COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5748

Konkoly Observatory
Budapest
22 January 2007

HU ISSN 0374 – 0676

DETECTION OF A LARGE FLARE IN FR Cnc (=1RXS J083230.9+154940)

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FR Cnc (= BD+16°1753 = MCC 527 = 1ES 0829+15.9 = 1RXS J083230.9+154940 = HIP 41889 = GSC 01392-02634 = TYC 1392-2634-1) (α_{2000} = $08^{\rm h}32^{\rm m}30\overset{\rm s}{.}5287$ and $\delta_{2000} = +15°49'26\overset{''}{.}193$) was first mentioned as a probable active star when it was identified as the optical counterpart of a soft X-ray source 1ES 0829+15.9 in the Einstein Slew Survey. It has $V = 10\overset{\rm m}{.}43$, spectral type K8V, the X-ray flux is of $\approx 10^{-11}$ erg $\cdot$ s^{-1} $\cdot$ cm^{-2} (Elvis et al., 1992; Schachter et al., 1996).

It was classified as BY Dra type star (i.e. its variability is caused by rotational modulation of starspots) and given the name FR Cnc by Kazarovets et al. (1999). The presence of Ca II H, K and H_α emission lines in the spectra indicates high chromospheric activity in FR Cnc (Pandey et al., 2002; Pandey, 2003). The other details concerning history of investigation of this object can be found in Pandey et al. (2005)

Flares in FR Cnc were not previously reported.

FR Cnc was observed on 23 November, 2006 quasi-simultaneously in B, V, R_j, I_j bands at Crimean Astrophysical Observatory (Ukraine) by Alex Golovin, using 38-cm Cassegrain telescope, which is equipped with SBIG ST-9 CCD camera, cooled by a Peltier system to about −30 °C. The exposure times were 20 s, 13 s, 8 s and 17 s for B, V, R_j, I_j bands respectively. Data reduction was done using "Maxim DL" package. Reduction included bias, dark-frame subtraction and flat field correction using twilight sky exposures. Since the field of FR Cnc is not crowded, the technique of aperture photometry was applied to extract the differential magnitudes. The total number of useful frames was 89 for each band. The brightness of FR Cnc was measured with respect to GSC 1392-2636 (α_{2000} = $08^{\rm h}32^{\rm m}23\overset{\rm s}{.}698$; $\delta_{2000} = +15°46'50\overset{''}{.}15$), while GSC 01392-02708 (α_{2000} = $08^{\rm h}32^{\rm m}38\overset{\rm s}{.}2271$; $\delta_{2000} = +15°44'22\overset{''}{.}095$) served as a check star. Since the magnitudes of the comparison star in all bands are not known, here we present just differential magnitudes.

The data points have a statistical accuracy of $0\overset{\rm m}{.}01$ or better (determined from the difference *check star−comparison star*). To rule out the possibility of observing brightness variations caused by the comparison star, an independent photometry of GSC 1392-2636 (comp. star) was performed with respect to the check star (GSC 01392-02708).

