

THE MINOR PLANET BULLETIN

BULLETIN OF THE MINOR PLANETS SECTION OF THE
ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

VOLUME 37, NUMBER 2, A.D. 2010 APRIL-JUNE

41.

LIGHTCURVE AND PHASE CURVE OF 1130 SKULD

Robert K. Buchheim
Altimira Observatory
18 Altimira, Coto de Caza, CA 92679 (USA)
rbuchheim@earthlink.net

(Received: 29 December)

The lightcurve period of asteroid 1130 Skuld is confirmed to be $P = 4.807 \pm 0.002$ h. Its phase curve is well-matched by a slope parameter $G = 0.25 \pm 0.01$

The 2009 October-November apparition of asteroid 1130 Skuld presented an excellent opportunity to measure its phase curve to very small solar phase angles. I devoted 13 nights over a two-month period to gathering photometric data on the object, over which time the solar phase angle ranged from $\alpha = 0.3$ deg to $\alpha = 17.6$ deg. All observations used Altimira Observatory's 0.28-m Schmidt-Cassegrain telescope (SCT) working at f/6.3, SBIG ST-8XE NABG CCD camera, and photometric V- and R-band filters. Exposure durations were 3 or 4 minutes with the SNR > 100 in all images, which were reduced with flat and dark frames. Differential photometry and lightcurve analysis were done with *MPO Canopus* using 3 to 5 comparison stars in each field of view. Comp stars were selected using *Canopus*' "comp star selector", which ensured that the comp stars were similar in color to the asteroid.

The comp stars were measured in two ways. First, a clear and stable night in 2009 December was devoted to "all sky" photometry to determine the standard V- and R-band magnitude of the stars by comparison to Landolt standard stars (principally SA-93), with appropriate correction for atmospheric extinction. Second, for some fields, there was sufficient overlap that the comp stars could be "bridged" using convenient field stars; this enabled me to confirm that the comp stars were stable over the period between "lightcurve nights" and the comp star calibration night. The formal errors in the V- and R-band magnitudes of the comp stars were generally better than ± 0.03 mag and their consistency between nights was also this good.

The lightcurve at small solar phase angle is shown in Figure 1. This is a typical bimodal lightcurve with a period of $P = 4.807 \pm 0.002$ h and amplitude $A = 0.25$ mag, peak-to-peak. This period confirms the results previously reported by Behrend (2009), which were based on data from 2004 provided by François Colas, and by

Robinson (2009) from his data taken in 2002. There is no evidence of any change of (V-R) color with asteroid rotation.

As a result of the relatively short period of this lightcurve, every night provided at least one minimum and maximum of the lightcurve. The phase curve was determined by polling both the maximum and minimum points of each night's lightcurve. Since

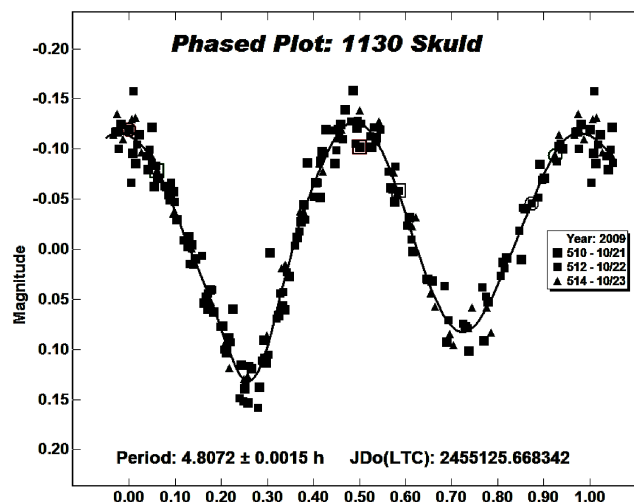


Figure 1: Phased lightcurve, at low solar phase angle

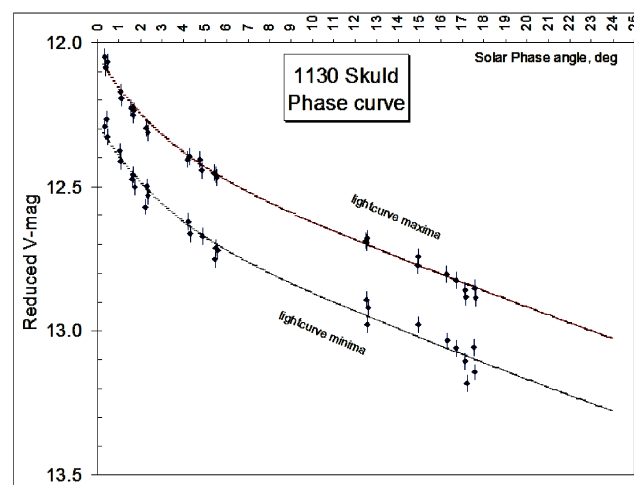


Figure 2: Phase curves of 1130 Skuld at maximum and minimum light.

