CCD PHOTOMETRY OF ASTEROIDS 38, 174, 276 AND 346

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Abstract. Photometric observations of the four selected asteroids, obtained at Yunnan Observatory, China during recent two years, are presented and analysed. We have determined the synodic periods of (174)\, Phaedra and (276)\, Adeldheid as 5.74h ± 0.01 and 6.29h ± 0.01, which confirmed the previous results. For (38)\, Leda and (346)\, Hermentria, we derived their period values, 10.171h ± 0.007 and 19.408h ± 0.005 for the first time. The color-indices of 38, were re-determined as 0.73 ± 0.02 for B-V and 0.41 ± 0.02 for U-B, respectively, which are the same as the ones given by Tedesco (1989).

Keywords: Asteroids, CCD photometry, synodic period

1. Introduction

Rotational properties of asteroids are important for a better understanding of the collisional evolution of small bodies. Extension of the sample of asteroids with known spin vector is also important (Magnusson,1990). Based on the precise synodic period and lightcurve, the determination of the spin vector and its shape will be more reliable. Taking advantage of the 1-m telescope of Yunnan Observatory, we are able to obtain the quality photometric data, especially for faint and low amplitude asteroids. Quality data give an opportunity to determine synodic period and to understand better the physical properties of surface. This paper is the second one in our research series, in which we continue to present our new observations and results.

2. Observation

The observations of the four selected asteroids were performed with the 1-meter telescope with a 1024 × 1024 (24 μm/pixel) CCD at Yunnan Observatory, China during 2000–2002. We observed (38)\, Leda on 16, 25 November 2000 and 29 December 2000. The data of three nights were gathered through V filter. In order to

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TABLE I

The condition of observations for selected asteroids

Asteroid	Date (UT)	Δ (AU)	r (AU)	α Degree	λ,β(J2000.0) Degree	Dispersion mag.
38	2000/11/16.7	1.530	2.349	16.8	97.596, + 6.167	0.007
	2000/11/25.8	1.456	2.343	13.4	97.831, + 6.029	0.006
	2000/12/29.6	1.359	2.329	3.9	90.068, + 5.600	0.002
174	2001/03/19.6	2.162	2.947	13.9	133.586, + 0.089	0.010
	2001/03/20.8	2.172	2.945	14.3	133.493, + 0.029	0.017
276	2000/11/26.6	2.773	3.192	17.3	351.092, +10.088	0.020
	2000/11/27.6	2.786	3.192	17.4	351.173, + 9.970	0.090
346	2001/02/21.6	2.080	2.783	16.6	99.457, + 4.787	0.007
	2001/03/20.6	2.443	2.812	20.3	101.341, + 5.006	0.008
	2002/04/19.7	2.137	3.080	7.7	188.590, +12.348	0.012
	2002/04/20.7	2.141	3.080	7.9	188.404, +12.310	0.011

determine colour indices, some observations through U and B filters were inserted in the second night's observational sequence. For the other asteroids, only the V filter was chosen. We obtained the photometric data of (174)\, Phaedra on 19–20 March 2001. On 26–27 November 2000, (276)\, Adelheid was observed. During 2001, the (346)\, Hermentria was observed on 21 February and 20 March. After about one year, precisely, on 19–20 April 2002, it was observed again. Table I lists the conditions of observation for the selected asteroids, which included the date of observation in UT, geocentric distance Δ and heliocentric distances r (in astronomical unit), phase α, ecliptic longitude and latitude in J2000.0 reference frame. We estimated the observational quality of individual night using the dispersion of corresponding magnitude difference between two comparison stars, which is also listed in the last column of Table I.

