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PERIOD DETERMINATION FOR 463 LOLA

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Minor planet 436 Lola was observed on four nights over a 13 day interval in October, 2004. The synodic period was detemined as 6.206 ± 0.002 hours. The peak to peak amplitude was 0.2 magnitudes.

Minor planet 463 Lola was discovered by Max Wolf at Heidelberg on October 31, 1900. It is most probably named from a character in an opera. From the book *Asteroids II* (Binzel et al., 1989), this main-belt asteroid – originally 1900 FS – has a quoted diameter of 21.5 ± 0.8 km, an albedo of 0.077 and a B-V of 0.71.

Observations of this minor planet were made as a result of a request for observations to back up radar work at Arecibo. No lightcurve or rotational period was to be found in the literature. The aspect data of the observations in 2004 are listed in Table I (PAB is the Phase Angle Bisector), which also shows the percent of the lightcurve observed each night. Due to the relatively short rotational period a complete light curve – with a short break for clouds – was observed on Oct. 13.

Using a 40cm aperture working at f/6.5, unfiltered CCD photometry was undertaken with integration times giving a S/N of 100 or better, thus yielding an internal precision of 1%. All data were light-time corrected and nightly plots were made of differential magnitude vs JD for an initial graphical analysis. This indicated a period close to 6.2 hours. This was then further refined using the "AVE" software (Barbera, 2004) and the Phase Disperson Minimisation (PDM) method. The final result was 6.206±0.002 hours, with an arbitrary epoch of minimum at JD 2453289.826 (see Figure 1). The overall peak to peak amplitude of the lightcurve at this opposition was 0.2±0.01, implying an axial ratio a/b of 1.2. These data have been forwarded to Dr. Mike Nolan and the team at Arecibo Observatory.

Acknowledgements

Brian Warner is thanked for his continuing advice and assistance.

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Barbera, R. (2004). "AVE" Analisis de Variabilidad Estelar, version 2.51, Grup Estudis Astronomics. http://usuarios.lycos.es/rbarbera/AVE/AveInternational.htm

Binzel, Richard P., Gehrels, Tom, and Matthews, Mildred Shapley (1989). *Asteroids II*. Univ. Ariz. Press, Tucson, Arizona.

Table I. Aspect data for 463 Lola in 2004.

UT Date	PAB Long	PAB Lat	Phase Angle	% Phase Coverage
2004 Oct 11	27.60	-4.45	7.27	72
2004 Oct 13	27.79	-4.21	6.04	100
2004 Oct 22	28.37	-2.90	2.16	72
2004 Oct 23	28.64	-2.70	2.35	84

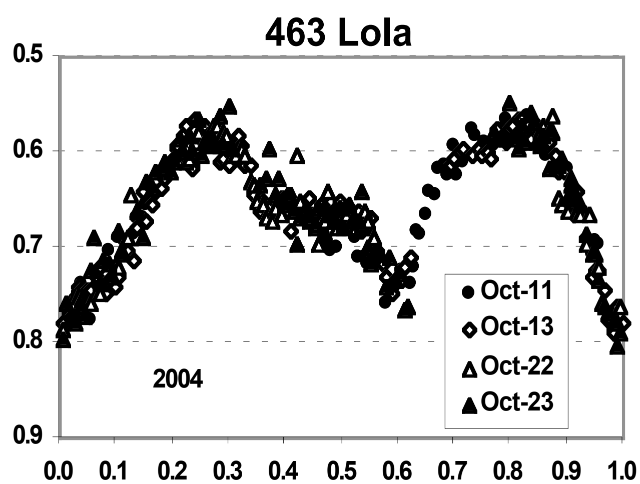

Figure 1. Composite lightcurve, Oct 2004.

REVISED LIGHTCURVE ANALYSIS FOR 1022 OLYMPIADA AND 3285 RUTH WOLFE

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Additional analysis of two previously published lightcurves by the author resulted in revised synodic periods for both. For 1022 Olympiada, the new synodic period is 3.833±0.005h while the revised synodic period for 3285 Ruth Wolfe is 3.94±0.01h.

Introduction

Following recent improvements in the software used to measure images and analyze lightcurves, the author re-examined several curves previously reported in past years. The selected curves were those that had marginal solutions due to lack of or poor data, or might have been misinterpreted due to a lack of experience.

<u>1022 Olympiada</u>. The lightcurve for 1022 Olympiada was previously reported by the author (Warner 1999) as being 4.589±0.002h. As misfortune would have it, two possible periods were found: the previously reported one and the one now being recommended. The shorter period allowed almost exactly one additional revolution in the interval between runs. In addition, remeasuring the images altered some data points that significantly affected the interpretation of the curve.

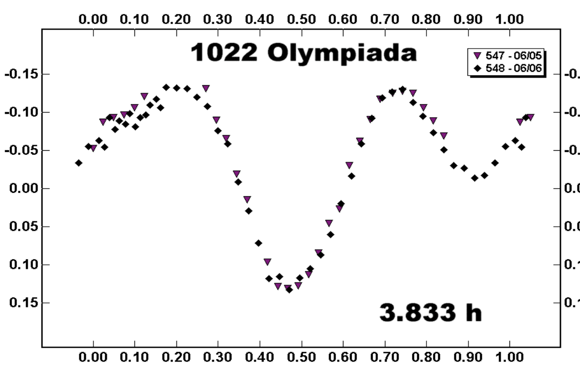

Figure 1. Data for 1022 Olympiada phased against a newly determined period of 3.833h. The amplitude is 0.24±0.02m.

Figure 1 shows the remeasured data phased against the new, shorter period. Working in favor of this solution was that the RMS value for the data fit of the Fourier analysis is smaller than for the longer period. Another factor in favor of the shorter period was that it agreed well a period reported by Zeigler from data obtained on 1999 June 11-12. (private communication to A. W. Harris).

Figure 2 shows the same data phased against 4.6 hours. This longer period was rejected based on its unusual shape. Specifically, it's nearly tri-modal and in a very unusual way. While this curve and associated period are possible, the more likely solution is the simpler bimodal curve associated with the shorter period.

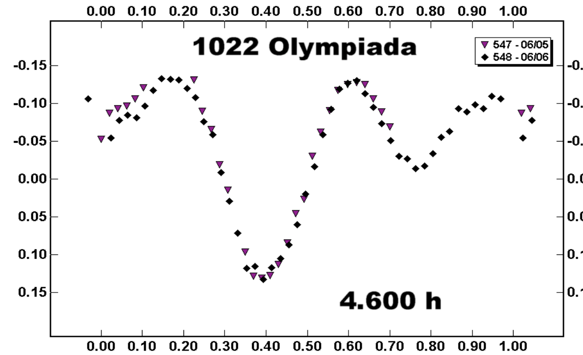

Figure 2. Data for 1022 Olympiada phased against the previous solution of 4.600h, a solution now considered less likely.

<u>3285 Ruth Wolfe</u>. Originally only two data sessions were used to report the previous results of 6.72±0.01h (Warner 2003). A third session was found while providing sample images to Frederick Pilcher for learning the MPO Canopus software. Pilcher's analysis gave a different result and so the author remeasured all three sets of data and obtained a new period of 3.94±0.01h. The amplitude of the new curve is 0.21±0.02m. Figure 3 shows the remeasured data against the new period. A plot of the data against the original period of 6.72h shows no correlation among the data. The Fourier analysis period spectrum showed no likely period out to 9 hours.

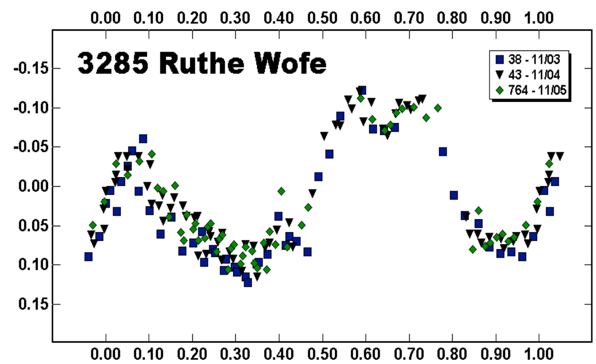

Figure 3. Data for 3285 Ruth Wolfe phased against a period of 3.94h. The amplitude of the curve is 0.20±0.02 m.

Conclusion

While it seems more likely than before that the 3.833h period for Olympiada is correct, additional curves would help make that certain. They might also show a different shape and/or amplitude and so provide some clues about the shape of the Hungaria family asteroid. The next good opportunity for additional study comes in 2005 October, when the asteroid will be about 15.5 and favoring Southern Hemisphere observers at a declination of –17°.

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Warner, B. D. (2003), "Lightcurve Analysis of Asteroids 331, 795, 886, 1266, 2023, 3285, and 3431", *Minor Planet Bulletin* **30**, 61-64.

ROTATIONAL PERIODS OF 743 EUGENISIS, 995 STERNBERGA, 1185 NIKKO, 2892 FILIPENKO, 3144 BROSCHE, AND 3220 MURAYAMA

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Lightcurve period and amplitude results from Santana Observatory are reported for 2004 September-December:

743 Eugenisis (10.23 ± 0.01 hours and 0.20 mag.), 995 Sternberga (15.26 ± 0.01 hours and 0.15 mag.), 1185 Nikko (3.79 ± 0.01 hours and 0.34 mag.), 2892 Filipenko (14.00 ± 0.01 hours and 0.21 mag.), 3144 Brosche (3.30 ± 0.01 hours and 0.70 mag.), 3220 Murayama (4.87 ± 0.01 hours and 0.16 mag.).

Introduction

Santana Observatory (MPC Code 646) is located in Rancho Cucamonga, California at an elevation of 400 meters and is operated by Robert D. Stephens. Details of the equipment used can be found in Stephens (2003) and at the author's web site (http://home.earthlink.net/~rdstephens/default.htm). All of the asteroids were selected from the "CALL" web site "List of Potential Lightcurve Targets" (Warner 2004). The images were measured use MPO Canopus, which uses differential aperture photometry to determine the values used for analysis. The period analysis was done within Canopus, which incorporates an algorithm based on the Fourier analysis program developed by Harris (1989).

Results

The results are summarized in the table below. The individual plots are presented afterwards. The data and lightcurves are presented without additional comment except when the circumstances for a given asteroid require more details. Columns 2 and 3 gives the full range of dates of observations while column 4 gives the number of actual runs made during that time span and column 5 gives the number of observations used. Column 6 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 7 and 8 give the range of values for the Phase Angle Bisector (PAB) longitude and latitude respectively. Column 9 gives the period and column 10 gives error in hours. Columns 11 and 12 gives the amplitude and error in magnitudes.

995 Sternberga: Sternberga was observed by Barucca et al. on four nights between January 7 and 12, 1989 for about 18 hours. They made 45 observations and determined a rotational period of 16.406 hours with an amplituded of 0.15 magnitudes. They noted that their resulting lightcurve was asymmetric. Their plot showed only one prominent peak and a minor peak only 0.02 magnitudes in amplitude. It appears from their light curve that none of their nightly sessions was over four hours in length. All of the five sessions obtained to determine the 15.26 hour rotational period were at least 7 hours in length was some showing both a minimum and a maximum.

Acknowledgments

Thanks are given to Dr. Alan Harris of the Space Science Institute, Boulder, CO, and Dr. Petr Pravec of the Astronomical Institute, Czech Republic, for their ongoing support of all amateur asteroid photometrists and for their input during the analysis on some of the lightcurves presented here.

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Barucci, M. A., Di Martino, M., and Fulchignoni, M. (1992). "Rotational Properties of Small Asteroids: Photoelectric Observations". *The Astronomical Journal* **103** (5), 1679-1686.

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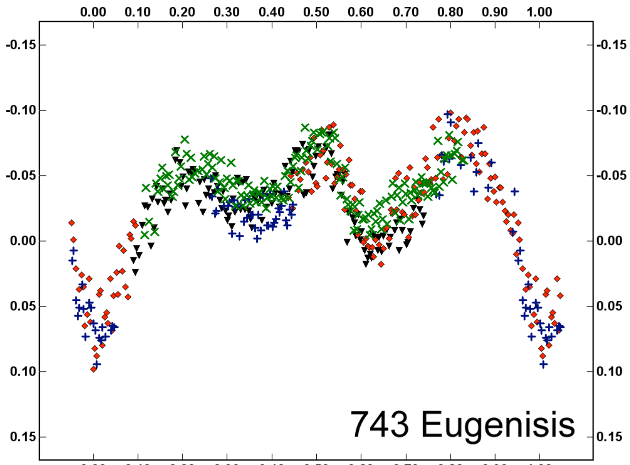
Warner, B. (2004). "Potential Lightcurve Targets". http://www.minorplanetobserver.com/astlc.targets.

