CCD lightcurves of several asteroids during their last apparitions

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Abstract

CCD photometry of asteroids have been carried out since November 1993 at the Bulgarian National Astronomical Observatory - Rozhen, using 2m RCC telescope and since July 2000 using a 0.50m/0.70m Schmidt telescope equipped with a CCD camera ST-8E. Possibilities of further photometric investigations will be discussed.

1 Instrumentation

The data were obtained with CCD camera Photometrics CE200A, comprising $1024 \times 1024 px^2$, $24 \mu m$ attached to 2m RCC telescope and CCD camera SBIG ST-8E Kodak KAF-1602E, comprising $1530 \times 1020 px^2$, $9 \mu m$ attached to 0.50m/0.70m Schmidt telescope at the National Astronomical Observatory, Rozhen. These combinations give fields of view $5'.26 \times 5'.26$ and $18'.35 \times 27'.52$, respectively.

2 Observations

Basic data for the observation are shown in Table 1.

Table 1: Geometrical conditions during the observations

Object	Date	Phase,Θ	m_V	Telescope	CCD
(7072) Beijindaxue	1998 12 25	00.4	17.6	2m RCC	CE200A
(1019) Strackea	2001 06 17	30.5	15.3	2m RCC	CE200A
(1019) Strackea	2001 06 26	31.5	15.4	Schmidt	ST-8E
(3443) Leetsungdao	2001 08 21	15.9	14.6	Schmidt	ST-8E
(509) Iolanda	2001 08 20	09.1	12.7	Schmidt	ST-8E

3 Data reduction

3.1 Preliminary reduction

- Bias (dark frame) subtraction. For this purpose master biases (dark frames) are used (Howell S. B., 2000);

- Flat fielding. Twilight and dawn sky flat fields are used for the master flat which has precision $< 1\%$;

- Cosmic rays removal. For this purpose BUIE acre procedure is used (Buie, M. W., 1998).

3.2 Aperture photometry and lightcurve analysis

For photometric measurement we use CCDPHOT software (M. W. Buie, 1998), which allows making aperture photometry. For lightcurve analysis - Asteroid Photometric Catalog Software (APC) (Lagerkvist et al, 1993), which produce composite lightcurves from several nights, calculate rotational period and also can make Fourier analysis fitting procedure of the lightcurve.

4 Results

Lighturves are derived from on-chip differential magnitudes between asteroid and comparison stars. For asteroids Strackea (1019) and Leetsungdao (3443) the composite lightcurves and preliminary calculations of synodic period are made (Fig. 1 and Fig. 2, respectively).

