

DETERMINING THE LIGHTCURVES AND ROTATION PERIODS OF FOUR MAIN-BELT ASTEROIDS

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Lightcurves and rotation periods were determined for the following four main-belt asteroids: 2854 Rawson: 4.775 ± 0.001 h, 5142 Okutama: 3.803 ± 0.001 h, (14362) 1988 MH: 3.645 ± 0.001 h, and 28248 Barthelemy: 3.128 ± 0.002 h.

This research was conducted in order to determine the rotation period of four main belt asteroids: 2854 Rawson, 5142 Okutama, (14362) 1988 MH, and 28248 Barthelemy. Photometric data were taken over the course of several nights; the resulting magnitudes were then plotted versus time to create lightcurves and analyzed to determine the asteroid's rotation period. Asteroids were chosen based on apparent magnitude, declination, and opposition date. To maximize the amount of data obtained each night, asteroids at or near opposition were chosen; additionally, these asteroids needed a magnitude of 16 or brighter for an optimal signal to noise ratio and have positive declinations because the telescope used was located in the northern hemisphere.

Asteroid 2854 Rawson was discovered by D. McLeish at the Argentine National Observatory in Córdoba in 1964. It has an orbital eccentricity of 0.123 and a semi-major axis of 2.21 AU (JPL, 2023). Asteroid 5142 Okutama was discovered by T. Hioki and S. Hayakawa at Okutama in 1990. It has an orbital eccentricity of 0.277 and a semi-major axis of 2.54 AU (JPL, 2023). Asteroid (14362) 1988 MH was discovered by E.F. Helin at the Palomar Observatory in 1988. It has an orbital eccentricity of 0.192 and a semi-major axis of 2.60 AU (JPL, 2023). Asteroid 28248 Barthelemy was discovered by the OCA-DLR Asteroid Survey (ODAS) at the CERGA Observatory in Caussols in 1999. It has an orbital eccentricity of 0.212 and a semi-major axis of 2.60 AU (JPL, 2023).

Method

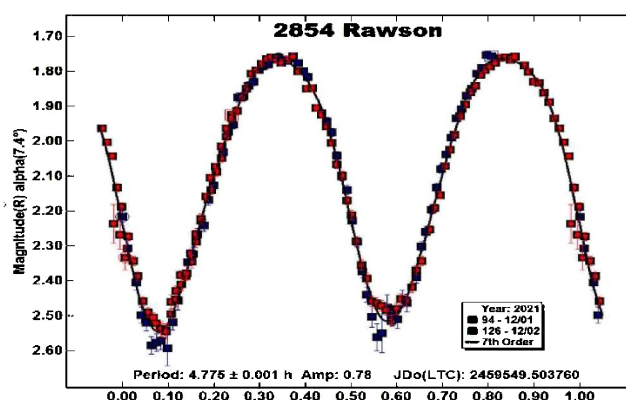
The telescope used to obtain the data is located at the Texas A&M University-Commerce Observatory in Commerce, Texas at latitude 33°N. It is a 0.7-m CDK 700 Planewave telescope equipped with an Andor iKon-XL CCD Camera. To reduce background noise, the camera was thermoelectrically cooled between -40°C and -60°C.

Flats, bias, and dark calibration images were taken each night in order to calibrate the images. Flat field images were taken against the twilight sky and exposed for gradually increasing amounts of time, and darks were exposed for three minutes, which is the same exposure time as the light images. All images were taken through a luminance filter which blocks the infrared and UV, therefore allowing only the visible light to be captured by the camera.

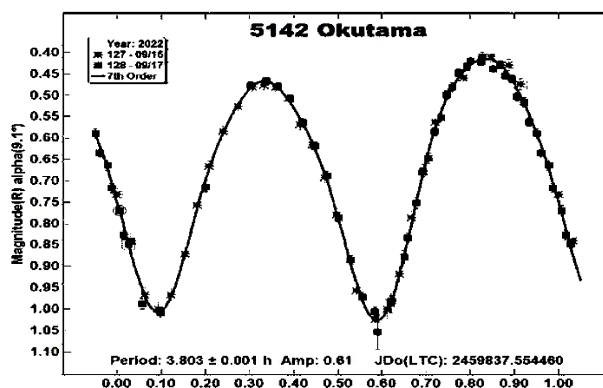
Light images were calibrated and aligned using *Maxim DL* software (Diffraction Limited). Then, photometry on each image was performed using *MPO Canopus* v.10.8.1.1 (Warner, 2019). Five comparison stars along with the asteroid were selected and aperture photometry was used to measure the brightness of the comparison stars and the asteroid. These data were then used to find the average difference in magnitude between the comparison stars and the asteroid for every image and plotted versus time to produce a lightcurve. If the asteroid passed close to a star, these data were deleted from the lightcurve, and a Fourier transform was also applied to the lightcurve to determine the rotation period and associated error in the period.

