Fixing the period at that value and letting all other parameters vary results in the best-fit lightcurve shown in the bottom panel of Figure 1. The relatively low amplitude of the lightcurve, 0.07 mag, is similar to that of 5261 Eureka and suggests either that the asteroid shape is axially (or spherically) symmetric or that the asteroid presented a pole-on aspect during the observations.

The periodogram for DH47 (Figure 2, top panel) indicates a most likely rotation period of P = 3.97 h. Adopting this as our nominal solution for the asteroid, we obtain the lightcurve shown in the bottom panel, which has an amplitude of 0.58 mag and achieves a goodness-of-fit of $\chi^2 = 1.3$. Adopting the period corresponding to the second highest peak in the periodogram, P = 2.2 h, results in a poorer fit with $\chi^2 \cong 7$. Assuming that the periodogram power for the true period must be higher than the peak power for this (incorrect) value, we conclude that the rotational period lies in the range 3.2-4.8 h.

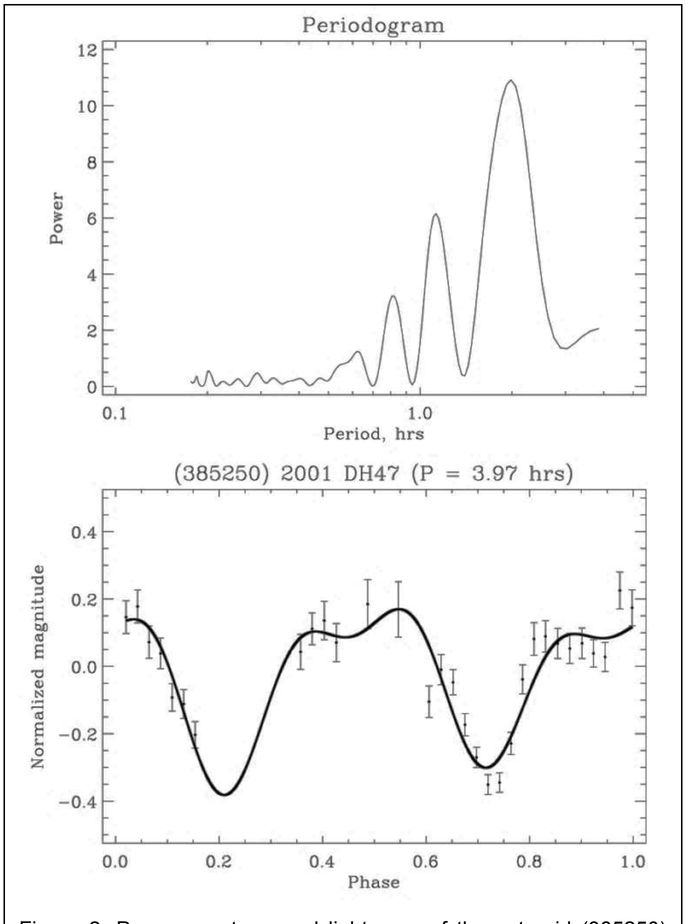


Figure 2. Power spectrum and lightcurve of the asteroid (385250) 2001 DH47.

We assign to both period determinations a quality code U = 2 (Warner *et al*., 2009) since it is unlikely that our nominal estimates are off by a factor of 2 or more.

Acknowledgments

This research was supported by Grant ST/M000834/1 from the UK Science and Technology Facilities Council. The authors gratefully acknowledge observing grant support from the Institute of Astronomy and Rozhen National Astronomical Observatory, Bulgarian Academy of Sciences and Chilean Time Allocation Committee (CNTAC). This research is based in part on observations and data collected at the 2-m RCC telescope at Rozhen National Astronomical Observatory and at Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatory (Project ID: CHILE-15B-FT01, PI: AAC), which is operated by the Association of Universities for Research in Astronomy (AURA) under a cooperative agreement with the National Science Foundation. This research has also made use of the NASA Exoplanet Archive, which is operated by the California Institute of Technology under contract with the National Aeronautics and Space Administration under the Exoplanet Exploration Program. Astronomical research at the Armagh Observatory is funded by the Northern Ireland Department of Culture, Arts and Leisure.