Asteroid	Dates	Sess	Obs	Phase	L_{PAB}	B_{PAB}	Per (h)	PE	Amp	AE
743 Eugenisis	2004 09/07-13	4	519	10.2,7.9	7.5	4.4	10.23	0.01	0.20	0.02
995 Sternberga	2004 10/12-31	5	756	5.3,12.5	14.5,15.6	8.2,6.2	15.26	0.01	0.15	0.03
1185 Nikko	2004 11/18-20	3	357	1.7,2.4	54.9	-2.3	3.79	0.01	0.34	0.03
2892 Filipenko	2004 11/24-12/04	5	496	10.5,10.3,10.6	65.6,66.0	21.9,21.7	14.00	0.01	0.21	0.03
3144 Brosche	2004 09/18-23	2	251	9.7,7.5	4.6,5.2	8.3	3.30	0.01	0.70	0.02
3220 Murayama	2004 10/05-10/08	4	442	9.1,7.2	24.7,25.0	-1.1,-0.9	4.87	0.01	0.16	0.04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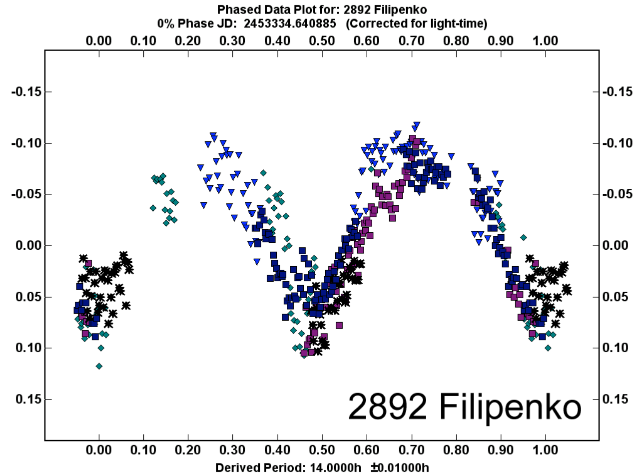
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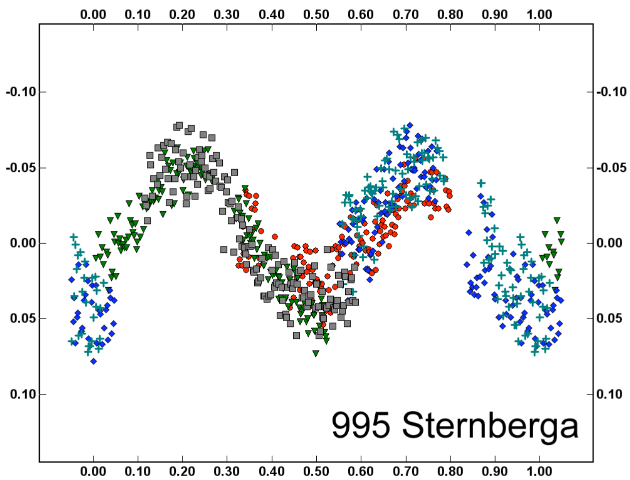
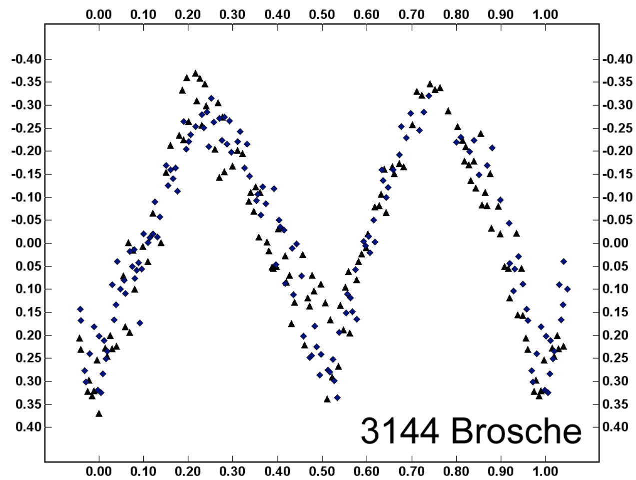
0% Phase JD: 2453334.640885 (Corrected for light-time)
2892 Filipenko
Derived Period: 14.0000h ±0.01000h


995 Sternberga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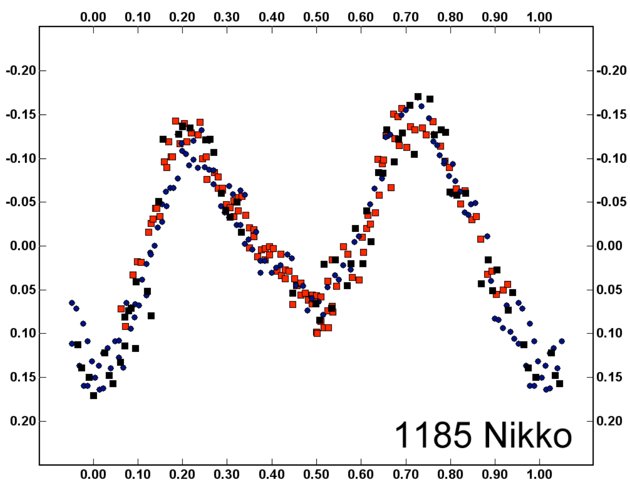
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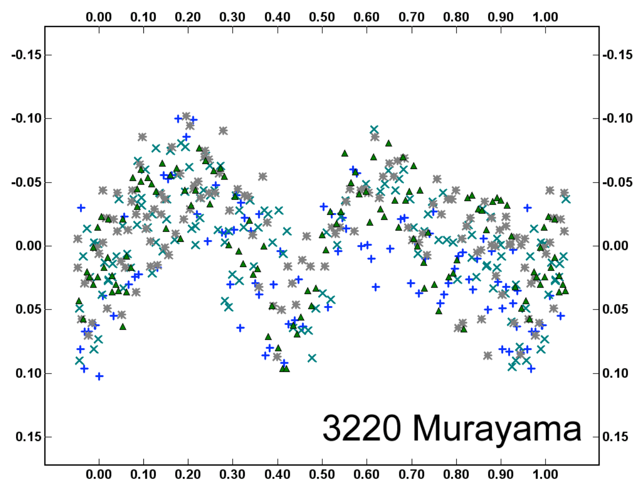
3220 Murayama

ASTEROID LIGHTCURVE ANALYSIS AT THE PALMER DIVIDE OBSERVATORY – FALL 2004

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The lightcurves for the following twenty asteroids were obtained at the Palmer Divide Observatory in late 2004 and analyzed to determine their synodic periods and amplitudes: 862 Franzia, 1307 Cimmeria, 1316 Kasan, 1360 Tarka, 1832 Mrkos, 2494 Inge, 2964 Jaschek, 4217 Engelhardt, 4431 Holeungholee, (4937) 1986 CL1, 5806 Archieroy, 6403 Steverin, 7560 Spudis, (7593) 1992 WP24, 10261 Nikdollezhal', (12559) 1998 QB69, (17664) 1996 VP30, (23712) 1998 AA, (33107) 1997 YL16, and 55735 Magdeburg.

Introduction

The asteroid lightcurve program at the Palmer Divide Observatory has been previously described in detail (Warner 2003) so only a summary is provided now. Several telescope/camera combinations were used to obtain the data for the curves. A: 0.5m R/C, FLI/SITe 1024; B: 0.25m SCT, SBIG ST-9; C: 0.35m SCT, SBIG ST-9; and D: 0.35m SCT, FLI/KAF-1001E.

Targets were chosen by comparing the list of known lightcurve periods maintained by Harris and Warner (Harris 2003), with supplementary information added by the author, against a list of asteroids that were above the horizon and in the magnitude range of 14.0 to 17.0. By selecting fainter targets than might otherwise be chosen, it's hoped to remove some of the observational biases in the list of known lightcurve parameters. These biases include faint objects due to size and/or distance as well as asteroids with lightcurves of small amplitudes, long periods, or complex nature.

The images were measured with MPO Canopus, which uses differential aperture photometry to determine the values used for analysis. The period analysis was done within Canopus, which incorporates an algorithm based on the Fourier analysis program developed by Harris (1989).

Results

The results are summarized in the table below. The individual plots are presented afterwards. The data and curves are presented without additional comment except when the circumstances for a given asteroid require more details.

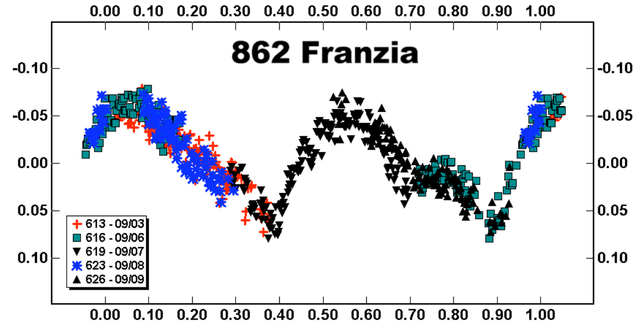
Column 3 gives the full range of dates of observations while column 4 gives the number of actual runs made during that time span. Column 5 is the range of phase angles over the full date range. If there are three values in the column, this means the phase angle reached a minimum with the middle value being the minimum. Columns 6 and 7 give the range of values for the Phase Angle Bisector (PAB) longitude and latitude respectively. Column 9 gives the period error in hours and column 11 gives the amplitude error in magnitudes.

Comments

(23712) 1998 AA. The asteroid was named Willpatrick after the data were obtained and results posted on the CALL and the author's web site (http://www.minorplanetobserver.com/htms/pdo_lightcurves.htm).

7560 Spudis. Most asteroid lightcurves are bimodal, i.e., with two minimum/maximum pairs per revolution. However, it is not uncommon for lower amplitude objects to have more complex curves. Many other periods were tried to reduce to a bimodal curve with no success. Petr Pravec of Ondrejov Observatory confirmed the analysis for a trimodal curve.