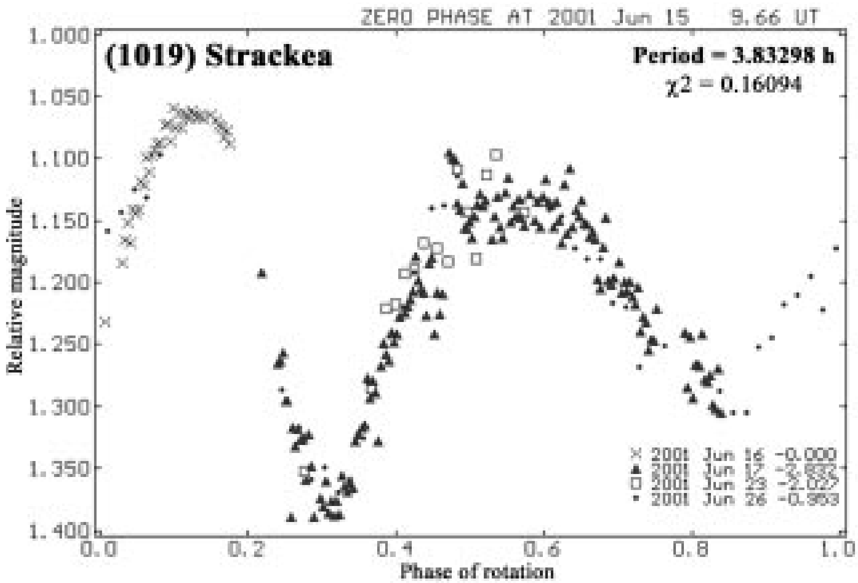

Figure 1: Lightcurve of asteroid (1019) Strackea

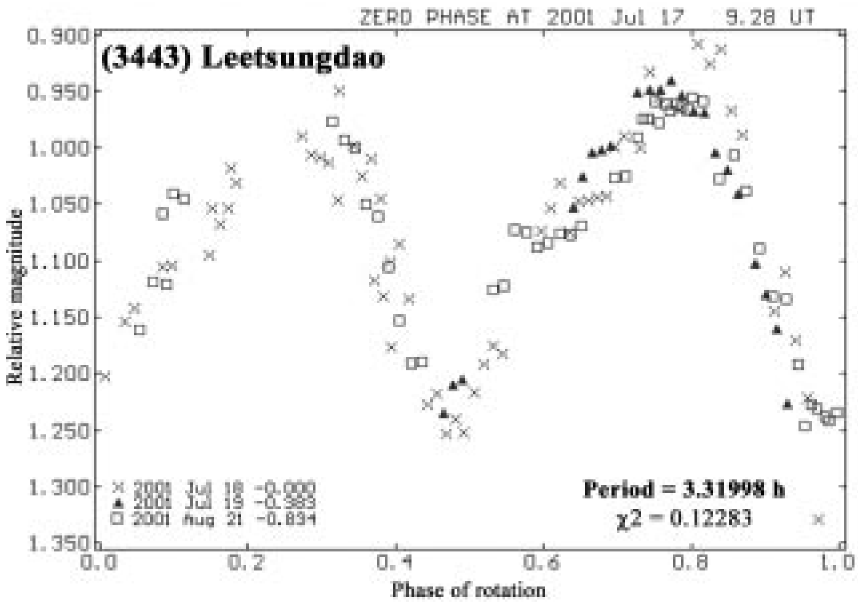

Figure 2: Lightcurve of asteroid (3443) Leetsungdao

For one of them (1019) we have observations from four different nights with two different telescopes and these results are more reliable. The other asteroid (3443) was observed three night, but there was covered more than one period on two of them – 18 July 2001 and 21 August 2001.
Single night partial lightcurve of (7072) Beijindaxue suggesting a period of ~ 10 hours. Period for (509) Iolanda was reported to be $12\overset{h}{.}306$ and in one night half of the rotation cycle has been covered.
All lightcurves are obtained with observations in V band. Also images in B, R and I filter for colour index determination are made. According to the sensitivity of the camera observing in U band is meaningful only for very bright asteroids ($m_v < 14$). In order to transform observation to a standard magnitude scale standards from the catalogue of Landolt (Landolt, A., 1992) were observed.

5 Strategy of observations and data reduction

In the lightcurves of asteroids (509) Iolanda and (7072) Beijindaxue (Fig. 3) are visible holes which appeared because during the time of observation images of standard fields were taken. As everyone can see, these holes in lightcurves are obstructions for lightcurve analysis. Because of this observing program need to be revolved very well before observations. For example standard fields need to be chosen so that the best time for their observations to be just at the beginning and at the end of observations. If we have possibility to chose such standards we can eliminate this holes in lightcurves and after this we can measure rotational period with much better accuracy. The other thing that we can do for obtaining good results is somehow to minimize errors as much as possible. The one of the most important thing for this is obtaining images with

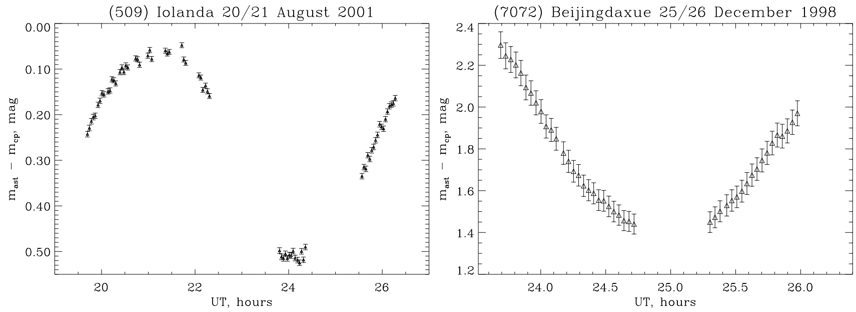

Figure 3: Lightcurve of asteroid (509) Iolanda and (7072) Beijindaxue

better S/N ratio. Often in asteroids observation this is impossible, because of their proper motion. For better S/N ratio we need to obtained images with long exposure, but then asteroids will look like tracks. Because of this we need to combine several images with smaller exposure, as settle them by asteroid position. For this purpose we subtract sky locally around the asteroid and then gather frames. After this procedure we have images with many tracks of all the stars and good starlike asteroid. In such a way we have good S/N ratio about photometry of asteroid. We also can make the same for the stars in the field of view and to use some of them for comparisons. This settle-procedure allow us better lightcurve analysis of faint and fast asteroids.

Conclusion

We have presented composite lightcurves and preliminary calculations of synodic period for two asteroids (1019) and (3443), as well as two partial differential lightcurves for (7072) and (509). No previous published periods of asteroids (7072) Beijindaxue, (1019) Strackea, and (3443) Leetsungdao have been found so far. The transformation to the $UBVRI$ standard system will be performed with a software PDP (Photometric Data Processing) (Denchev, P., 2000). This program was used for the reduction of photoelectric data taken in a UBV photometric system and should be modified for the reduction of CCD photometric data.

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