LIGHTCURVE AND ROTATION PERIOD ANALYSIS OF 4226 DAMIAAN AND (25242) 1998 UH15

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Photometric observations of two main-belt asteroids were obtained between 2023 July 7 and 2021 October 3. The following rotational periods were determined: 4226 Damiaan, 32.639 ± 0.005 h; (25242) 1998 UH15, 7.869 ± 0.002 h. Images were obtained from observatories around the globe. Several of the co-authors used their own equipment while others used the Las Cumbres Observatory facilities.

Photometry and period determination were carried out using *TychoTracker Pro* Version 10.7.5. (TT), easily performing both functions. Photometric analysis was done using standard differential techniques on images. The TT software has the facility to allow the user to choose comparison stars, for which the default color range of +0.50 < (B-V) < +0.90 was employed. The Carlsberg Meridian Catalog (CMC15) catalog was used as the source of reference stars for 4226 Damiaan, whereas the UCAC4 magnitude database was used as the reference catalog for photometry of (25242) 1998 UH15. TT's period determination operates by finding model light curves - comprising a user-defined number of Fourier components which best fit the asteroid photometric data. The program lists the candidate periods found within a user-defined period range and sampling frequency, based on minimizing Root Mean Square Errors (RMSE), i.e., using the difference between modelled and photometric magnitudes. The candidate periods are listed in increasing RMSE value and the entire suite of RMSE values is plotted as a "periodogram" for quality control.

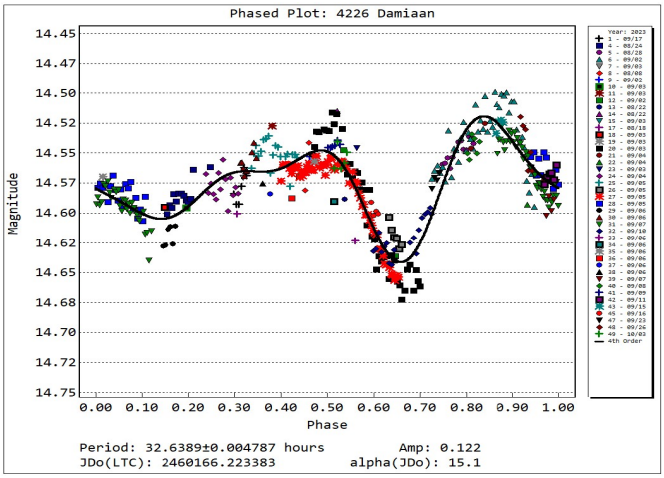
In these periodograms, both objects yielded clear 'best-fit' period solutions having well-defined 'stalactites' as shown in the following Figures. 4226 Damiaan (1989 RE) has a previously published rotation period of approximately 24 hours (Behrend, 2004web), but this value has been assigned an quality value of U = 1, i.e., it is unlikely to be correct. The period reported in this work is very different to that previously published online.

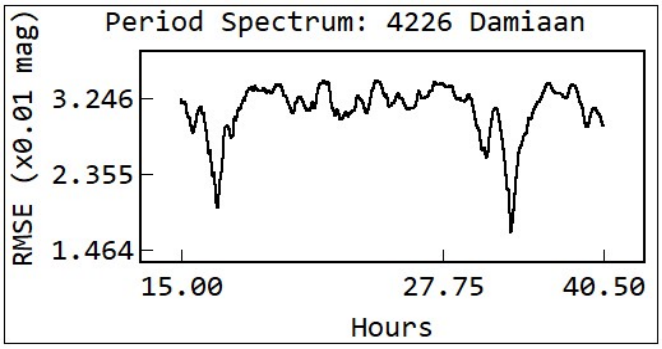
Periodograms often exhibit several possible candidate periods, in which case an examination of the rotational phase plot for each of these is then conducted looking for a credible lightcurve. Where the object shape is the dominant factor in producing the observed magnitude changes (typically having lightcurve amplitudes of >0.2 mag), the rotational phase plot often has two peaks and two troughs (bimodal) and this is usually chosen as the most likely for such asteroids.

In this paper, there is no attempt to find an absolute magnitude for any of the asteroids and a value of G = 0.15 has been used throughout the calculations. Time-series from different nights and observing locations using a variety of imaging equipment were offset in magnitude to bring them into alignment when producing the raw and rotational-phase plots. The same offset was used for each instance of an individual imaging setup. When this paper is accepted for publication all the observations will be loaded into the ALCDEF database. Some individual datapoints have been combined by stacking during period analysis to improve the signal-to-noise ratio.

