

LIGHTCURVE ANALYSIS OF ASTEROIDS 1228 SCABIOSA AND 12016 GREEN

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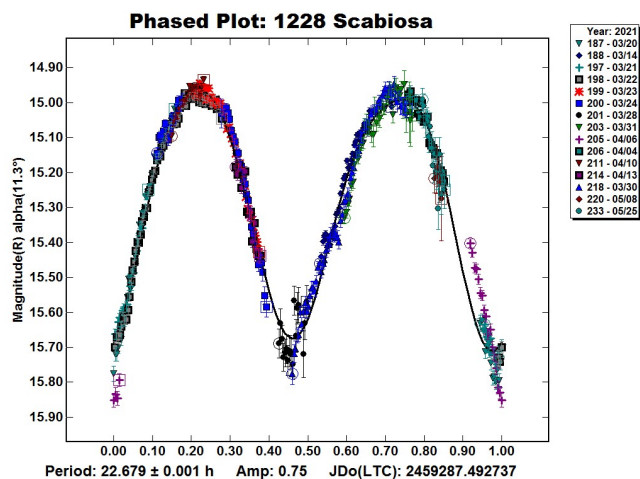
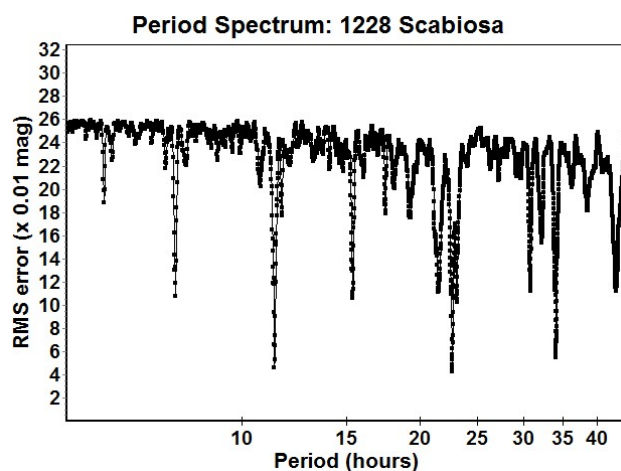
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Photometric observations of asteroids 1228 Scabiosa and 12016 Green were made from the Phillips Academy Observatory (PAO) from 2021 March 14 to May 16. The rotational periods and amplitudes were determined to be: 1228 Scabiosa, $P = 22.769 \pm 0.001$ h, $A = 0.75 \pm 0.02$ mag; 12016 Green, $P = 4.911 \pm 0.001$ h, $A = 0.52 \pm 0.05$ mag.

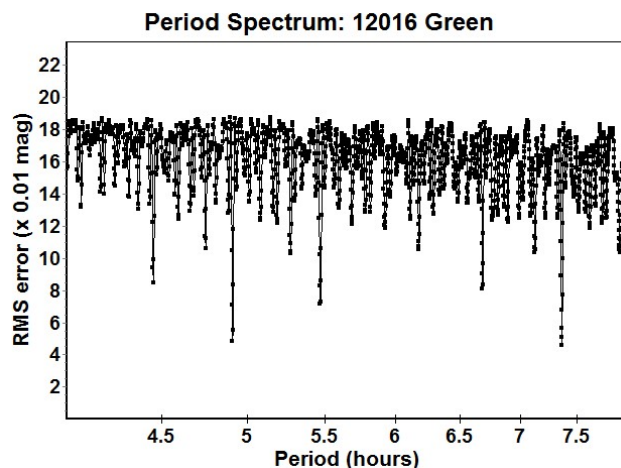
CCD photometric observations of asteroids 1228 Scabiosa and 12016 Green were made from the Phillips Academy Observatory. The asteroids were chosen from the CALL website. All observations were made with a 0.50-m $f/6.8$ Ritchey-Chrétien (RC) Astrograph telescope manufactured by PlaneWave Instruments and 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 v. 3.2.21 (Collins et al., 2018). 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.

