

**LIGHTCURVE ANALYSIS OF ASTEROIDS 131 VALA,
1184 GAEA, 7145 LINZEXU, AND 26355 GRUEBER**

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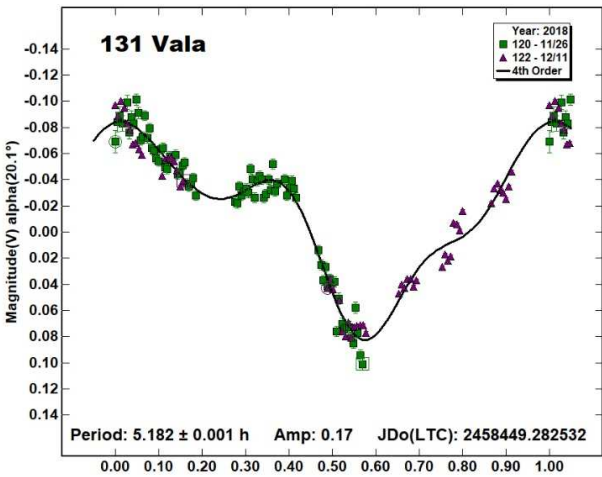
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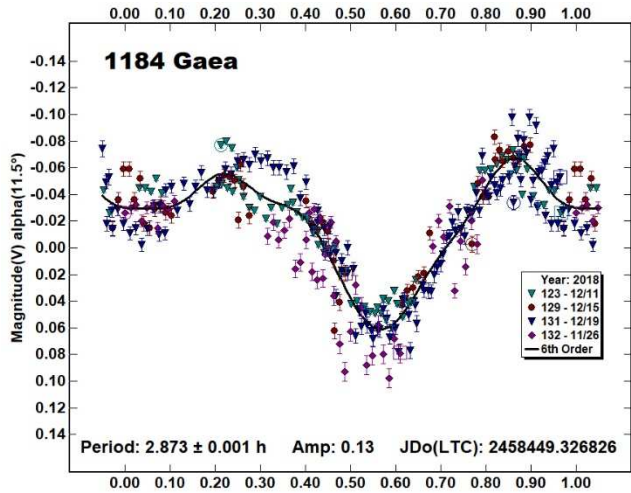
Photometric observations of 4 main-belt asteroids were obtained on four nights between 2018 November 26 and 2018 December 19. We derived the following rotational periods: 131 Vala 5.182 ± 0.001 h; 1184 Gaea 2.873 ± 0.001 h; 7145 Linzexu 2.905 ± 0.001 h and 26355 Grueber 4.539 ± 0.001 h.

We report on the results of photometric observations obtained with two of the Southeastern Association for Research in Astronomy (SARA) consortium telescopes. For the nights of 2018 November 26, 2018 December 11 and 2018 December 15 we utilized the 1m Jacobus Kapteyn Telescope at the Observatorio del Roque de los Muchachos on the Spanish island of La Palma. The telescope is coupled with an Andor iKon-L series CCD. For the night of 2018 December 19 we utilized the 0.9m telescope at Kitt Peak National Observatory. The telescope is coupled with an ARC CCD. The data was calibrated using MaximDL and photometric analysis was performed using MPO Canopus (Warner, 2017). Unfortunately, the bright Moon hindered some of the later observations.

131 Vala. Was selected from the Shape Modelling Target list published in the Minor Planet Bulletin (Warner et al., 2018). We were only able to observe 131 Vala on two nights, as it was too close to the Moon on the third night and equipment failure hampered observations on our last assigned night. There are five previously published rotational periods for 131 Vala. Pilcher (2008) published a rotation period of 10.359h based on a bimodal lightcurve with small amplitude. Behrend (2009) published a period of 5.1803 ± 0.0006 h. Pilcher (2009) re-analyzed his previous data -assuming a near pole-on viewing geometry and a monomodal lightcurve- and added new observations confirming the ~ 5.18 h period suggested by Behrend. Additional observations from 2009 (Galad et al., 2010) and from 2017 (Pilcher, 2017) confirmed the rotational period. We derived a rotational period of 5.182 ± 0.001 h with an amplitude of 0.17 mag in agreement with previous measurements. We will submit our data to the Database of Asteroid Models from Inversion Techniques (DAMIT) (Durech et al., 2010) web site and hopefully contribute to a viable shape model of 131 Vala.



