

ASTEROID LIGHTCURVE ANALYSIS AT MENKE OBSERVATORY

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The lightcurves for the following asteroids are reported: 305 Gordonia, 316 Goberta, 608 Adolfine, 707 Steina, 710 Gertrud, 1187 Afra, 1216 Askania, 1325 Inanda, 1462 Zamenhoff, 1559 Kustaanheimo, 1671 Chaika, 1999 Hirayama, 2075 Martinez, 2094 Magnitka, 2444 Lederle, 3156 Ellington, 4264 Karljosephine, and 7895 Kaseda. Three of these (707, 1325, and 4264) are slow rotators.

The asteroid program at Menke observatory has been described elsewhere (Menke 2005a) and website (Menke 2008). In brief, a C11 with ST7E camera is used in an automated setup. The data are taken and the images are read using *MaximDL* to create text files of raw intensity values using a digital reference star plug-in. These files are imported into Excel where the data are analyzed. The period is determined by inspection using a data folding process. In the case of slow rotators, Menke also uses a time plot against Julian Day with comparison sine waves to assist in the analysis. Night-to-night calibration was done using a modified Landolt star reference process and/or manual offsets. The data are not light-time corrected. Virtually all targets were taken from the CALL web site lists (Warner 2005).

The results are presented in the table below, followed by the plots of the curves. The plots show data session dates as DXMMDDYY where X is a session number. Where appropriate, comments are provided comments on individual results. In some data sets, interfering stars were removed from the original images using *StarZap* (Menke 2005b), and these are noted with an "SZ" in the name of the session date.

608 Adolfine. Data set D2 was very noisy, but its period and phase are consistent with the remaining data and helped eliminate aliases. The plot uses only the better data sets in order to show the main curve.

707 Steina. This large amplitude (1 mag), extremely slow rotator (414 hr) was done in collaboration with David Higgins in Australia, thus providing a key series of data with minimal calibration issues. The Higgins data were essential for eliminating period aliases. The long-time plot shows the Menke and Higgins data without manual offsets. The baseline magnitude of the sine curve is set to fit the magnitudes of data set D13, with the slope of the sine curve matching the predicted magnitude change as given by *TheSky* software. The residual differences between the Menke data and the curve indicate that there are calibration problems in some of the Menke data sets that could not be resolved. However,

the inferred period and amplitude are unambiguous. In the Steina phase plot, manual offsets were introduced and chosen to fit the data to a non-sloped version of the sine curve time plot (not shown), but having the same period and phase as shown in the displayed time plot. The phase space is reasonably well sampled; however, the details of the rotation curve are obviously not continuously sampled.

1325 Inanda. These are data taken in 2003, but due to their complexity were not successfully analyzed until 2007. There were 15 data sessions over 32 days. Some of the sessions were done using the modified Landolt reference star methods but others had no calibration data and required use of manual offsets. Complicating the analysis, the data in the last four sessions (Day12-15) were obviously significantly different from the earlier sessions, that is, their slopes were substantially steeper. A time plot was created because of the difficulty of finding a simple solution. Nightly offsets were adjusted to move the data to fit the sine wave while a phase plot was used to assure that incorrect periods were avoided. Using this method, the fundamental frequency was found to be 70.8 h for a presumed rotation period of 141.6 h. The first two-thirds of the data are consistent with an amplitude of 0.4 mag. However, judging from the steepness of the slopes in the last four sessions, the amplitude apparently exceeded 0.8 mag. If this is correct, Inanda has a strongly asymmetric shape which was coming into view (or illumination) sometime around JD 2452960. Note that Inanda has been listed as having a period of 8 h (Warner 2000), but that was clearly in error.

2075 Martinez. A run of bad weather and a small amplitude made analysis of these data very problematic. Because of the poor data quality, the period and amplitude shown must be considered uncertain.

2444 Lederle. This asteroid was in a crowded star field, and required extensive use of *StarZap* to remove interfering stars from the images, which greatly improved the quality of the results.