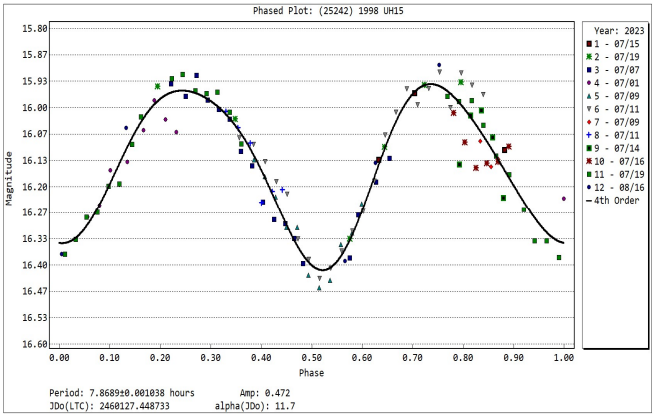
The results are summarized in Table I. Column 3 gives the span of dates over which the observations were made. Column 4 is the range of phase angles for each date range; if this is preceded by an asterisk, the asteroid passed through opposition during the observing period. Columns 5 and 6 give the range of values for the Phase Angle Bisector (PAB) longitude and latitude respectively. Column 7 gives the period and Column 8 the minimum possible formal error in hours given by *TychoTracker Pro*. Columns 9 and 10 give the amplitude and its associated uncertainty in magnitude. Dips in the results from the period analysis have been checked to see if they are monomodal or bimodal and bimodal periods have been chosen for the best-fit period for each asteroid. Information given below for each of the objects is taken from the JPL Small-Body Database Lookup webpage.

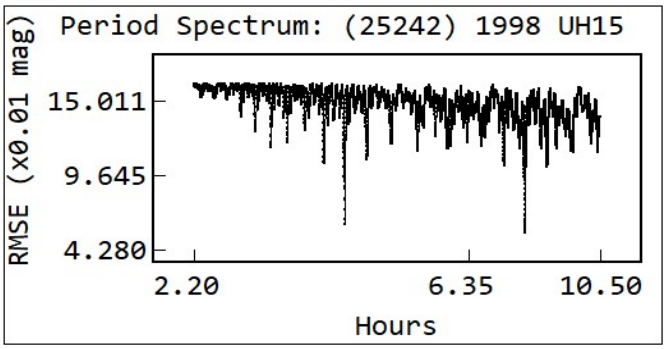
4226 Damiaan is an outer main-belt asteroid that was discovered on 1989 September 1 by Eric W. Elst at Haute Provence, France. It has approximate diameter of 31 km. Behrend (2004web) from observations by Laurent Bernasconi suggested a rotation period of 24 h based on a very fragmentary partial lightcurve. The lightcurve period and amplitude results reported here are based on 49 observing sessions (a total of 2451 exposures) during 2023 July - October (32.639 ± 0.005 h, 0.12 ± 0.02 mag).





(25242) 1998 UH15 is a member of the Eunomia family. It was discovered on 1998 October 20 by R.G. Davis from Granville, MA, USA. It is a relatively small object having an approximate diameter of 5 km. No previously published rotation period has been found. Lightcurve period and amplitude results from 12 sessions (529 exposures) are reported for 2023 July - August (7.869 ± 0.002 h, 0.47 ± 0.04 mag).





Acknowledgements

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Observatory	Telescope	CCD/ CMOS	Filter	Asteroid (Sessions)
Old Orchard (Z09, Hawley)	0.25-m *f*/10 SCT	SX694 Trius Pro (2×2)	SG/SR	4226 (12) 25242 (5)
University of Utah, Tooele (718, Wiggins)	0.35-m *f*/5.5 SCT	ST-10XME (3×3)	C	4226 (11) 25242 (4)
Farm Cove (E85, McCormick)	0.35-m *f*/10 SCT	ST-8XME (2×2)	C	4226 (1)
Siding Spring LCO-A (Q63, Miles)	1.0-m *f*/8	Sinistro (1×1)	SR	4226 (11)
Siding Spring Faulkes Telescope South (E10, Miles)	2.0-m *f*/10	Spectral (2×2)	SR/V	4226 (18) 25242 (3)
Siding Spring LCO-B (Q64, Miles)	1.0-m *f*/8	Sinistro (1×1)	SR/V	4226 (5)
Sutherland LCO-A (K91, Miles)	1.0-m *f*/8	Sinistro (1×1)	SR	4226 (1)
Sutherland LCO-C (K93, Miles)	1.0-m *f*/8	Sinistro (1×1)	SR	4226 (1)
McDonald LCO-A (V37, Miles)	1.0-m *f*/8	Sinistro (1×1)	SR/V	4226 (3)
McDonald LCO Aqawan A #1 (V38, Miles)	0.4-m *f*/8	SBIG STL6303 (1×1)	SR	4226 (2)
16.5402 East 38.7655 North (247, Dawson)	0.5-m *f*/3.76 Newtonian	Apogee U9000 (1×1)	C	4226 (1)
Organ Mesa Las Cruces (G50, Pilcher)	0.35-m *f*/10 SCT	SBIG STL-1001E (1×1)	C	4226 (3)

Table II. The first three columns are the observers, equipment used, and filters (Sx = Sloan; C = clear or unfiltered). The fourth column is the number of the asteroid observed and, in parentheses, the number of sessions for that asteroid.

Number	Name	yyyy mm/dd	Phase	L_{PAB}	B_{PAB}	Period (h)	P.E.	Amp	A.E.	Grp
4226	Damiaan	2023 07/26-10/03	*3.6,15.1	344	6	32.639	0.005	0.121	0.015	9106
25242	1998 UH15	2023 07/07-08/16	11.3,20.6	286	19	7.869	0.002	0.470	0.044	502

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 a minimum 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).