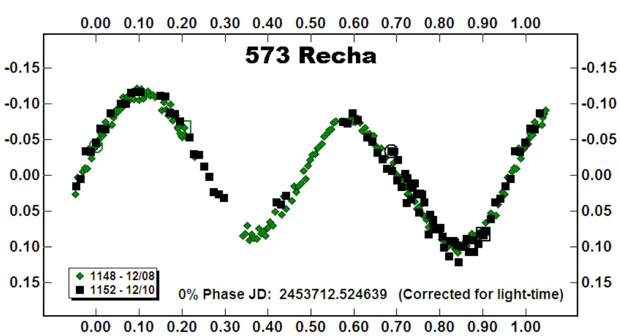
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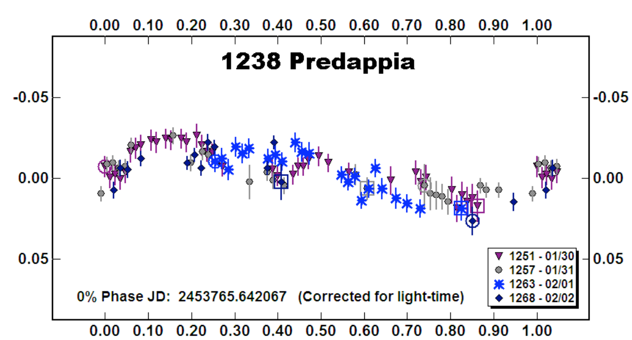
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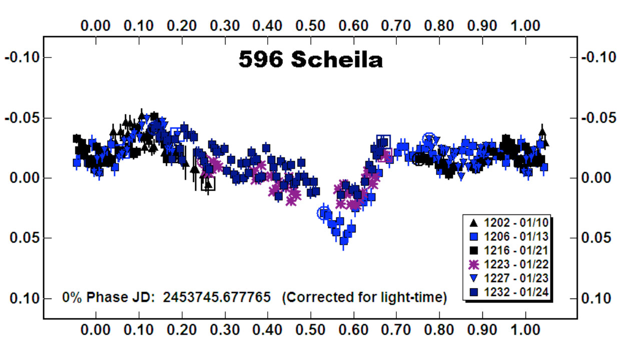
596 Scheila
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1216 - 01/21
1223 - 01/22
1227 - 01/23
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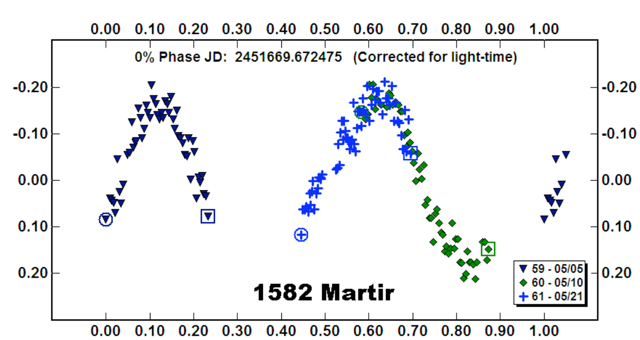
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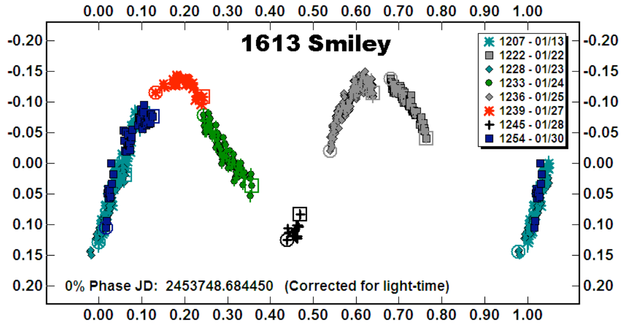
59 - 05/05
60 - 05/10
61 - 05/21


1613 Smiley
1207 - 01/13
1222 - 01/22
1228 - 01/23
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1239 - 01/27
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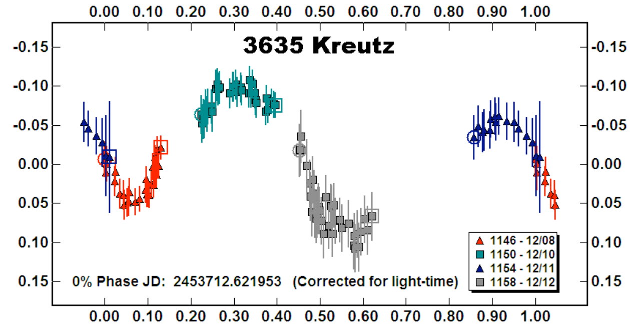
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1154 - 12/11
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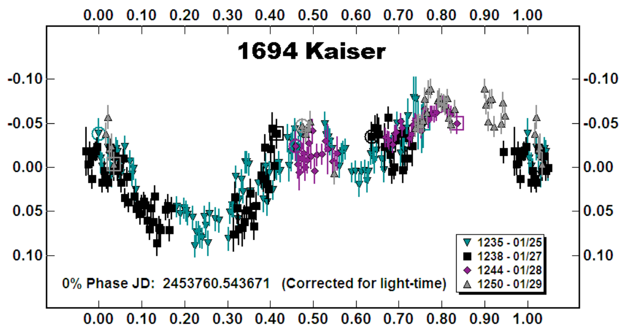
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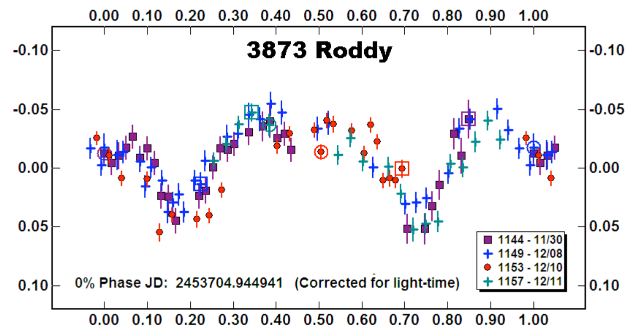
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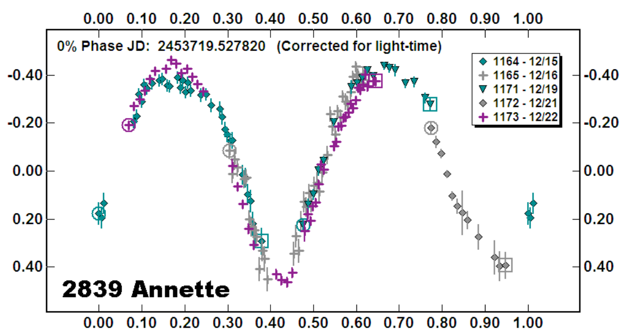
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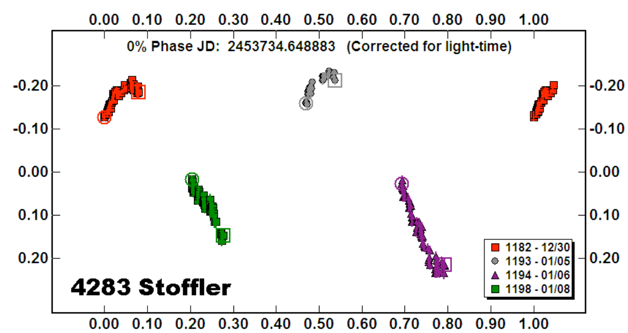
2839 Annette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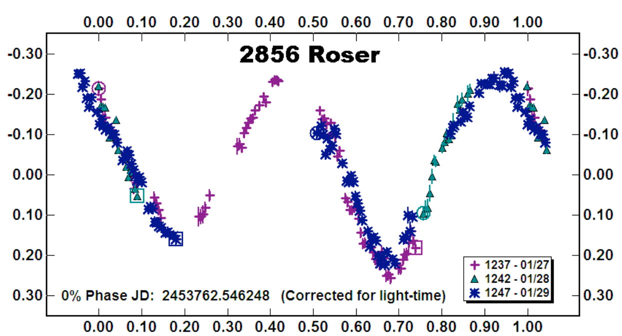
4283 Stoffler


2856 Roser
1237 - 01/27
1242 - 01/28
1247 - 01/29
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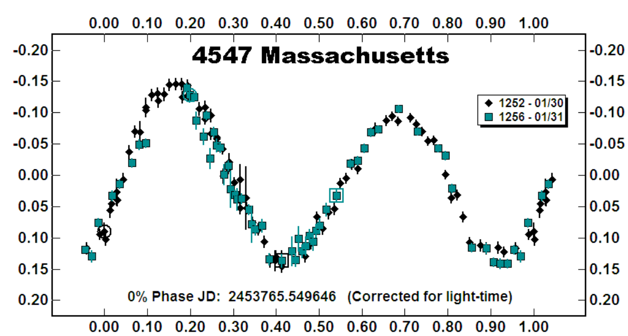
4547 Massachusetts
1252 - 01/30
1256 - 01/31
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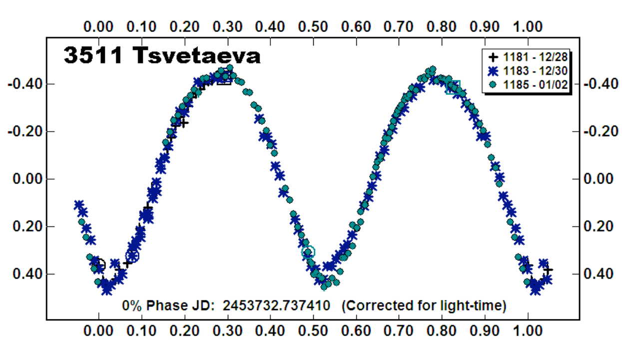
3511 Tsvetaeva
1181 - 12/28
1183 - 12/30
1185 - 01/02
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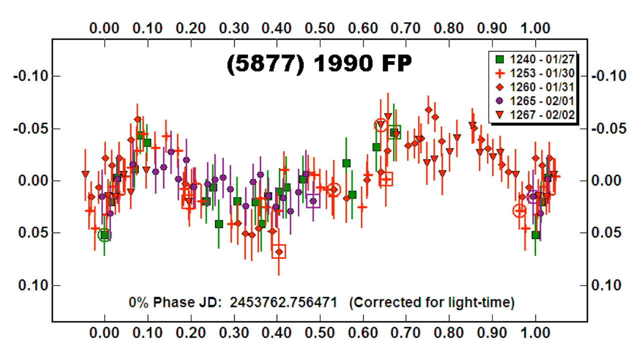
(5877) 1990 FP
1240 - 01/27
1253 - 01/30
1260 - 01/31
1265 - 02/01
1267 - 02/02
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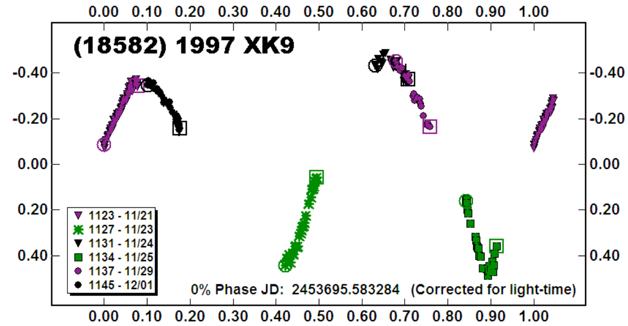

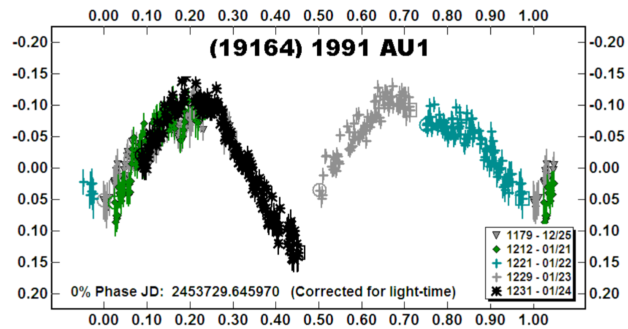

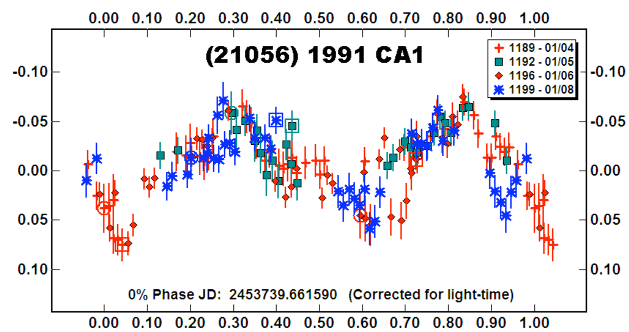

CONGRATULATIONS TO PROFESSOR FRED PILCHER

Congratulations are in order to Professor Frederick Pilcher who has retired from teaching physics at Illinois College after 43 years. Professor Pilcher has been active in the Minor Planets Section since its founding 33 years ago and has been the Recorder for the Minor Planets Section since 1983. Professor Pilcher will continue his leadership in the Minor Planets Section and looks forward to the better weather for pursuing an active astronomy program from his new location. His new mailing address appears below, while his email address remains unchanged. Congratulations Fred and clear skies!