3. Results

The methods and applied software in reducing and analysing the photometric data are the same as ones introduced in paper I (Wang, 2002). The measured magnitudes of an asteroid and corresponding comparison stars, were determined utilizing APPHOT (one of software packages in IRAF), and in some cases the DAOPHOT package was applied when the asteroid was in a crowded-field. Our main goal in this paper was to estimate the asteroid's rotational synodic period. Thus it is the magnitude difference between the asteroid and the selected comparison star was used to estimated the periods. The shift was added into individual night's observa-

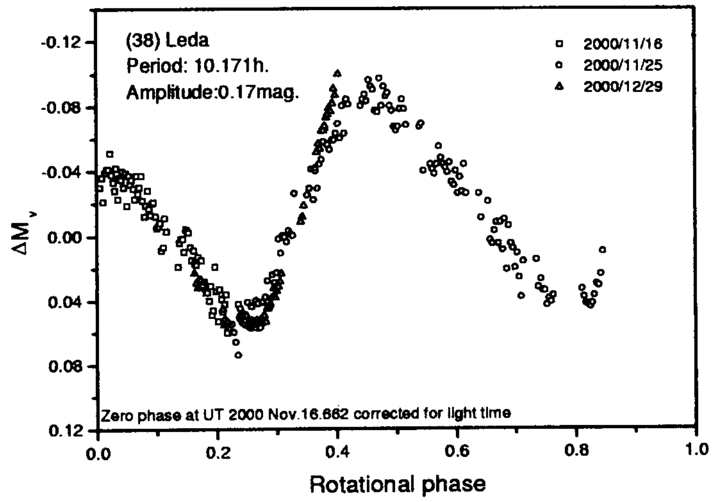

Figure 1. The lightcurve of (38)\, Leda. ΔM_v presents the magnitude difference between asteroid and comparison star.

tion in order to obtain an uniform data set. Then, the PDM method (Wang, 2002) was applied to analyse the rotational period of the asteroid. For the asteroid with an unknown rotational period, the results of PDM method will not give a unique period value for short overlap of data. We selected the period from several possibilities by comparing the reasonableness of the lightcurve when it was constructed, and by noting the dispersion of lightcurve at overlapped parts. In order to estimate the possible period values, especially for those asteroids observed in discrete nights, Julian Date was applied as the time index. The detail analysis about the observed asteroids are given as follows.

3.1. (38)\, LEDA

The (38)\, Leda, C-type asteroid had been observed previously by Carlsson and Lagerkvist (1981). They did not present any lightcurves due to short observational time. We observed the asteroid during three discrete nights. From the observations, we estimated a period of 10.171h ± 0.007 with an amplitude of 0.17 magnitude. Using the U, B and V data collected on 25 Nov. 2000, the colour-indices B-V and U-B were calculated to be 0.73 ± 0.02 and 0.41 ± 0.02, respectively. These are the same as values given by Tedesco (1989). Figure 1 shows the composite lightcurve using the estimated period. From the lightcurve, two different maxima can be noted. The difference between two maxima values reaches 0.06 magnitude, which may mean the 38 is not a symmetry body if its surface properties are uniform.

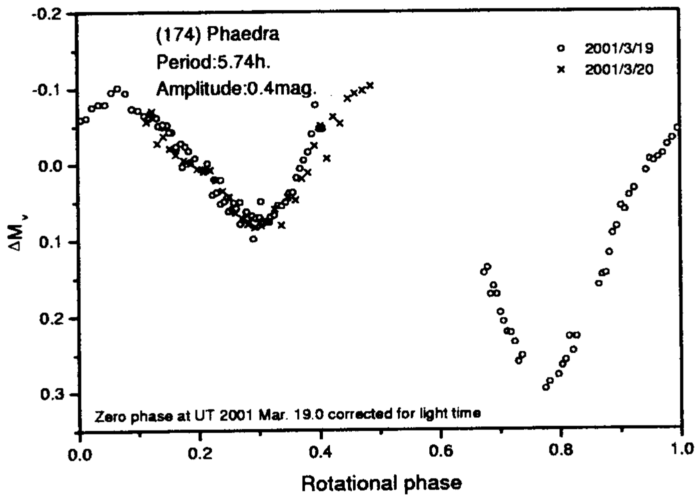

Figure 2. The lightcurve of (174)\, Phaedra. ΔM_v presents the magnitude difference between asteroid and comparison star.

3.2. (174)\, PHAEDRA

Magnusson and Lagerkvist (1991) observed (174)\, Phaedra for two nights and estimated its synodic period to be 5.8 h with amplitude of 0.53 magnitude. About one hundred and fifty new observations of (174)\, Phaedra collected during 2001 were used to estimate the synodic period. We obtained an accurate synodic period of 5.74h $\pm$ 0.01. Figure 2 shows the composite lightcurve of the asteroid. The amplitude of this apparition was 0.4 magnitude, being smaller than the amplitude given by Magnusson and Lagerkvist (1991), which may mean that this asteroid is more pole on in our observation than Magnusson and Lagerkvist's observation. Two significantly different minima (one minimum is deep, another is shallow), may reflect some information about (174)\, Phaedra's shape. The extensive observations are needed to determine the orientation of spin vector and the shape.

