Feeding Compact Objects: Accretion on All Scales
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Mass Accretion in Intermediate Polar V1223 Sgr

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Abstract. Intermediate polars (IPs) represent more than 70 % of all cataclysmic variables (CVs) detected by *INTEGRAL* in hard X-ray. Nevertheless, only a quarter of all known IPs have been detected in this spectral band. This fact can be related to the activity state of these object ruled by changes in the mass accretion rate.

Keywords. Stars: novae, cataclysmic variables, accretion, accretion disks

1. Introduction

CVs are close binaries consisting of a white dwarf (WD) and a red main-sequence star, which fills the volume of its inner Roche lobe and transfers matter to the vicinity of the WD. According to strength of the WD magnetic field, this matter creates an accretion disc or follows magnetic field lines. In IPs, the WD magnetic field ($10^4 - 10^6$ G) is not strong enough to disrupt the disc entirely (as in the case of polars) and it simply truncates the inner part of the disc (Patterson 1994). An accretion flow is channelled down towards the magnetic poles of the WD. When the transferred material impacts onto the WD atmosphere, a shock will form and the hot post-shock region (PSR) is cooled mainly via optically thin bremsstrahlung radiation in hard X-ray. As we showed in our previous analysis (Gális *et al.* 2009), the broad-band spectra (3 - 100 keV) of the studied IPs can be well fitted by a thermal bremsstrahlung model with the PSR temperature $kT \approx (20 - 25)$ keV. The sample detected by *INTEGRAL* represented only 25% of all known IPs (Gális *et al.* 2009). Some IPs were not detectable even though we had significant exposure time (more than 4Msec) for these sources. This fact can be related to the activity state of these interacting binaries.

2. Observations, analysis and results

We used all publicly available observational data from *INTEGRAL*/JEM-X and *INTEGRAL*/IBIS to study possible variability of V1223 Sgr in the X-ray band. The data were processed by *INTEGRAL*/'s Offline Standard Analysis Package OSA7.

We analysed all available observational data from *INTEGRAL*/IBIS for V1223 Sgr (Gális *et al.* 2009). Our analysis showed that the fluxes of this IP are long-term variable, mainly in (15 - 25) keV and (25 - 40) keV bands. Moreover this hard X-ray variability is correlated with the changes in optical spectral band. Our analysis revealed a deep flux drop around MJD ≈ 53 650 observed in both the X-ray band and the optical band.

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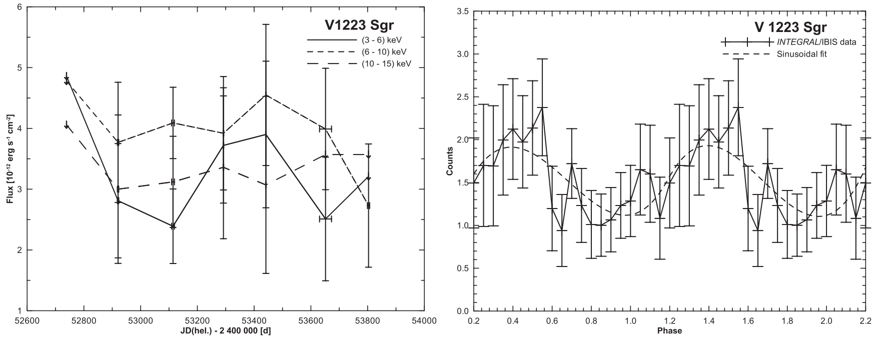

Figure 1. Left panel: *INTEGRAL*/JEM-X flux curves of V 1223 Sgr in the corresponding energy bands. Right panel: *INTEGRAL*/IBIS phase diagram of V1223 Sgr in (15 - 25) keV band folded with orbital period (3.37 hrs). The arrows represent $3\,\sigma$ upper limits.

As the next step we analysed the long-term variability of V1223 Sgr using all available observational data from *INTEGRAL*/JEM- X. The observational material consisted of 132 individual pointings obtained in the course of almost three years (MJD 52710.38 - 53809.25). The total exposure time was 80.6 ksec.

The inspection of the data showed that the observations were obtained in the course of 7 separate seasons. As the next step we split the data according to these seasons. The flux curves are displayed in Fig. 1 (left panel). As we can see the corresponding errors are too large for subsequent analysis and therefore we can conclude that the *INTEGRAL*/JEM-X fluxes of V1223 Sgr were persistent within their errors in the monitored period.

Typically, soft X-ray modulations were observed in the orbital period, in spin period of WD, or a beat between the two in IPs. However, the IPs are close binary systems with orbital periods in the order of hours and these objects are not detectable on these time scales by *INTEGRAL*/IBIS. Nevertheless, we prepared a unique method of folding the particular phase interval on the basis of proper time intervals from the individual science windows. Our method applied Good Time Intervals (GTIs) according to the (orbital or other) phase bin and created phase resolved mosaics (assuming sufficient exposure) of a periodic source. A phase diagram of the fluxes V1223 Sgr in the (15 - 25) keV band folded with the orbital period (3.37 hrs) and constructed using the data from time interval MJD (52 917.17 - 52 926.84) is shown in Fig. 1 (right panel).

3. Conclusions

We analysed all available observational data from *INTEGRAL* for IP V1223 Sgr. While the large errors of the *INTEGRAL*/JEM-X fluxes did not allow subsequent analysis, our investigation revealed the variability of the *INTEGRAL*/IBIS fluxes at both short and long time scales. The short term variability is probably related to the changes of visibility of the impact region at the WD surface during its orbital motion.

The significant part of the optical emission from IPs is produced by a hot spot, where the matter from the donor star interacts with outer rim of the accretion disk. X-ray emission is produced by the interaction of the accreting matter with the WD surface. So, the emission in both optical and X-ray bands is related to the mass transfer and therefore observed variations are probably caused by changes in the mass accretion rate.

References

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