3156 Ellington. Although these data are not of high quality, the period and amplitude given are highly certain.

4264 Karljosephine. This slow rotator was done in collaboration with Cooney, Gross, and Terrell of Sonoita Research Observatory (SRO). The SRO data were 5-minute unfiltered integrations. The changing nightly fields were calibrated against each other to put all measurements on the same relative instrumental scale. The data are light-time corrected. The effects of changing phase angle and distance from night-to-night were taken into account, leaving only the period and the slope parameter, G , as variables to adjust to synthesize the light curve. A best fit was obtained with a period of 98.2 ± 1.5 h and a slope parameter of 0.35 ± 0.15 . The high slope parameter indicates the asteroid has somewhat higher albedo than typical but not outside normal bounds. The data of Menke were light-time corrected and overlaid on the SRO light curve. The magnitude scale is from Menke's data using his approximate Landolt calibration method. The data of Menke taken alone would indicate that a period of 92.8 h is also possible but this period is not favored with the addition of the internally calibrated SRO data.

7895 Kaseda. This asteroid had a low amplitude as well as being in a very crowded star field. The raw data were nearly useless and required the use of *StarZap* on every data set. Three days of data are shown with different offsets to demonstrate the consistency of the rotation curves.

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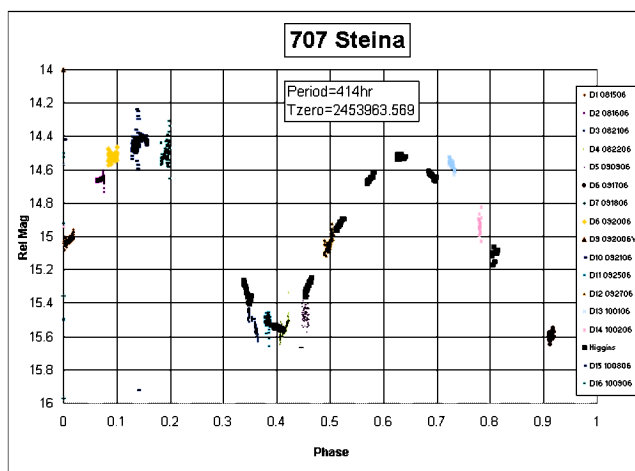
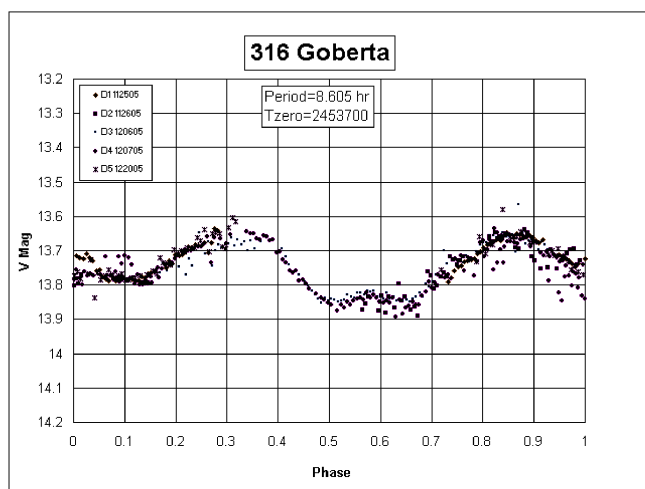
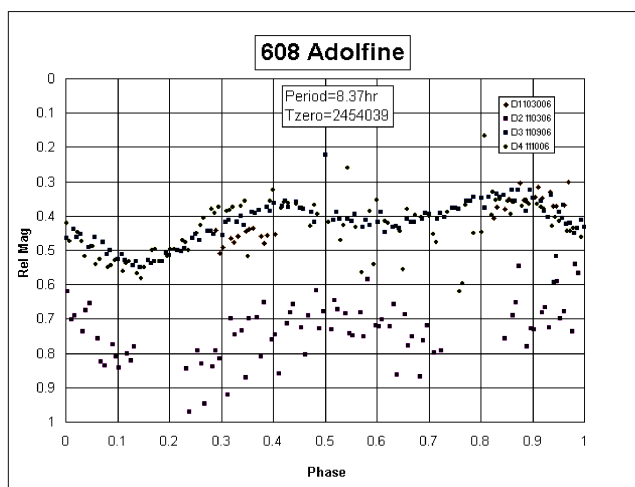
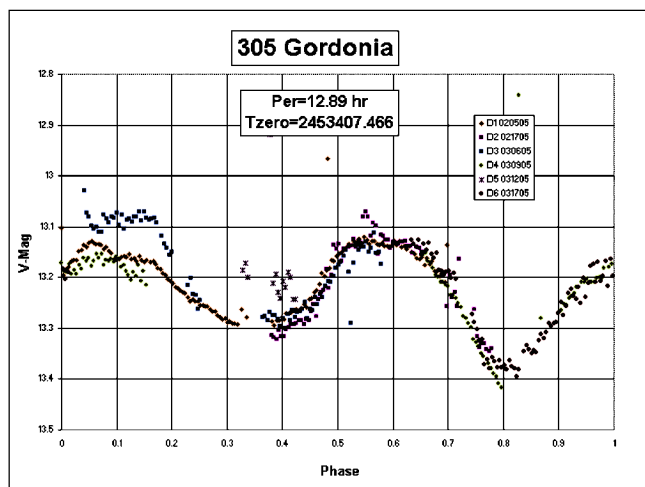
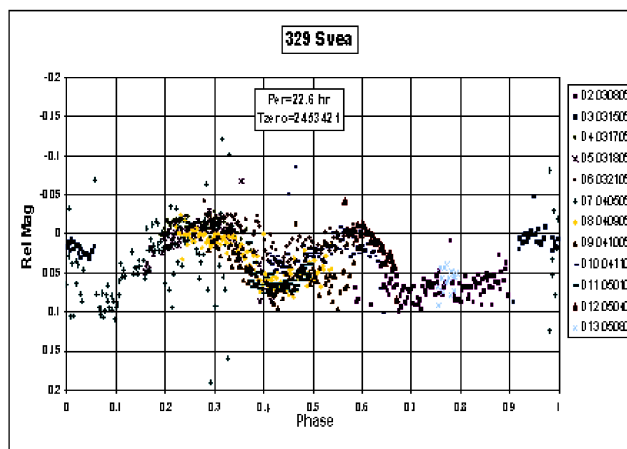
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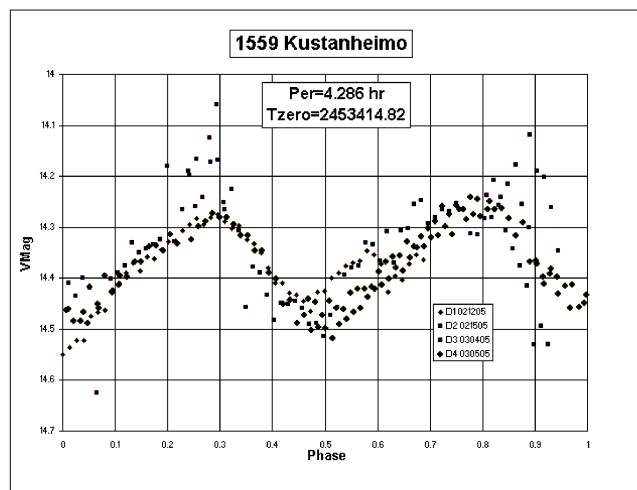
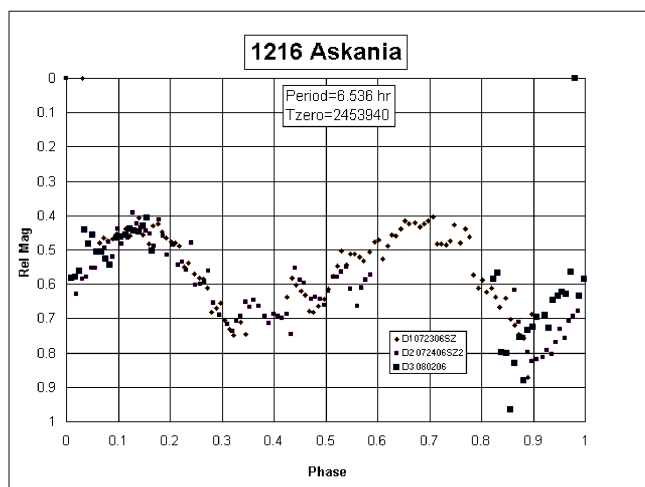
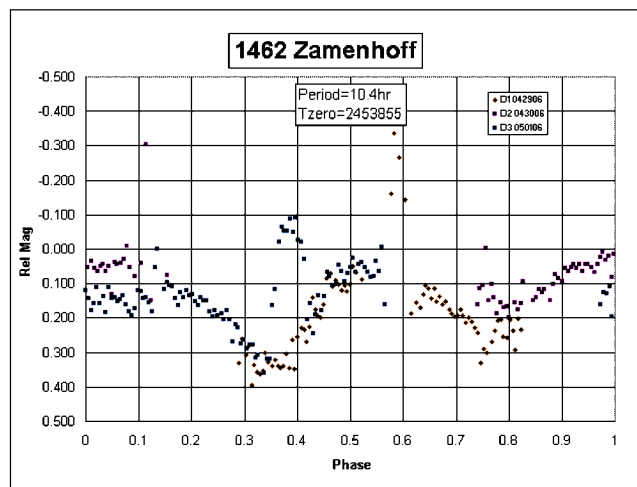