#	Name	Date Range 2004	Sess	Phase	L_{PAB}	B_{PAB}	Per (h)	PE	Amp	AE
862	Franzia	09/03-09	5	5.2-7.4	337.3	11.1-11.5	15.05	0.02	0.12	0.02
1307	Cimmeria	09/13-15	3	6.9-7.8	339.4	5.2	2.820	0.005	0.31	0.02
1316	Kasan	09/06-08	3	25.4	343.9-344.2	35.9-35.8	5.83	0.01	0.26	0.02
1360	Tarka	09/16-18	3	13.1-12.6	19.5	19.6-19.8	8.87	0.01	0.82	0.02
1832	Mrkos	09/23–10/14	5	12.4-8.0	26.3-26.9	18.0-18.7	13.64	0.01	0.18	0.02
2494	Inge	09/11-12	2	5.8-6.1	340.6	12.4	6.76	0.01	0.92	0.02
2964	Jaschek	12/10-15	5	14.7-16.2	59.4-60.0	18.6-18.4	12.53	0.01	0.46	0.02
4217	Engelhardt	10/31–11/07	6	15.4-16.0	40.2-40.6	24.2-25.1	3.066	0.001	0.16	0.02
4431	Holeungholee	09/13-15	3	4.3	351.7	10.8	8.17	0.01	0.52	0.03
4937	1986 CL1	09/06-08	3	10.3-10.1	350.0	21.2	3.123	0.005	0.22	0.05
5806	Archieroy	12/10-12	3	16.5-16.7	69.7	23.6-23.3	12.16	0.01	0.34	0.02
6403	Steverin	09/10-11	2	9.1-8.9	354.5	16.2	3.485	0.005	0.35	0.03
7560	Spudis	12/03-08	5	13.3-13.7	67.7-68.0	17.9-17.1	5.402	0.002	0.17	0.03
7593	1992 WP24	09/24-10/03	3	16.3-13.6	25.5-26.4	16.1-17.0	2.557	0.001	0.14	0.02
10261	Nikdollezhal'	09/14-10/08	6	7.0,5.2,11.5	358.5-1.4	6.0-8.2	12.56	0.01	0.07	0.02
12559	1998 QB69	09/13-15	3	5.3-5.1	355.0	14.1	6.21	0.01	0.18	0.02
17664	1996 VP30	09/09-10	2	10.7	341.7	16.3	3.68	0.01	0.20	0.02
23712	1998 AA	09/16-18	3	24.2-23.7	16.7-17.0	29.7-29.5	3.902	0.005	0.40	0.02
33107	1997 YL16	10/09-22	8	15.1-12.3	28.4-29.9	17.8-17.5	5.173	0.002	0.28	0.02
55735	Magdeburg	09/09-12	4	11.7-11.5	349.3-349.6	16.6	15.41	0.02	0.14	0.03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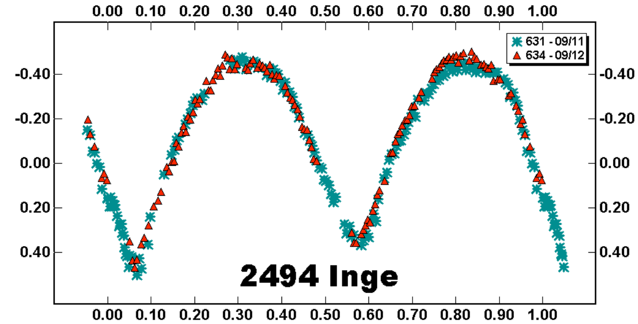
613 - 09/03
616 - 09/06
619 - 09/07
623 - 09/08
626 - 09/09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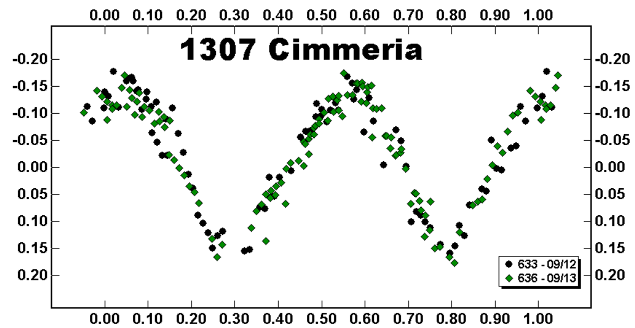
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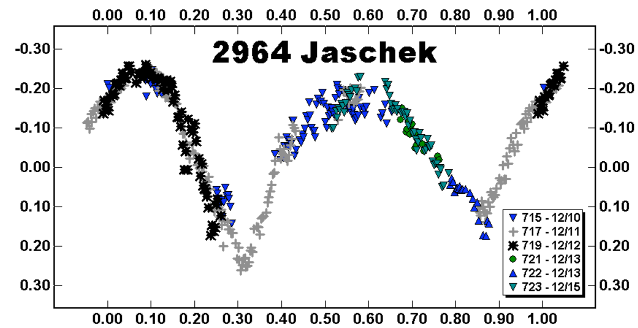
636 - 09/13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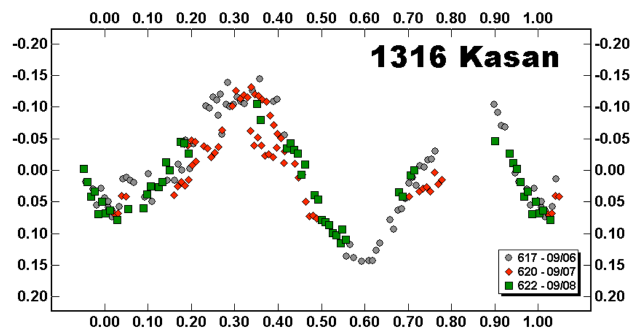
722 - 12/13
723 - 12/15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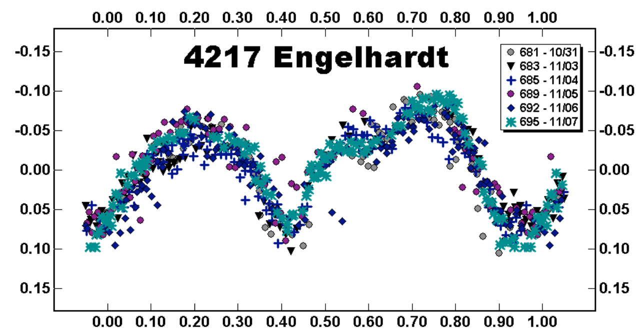
620 - 09/07
622 - 09/08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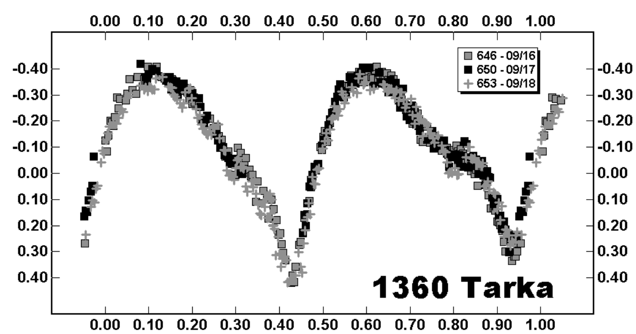
689 - 11/05
692 - 11/06
695 - 11/07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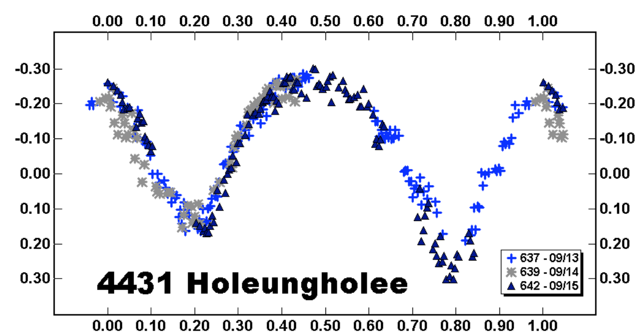
653 - 09/18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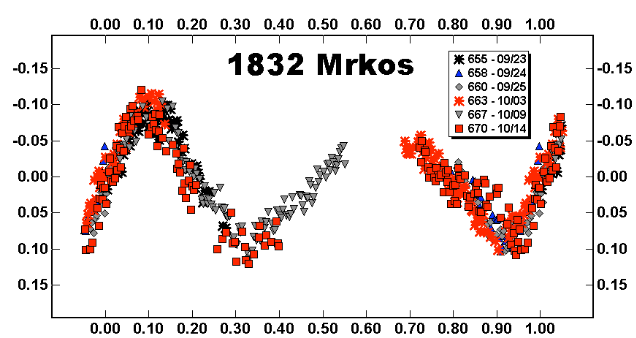
639 - 09/14
642 - 09/15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663 - 10/03
667 - 10/09
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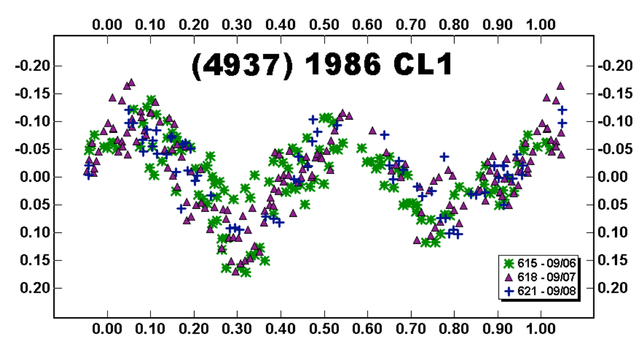
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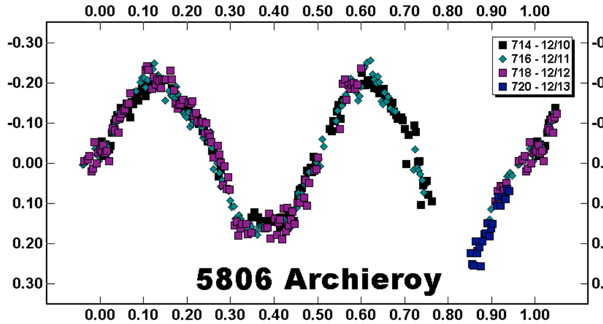
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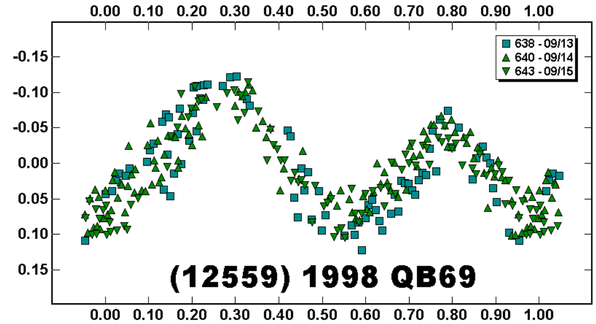
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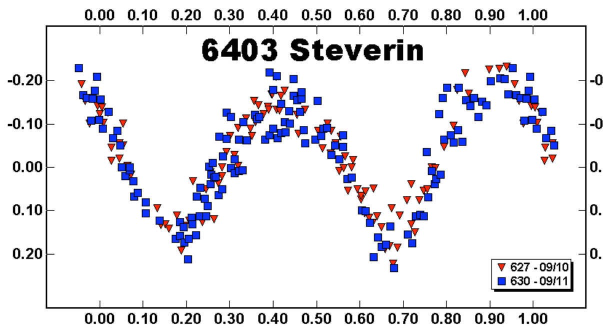
6403 Steverin
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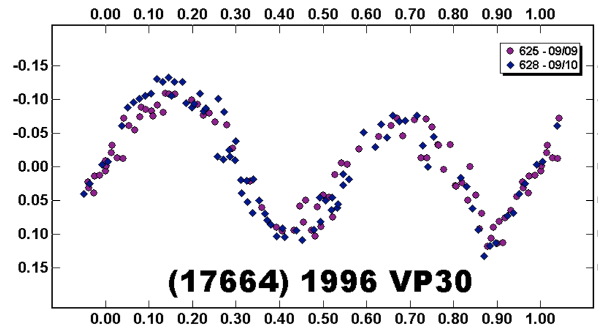
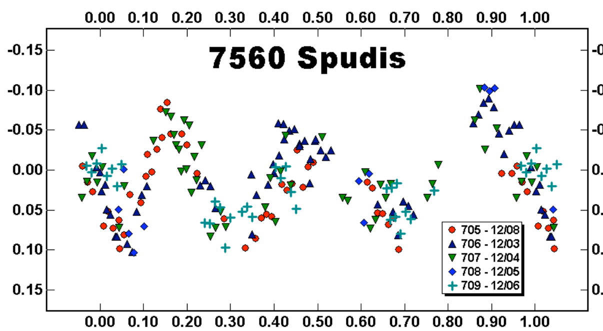
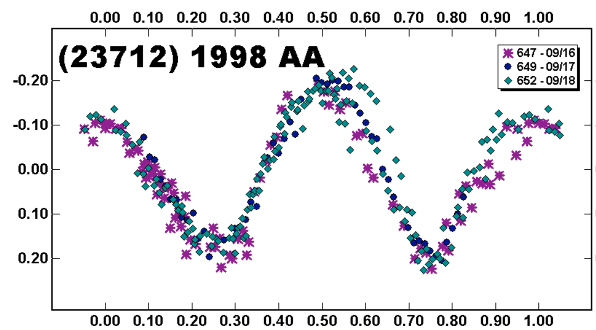
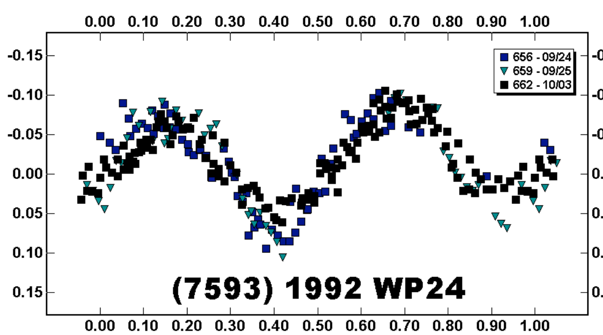
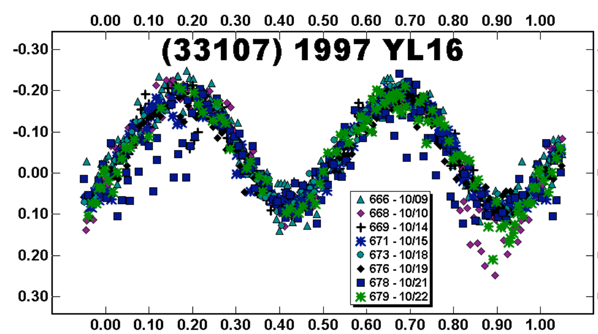
630 - 09/11

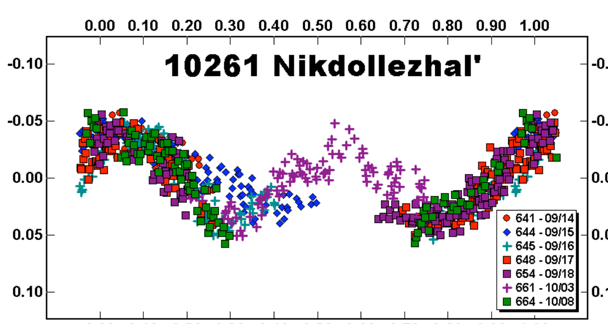

(17664) 1996 VP30
625 - 09/09
628 - 09/10

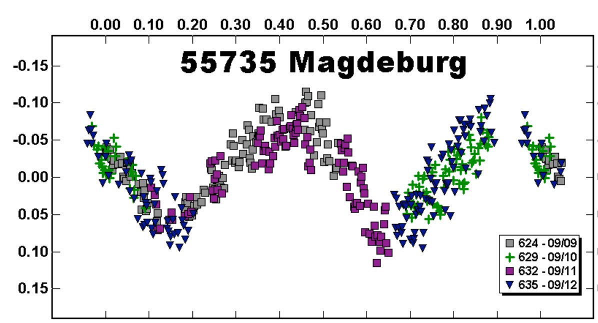

7560 Spudis
705 - 12/08
706 - 12/03
707 - 12/04
708 - 12/05
709 - 12/06


(23712) 1998 AA
647 - 09/16
649 - 09/17
652 - 09/18


(7593) 1992 WP24
656 - 09/24
659 - 09/25
662 - 10/03


(33107) 1997 YL16
666 - 10/09
668 - 10/10
669 - 10/14
671 - 10/15
673 - 10/18
676 - 10/19
678 - 10/21
679 - 10/22


10261 Nikdollezhal'
641 - 09/14
644 - 09/15
645 - 09/16
648 - 09/17
654 - 09/18
661 - 10/03
664 - 10/08


55735 Magdeburg
624 - 09/09
629 - 09/10
632 - 09/11
635 - 09/12

(33107) 1997 YL16. On three runs, 10/19, 21, and 22, the data seemed to indicate the possibility of a satellite. However, follow-up observations could not confirm the observations. It is likely that the asteroid is not a binary. However, this possibility should be considered in the analysis of future observations.

Acknowledgments

Thanks are given to Dr. Alan Harris of the Space Science Institute, Boulder, CO, and Dr. Petr Pravec of the Astronomical Institute, Czech Republic, for their ongoing support of all amateur asteroid photometrists and for their input during the analysis of some of the lightcurves presented here.

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LIGHTCURVE PHOTOMETRY OF ASTEROIDS 212 MEDEA, 517 EDITH, 3581 ALVAREZ, 5682 BERESFORD, AND 5817 ROBERTFRAZER

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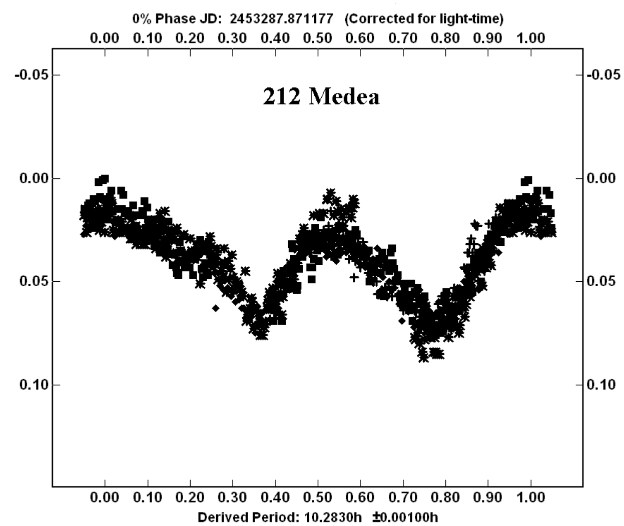
(Received: 22 December Revised: 12 February)

Lightcurve period and amplitude results are reported from Antelope Hills Observatory: 212 Medea 10.283 ± 0.001 hr and 0.08 ± 0.01 mag.; 517 Edith 9.274 ± 0.001 hr and 0.12 ± 0.01 mag.; 3581 Alvarez 33.42 ± 0.02 hr, and 0.06 ± 0.02 mag.; 5682 Beresford 7.536 ± 0.002 hr and 0.20 ± 0.02 mag.; 5817 Robertfrazer 4.051 ± 0.001 hr and 0.33 ± 0.02 mag.

