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LETTER

Letter to the Editor

Short period oscillations in the light curve of the asteroid 1689 Floris-Jan

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Abstract. We present CCD photometry of the long period asteroid 1689 Floris-Jan. On the light curve from nights 1997.02.10/11 and 1997.02.11/12 we detected coherent sine-like oscillations with a period P=4.98 $\pm$ 0.01 minutes and full range amplitude of about 0.11 mag. The observations from night 1997.03.07/08 show no light variations with this period.

Key words: minor planets, asteroids

1. Introduction

The asteroid 1689 Floris-Jan is a small size object from the main asteroid belt. It was discovered in September 1930 by H. Van Gent. The diameter of 1689 Floris-Jan is estimated to be 9 to 27 km depending on the assumed albedo. In 1982 Schober et al. (1982) presented UBV photometry of this object, which revealed its unusually long period of rotation of 6.042 $\pm$ 0.21 days. Typical periods of rotation of asteroids range from about 2 to about 20 hours. For many years this asteroid was considered to be one of the slowest rotators among minor planets. In 1997 our colleagues from the Astronomical Observatory of Adam Mickiewicz University, Poznań, selected 1689 Floris-Jan as a target for the observations in a long term program of CCD photometry of minor planets (Kryszczyńska et al., 1996).

2. Observations, data reduction and photometry

The observational data were collected at the Ostrowik Station of the Warsaw University Observatory on the nights of February 10, February 11, and March 7, 1997. We used a CCD system attached to a 0.6 m telescope (Udalski and Pych, 1992). On the nights of February 10, 1997 and February 11, 1997, we used Cousins I filter for 120 second exposures. On the night of March 7, 1997, we made unfiltered exposures with the integration time of 60 seconds. De-biasing and flat-fielding were done with the procedures available in the IRAF[1] package. The aperture photometry was obtained with the DaophotII program (Stetson, 1987). Since the object was moving, observed fields were different each night. The sum of the light of several bright, apparently constant stars was used as a comparison for each field.

3. Results and data analysis

Light curves obtained in February, 1997, are presented in Figs. 1 and 2. These figures are plotted with the same scales in both axes. Fig. 1 presents the light curve of the 1689 Floris-Jan obtained on the night 1997.02.10/11 compared with a nearby star. Although there are only 12 data points, the oscillations of the light of the asteroid are clearly visible. Fig. 2 presents the light curve of the 1689 Floris-Jan compared with the light curves of two nearby stars, obtained on the night 1997.02.11/12. Our observations were obtained a few days after the opposition of the 1689 Floris-Jan. The heliocentric and geocentric distances and the phase angle were increasing. The apparent brightness of the object should then be rather declining. The observed monotonic rise of brightness is therefore interpreted as the manifestation of the long rotational period of the asteroid. Short period light variations with an amplitude of about 0.1 mag. are superimposed onto the long term trend. Several possible instrumental effects were checked to be the reason for such oscillations. None of them were found to have such a large amplitude or to be periodical with the time-scales of minutes.

We subtracted the linear trends from the data from February 10 and 11 separately. In order to determine the period of the short period modulation we computed power spectra using the AoV (Schwarzenberg-Czerny, 1991) and Fourier-Clean (Roberts et al., 1987) algorithms. Fig. 4 shows the periodograms computed on the collected data points. The peaks corresponding to the period of 0.003461 $\pm$ 0.000006 [days] (4.98 $\pm$ 0.01 minutes) are clearly present on both periodograms.