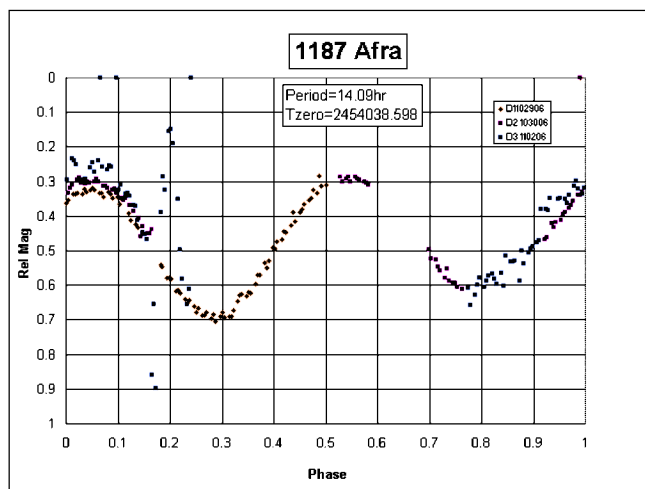
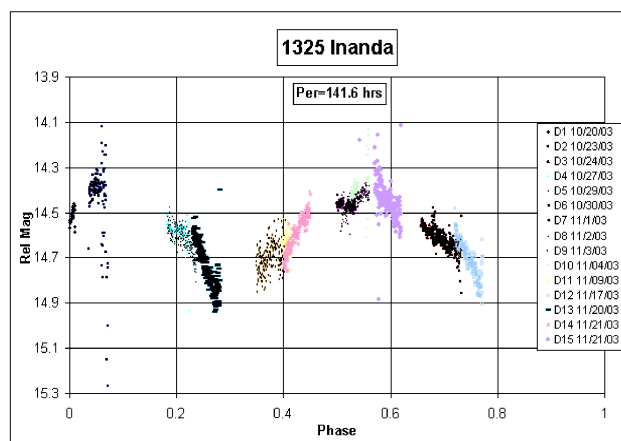
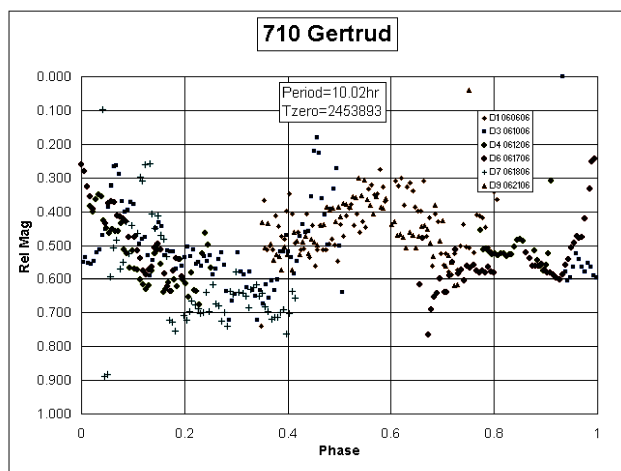
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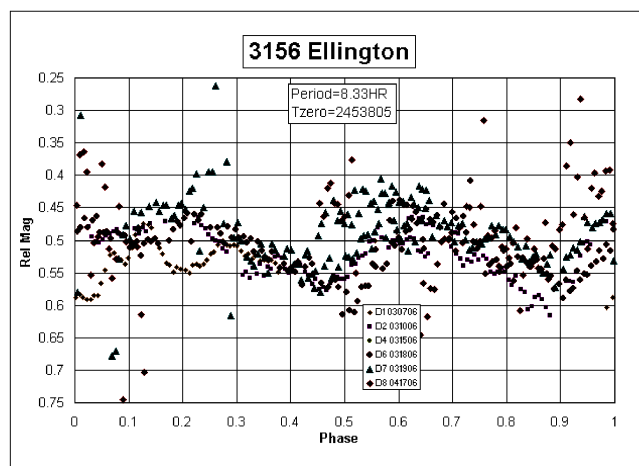
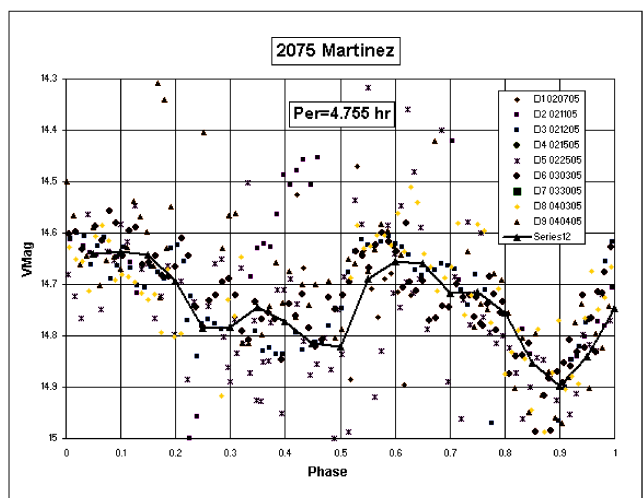
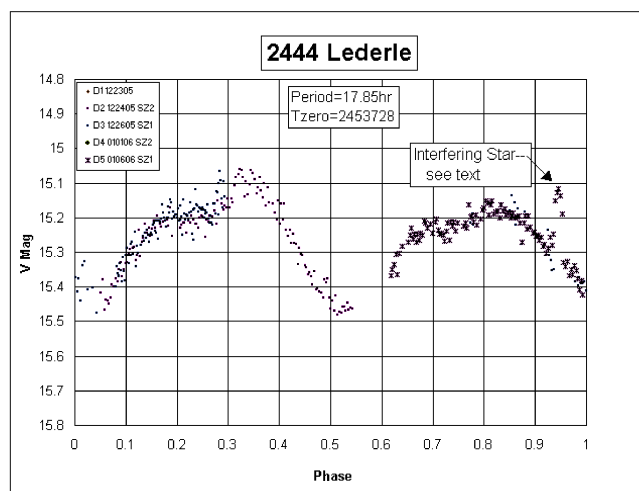
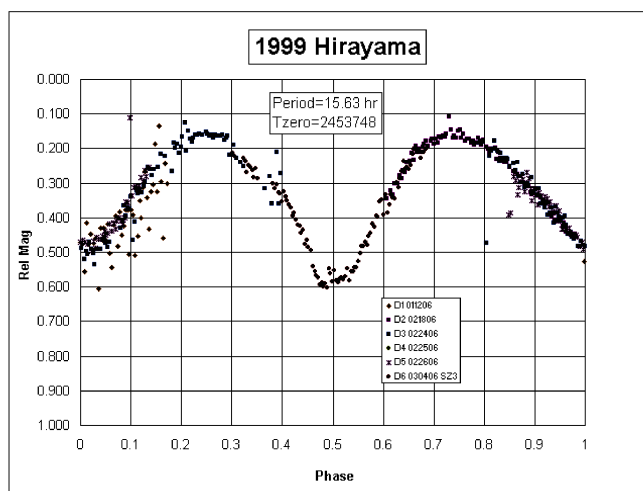
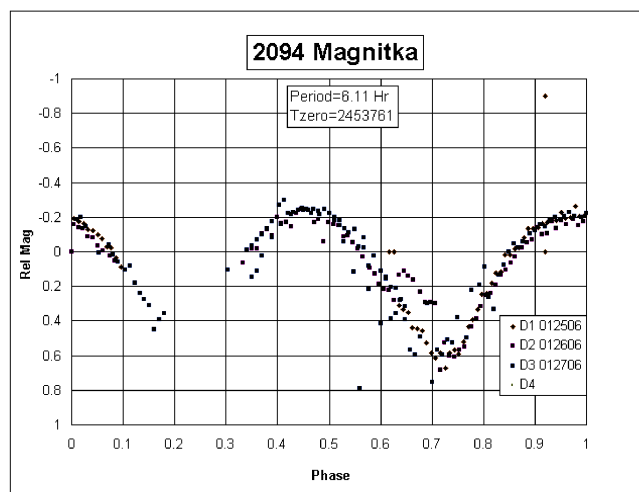
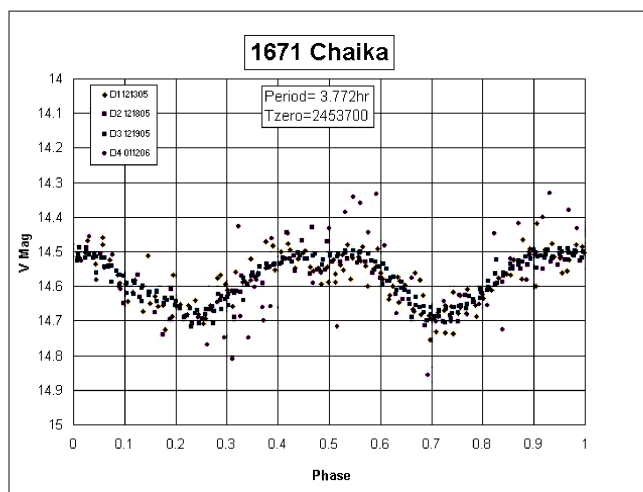
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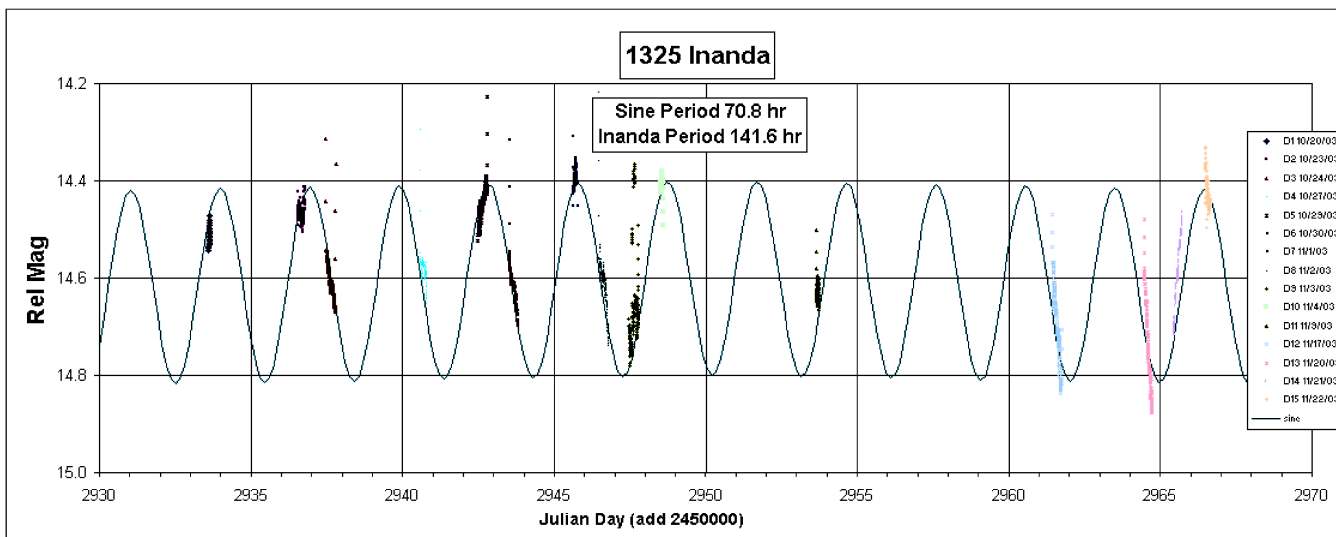
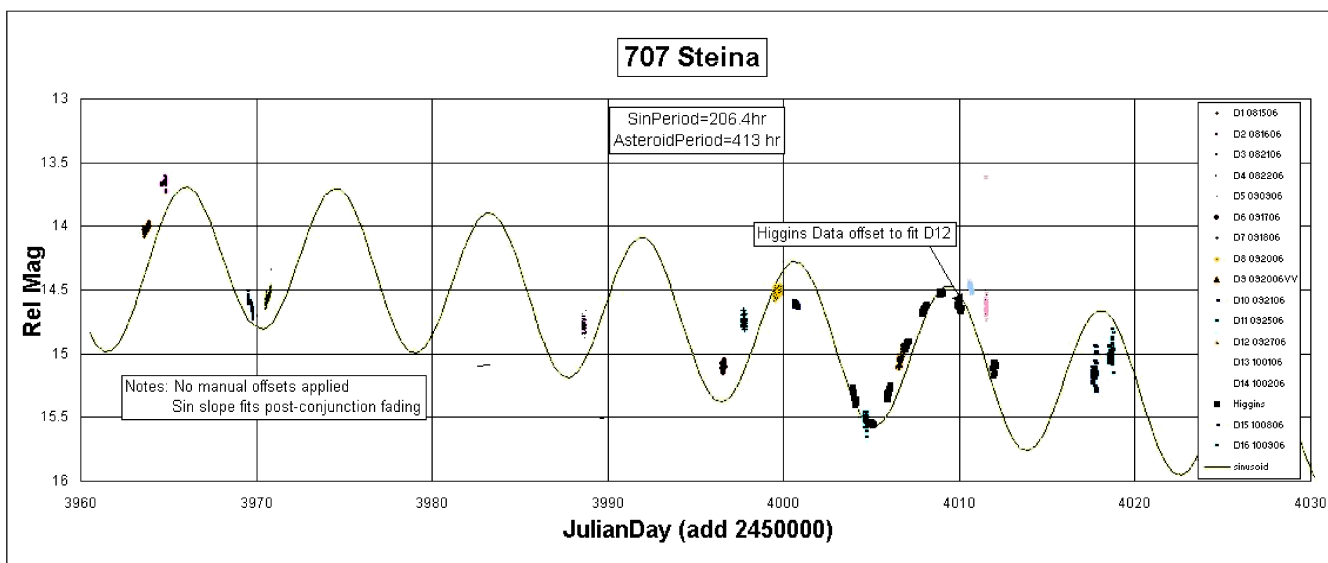
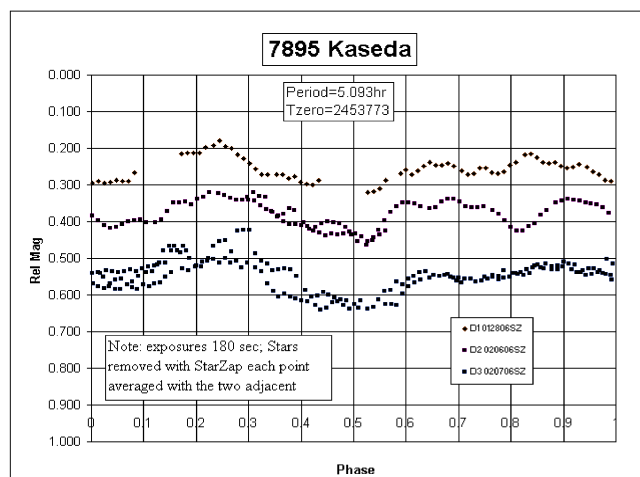
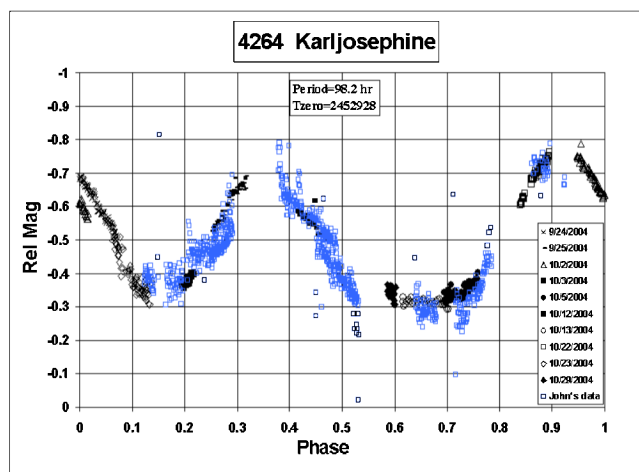