Antelope Hills Observatory, MPC Code H09, is located near Bennett, Colorado at an elevation of 1740 meters. The equipment and instrumentation have been detailed in a previous paper (Koff, 2004). Targets were selected from the "Potential Lightcurve Targets" on the CALL website (Warner, 2002). Targets were further refined to include Mars-crossing asteroids, including those with reported but uncertain periods (Harris, 2003). Additional targets were selected from the list of upcoming radar study targets provided by M. Nolan of the NAIC Arecibo Observatory. The two radar target asteroids herein reported were also shown as having an uncertain period in the lists prepared by A. Harris (Harris, 2003).

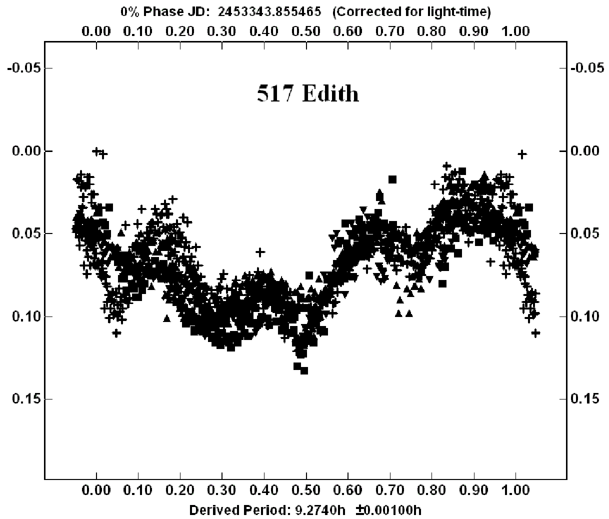
The images were obtained through a clear filter with an IR cutoff of 700 nm. All images were calibrated with dark frames and flat field frames. Lightcurves were prepared using the program "Canopus", which is based on the method developed by Dr. Alan Harris (Harris et al., 1989). The program uses aperture photometry. Differential photometry was performed to obtain instrumental asteroid magnitudes. Night-to-night comparison star variation was compensated for by manually shifting individual night's magnitude scales to obtain a best fit.

212 Medea. Medea was studied in cooperation with the Arecibo radar program. Medea is a main-belt asteroid, discovered February 6, 1880 by J. Palisa at Pola. It is approximately 140 km in diameter. This object was previously reported to have a period of 10.12 to 10.25 hours and an amplitude ranging from 0.11 to 0.13 magnitude, and was classified by Harris as having an uncertain period (Harris, 2003). Observations were made on four nights during the period from October 8, 2004 to November 2, 2004. During the period of the investigation, the phase angle decreased from 5.1 degrees to 4.4 degrees, before opening to 6.3 degrees. Exposure times for this investigation were one minute each. Images were taken at 2-minute intervals. A total of 886 observations were used in the solution. The zero point of the curve is J.D. 2453287.87118. The synodic period was determined to be 10.283 hours with a formal error of ± 0.001 hours. The amplitude was 0.08 ± 0.01 magnitude.

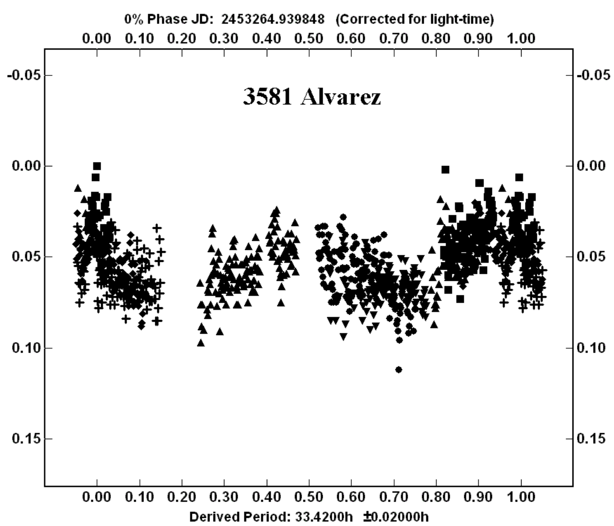


517 Edith. Edith was also studied in cooperation with the Arecibo asteroid radar program. Edith is a main-belt asteroid, discovered September 22, 1903 by R. S. Dugan at Heidelberg. It is approximately 95 km diameter. This object was previously reported by Harris to have a period 4.328 hours and an amplitude of 0.18 magnitude (Harris, 2003), but was listed as an uncertain period. Observations were made on 10 nights during the period from October 26, 2004 to December 10, 2004. During the period of the investigation, the phase angle decreased from 18.32 degrees to 1.39 degrees. Exposure times for this investigation were two minutes each. Images were taken at 2.7-minute intervals. A total of 1345 observations were used in the solution. The unusual lightcurve, together with the low amplitude, led to difficulty in obtaining a period solution. Dr. Petr Pravec agreed to assist in the analysis, and suggested obtaining additional observations. At the completion of those observations, Dr. Pravec and the author

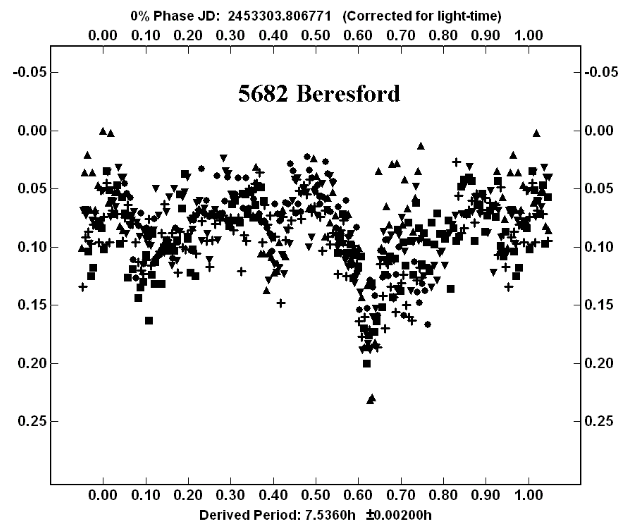
obtained the period 9.274 hours ± 0.001 hours. Dr. Pravec found the solution to be unique. He also noted that the amplitude, 0.12 ± 0.01 magnitude was less than that reported in the previous investigation, and that together with the unusual lightcurve might indicate that the asteroid was closer to a pole orientation than during the previous observations. The zero point of the curve is J.D. 2453343.85547. As previously noted, the synodic period was determined to be 9.274 hours with a formal error of 0.001 hour. The amplitude was 0.12 ± 0.01 magnitude.



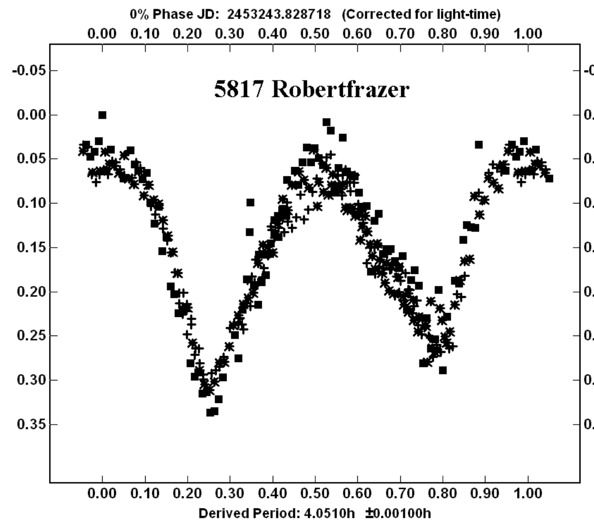
3581 Alvarez. Alvarez is a marginal Mars-crossing asteroid. It was discovered April 23, 1985, by C. S. Shoemaker at Palomar. It is approximately 25 km diameter. The perihelion is 1.64 AU, and the aphelion is 3.91 AU. This object was previously observed by Wisniewski and reported in 1997 to have a period >24 hours and an amplitude >0.06 (Harris, 2003). Observations were made on seven nights during the period from September 9, 2004 to October 7, 2004. During the period of the investigation, the phase angle decreased from 28.4 degrees to 13.6 degrees. Exposure times for this investigation were two minutes each. Images were taken at 2.7-minute intervals. A total of 943 observations were used in the solution. Due to the low amplitude and long period of this asteroid, an effort was made to correlate the first four nights of observations by calibrating the comparison stars to a common standard. This was carried out by measuring a standard field and the fields of the first four nights on the same photometric night. The results of this effort indicated that the first four nights correlated to within 0.01 magnitude, indicating that there was not night-to-night variation in the overall magnitude. For the remainder of the study, the nightly lightcurves were shifted to correct for differences in the comp stars. The zero point of the composite lightcurve is J.D. 2453264.93985. The synodic period was determined to be 33.42 hours with a formal error of ± 0.02 hours. The amplitude was 0.06 ± 0.02 magnitude.



5682 Beresford. Beresford is a marginal Mars-crossing asteroid. It was discovered October 9, 1990, by R. H. McNaught at Siding Spring. It is approximately 10 km in diameter. The perihelion is 1.61 AU, and the aphelion is 2.99 AU. This object was previously observed by Kamel and reported in 1998 a having a "long(?)" period and amplitude <0.1. Observations were made on five nights during the period from October 24, 2004 to November 3, 2004. During the period of the investigation, the phase angle increased from 10.1 degrees to 15.9 degrees. Exposure times for this investigation were two minutes each. Images were taken at 2.7-minute intervals. A total of 579 observations were used in the solution. A distinctive dip in the lightcurve, noted on several nights, was used in the determination of the period. The zero point of the curve is J.D. 2453303.80677. The synodic period was determined to be 7.536 hours with a formal error of ± 0.002 hours. The amplitude was 0.20 ± 0.02 magnitude.



5817 Robertfrazer. Robertfrazer is a marginal Mars-crossing asteroid. It was discovered September 5, 1989, by E. F. Helin at Palomar. It is approximately 20 km diameter. The perihelion is 1.59 AU, and the aphelion is 3.22 AU. No previous lightcurve has been reported for this object (Harris, 2003). Observations were made on three nights during the period from August 26, 2004 to September 8, 2004. During the period of the investigation, the phase angle dropped from 26.4 degrees to 23.3 degrees. Exposure times for this investigation were two minutes each. Images were taken at 2.7-minute intervals. A total of 354 observations were used in the solution. The zero point of the curve is J.D. 2453243.82872. The synodic period was determined to be 4.051 hours with a formal error of ± 0.001 hours. The amplitude was 0.33 ± 0.02 magnitude.



Acknowledgments

A thank you to Petr Pravec for his assistance on determining the period of a particularly difficult target. Dr. Pravec's ongoing support has been of great value to the author. Many thanks to Brian Warner for his continuing work on the CALL website and the program "Canopus", which has made it possible for amateurs to analyze and share lightcurve data.

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FIRST PHOTOMETRIC LIGHTCURVE OBSERVATIONS FROM THE EVELYN L. EGAN OBSERVATORY

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(Received: 3 December)

The first photometric lightcurve results from the Evelyn L. Egan Observatory [MPC Code H72] are reported. Despite a wildfire on campus and four land falling hurricanes, we were able to obtain detailed lightcurve measurements over a period of several nights for two main-belt asteroids: 287 Nephthys and 479 Caprera. The following synodic periods and amplitudes were determined: 287 Nephthys: 7.6065h±0.0002h with an amplitude of 0.20m; 479 Caprera: 9.4250h±0.0003h with an amplitude of 0.11m.

The Evelyn L. Egan Observatory is located on the campus of Florida Gulf Coast University (FGCU) in Fort Myers, Florida. Its location at +26.5° latitude makes it probably one of the southernmost observatories in the continental US enabling access to parts of the celestial sphere not easily covered by other observatories. Unfortunately, the sub-tropical climate in Florida – where the summer time coincides with the rainy season – together with the sea-level elevation provide some unique challenges to photometric observations. The Observatory is home to a 0.4m Ritchey-Chretien telescope from Optical Guidance System (f/8.4), with a thermally stable carbon fiber OTA inside a 16 foot dome. The telescope is mounted on a robotic Paramount GT1100ME, and is computer controlled, via Software Bisque's TheSky software. For photometric measurements, the telescope is equipped with an Optec IFW filter wheel with Bessel BVRI filters, a high quantum efficiency, back illuminated Apogee AP7ap camera and a 0.63 focal reducer, bringing the f-ratio to f/5.3. The field of view of a single exposure using this setup is roughly 20 arcminutes by 20 arcminutes. Camera control and subsequent image calibration was performed via MaximDL by Diffraction Limited. Photometric data was obtained utilizing the computer program "MPO Canopus" from BDW Publishing. A list of potential target asteroids was identified using the Collaborative Asteroid Lightcurve Link (CALL) webpage, and associated links. An asteroid was then observed throughout the night, and photometric data was obtained. All images for 287 Nephthys were taken utilizing a Bessel V filter, whereas a clear filter was chosen for 479 Caprera. As this was our first attempt at lightcurve photometry, we decided to concentrate on differential and not absolute photometry. However, with the experience we have gained during this initial program and the onset of the dry-season, we will explore absolute photometry in the future. Despite wildfires on campus, as well as hurricanes, with associated poor weather and power outages, rotational periods and photometric amplitudes for two asteroids were obtained during the summer and early fall 2004. The observations for each asteroid covered several nights – due to weather sometimes several weeks apart.