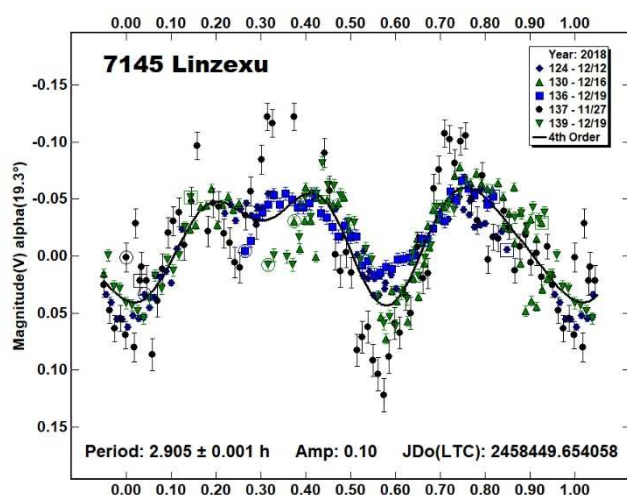
1184 Gaea. Two previously published periods exist for 1184 Gaea. Behrend (2011) reports a period of 2.94 ± 0.06 h. Our group observed the asteroid in 2017 and derived a period of 2.871 ± 0.001 h (Fauerbach and Brown, 2018). We decided to observe 1184 Gaea again in order to provide a shape model of the asteroid in the future. Our observations cover all four available nights and span almost an entire month, thereby providing a larger variation in phase angle than in our previous observation. On three of the nights we observed the asteroid for approximately 6 h, therefore covering two full rotations during each of these nights. We derive a period of 2.873 ± 0.001 h and an amplitude of 0.13 mag in agreement with the previous measurement.



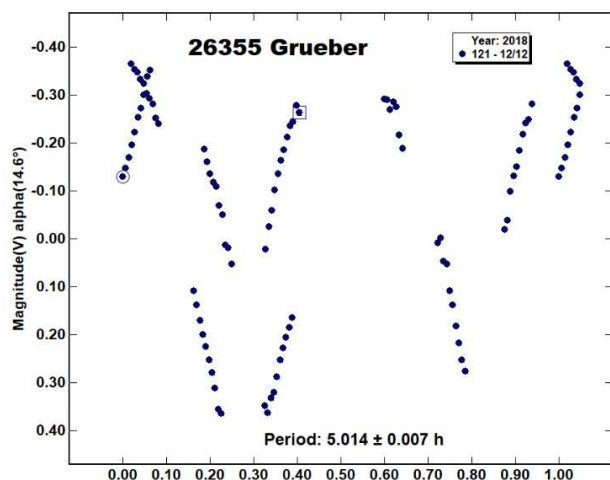
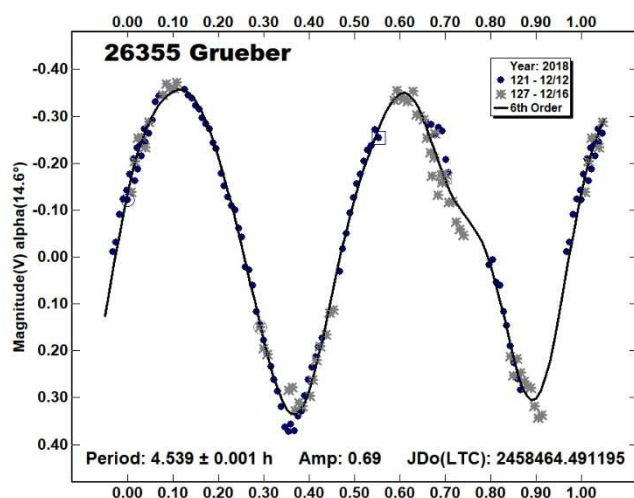
7145 Linzexu. Only one prior measurement of the rotational period exists. Dittion and West (2011) reported a period of 2.905 ± 0.003 h. Our observations cover all four available nights and span almost an entire month. We obtained a rotational period of 2.905 ± 0.001 h with an amplitude of 0.10 mag in excellent agreement with the previous measurement.