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THE MINOR PLANET OBSERVER: THE NEW VERMIN OF THE SKY

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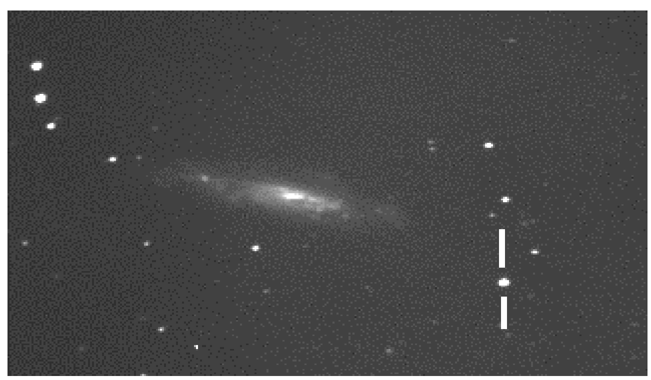
Many years ago, asteroids were given a bad reputation when they were called the "vermin of the sky," mostly because they caused streaks across photographic images of other targets. I can well imagine how, after exposing a plate for hours only to find the asteroid's trail had obliterated the intended target, that some frustration would result. Nowadays, it's often a passing airplane with its twin wing lights or some artificial satellite.

In the discussions about new large telescopes coming on line, there have been jokes about how very small and faint galaxies, down around 28th–30th magnitude, will become the new vermin as they are mistaken for distant Kuiper Belt Objects or other intended targets. There is truth in the saying that "one man's treasure is another man's junk."

I don't mind the galaxies at all – usually. I find that I particularly like doing asteroid lightcurve work during the early months of the year. It's then that asteroids approaching or reaching opposition can be found among the galaxy-rich constellations of Leo and Virgo and so two objects, one in our backyard and the other in some distant corner of the Universe, share the spotlight. The photo below is from a sequence I shot in January 2006 as 596 Scheila slipped by NGC 3003. This was a big, bright galaxy compared to most that I see and made the evening's run all the more interesting.



On the other hand, a few nights later I was imaging 1694 Kaiser and found myself thinking "vermin." For the first hour, the images were "ruined" because the asteroid was a few arcseconds from the nucleus of a galaxy. It looked so much like a supernova that I sent a message to the Minor Planet Mailing List so that someone seeing or imaging the event would not be misled.

Issue 33-1 (January-March) of the Minor Planet Bulletin provides a "best of" list of DSO-asteroid appulses for 2006 that I put together, along with a link on my web site for a more complete listing. If you'd like a little diversion some evening, try catching one of these appulses in a sequence of images. It makes a great demonstration of an asteroid's daily motion. Just hope that the galaxy isn't "on top" of your asteroid if you're trying to get a lightcurve. Clear Skies!

LIGHTCURVES OF ASTEROIDS 125 LIBERATRIX, 461 SASKIA, AND 2781 KLECZEK

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(Received: 25 March)

The lightcurves of 125 Liberatrix, 461 Saskia, and 2781 Kleczek were measured during their winter 2005-2006 apparitions. Lightcurve period and amplitude results were, respectively: P=3.968 ±0.001 hr, Δm=0.3; P=7.34 ±0.01 hr, Δm= 0.25; and P=7.306 ±0.003 hr, Δm= 0.3.

Altimira Observatory is located in southern California, and is equipped with a 0.28-m Schmidt-Cassegrain telescope (Celestron NexStar-11 operating at F/6.3), and CCD imager (ST-8XE NABG, with Johnson-Cousins filters). Equipment details and instrument characterization are available at the author's website (http://www.geocities.com/oca_bob). Here, I report lightcurves for three asteroids measured during the 2005-06 season.

125 Liberatrix. This asteroid's lightcurve period is well determined, and it is the subject of a shape-modeling program. Fauerbach and Bennett (2005) reported a lightcurve from December 2004 and Trigo-Rodriguez and Caso (2003) reported a lightcurve from one night in January 2002. The accepted value of the lightcurve period for this object is P= 3.968 hr. My R-band lightcurve yields a peak-to-peak amplitude of Δm=0.3 and best-fit period P= 3.968 ±0.001 hrs. This period matches the accepted value. On one night (Jan 21, 2006 UT), I gathered a continuous stream of images in B, V, and R bands, to search for possible color variations during the asteroid's rotation. No change in color was detectable above the noise level of ±0.02 mag in V and R bands.

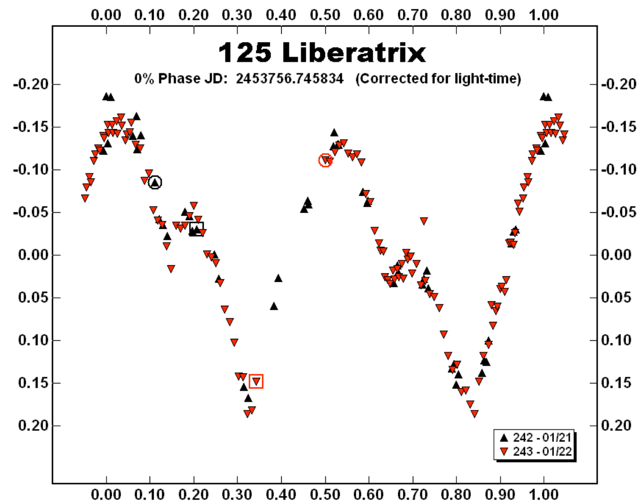
461 Saskia. No previous lightcurves have been published for this object. A single night's unfiltered lightcurve appears to show a complete period with peak-to-peak amplitude Δm=0.25. The best-fit period from this single night is P= 7.34 ±0.01 hrs.

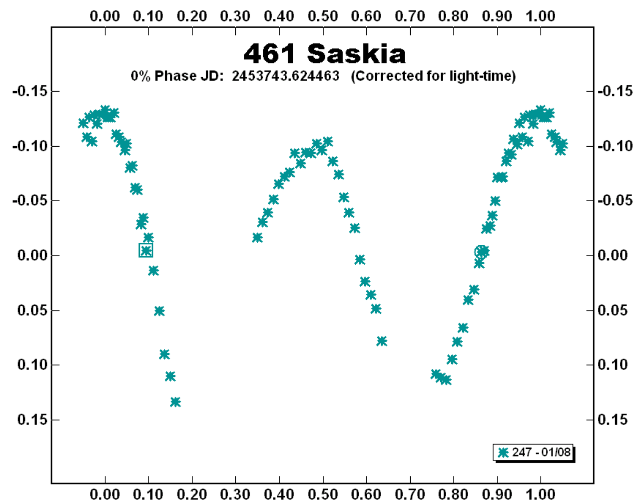
2781 Kleczek. No previous lightcurve reports have been published for this object. Three nights were devoted to this object, very close to its opposition. Because it was faint (Vmag ≈ 15), unfiltered observations were used. My results, wrapped to the best-fit period P=7.306 ± 0.003hr show a peak-to-peak magnitude Δm=0.30. One night (Nov 27, 2005 UT) was hazy, resulting in a low SNR (note the large error bars for that night), but the shape of the lightcurve for that night confirms the period estimate derived from the other nights.

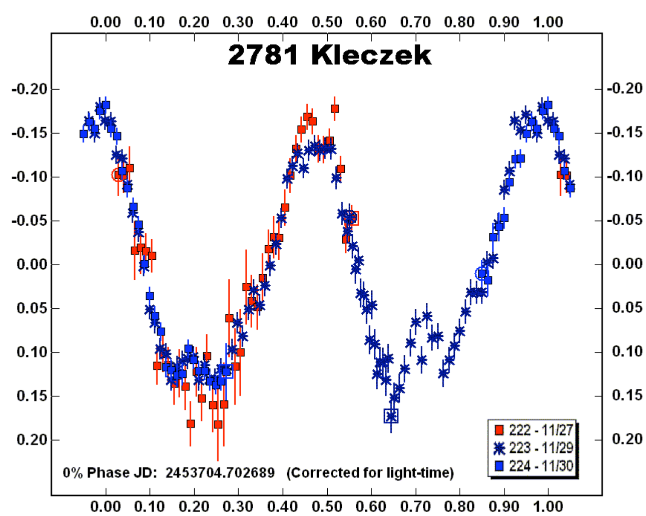
References

Fauerbach, M., and Bennett, T. (2005). "Photometric Lightcurve Observations of 125 Liberatrix ...", *Minor Plan. Bull.* **32**, 80-80.

Trigo-Rodriguez, J., and Caso, A. (2003). "CCD Photometry of Asteroids 22 Kalliope and 125 Liberatrix", *Minor Plan. Bull.* **30**, 26-27.







ASTERIOD LIGHTCURVE ANALYSIS AT HUNTERS HILL OBSERVATORY AND COLLABORATING STATIONS – SUMMER 2005/6

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(Received: 17 March)

Lightcurves for eight asteroids were obtained at Hunters Hill Observatory and collaborating stations and then analysed to determine the synodic period and amplitude. We report on: 4222 Nancita, 5333 Kanaya, 6153 Hershey, (9948) 1990 QB2, (15607) 2000 GA124, (24814) 1994 VW1, (28887) 2000 KQ58, 2000 RX211

Hunters Hill Observatory is equipped with a 0.36m SCT fitted with a Meade f/3.3 focal reducer and an SBIG ST-8E CCD producing a final focal ratio of f/4. The guide scope utilizes a 0.1m SCT fitted with Meade f/6.4 focal reducer and an MX716. The targets were observed by binning 2x2 at the camera with fixed temperatures between -5 and -10 degrees Centigrade (dependant on ambient temperature). Pixel scale at 2x2 binning is 2.64 arcsecs. All observations for this paper were made using a clear filter with guided exposure times ranging from 240 seconds to 300 seconds. MaxIm DL/CCD, driven by ACP4 by DC3 Dreams, was used for telescope and camera control whilst calibration and image measurements were undertaken by MPO Canopus v9.

Ondrejov Observatory is equipped as described in Pravec et al. (1998) though they have fitted a new Apogee AP7p camera. Badlands Observatory is equipped with a 26 inch f/4.8 Newtonian, an Apogee AP-8 CCD camera with images taken through R filter at 180 second integrations.

Targets were chosen either from the list provided by Warner (2005) or, more recently, from a list of suitable targets provided by Pravec (2005a), but even the earlier targets chosen from the Warner list fit with the criteria of the Survey of Asynchronous Binary Asteroids (Pravec, 2005b). Results are summarised in the table below with the individual plots presented at the end. Additional comment, where appropriate, is provided.

The strategy of all collaborating stations is to work objects carefully for potential deviations that would indicate the presence of a satellite. Considerable effort was made to identify and eliminate sources of observational errors that might corrupt the observations and lead to false attenuation events. It was particularly important to identify and eliminate data points affected by faint background stars, bad pixels, and cosmic ray hits.

4222 Nancita. Equal coverage by Badlands and Hunters Hill Observatories resulted in the equivalent of 12 hours coverage over 2 consecutive nights.

