LIGHTCURVE ANALYSIS OF FIVE MAIN BELT ASTEROIDS AT THE CALVIN-REHOBOTH OBSERVATORY

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Synodic rotation periods and amplitudes for five main-belt asteroids observed at the Calvin-Rehoboth Observatory are reported: 1335 Demoulina, 2658 Gingerich, 3091 van den Heuvel, 8887 Scheeres, and (12168) 5141 T-2. The asteroid 2658 Gingerich is a binary candidate, having exhibited a possible eclipse. The asteroid (12168) 5141 T-2 has an amplitude of 1.44 mag, matching the largest value established for main belt objects.

Calvin College operates a robotic observatory located in Rehoboth, NM, at an elevation of 2024 m. Data were taken using a 0.4 m OGS Ritchey-Chretien telescope and an SBIG ST-10XE camera. All images were taken with no filter at a pixel scale of 1.31 arcseconds per pixel (excepting 1335 Demoulina, which was observed with an R filter at a pixel scale of 1.97 arcseconds per pixel). Exposure times ranged from 60 to 300 s. Standard image calibration and differential aperture photometry were done with MaxIm DL. Period analysis was done with Peranso 2.02 (Vanmunster 2006), using the Fourier algorithm (FALC) developed by Harris et al. (1989).

Previously published light curves exist for only one of the five asteroids, 1335 Demoulina (cf. the catalog of Harris et al. 2007). Our results are summarized below.

1335 Demoulina. Data were taken on 11 nights in January and February of 2006. For asteroids with periods much greater than the length of an observing session, it is important to tie the calibration scale of successive sessions together as much as possible to reduce the degrees of freedom in the period analysis. We connected adjoining days by calibrating the reference stars from one night to those of the following. For observations separated by more than one day, this was not possible. We found a best fit period of 74.86 h and an amplitude of 0.78 mag. A number of cycles were covered and there is no ambiguity in the period. However, the presence of gaps in the phase coverage makes the standard approach to determining the uncertainty an underestimate. (The shape of the light curve requires a higher order fit, but a higher order fit misbehaves in the gaps.) We therefore quote a more conservative uncertainty of 0.10 h which is based on the change in the best fit period as the order of the solution is varied.

Behrend (2007) cites provisional evidence for two different periods (0.15 and 0.23 h), each based on a single night of data. Either of these values would be noteworthy, as they are much shorter than the approximately 2.1 hour lower limit to periods found in any but the smallest asteroids. However, the amplitudes cited by Behrend, about 0.1 mag, are consistent with the measurement uncertainties of those data and are not inconsistent with the gradual rate of change we find.

2658 Gingerich. Data were taken for this asteroid on two nights in November 2005 and then again for five nights in June 2007. The 2005 data contained more than one cycle per observing session, and so yielded an unambiguous period of 2.9392 ± 0.0011 h with an estimated amplitude of 0.39 mag. (The last 2.5 hours of the first night of observation were omitted from the period fit and from the figure for reasons described below.) The 2007 data consisted of shorter observing sessions (as the asteroid was well past opposition) but spanned a greater total time. Analysis of these data (using the 2005 period to resolve ambiguities) yielded a more precise period of 2.9415 ± 0.0006 h, again with an estimated amplitude of 0.39 mag.

In the 2005 data, we observed a decrease in the asteroid's brightness in the last few hours of the first night that could not be traced to any problems with the data (such as variations in sky quality or close passage by a star). The figures show the asteroid's lightcurve for that night and the residuals to a periodic fit based on binned averages of all but the late data. The most likely interpretation of this dip is that it was due to an eclipse by a binary companion. Pravec et al. (2006) show binaries to be quite common among small, rapidly rotating NEAs, and they give more limited evidence that this extends to larger, main belt objects as well. Furthermore, the depth and duration of the event are within the range of eclipses observed in other systems. Additional observations at the next opposition are desirable to confirm the binary nature of 2658 Gingerich and determine the orbital period.

3091 van den Heuvel. Data were taken of this object on eight of a string of nine nights in June 2006. As with Demoulina, it was both possible and necessary to tie the calibration scale from successive nights together. Variations of this relatively faint asteroid were slow and of small amplitude, so the data points in the figure each represent the average of ten images. With the combination of short June nights and a long rotation period, even eight full nights of data were inadequate to completely fill in all phases of the folded lightcurve. Nonetheless, only one period was found to be consistent with the entire data set: 30.9 ± 0.2 h.