Number	Name	2018 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
131	Vala	11/26,12/11	134	20.1,21.8	10.9	-3.9	5.182	0.001	0.17	0.02	MB-I
1184	Gaea	11/26-12/19	304	6.9,13.8	53.8	12.5	2.873	0.001	0.13	0.02	MB-M
7145	Linzexu	11/27-12/19	306	23.5,16.8	114.6	-11.2	2.905	0.001	0.10	0.02	MB-I
26355	Grueber	12/12,12/16	149	14.1,12.3	108.1	2.0	4.539	0.001	0.69	0.03	MB-I

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). Grp is the asteroid family/group (Warner *et al.*, 2009).



26355 Grueber. The only previously reported rotational period is by Waszczak et al. (2015) based on a fit to sparse data. They reported a period of 5.015 ± 0.0006 h with an amplitude of 0.59 mag. We observed 26355 Grueber on two nights for 7 h and 6 h respectively, thereby covering more than one rotational period each night. Our derived rotational period of 4.539 ± 0.001 h with an amplitude of 0.69 mag does not agree with the previous result. Below we plot our data for a single night -covering 7h of observations- with the Waszczak et al. period to highlight that our data cannot fit the previous result.



References

- Behrend, R. (2009). Observatoire de Geneve web site. http://obswww.unige.ch/~behrend/page_cou.html
- Ditteon, R., West, J. (2011). "Asteroid Lightcurve Analysis at the Oakley Southern Observatory: 2011 January thru April." *Minor Planet Bulletin* **38**, 214-217.
- Durech, J., Sidorin, V., Kaasalainen, M. (2010). "DAMIT: a database of asteroid models." *Astronomy and Astrophysics* **513**, A46 <http://astro.troja.mff.cuni.cz/projects/asteroids3D>
- Fauerbach, M., Brown, A. (2018). "Lightcurve Analysis of Minor Planets 1132 Hollandia, 1184 Gaea, 1322 Copernicus, 1551 Argelander, and 3230 Vampilov." *Minor Planet Bulletin* **45**, 240-241.
- Galad, A., Kornos, L., Vilagi, J. (2010). "An Ensemble of Lightcurves from Modra." *Minor Planet Bulletin* **37**, 9-15.
- 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.
- Higgins, D., Pravec, P., Kusnirak, P., Oey, J., Pray, D. (2007). "(1830) Pogson." *Central Bureau Electronic Telegrams*, No. 957, #1
- Pilcher, F. (2008). "Period determination for 84 Klio, 98 Ianthe, 102 Miriam 112 Iphigenia, 131 Vala, and 650 Amalasuntha." *Minor Planet Bulletin* **35**, 71-72.
- Pilcher, F. (2009). "Rotation Period Determinations for 120 Lachesis, 131 Vala 157 Dejanira, and 271 Penthesilea." *Minor Planet Bulletin* **36**, 100-102.
- Pilcher, F. (2017). "Lightcurves of 131 Vala and 612 Veronika During Their 2017 Apparitions." *Minor Planet Bulletin* **44**, 317-318.
- Warner, B.D. (2017). MPO Canopus software version 10.7.10.0. <http://www.bdwpublishing.com>
- Warner, B.D., Harris, A.W., Durech, J., Benner, L.A.M. (2018). "Lightcurve Photometry Opportunities: 2018 October-December." *Minor Planet Bulletin* **45**, 404-408
- Warner, B.D., Harris, A.W., Pravec, P. (2009). "The Asteroid Lightcurve Database." *Icarus* **202**, 134-146. Updated 2018 June 23 <http://www.minorplanet.info/lightcurvedatabase.html>
- Waszczak, A., Chang, C.-K., Ofek, E.O., Laher, R., Masci, F., Levitan, D., Surace, J., Cheng, Y.-C., Ip, W.-H., Kinoshita, D., Helou, G., Prince, T.A., Kulkarni, S. (2015). "Asteroid Light Curves from the Palomar Transient Factory Survey: Rotation Periods and Phase Functions from Sparse Photometry," *The Astronomical Journal*, Volume 150, Issue 3, article id. 75, 35 pp.