6153 Hershey. Analysis reveals 2 fitting solutions at 8.174 hrs and the selected period of 6.094 hrs. A unique solution could not be found due to the low amplitude of the target. The latter period was chosen as it provided a better curve fit visually.

(9948) 1990 QB2. Additional single night data was provided by Peter Kusnirak of the Ondrejov Observatory.

(24814) 1994 VW1. Additional analysis was conducted by Dr. Petr Pravec who concluded that the data did not bring a unique solution, partially because of the low amplitude of the asteroid and also because the observing nights were not consecutive. The period was chosen as it gave the best possible fit with the data available.

2000 RX211. Analysis by Dr. Petr Pravec could not rule out a 4 peak (double period) solution. Petr indicated that the double period had a slightly better fit solution. Unfortunately the target became too dim to get further data. The bimodal solution was chosen as statistically it was the more probable solution.

Acknowledgements

Thanks go to Brian D. Warner for his continued development and support for the Equipment Control and Capture software, MPO Connections and the data analysis software, MPO Canopus. The SBIG ST-8E at Hunters Hill Observatory was funded by The Planetary Society under the 2005 Gene Shoemaker NEO Grants program. The work at Ondrejov was supported by the Grant Agency of the Czech Republic, Grant 205/05/0604.

#	Name	Date Range	Sess	Period hrs.	P.E.	Amp. Mag.
4222	Nancita	20 Jan – 21 Jan 2006	4	3.8732	0.0003	0.97
5333	Kanya	22 Dec – 30 Dec 2005	6	3.8022	0.0008	0.22
6153	Hershey	13 Dec – 02 Jan 2005/6	5	6.094	0.003	0.14
9948	1990 QB2	09 Nov – 12 Nov 2005	4	3.5257	0.0007	0.77
15607	2000 GA124	10 Oct – 14 Oct 2005	3	3.588	0.001	0.16
24814	1994 VW1	01 Dec – 11 Dec 2005	3	4.533	0.002	0.05
28887	2000 KQ58	21 Nov – 07 Dec 2005	6	6.8429	0.00011	0.51
	2000 RX211	27 Oct – 08 Nov 2005	5	5.0689	0.006	0.22

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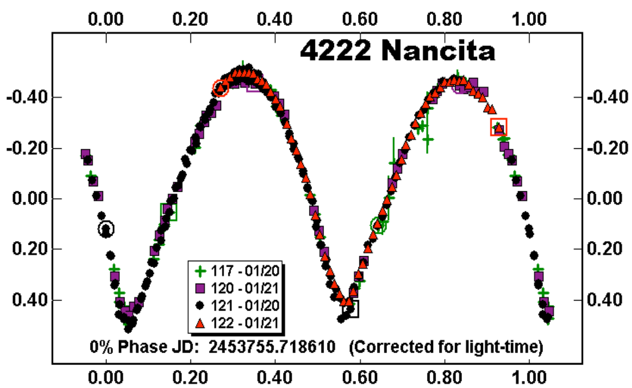
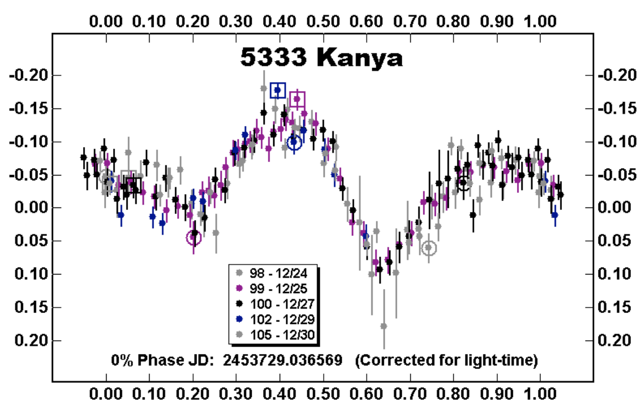
Pravec, P. (2005a). Photometric Survey of Asynchronous Binary Asteroids , http://www.asu.cas.cz/~asteroid/binastphotsurvey.htm.

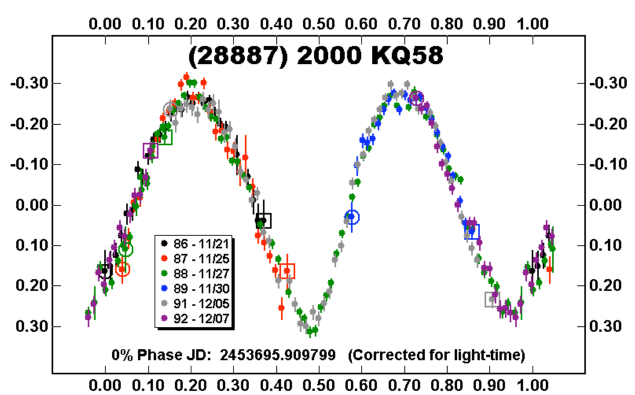
Pravec, P. (2005b). Photometric Survey of Asynchronous Binary Asteroids. In Proceedings of the *Symposium on Telescope Science* (The 24th Annual Conference of the Society for Astronomical Science), B. D. Warner, D. Mais, D. A. Kenyon, J. Foote (Eds.), pp. 61-67.

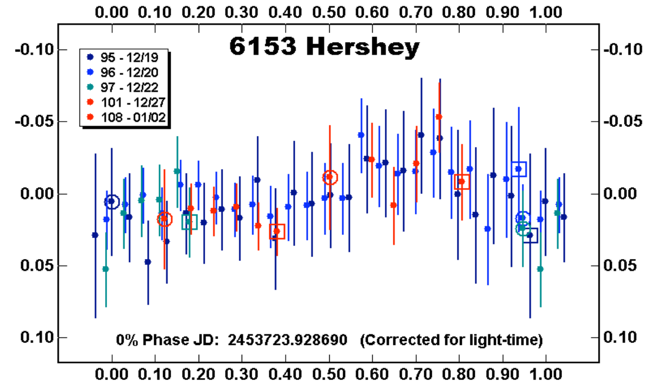
Pravec, P., Wolf, M., Sarounova, L., (1998). Lightcurves of 26 near-Earth asteroids. Icarus **136**, 124-153

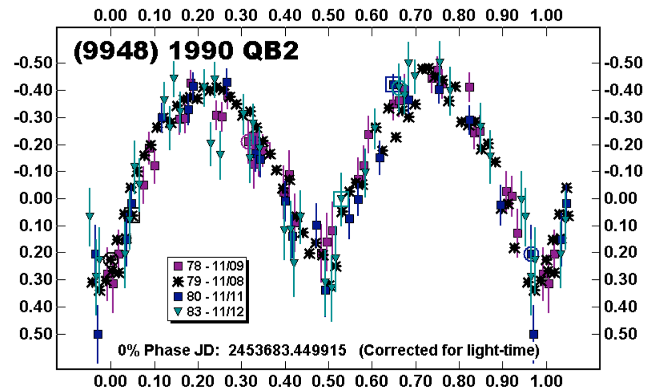
Warner, B.D. (2005). *CALL Website*, http://www.minorplanetobserver.com/astlc/default.htm.

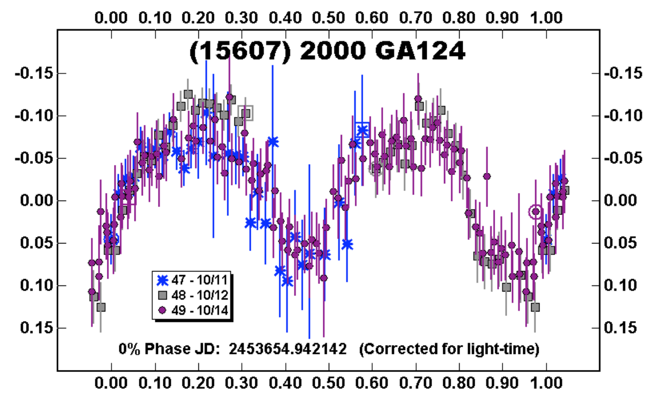


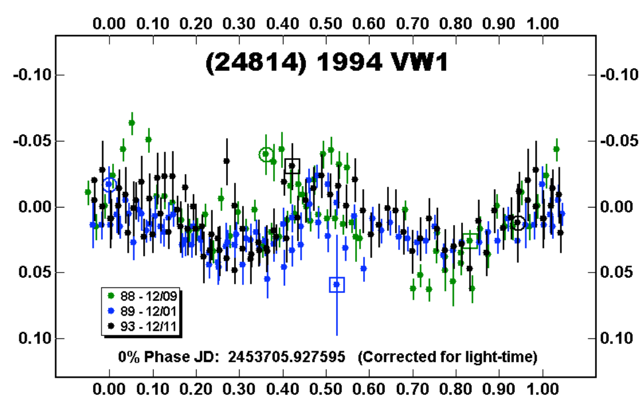


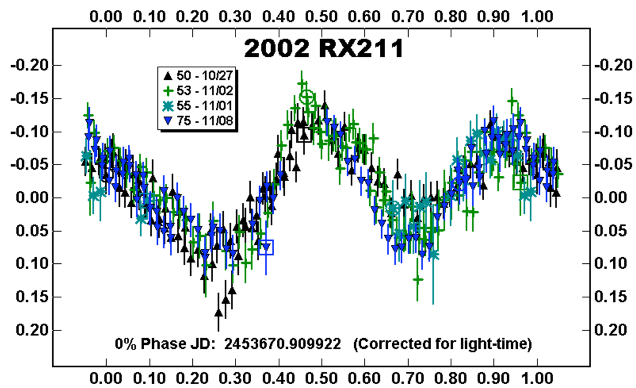












2005-2006 FALL OBSERVING CAMPAIGN AT ROSE-HULMAN INSTITUTE OF TECHNOLOGY

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(Received: 30 March)

CCD images recorded in October, November, and December 2005 using the Tenagra 32" telescope and four telescopes located at Rose-Hulman's Oakley Observatory yielded lightcurves and periods for five asteroids: 1967 Menzel has a period of 2.834±0.001h and an amplitude of 0.40mag; 3998 Tezuka has a period of 3.079±0.001h and an amplitude of 0.5mag; 4914 Pardina has a period of 4.142±0.001h and an amplitude of 0.3mag; (31060) 1996 TB6 has a period of 5.103±0.001h and an amplitude of 0.8mag; and (42264) 2001 QZ30 has a period of 9.77±0.01h and an amplitude of 1.1mag. Several asteroids produced inconclusive results due to low amplitudes and/or long periods: 154 Bertha, 2871 Schober, 1176 Lucidor, 549 Jessonda, 961 Gunnie, 6395 Hilliard, 760 Amenia, 406 Erna, 680 Genoveva, 1662 Hoffmann, and (14276) 2000 CF2.

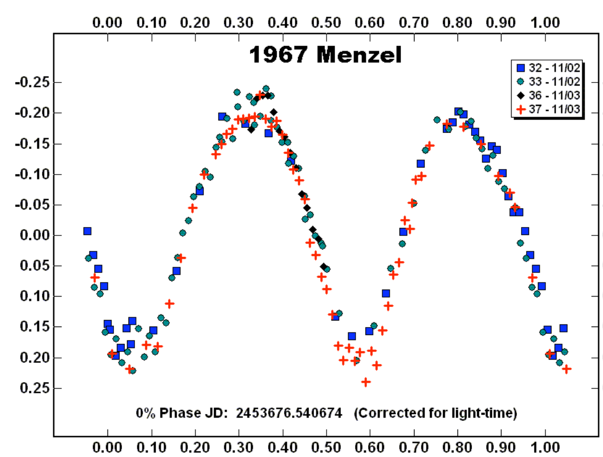
During the fall of 2005-2006 five Rose-Hulman students (LeCrone, Duncan, Hudson, Mulvihill, Reichert) and a professor (Ditteon) obtained images with the 32" Ritchey-Chretien telescope with a V-filter at the Tenagra Observatory in Arizona and four 14" Celestron telescopes on Paramount ME and GT1100 mounts at the Oakley Observatory in Terre Haute, Indiana. The Tenagra telescope operates at f/7 with a CCD camera using a 1024x1024x24μ SITe chip and binned 2x2 (Schwartz, 2004). The Oakley Telescopes operate at f/7 with two Apogee AP7 (512x511x24μ SITe chip) and one AP8 (1024x1024x24μ SITe chip) cameras along with an SBIG STL-1001E (1024x1024x24μ KAF-1001E chip) camera. The exposures were 90 seconds for Tenagra and 120 seconds for Oakley images.

