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Broad-band X-ray properties of magnetic cataclysmic variables

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Abstract. Intermediate Polars (IPs), the hardest X-ray emitting Cataclysmic Variables (CVs), thanks to the Integral, Swift and RXTE slew surveys, are now believed to constitute a potentially important population of galactic X-ray sources with detections up to ~90 keV. A significant fraction of IPs was recently discovered to exhibit a soft, black-body component spanning a broad range of temperatures (30–100 eV). Their broad-band X-ray spectral properties are however known for a handful of bright sources which could be observed simultaneously from 0.2 to 100 keV. A full characterization of this class of accreting magnetic CVs is still missing but well suited for the broad-band, high sensitivity Simbol-X mission.

Key words. Stars: binaries:close – Stars: Cataclysmic Variables – X-rays: binaries

1. Introduction

Cataclysmic Variables (CVs), close binaries containing an accreting white dwarf (WDs) from a late type Roche-lobe filling secondary star, represent a large fraction of the galactic population of compact interacting binaries. The magnetic systems (mCVs) constitute a conspicuous group representing ~ 25% of all CVs. They are divided into the Polars (63%) with field strength high enough (~10-230 MG) to lock the WD rotation with the orbital period and the Intermediate Polars (IPs) (37%), which are instead highly asynchronous ($P_{rot} << P_{orb}$) with likely lower magnetic field WDs. The latter are the brightest and hardest X-ray sources among CVs with $L_X \sim 10^{32} - 10^{33}\,\mathrm{erg\,s^{-1}}$. Interest in IPs has grown recently, being a potentially important population of galactic X-ray sources (Muno et al. 2004; Ruiter et al. 2006;

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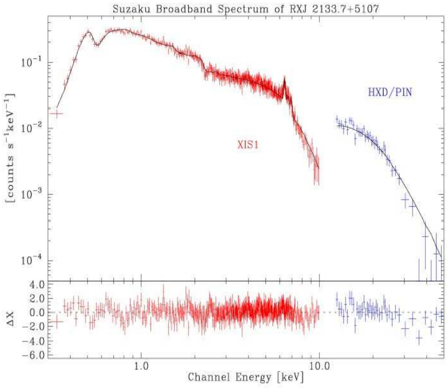

Fig. 1. The remarkable broad-band X-ray spectrum of the IP RX J2133+5107 observed by Suzaku fitted with a composite model (Mukai et al. 2007).

Sazonov et al. 2006; Barlow et al. 2006). New IP candidates have increased this group by ~ 50% in the last 4 yrs (Gänsicke et al. 2005; Bonnet-Bidaud et al. 2006, 2007). Also, 5% of the Integral source catalogue are CVs most of them IPs (Masetti et al. 2006; Bird et al. 2007; Bonnet-Bidaud et al. 2007), suggesting that they may represent a still hidden population of galactic X-ray binaries.

2. X-ray spectral properties

The X-ray emission of IPs, was found to extend up to about 90 keV (de Martino et al. 2001, 2004; Falanga et al. 2005; Bonnet-Bidaud et al. 2007; de Martino et al. 2007). A few systems were studied above 30 keV and, as of today, only a handful of bright IPs were observed simultaneously on a wide energy range (0.2–100 keV) with BeppoSAX and Suzaku (de Martino et al. 2001, 2004; Mukai et al. 2007) (see Fig. 1). A broad-band coverage is important because the X-ray emission is known to be complex with multiple components. These provide important information on the post-shock and pre-shock accretion flow as well as on the WD mass. A multi-temperature optically thin plasma, from few keV up to 30-40 keV, is generally required. A Compton reflection component is also identified at high energies and is related to the fluorescent Fe K_α 6.4 keV line (EWs up to 300 eV). The spectra are also heavily affected by complex absorption with densities up to $N_H \sim 10^{23}$ cm^{-2}. This material, located in the pre-shock flow, is generally the major responsible for the observed X-ray pulses. Because of the lack of detection of a soft X-ray black–body component in the majority of IPs, it was believed that the reprocessing of hard X-rays in the WD atmosphere affects wide areas shifting this component in the EUV. However, the recent detection of a soft X-ray, heavily absorbed, component in an increasing number of IPs with temperatures covering a wider range (30-100 eV) than in the Polars, is a new and challenging result that BeppoSAX and XMM-Newton have brought into light (Haberl et al. 2002; de Martino et al. 2004, 2006, 2007). The simultaneous study of broad-band X-ray spectra with high sensitivity instrumentation is then essential to characterize this class of accreting magnetic CVs, forseen to substantially increase in the near future. This is a well suited project for the Simbol-X mission which will be operative after Suzaku.

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