

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 Nikdollezhai', (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.

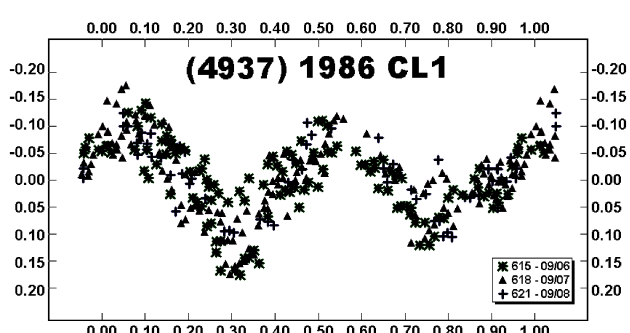
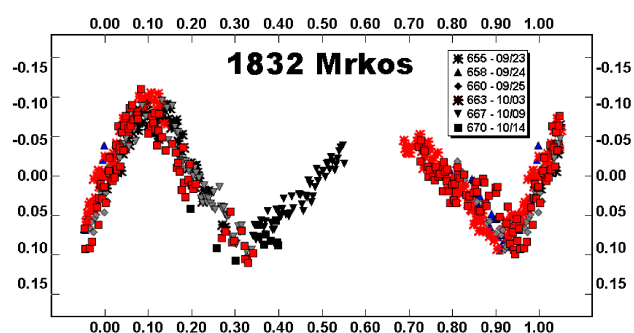
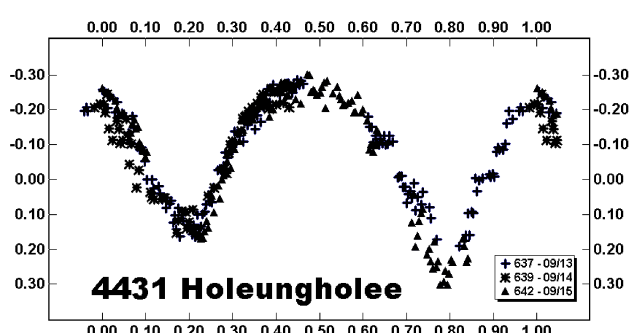
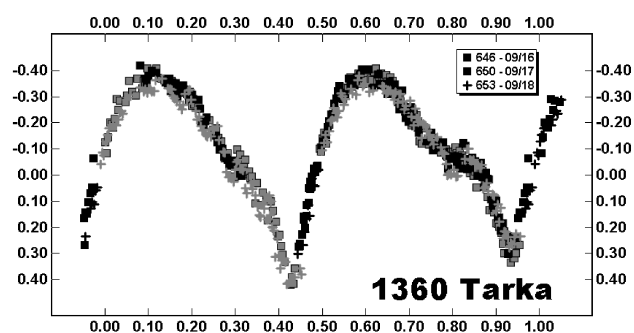
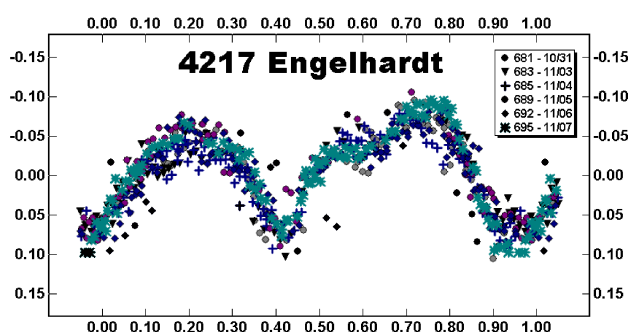
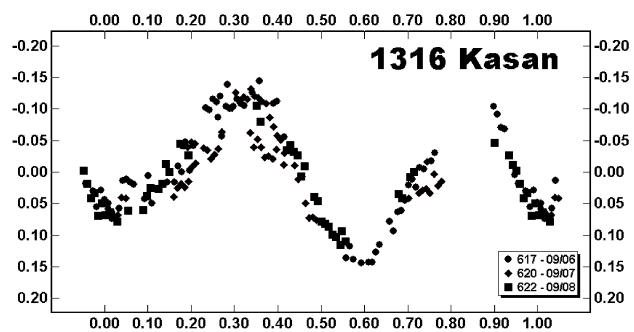
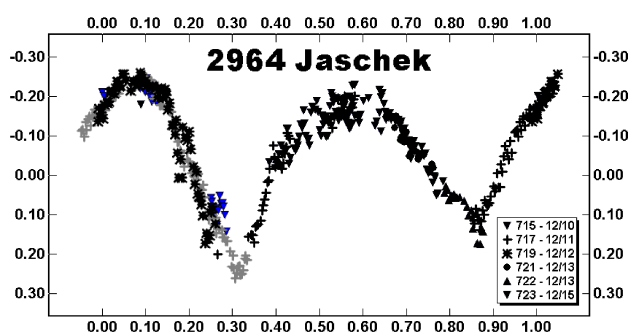
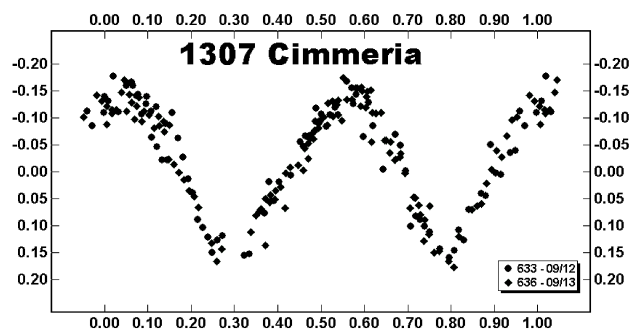