Asteroids were selected for observation by using *TheSky*, published by Software Bisque, to locate asteroids that were at an elevation angle of between 20° and 30° one hour after local sunset. In addition, *TheSky* was set to show only asteroids between 14 and 16 mag. Bright asteroids were avoided because we pay for a minimum 60 second exposure while using the Tenagra telescope. The asteroids were cross checked with Alan Harris' list of light curve parameters (Harris, 2003). We tried to observe only asteroids that did not have previously reported measurements or had very uncertain published results.

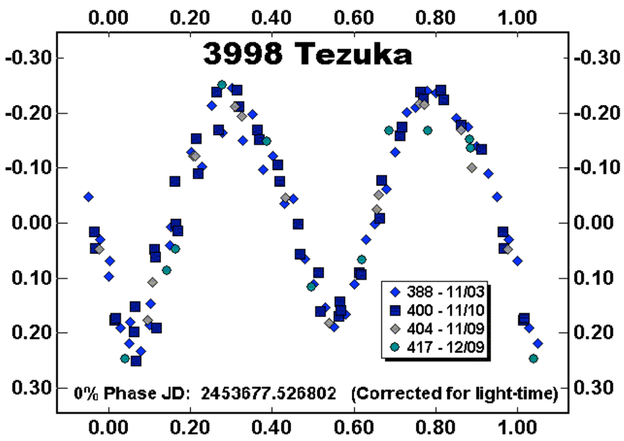
Observation requests for the asteroids and Landolt reference stars were submitted by LeCrone using ASCII text files formatted for the TAO scheduling program (Schwartz, 2004). The resulting images were downloaded via ftp along with flat field, dark and bias frames. Standard image processing was done using *MaxImDL*, published by Diffraction Limited. Photometric measurements and light curves were prepared using *MPO Canopus*, published by BDW Publishing.

A total of 16 asteroids were observed during this campaign, but lightcurves were not found for all of them. An asteroid was dropped if it had a very small variation in brightness, the signal-to-noise ratio was too small, or it had a very long period. This allowed the maximum number of quality observations with limited funds. Asteroid 154 Bertha had a long period. The data on three asteroids (2871 Schober, 1176 Lucidor, and 549 Jessonda) turned out to be little more than noise, while the data on 961 Gunnie and 6395 Hilliard had no observable magnitude variation. There was not enough data for asteroids 760 Amenia, 406 Erna, 680 Genoveva, 1662 Hoffmann, and (14276) 2000 CF2.

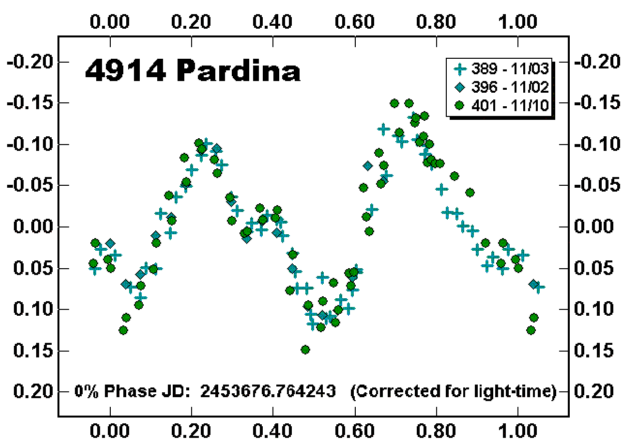
1967 Menzel. A total of 178 images were taken over two nights: 2 and 3 November 2005. The data reveal a lightcurve with a 2.834±0.001h period and 0.40 mag amplitude. All of the images of 1967 Menzel were taken at Oakley Observatory.



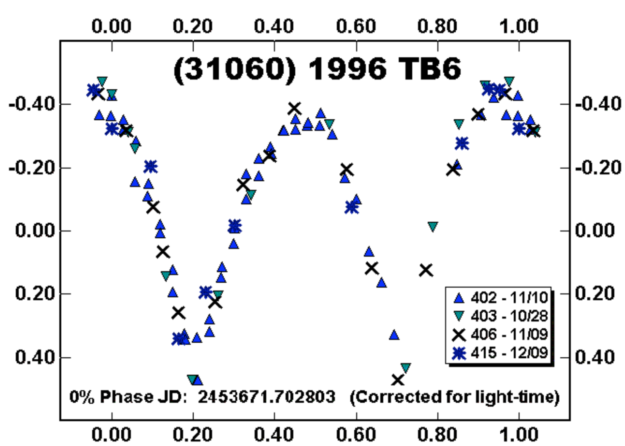
3998 Tezuka. Data for 3998 Tezuka were taken over five nights: 2, 3, 9, and 11 November 2005 and 9 December 2005. A total of 109 images were used in creating the light curve (the data from 2 December 2005 were not used). The data reveal a lightcurve with a 3.0789±0.0001h period and 0.50mag amplitude. Images of 3998 Tezuka were taken at Oakley Observatory and Tenagra.



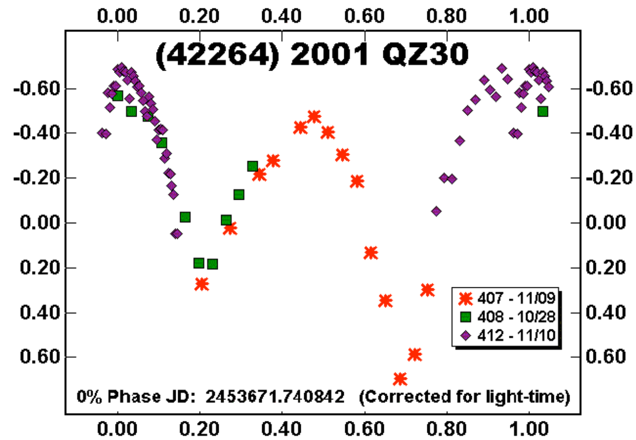
4914 Pardina. A total of 136 images were taken over three nights: 2, 3 and 11 November 2005. The data reveal a lightcurve with a 4.1421±0.0004h period and 0.3mag amplitude. Images of 4914 Pardina were taken at the Oakley Observatory.



(31060) 1996 TB6. A total of 83 images were taken over 4 nights: 28 October, 9 and 11 November, and 9 December 2005. The data reveal a lightcurve with a 5.1032±0.0003h period and 0.8mag amplitude. Images of (31060) 1996 TB6 were taken at Oakley Observatory and Tenagra.



(42264) 2001 QZ30. A total of 74 images were taken over 4 nights: 28 October, 9 and 11 November, and 9 December 2005. We did not use the data from 9 December 2005. The data reveal a lightcurve with a 9.7702±0.0019h period and 1.1mag amplitude. Images of (42264) 2001 QZ30 were taken at Oakley Observatory and Tenagra.



All of our data are available upon request.

Acknowledgements

We also want to thank Michael Schwartz and Paulo Holvorcem for making remote observing with their telescope both possible and enjoyable.

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GENERAL REPORT OF POSITION OBSERVATIONS BY THE ALPO MINOR PLANETS SECTION FOR THE YEAR 2005

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Observations of positions of minor planets by members of the Minor Planets Section in calendar year 2005 are summarized.

During the year 2005 a total of 1712 positions of 510 different minor planets were reported by members of the Minor Planets Section. Of these 124 are CCD images (denoted C), and 13 are photographic measures (denoted P). All the rest are approximate visual positions.

The summary lists minor planets in numerical order, the observer and telescope aperture (in cm), UT dates of the observations, and the total number of observations in that period. The year is 2005 in each case.

Positional observations were contributed by the following observers:

Observer, Instrument	Location	Planets	Positions
Arlia, Saverio 15 cm f/6 reflector	Buenos Aires, Argentina	2	7P
Bookamer, Richard E. 41 cm reflector	Micco, Florida USA	215	631
Faure, Gerard 20 cm Celestron, 35 cm SCT	Col de L'Arzelier, France	99	309(109C)
Faure, Gerard, and Marchal, Remy 20 cm Celestron	Col de L'Arzelier, France	2	5
Faure, Gerard, Bardin, Fred, and Elst, Eric 63.5 cm reflector	Sirene Observatory, France	1	2
Garrett, Lawrence 32 cm f/6 reflector 20x80 mm binoculars	Fairfax, Vermont, USA	31	62
Harvey, G. Roger 74 cm Newtonian	Concord, North Carolina, USA	117	405
Hudgens, Ben 38 cm f/5 reflector 41 cm f/4.5 reflector 25 cm f/5 reflector	Stephenville, Texas, USA	118	243
Jardine, Don, and Pilcher, Frederick 35 cm Meade Cassegrain + CCD	Pleasant Plains, Illinois, USA	4	15C
Pryal, Jim 6.4 cm telephoto lens	Rattlesnake Lake, WA USA	2	6P
Watson, William W. 20 cm Celestron	Tonawanda, NY USA	10	27

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
1 Ceres	Faure, 20	Jun 11	10C
8 Flora	Pryal, 6.4	Jan 15-Feb 3	3P
10 Hygiea	Jardine & Pilcher, 35	Apr 26	3C
14 Irene	Faure, 20	Mar 20	4C
18 Melpomene	Faure & Marchal, 20	Jul 14-15	3
26 Proserpina	Arlia, 15	Jul 17-26	3P
29 Amphitrite	Jardine & Pilcher, 35	Apr 25	3C
34 Circe	Bookamer, 41	Jun 13	3
51 Nemausa	Bookamer, 41	Sep 18	2
56 Melete	Bookamer, 41	Jan 30	3
57 Mnemosyne	Faure, 20	Nov 11	6C
59 Elpis	Bookamer, 41	Jan 21	2
61 Danaë	Watson, 20	Oct 30-Nov 4	5
64 Angelina	Bookamer, 41	Feb 10	3
65 Cybele	Bookamer, 41	Feb 11	3
69 Hesperia	Bookamer, 41	Feb 20	3
71 Niobe	Bookamer, 41	Jan 21	3
72 Feronia	Bookamer, 41	Jul 19	3
73 Klytia	Bookamer, 41	Jan 25	3
80 Sappho	Garrett, 32	Jan 1-2	2
81 Terpsichore	Bookamer, 41	Jan 25	4
83 Beatrix	Bookamer, 41	Mar 7	3
91 Aegina	Bookamer, 41	Jan 17	3
93 Minerva	Bookamer, 41	Oct 29	3
96 Aegle	Bookamer, 41 Faure, 20	Oct 31 Nov 12	2 6C

