

LIGHTCURVES FOR TEN MINOR PLANETS

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Photometric measurements were made for 10 main-belt asteroids, based on CCD observations made from 2023 January through 2023 February. Phased lightcurves were created for seven asteroids, while three did not yield period solutions. All the data have been submitted to the ALCDEF database.

CCD photometric observations of 10 main-belt asteroids were performed at Command Module Observatory (MPC V02) in Tempe, AZ. Images were taken using a 0.32-m f/6.7 Modified Dall-Kirkham telescope, SBIG STXL-6303 CCD camera, and a ‘clear’ glass filter. Exposure time for all the images was 2 minutes. The image scale after 2×2 binning was 1.76 arcsec/pixel. Table I shows the observing circumstances and results. All of the images for these asteroids were obtained between 2023 January and 2023 February.

Images were calibrated using a dozen bias, dark, and flat frames. Flat-field images were made using an electroluminescent panel. Image calibration and alignment was performed using MaxIm DL software.

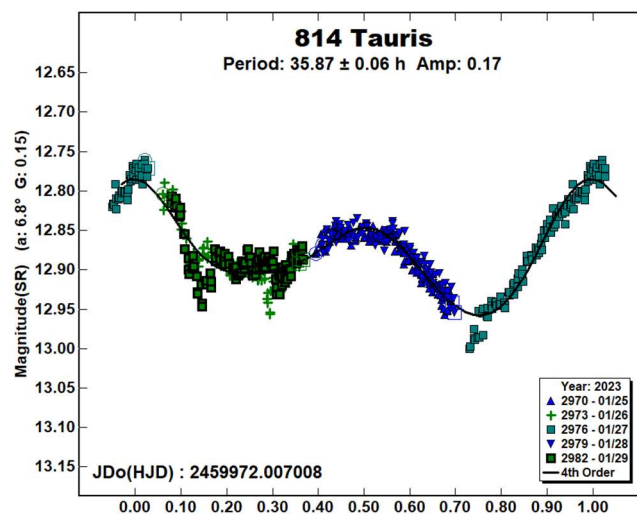
The data reduction and period analysis were done using *MPO Canopus* (Warner, 2023). The 45′×30′ field of the CCD typically enables the use of the same field center for three consecutive nights. In these fields, the asteroid and three to five comparison stars were measured. Comparison stars were selected with colors within the range of $0.5 < B-V < 0.95$ to correspond with color ranges of asteroids. In order to reduce the internal scatter in the data, the brightest stars of appropriate color that had peak ADU counts below the range where chip response becomes nonlinear were selected. *MPO Canopus* plots instrumental vs. catalog magnitudes for solar-colored stars, which is useful for selecting comp stars of suitable color and brightness.

Since the sensitivity of the KAF-6303 chip peaks in the red, the clear-filtered images were reduced to Sloan r' to minimize error with respect to a color term. Comparison star magnitudes were obtained from the ATLAS catalog (Tonry et al., 2018), which is incorporated directly into *MPO Canopus*. The ATLAS catalog derives Sloan $griz$ magnitudes using a number of available catalogs. The consistency of the ATLAS comp star magnitudes and color-indices allowed the separate nightly runs to be linked often with no zero-point offset required or shifts of only a few hundredths of a magnitude in a series.