Results

2854 Rawson. Asteroid 2854 Rawson was imaged on 2021 December 1 for 86 times and on 2021 December 2 for 110 times. A rotation period of 4.775 ± 0.001 h with an amplitude variance of 0.78 mag was found. Black et al. (2016) found a similar period of 4.7755 ± 0.0003 h with an amplitude of 0.63 mag. Durech et al. (2019) found a similar period of 4.775587 ± 0.000002 h.



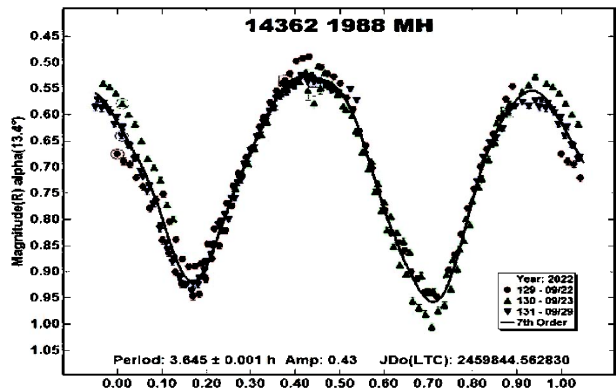
5142 Okutama. Asteroid 5142 Okutama was imaged on 2022 September 15 for 60 times and on 2022 September 17 for 100 times. A rotation period of 3.803 ± 0.001 h with an amplitude variance of 0.61 mag was found. Ditteon and Hawkins (2007) found the same period of 3.803 ± 0.001 h with an amplitude of 0.27 mag.



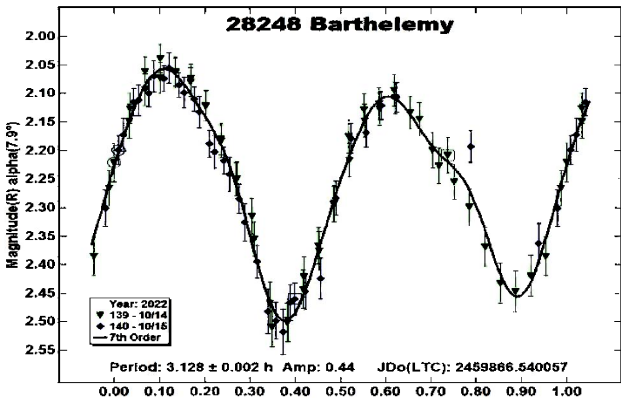
Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.
2854	Rawson	2021 12/01-12/02	7.86	259.4	-1.9	4.775	0.001	0.78	0.02
5142	Okutama	2022 09/15-09/17	10.13	132.9	-5.4	3.803	0.001	0.61	0.01
14362	1988 MH	2022 09/22-09/29	15.83	97.4	5.3	3.645	0.001	0.43	0.02
28248	Barthelemy	2022 10/14-10/15	8.44	120.6	1.1	3.128	0.002	0.44	0.04

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

(14362) 1988 MH. Asteroid (14362) 1988 MH was imaged on 2022 September 22 for 100 times, on 2022 September 23 for 100 times, and on 2022 September 29 for 100 times. A rotation period of 3.645 ± 0.001 h with an amplitude variance of 0.43 mag was found. Behrend (2001web) found a similar period of 3.639 ± 0.002 h with an amplitude of 0.44 mag. Durech and Hanus (2018) found a similar period of 3.64387 ± 0.00002 h.



28248 Barthelemy. Asteroid 28248 Barthelemy was imaged on 2022 October 14 for 100 times and on 2022 October 15 for 100 times. A rotation period of 3.128 ± 0.002 h with an amplitude variance of 0.44 mag was found. No previous studies regarding the rotation period were found in either the JPL Small-Body Database (NASA, n.d.) or the Minor Planet Light Curve Database (Warner et al., 2009).



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