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
101 Helena	Faure, 20	Nov 11	8C
106 Dione	Bookamer, 41	Feb 4	2
107 Camilla	Bookamer, 41 Faure, 20	Nov 6 Nov 26-27	2 2
108 Hecuba	Bookamer, 41	Oct 30	2
110 Lydia	Bookamer, 41	Feb 17	3
112 Iphigenia	Bookamer, 41	Mar 4	4
114 Kassandra	Bookamer, 41	Jan 26	3
118 Peitho	Bookamer, 41	Feb 18	3
119 Althaea	Bookamer, 41	Jul 18	3
120 Lachesis	Bookamer, 41	Jul 5	2
122 Gerda	Bookamer, 41	Sep 12	2
124 Alkeste	Bookamer, 41	Oct 27	2
125 Liberatrix	Bookamer, 41	Dec 29	3
126 Velleda	Bookamer, 41	Sep 10	3
130 Elektra	Bookamer, 41	Feb 20	3
131 Vala	Bookamer, 41	Mar 2	2
134 Sophrosyne	Bookamer, 41	Dec 12	2
135 Hertha	Bookamer, 41	Jan 20	2
142 Polana	Faure, 20	Nov 12	10C
144 Vibilia	Watson, 20	Jul 3-10	2
145 Adeona	Bookamer, 41	Feb 1	3
148 Gallia	Bookamer, 41	Dec 10	2
154 Bertha	Bookamer, 41	Oct 2	2
157 Dejanira	Bookamer, 41	Mar 12	2
160 Una	Bookamer, 41	Nov 12	2
161 Athor	Bookamer, 41	Aug 6	3
171 Ophelia	Garrett, 32	Apr 10	2
172 Baucis	Bookamer, 41	Jan 30	3
173 Ino	Bookamer, 41	Dec 12	3
174 Phaedra	Garrett, 32	Feb 1-2	2
179 Klytaemnestra	Bookamer, 41	Oct 25	2
181 Eucharis	Bookamer, 41	Jan 24	3
182 Elsa	Bookamer, 41	Mar 12	3
185 Eunike	Bookamer, 41	Feb 18	2
192 Nausikaa	Bookamer, 41	Feb 4	2
193 Ambrosia	Bookamer, 41	Mar 19	3
199 Byblis	Bookamer, 41	Oct 30	3
202 Chryseïs	Bookamer, 41	Feb 16	3
204 Kallisto	Watson, 20	Aug 25	2
210 Isabella	Bookamer, 41	Nov 27	2
214 Aschera	Bookamer, 41	Dec 8	2
216 Kleopatra	Bookamer, 41	Jan 27	2
218 Bianca	Bookamer, 41	Mar 14	2
221 Eos	Bookamer, 41	Oct 19	2
222 Lucia	Bookamer, 41	Jul 29	2
223 Rosa	Bookamer, 41	Nov 23	3
230 Athamantis	Bookamer, 41	Feb 9	2
231 Vindobona	Garrett, 32	Apr 10	2
232 Russia	Bookamer, 41 Garrett, 32	Jan 6 Feb 6	3 2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
235 Carolina	Bookamer, 41	Oct 31	2
237 Coelestina	Bookamer, 41	Dec 3	3
238 Hypatia	Bookamer, 41	Feb 14	3
246 Asporina	Watson, 20	May 10-13	2
248 Lameia	Bookamer, 41	Mar 29	2
261 Prymno	Bookamer, 41	Jan 27	2
	Watson, 20	Jan 7-15	2
264 Libussa	Bookamer, 41	Feb 13	3
284 Amalia	Bookamer, 41	Jun 12	2
286 Iclea	Bookamer, 41	Dec 29	3
289 Nenetta	Bookamer, 41	Nov 12	3
305 Gordonia	Bookamer, 41	Jan 6	2
308 Polyxo	Bookamer, 41	Mar 28	3
309 Fraternitas	Bookamer, 41	Jul 31	3
315 Constantia	Hudgens, 38	Aug 24-Sep 1	2
316 Goberta	Bookamer, 41	Nov 26	3
317 Roxane	Bookamer, 41	Jul 29	3
319 Leona	Garrett, 32	Jan 2	2
322 Phaeo	Garrett, 32	Apr 10	2
326 Tamara	Bookamer, 41	Jul 11	2
	Watson, 20	Apr 13-15	3
331 Etheridgea	Bookamer, 41	Dec 21	3
337 Devosa	Bookamer, 41	Jul 11	2
346 Hermentaria	Bookamer, 41	Feb 10	3
352 Gisela	Bookamer, 41	Aug 15	3
353 Ruperto-Carola	Bookamer, 41	Dec 30	3
354 Eleonora	Bookamer, 41	Jan 26	3
357 Ninina	Bookamer, 41	Mar 10	3
358 Apollonia	Bookamer, 41	Jan 31	3
	Garrett, 32	Apr 10	2
360 Carlova	Bookamer, 41	Oct 9	3
363 Padua	Bookamer, 41	Nov 29	3
365 Corduba	Bookamer, 41	Feb 7	3
372 Palma	Bookamer, 41	Aug 27	3
373 Melusina	Bookamer, 41	Jan 10	3
	Garrett, 32	Feb 6	2
374 Burgundia	Bookamer, 41	Dec 2	2
375 Ursula	Bookamer, 41	Mar 4	4
377 Campania	Bookamer, 41	Jan 29	2
378 Holmia	Garrett, 32	Jan 2	2
379 Huenna	Bookamer, 41	Jan 10	3
383 Janina	Garrett, 32	Feb 6	2
386 Siegena	Bookamer, 41	Aug 21	2
389 Industria	Faure, 20	Dec 23	2
393 Lampetia	Bookamer, 41	Oct 15	2
402 Chloë	Bookamer, 41	Feb 1	3
405 Thia	Bookamer, 41	Dec 31	3
406 Erna	Bookamer, 41	Oct 31	3
409 Aspasia	Arlia, 15	Jul 7-10	4P
410 Chloris	Watson, 20	Apr 13-15	3
414 Liriope	Hudgens, 38	Oct 29-Nov 5	2
419 Aurelia	Bookamer, 41	Sep 30	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
420 Bertholda	Bookamer, 41	Dec 8	2
423 Diotima	Bookamer, 41	Mar 11	3
427 Galene	Bookamer, 41	Sep 26	3
432 Pythia	Bookamer, 41	Jun 13	2
437 Rhodia	Bookamer, 41	Aug 16	2
444 Gyptis	Bookamer, 41	Jul 16	2
448 Natalie	Bookamer, 41	Nov 4	3
452 Hamiltonia	Hudgens, 38	Dec 24-29	3
453 Tea	Faure, 20	Nov 12	6C
461 Saskia	Bookamer, 41	Dec 23	3
468 Lina	Bookamer, 41	Dec 3	4
470 Kilia	Bookamer, 41	Jan 31	3
472 Roma	Bookamer, 41	Feb 28	2
487 Venetia	Bookamer, 41	Feb 18	3
	Garrett, 32	Apr 10	2
498 Tokio	Watson, 20	Jul 29	2
502 Sigune	Bookamer, 41	Dec 21	3
505 Cava	Bookamer, 41	Mar 13	3
510 Mabella	Bookamer, 41	Oct 25	3
523 Ada	Bookamer, 41	Dec 14	3
532 Herculina	Bookamer, 41	Jan 27	3
	Garrett, 8	Jan 28-29	2
	Pryal, 6.4	Jan 5-Feb 3	3P
	Watson, 20	Feb 2-13	4
536 Merapi	Bookamer, 41	Dec 5	2
542 Susanna	Bookamer, 41	Jan 8	3
545 Messalina	Bookamer, 41	Jul 4	5
553 Kundry	Hudgens, 41	Jan 8-9	2
554 Peraga	Bookamer, 41	Jun 12	3
555 Norma	Bookamer, 41	Dec 23	4
567 Eleutheria	Bookamer, 41	Jul 7	4
573 Recha	Bookamer, 41	Nov 4	3
578 Happelia	Bookamer, 41	Oct 1	3
579 Sidonia	Bookamer, 41	Dec 13	3
584 Semiramis	Bookamer, 41	Mar 1	2
592 Bathseba	Garrett, 32	Feb 6	2
598 Octavia	Bookamer, 41	Dec 3	3
604 Tekmessa	Bookamer, 41	Nov 9	3
608 Adolfine	Hudgens, 38	Jun 30	2
621 Werdandi	Hudgens, 38	Nov 5-6	2
622 Esther	Bookamer, 41	Jan 30	3
	Garrett, 32	Apr 11	2
629 Bernardina	Bookamer, 41	Nov 29	3
635 Vundtia	Bookamer, 41	Jan 12	3
649 Josefa	Faure, 20	Dec 1	2
	Hudgens, 38	Nov 23-Dec 1	3
655 Briseïs	Bookamer, 41	Oct 29	3
660 Crescentia	Bookamer, 41	Mar 8	3
	Garrett, 32	Apr 10	2
680 Genoveva	Bookamer, 41	Nov 2	3
686 Gersuind	Bookamer, 41	Aug 21	2
	Watson, 20	Sep 28	2
693 Zerbinetta	Bookamer, 41	Oct 28	4
694 Ekard	Bookamer, 41	Oct 1	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
696 Leonora	Bookamer, 41	Sep 10	3
698 Ernestina	Hudgens, 38	Nov 5-6	2
706 Hirundo	Bookamer, 41	Nov 6	3
709 Fringilla	Bookamer, 41	Jan 3	3
715 Transvaalia	Bookamer, 41	Nov 25	3
718 Erida	Bookamer, 41	Mar 8	3
721 Tabora	Bookamer, 41	Oct 29	3
727 Nipponia	Bookamer, 41	Nov 9	3
729 Watsonia	Bookamer, 41	Jul 7	4
740 Cantabia	Bookamer, 41	Jul 5	3
742 Edisona	Bookamer, 41	Nov 3	3
745 Mauritia	Faure, 20	Dec 24	2
	Hudgens, 38	Dec 24	2
753 Tiflis	Garrett, 32	Apr 10	2
757 Portlandia	Bookamer, 41	Mar 11	4
762 Pulcova	Garrett, 32	Feb 1-2	2
771 Libera	Bookamer, 41	Feb 14	3
778 Theobalda	Bookamer, 41	Feb 8	3
780 Armenia	Bookamer, 41	Sep 11	3
785 Zwetana	Bookamer, 41	Jul 23	2
786 Bredichina	Bookamer, 41	Jun 24	4
797 Montana	Bookamer, 41	Mar 13	3
	Garrett, 32	Apr 11	2
801 Helwerthia	Hudgens, 38	Sep 26	2
803 Picka	Bookamer, 41	Dec 28	3
804 Hispania	Bookamer, 41	Feb 3	2
809 Lundia	Bookamer, 41	Oct 28	3
814 Tauris	Bookamer, 41	Nov 16	3
818 Kapteynia	Bookamer, 41	Dec 22	4
823 Sisigambis	Bookamer, 41	Feb 3	3
830 Petropolitana	Bookamer, 41	Feb 13	3
831 Stateira	Faure, 20	Oct 29-30	2
833 Monica	Hudgens, 38	Nov 5-6	2
838 Seraphina	Bookamer, 41	Oct 26	3
839 Valborg	Bookamer, 41	Oct 28	3
840 Zenobia	Bookamer, 41	Oct 28	3
846 Lipperta	Bookamer, 41	Dec 30	3
862 Franzia	Bookamer, 41	Dec 26	3
868 Lova	Bookamer, 41	Jan 31	3
872 Holda	Bookamer, 41	Dec 23	4
893 Leopoldina	Bookamer, 41	Nov 23	3
908 Buda	Bookamer, 41	Feb 13	3
	Garrett, 32	Apr 11	2
912 Maritima	Bookamer, 41	Oct 26	2
919 Ilsebill	Hudgens, 38	Aug 27-Sep 1	2
921 Jovita	Faure, 20	Nov 12	5C
923 Herluga	Hudgens, 41	Jan 8-9	2
924 Toni	Bookamer, 41	Nov 12	4
932 Hooveria	Bookamer, 41	Dec 13	3
942 Romilda	Bookamer, 41	Dec 28	3
943 Begonia	Bookamer, 41	Mar 4	4
950 Ahrensa	Bookamer, 41	Mar 29	3
	Garrett, 32	Apr 10	2
	Hudgens, 25	Apr 10	2
951 Gaspra	Bookamer, 41	Oct 27	3
956 Elisa	Hudgens, 38	Nov 23-24	2
960 Birgit	Hudgens, 38	Aug 24-27	2
961 Gunnie	Faure, 20	Oct 28	2
962 Aslög	Faure, 20	Oct 26	2
986 Amelia	Bookamer, 41	Aug 6	3
987 Wallia	Bookamer, 41	Jul 16	3
991 McDonalda	Hudgens, 38	Sep 1	2
994 Otthild	Bookamer, 41	Sep 23	4
1001 Gaussia	Bookamer, 41	Jan 6	3
1008 La Paz	Faure, 20	Oct 30	2
	Hudgens, 38	Nov 5-6	2
1012 Sarema	Hudgens, 38	Dec 28-29	2
1015 Christa	Garrett, 32	Apr 10	2
1016 Anitra	Faure, 20	Oct 8	2
1021 Flammario	Bookamer, 41	Jan 24	4
1028 Lydina	Bookamer, 41	Dec 22	4
1039 Sonneberga	Faure, 20	Mar 1-2	2
1052 Belgica	Faure, 20	Oct 26	2
1054 Forsytia	Bookamer, 41	Nov 25	3
1069 Planckia	Bookamer, 41	Feb 15	3
1077 Campanula	Faure, 20	Jan 10	2
1083 Salvia	Bookamer, 41	Dec 24	3
1092 Lilium	Hudgens, 38	Sep 2	2
1098 Hakone	Garrett, 32	Feb 6	2
1122 Neith	Garrett, 32	Jan 2	2
1137 Raïssa	Bookamer, 41	Dec 29	3
1139 Atami	Bookamer, 41	Sep 24	4
	Hudgens, 38	Oct 29-Nov 5	2
1145 Robelmonte	Jardine & Pilcher, 35	Apr 25	4C
1175 Margot	Faure, 20	Oct 27	2
1176 Lucidor	Bookamer, 41	Nov 3	3
1181 Lilith	Garrett, 32	Jan 2	2
1196 Sheba	Bookamer, 41	Jul 27	3
1225 Ariane	Hudgens, 38	Dec 4	2
1235 Schorria	Bookamer, 41	Nov 4	4
1243 Pamela	Bookamer, 41	Nov 22	5
1249 Rutherfordia	Bookamer, 41	Dec 1	4
1255 Schilowa	Hudgens, 38	Sep 2	2
1259 Ógyalla	Faure, 20	May 8-9	2
1276 Ucclia	Hudgens, 38	Dec 24	2
1294 Antwerpia	Garrett, 32	Feb 6	2
1304 Arosa	Bookamer, 41	Nov 26	3
1330 Spiridonia	Faure, 20	May 8-9	2
1333 Cevenola	Faure, 20	Dec 23-24	2
	Hudgens, 38	Dec 1	2
1361 Leuschneria	Faure, 20	Jul 31	2
1366 Piccolo	Faure, 20	Dec 23	2
1381 Danubia	Hudgens, 38	Dec 1	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
1405 Sibelius	Faure, 20	Jan 11	2
1407 Lindelöf	Hudgens, 38	Dec 4	2
1412 Lagrula	Bookamer, 41	Dec 25	3
	Hudgens, 38	Dec 24	2
1431 Luanda	Hudgens, 38	Sep 1	2
1438 Wendeline	Faure, 20	Oct 8	2
	Hudgens, 38	Sep 26	2
1447 Utra	Faure, 20	Dec 23	2
	Hudgens, 38	Dec 1	2
1458 Mineura	Hudgens, 38	Sep 3	2
1469 Linzia	Bookamer, 41	Nov 22	5
1483 Hakoila	Hudgens, 25	Feb 4	2
1490 Limpopo	Hudgens, 38	Sep 3	2
1524 Joensuu	Faure, 20	Oct 27	2
1543 Bourgeois	Faure, 20	Aug 1	2
	Hudgens, 38	Sep 1	2
1547 Nele	Bookamer, 41	Nov 21	3
1549 Mikko	Faure, 20	Oct 27	2
1578 Kirkwood	Bookamer, 41	Dec 26	3
1579 Herrick	Faure, 20	Oct 27-28	2
1600 Vyssotsky	Bookamer, 41	Nov 24	4
1609 Brenda	Bookamer, 41	Jul 14	4
1636 Porter	Faure, 20	Sep 4	2
1639 Bower	Bookamer, 41	Dec 1	3
1656 Suomi	Hudgens, 38	Dec 1	2
1659 Punkaharju	Bookamer, 41	Dec 29	3
1662 Hoffmann	Bookamer, 41	Oct 31	3
	Faure, 20	Oct 29	2
1671 Chaika	Bookamer, 41	Nov 29	3
	Faure, 20	Nov 27	2
	Hudgens, 38	Dec 4	2
1687 Glarona	Bookamer, 41	Dec 26	4
1701 Okavango	Hudgens, 38	Nov 23-24	2
1707 Chantal	Bookamer, 41	Dec 3	3
1708 Pólit	Hudgens, 25	Feb 4	2
1715 Salli	Faure, 20	May 8	3
	Hudgens, 25	Apr 10	2
1723 Klemola	Hudgens, 38	Jun 2	2
1747 Wright	Hudgens, 38	Jun 25	2
1771 Makover	Bookamer, 41	Nov 24	4
1780 Kippes	Hudgens, 38	Sep 2	2
1821 Aconcagua	Faure, 20	Jul 3	2
1830 Pogson	Hudgens, 38	Nov 5-6	2
1852 Carpenter	Hudgens, 38	Dec 28-29	2
1853 McElroy	Hudgens, 38	Dec 24	2
1857 Parchomenko	Bookamer, 41	Dec 4	4
1859 Kovalevskaya	Hudgens, 25	Apr 10	2
1862 Apollo	Bookamer, 41	Nov 14	4
	Faure, 20	Nov 26	4
	Hudgens, 38	Nov 23-24	4
1894 Haffner	Harvey, 74	Sep 12	3
1900 Katyusha	Hudgens, 25	Feb 4	2
1911 Schubart	Faure, 20	Dec 23	2
1912 Anubis	Hudgens, 38	Dec 1	2
1936 Lugano	Hudgens, 25	Feb 4	2