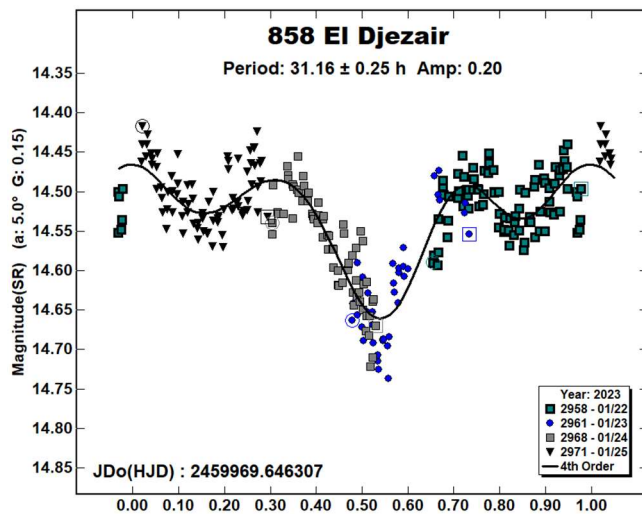
A 9-pixel (16 arcsec) diameter measuring aperture was used for asteroids and comp stars. It was typically necessary to employ star subtraction to remove contamination by field stars. For the asteroids described here, I note the RMS scatter on the phased lightcurves, which gives an indication of the overall data quality including errors from the calibration of the frames, measurement of the comp stars, the asteroid itself, and the period-fit. Period determination was done using the *MPO Canopus* Fourier-type FALC fitting method (cf. Harris et al., 1989). Phased lightcurves show the maximum at phase zero. Magnitudes in these plots are apparent and scaled by *MPO Canopus* to the first night. In cases where rotation periods could not be determined, raw lightcurves are presented, with “RAW” appearing in the upper right-hand corner of the plots.

Asteroids were selected from the CALL website (Warner, 2011), either for having uncertain periods or for needing more lightcurves for shape modeling. In this set of observations, 2 of the 10 asteroids had $U = 1$, 6 were rated as $U = 2$, and 2 had $U = 3$. The Asteroid Lightcurve Database (LCDB; Warner et al., 2009) was consulted to locate previously published results. All the new data for these asteroids can be found in the ALCDEF database.

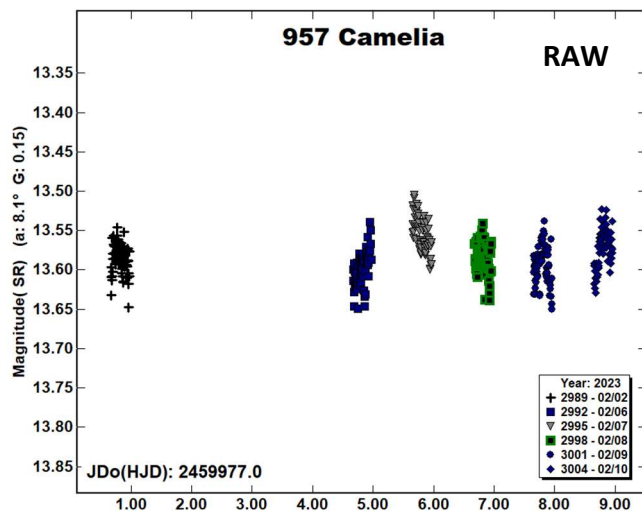
814 Tauris was discovered in 1916 by Grigory Neujmin at Simeis in 1883. It lies in a highly eccentric and inclined orbit. Recent published rotation periods include Alkema (2013), 35.8 ± 0.1 h; Behrend (2020web), 18.030 ± 0.002 h; and Colazo et al. (2022a), 36.081 ± 0.008 h. During five nights, 573 data points were gathered to determine a period of 35.87 ± 0.06 h, agreeing with previous values. The amplitude of the lightcurve is 0.17 ± 0.015 mag.



