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CCD PHOTOMETRY OF ASTEROIDS 168, 206 AND 506

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Abstract. A quantity of C-type asteroids with intermediate size has been selected as the targets of our observational program in Yunnan Observatory, China since 2000. In this paper, we report the results of the photometric observation for three of them, 168 Sibylla, 206 Hersilia and 506 Marion during 2002–2003. The synodic period of 9.100± 0.009 h of 206 is different from the value given by Harris (2003). The synodic periods of 168 and 506 we estimated are 24.41±0.01 h, and 13.51±0.01 h, respectively, which are slightly different from the values given by Harris (2003). Their composed lightcurves using new periods are presented.

1. Introduction

Rotational properties of asteroids are important for a better understanding of their physical properties and mechanics of collision within asteroid belt. An abundant data of spin periods make such an understanding full. The observation and analysis for slower rotators of C-type in main belt, which might concern with their lower mean density (Harris, 1979) or angular momentum drain (Dobrovolskis and Burns, 1984), or unseen binary systems (Farinella et al., 1981), should be more important. And the less of the spin period data of C-type asteroids with intermediate size where the slower rotators are probable to occur, limits the understanding for slower rotators. So, we began an observational program in 2000, in which those C-type main belt asteroids with intermediate size, and with poor or even shortage in photometric data, were involved.

For the slower rotators, the photometric observations for obtaining their synodic period are relatively hard. In order to get their whole lightcurve, the long-term observation, even the joint observation with other colleagues are needed.

From the photometric lightcurves, we not only can estimate the synodic period and the three-axes ellipsoid shape of asteroid, but also can infer the shape departure from the three-axes ellipsoid based on the subtle shape of lightcurves considering that its surface is homogeneous.

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This paper is the third one in our research series, in which three C-type asteroid's new photometric lightcurves are presented. The continuous observations for this kind of asteroids will be done in future, that is important in extending the photometric data of asteroids, and in understanding the intrinsic link between the distribution of spin rate and the collision evolution.

2. Observation

The observations of the three C-type asteroids were performed with the 1-meter telescope equipped with a 1024×1024 (24μm/pixel) CCD at Yunnan Observatory, China during 2002–2003.

The 168 Sibylla was observed in four nights, from March 28 to 31 2003. The V filter was used in the first night. Because of the weather condition and its fainter magnitude, the dispersion of lightcurve of the first night is slightly large. So we used the R filter instead in later three night's observation. For its slow motion in this period, the same field of view was taken during the four night's observations. And, the same comparison stars were used to calculate the magnitude difference of 168 in this period.

The 206 Hersilia was observed through the V filter on November 29, 2002 and December 1, 2002. And the 506 Marion was observed also with V filter on November 9–10 2002.

Table 1 lists the conditions of observations for these three asteroids, which includes the date of observation in UT, geocentric distance Δ, heliocentric distances r (in astronomical unit), phase α, ecliptic longitude and latitude in J2000.0 reference frame. The observational quality of individual night estimated using the dispersion of corresponding magnitude difference between two comparison stars, is listed in the last column of Table I.

TABLE I
The conditions of observations for selected asteroids

Asteroid	Date (UT)	Δ (AU)	r (AU)	α Degree	λ, β(J2000.0) Degree	Dispersion mag.
168	2003/03/28.6	2.875	3.513	13.8	129.944, −5.018	0.016
	2003/03/29.5	2.888	3.514	13.8	129.933, −4.991	0.007
	2003/03/30.6	2.901	3.514	13.8	129.928, −4.962	0.007
	2003/03/31.6	2.916	3.515	13.8	129.926, −4.931	0.008
206	2002/11/29.6	1.656	2.639	02.3	068.612, −5.880	0.007
	2002/12/01.7	1.656	2.639	02.2	068.125, −5.863	0.025
506	2002/11/09.7	1.795	2.708	09.9	059.006, 25.694	0.008
	2002/11/10.7	1.791	2.707	09.8	058.805, 25.711	0.008

3. Results

These three asteroids presented here are the part of observational targets in our program. The method and applied software in reducing and analyzing these photometric data are the same as ones we adopted before, which was introduced by Wang (2002). The tasks APPHOT and DAOPHOT of IRAF software were used to measure the magnitudes of asteroids and corresponding comparison stars. From the magnitude variation of the asteroid relative to selected comparison star, the synodic period was estimated using the period98 program (Sperl, 2003) and PDM software. The individual shift was added into individual night's data so as to obtain an uniform data set. The detail analysis is given as follows.