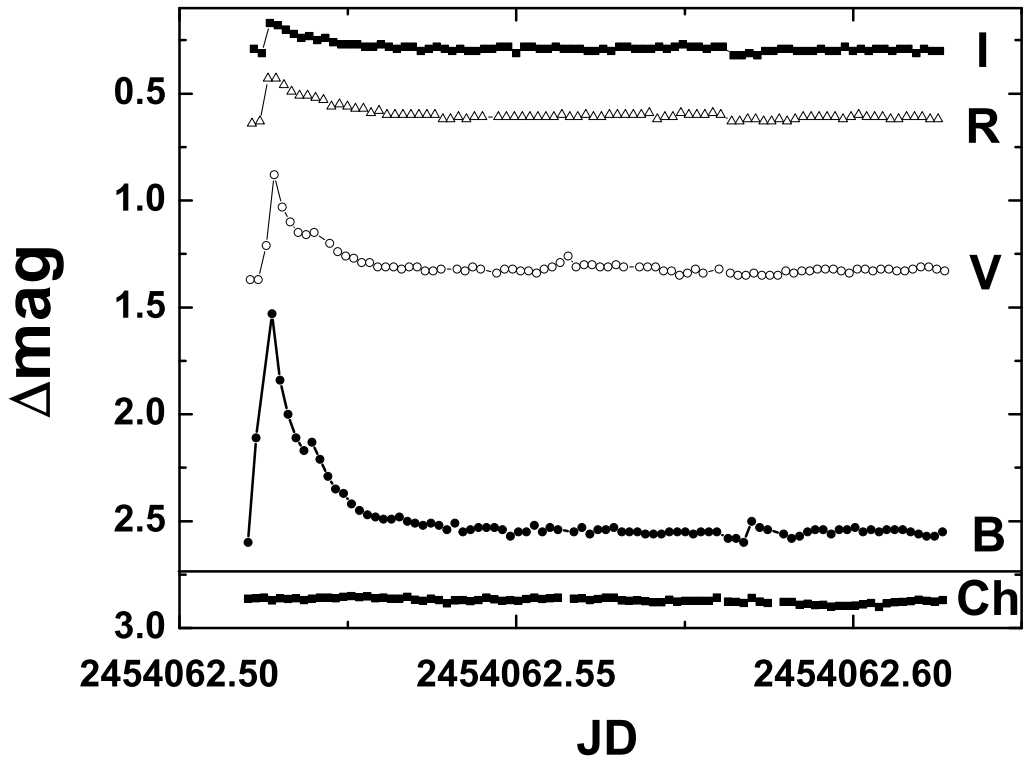

Figure 1. The flare of FR Cnc: shifted differential lightcurves in B, V, R and I bands as well as the difference *check star* − *comparison star* ('Ch' on the plot)

The flare of FR Cnc was detected on 23 November, 2006 with the maximum at 00:19 (UT). After the initial rapid flaring, the brightness of FR Cnc decreased slowly. The time between the flare began and reached its maximum was about 4 minutes, while the total duration of the flare was about 41 minutes.

The flare had a maximum amplitude ($1\overset{\mathrm{m}}{.}02$) in the B band. In other bands the amplitudes were $0\overset{\mathrm{m}}{.}49$, $0\overset{\mathrm{m}}{.}21$ and $0\overset{\mathrm{m}}{.}14$ for V, R_j and I_j bands respectively.

Noteworthy, in 8 minutes after the flare's maximum a notable "spike" was observed in B and V bands (in other bands the amplitude was probably too low) during the brightness decline. Remarkable, that FR Cnc remained to be about $0\overset{\mathrm{m}}{.}05$ brighter for at least an hour after the flare began comparing with brightness before flare.

Following the idea, described at Kozhevnikova et al. (2006), we calculated the intensity of the flare and the *absolute* energy output. The relative intensity of the flare was determined via the following relation: $\frac{I_f}{I_0} = (\frac{I_0+I_f}{I_0}) - 1$, where $I_0 + I_f$ is the intensity of the object, integrated over the duration of the flare, I_0 is the intensity of the star in quiescent level in one of the bands (corrected to the flare duration). For calculation of the *absolute* energy output, we assume for FR Cnc's quiescent level the following magnitude and colour indices: $V = 10.43, B - V = 1.35, V - R = 1.15, V - I = 1.93$. We used 30.24 ± 2.03 mas parallax (Perryman et al., 1997) that imply distance 33 ± 2 pc.

Similar calculations of the flare intensity and energy output were also done by Moffett (1973) and by Panov et al. (2000).

So, we get the values listed in Table 1. Fig. 1 shows differential lightcurves in B, V, R_j and I_j bands of FR Cnc during our observations on 23 November, 2006.

However, the observed rotational period (0.8267 ± 0.0004 from Pandey et al., 2005) is

Table 1. Flare properties

Band	Amplitude [mag]	Flare flux/quiescent flux [%]	Flare energy [erg / Å]
B	1.02	38.63	1.73×10^{31}
V	0.49	14.05	1.14×10^{31}
R	0.21	8.25	0.89×10^{31}
I	0.14	2.9	0.29×10^{31}

unusually short for such type of stars, which implies that this star should manifest strong flaring activity (see Dorren et al., 1994). We detected a flare of FR Cnc for the first time. Further monitoring of this object is highly desirable.

Acknowledgements: First of all, it is a great pleasure for the authors to express here sincere thanks to Galvez Mari Cruz (Depto. Astrofisica, Universidad Complutense de Madrid, Madrid, Spain) for pointing our interest to this object. Authors are very grateful to R. Gershberg, A. Kozhevnikova and I. Alekseev for valuable comments. Alex Golovin indebted to Jevgeniy Kachalin for his great help with preparation this manuscript and for the proof-reading. It is a great pleasure for Alex Golovin to express personal thankfulness to Maksim Andreev (Terskol Branch of the RAS Institute of Astronomy, Terskol, Russia) for useful discussions and suggestions during preparation of this paper.

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