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
1963 Bezovec	Hudgens, 25	Feb 4	2
1967 Menzel	Faure, 20	Oct 26	2
1994 Shane	Hudgens, 38	Nov 5-6	2
2006 Polonskaya	Faure, 20	Oct 30	2
2008 Konstitutsiya	Garrett, 32	Apr 10	2
2016 Heinemann	Hudgens, 38	Oct 29-Nov 5	3
2019 van Albada	Bookamer, 41	Jul 2	3
2029 Binomi	Harvey, 74	Sep 12	3
2034 Bernoulli	Hudgens, 38	Oct 29-Nov 5	2
2040 Chalonge	Hudgens, 38	Dec 24	2
2044 Wirt	Bookamer, 41	Nov 22	5
	Faure, 20	Nov 26	2
	Hudgens 38	Nov 23-24	2
2075 Martinez	Garrett, 32	Jan 2	2
2089 Cetacea	Hudgens, 38	Sep 26	2
2093 Genichesk	Faure, 20	May 8-9	2
2099 Öpik	Hudgens, 38	Oct 29	2
2105 Gudy	Bookamer, 41	Jan 2	3
	Garrett, 32	Jan 2	2
2107 Ilmari	Hudgens, 38	Dec 1	2
2108 Otto Schmidt	Faure, 20	Oct 27	2
2243 Lönnrot	Harvey, 74	Sep 4	3
2245 Hekatostos	Hudgens, 38	Nov 5-6	2
2264 Sabrina	Faure, 20	Sep 4	2
2266 Tchaikovsky	Faure, 20	Nov 6-7	2
	Hudgens, 38	Nov 5-6	2
2346 Lilio	Hudgens, 38	Aug 1	2
2382 Nonie	Hudgens, 38	Sep 26	2
2406 Orelskaya	Hudgens, 38	Sep 26	2
2407 Haug	Faure, 20	Jul 31	2
	Hudgens, 38	Aug 1	2
2443 Tomeileen	Hudgens, 25	Feb 4	2
2453 Wabash	Hudgens, 38	Sep 26	2
2464 Nordenskiöld	Hudgens, 38	Dec 4	2
2494 Inge	Hudgens, 38	Dec 28-29	2
2545 Verbiest	Hudgens, 38	Dec 28-29	2
2592 Hunan	Harvey, 74	Mar 7	3
2616 Lesya	Hudgens, 38	Sep 3	2
2644 Victor Jara	Harvey, 74	Sep 4	3
2731 Cucula	Faure, 20	Jul 2-3	2
	Hudgens, 38	Jun 25	2
2757 Crisser	Hudgens, 38	Oct 29-Nov 5	2
2794 Kulik	Faure, 20	Dec 1	2
	Hudgens, 38	Nov 5-6	2
2808 Belgrano	Hudgens, 38	Dec 28-29	2
2839 Annette	Bookamer, 41	Oct 27	3
	Faure, 20	Oct 29-30	2
2886 Tinkaping	Hudgens, 38	Dec 28-29	2
3037 Alku	Faure, 20	Jan 10-11	3
	Garrett, 32	Jan 2	2
	Hudgens, 41	Jan 8-9	2
3109 Machin	Hudgens, 25	Apr 10	2
3272 Tillandz	Harvey, 74	Jan 18	3
3397 Leyla	Harvey, 74	Apr 10	3
3421 Yangchening	Harvey, 74	Dec 3	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
3425 Hurukawa	Faure, 20	Nov 6-7	2
3449 Abell	Harvey, 74	Dec 3	3
3511 Tsvetaeva	Harvey, 74	Dec 3	3
3614 Tumilty	Faure & Marchal, 20	Jul 15	2
3631 Sigyn	Faure, Bardin, Elst, 63	Jun 6	2
3632 Grachevka	Garrett, 32	Jan 2	2
3635 Kreutz	Harvey, 74	Nov 26	6
3721 Widorn	Harvey, 74	Feb 12	3
3831 Pettengill	Harvey, 74	Sep 6	3
3875 Staehle	Faure, 20	Sep 4	2
	Hudgens, 38	Sep 1	2
3895 Earhart	Harvey, 74	Jan 18	3
	Hudgens, 25	Feb 4	2
3899 Wichterle	Hudgens, 38	Nov 23-24	2
3925 Tret'yakov	Hudgens, 38	Sep 26	2
3943 Silbermann	Harvey, 74	Oct 29	3
3981 Stodola	Harvey, 74	Dec 3	3
3995 Sakaino	Faure, 20	Nov 12-27	10(7C)
3998 Tezuka	Faure, 20	Dec 1	2
	Hudgens, 38	Nov 5-6	2
4028 Pancratz	Harvey, 74	Nov 26	3
4049 Noragal'	Faure, 20	Jul 3	2
4081 Tippett	Harvey, 74	Sep 12	3
4089 1986 JG	Harvey, 74	Mar 6	3
4110 Keats	Harvey, 74	May 4	3
4121 Carlin	Hudgens, 38	Nov 23-24	2
4132 Bartók	Bookamer, 41	Sep 24	4
	Faure, 20	Sep 4	2
4178 1988 EO1	Harvey, 74	Apr 10	3
4221 Picasso	Harvey, 74	Apr 10	3
4227 Kaali	Harvey, 74	Feb 12	3
4378 Voigt	Faure, 20	Mar 12	4C
	Hudgens, 25	Apr 10	2
4384 1990 AA	Hudgens, 38	Aug 24-27	2
4431 Holeungholee	Hudgens, 38	Dec 24	2
4457 Van Gogh	Harvey, 74	May 4	3
4467 Kaidanovskij	Faure, 20	Oct 27	2
4577 Chikako	Bookamer, 41	Dec 24	3
	Hudgens, 38	Dec 4	2
4608 1988 BW3	Faure, 20	Nov 27	2
	Hudgens, 38	Dec 28-29	2
4655 Marjoriika	Harvey, 74	Sep 6	3
4698 Jizera	Harvey, 74	Mar 7	3
4706 Dennisreuter	Harvey, 74	Jan 18	3
4744 1988 RF5	Faure, 20	Mar 1	2
4768 Hartley	Hudgens, 38	Sep 2-3	2
4856 Seaborg	Harvey, 74	Nov 26	3
4892 Chrispollas	Harvey, 74	Apr 11	3
4914 Pardina	Faure, 20	Oct 30	2
	Hudgens, 38	Nov 23-24	2
5034 Joeharrington	Harvey, 74	Sep 6	3
5079 Brubeck	Harvey, 74	Feb 19	3
5118 Elnapoul	Faure, 20	Nov 6	2
	Harvey, 74	Oct 29	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
5147 Maruyuma	Harvey, 74	Apr 10	3
5164 Mullo	Faure, 20	Dec 23	2
	Hudgens, 38	Dec 28-29	2
5176 Yoichi	Hudgens, 38	Sep 26	2
5216 1941 HA	Faure, 20	Jul 3	2
	Hudgens, 38	Aug 1	2
5237 Yoshikawa	Harvey, 74	Mar 6	3
5477 1989 UH2	Harvey, 74	Oct 31	3
5565 Ukyounodaibu	Harvey, 74	Oct 30	3
5567 Durisen	Bookamer, 41	Oct 1	4
	Faure, 20	Oct 9	2
5660 1974 MA	Faure, 20	Aug 1	4
	Hudgens, 38	Aug 1	2
5707 Shevchenko	Harvey, 74	Apr 11	3
5798 Burnett	Harvey, 74	Oct 31	3
5811 Keck	Faure, 20	Jul 3	2
5847 Wakiya	Bookamer, 41	Sep 26	3
	Faure, 20	Sep 4	2
5925 1994 CP1	Harvey, 74	Mar 6	3
5994 Yakubovich	Harvey, 74	Oct 29	3
	Hudgens, 38	Oct 29-Nov 5	2
6035 Swift	Faure, 20	Jan 10	2
6071 Sakitama	Faure, 20	Jan 10	2
6074 Bechtereva	Harvey, 74	Sep 5	3
6086 1987 VU	Harvey, 74	Nov 4	3
6139 Naomi	Harvey, 74	Jan 19	3
6153 Hershey	Hudgens, 38	Dec 1	2
6179 Brett	Harvey, 74	Mar 6	3
6181 1986 RW	Harvey, 74	Sep 7	3
6186 Zenon	Harvey, 74	Nov 4	3
6249 Jennifer	Faure, 20	Sep 3	2
	Hudgens, 38	Sep 3	2
6277 1949 QC1	Harvey, 74	Sep 5-6	3
6327 1991 GP1	Faure, 20	Jul 2	2
	Harvey, 74	May 9	3
6364 Casarini	Hudgens, 38	Sep 1	3
6381 1988 DO1	Harvey, 74	Mar 6	3
6395 Hilliard	Harvey, 74	Oct 29	3
6454 1991 UG1	Harvey, 74	Nov 26	3
6456 Golombek	Faure, 20	Sep 3	2
	Harvey, 74	Sep 5	3
6463 Isoda	Hudgens, 38	Dec 1	2
6535 Archipenko	Harvey, 74	Sep 8	3
6554 Takatsuguyoshida	Harvey, 74	Sep 6	3
6611 1993 VW	Faure, 20	May 8	4
	Harvey, 74	May 5	6
	Hudgens, 38	May 7	3
	Jardine & Pilcher, 35	May 7	5C
6734 1992 FB	Harvey, 74	Dec 3	3
6911 Nancygreen	Faure, 20	Jul 31	4
7201 Kuritariku	Harvey, 74	Nov 26	3
7357 1995 UJ7	Harvey, 74	Sep 6	3
7741 Fedoseev	Harvey, 74	Sep 6	3
7806 1971 UM	Harvey, 74	Oct 29	3
8131 Scanlon	Harvey, 74	Oct 29	3
8180 1992 PY2	Harvey, 74	Sep 8	3