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Number	Name	Period (h)	Unc	Amp	Unc	DateStart	DateEnd	Span	#Sess	Cov%
305	Gordonia	12.89	0.01	0.17	0.03	02/05/05	03/06/05	32	3	80
316	Goberta	8.605	0.01	0.20	0.05	11/25/05	12/20/05	26	5	100
329	Svea	22.6	0.01	0.10	0.03	03/08/05	05/08/05	61	12	100
608	Adolfine	8.37	0.03	0.25	0.05	10/30/06	11/10/06	11	4	100
707	Steina	414	10	1.00	0.15	08/15/06	10/09/06	55	(1) 23	35
710	Gertud	10.02	0.03	0.35	0.04	06/06/06	06/21/06	16	6	100
1187	Afra	14.09	0.02	0.40	0.02	10/29/06	11/02/06	4	3	90
1216	Askania	6.536	0.003	0.30	0.03	07/23/06	08/02/06	10	3	100
1325	Inanda	141.6	0.2	0.4/0.8	--	10/20/03	11/21/03	32	15	75
1462	Zamenhoff	10.4	0.1	0.35	0.04	04/29/06	05/01/06	3	3	80
1559	Kustaanheimo	4.286	0.003	0.25	0.05	02/12/05	03/05/05	24	4	100
1671	Chaika	3.774	0.003	0.18	0.03	12/07/05	12/19/05	13	4	100
1999	Hirayama	15.63	0.01	0.45	0.04	01/12/06	03/04/06	53	6	100
2075	Martinez	4.755	0.002	0.30	0.1	02/07/05	03/03/05	27	6	100
2094	Magnitka	6.11	0.02	0.80	0.08	01/25/06	01/27/06	3	3	90
2444	Lederle	17.85	0.02	0.45	0.05	12/23/05	01/06/06	14	5	90
3156	Ellington	8.33	0.01	0.10	0.02	03/07/06	04/17/06	41	7	100
4264	Karljosephine	98.2	1.5	0.45	0.15	09/21/04	11/06/04	46	(2) 23	85
7895	Kaseda	5.093	0.003	0.10	0.02	01/28/06	02/06/06	9	3	100