References

Christou, A.A. (2013). "Orbital clustering of Martian Trojans: An asteroid family in the inner solar system?" *Icarus* **224**, 144-153.

Ćuk, M., Christou, A.A., Hamilton, D.P. (2015). "The Yarkovsky-driven spreading of the Eureka family of Mars Trojans." *Icarus* **252**, 339-346.

de la Fuente Marcos, C., de la Fuente Marcos, R. (2013). "Three new stable L5 Martian Trojans." *MNRAS* **432**, 31-35.

Koehn B.W., Bowell, E.G., Skiff, B.A., Sanborn, J., McLelland, K.P., Pravec, P., Warner, B.D. (2014). "Lowell Observatory Near-Earth Asteroid Photometric Survey (NEAPS) – 2009 January through 2009 June." *Minor Planet Bulletin* **41**, 286-300.

NASA Exoplanet Archive.
http://exoplanetarchive.ipac.caltech.edu/cgi-bin/Pgram/nph-pgram

Scargle, J.D. (1982). "Studies in Astronomical Time Series Analysis II: Statistical Aspects of Spectral Analysis of Unevenly Spaced Data." *Ap. J.* **26**, 835-853.

Scholl, H., Marzari, F., Tricarico, P. (2013). "Dynamics of Mars Trojans." *Icarus* **175**, 397-408.

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2016 Feb. *http://www.minorplanet.info/lightcurvedatabase.html*

CCD LIGHTCURVE FOR THE MAIN-BELT ASTEROID 240 VANADIS

Kevin B. Alton
UnderOak Observatory
70 Summit Ave.
Cedar Knolls, NJ 07927
mail@underoakobservatory.com

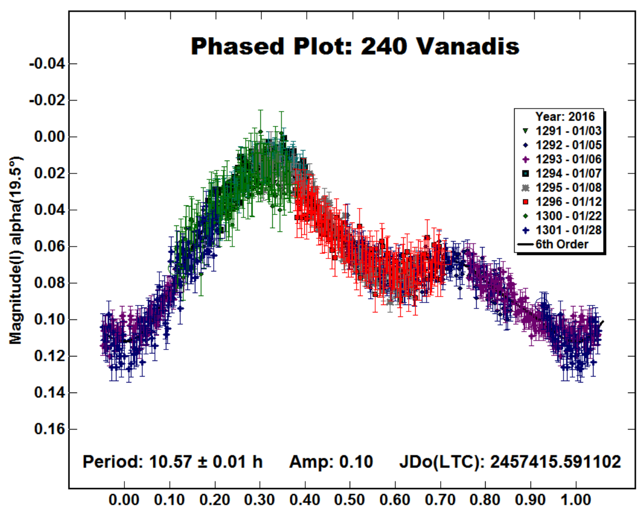
(Received: 2016 March 1)

Fourier analysis of a new CCD-derived lightcurve produced a synodic period solution for 240 Vanadis of 10.57 ± 0.01 h.

Observations of the main-belt asteroid 240 Vanadis were made in 2016 January at the UnderOak Observatory (UO). The instrument used was a 0.28-m Schmidt-Cassegrain (SCT) equipped with an

SBIG ST-8XME thermoelectrically-cooled CCD camera. Image calibration and registration procedures employed at UO have been published elsewhere (Alton, 2013). Data reduction with *MPO Canopus* (Warner, 2015) used at least four non-varying comparison stars in the same field-of-view (FOV) to generate lightcurves by differential aperture photometry. Data were light-time corrected but not reduced to standard magnitudes. Fourier analysis (Harris *et al.*, 1989) yielded a period solution from the folded dataset which was independently verified with *Peranso* (Vannmunster 2006) using ANOVA (Schwarzenberg-Czerny, 1996). Phased lightcurve data are available via email to the author upon request.