PLANET	OBSERVER & APERTURE (cm)	OBSERVING PERIOD (2005)	NO. OBS.
8257 Andycheng	Harvey, 74	May 4	6
8290 1992 NP	Faure, 20	Oct 8	2
	Harvey, 74	Sep 7	3
8297 Gérardfaure	Faure, 20, 35	Jan 16-Mar 12	29(25C)
8345 Ulmerspatz	Harvey, 74	Jan 18	3
8369 1991 GR	Faure, 20	Dec 1	2
	Harvey, 74	Nov 26	3
8397 Chiakitanaka	Harvey, 74	Sep 7	3
8400 Tomizo	Hudgens, 38	Oct 29-Nov 5	2
8441 Lapponica	Harvey, 74	Apr 11	3
8474 Rettig	Harvey, 74	May 9	3
8882 Saketamura	Harvey, 74	Feb 19	6
8889 Mockturtle	Harvey, 74	Sep 8	3
9566 Rykhlova	Harvey, 74	Sep 4	3
9716 Severina	Harvey, 74	Sep 7	3
10236 1998 QA93	Harvey, 74	Nov 26	3
12745 1992 UL2	Harvey, 74	Nov 4	3
12867 Joeloic	Faure, 20	Jun 11	4C
12919 1998 VB6	Harvey, 74	Sep 8	3
13123 Tyson	Harvey, 74	May 9	3
13553 1992 JE	Faure, 20	Jul 2-3	2
	Harvey, 74	Aug 2	6
14257 2000 AR97	Faure, 20	Oct 28	2
14276 2000 CF2	Faure, 20	Oct 28	2
	Harvey, 74	Oct 30	3
	Hudgens, 38	Oct 29-Nov 5	2
14375 1989 SU	Faure, 20	Nov 11	2C
	Harvey, 74	Sep 7	3
14643 Morata	Harvey, 74	Sep 8	3
14835 Holdridge	Harvey, 74	Oct 29	3
	Hudgens, 38	Nov 23-24	2
15276 Diebel	Harvey, 74	May 9	3
15350 Naganuma	Harvey, 74	Oct 29	3
16009 1999 CM8	Faure, 20	Nov 6-7	2
	Hudgens, 38	Nov 5-6	2
16403 1984 WJ1	Bookamer, 41	Oct 29	3
	Faure, 20	Oct 27-28	2
	Hudgens, 38	Oct 29-Nov 5	2
16924 1998 FL61	Harvey, 74	Sep 12	3
16941 1988 GR7	Harvey, 74	Dec 3	3
17738 1998 BS15	Harvey, 74	Mar 6	3
18582 1997 XK9	Hudgens, 38	Dec 1	2
21831 1999 TX93	Harvey, 74	Feb 12	3
22753 1998 WT	Faure, 20	Mar 1	3
	Harvey, 74	Feb 19	6
23127 2000 AV97	Harvey, 74	Oct 31	3
24814 1994 VW1	Harvey, 74	Dec 3	3
26120 1991 VZ2	Harvey, 74	Sep 12	3
27136 1998 XJ16	Faure, 20	Nov 26-27	2
	Harvey, 74	Oct 31	3
	Hudgens, 38	Dec 1	2
28610 2000 EM158	Harvey, 74	Sep 5-6	3
29495 1997 WU7	Hudgens, 38	Oct 29-Nov 5	2
30825 1990 TG1	Faure, 20	Mar 1	4
	Harvey, 74	Feb 11	6
31060 1996 TB6	Harvey, 74	Oct 31	3
32555 2001 QZ29	Faure, 20	Jul 30	2
34706 2001 OP83	Bookamer, 41	Dec 1	5
	Faure, 20	Dec 23-24	2
	Harvey, 74	Dec 3	3
	Hudgens, 38	Dec 4	2
37671 1994 UY11	Harvey, 74	Oct 29	3
42264 2001 QZ30	Faure, 20	Oct 29	2
42600 1997 YF10	Harvey, 74	Jan 19	3
43769 1988 EK	Harvey, 74	Mar 7	3
44896 1999 VB12	Harvey, 74	Mar 6	3
46354 2001 TY8	Harvey, 74	Oct 31	3
49385 1998 XA12	Faure, 20	Nov 11	7C
	Harvey, 74	Oct 4	3
50098 2000 AG98	Harvey, 74	Sep 12	3
53430 1999 TY16	Harvey, 74	Nov 26	3
100085 1992 UY4	Faure, 20	Jul 31	4
	Harvey, 74	Aug 2	6
	Hudgens, 38	Aug 1	2
118303 1998 UG	Hudgens, 38	Dec 31	3
1999 RR28	Harvey, 74	Apr 6	6
1999 XA143	Harvey, 74	Jan 18	6
2002 EX12	Faure, 20	Jul 30	4
2004 QD3	Harvey, 74	Mar 4	6
2004 QT24	Harvey, 74	Apr 16	6
2004 RF84	Harvey, 74	Mar 1	6
2004 VG64	Faure, 20	Oct 26	8
	Harvey, 74	Oct 24	6
2004 YZ23	Hudgens, 38	Jun 2	2
2005 AB	Harvey, 74	Mar 4	3
2005 ED318	Harvey, 74	May 22	6
2005 GR33	Harvey, 74	Apr 11	6
2005 JE46	Faure, 20	Nov 12-26	7(5C)
	Harvey, 74	Nov 23	6
	Hudgens, 38	Nov 22	3
2005 WC1	Harvey, 74	Dec 13	6

LIGHTCURVE PHOTOMETRY OPPORTUNITIES JULY – SEPTEMBER 2006

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We present here three lists of “targets of opportunity” for the period 2006 July through September. 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. These circumstances make the asteroids particularly good targets for those with modest “backyard” telescopes, i.e., 0.2-0.5m.

The goal for these asteroids is to find a well-determined rotation rate, if at all possible. Don’t hesitate to solicit help from other observers at widely spread longitudes should the initial finding for the period indicated that it will be difficult for a single station to find the period.

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 final list is those asteroids needing only a small number of lightcurves to allow Kaasalainen and others to work on a shape model. Some of the asteroids have been on the list for some time, so work on them is strongly encouraged in order to allow models to be completed. For these objects, we encourage you to do absolute photometry, meaning that the observations are not differential but absolute values put onto a standard system, such as Johnson V. If this is not possible or practical, accurate relative photometry is also permissible. This is where all differential values are against a calibrated zero point that is not necessarily on a standard system.

Keep in mind that as new large surveys, e.g., Pan-STARRS, come on line and start producing data individual, lightcurves obtained by smaller observatories will become even more important. Using a sparse sampling technique developed by Kaasalainen, the accumulated data from the surveys, and the high-density coverage provided by amateurs or small institutions, period analysis can progress at a more rapid rate, providing a better data pool for statistical analysis. It may also be possible to discover binary asteroids using the combined data. Observers should not see the surveys as competition but as a means to obtaining the ever needed “more data” and the opportunity to make new discoveries.

Once you have data and analyzed them, it’s important that you publish your results in the *Minor Planet Bulletin* and, if nothing else, make the data available on a personal website or upon request. If you don’t make the data available, then the potential gains in cooperation with the large surveys nay not be possible. Previous issues have covered larger upload sites such as OLAF, SAPC, and the ADU. For more information about those sites, please contact Warner at the email address given above.