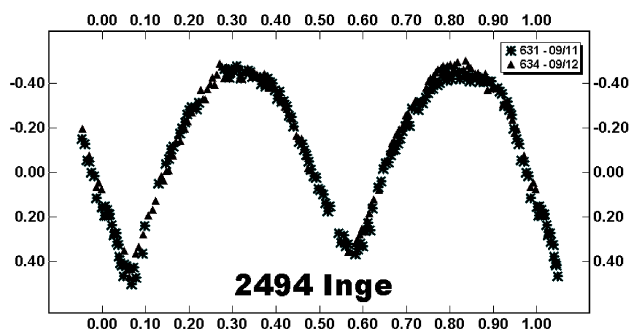
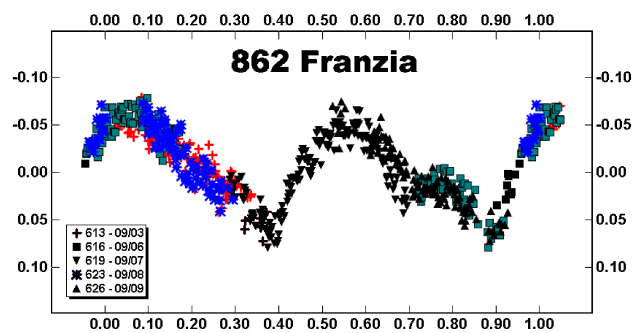
Column 3 gives the full range of dates of observations while column 4 gives the number of actual runs made during that time span. Column 5 is the range of phase angles over the full date range. If there are three values in the column, this means the phase angle reached a minimum with the middle value 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.