287 Nephthys. Nephthys was discovered on August 25th, 1889 by C.H.F. Peters. The asteroid was chosen for study, as there was some ambiguity about the period according to the list of "Minor Planet lightcurve Parameters" maintained by Harris and Warner (2003). Observations were obtained during 4 nights between July 24, 2004 and August 21, 2004. Despite the fact that we were unable to obtain complete lightcurve coverage, the obtained lightcurve parameters are in good agreement with previously published results on this asteroid. We derived a synodic period of 7.6065h±0.0002h with an amplitude of 0.20m, consistent with previously published results. The obtained lightcurve is shown in Figure 1, where the data are binned by a factor of two for clarity.

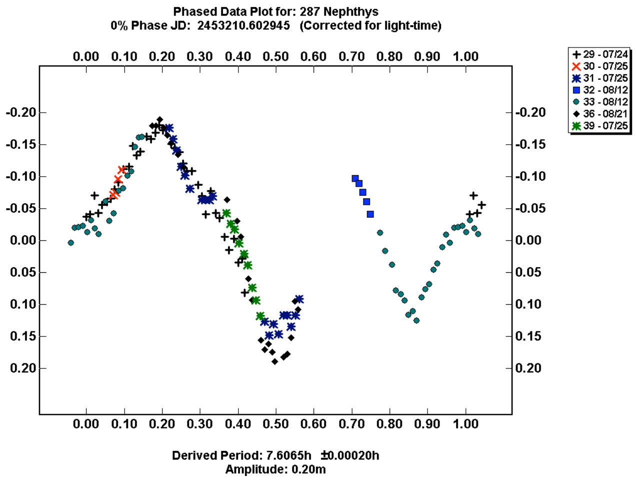

Figure 1. Lightcurve for 287 Nephthys.

479 Caprera. This asteroid was discovered on November 12th, 1901 by L. Carnera in Heidelberg. Our observations were obtained during 5 nights between August 12, 2004 and October 17, 2004. Only one previous publication of lightcurve parameters, based on only a partial lightcurve made this a reasonable target for our observations. The previously published period for 479 Caprera was 5.324h, whereas our data indicate the period is 9.4250h±0.0003h, almost twice the previously published value. Our observed amplitude is 0.11m, significantly smaller than the previous value of 0.29m. The obtained lightcurve is shown in Figure 2, where the data is binned by a factor of two for clarity.

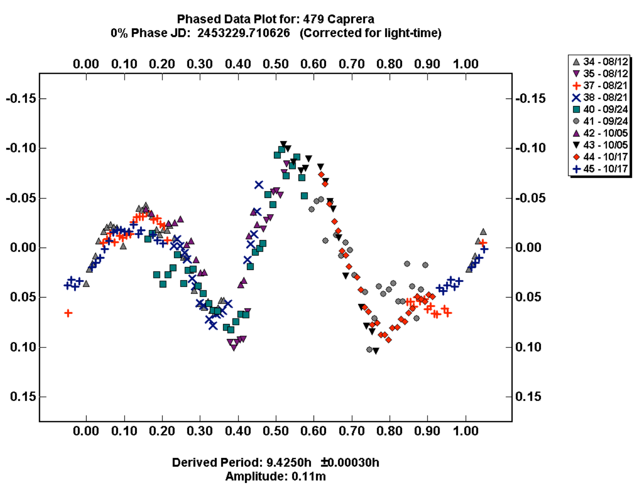

Figure 2. Lightcurve for 479 Caprera.

Acknowledgements

One of us (T.B.) acknowledges support from the Florida Space Grant Consortium's "Undergraduate Space Research Participation Scholarship". We would also like to give our special thanks to Brian Warner for his help and support in getting started with lightcurve photometry.

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LIGHTCURVE OF 147 PROTOGENEIA

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The lightcurve period and amplitude of asteroid 147 Protogeneia are found to be 7.8528 ± 0.0008 hrs. and 0.28 mag. Phase curve measurements yield an absolute magnitude H=8.87 ± 0.07 and slope parameter G= 0.38.

Altimira Observatory is located in southern California. Details of the observatory and its equipment are available at http://www.geocities.com/oca_bob. For the study reported here, CCD images of the target asteroid were taken through Johnson-Cousins B, V, and R filters. Nightly zero-points were determined by measuring Landolt standard fields, and using either comparison stars or the Hardie (1962) method for extinction determination. Results were put onto the standard system with transformation coefficients that had been previously determined for this equipment.

Five nights from 11/5/04 to 12/19/04 were devoted to lightcurve photometry imaging of asteroid 147 Protogenia, covering solar phase angles from 0.7 degrees (waxing) to 14 degrees (waning). No previous lightcurve has been reported for this asteroid. The best fit lightcurve period to the data obtained is 7.8528 ± 0.0008 hours with an amplitude of 0.28 mag., as shown in Figure 1.

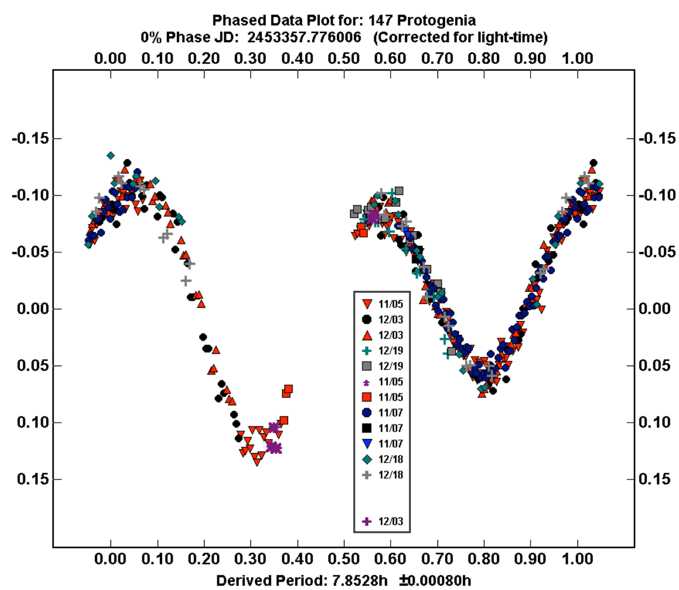

Figure 1: Lightcurve of 147 Protogeneia, wrapped to period P= 7.8528 hours

Standard V-band magnitude calibrations were determined on five nights. These data were corrected for asteroid rotational orientation (to put it onto the "delta mag = 0.0" line of the lightcurve), and corrected to "reduced" magnitudes by:

$$VR = V - 5 \cdot \log (D \cdot R)$$

where Earth distance =D and Sun distance =R (in AU). The Small Bodies Node reports absolute magnitude (zero phase and 1AU distance from Sun and Earth) H= 8.27, based on an assumed slope parameter G= 0.15. My data, shown in Figure 2, are quite different: I show a substantially fainter absolute magnitude and a shallower slope. The best fit to my data is H= 8.87 ± 0.07 and G= 0.38.

Zellner et al. (1985) report a single data point V= 13.010 at solar phase angle α=1.00 degrees, with R= 3.057 AU and D= 2.048 AU, which translates to a reduced magnitude V(1, α) = 13.010 –5*log(RD) = 9.027. This data point, which is plotted as an open circle in Figure 2, is quite consistent with my data, considering the uncertain rotational phase for that one data point. Lagerkvist et al. (1987) report a single night's observation of V= 12.38, at solar phase angle α = 1.74 degrees, with R= 3.0564 AU and D= 2.0505 AU, which translates to a reduced magnitude V(1, α) = 12.38 –5*log(RD) = 8.395. This different data point, which is plotted as an open square in Figure 2, is close to the Small Bodies Node' reported parameters. One possibility for the difference is a very different polar aspect angle for the asteroid.

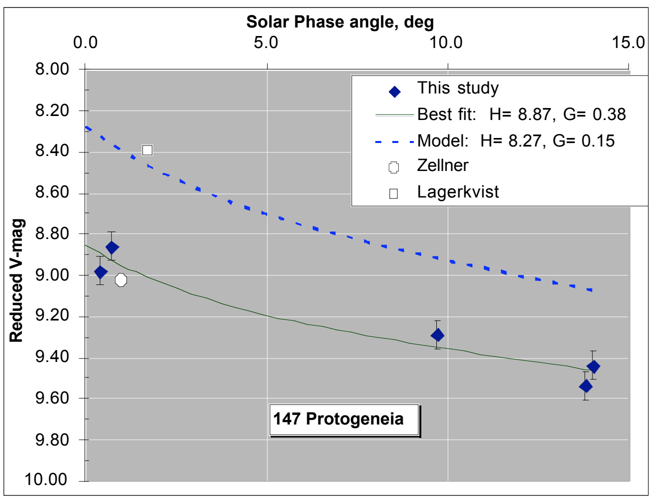

Figure 2: Phase curve of 147 Protogeneia. Small Bodies Node reported parameters are shown as the dashed curve. My data points are shown with error bars (± 0.07 mag), and best fit to my data is the solid curve. Zellner's (1985) single data point is shown as an open circle. Lagerkvist's (1987) single night is shown as an open square.

Acknowledgements

Photometric reductions were performed with Brian Warner's MPO Canopus/PhotoRed program. Ephemerides were calculated using Chris Marriott's SkyMap Pro program, using a database from the Minor Planet Center. Automated observatory control is accomplished with Software Bisque's suite (TheSky, Automadome, Orchestrate and CCDSoft).

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LIGHTCURVE AND PERIOD DETERMINATION FOR 479 CAPRERA, 2351 O'HIGGINS, (36378) 2000 OL19, (52750) 1998 KK17, (87684) 2000 SY2

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(Received: 25 November Revised: 20 December)

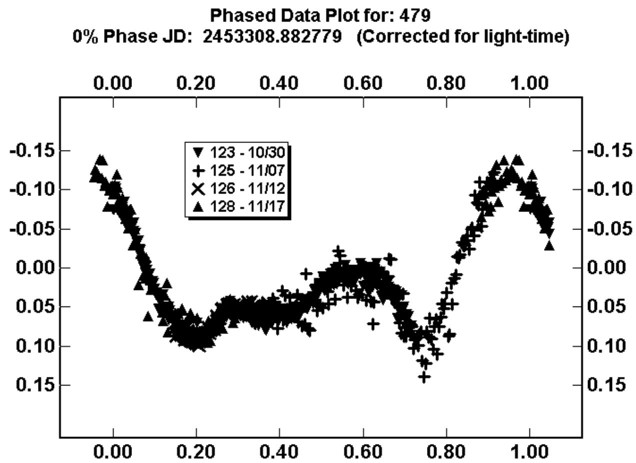
CCD photometry results of two near-Earth objects and three main-belt asteroids obtained from Hunters Hill Observatory during October-December 2004 are reported. The period and amplitudes are: 479 Caprera, 9.4277 ± 0.0004 hrs, 0.12 ± 0.01mag; 2351 O'Higgins, 4.7889 ± 0.0006 hrs, 0.50 ± 0.02 mag; (36378) 2000 OL19, 4.3437 ± 0.0003 hrs, 1.1 ± 0.1mag; (52750) 1998 KK17, 3.124 ± 0.002 hrs, 0.16 ± 0.05mag; (87684) 2000 SY2, 8.80 ± 0.04 hrs, 0.16 ± 0.04 mag.

This lightcurve investigation was carried out at Hunters Hill Observatory located at Ngunnawal in Canberra, Australia. The near-Earth objects (NEOs) were traveling at close to 4"/min at magnitude 15.5. As the targets could not be imaged to a suitable SNR, the images were binned 2x2 pixels allowing the objects to be imaged with exposures up to 150 seconds to obtain an average SNR of 50. Due to their rapid movement, the targets could only be kept in the CCD's field of view for a maximum of 5 hours resulting in at least 2 data sessions per observing night. The main-belt asteroid targets were traveling considerably slower and with higher amplitude, targets at fainter magnitudes could be observed.

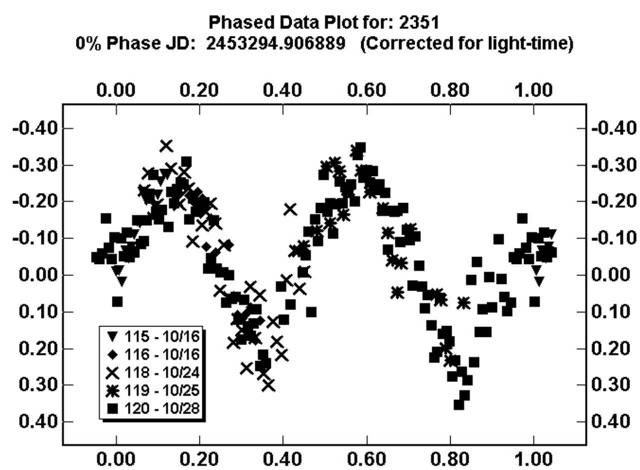
The NEO targets were supplied by Dr. Petr Pravec at my request and were observed using an 0.36m SCT at f/2.95 and Starlight Xpress MX716 CCD camera with Clear filter and 2x2 binning producing an image resolution of 3.38"/pixel. During each session, a continuous flow of 120 second (1998 KK1) or 150 second (2000 SY2) integrations were made. Images were calibrated with darks and artificial flats and measured using MPO Canopus version 7.6.3.2. The other targets were imaged unbinned resulting in an image resolution of 1.68"/pixel. Some sessions were run with the camera in self-guide mode and other times (when conditions were favorable) a separate camera and guide scope were used. In self-guide mode for the Starlight Xpress MX series camera, the exposure is lost to guiding so it was beneficial to use the separate camera and guide scope for the fainter objects to improve SNR. Using a separate guide scope/camera also resulted in considerably less scatter of data points.

