Suzaku observation of the enigmatic hard X-ray source XSS J12270–4859

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Abstract

We report on the results of Suzaku and RXTE X-ray observations of XSS J12270–4859, one of the hard X-ray sources in the INTEGRAL catalogue. From optical spectroscopic characteristics and a report of putative X-ray periodicity of ∼860 s, the object was once classified as an intermediate polar (IP). Our Suzaku observation revealed a lack of the Fe Kα emission in a power-law spectrum and exotic phenomena in the light curve such as (1) repetitive rapid flux amplification, (2) sudden flux declines with no periodicity, and (3) spectral hardening. We also analyzed archival RXTE data, confirming flux variations similar to those found in Suzaku, and found that the previously reported 860 s period is interpreted by semi-regularly repeated flares. These timing behaviors and the power-law spectrum suggest that XSS J12270–4859 is a low-mass X-ray binary rather than an IP. Some of the temporal characteristics are also similar to those of the type II bursters, making XSS J12270–4859 a very rare type II burster candidate.

Key words: stars: individual (XSS J12270–4859) — stars: variables: other — X-rays: stars

1. Introduction

XSS J12270–4859 (hereafter J12270) is one of the hard X-ray emitters in the INTEGRAL catalogue (Bird et al. 2007), and was classified as an intermediate polar (IP) based on its optical spectrum and a putative X-ray period of 860 s (Masetti et al. 2006; Butters et al. 2008). IPs, which are a subclass of cataclysmic variables, are binary systems of a moderately magnetized ($10^5 - 10^7$ G) white dwarf with a late-type companion.

Following observations of J12270, however, cast doubted on the IP classification. The Fe Kα emission and the complex absorption profile are absent in X-rays (Butters et al. 2008; Landi et al. 2009), both of which are typically seen in IPs. Optical photometry could not identify the reported X-ray period, but instead found flux flickering with a large amplitude (>1 mag) and possible phase changes of entirely different temporal behaviors (Pretorius 2009). All these features are unlikely in an IP.

2. Observations and Data Reduction

We observed J12270 with Suzaku (Mitsuda et al. 2007) in August 2008 and retrieved archival RXTE (Bradt et al. 1993) data observed in November 2007. We used the data of the XIS and the HXD PIN onboard Suzaku and the PCU 2 onboard RXTE. All data were cleaned with the standard criteria. As a result of the filtering, net exposure time was 30, 35, and 35 ks for the data of the XIS, the HXD PIN, and the PCU 2, respectively.

3. Analysis

We constructed binned light curves of J12270 using the Suzaku and RXTE data (see figure 1 of Saitou et al. 2009 for the Suzaku data), and found following temporal features: (1) rapid (∼100 s) amplification with a five-fold increase in flux (we call them "flares"), (2) sudden declines with no apparent periodicity ("dips"), and (3) spectral hardening after some flares ("hard" phases). For quantitative definition of these features, see Saitou et al. (2009).

For a timing analysis, we employed a generalized Lomb-Scargle algorithm (GLS; Zechmeister et al. 2009). GLS can process unevenly sampled data and takes the errors fully into account, which is suitable for the satellites in a low-Earth orbit such as Suzaku and RXTE. In the Suzaku periodogram (see figure 2 of Saitou et al. 2009), the red noise is dominant, which we derived by fitting with an exponential function (Vaughan 2005). The maximum power is slightly above the 2σ level, which we regard as being insignificant. We also applied the GLS to the RXTE data, and conclude that the previously reported period is caused by quasi-periodic flares.

