

LIGHTCURVE ANALYSIS OF ASTEROIDS 2040 CHALONGE, 4575 BROMAN AND 5852 NANETTE

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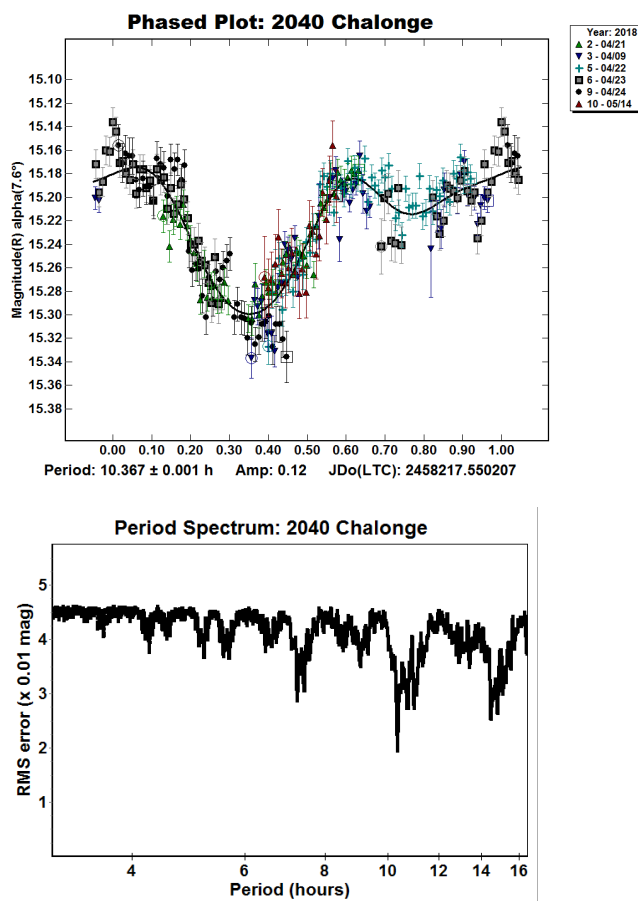
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Photometric observations of asteroids 2040 Chalonge, 4575 Broman, and 5852 Nanette were made at the Phillips Academy Observatory from 2018 March through 2018 June. 2040 Chalonge was found to have rotational period of 10.367 ± 0.001 h with amplitude 0.12 mag, consistent with the previously reported period; 4575 Broman was found to have a rotational period of 10.774 ± 0.001 h with an amplitude of 0.59 mag; 5852 Nanette was found to have a rotational period of 5.606 ± 0.001 h with an amplitude of 0.49 mag.

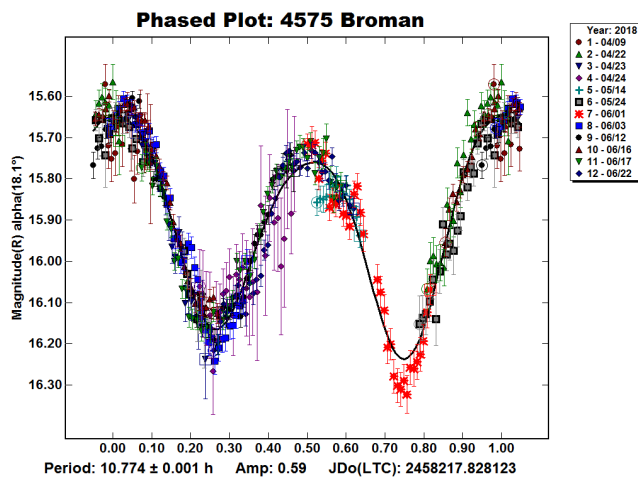
CCD photometric observations of 2040 Chalonge, 4575 Broman, and 5852 Nanette were made between 2018 March and 2018 June at the Phillips Academy Observatory as part of a high school astronomy research course taught by Odden. The CALL website was used to select the targets, which were chosen for their favorable declinations, appealing names, and relatively bright magnitudes. All observations were made with a 0.40-m *f*/8 Ritchey-Chrétien telescope by DFM Engineering. Images were taken with an Andor Tech iKon DW436 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, unbinned, and guided. The images were calibrated with *AstroimageJ* software (Collins et al., 2017).

MPO Canopus was used to make photometric measurements of the asteroid as well as to generate the final lightcurve and period spectrum. 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 the Fourier analysis algorithm of Harris (Harris et al., 1989). The combined data sets were analyzed by the authors.

2040 Chalonge was observed for six nights in 2018 April. A total of 285 data points were used, resulting in a composite lightcurve with period 10.367 ± 0.001 h and amplitude 0.12 mag. 2040 Chalonge was measured previously (Odden et al., 2016) and reported to have a rotational period of 10.383 ± 0.001 h with amplitude 0.22 mag. The results reported here are consistent with those findings. The period spectrum is included along with the composite lightcurve.