479 Caprera. According to the list of Minor Planet Lightcurves (Harris 2003), no previous attempts have been published for Caprera. It is a main-belt asteroid discovered on 12 November

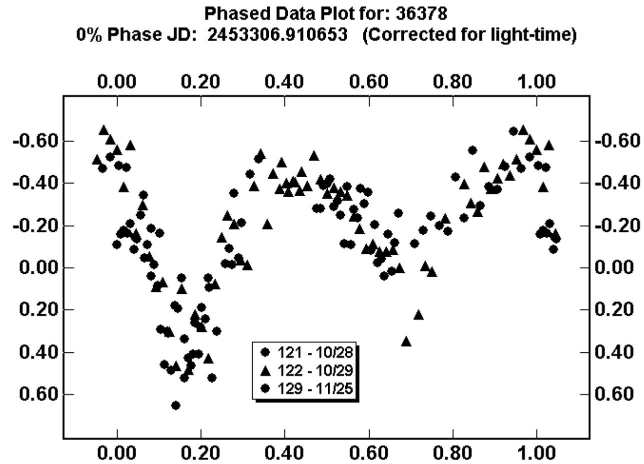
1901 by L. Carnera at Heidleberg. Its original designation was 1901 HJ and has an absolute magnitude of 9.6 with an albedo of 0.041 ± 0.002 , giving it an assumed diameter of 77.5 ± 1.7 km. The results of the observing run conducted between October 23 and November 12 show a synodic rotation of 9.427 ± 0.002 hrs with amplitude of 0.12 ± 0.01 mag.



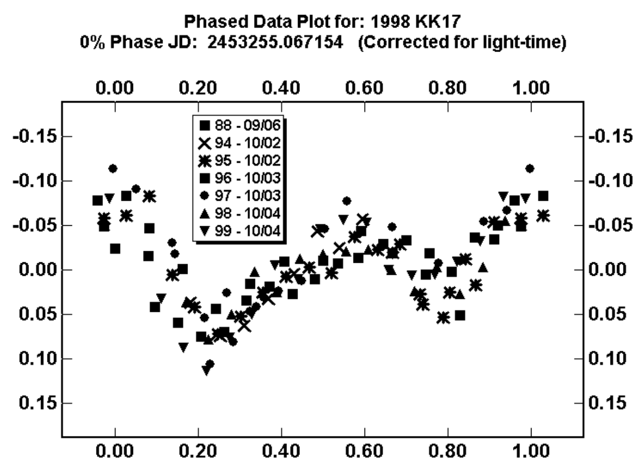
2351 O'Higgins. According to the list of Minor Planet Lightcurves (Harris 2003), no previous attempts have been published for O'Higgins. It is a main-belt asteroid discovered on 03 November 1964 by Indiana University at Brooklyn. It has an absolute magnitude of 12.8, giving it an assumed diameter of 18.2 km. The results of the observing run conducted between October 16 and October 28 show a synodic rotation of 4.7889 ± 0.0006 hrs with amplitude of 0.50 ± 0.02 mag.



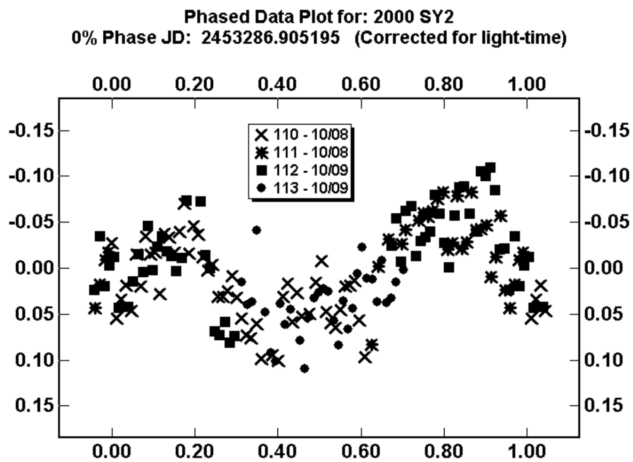
(36378) 2000 OL19. According to the list of Minor Planet Lightcurves (Harris 2003), no previous attempts have been published for 2000 OL19. This was a target of opportunity as it was found in the same field as the last observing run on O'Higgins. At magnitude 17.8 and near the edge of the field I did not hold out much hope but reduction of the data produced a very definite curve due to the objects large amplitude. At Brian Warner's insistence I decided to dedicate a further night to the object. 2000 OL19 is a main-belt asteroid discovered on 29 July 2000 by LINEAR at Socorro. It has an absolute magnitude of 14.2, giving it an assumed diameter of 9.5 km. The results of the observing run conducted between October 28 and November 25 show a synodic rotation of 4.3437 ± 0.0003 hrs with amplitude of 1.1 ± 0.1 mag.



(52750) 1998 KK17. According to the list of Minor Planet Lightcurves (Harris 2003), no previous attempts have been published for 1998 KK17. It is an NEO discovered on 29 May 1998 by LINEAR at Socorro. It has an absolute magnitude of 16.5, giving it an estimated diameter of 3.3 km. The results of the observing run conducted between October 2 and October 4 show a synodic rotation of 3.124 ± 0.002 hrs with amplitude of 0.16 ± 0.04 mag. Due to the noise level in the data, a range of apparently valid periods were uncovered from 3.117 hrs to 3.147 hrs. I supplied a copy of my data to Dr Petr Pravec who graciously analyzed the data and stated that in his opinion the most likely period was 3.124 hrs. Note the plot below is shown with the lightcurve points binned to improve the SNR.



(87684) 2000 SY2. According to the list of Minor Planet Lightcurves (Harris 2003), no previous attempts have been published for 2000 SY2. It is an Aten-class NEO discovered on 20 September 2000 by LINEAR at Socorro. It has an absolute magnitude of 16.5, giving it an estimated diameter of 3.5 km. The results of the observing run conducted between October 6 and October 9 indicate a synodic rotation of 8.80 ± 0.04 hrs with amplitude of 0.16 ± 0.04 mag. Much of the data from the first night's observation, however, does not fit this plot (these data are not shown in the plot). I could find no reason to fault this data so I suggest that the deduced period is indicative only.



Acknowledgements

Thanks goes to Brian Warner for his mentoring support and for the development and improvements made to the MPO Canopus software and for maintaining the CALL web site which provides us with suitable targets to follow. I would also like to thank Dr. Petr Pravec for providing me with lists of suitable NEO targets to observe as well as taking the time to analyze my data.

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ROTATIONAL PERIOD DETERMINATION OF 690 WRATISLAVIA

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Combined observations of 690 Wratislavia are used to solve for a lightcurve period of 8.64 ± 0.01 hours and an amplitude 0.12 magnitude.

On September 24, 2004, Mike Nolan of Arecibo Observatory posted a request for observations on the Minor Planet Mailing List for a number of minor planets which their team planned to observe in October. On that list was 690 Wratislavia, which both Stephens and Durkee independently selected for observation. Stephens observes from Santana Observatory (MPC Code 646) located in Rancho Cucamonga, California at an elevation of 400 meters. Details of the equipment used can be found in Stephens (2003) and at the author's web site (http://home.earthlink.net/~rdstephens/default.htm). Durkee observes from The Shed of Science Observatory (MPC Code H39) in Minneapolis, Minnesota at an elevation of 271 meters. The observatory utilizes a 0.35 meter schmidt-cassegrain telescope operating at f8.6 with a SBIG ST10XE CCD camera binned 3x3, resulting in an image scale of 1.4 arcseconds per pixel. All images were unfiltered.

Stephens had four sessions between September 24 and 28, 2004 obtaining 711 observations. He posted his results to the CALL Web Site operated by Brian Warner. Durkee noticed the posting the next day and contacted Stephens to report two additional sessions on September 28 and 29 and propose combining the data sets. Both Stephens and Durkee measured the images using MPO Canopus, which uses differential aperture photometry to determine the values used for analysis and allows the combining of sessions from different observers. The period analysis was done within Canopus, which incorporates an algorithm based on the Fourier analysis program developed by Harris (1989). The position angles ranged from 12.2 to 10.5 during the observing run. The Phase Angle averaged 25.7 degrees longitude and 11.6 degrees latitude.

Discussion

Wratislavia has a prior history of observations with many different period solutions. Gil-Hutton (1988) reported observations of Wratislavia on three nights in September 1987, totaling 96 photometric measurements. His composite lightcurve had a period of 6.31 hours and showed only one maximum and one minimum. Gil-Hutton (1995) reported additional observations from July 6, 1992 yielding a partial lightcurve with two unequal maxima separated by 5.2 hours with an amplitude not less than 0.2 mag. He reported that the 6.31 hour period was not correct but that 9.9 or 12.6 hour periods were possible.

Denchev (2000) reported that Wratislavia had a 9.909 hour period. Sada (2000) observed Wratislavia on five nights between December 6 and 14, 1999. He used 150 observations to determine that the asteroid had a 8.60 ± 0.01 hour period. His composite lightcurve had two very similar maxima and minima.

Our 2004 composite lightcurve was very difficult to resolve. Initially, it showed bimodal maxima with flattened and extended minima exhibiting rough, but repeating features using a 17.23 hour solution. Even though several of the individual sessions were approximately 8 hours in length, no individual session detected more than one maximum. However, the shape of the lightcurve was troubling in that it displayed two identical maxima separated by identical flattened minima; a solution that seemed unlikely. Since this solution was twice the Sada period, a period of 8.62 hours with a single set of extrema was explored. We could not distinguish between the 8.62 and 17.23 hour periods using the Noise Spectrum of the fit in the Fourier Analysis routine, so we decided to re-fit the 1987 Gill-Hutton and 1988 Denchev data to see if it is consistent with the 8.62 hour period.

Our rephasing of those lightcurves shows that the Gil-Hutton data had an amplitude of just over 0.1 magnitudes. The resulting lightcurve is consistent with a 8.64 hour period, has one set of extrema, and is similar in shape to the Stephens-Durkee lightcurve. Rephasing the Denchev lightcurve was consistent with either a 8.603 or 8.642 hour periods. With the exception of a single observation on September 25, 1998 the shape of the lightcurve is similar to the Gil-Hutton lightcurve and the Stephens-Durkee lightcurve. Because of the two-month span of data, the Denchev period is more precise, but ambiguous as to which of the two periods is correct.

Gil-Hutton's reported 1992 observations had an amplitude of between 0.2 and 0.3 magnitudes. The 1999 Denchev observations had an amplitude of at least 0.1 magnitude. This implies that Sada's 1999 observations are closest to being equatorial and the Stephens-Durkee observations are the closest to pole-on, consistent with the low amplitude and the singly periodic lightcurve. In conclusion, the Stephens-Durkee period of 8.64 hours is similiar the Sada period of 8.60 hours, but is not quite within the error bars of both sets of observations. Rephasing the Gil-Hutton period is consistent with this period and the Denchev observations could fit either a 8.603 or 8.642 period.

Acknowledgments

Many thanks to Alan W. Harris of the Space Science Institute who helped resolve whether this lightcurve has a single, or double set of extrema by suggesting that the Stephens-Durkee observations are the nearest to being pole-on; and for assisting in digitizing the Gil-Hutton and Denchev observations.

Also, Many thanks to Brian Warner for his continuing work and enhancements to the software program "Canopus" which allowed us to import the old observations and rephrase the lightcurves. Also many thanks for maintaining the CALL Web site that helps coordinate collaborative projects between amateur astronomers.

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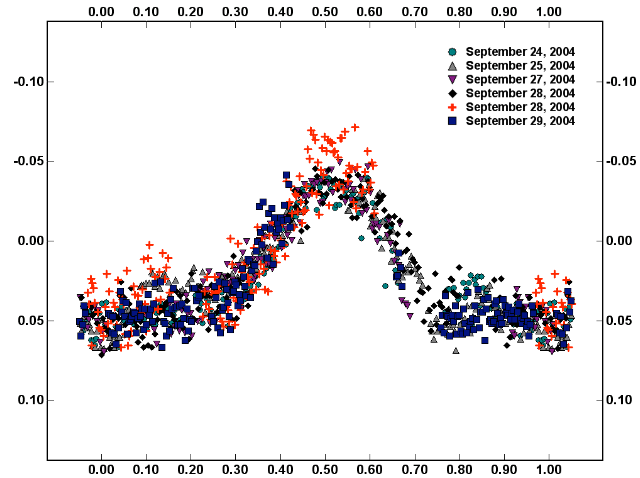

Figure 1: Lightcurve of 690 Wratislavia based upon a derived period of 8.64 ± 0.01 hours. The 0% Phase is equal to 2453276.716294 JD (corrected for light-time).