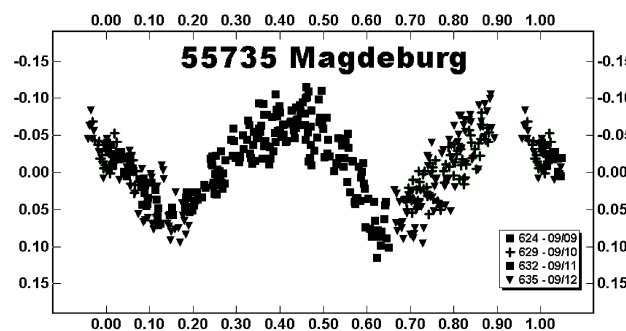
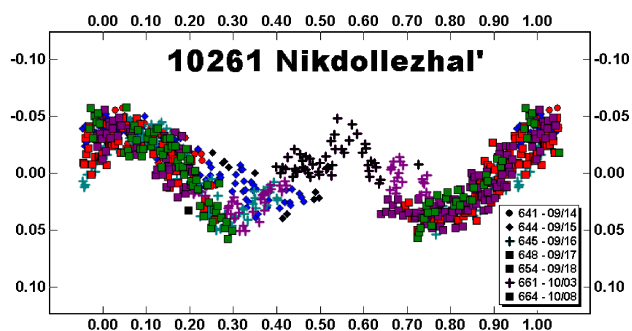
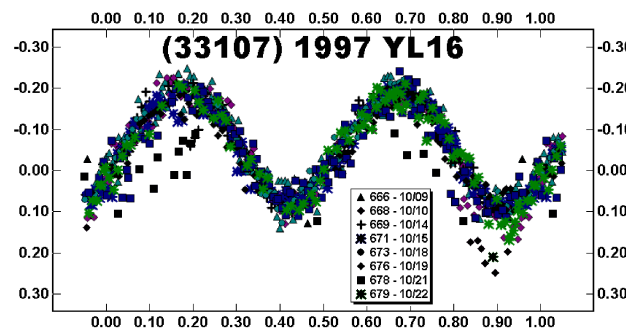
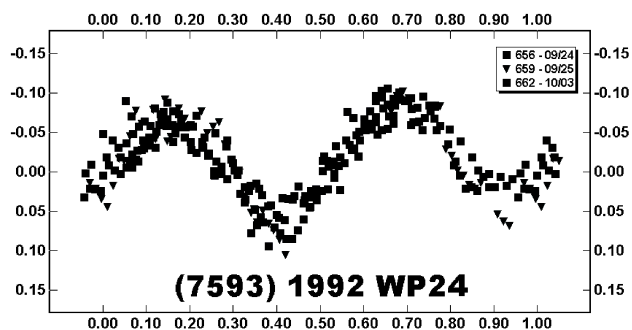
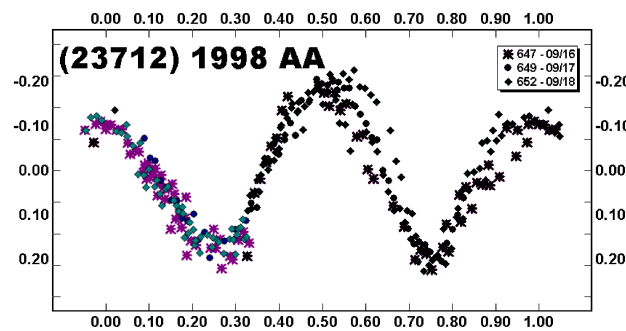
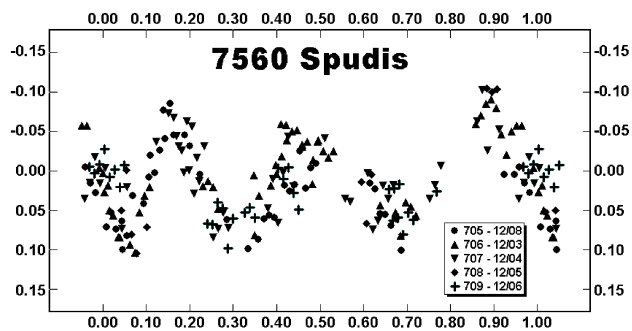
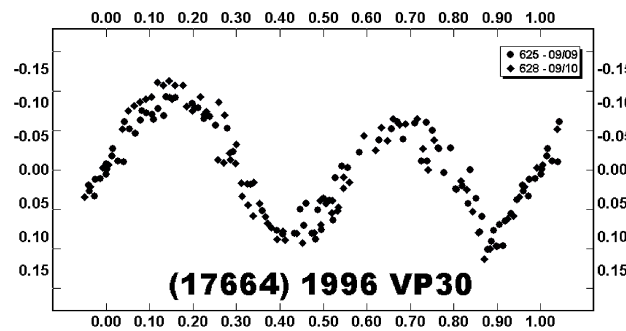
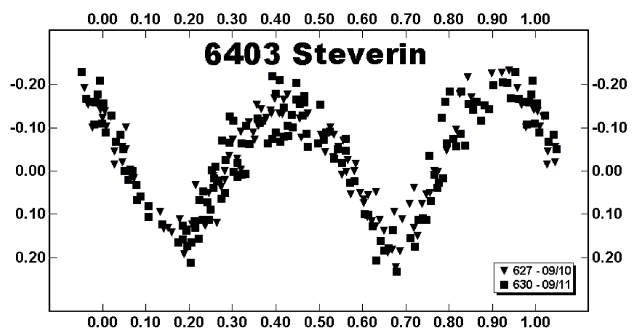
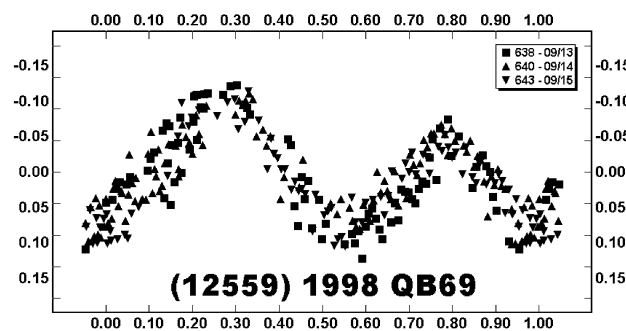
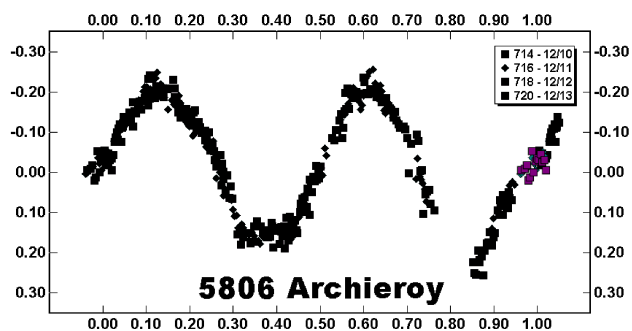
Comments

