

LIGHTCURVE ANALYSIS OF ASTEROID 2999 DANTE

Caroline Odden, Claire Cahill, Nishani Clarke,
Isabella Clemmons, Ethan Gerakaris, Yihao Huang, Fred Javier,
Davin Jeong, Stewart Kristiansen, Lauren Lee, Jeremy Lin,
Mason McCormack, Emily Mae Murtha, Marah Quran,
Lexiana Tucci, Olha Yarynich, Ki Zhang
Phillips Academy Observatory (MPC I12)
180 Main Street
Andover, MA 01810 USA
ceodden@andover.edu

Jonathan Kemp
Middlebury College
Mittelman Observatory
Middlebury, VT 05753 USA

(Received: 2022 July 14)

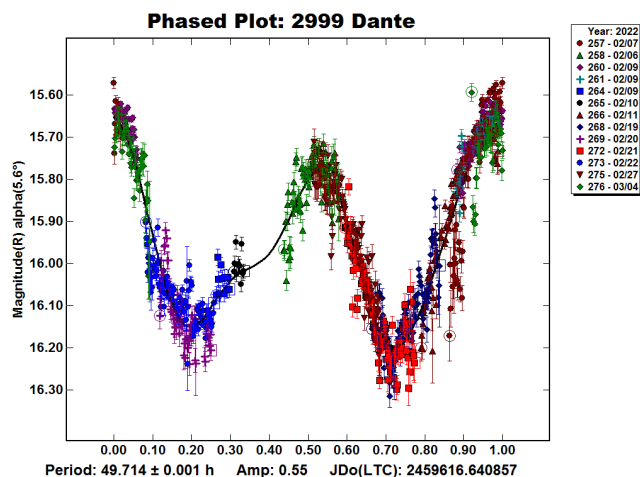
Photometric measurements were conducted on asteroid 2999 Dante from the Phillips Academy Observatory (PAO), the Mittelman Observatory, and the iTelescope T18 Observatory from 2022 February 06 to March 04. The rotational period and amplitude were determined to be 49.714 ± 0.001 h and 0.55 ± 0.05 mag.

Asteroid 2999 Dante was chosen from the CALL website. Observations were mostly made from the Phillips Academy Observatory (PAO), located in Andover, Massachusetts. Observations from PAO were made with a 0.50-m f/6.8 Corrected Dall-Kirkham (CDK) Astrograph telescope manufactured by PlaneWave Instruments and an FLI ProLine 4240 Camera with a 2048×2048 array of 13.5-micron pixels cooled to a temperature of -40°C . The resulting image scale was 0.81 arcseconds per pixel. 300 second exposures were taken through a luminance filter. Exposures were unbinned and unguided. All images were corrected using dark frames, flat-fields, and bias frames using *AstroImageJ* Software v.3.2.21 (Collins et al., 2017). Observations from the Phillips Academy Observatory were supplemented with a data set from the iTelescope T18 telescope in Nerpio, Spain as well as a data set from the Mittelman Observatory at New Mexico Skies. Detailed information about the additional observatory sites used are listed in the table below.

Site	Telescope	Camera	Sessions
Mittelman Observatory	PlaneWave CDK20 0.50-m f/6.8	SBIG STX (KAF-16803)	2022 February 9 (session 260)
iTelescope T18 Astrocamp	PlaneWave CDK12 0.32-m f/8.0	SBIG STL-6303E	2022 February 9 (sessions 264,265)

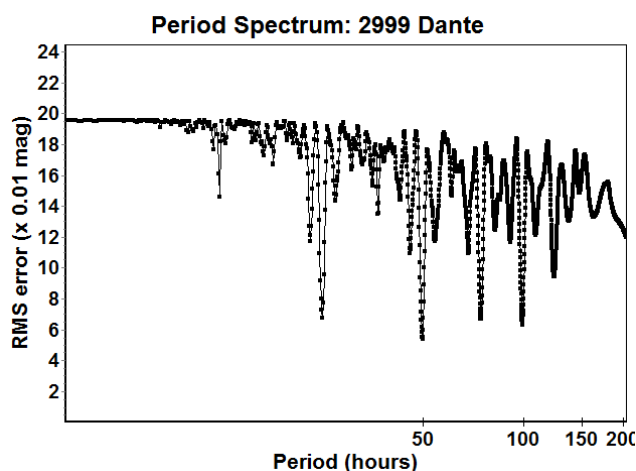
MPO Canopus (Warner, 2018) was used to make photometric measurements of the images using differential photometry as well as to generate the final lightcurves. Comparison stars were chosen to have near solar-color, a B-V value close to 0.8, and a V-R value close to 0.45 (Warner, 2012). Data merging and period analysis were done with *MPO Canopus* using the Fourier Analysis for Lightcurves (FALC) algorithm developed by Alan Harris (Harris et al., 1989) and modified by Petr Pravec (Warner, 2012). The research was conducted for the Astronomy Research course at Phillips Academy, a high school in Andover, Massachusetts.

2999 Dante was discovered on 1981 February 6 by Norman G. Thomas at Lowell Observatory in Flagstaff, Arizona (JPL, 2022). The Asteroid Lightcurve Database (LCDB; Warner et al., 2009) did not have any recorded rotational period. Over the course of 11 nights between 2022 February 06 and 2022 March 04, 979 data points were collected. These data points fit a rotational period of 49.714 ± 0.01 h with amplitude 0.55 ± 0.05 mag. Since Dante is a very slow rotator with a period close to twice the rotational period of the Earth, multiple sessions of images across different nights were required to obtain full coverage of the lightcurve. Images were taken from different observatory sites to further increase the coverage of the lightcurve. In spite of a dedicated campaign involving three different observatories, complete coverage could not be achieved due to moon placement and weather. Regardless, a bimodal solution with a period of $P = 49.714 \pm 0.001$ h is favored. The period spectrum is included along with the phased plot.



