

## FR Cnc - A Young Spotted Star

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**Abstract.** Optical photometric and spectroscopic studies of the star FR Cnc = BD +16 1753 have been carried out during the years 2001 - 2002. The star is photometrically variable with a mean period of  $0^d.8271 \pm 0.0002$ . The rapid changes in the shape of light curve can be attributed to the formation and distribution of two groups of spots on the surface of the star. The presence of strong CaII H, K and  $H_\alpha$  emission lines in the spectra indicates high chromospheric activity in the star. The kinematics of the star suggest that it belongs young population of disk stars.

*Keywords :* Star – young – active – X-ray

### 1. Introduction

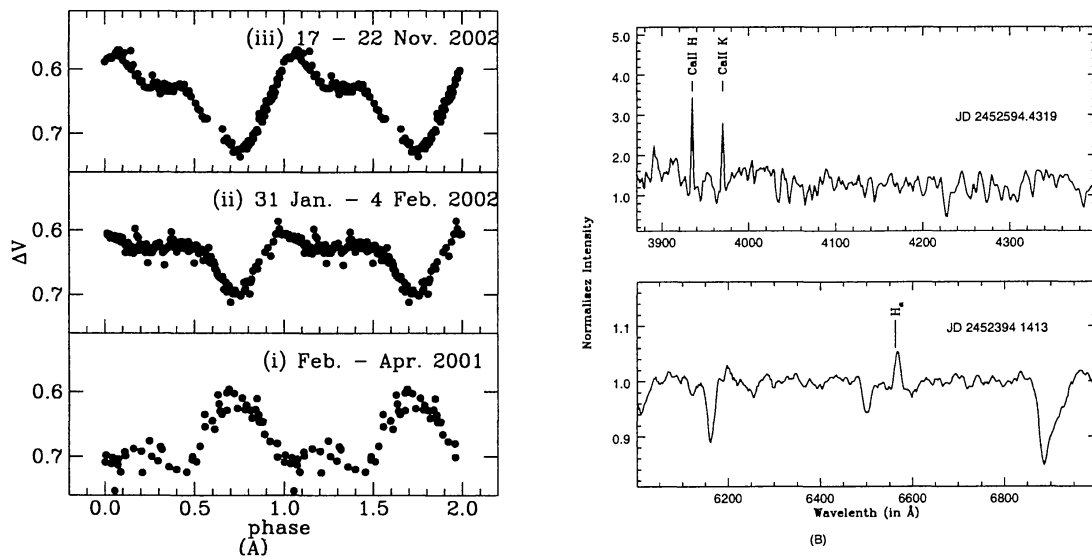
X-ray emission from late type stars is a useful way of finding their chromospheric/coronal activity. BD +16 1753, a dK type star of V magnitude 10.43 was detected as a soft X-ray source 1ES 0829+15.9 = 1RXS J083230.9+154940 ( Elvis et al. 1992; Voges et al. 1999). The ratio of X-ray to bolometric luminosity  $f_x/f_{bol}$  of  $10^{-3}$  shows that the star may have an active corona. It is classified as unsolved Hipparcos variable (FR Cnc) with 0.17 mag variability and suspected BY Dra variable (Kazarovets et al. 1999). FR Cnc was found to be photometrically variable with period of  $0^d.827 \pm 0.002$ . The radial velocity measurements indicate that it is more likely a single star ( Pandey et al. 2002 and references within) .

### 2. Observations

BVR broad band observations were taken from the State Observatory Naini Tal using  $2K \times 2K$  CCD mounted at 104 cm Sampurnanand reflector.  $H_\alpha$  spectroscopic measurements were also

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**Figure 1.** (A) Light curve of FR Cnc in V band at different epochs using period 0.827 and an arbitrary epoch JD = 2451943.1980. (B) Spectrum of FR Cnc near  $H_{\alpha}$  and Ca II H and K region.

done from the same telescope using low resolution HR-320 spectrograph while *Ca I H* and *K* spectroscopy were done from 2.3 m Vainu Bappu Telescope Kavalur using Medium resolution Optometrics Research Spectrograph (OMRS). Both photometric and spectroscopic data were reduced using IRAF .

### 3. Results and Conclusion

The light curve of FR Cnc in the V filter is presented in Fig. 1(A) at different epochs. For this, differential magnitudes of the program star were determined with respect to comparison stars located in the same CCD frame (see Pandey et al. 2002). The full set of the data was analyzed for the periodicity using 'standard period finding techniques' and a mean period  $0^d.8271 \pm 0.0002$  was found. To plot the light curve in chronological order an epoch JD 2451943.1980 and period  $0^d.8271$  were used. The minimum of light curve was shifted in each epoch. At the same time the amplitude of the V - light curve changed; it decreased from 0.11 mag to 0.10 mag during epoch (i) to epoch (ii) then increased during the epoch (iii) to 0.16 mag. This implies that the variability could be due to the presence of spots on the surface of star. Also the shift of the minimum on the light curve indicate the wave like distortion in FR Cnc. Each light curve shows two phase minima at  $\sim 180^\circ$  longitude apart indicating the presence of two spots (or group of spots).  $H_{\alpha}$  and *Ca I H* and *K* emission in the spectrum indicate high chromospheric activity in the star ( see top and bottom panel of Fig. 1(B)). The galactic space velocity component ( $-24.1, -22.8, -5.1$ ) km/sec of FR Cnc indicate that it is a young population disk star.

It is clear from highly variable light curve, amplitude variation, phase shift, strong CaII H and K and  $H_\alpha$  emission, X-ray emission and youthfulness of FR Cnc that it is a highly active and spotted star.

### References

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