(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/htmls/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	Nikdollezhai'	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





(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.

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

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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 Robertfrazier 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).

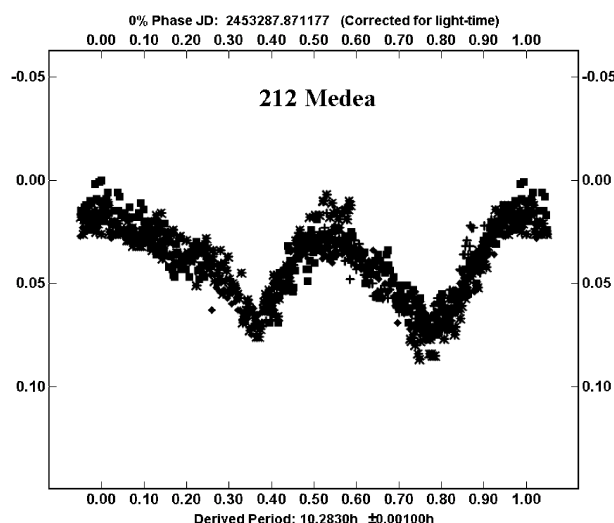
The images were obtained through a clear filter with an IR cutoff of 700 nm. All images were calibrated with dark frames and flat field frames. Lightcurves were prepared using the program "Canopus", which is based on the method developed by Dr. Alan Harris (Harris et al., 1989). The program uses aperture 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

References

- Harris, A. W., Young, J. W., Bowell, E., Martin, L. J., Millis, R. L., Poutanen, M., Scaltriti, F., Zappala, V., Schober, H. J., Debehogne, H., and Zeigler, K. W. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.
- Harris, Alan W. (2003). "Minor Planet Lightcurve Parameters", On Minor Planet Center web site: <http://cfa-www.harvard.edu/iau/lists/LightcurveDat.html>
- Warner, B. D. (2003), "Lightcurve Analysis for (Several) Asteroids", *Minor Planet Bulletin* **30**, 21-24.

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