Number	Name	yyyy mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
2999	Dante	2022 02/06-03/04	5.5, 15.3	137.9	9	49.714	0.001	0.55	0.05	MB-M

Table 1. 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).



Acknowledgements

Research at the Phillips Academy Observatory is supported by the Israel Family Foundation. Funding for the FLI camera and PlaneWave telescope at Phillips Academy was provided by the Abbot Academy Association and the Donald T. Ganem Fund. This work includes observations obtained with the Mittelman Observatories 0.5-m telescope at New Mexico Skies in Mayhill, New Mexico.

References

- CALL: Potential Lightcurve Targets (with LCDB data) Query. http://www.minorplanet.info/PHP/call_OppLCDBQuery.php
- Collins, K.A.; Kielkopf, J.F.; Stasson, K.G.; Hessman, F.V. (2017). "ASTROIMAGEJ: Image processing and photometric extraction for ultra-precise astronomical light curves." *Astron. J.* **152**:77, 13pp. AstroImageJ, v.3.2.21. <http://www.astro.louisville.edu/software/astroimagej/>
- Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57**, 251-258.
- Harris, A.W.; Young, J.W.; Bowell, E.; Martin, L.J.; Millis, R.L.; Poutanen, M.; Scaltriti, F.; Zappala, V.; Schober, H.J.; Debehogne, H.; Zeigler, K. (1989). "Photoelectric Observations of Asteroids 3, 24, 60, 261, and 863." *Icarus* **77**, 171-186.
- JPL (2022). Small Body Database Browser. <http://ssd.jpl.nasa.gov/sbdb.cgi>
- Warner, B.D.; Harris, A.W.; Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2021 Dec. <http://www.minorplanet.info/lightcurvedatabase.html>
- Warner, B.D. (2012). The MPO Users Guide: A Companion Guide to the MPO Canopus/PhotoRed Reference Manuals. BDW Publishing, Colorado Springs, CO.
- Warner, B.D. (2018). MPO Software, *MPO Canopus* v10.7.12.2. Bdw Publishing. <http://bdwpublishing.com>

LIGHTCURVE ANALYSIS OF ASTEROID 5889 MICKIEWICZ

Caroline Odden, Claire Cahill, Victoria Darling, Anna Du,
Nicholas von Eckartsberg, Ethan Gerakaris, Jessica He, Yifei Jin,
Jeremy Lin, Mason McCormack, Brooklyn Reagan, Xinkai Shen
Phillips Academy Observatory (MPC I12)
180 Main Street
Andover, MA 01810 USA
ceodden@andover.edu

(Received: 2022 July 14)

Photometric observations of asteroid 5889 Mickiewicz were performed at the Phillips Academy Observatory (PAO) from 2022 April 30 to May 26. The rotational period and amplitude were determined to be: $P = 6.141 \pm 0.001$ h, $A = 0.51 \pm 0.05$ mag.

CCD photometric observations of the asteroids were made from the Phillips Academy Observatory. The asteroids were chosen from the CALL website. All observations were made with a 0.50-m $f/6.8$ Corrected Dall-Kirkham (CDK) Astrograph telescope manufactured by PlaneWave Instruments and an Andor Tech iKon DW436 CCD camera with a 2048×2048 array of 13.5-micron pixels. The resulting image scale was 0.81 arcseconds per pixel. All images were corrected using dark frames, flat-fields, and bias frames using *AstroImageJ* software (Collins et al., 2017). All exposures were taken through a luminance filter at -50°C and were unbinned. Exposures were 300 s in length and unguided.

MPO Canopus (Warner, 2018) was used to make photometric measurements of the images using differential photometry as well as to generate the final lightcurves. Comparison stars were chosen to have near solar-color, a B-V value close to 0.8, and a V-R value close to 0.45 (Warner, 2012). In addition, brighter comparison stars were favored. Data merging and period analysis were done with *MPO Canopus* using the Fourier Analysis for Lightcurves (FALC) algorithm developed by Alan Harris (Harris et al., 1989) and modified by Petr Pravec (Warner, 2012). The research was conducted for the Astronomy Research course at Phillips Academy, a high school in Andover, Massachusetts.

5889 Mickiewicz was discovered by N. S. Chernykh at Nauchnyj on 1979 March 31. In the Asteroid Lightcurve Database (LCDB; Warner et al., 2009), there are two observed periods: $P = 6.14148 \pm 0.00002$ (Durech et al., 2019) with no lightcurve and quality code U, and $P = 6.1412 \pm 0.0543$, $A=0.37$ (Ergashev et al., 2019) with quality code value 3-.

Data were collected from 2022 April 20 to 2022 May 26, with a total of 295 data points included in the plot. Double coverage for the entire period is presented. Note that a portion of the session from 10 March 2022 appears to deviate from the typical behavior. Inspection of the original images did not reveal any abnormality. Finding no justification for removing this data, the authors have left it in. The period spectrum shows several favorable solutions, but the bimodal solution $P = 6.141$ h is most likely given the amplitude (Harris et al. 2014). This result corresponds with the previously reported periods.