3.1. 168 Sibylla

The 168 Sibylla was discovered by Watson in Ann Arbor on September 28, 1876. This C-type asteroid with diameter of 153 km has low albedo. Di Martino et al. (1994) reported a period of 23.82 h. We estimated its synodic period as 24.41±0.01 h, which is slightly different from the one of Di Martino et al. (1994). Figure 1 shows the composed lightcurve of 168 Sibylla using the synodic period of 24.41 h. From the Figure 1, it can be seen that the data of first three nights fit each other well in general, only a few points of the fourth night have a little deviation from the general trend. We think, it was due to the low altitude of 168 Sibylla and strong background light of

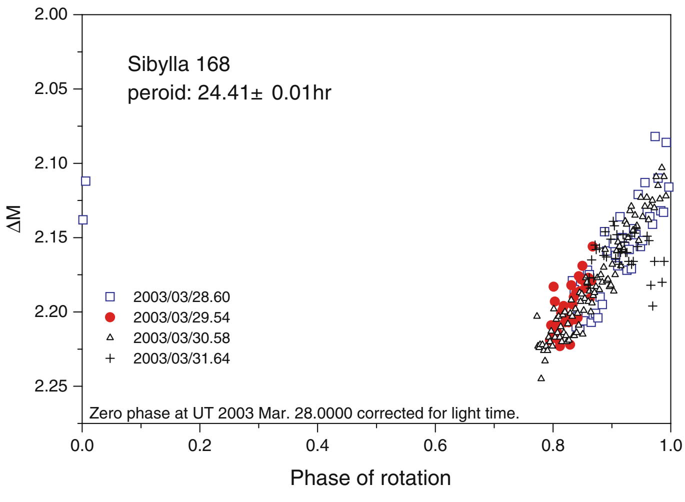

Figure 1. The lightcurve of 168 Sibylla. ΔM presents the magnitude difference between the asteroid and the comparison star.

Kunming city when they were gathered. We also composed the our photometric observational data of 168 with the period of 23.82 h proposed by Di Martino et al. (1994)(see Figure 2), and found that the dispersion of lightcurve was larger. That demonstrates that the new period of 24.41 h is more proper to compose the recent observational data.

For only a quart of the rotational phase was covered, we just can estimate that its amplitude is larger than 0.21 magnitude in this aspect. In the procedure of the analysis to four nights' data, we also found that the value 12.34 h also owned small dispersion in composed lightcurve. But, such a shape of the composite lightcurve with only a maximum and a minimum, is not easy to be explained with a certain reasonable shape of asteroid. So the value of 24.41 h is more reasonable than that of 12.34 h.

For the asteroids with spin period of 24 h around, it is difficult to obtain their whole rotational phase curve in a observational site. A very long observation time or the joint observations with other longitude site are needed to obtain the whole lightcurve and to determine the accurate spin period of 168 in future.

3.2. 206 Hersilia

The 206 Hersilia, a C-type asteroid with a diameter of 244 km was discovered by Peters in Clinton on October 13, 1879. Shevchenko et al. (1992) observed it in 1991, and reported a rotational period of 7.33 h. Our observational result is different from theirs. We estimated a period of 9.100±0.009 h with an amplitude of 0.17 magnitude. The composed

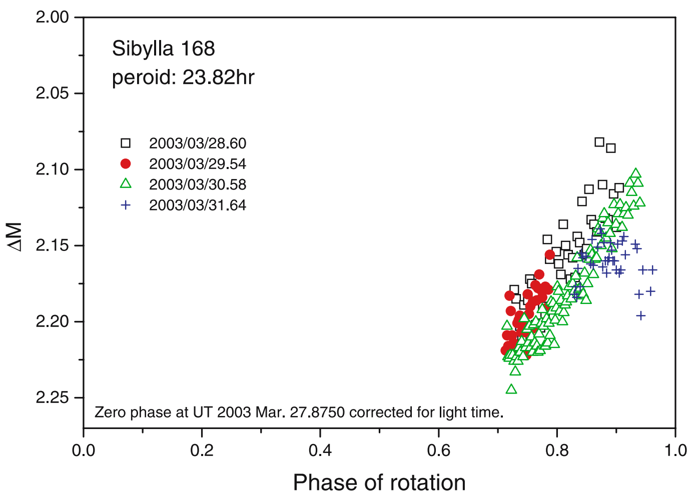

Figure 2. The composed lightcurve of 168 Sibylla using period of 23.82 h.