Minor Planet Bulletin 37 (2010)

Available on line <http://www.minorplanetobserver.com/mpb/default.htm>

both the primary and secondary maxima are of nearly equal brightness, all of the extrema were polled without distinction between primary or secondary. The primary and secondary minima differ by about 0.05 mag, but they were treated equally as well; this contributes to the somewhat higher scatter in the “lightcurve minima” phase curve, compared to the phase curve for the “lightcurve maxima.” Two methods were used to poll the asteroid’s brightness at the extrema. First, the Fourier fit to the lightcurve was adjusted up and down to minimize the mean-square error to the measured lightcurve data in the neighborhood of the extremum of interest, and then the magnitude of the Fourier fit was determined. Second, the actual photometric measured data point at the time of maximum/minimum light was recorded. The difference between these two estimates of maximum or minimum brightness rarely differed by more than a few hundredths of a magnitude. Both the “Fourier fit” and the “actual measured” data points are included in the final phase curve in order to give a visual feel for the quality of the data.

The JPL Horizons ephemeris system was used to determine the solar phase angle (α), Sun and Earth distances (R and D , respectively) for the time of each lightcurve extremum, and the reduced magnitude $V_R = V - 5\log(RD)$ was calculated using this information. The phase curves (V_R vs. α) for the lightcurve maxima and minima are shown in Figure 2. The best fits to the data are:

Lightcurve brightness maxima

$$H_{max} = 12.053 \pm 0.006, G = 0.259 \pm 0.008$$

Lightcurve brightness minima

$$H_{min} = 12.289 \pm 0.009, G = 0.246 \pm 0.014$$

Combining these, the best estimate of the mean V-magnitude is

$$H_0 = 12.17 \pm 0.02, G = 0.25 \pm 0.01$$

This value of absolute magnitude is consistent with the previously-reported data recorded in the asteroid lightcurve database.

This appears to be the first report of a phase curve for this object. In the small bodies node (<http://pdssbn.astro.umd.edu/>), 1130 Skuld is identified as a “class S” asteroid, and the slope parameter determined here is consistent with that designation. It is a member of the Flora dynamical family; I note that the slope parameter for 4 Flora is reported as $G = 0.28$, so my reported slope parameter of 1130 Skuld is quite similar to that of the main body of this family.

References

Behrend (2009) reported at:

http://obswww.unige.ch/~behrend/page_cou.html

Robinson (2009) reported at: <http://btboar.tripod.com/lightcurves/>

Acknowledgements

This research made use of the JPL Horizons system (<http://ssd.jpl.nasa.gov/?horizons>), and the NASA Astrophysics Data System (<http://adswww.harvard.edu/index.html>).

CCD PHOTOMETRY AND LIGHTCURVE ANALYSIS OF 985 ROSINA AND 990 YERKES FROM GRUP D’ASTRONOMIA DE TIANA (G.A.T.) OBSERVATORY

Jaume Martínez, Josep Maria Aymamí,
Ramón Bosque, Joan Martín
Observatori Grup d’Astronomia de Tiana
Av. Eduard Fontserè, 08391 Tiana, Spain
astrotiana.mpc@gmail.com

(Received: 22 November 2009)

Two first lightcurve determination attempts were carried out from the Grup d’Astronomia de Tiana Observatory on several nights spanning from 2009 July 19 to November 10. The asteroids covered by this work are 985 Rosina, a body of known lightcurve parameters, and 990 Yerkes, a main-belt asteroid whose period had not been determined to date. We obtained a synodic period of 3.012 ± 0.001 h for 985 Rosina that matches very accurately previous lightcurve measurements. For 990 Yerkes a 24.56 ± 0.01 h period and 0.25 mag amplitude has been tentatively established by our observations.

The *Grup d’Astronomia de Tiana* (G.A.T.) Observatory is situated in Tiana, in the southernmost part of the *Serra de Marina*, a moderately-polluted suburban park 15 km north of Barcelona. In spite of the limitations imposed by the local light conditions, useful observations can still be carried out thanks to the forest surrounding the building. The G.A.T. Observatory was recently equipped with a Paramount GEM (German Equatorial Mount), a 43-cm modified Dall-Kirkham Planewave reflector, and a dual-chip SBIG STL-1001 CCD camera with filter wheel and AO-L adaptive optics unit, yielding a 28.9' x 28.9' field of view and an effective resolution of 1.70 arc sec/pix.

This work has been carried out by four members of the G.A.T.: Jaume Martínez, who has been carrying out a high-school research project, was in charge of target selection, telescope operation, and data processing; Joan Martín operated the telescope and acquired images on several nights; Ramón Bosque worked in data reduction and revised this paper, and Josep M. Aymamí acquired, processed and reduced data, and wrote this paper.

985 Rosina is a Mars-crossing (MC) asteroid ($e = 0.27669$, $a = 2.2997$) with a well known rotational period of 3.0126 h (quality code 3; see documentation in Warner et al, 2009) and an amplitude of 0.22 mag (Behrend, 2009). We collected 260 60s images on the nights of 2009 July 19 and July 22 through a C filter with *Maxim DL* acquisition software. The imaging chip of the STL-1001 CCD camera operated at -20° C and all images were calibrated with master bias, dark, and flat frames. Differential photometry of the asteroid was performed “live” at the observatory by using *Fotodif*, a free software program that allows us to follow the asteroid’s lightcurve easily on-site as the images are being downloaded. Measurements carried out with different software packages (*Astrometrica* and *Focas II*) showed that the asteroid’s brightness compared to a number of stars in the R band of the USNO A2 catalogue was approximately mag 13.8. With the weather cooperating, we managed to capture a full rotation period on the very first night and, after obtaining images on a second night, we could derive our own lightcurve with *Canopus*, which shows a period of 3.012 ± 0.001 h and 0.22 mag amplitude,