1228 Scabiosa was discovered on 5 October 1931 by K. Reinmuth (JPL, 2021). This object did not have any previous rotational period results in the Asteroid Lightcurve Database (LCDB; Warner et al., 2009). Images were taken over fifteen nights from 2021 March 14 to May 25. Analysis of 500 data points indicated a rotational period of 22.769 ± 0.001 h with amplitude 0.75 ± 0.03 mag. The composite lightcurve is well covered, and a bimodal solution is expected given the amplitude (Harris et al., 2014). Because this is a slow rotator with a period close to Earth's rotation period, many sessions and a little bit of luck were required to achieve full coverage of the lightcurve. The group was unable to obtain full coverage due to a combination of poor weather and moon placement. Nevertheless, four consecutive nights of imaging in March helped to constrain the period, and the period spectrum strongly favors the reported period.



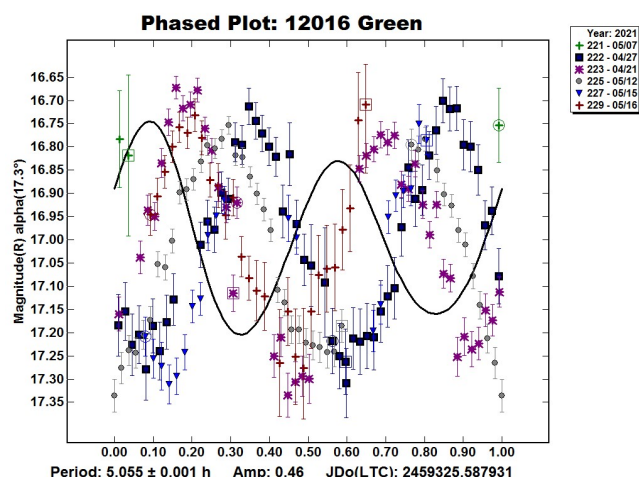
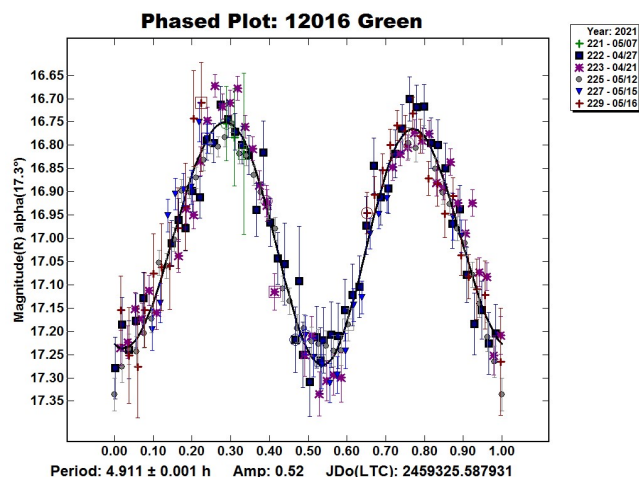
12016 Green was discovered on 1 December 1996 by P. G. Comba and was named after George Green (JPL, 2021), the self-taught physicist who is associated with “Green’s Function.” This object has a previously reported period of 5.055 h (Behrend, 2006web) with a quality rating of 2 (LCDB; Warner et al., 2009).



Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
1228	Scabiosa	2021 03/14-05/21	8.9, 22.3	156	-2	22.679	0.001	0.75	0.02	MB-M
12016	Green	2021 04/21-05/16	10.1, 20.6	197	9	4.911	0.001	0.52	0.05	MB-M

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 an extremum 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).

Images were taken over six nights from 2021 April 21 to May 16. Analysis of 193 data points indicated a period of 4.911 ± 0.001 h with amplitude 0.52 ± 0.03 mag. The period spectrum also includes relative minima at 4.455 h and 5.470 h, but when the data are phased to these periods, the fit is noticeably worse. The data do not phase at all well to the previously reported period of 5.055 hrs.



Acknowledgements

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