Fig. 5 presents the phased light curve based on the points from the two nights. The solid line shows sine fit to the obtained light curve. The full amplitude of the fit is 0.084 mag. Since the exposure time was about 40% of the period, the observed amplitude is smaller than the real one. In the case of an exposure

[1] IRAF is distributed by the National Optical Astronomical Observatories, operated by the Association of Universities for Research in Astronomy, Inc., under contact with the National Science Foundation

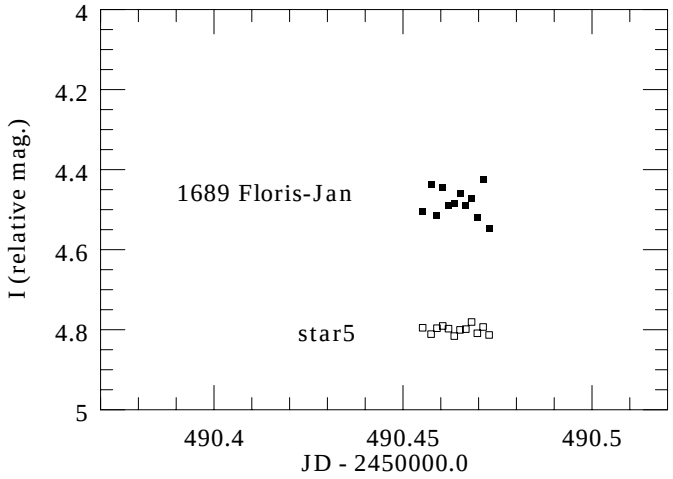

Fig. 1. Light curve of 1689 Floris-Jan compared with the light curve of a nearby star. Data from 1997.02.10/11

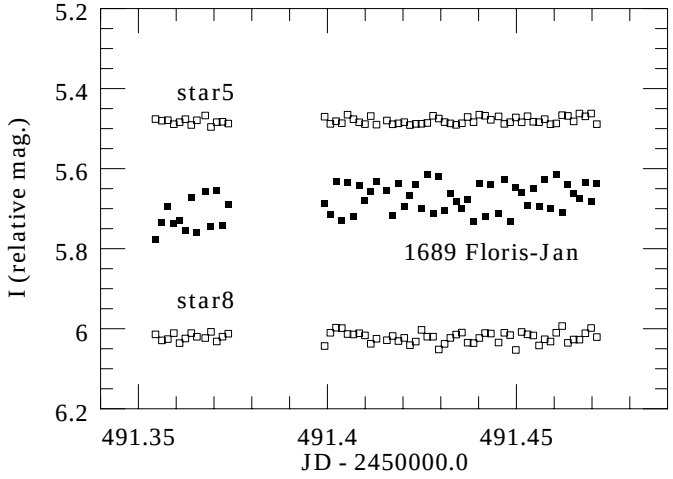

Fig. 2. Light curve of 1689 Floris-Jan compared with two light curves of a nearby stars. Data from 1997.02.11/12

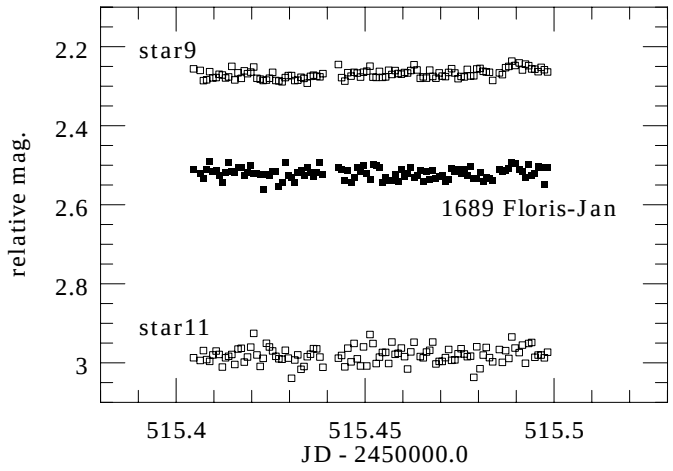

Fig. 3. Light curve of 1689 Floris-Jan compared with two light curves of a nearby stars. Data from 1997.03.07/08