8887 Scheeres. Data were taken of this object on two successive nights in May 2006. This asteroid, like 2658 Gingerich, has a very short rotation period, so multiple cycles were observed each night, and an unambiguous period of 2.9827 ± 0.0017 h was determined. Color is used in the figure to distinguish data from successive

#	Name	Dates of observation	Data pts	Period (h)	P. error (h)	Est. amp. (mag)
1335	Demoulina	Jan 2006: 21-24,27,29-31	709	74.86	0.10	0.78
		Feb 2006: 7,8,12				
2658	Gingerich	Nov 2005: 20-21	282	2.9392	0.0011	0.39
		Jun 2007: 4,5,8-10	81	2.9415	0.0006	0.39
3091	van den Heuvel	Jun 2006: 15,17-23	469	30.9	0.2	0.30
8887	Scheeres	May 2006: 7-8	110	2.9827	0.0017	0.18
12168	5141 T-2	Jan 2007: 9,10,15-17	307	9.4071	0.0007	1.44

cycles within a single night.

(12168) 5141 T-2. Data were taken of this object on five nights in January 2007. A complete cycle could be observed each night, and an unambiguous period of 9.4071 ± 0.0007 h was determined. As can be seen in the plot, the first few hours of 16 January showed a small unexplained decrease in magnitude, but the event is less well covered than the 2658 Gingerich event, so definite conclusions cannot be drawn from it. Data from 16 January were omitted from the period fit. The amplitude of the average rotation was 1.44 mag, greater than all but two other well observed main belt object (see the catalog of Harris et al. 2007). The asteroid 1742 Schaifers has a period of 8.56 h and showed an amplitude of 1.46 mag (Binzel 1987), while 5247 Krylov is tumbling with periods of 68.5 and 81.5 hours and an amplitude of about 1.5 mag (Pravec et al. 2007).

Acknowledgements

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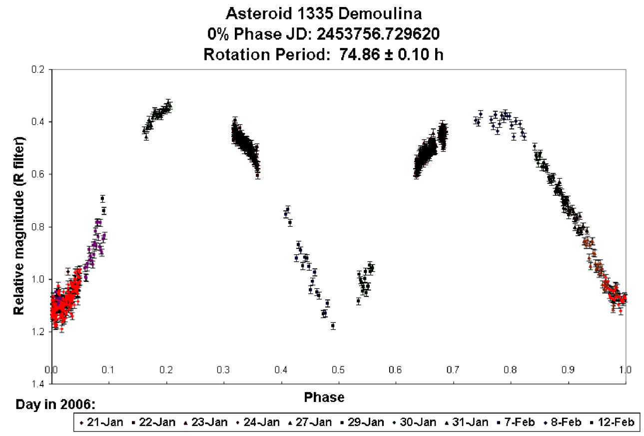