Note (1) includes 16 sessions by Menke, 8 by Higgins

(2) includes 13 sessions by Menke, 10 by Cooney, Gross, and Terrell

LIGHTCURVE ANALYSIS OF ASTEROIDS 3036 KRAT, 3285 RUTH WOLFE, AND 5448 SIEBOLD

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Main-belt asteroids 3036 Krat, 3285 Ruth Wolfe, and 5448 Siebold were observed by the authors. 3036 Krat, observed at Lowell Observatory in 2007 December, was found to have a period of 9.61 ± 0.01 h. For the other two asteroids, both observed at the Truman Observatory in 2007, we found 3285 Ruth Wolfe to have a period of 3.919 ± 0.001 h and 5448 Siebold was determined to have a period of 2.929 ± 0.001 h.

Truman Observatory is located in Kirksville, Missouri, in a rural setting about 1.5 miles from the campus of Truman State University. Observations reported here were obtained with the Observatory's 14-inch Meade LX-200GPS telescope with an attached f/6.3 focal reducer. Truman State University is a member of the National Undergraduate Research Observatory (NURO), a consortium of colleges and universities that shares time on the 31-inch telescope at Lowell Observatory in Flagstaff, Arizona. This telescope is equipped with a 2048x2048 pixel Loral CCD camera. All of the data were analyzed using MPO Canopus (Bdw Publishing) which employs differential aperture photometry. The period analysis was performed within Canopus, using the Fourier analysis algorithm developed by Harris (1989).

3036 Krat. No previous photometry on this asteroid has been published. Photometric measurements of 3036 Krat were obtained at Lowell Observatory over two nights, 2007 December 18 and 20. The asteroid remained at magnitude 14.8 and phase angle 8.4 deg during the observing period. A total of 820 unfiltered images were acquired. The synodic period was determined to be 9.61 ± 0.01 h;

the amplitude is 0.38 ± 0.03 mag.

3285 Ruth Wolfe. Warner (2003) initially published a rotational period for 3285 Ruth Wolfe of 6.72 hours but later revised that period to 3.94 hours (Warner 2005). This asteroid was observed at the Truman Observatory over two nights, 2007 October 30 and November 5. A total of 292 unfiltered CCD images were taken with an SBIG ST-402ME CCD camera. During this time the asteroid was near magnitude 14.6, with a phase angle of 10.9 deg on October 30, and 11.5 deg on November 5. Our analysis gives a best-fit synodic period of 3.919 ± 0.001 h and an amplitude of 0.20 ± 0.05 mag. This period and the overall shape of the light curve are consistent with Warner's 2005 measurements.

5448 Siebold. Photometric measurements of the main-belt asteroid 5448 Siebold were obtained on the nights of 2007 March 12 and 19 with an SBIG ST-7XME CCD camera at the Truman Observatory. During this time the asteroid was near magnitude 15, while its phase angle varied from 14 deg on March 12 to 18 deg on March 19. A total of 127 CCD images were acquired with a Bessell V filter. Analysis of the data revealed a bimodal lightcurve with a best-fit synodic period of 2.929 ± 0.001 h and an amplitude of 0.33 ± 0.02 mag.

Acknowledgements

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