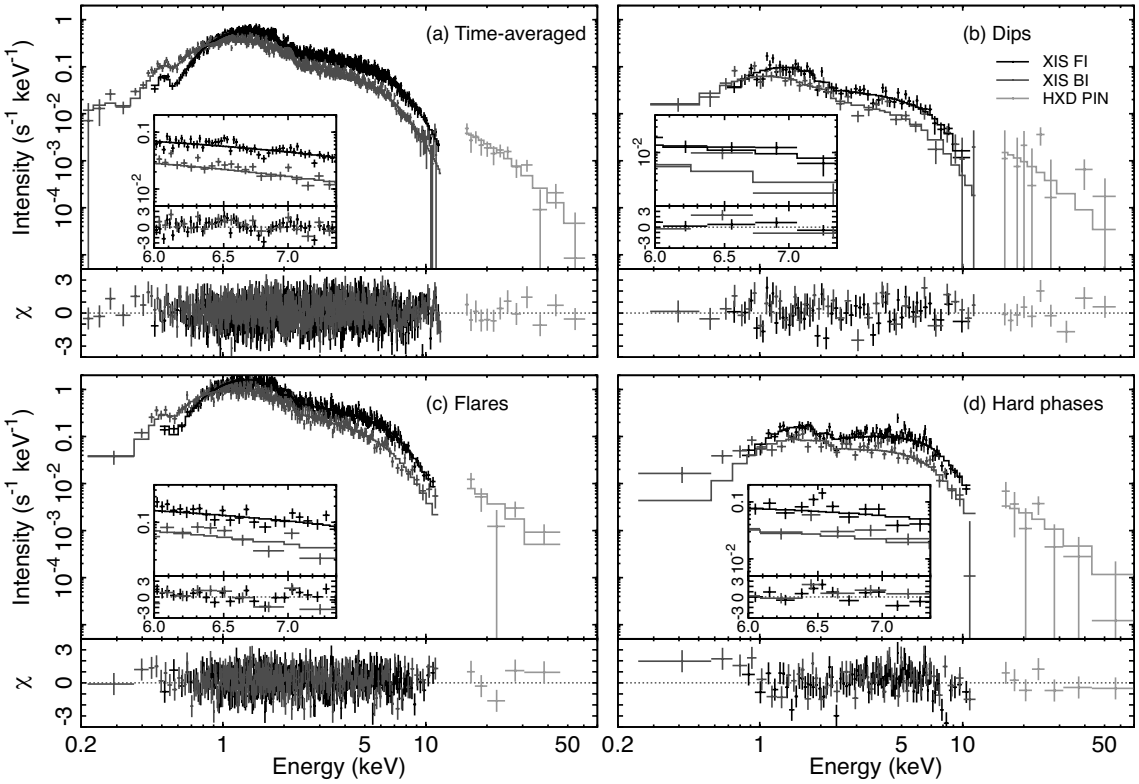

Fig. 1. Suzaku background-subtracted spectra for (a) the entire observation as well as for intervals during (b) dips, (c) flares, and (d) hard phases. Upper panels show the data and the spectral model, whereas lower panels show the residuals of the data from the model. The inset in each upper panel is the close-up view in 6.0–7.4 keV for the iron K complex.

We produced background-subtracted spectra with Suzaku in the 0.2–70 keV band using the XIS and the HXD PIN for various time intervals (figure 1). All the spectra are explained by a power-law model convolved with an interstellar extinction. There is no sign of Fe Kα emission line. Best-fit parameters are listed in table 1.

Table 1. Suzaku best-fit parameters for the power-law model.*

State	$N_{\rm H}/10^{21}$	Γ	$F_{\rm X}/10^{-11}$	$\chi^2_\nu(\nu)$
Average	$1.0^{+0.1}_{-0.1}$	$1.53^{+0.02}_{-0.02}$	$1.82^{+0.02}_{-0.02}$	0.99(1244)
Dip	< 0.3	$1.32^{+0.09}_{-0.07}$	$0.37^{+0.03}_{-0.02}$	1.12(98)
Flare ..	$1.2^{+0.2}_{-0.2}$	$1.62^{+0.04}_{-0.04}$	$4.54^{+0.11}_{-0.11}$	0.90(603)
Hard ...	$2.9^{+1.3}_{-1.3}$	$0.64^{+0.10}_{-0.10}$	$1.70^{+0.27}_{-0.27}$	1.28(141)

* The parameters $N_{\rm H}$, Γ, and $F_{\rm X}$ represent respectively the absorption column density in cm^{-2}, the photon index, and the 0.2–12 keV flux in erg s^{-1} cm^{-2}. The errors indicate the 90% statistical uncertainty.

4. Discussion

Our results show that J12270 satisfies none of the defining X-ray characteristics of IPs. The flux changes in $\sim$100 s and the power-law spectrum hint at a low-mass X-ray binary (LMXB) nature of this source. In fact, LMXBs commonly exhibit short bursts and dips. Bursts can be caused by thermonuclear flashes on the neutron-star surface (type I), or a sudden increase of the accretion rate due to disk instability (type II). The flares in J12270 are quite similar to those in the Rapid Burster (Lewin et al. 1976) or GRO J1744–28 (Kouveliotou et al. 1996), which are the only known type II bursters. The flares in these sources commonly show a repetition in a short time flux amplification by a factor of $\sim$5 from the quiescence, and a flux decrease immediately after some flares. J12270 may belong to the rare type of such type II bursters.

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