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PHOTOMETRIC STUDY OF ASTEROID 4730 XINGMINGZHOU FROM GAOYAZI AND XINGMING OBSERVATORIES

Hanjie Tan
Department of Physics
National Central University
No.300 Zhongda Rd., Taoyuan, TAIWAN
h.tan1996@hotmail.com

Xing Gao
Xinjiang Astronomical Observatory
150 Science 1-StreetUrumqi, Xinjiang, CHINA PR

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Lightcurve and filter photometry of main-belt asteroid 4730 Xingmingzhou were made at Gaoyazi and Xingming Observatories in 2018 October. We find the asteroid has a synodic rotation period of 3.396 ± 0.001 hr and amplitude of 0.15 ± 0.02 mag. We also found color indices of B-V = 0.783 ± 0.068, V-R = 0.367 ± 0.074, and R-I = 0.722 ± 0.054 mag. According to these color indices, 4730 Xingmingzhou can be classified as a C-type asteroid.

CCD photometric observations were made of main-belt asteroid 4730 Xingmingzhou in 2018 October. At Gaoyazi Observatory we used a 50-cm *f*/4 reflector and QHY11 CCD camera. The image scale was 0.9 arcsec/pixel; exposures were unfiltered and 90 seconds. Filtered photometric observations were made using the Ningbo Bureau of Education and Xinjiang Observatory Telescope (NEXT). The instrument was a 60-cm *f*/8.0 Ritchey-Chretien and LI PL230 CCD camera; this gave a pixel scale of 0.64 arcsec/pixel. Observations were made in Johnson-Cousins BVR_CI_C filters. Each image was taken with 90 seconds exposure. All images were calibrated using standard procedures, including flat-correction and dark and bias frames using *Maxim DL*.

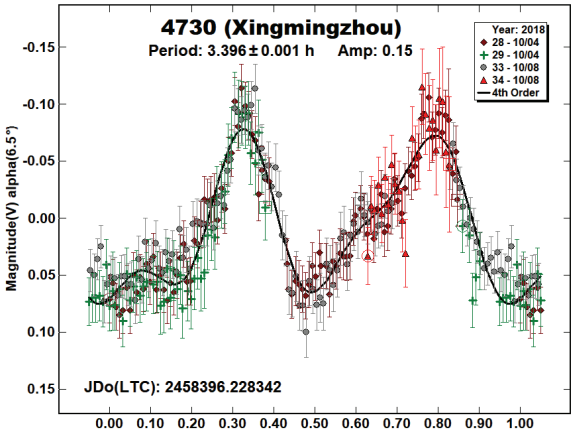

Fig.1. Lightcurve for asteroid 4730 Xingmingzhou fit to a period of 3.396 ± 0.001 hr; the peak-to-peak amplitude is 0.15 ± 0.02 mag.

Number	Name	2018/ mm/dd	Pts	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
4730	Xingmingzhou	10/04-10/08	288	6.4,5.5	23	-13	3.0396	0.001	0.16	0.02	MB-O

Table III. 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): MB-O: Main-belt Outer

We observed the asteroid for nearly 9 hours under good conditions on 2018 Oct 4 and 8. The relative photometry and Fourier period analysis were obtained using *MPO Canopus*. Analysis of our observations with a total of 285 data points provides a good fit to a lightcurve with P = 3.396 ± 0.001 h and A = 0.15 mag (Fig. 1). Prior to our work, the only previous rotational period result for 4730 Xingmingzhou was by Waszczak et al. (2015; 3.396 hr) with an uncertainty degree U = 2. Our results confirm those from Waszczak et al. (2015).

Four images each in B, V, R_C and I_C filters were obtained alternately in ten minutes on 2018 Oct 6 and 7. For example, on these two nights, we observed the asteroid in the following order: BVRI-BVRI.

We used the AAVSO Photometric All-Sky Survey (APASS) catalog (Henden, 2016) as the photometric reference stars catalog to reduce data to B and V band directly. The APASS catalog does not have R_C or I_C magnitudes. For these two filters, we used the equations derived by Lupton (2005) to transform Sloan r′ and i′ magnitudes to R_C and I_C. Aperture and differential photometry of five field stars and asteroid were used to find the asteroid's magnitude.

Date(UT)	B	ΔB	V	ΔV	R	ΔR	I	ΔI
Oct.2018								
6.715	16.803	0.04	16.022	0.04	15.658	0.01	15.315	0.01
7.702	16.831	0.03	16.045	0.02	15.670	0.05	15.310	0.02

Table I. A summary of the apparent brightness of 4730 Xingmingzhou on 2018 Oct 6 and 7.

These measurements allowed us to calculate the color indices from the mean of values (Table. II). The results from the two nights were consistent with one another.

Mean color Indices of 4730 Xingmingzhou	
B-V	0.783±0.068
V-R	0.367±0.074
V-I	0.722±0.054

Table II. A summary of the mean color indices of 4730 Xingmingzhou.

The distribution of the color indices of different taxonomic types is shown in Figures 2 and 3. Based on these plots, we suggest that 4730 Xingmingzhou is a type G class asteroid using classification method proposed by Dandy et al. (2003) that used Tholen taxonomy classes (Tholen, 1984).