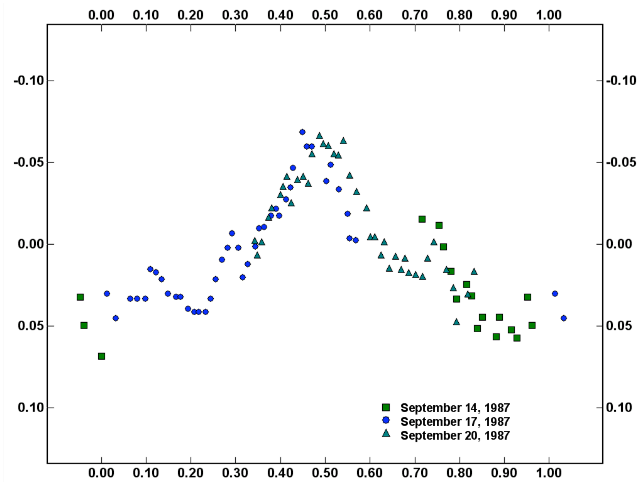

Figure 2: Gil-Hutton observations from September 1987 rephased to an 8.64 hour period.

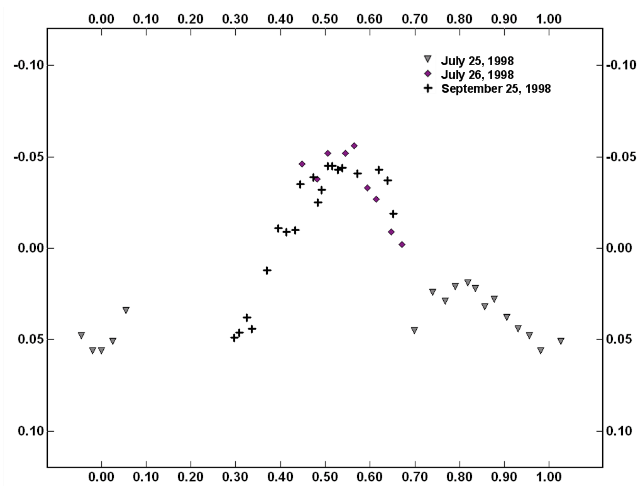

Figure 3: Denchev observations from July and September 1998 rephased to a period of 8.642 hours.

A REVISED PERIOD FOR 3447 BURCKHALTER

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Observations of 3447 Burckhalter in 2001 and 2003 yielded possible period solutions of 22.8 and 38.4 hours. However, observations in late 2004 showed that a longer period of 60.00 ± 0.25 h is more likely, with an amplitude of 0.30 mag.

Minor planet 3447 Burckhalter was discovered from Brooklyn by an Indiana University team on 1956 Sept. 29. Burckhalter is an inner main-belt asteroid – one of the Hungaria group. The latest list of Harris and Warner (2003) indicates that the rotation period is 22.8 hours and the delta magnitude is at least 0.24. However, a reliability code of only two is assigned to these data. Behrend (2003) reports a period of some 0.9 days on the basis of a partial lightcurve, where the delta magnitude was at least 0.1 in 2001.

Following the publication by Warner (2002), author Bembrick contacted author Warner regarding proposed observations in 2003 and a joint paper. Following these 2003 observations by Bembrick, which indicated a different (longer) period was possible, the suggestion was to wait until late 2004 when the asteroid would be favorably positioned again (for the Northern Hemisphere) and additional observations could be made by Warner. Table I gives the observing circumstances, where L_{PAB} and B_{PAB} are the phase angle bisector longitude and latitude.

Table I. The observing circumstances for 3447 Burckhalter.

Date	Phase	L_{PAB}	B_{PAB}
2001 Oct. 17	10.4	8.5	6.7
2001 Oct. 18	11.0	8.5	6.9
2001 Oct. 19	11.5	8.5	7.0
2001 Oct. 25	14.7	8.7	7.9
2001 Oct. 26	15.2	8.8	8.0
2003 Apr. 06	12.3	209.0	-12.9
2003 Apr. 09	11.4	209.1	-13.5
2003 Apr. 12	10.8	209.2	-14.1
2003 Apr. 14	10.5	209.3	-14.4
2003 Apr. 21	10.6	209.4	-15.7
2003 Apr. 23	11.0	209.4	-16.0
2004 Nov. 03	12.7	41.9	20.2
2004 Nov. 04	12.7	41.9	20.3
2004 Nov. 06	12.9	41.9	20.5
2004 Nov. 07	13.0	41.9	20.7

<u>2003 Observations.</u> Burckhalter was observed from Mt. Tarana Observatory over six nights when at southerly declinations. The instrumental magnitude varied from 14 to nearly 15, and consequently the photometric precision ranged between 1% and 2%, yielding a somewhat noisy lightcurve. Data from each night were plotted as differential instrumental magnitude vs. JD. All data were light time corrected. Initial attempts to do a phase stack with the previously reported period of 22.8 hours (Warner, 2002) failed and an examination of the light curve segments from individual nights suggested that the period had to be longer than 30 hours. Possible periods were around 30 and 45 hours.

A Fourier analysis (Belsrenne 1988) was applied and the power spectrum yielded possible periods of 19, 30, 26 and 35.8 hours – in order of "power". The smallest of these was obviously too short and a trial phase stack gave a unimodal light curve. Doubling this to 38 hours gave a "reasonable looking" phase stack with two maxima and two minima. A trial phase stack with the longest period gave poor results. The "AVE" software (Barbera, 2004) was used for a period search utilizing the Phase Dispersion Minimization (PDM) method. Searching between 17 and 48 hours yielded broad but distinct minima in the "periodogram" around 19 and 38 hours. A number of trial phase plots showed that 38.4 hours produced the "best" phase stack. Using the above period, the composite light curve for 2003 is displayed in Figure 1 – with arbitrary zero phase (JD 2452734.8). Magnitudes from individual nights were adjusted by an additive constant to give a "best fit" to the phase stack.

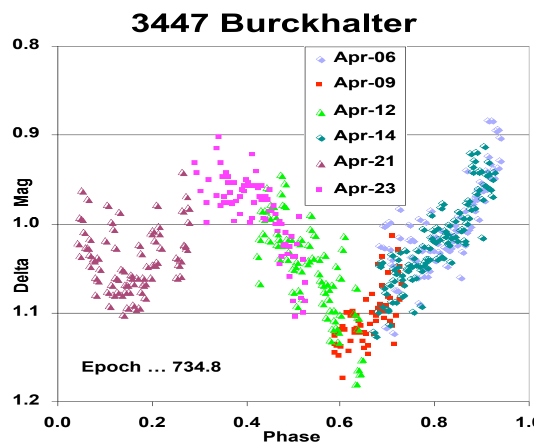

Figure 1. Data from 2003 phased against a period of 38.4h

<u>2004 Observations</u>. Burckhalter was observed again from the Palmer Divide Observatory in 2004 November. Periods ranging from 20 to 80 hours were examined using the Fourier analysis routine in MPO Canopus, which is based on the program written by Harris et al. (1989). The best period fit was found to be 60.00±0.25h. Figure 2 shows the 2004 data phased to that period. Again, all data were light-time corrected. As a check, a plot of the half-period showed a well-fitting unimodal curve. It should be noted that the period solution is sensitive to order chosen for the Fourier analysis. When an order of 2 was used, the period was 60.48±0.15h. An order 4 gave the 60.00±0.25h solution.

Following on this result, author Bembrick re-analyzed the 2003 data and found that this could be satisfactorily phased with a period of 60.00 ± 0.23 hours. This composite lightcurve is shown in Figure 3. As can be seen from Figures 2 and 3, the peak to peak variation was 0.3 magnitudes in both 2003 and 2004.

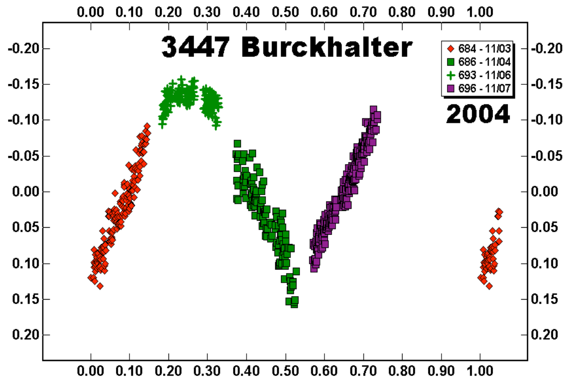

Figure 2. Data from 2004 phased against a period of 60.0h.

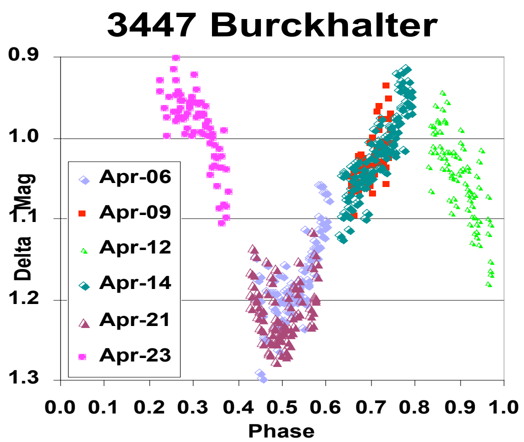

Figure 3. Data from 2003 phased against a period of 60.0 hr.

2001 Observations. The original images from 2001 were remeasured with improved software to see if results from the recent findings could be applied. Unfortunately, no manipulation of the data, e.g., changing the offsets for one or more data sets, allowed finding a period near 60h. Figure 4 shows one of the attempts at fitting the 2001 data to the 60h period and is not particularly promising. Other forced fits near the originally reported period of 22h and another at 30h had anomalies that were highly suspicious and made them unlikely solutions.

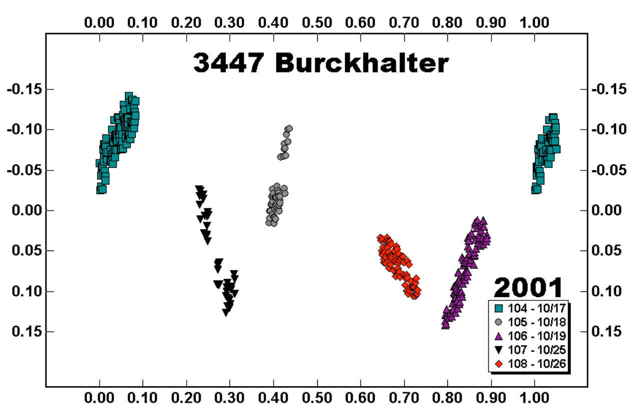

Figure 4. Data from 2001 phased against a period of 59.1h.

Conclusions

Minor planet 3447 Burckhalter is an asteroid that poses a real problem for one observer, with a rotation period of 2.5 days. The resolution of its synodic rotation period is an example of the benefits of collaboration, particularly with observers at very different longitudes. The long rotation rate makes Burckhalter a somewhat unusual member of the Hungaria asteroids in that among the 35 or so members of the family with lightcurves in Harris and Warner list, only four have periods >20 hours while the preponderance (25) have periods in the range of 2-6 hours.

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THE MINOR PLANET OBSERVER: HISTORY REVISTED - I

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It seems I've been interested in history for some time. Way back in seventh grade (I'm not going to give the year), we were offered discounts on books from a publisher specializing in popular science. My choice was one with short biographies of the more famous early astronomers – Galileo, Newton, Kepler, Copernicus, and others. I was probably one of the few in my class that actually looked forward to history class. No wonder I was considered "different."

When I was in college, still enjoying the mandatory history class while working towards a degree in physics, my instructor encouraged me to consider a minor in history. "The history of science", he said, "can be very interesting." I nodded in agreement and then went back to my dorm to try to figure out the latest assignment in mechanics. History, while interesting, was something for "old people", someone at least 35 or 40. Little did I know that many years later, one of the foremost astronomical historians, Owen Gingerich, would write in an abstract for a talk he was giving at the San Diego meeting of the American Astronomical Society:

> "Today history of astronomy is recognized as a serious endeavor on the part of younger scholars, and is [no] longer dismissed as an activity best carried out by retired astronomers long past their prime!"

OK, so I was wrong – then.

Awhile back I wrote of reading Dava Sobel's wonderful book, *Galileo's Daughter*. If you haven't read it for some reason – do. It gives an amazing insight into the life and times of Galileo through a unique perspective. Reading that book rekindled my interest in astronomical history, which lead me to my local library branch. A visit there is only a couple of minutes from work and a great way to take a break from the daily routine. As I browsed through the shelves, I found two books that I highly recommend.

The first is by the aforementioned Dr. Gingerich, *The Book Nobody Read: chasing the revolutions of Nicolaus Copernicus*. Actually, quite a few people did read Copernicus' *De revolutionibus,* the famous book that spelled out in detail the Copernican theory of a heliocentric solar system. However, when first released, after the author's death, it was not in good keeping with Church-backed thinking – that is, the geocentric solar system of Ptolemy. So, to admit reading the book might not have been the best for one's reputation and, possibly, health. *The Book Nobody Read* is not only a history of the writing of *De revolutionibus* but Gingerich's long-time research that tried to track down every existing copy, who owned them through the years, and whether or not a given copy was complete. It reads more at times like a mystery novel and autobiography and never as a dry lecture.

Two men irrevocably tied together in astronomical history are Tycho Brahe and Johannes Kepler. Brahe, of course, was the Danish astronomer who revolutionized observational astronomy by producing the equipment necessary to make measurements of the highest quality to that date. Such high quality positions were fundamental to the development of astronomy and helped expand, if only slightly, the scale of the Universe. Those measurements would also prove vital to Kepler's development of his Three Laws. The story of the two men, individually, and as a combined force in early astronomy is well handled in Kitty Ferguson's *Tycho & Kepler: the unlikely partnership that forever changed our understanding of the heavens.* There is more here than astronomy. One gets an in-depth and interesting look at the life style of a well-to-do astronomer favored, for a time, by the royal family of his nation. Kepler's more humble surroundings offer a sharp contrast and a comparison of the two reveals some of the aspects of class divisions of the time.