lightcurve of 206 (Figure 3) shows two different maxima, on each top of which the significant notch can be distinguished. The depths of two minima are also different. Further observations are needed to understand the notches and to determine the parameters of its shape and the spin orientation.

3.3. 506 Marion

Dugan discovered the 506 Marion in Heidelberg in 1903. It is a C-type asteroid with diameter of 104 km. Robinson and Warner (2002) observed it in six nights of 2001, and estimated a period of 10.58 h. Behrend (2003) presented the composite lightcurves of 506 observed by Bernasconi and Cavadore, and gave a similar synodic period value. Anyway, we cannot compose ours lightcurve well with the period of 10.58 h. With our two nights' magnitude data, we estimated a period of 13.51±0.01 h. Figure 4 shows the composed lightcurve of 506 with new period. In our composite lightcurve, one minimum and two maxima are distinct. One of the maxima is high and sharp and another is flat and broad. From our composite lightcurve, we infer that the depth of the missing minimum should be shallow. The amplitude of lightcurve in this aspect is 0.18 magnitude around. In detail, some small fluctuations can be seen in lightcurve of the second night, which might be caused by atmosphere's change. In order to understand the property of spin and shape of 506 well, the continuous observations are needed in future.

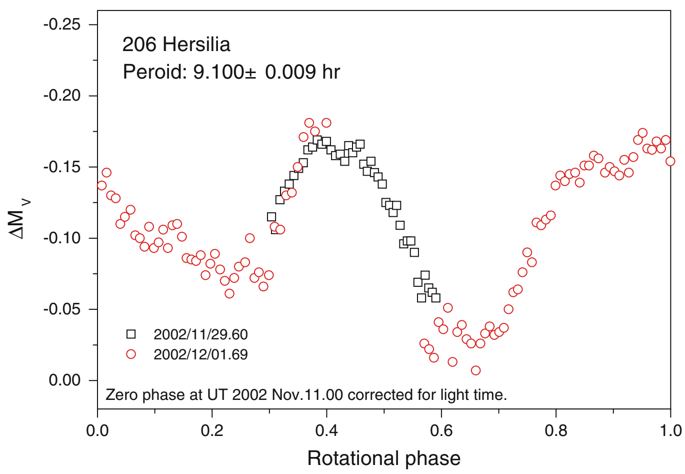

Figure 3. The lightcurve of 206 Hersilia. ΔM_v presents the magnitude difference between the asteroid and the comparison star.

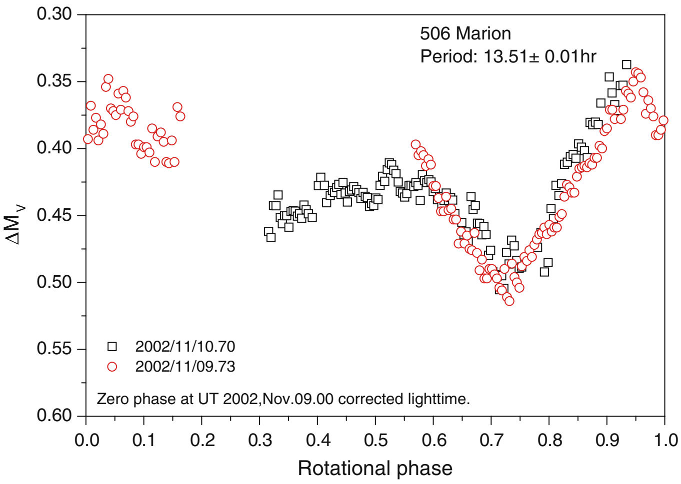

Figure 4. The lightcurve of 506 Marion. ΔM_v presents the magnitude difference between the asteroid and the comparison star.

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