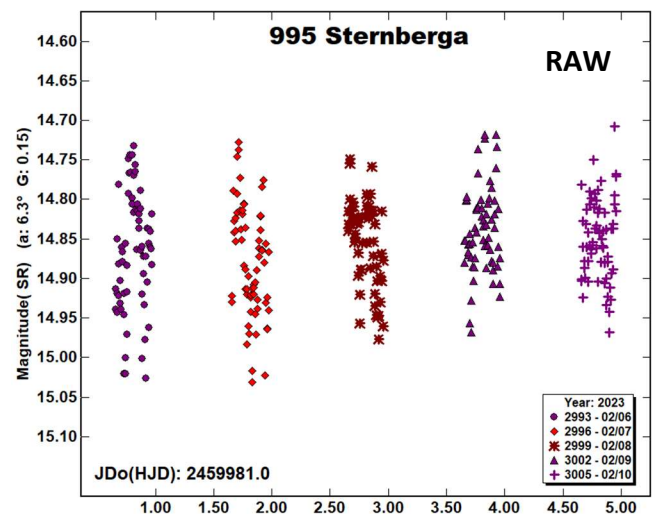
858 El Djézair is an outer main-belt asteroid, discovered by Frédéric Sy in 1916 at Algiers. Several disparate periods have been published. They include Warner (2005), 22.31 ± 0.2 h; Polakis (2019), 14.830 ± 0.015 h; Colazo et al. (2021), 33.525 ± 0.013 h; and Dose (2022), 29.639 ± 0.003 h. A total of 271 images were taken in four nights, producing a period of 31.16 ± 0.25 h, in rough agreement with Colazo’s and Dose’s results. The amplitude is 0.20 ± 0.032 mag.



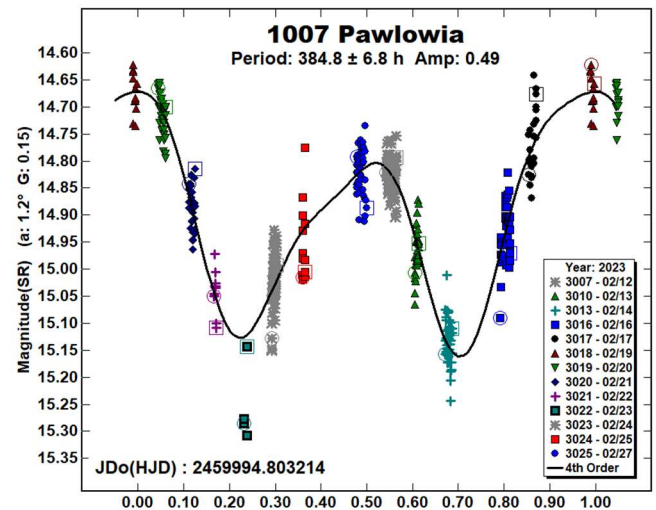
957 Camelia was discovered by Karl Reinmuth in 1921 from Heidelberg. Again, there is no consensus on the period. Warner (2001) shows a period of 5.391 ± 0.02 h, while Polakis (2022) computed 85.05 ± 0.11 h. During six nights, 380 images were taken, but no period solution was obtained. The raw lightcurve is presented.



995 Sternberga was discovered by Sergey Belyavskij at Simeis in 1923. Several period solutions appear in the literature. Stephens (2013) obtained 14.612 ± 0.001 h, Marciniak et al. (2018) shows 11.198 ± 0.002 h, and Colazo et al. (2022b) published a period of 22.392 ± 0.006 h. A total of 319 images were gathered in five nights. As shown, the raw lightcurve was flat, so no further imaging was done, as a period solution could not be determined.



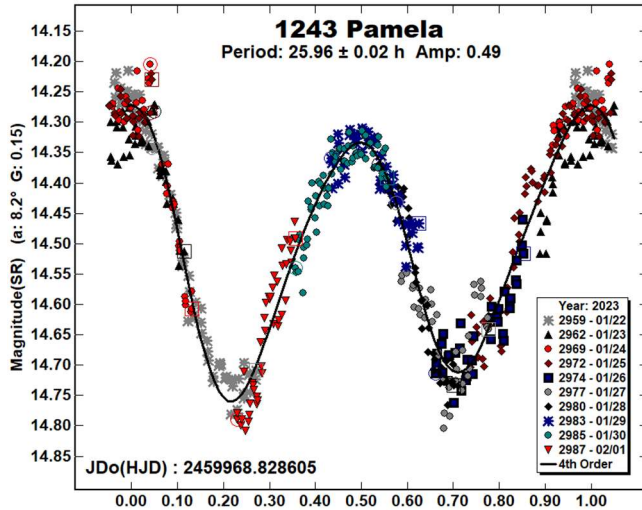
1007 Pawlowia is an outer main-belt asteroid, discovered by Vladimir Albitzkij in 1923 at Simeis. Clark (2006) computed a period of 8.23 h, while Fauerbach and Nelson (2019) published a value of 121 ± 3 h. The slow rotation of the target required 13 nights of observation, during which 435 images were obtained. The rotation period of 384.8 ± 6.8 h disagrees with previous assessments. The amplitude is 0.49 mag, with an RMS error of 0.045 mag.