A book I haven't read, save an excerpt, and is next on the list deals with the same two men. It's Joshua Gilder's *Heavenly intrigue: Johannes Kepler, Tycho Brahe, and the murder behind one of history's greatest scientific discoveries* (as an aside: I wonder what it is with astronomy history books having very long titles). Judging only from the introduction, this could be more like a Sherlock Holmes story. If you're not familiar, there is a belief that Kepler poisoned Brahe in order to get possession of Brahe's observations. The official story is that Brahe died of a ruptured bladder after drinking too much wine and staying too long at the dinner table. However, Gilder presents evidence that mercury poisoning may have been the real cause. Is it true? We'll have to read the book to find out. Remember that history is often tainted by legend. After all, if you believe the story in the play and movie, *Amadeus,* Salieri drove Mozart to his death in order to claim credit for the famous Requiem after Salieri used an intermediary to commission the work.

History is not only biographical works. Reading the original papers of astronomers can provide some fascinating reading as well. You'll find that some astronomers had a lot more insight that originally given credit. Sometimes they are a bit flamboyant, like T.J.J See (see the article from a sample of the *Journal of Astronomy History* at http://www.shpltd.co.uk/jha.pdf) and not well received at the time or even on retrospect. Last year, I happened to acquire a carload of *Astronomical* and *Astrophysical Journals*. They were extras being considered for the trash bin but would be given a reprieve for the cost of shipping. They are now in my storage room being slowly but surely reviewed for insights from past days that might have new or different meaning in light of the more enlightened knowledge of current times.

There is more to astronomy than "what's new." To study the past, the "old", is often a window into the future. If nothing else, one can gain a better understanding of what we do know and, maybe just as important, what we have yet to learn. Through your local library, the Internet, or any other resource, give some time to reflections of a nature other than photons bouncing off mirrors. Not all nights are clear and moonless and an armchair voyage through astronomical history is certainly a good use of that "down time." The best part: there won't be a quiz or test when you're done. This history class is strictly for pleasure.

I'll remind you again that you can make a contribution to history each time you do a lightcurve by submitting your data (after publication is OK) to the OLAF site run by the NASA Planetary Data System PDS. The URL is http://dorothy.as.arizona.edu/olaf. Data is a terrible thing to lose and the dusty filing cabinets need cleaning from time to time. Clear Skies!

LIGHTCURVE PHOTOMETRY OPPORTUNITIES APRIL-JUNE 2005

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It wasn't that long ago that binary asteroids were, at best, suspected but not confirmed. Now there are nearly two dozen known binaries and that's just among the near-Earth object (NEO) population. There are others among the general main belt group and beyond as well. Author PP has started an observing program that targets NEOs in hopes of finding additional binaries. This is towards the goal of forming a better understanding of the nature of these objects. If you are capable of doing work of 0.01-0.02m precision (or better) down to around 16th magnitude, then you should contact him at the email address above for more details. A Yahoo newsgroup has been set up specifically for this study and there is a general operational plan available as well.

Of course, there is no guarantee that the previously unstudied asteroid you choose to observe is going to be a binary. It's believed that about 16-20% of NEOs are binaries, or about 1 in 6. Observing geometries and luck – will reduce those odds considerably. That should not stop you from taking part. There are few sure things and the rewards for – literally – taking shots in the dark can be significant.

Whatever your reasons for taking part in asteroid photometry, there are a couple of suggestions that will make your efforts, especially period determinations, a little easier. First, observe the target as thoroughly as possible on two consecutive nights. This helps eliminate aliases. If you happen to cover more than one complete cycle in a given night, you might be able to skip a night should bad weather move in. Finally, don't give up too soon. That applies both to thinking that only two nights is enough and to having to work an asteroid many nights so that it finally gives up its secrets.

Of course, the idea is to publish your results so that others can make use of them. This can be for statistical analysis of spin axis rates versus any number of parameters or to provide the data for shape modeling. Within reason and space limitations, try to include information that is important to understanding the data in light of the research objectives. In lieu of discovery circumstances and orbital elements, save where they make the object unique, give consideration to other data that saves the research the need of having to reconstruct it at a later date and possibly with different values than you used.

Something that is often missing from *MPB* publications is a minimal aspect table, listing the sky position of the PAB at some point in the run, or the range if it changes significantly, and the solar phase angle of each observation night. For absolute photometry, the vertical magnitude offsets applied each night to produce the composite lightcurve should be given. The tabular values of phase angle and vertical magnitude offset when plotted are directly the phase relation. The phase plot may not be worth presenting (particularly if the vertical offsets are assumed from a nominal phase relation), but in any case should be provided if the magnitude levels are calibrated, even if only relative to each night.

Again, what you include must also take into consideration the space allotments and formatting of the *Minor Planet Bulletin*. No doubt our editor – like all editors – will let you know when things may get out of hand. Be sure to refer to the MS Word template and authors' guide available on the CALL site (www.MinorPlanetObserver.com/astlc/default.htm) so that your submissions at least following the *MPB*'s formatting guidelines. The CALL also has a more complete listing of potential lightcurve targets as well as links to research sites for other targets.

Lightcurve Opportunities

Of particular note is 2004 YZ_{23}, reaching brightest in early June. While well south of the equator at that time, it is still within reach of larger amateur instruments towards the middle of the month when it reaches the celestial equator.

#	Name	Brightest Date	Mag	Dec	U	Per	Amp
2679	Kittisvaara	4 07.8	14.9	-10	0		
3129	Bonestell	4 10.5	14.7	+ 4	0		
13859	Fredtreasure	4 12.4	14.9	-31	0		
4892	Chrispollas	4 12.0	14.8	-11	0		
44711	Carp	4 16.0	15.7	-21			
785	Zwetana	4 20.5	11.7	+ 5	2	8.919	0.13
274	Philagoria	4 23.2	13.6	- 8	0		
1764	Cogshall	4 23.8	14.7	-10	0		
1145	Robelmonte	4 25.5	13.5	-21	0		
1715	Salli	4 28.4	13.2	-14	1	>11.	>0.5
4544	Xanthus	4 29.7	15.0	-38	0		
6611	1993 VW	4 30.3	13.3	-21	1		<0.1
1831	Nicholson	5 05.1	14.5	-11	0		
1259	Ogyalla	5 07.7	14.4	-15	1	12.	>0.3
1575	Winifred	5 07.2	14.6	+ 1	0		
79506	1998 HG7	5 10.2	15.8	-19			
910	Anneliese	5 11.2	13.2	-18	0		
46773	1998 HZ12	5 12.0	15.9	- 6			
834	Burnhamia	5 12.7	12.7	-14	0		
3909	Gladys	5 15.2	14.8	-13	1	6.83	0.15
13018	Geoffjames	5 22.0	14.8	-14	0		
222	Lucia	5 22.9	12.5	-19	2	7.	0.33
6327	1991 GP1	5 24.0	14.6	+ 5	0		
21556	1998 QE71	5 24.9	15.0	-16	0		
68329	2001 HV48	5 25.3	15.6	-23			
3901	Nanjingdaxue	5 27.4	14.5	-45	0		
1365	Henyey	5 29.1	13.3	-24	0		
23044	1999 XS25	5 29.3	15.8	-18			
57037	2000 YC15	5 30.0	15.8	-33			
9414	1995 UV4	5 30.4	14.6	-27	0		
4408	Zlata Koruna	5 30.4	15.0	-18	0		
2474	Ruby	5 31.8	13.8	-19	2	7.418	0.16
	2004 YZ23	6 03.7	14.4	-32			
5852	Nanette	6 05.5	14.5	-20	0		
2739	Taguacipa	6 05.2	14.9	-23	0		
22252	1978 SG	6 05.6	16.0	-39			
7808	1976 GL8	6 05.9	14.6	-26	0		
2497	Kulikovskij	6 07.1	14.9	-32	0		
46819	1998 MH27	6 10.5	15.8	-18			
45876	2000 WD27	6 14.2	16.0	-21			
7594	Shotaro	6 14.7	14.7	-19	0		
2019	van Albada	6 15.0	13.1	-22	0		
1506	Xosa	6 16.0	13.4	-10	2	5.9	0.28
6548	1988 BO4	6 16.0	14.9	-27	0		
21914	1999 VX34	6 16.3	15.8	-19			
75452	1999 XP142	6 16.9	15.6	-39			
23554	1994 PJ11	6 17.5	15.9	-26			
269	Justitia	6 18.2	11.6	-13	2	16.545	0.25
28039	1998 FV78	6 18.2	15.4	-25			
	2003 UR170	6 19.0	15.9	-22			
2297	Daghestan	6 19.3	14.6	-21	0		
82091	2001 DE81	6 19.4	15.9	-38			
2199	Klet	6 20.8	14.5	- 8	0		
4875	Ingalls	6 20.5	14.3	-17	0		
2731	Cucula	6 20.0	14.3	- 4	0		
29241	1992 GA5	6 24.6	15.7	-29			
786	Bredichina	6 24.4	12.2	-25	0		
6274	Taizaburo	6 24.2	14.8	-23	0		
82329	2001 LC4	6 24.5	16.0	-25			
4894	Ask	6 26.9	14.4	-22	2	3.4	0.16
5292	1991 AJ1	6 27.0	14.7	-24	0		
1937	Locarno	6 29.1	13.9	-31	0		
2492	Kutuzov	6 29.5	14.8	-24	0		

Low Phase Angle Opportunities

#	Name	Date	PA	V	Dec	Per	Amp
16	Psyche	04 01.8	0.59	10.7	+03	4.196	0.03-0.42
127	Johanna	04 06.1	0.57	13.5	+05	11.	0.18
75	Eurydike	04 06.4	0.67	13.3	-09	5.357	0.12
160	Una	04 06.9	0.15	14.0	+07	5.61	0.14
362	Havnia	04 10.0	0.63	12.3	-06	18.	0.1
176	Iduna	04 11.2	0.12	13.0	-08	11.289	0.35
79	Eurynome	04 22.7	0.16	11.9	+12	5.978	0.05-0.24
33	Polyhymnia	04 25.6	0.28	12.6	+14	18.601	0.14
496	Gryphia	04 30.0	0.64	14.0	-13		

(continues on next page)

Low Phase Angle Opportunities (continued)

#	Name	Date	PA	V	Dec	Per	Amp
631	Philippina	05 02.5	0.56	12.2	-17	5.923	0.05-0.58
906	Repsolda	05 05.6	0.53	13.4	-18		
68	Leto	05 07.5	0.24	10.7	-17	14.848	0.15-0.19
175	Andromache	05 09.0	0.39	13.5	+18	7.109	0.21
910	Anneliese	05 11.2	0.14	13.2	-18		
270	Anahita	05 12.1	0.31	12.9	+19	15.06	0.32
222	Lucia	05 22.9	0.41	12.5	-19	7.	0.33
405	Thia	05 23.8	0.67	14.0	+23	10.08	0.15
409	Aspasia	05 25.0	0.21	10.3	-20	9.020	0.10-0.14
95	Arethusa	05 30.3	0.56	12.6	-20	8.688	0.24
579	Sidonia	06 03.3	0.48	13.5	+21	16.5	0.02-0.28
7	Iris	06 03.8	0.36	9.2	-23	7.139	0.04-0.29
177	Irma	06 03.8	0.67	13.7	-24	14.208	0.37
914	Palisana	06 06.0	0.07	13.8	+23	15.62	0.18
9	Metis	06 07.8	0.26	10.4	+23	5.079	0.04-0.36
566	Stereoskopia	06 10.8	0.09	12.8	-23	17.	0.08
690	Wratislavia	06 12.3	0.42	13.4	+22	8.60	0.13-0.3
240	Vanadis	06 13.4	0.55	13.2	-22	10.64	0.30
147	Protogeneia	06 16.1	0.13	13.9	+23		
135	Hertha	06 16.5	0.63	13.2	+25	8.4006	0.12-0.30
556	Phyllis	06 18.9	0.53	13.9	+25	4.293	0.27
346	Hermentaria	06 19.1	0.19	12.1	+23	19.408	0.07
583	Klotilde	06 19.1	0.63	13.6	-21	9.210	0.18
424	Gratia	06 23.1	0.55	13.9	-22	19.47	0.32
65	Cybele	06 24.3	0.67	13.1	+21	4.041	0.04-0.12
786	Bredichina	06 24.5	0.48	12.2	-25		
128	Nemesis	06 25.4	0.53	12.5	+25	39.	0.10
351	Yrsa	06 25.8	0.42	13.1	-22		
150	Nuwa	06 27.1	0.52	13.7	+22		

Shape/Spin Modeling Opportunities

		Brightest			Per		
#	Name	Date	Mag	Dec	(h)	Amp.	U
334	Chicago	4 28.5	13.0	-08	7.3607	0.15-0.67	3
34	Circe	5 13.8	11.9	-12	12.15	0.24	3
409	Aspasia	5 25.0	10.3	-20	9.020	0.10-0.14	3
369	Aeria	6 07.1	12.1	-16	4.787	0.08	2
54	Alexandra	6 24.8	10.3	-38	7.024	0.10-0.31	4
258	Tyche	6 25.4	12.0	-02	10.041	0.40	3
233	Asterope	6 25.9	11.6	-13	19.70	0.35	3
77	Frigga	6 27.5	12.5	-27	9.012	0.07-0.19	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).

CALL FOR OBSERVATIONS

Frederick Pilcher
Illinois College
Jacksonville, IL 62650 USA

Observers who have made visual, CCD, or photographic measurements of positions of minor planets in calendar 2004 are encouraged to report them to this author on or before April 1, 2005. This will be the deadline for receipt of reports which can be included in the "General Report of Position Observations for 2004," to be published in *MPB* Vol. 32, No. 3.

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The deadline for the next issue (32-3) is April 15, 2005. The deadline for issue 32-4 is July 15, 2005.