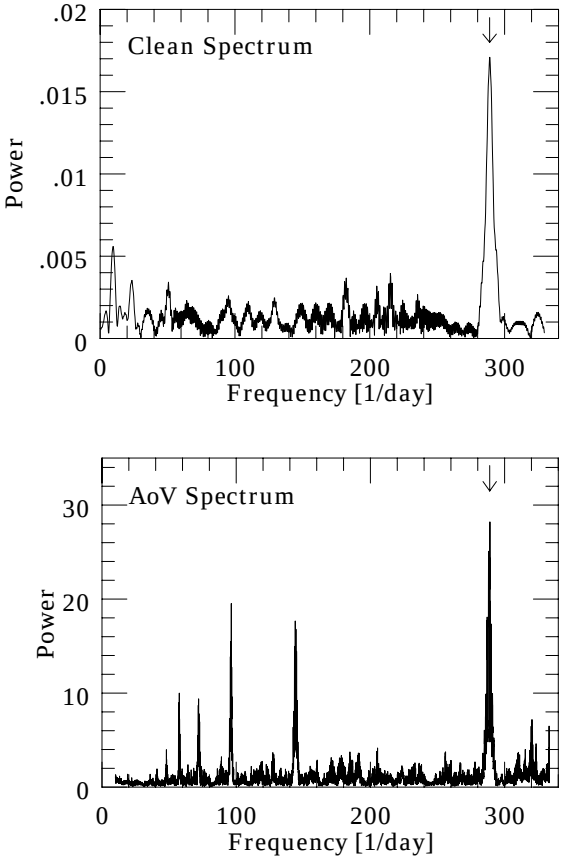

Fig. 4. 1689 Floris-Jan: Clean and AoV periodograms of data points from 1997.02.10/11 and 1997.02.11/12

centered at the maximum brightness, the observed amplitude is given by the formula:

$$A_{obs} = A \cdot \frac{\int_{0.1\pi}^{0.9\pi} \sin(t) dt}{\int_{0.1\pi}^{0.9\pi} dt} \tag{1}$$

Because of that we made the amplitude correction according to the following formula:

$$A = A_{obs} \cdot \frac{\int_{0.1\pi}^{0.9\pi} dt}{\int_{0.1\pi}^{0.9\pi} \sin(t) dt} \approx 1.32 \cdot A_{obs} \tag{2}$$

This correction yields the true amplitude of about 0.11 mag.

The photometric light curves of asteroids are thought to provide information about their rotation. In such case the period of rotation should be two times longer than the period obtained from the Fourier analysis of a sine-like signal (i.e. about 10 minutes). The six day period should then represent the slow rotation along a different axis. This interpretation is in conflict with the fact that no light oscillations of the 5 minute period are observed in the data obtained on the night of March 7, 1997. The light curve of 1689 Floris-Jan presented in Fig. 3 shows no significant light variations. This may happen when we look at the rotating object along its axis of rotation. In our opinion the probability that we are dealing with such a case is very small.

Lately two independent groups claimed similar periodicity in the light variations of an Apollo-type object 1998 KY26

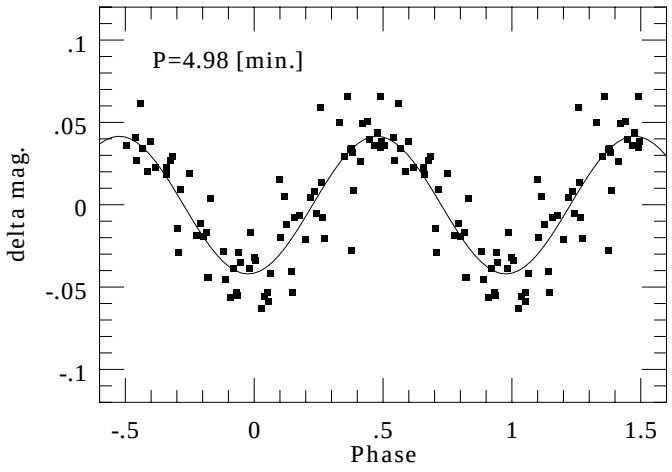

Fig. 5. 1689 Floris-Jan: Phased light curve. Data points from 1997.02.10/11 and 1997.02.11/12 after linear trend subtraction.

(Hicks and Rabinowitz, 1998; Pravec and Sarounova, 1998). These oscillations were detected in the radar observations (Ostro et al., 1998), which suggests their rotational origin. We conclude then that the ultrashort periodicity is not a feature of this particular object and may be present also in other asteroids.

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