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RXTE Observations of Magnetic Cataclysmic Variables

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Abstract. Results from hard X-ray observations with *RXTE* of 5 Polar systems– V2301 Oph, V1432 Aql, EP Dra, GG Leo and V834 Cen, and an Intermediate Polar TV Col are presented. An improved ephemeris for V2301 Oph using mid-eclipse timings has been derived. V1432 Aql shows structured lightcurve containing several prominent peaks and dips. A likely eclipse of X-ray source in EP Dra is observed for the first time. The X-ray emission in EP Dra and GG Leo is found to be consistent with a single pole accretion. V834 Cen was observed to be bright during 1996–1998, but was ≥16 times fainter during 2002 observations. The power spectrum of TV Col shows a significant power at frequencies corresponding to the spin period (1910s) and the binary period (5.5hr) and their side-bands, thereby suggesting that both the stream-fed and disk-fed accretion components are present in TV Col.

Keywords : binaries: close – novea, cataclysmic variables – stars: individual – TV Col – X-rays: stars.

1. Introduction

Magnetic Cataclysmic Variables (MCVs) are close binary systems in which a white dwarf with a strong magnetic field (B>10 MG: Polars; B<10 MG Intermediate Polars, IP) accretes matter from the Roche-Lobe filling late type dwarf companion. The hard X-ray emission from MCVs mainly comes from the shocked hot plasma near the white dwarf surface. Thus, hard X-ray study of MCVs provides good insight about the region close to the white dwarf. It can also be useful to investigate the coupling region where the accretion stream from the secondary impacts on to the accretion disk or the magnetosphere. We have analysed the X-ray data for several MCVs (as mentioned in the abstract) from Rossi X-ray Timing Explorer (*RXTE*). The page limitations for this paper do not allow us to present all the results. *Below, we present only the results from X-ray analysis of an Intermediate Polar TV Col. The results regarding the 5 Polars are presented briefly in Singh et al. (2003) and summarized in the abstract.*

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2. TV Columbae

TV Col, an IP, was first discovered with the *ARIEL V* satellite (Cooke et al. 1978) and identified as an optical counterpart of a hard X-ray source (2A 0526-328) by Charles et al. (1979). It is a 13-14 mag star at a distance of 368^{+17}_{-15} pc (McArthure et al. 2001). Multiple periods of 5.2 hr, 5.5 hr and 4 days for TV Col have been observed in optical observations (Augusteijn 1994 and references therein) but not seen clearly in any of past X-ray observations. The spin period of white dwarf (1911±5 s) has been seen clearly in X-rays (Schrijver et al. 1987; Norton & Watson 1989) but not observed in optical bands.

The source lightcurve in 2–20 keV band was extracted and analysed for its power spectrum. The power spectrum obtained using 1-dimensional "CLEAN" algorithm is shown in Figure 1(left). The most dominant peak in the power spectrum corresponds to the spin frequency (ω) of the white dwarf, and corresponds to a spin period of 1909.7±2.5s. A significant power is also observed at frequency corresponding to a value of 19819±267s, close to the 5.5h orbital period (orbital frequency, Ω_o). Several side-bands due to the interaction of these periods and side-bands due to interaction of Ω_o with the 4 day disk precession period (precession frequency, Ω_{pr}) are also present in the power spectrum of TV Col as shown with tick-marks in Fig. 1(left). We have marked only those frequencies that are related to system. The tick-marks represent frequency components Ω_o-$3\Omega_{pr}$, Ω_o, $2\Omega_o$-$3\Omega_{pr}$, $2\Omega_o+\Omega_{pr}$, $3\Omega_o$, $3\Omega_o+\Omega_{pr}$, $4\Omega_o$-$3\Omega_{pr}$, $4\Omega_o+\Omega_{pr}$, ω, $\omega+2\Omega_o$, $\omega+3\Omega_o$ and $2\omega+3\Omega_o$ respectively. Folded X-ray lightcurves of TV Col are shown in Figure 1(right). The upper panel shows intensity modulation with the spin period and the lower panel shows the orbital modulation of the hard X-rays. An arbitrarily defined epoch is used for

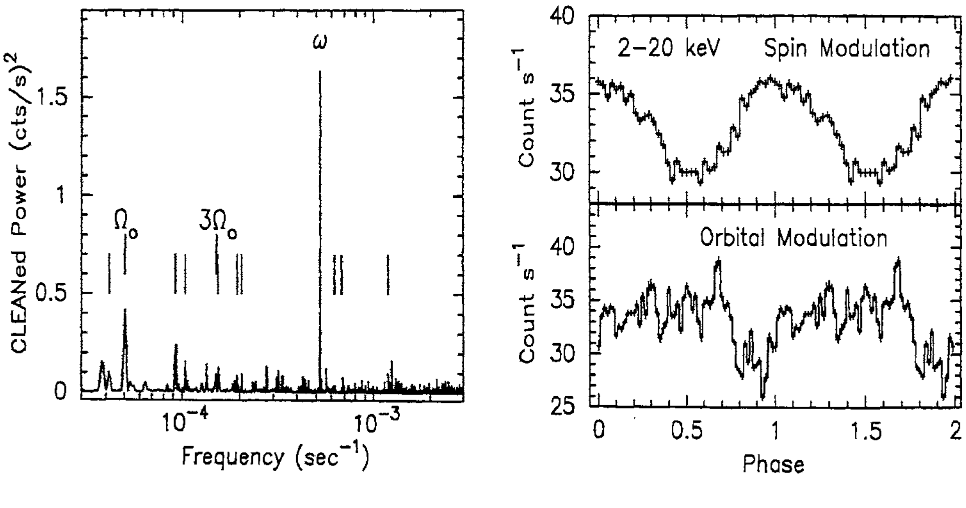

Figure 1. Left: The CLEANed power spectrum of TV Col in 2–20 keV energy band from the 1996 *RXTE* observations. Right: The X-ray lightcurves folded on the spin period of the white dwarf (top) and folded on the binary period (bottom).

folding the lightcurve on the spin period whereas an accurate ephemeris as given by Augusteijn et al. (1994) is used for folding the lightcurve on the binary period. The spin modulation follows a nearly sinusoidal profile, whereas the orbital modulation is highly non-sinusoidal.

According to Norton et al. (1996) the presence of frequency components that are observed for TV Col indicate a combination of disk-fed and a stream-fed accretion for this source. The broad dip during the binary phase ϕ=0.7-1.1 is consistent with absorption by a high density material fixed in the orbital frame. The substructure in the dip profile suggests that the absorber is distributed non-homogeneously. A common explanation for such absorption feature in IPs is the interaction of accretion stream from the secondary with the accretion disk or the magnetosphere which can in turn produce shocks and throw some material out of the plane of the disk into the line-of-sight and thus give absorption feature modulated over the binary period. On the other hand the spin modulation of X-rays can arise due to self- occultation of X-ray source and/or due to absorption and electron scattering in the accretion curtain. A detailed analysis and discussion is being published elsewhere (Rana et al. 2003).

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