Lightcurve Opportunities

#	Name	Brightest Date	Brightest Mag	Dec	U	Per.	Amp
5199	Dortmund	7 02.5	14.3	-29	1		<0.1
1765	Wrubel	7 07.9	13.8	-41			
1750	Eckert	7 08.1	14.7	-14			
537	Pauly	7 08.3	11.6	-18	2	16.250	0.17
4444	1985 SA	7 09.1	14.7	-19			
1676	Kariba	7 09.9	14.1	-33			
826	Henrika	7 10.5	13.8	-11			
646	Kastalia	7 12.7	14.0	-25			
2058	Roka	7 12.1	14.2	-23	2	10.044	0.34
1288	Santa	7 13.1	15.0	-24	2	8.28	0.46
1702	Kalahari	7 14.4	14.2	-24			
5220	Vika	7 14.0	14.6	-34			
1055	Tynka	7 15.8	13.0	-15			
4353	Onizaki	7 16.9	14.6	-31			
18590	1997 YO10	7 16.7	14.0	-31			
9021	Fagus	7 20.5	14.6	-31			
3127	Bagration	7 20.4	14.1	-20			
1604	Tombaugh	7 21.7	14.2	-23	2	7.04	0.20
2409	Chapman	7 22.2	14.6	-18			
1847	Stobbe	7 24.0	14.2	-24	2	6.37	0.27
6934	1994 YN2	7 27.5	14.6	-28			
1795	Woltjer	7 27.9	14.6	- 7			
20691	1999 VY72	7 27.2	14.6	-30			
1293	Sonja	7 29.6	12.7	- 7			
1493	Sigrid	7 30.0	13.5	-21			
4192	Breysacher	8 01.9	14.9	-17			
6406	1992 MJ	8 03.3	14.0	-13			
477	Italia	8 07.0	12.0	-25	1		
5719	Krizik	8 11.1	14.4	-16			
1456	Saldanha	8 12.8	14.3	- 5			
4428	Khotinok	8 13.8	14.5	-23			
3253	Gradie	8 14.0	14.9	-29	2	6.3	0.54
366	Vincentina	8 14.8	12.5	-21	1	15.5	0.08
1329	Eliane	8 15.2	13.2	-18	2	8.0	0.08
474	Prudentia	8 17.6	12.1	- 8			
562	Salome	8 17.2	13.8	-29	1	10.4	0.14
3560	Chenqian	8 18.1	14.0	-13			
707	Steina	8 20.8	14.0	- 7	1	24.	0.1
2294	Andronikov	8 22.7	14.1	- 5			
4087	Part	8 22.3	14.8	-19	2	16.47	0.59
2557	Putnam	8 24.1	14.5	- 5			
1336	Zeelandia	8 25.3	14.1	-15			
4420	Alandreev	8 26.2	13.7	- 3			
1350	Rosselia	8 28.3	14.1	-11	2	6.0	0.3
2466	Golson	8 30.2	14.3	- 9			
717	Wisibada	9 01.9	13.7	- 8	?		
6260	Kelsey	9 01.0	14.4	- 4	2	5.11	0.17
1551	Argelander	9 01.8	14.6	-13			
191	Kolga	9 04.3	12.4	- 8	2	27.80	0.5
1159	Granada	9 05.3	13.9	- 9	2	31.	0.28
1682	Karel	9 05.9	13.9	- 4			
685	Hermia	9 06.4	13.0	+ 1			
845	Naema	9 07.3	13.6	-22			
3699	Milbourn	9 08.2	14.5	-15			
3043	San Diego	9 08.1	14.5	-13	2	30.72	0.37
1494	Savo	9 08.3	14.1	- 3			
2989	Imago	9 09.6	14.6	-12			
3657	Ermolova	9 09.5	14.6	+ 5			
571	Dulcinea	9 11.8	13.0	- 7			
3216	Harrington	9 12.2	14.8	-13	2	6.1	0.2
2510	Shandong	9 12.3	14.1	-13			
1643	Brown	9 13.4	14.6	+ 2			
916	America	9 14.0	12.5	+ 5	1	38.	0.28
186	Celuta	9 16.7	10.9	-12	2	19.6	0.4
3438	Inarradas	9 16.3	14.6	- 7			
2574	Ladoga	9 18.0	14.6	- 4			
672	Astarte	9 18.4	13.8	+ 2			
1605	Milankovitch	9 20.3	14.0	- 2	2	11.60	0.12
1692	Subbotina	9 20.2	14.0	+ 0			
2754	Efimov	9 20.1	14.5	+11			
935	Clivia	9 21.9	14.4	+ 1			
2590	Mourao	9 23.7	14.8	+ 7			
972	Cohnia	9 24.6	12.5	+13			
671	Carnegia	9 24.7	14.1	+ 1			
7355	Bottke	9 29.0	14.8	-10			

Low Phase Angle Opportunities

#	Name	Date	PhA	V	Dec
3093	Bergholz	07 04.5	0.69	14.0	-21
1509	Esclangona	07 05.9	0.09	13.7	-23
767	Bondia	07 06.0	0.56	13.6	-24
507	Laodica	07 10.0	0.48	13.4	-24
10	Hygiea	07 13.1	0.26	9.2	-21
678	Fredegundis	07 17.7	0.90	12.3	-19
925	Alphonsina	07 25.9	0.64	12.1	-18
492	Gismonda	07 31.6	1.00	13.1	-21
301	Bavaria	08 02.0	0.72	13.3	-16
506	Marion	08 02.0	0.46	13.5	-19
208	Lacrimosa	08 04.2	0.74	12.8	-19
167	Urda	08 05.3	0.72	12.8	-15
3500	Kobayashi	08 07.1	0.08	13.5	-17
465	Alekto	08 08.1	0.62	13.6	-15
382	Dodona	08 11.2	0.31	12.8	-14
1085	Amaryllis	08 28.8	0.83	13.6	-12

#	Name	Date	PhA	V	Dec
200	Dynamene	08 31.2	1.00	11.5	-06
717	Wisibada	09 01.8	0.15	13.8	-08
191	Kolga	09 04.3	0.29	12.5	-08
318	Magdalena	09 07.0	0.21	13.8	-07
120	Lachesis	09 11.8	0.40	12.1	-03
973	Aralia	09 13.0	0.18	13.8	-03
834	Burnhamia	09 18.4	0.31	13.3	-01
902	Probitas	09 19.1	0.32	14.0	-01
76	Freia	09 27.9	0.31	12.5	+03

Shape/Spin Modeling Opportunities

#	Name	Brightest Date	Mag	Dec	Per (h)	Amp.	U
83	Beatrix	7 28.4	11.8	-27	10.16	0.18-0.27	4
218	Bianca	8 04.5	12.0	-02	6.337	0.11-0.24	4
34	Circe	8 20.6	12.5	-08	12.15	0.24	3
76	Freia	9 27.9	12.4	+03	9.972	0.10-0.33	2
409	Aspasia	9 30.1	11.2	+16	9.020	0.10-0.14	3

Note that the amplitude in the table just above could be more, or less, than what's given. Use the listing as a guide and double-check your work. Also, if the date is '1 01.' Or '12 31. ', i.e., there is no value after the decimal, it means that the asteroid reaches its brightest just as the year begins (it gets dimmer all year) or it reaches its brightest at the end of the year (it gets brighter all year).

CHOOSING THE REFERENCE STARS

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A key step in asteroid astrometry is choosing a set of comparison stars or reference stars. The final precision depends upon the intrinsic positional accuracy of each of the reference stars. Here we show how the precision of asteroid astrometry is dependent on the geometry of the reference star configuration relative to the asteroid.

Summary of method of reduction (Plate constants)

First, the equatorial coordinates (α,δ) are transformed to standard coordinates (ξ,η). For our presentation, we consider only the ξ coordinate, where results for η are similar. For the ξ coordinate:

$X_1 a + Y_1 b + c = \xi_1$
$X_2 a + Y_2 b + c = \xi_2$
....
$X_i a + Y_i b + c = \xi_I$
....
$X_n a + Y_n b + c = \xi_n$ (1)

In the normal equations, X_i ,Y_i are measured coordinates of stars expressed in units of focal length and with origin in the "center", so that [X] = [Y] = 0 (the rectangular bracket denoting summations for i=1,2,..,n) and n is the number of stars. Then, the plate constants (a,b,c) are obtained by the method of least squares. Equations of condition for (1) are:

$[X^2]\, a + [XY] b = [\xi X]$
$[XY] a + [Y^2]\, b = [\xi Y]$
$nc = [\xi]$ (2)

Mean error of the measured position and propagation of errors.

The calculated constants in (2) are replaced in (1). The residuals, $V_i = \xi_i' - \xi_i$, satisfy the properties of the arithmetical mean, $[V_i] = 0$, and $[V_i^2]$ = minimum. The mean error of the measured position is:

$$E\xi' = ([V_i^2]/(n-3))^{1/2},$$

and the mean error of each plate constant is

$$E_a = E\xi' /(W_a)^{1/2}; \quad E_b = E\xi' /(W_b)^{1/2}; \quad E_c = E\xi' /(W_c)^{1/2}; \qquad (3)$$

where W_a, W_b and W_c are the weights of the constants. These are obtained when replacing the absolute terms in (2) by (1,0,0) to calculate $1/W_a$; (0,1,0) to calculate $1/W_b$; and (0,0,1) to calculate $1/W_c$. The errors are propagated in the standard coordinate of asteroid, $\xi_A = X_A a + Y_A b + c$, by:

$$E\xi_A = (E^2_a X^2_A + E^2_b Y^2_A + E^2_c)^{1/2} \qquad (4)$$

(X_A,Y_A) are the measured coordinates of asteroid. A similar result is also obtained for the η_A coordinate.

Conclusion on the Propagation of Errors

If we write equation (4) as $E\xi_A = f(X_A,Y_A)$, we can see (Figure 1) the errors of the ξ_A coordinate distributed in different points (X_A,Y_A) inside of the stars' configuration. The figure is a concave surface with its minimum at the origin (center) and apart of the plane of the image by E_c value. Then, when $X_A = Y_A = 0$ we have,

$$E\xi_A = E_c = E\xi' /(W_c)^{1/2} = E\xi' /(n)^{1/2} = \text{minimum}$$

Here, we can see that the minimum value is obtained at the origin. Also, if $E\xi_A$ = constant, we can obtain the contour lines (or lines of equal error) of Figure 2. These lines are concentric ellipses and its principal axes agree with the coordinates axes. Eventually, if the configuration of stars have a regular geometric form, the contour lines should be concentric circles. We can predict the orientation and shape (minor axis / major axis) of the ellipses as follows. From (3) and (4):

$$E\xi_A^2 = E\xi'^2 X^2_A /W_a + E\xi'^2 Y^2_A /W_b + E^2_c$$

We thus find that when $E\xi_A = K$ and ($X_A = 0$; $Y_A > 0$),

$$Y^2_A = (K-E^2_c)W_b /E\xi'^2 = [\text{semi minor (major) axis}]^2 = \text{semi1}^2 \qquad (5)$$

and when $E\xi_A = K$, but, ($X_A > 0$; $Y_A = 0$),

$$X^2_A = (K-E^2_c)W_a /E\xi'^2 = [\text{semi major (minor) axis}]^2 = \text{semi2}^2 \qquad (6)$$

From (5) and (6):

$$\text{semi1/semi2} = (Y^2_A/X^2_A)^{1/2} = (W_b/W_a)^{1/2} = ([Y^2]/[X^2])^{1/2}.$$

It is interesting to observe the analog to the field of Mechanics. For example: $([Y^2]/[X^2])^{1/2} = (I_X/I_Y)^{1/2} = K_X/K_Y$, where I_X, I_Y are the moments of inertia of the system of masses (supposing every star with a "mass" m=1). In this analogy, K_X, K_Y are the radii of gyration.

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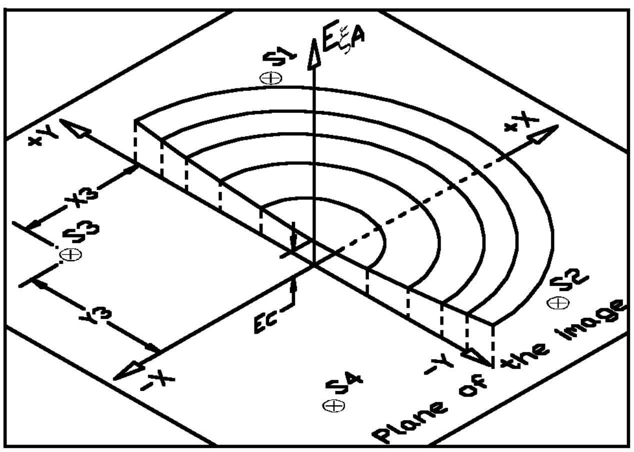

Figure 1. Cross section view of the equation $E\xi_A = f(X_A, Y_A)$

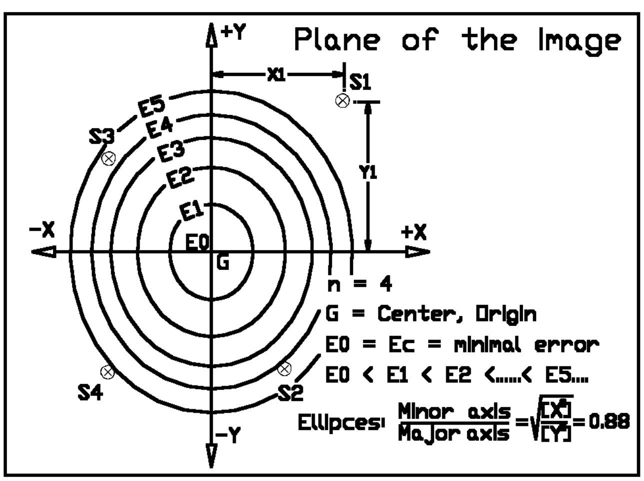

Figure 2. Contour lines of $E\xi_A = K = f(X_A, Y_A)$.

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* * * * *

The deadline for the next issue (33-4) is July 15, 2006. The deadline for issue 34-1 is October 15, 2006.