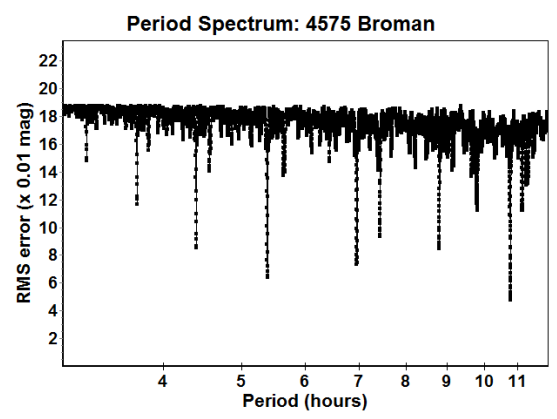


4575 Broman was observed for twelve nights between 2018 April and 2018 June. No previous entries were found in the asteroid lightcurve database (Warner et al., 2009). A total of 403 data points were used, resulting in a composite lightcurve with period 10.774 ± 0.001 h and amplitude 0.59 mag. Given the amplitude, a bimodal solution is expected. The period spectrum is included along with the composite lightcurve.

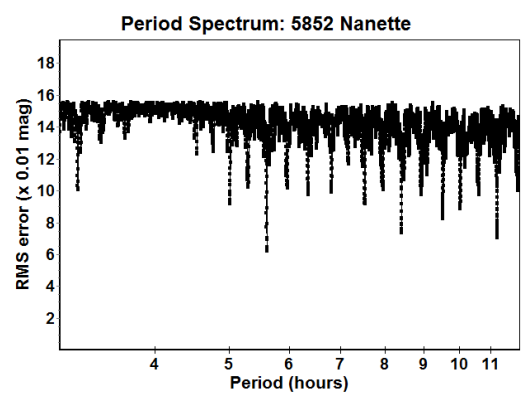
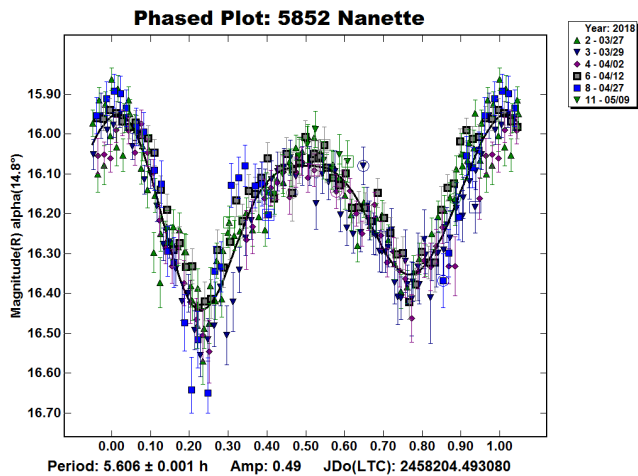


Number	Name	2016/2017 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	TxC
2040	Chalonge	04/09-04/24	285	3.7, 8.3	194.5	7.0	10.367	0.001	0.12	0.03	C
4575	Broman	04/22-06/22	403	18.0, 8.2	254.5	13.2	10.774	0.001	0.59	0.05	C
5852	Nanette	03/27-05/09	326	14.7, 22.9	161.6	22.1	5.606	0.001	0.49	0.05	C

Table I. Observing circumstances and results. Pts is the number of data points. The phase angle is given for the first and last date. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris *et al.*, 1984). TxC is the taxonomic class as found in the LCDB (Warner *et al.*, 2009).



5852 Nanette was observed for six nights between 2018 March and 2018 June. No previous entries were found in the asteroid lightcurve database (Warner *et al.*, 2009). A total of 326 data points were used, resulting in a composite lightcurve with period 5.606 ± 0.001 h and amplitude 0.49 mag. Given the amplitude, a bimodal solution is expected. The period spectrum is included along with the composite lightcurve.



Acknowledgements

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References

CALL: Potential Lightcurve Targets (with LCDB data) Query.
http://www.minorplanet.info/PHP/call_OppLCDBQuery.php

Collins *et al.*, 2017, *AstroImageJ*, v. 3.2.0.
<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 Geytis." *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.

Harris, A.W., Pravec, P., Galád, A., Skiff, B.A., Warner, B.D., Világi, J., Gajdoš, Š., Carbognani, A., Hornoch, K., Kušnirák, P., Cooney, W.R., Gross, J., Terrell, D., Higgins, D., Bowell, E., Koehn, B.W. (2014). "On the maximum amplitude of harmonics of an asteroid lightcurve." *Icarus*, **235**, 55-59.

Odden, C.E., Caso, M., Dettore, C., Dial, P.J., Hoang, K., Hughes, R., Lazar, T.T., Morss, P.P., Mundra, A.R., Naiyapatana, A., Rooney, M. (2017). "Lightcurve Analysis of 1773 Rumpelstilz and 2040 Chalonge." *Minor Planet Bull.* **44**, 219-220.

Warner, B.D. (2010). *The MPO Users Guide: A Companion Guide to the MPO Canopus/PhotoRed Reference Manuals*. BDW Publishing, Colorado Springs, CO.

Warner, B.D., Harris, A.W., Pravec, P. (2009). *Icarus* **202**, 134-146. Updated 2018 June 23.
<http://www.MinorPlanet.info/lightcurvedatabase.html>

[Editor's Note: Congratulations to this team of high school students and a salute to their mentor Odden for guiding them.]