

**LIGHTCURVE ANALYSIS AND
ROTATION PERIOD FOR (3394) BANNO**

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(Received: 2018 Jun 11)

Photometric data for asteroid 3394 Banno were collected from 2018 April 19-25. The analysis obtained led to a good multiple coverage lightcurve that fit to a period of 7.324 ± 0.002 hours and amplitude of 0.24 mag.

The main-belt asteroid 3394 Banno (1986 DB) was discovered by S. Inoda and T. Urata, at Karasuyama in 1986. It orbit has a semi-major axis of 2.317 AU, period of 3.53 years, eccentricity of 0.197, and inclination of 7.093 deg. The SMASS catalog (Bus and Binzel, 2002) classifies the asteroid as type S. With $H = 13.1$ and $p_V = 0.271$ (JPL, 2018) the estimated diameter is 6 km. Marchini et al. (2018) previously reported the rotation period to be 7.324 h.

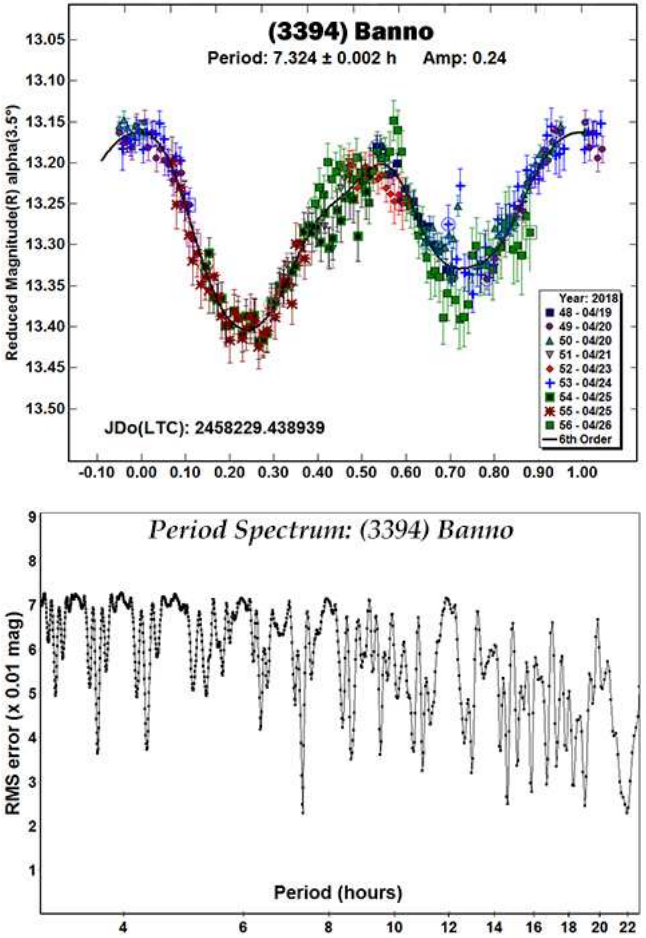
Observations were conducted from Elianto observatory (MPC K68) using an $f/4$ 0.30-m Newtonian telescope. The CCD camera had a KAF-1603 chip with 9-micron pixels in a 1536x1024 array. No filter was used. Exposures were 240 seconds. Master dark and flat fields were obtained using *CCD Stack*. *MPO Canopus* (Warner, 2016) was used to measure the magnitudes with MPOSC3, a hybrid catalog based on the 2MASS catalog (<http://www.ipac.caltech.edu/2mass>) with magnitudes converted from J-K to BVRI (Warner, 2007). The Rc derived magnitudes were reduced to unity Sun-asteroid and Earth-asteroid distances and normalized to a phase angle of 3.5° and using $G = 0.15$.

Night-to-night zero-point calibration was accomplished by selecting up to five comparison stars with near-solar colors, using the Comp Star Selector feature. The StarBGone routine within *MPO Canopus* was used as well in order to subtract stars that occasionally merged with the asteroid during the observations.

A total of 294 lightcurve data points were collected in five observing sessions from 2018 April 19-25. *MPO Canopus* was used to find the rotation period from the data using the FALC method by Harris (Harris et al., 1989). The individual sessions were divided into two parts (except on April 23), one before and one after the asteroid crossed the meridian. We found a period of

7.324 ± 0.002 hours. The bimodal lightcurve amplitude is 0.24 mag. Table I gives the observing circumstances and results.

It is clear that the phased curve covers the adopted period multiple times. The whole process was quite straightforward, providing a result without any particular ambiguity. The period spectrum shows that the best solution (with the lowest RMS) is the one adopted here.



References

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Number	Name	2018 mm/dd	Pts	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	U	Exp
3394	Banno	04/19–04/25	294	3.5, 6.9	206	3	7.324	0.002	0.24	0.01	2	240

Table II. Observing circumstances and results. The phase angle is given for the first and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris et al., 1984). The U rating is our estimate and not necessarily the one assigned in the asteroid lightcurve database (Warner et al., 2009). Exp is average exposure, seconds.

JPL (2018). Small-Body Database Browser.
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FIVE LIGHTCURVES FROM THE SHED OF SCIENCE: 2017 NOVEMBER - 2018 APRIL

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(Received: 2018 Jun 14)

CCD observations of five asteroids were made between 2017 November and 2018 April. Analysis of the data found the period and lightcurve amplitudes for 965 Agnelica ($P = 26.63 \pm 0.03$ h, $A = 0.12$ mag), 1266 Tone ($P = 15.55 \pm 0.03$ h, $A = 0.19 \pm 0.05$ mag), 3210 Lupishko ($P = 14.255 \pm 0.03$ h, $A = 0.74 \pm 0.05$ mag), 4435 Holt ($P = 2.867 \pm 0.002$ h, $A = 0.18 \pm 0.05$ mag), and 5133 Phillipadams ($P = 6.665 \pm 0.005$ h, $A = 0.43$ mag).

CCD Photometry observations of five asteroids took place from the Shed of Science Observatory between 2017 November and 2018 April in partnership with Minnetonka High School in Minnetonka, Minnesota.

The observations used a 0.5-m Planewave corrected Dall-Kirkham telescope using a focal reducer, which resulted in a focal ratio of $f/5.3$ and a plate scale of 1.24 arcsec/pixel. An SBIG ST-10XME CCD camera was used and all exposures were made through a Celestron UHC LPR filter.

All images were dark and flat-field corrected. Images were measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique. The *MPO Canopus* Comp Star Selector was used to link sessions. The data were light-time corrected. Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm developed by Harris (Harris et al., 1989).

965 Angelica. Observations were made over nine nights between 2017 Dec 12 and 2018 Feb 6. Data analysis indicates a synodic period of $P = 26.63 \pm 0.03$ h, $A = 0.12$ mag. This is in agreement with earlier observations by Polakis (2018).