This somewhat dark (p_v = 0.0411) taxonomic type-C main-belt asteroid with an estimated diameter of *D* = 91 km (Mainzer *et al.*, 2011) was discovered in 1884 by A. Borrelly. The only published photometric study that produced a lightcurve and determined a synodic period was by Denchev (2000; 10.64 ±0.08 h). At UO, a total of 1055 images (I_c bandpass for 75 s) were taken over eight nights from 2016 Jan 3-28. Fourier analysis of these lightcurve data produced a best folded fit at 10.57 ± 0.01 h. The period solution (10.64 h) reported from the 1999 apparition (Denchev, 2000) did not provide a good fit to the 2016 data. The maximum peak-to-peak amplitude of 0.1 mag observed in 2016 is smaller than the 0.34 mag from Denchev (2000) and reported in the Asteroid Lightcurve Database (Warner *et al.*, 2009).



Acknowledgements

Many thanks to the SAO/NASA Astrophysics Data System, the JPL Small-Body Database Browser, and the asteroid lightcurve database (LCDB; Warner *et al.*, 2009), all of which were essential to locating relevant literature references.

References

Alton, K.B. (2013). "Simultaneous CCD Photometry of Two Eclipsing Binary Stars in Pegasus – Part 1: KW Pegasi." *JAAVSO* **41,** 97-113.

Denchev, P. (2000). "Photometry of 11 asteroids during their 1998 and 1999 apparitions." *Plan. Space Sci.* **48**, 987-992.

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.

Mainzer, A., Grav, T., Bauer, J., Masiero, J., McMillan, R.S., Cutri, R.M., Walker, R., Wright, E., Eisenhardt, P., Tholen, D.J., Spahr, T., Jedicke, R., Denneau, L., DeBaun, E., Elsbury, D., Gautier, T., Gomillion, S., Hand, E., Mo, W., Watkins, J., Wilkins, A., Bryngelson, G.L., Del Pino Molia, A., Desai, S., Gómez Camus, M., Hidalgo, S.L., Konstantopoulos, I., Larsen, J.A., Maleszewski, C., Malkan, M.A., Mauduit, J.-C., Mullan, B.L., Olszewski, E.W., Pforr, J., Saro, A., Scotti, J.V., Wasserman, L.H. (2011). "NEOWISE observations of near-Earth objects: Preliminary results." *Ap. J.* **743**, A156.

Schwarzenberg-Czerny, A. (1996). "Fast and Statistically Optimal Period Search in Uneven Sampled Observations." *Ap. J.* **460**, L107.

Vannmunster, T. (2006). *Peranso* v2.5. Period Analysis Software. CBA Belgium Observatory.

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2016 Feb. *http://www.minorplanet.info/lightcurvedatabase.html*

Warner, B.D. (2015). MPO Software, *MPO Canopus* v10.7.1.3. Bdw Publishing, Eaton, CO.

FINDING THE LIGHTCURVES AND ROTATION PERIODS OF 2925 BEATTY, 3012 MINSK, AND 9060 TOYOKAWA

Caroline E. Odden, Lior Hirschfield, Aidan Driscoll, Ethan Brown Marwa AlAlawi, Ben Anthony, Alex Davenport, Alana Gudinas, Aditya Krishnamachar, Seung Min Lee, Claire Park, Methin Paspanthong, BrianPaul Robert, Ashley Scott, Charles Stacy III, Emma Taylor-Brill, Elizabeth Tso, Matt Wesoloski, Siye Zhu
180 Main Street, Andover, MA 01810
ceodden@andover.edu

(Received: 2016 Mar 31)

Lightcurves of three asteroids were made from 2015 December to 2016 January. We report the results of our lightcurve analysis for 2925 Beatty, 3012 Minsk, and 9060 Toyokawa.

CCD photometric observations were made from the Phillips Academy of three asteroids from 2015 December and 2016 January. The targets were chosen for their relatively bright magnitudes and high declinations. All observations were made with a 0.40-m *f*/8 Ritchey-Chrétien by DFM Engineering and Andor Tech iKon DW436 CCD camera with a 2048x2048 array of 13.5-micron pixels. The resulting image scale was 0.86 arcseconds per pixel. All images were dark and flat-field corrected and guided.

MPO Canopus (Warner, 2013) 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 using the Comp Star Selector tool in *MPO Canopus*. In addition, brighter comparison stars were favored. Data merging and period analysis were also done with *MPO Canopus* using an implementation of a Fourier analysis algorithm by Harris (FALC; Harris *et al.*, 1989). The combined data set was analyzed by students in an astronomy research class taught by Caroline Odden.