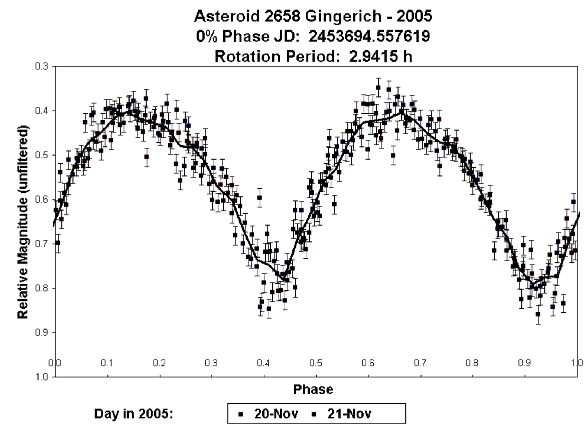

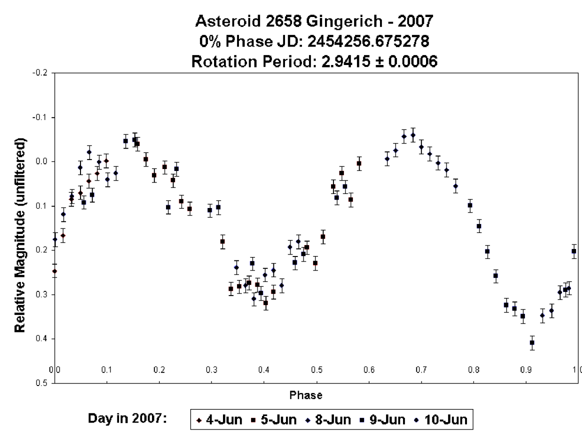

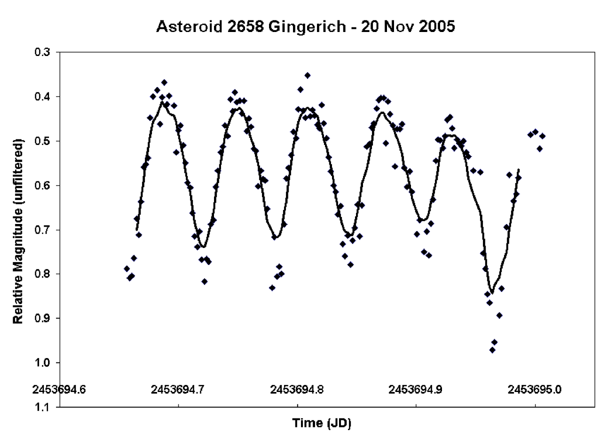

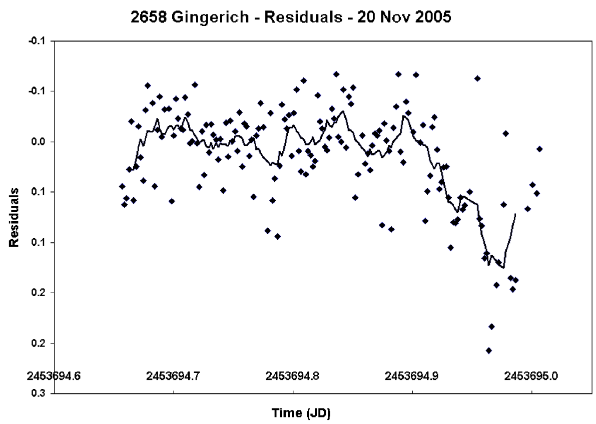

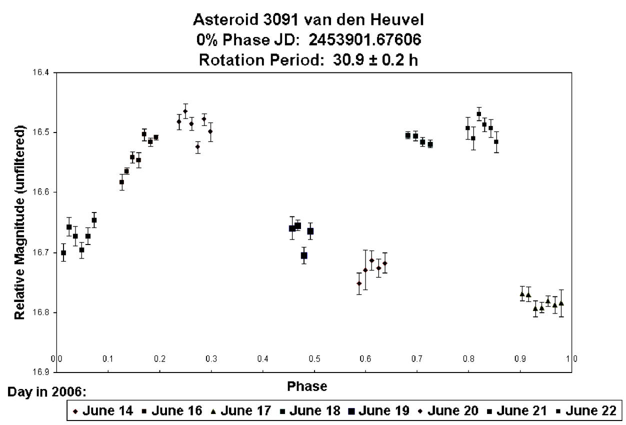

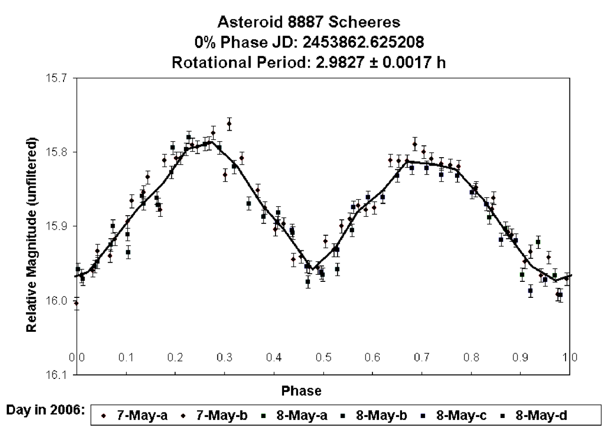

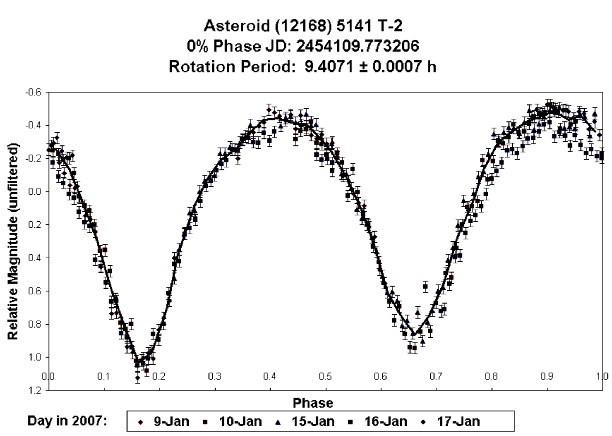

THE ROTATION PERIOD OF 3406 OMSK

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Minor planet 3406 Omsk was observed over six nights in May 2007. The synodic period was determined as 7.275 ± 0.006 hr. The peak to peak amplitude was approximately 0.28 magnitudes, implying an axial ratio (a/b) of 1.3.

Observations of this asteroid were conducted from two sites in Australia – Mt Tarana Observatory undertook unfiltered observations and Bagnall Beach Observatory observed in V band. All observations were light-time corrected. The aspect data (Table I) also shows the percentage of the light curve observed each night. Analysis was carried out using the "Peranso" software (Vanmunster, 2006), using various routines available including the "FALC" routine (based on Harris, et al, 1989).

The final analysis determined a synodic period of 7.275 ± 0.006 hours which was used to compile the composite light curve, with the arbitrary epoch of maximum at JD 2454231.60298. The peak to peak variation in the lightcurve implies an axial ratio (a/b) of 1.3 if we are observing at near-equatorial aspect. Full phase coverage was achieved and this is considered a secure result. At 3.3 rev/day Omsk is an average asteroid with regards to spin rate vs. size (Pravec et al 2002). The latest list of parameters (Harris & Warner, 2007) has no data for this asteroid.

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