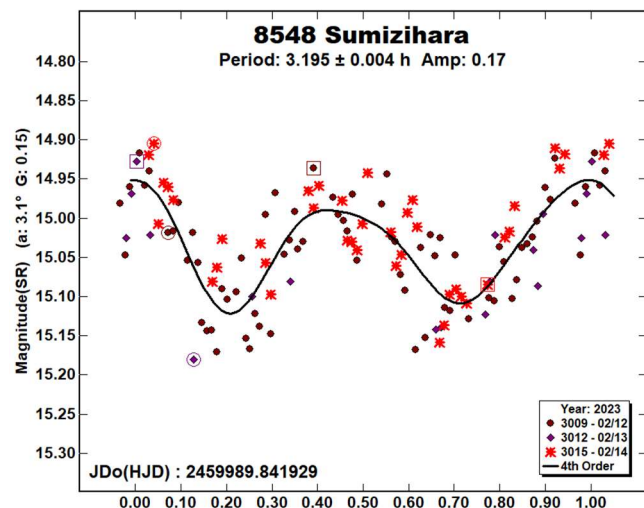
1243 Pamela. This minor planet was discovered by Cyril Jackson at Johannesburg in 1932. There is good agreement in the period solutions in the LCDB. Garceran et al. (2016) computed 26.00 ± 0.01 h and Polakis (2022) shows 26.01 ± 0.02 h. A total of 517 images were taken during 10 nights, and a rotation period of 25.96 ± 0.02 h was computed. The amplitude of the lightcurve is 0.49 ± 0.038 mag.

Number	Name	yy/mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
814	Tauris	23/01/25-01/29	6.8, 7.9	113	13	35.87	0.06	0.17	0.02	MB-O
858	El Djezair	23/01/22-01/25	5.0, 5.9	112	8	31.16	0.25	0.20	0.03	MB-O
957	Camelia	23/02/02-02/10	8.1, 8.4	135	-19	--	--	--	--	MB-O
995	Sternberga	23/02/06-02/10	6.3, 6.6	135	-16	--	--	--	--	MB-M
1007	Pawlowia	23/02/12-02/27	1.2, 7.4	140	-1	384.8	6.8	0.49	0.05	MB-O
1243	Pamela	23/01/22-02/01	8.1, 10.9	100	-10	25.96	0.02	0.49	0.04	MB-O
1478	Vihuri	23/01/22-01/23	5.3, 5.8	113	4	--	--	--	--	MB-I
2089	Cetacea	23/01/26-02/10	5.3, 8.7	125	9	206.6	0.2	0.79	0.05	MB-I
2545	Verbiest	23/02/12-02/14	2.3, 1.1	147	-1	10.064	0.027	0.13	0.03	FLOR
8548	Sumizihara	23/02/12-02/14	3.1, 1.9	147	1	3.195	0.004	0.17	0.05	MB-I

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).



8548 Sumizihara. This inner-belt asteroid was discovered by Kin Endate and Kazuro Watanabe in 1994 at Kitame. The target is in a highly eccentric orbit, and its 2023 opposition was near favorably placed near perihelion. Waszczak et al. (2015) published a period of 3.192 ± 0.0006 h. During three nights, 124 images were used to calculate a synodic period of 3.195 ± 0.004 h, in agreement with the previous solution. The amplitude of the lightcurve is 0.17 mag, with an RMS error of 0.045 mag.



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