3.3. (276)\, ADELHEID

Carlsson and Lagerkvist's (1983) observation of (276)\, Adelheid did not provide the lightcurve due to short observation time. Piironen et al. (1994) provided a period of 6.32 h when they observed the asteroid at small phase angles. Our result is 6.29h $\pm$ 0.01. The amplitude of this apparition is small, 0.18 mag. The amplitude of lightcurve obtained by Piironen et al. (1994) was also low. Its lightcurve is displayed in Figure 3. Dispersion of the lightcurve is slightly large, but the shape of lightcurve with only one maximum during one rotation period is ascertained.

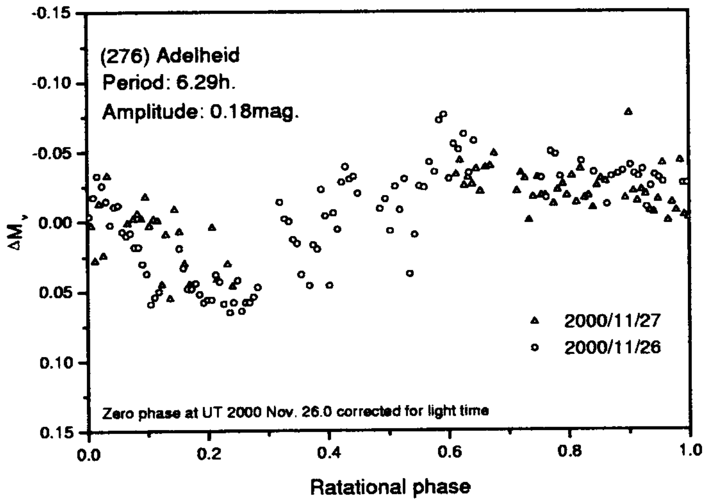

Figure 3. The lightcurve of (276)\, Adelheid. ΔM_v presents the magnitude difference between asteroid and comparison star.

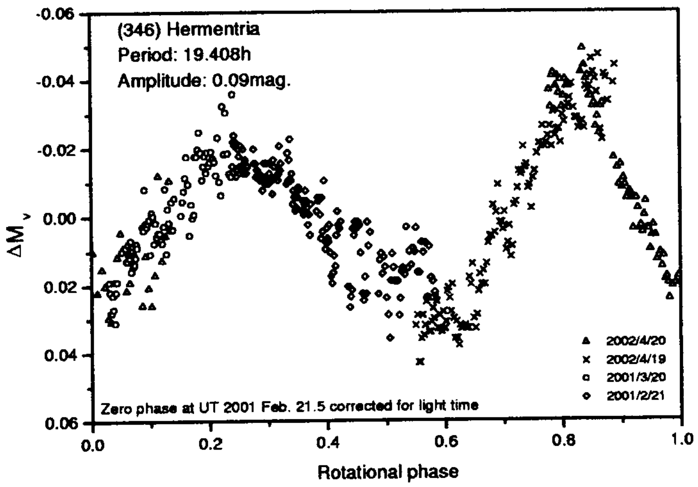

Figure 4. The lightcurve of (346)\, Hermentria. ΔM_v presents the magnitude difference between asteroid and comparison star.

3.4. (346)\, HERMENTRIA

The rotational period of (346)\, Hermentria has not been determined previously. We were not able to determine its rotational period using only the observations of 21 February and 20 March 2001. So, we observed the asteroid again on 19–20 April 2002. Using the PDM method, we derived the rotational period of 19.408h $\pm$ 0.005 with an amplitude of 0.09 magnitude. Figure 4 shows the composite lightcurve of the (346)\, Hermentria. The dispersion near 0.8 phase, we think, was caused by slight variation of synodic period for large interval between two sets of observation. The extensive observations are needed to ascertain the orientation of spin and to determine the shape.

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