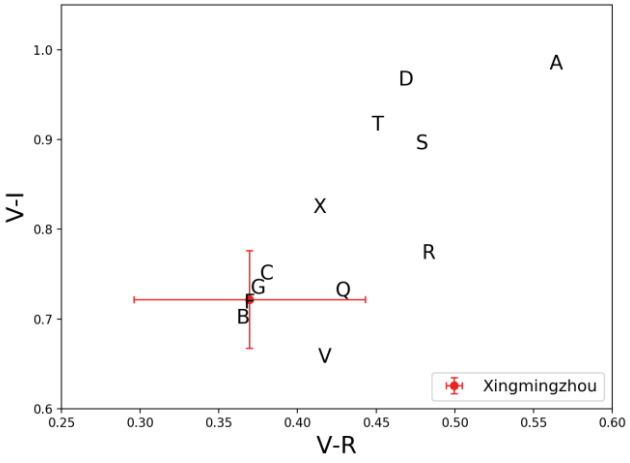

Fig.2. The V-R vs. V-I color-color diagram with 4730 Xingmingzhou and different taxonomic types based on Dandy et al. (2003).

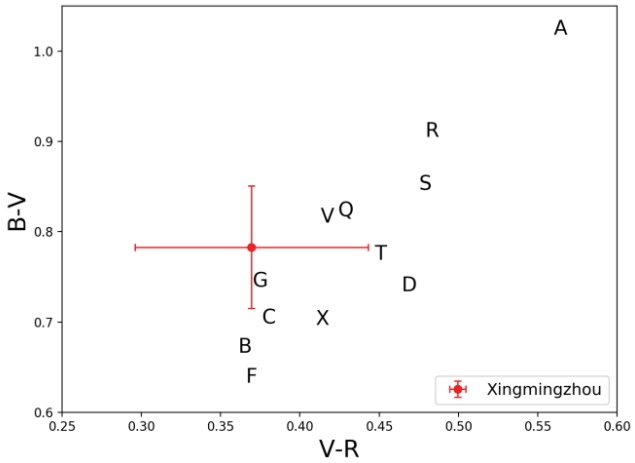

Fig.3. The V-R vs. B-V color-color diagram with 4730 Xingmingzhou and different taxonomic types based on Dandy et al. (2003).

We subtracted the solar color index in each band from the color index for asteroid (Howell, 1995) and then calculated relative reflectance values (Lin et al., 2014). The comparisons of the resulting relative reflectance spectra of against spectra of Bus-DeMeo (DeMeo et al., 2009; DeMeo et al., 2013) classes Cgh, Cg, Q, V, and C classes are shown in Fig. 4. These show a best fit for the asteroid to the Cgh class.

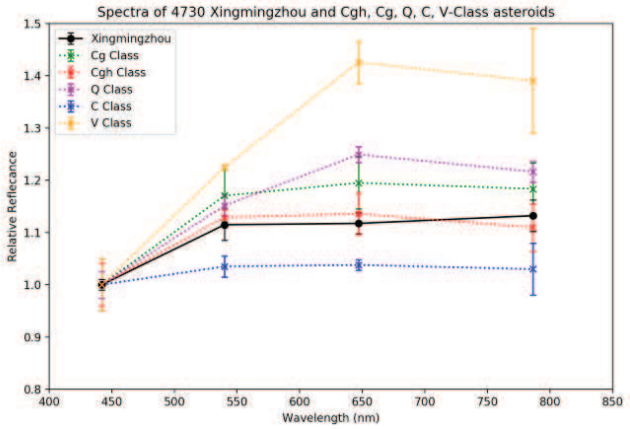

Fig.4. The relative reflectance spectrum of 4730 Xingmingzhou determined using BVRI observations in comparison with spectra of five Bus-DeMeo clases.

In some cases, Cgh-type and G-type were classified as C-type or C-subtypes (Binzel et al., 2004; Lin et al., 2018; Stuart et al., 2004; Ye, 2011) because their spectra are very similar. For this asteroid, our result showed the B-V color is slightly redder than a normal C-type asteroid but closer to G-type and the asteroid's spectrum shows little differences from a typical C-type.

The only classification before our work was from Pan-STARRS observations that suggested a C-class asteroid (Vereš, 2015) based on H and G parameters (absolute magnitude and phase slope parameter). It's hard to distinguish among Cgh, G, and C-type using only BVRI photometry and so, in this work, a conservative assignment of type C in the Tholen classification scheme is given (Dandy et al., 2003; Tholen, 1984). This puts our result in agreement with that from Vereš (2015).

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Asteroid 4730 Xingmingzhou was named after the Chinese amateur astronomer Xing-Ming Zhou (1965-2004). He was an exceptional comet hunter, logging around 1500 hours in night sky comet hunting in almost 20 years. He discovered 63 SOHO comets and one SWAN comet: C/2004 H6 (SWAN). He was ranked fourth in the world among SOHO hunters before he left us. In 2000, Xingming was the first and only Chinese SOHO discoverer; there are now 24. He inspired a generation of hundreds of amateurs in China that are now searching for comets, asteroids, and supernova using the data from the Xingming Observatory, which is named in his honor. We would like to offer our highest respect and admiration to him and his family in this paper.

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