The X-ray Universe 2008, Granada, Spain, 2008 May 27–30

Suzaku Observation of IGR J16318−4848

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Abstract

IGR J16318−4848 is the first example of a new class of highly absorbed X-ray binaries that has been discovered by the INTErnational Gamma-Ray Astrophysics Laboratory (*INTEGRAL*) in the last years.

We analysed the first *Suzaku* observation of this source (2006 August 14–17), and obtained a spectrum that can be well described based on an absoption model (TBabs) and a cutoff powerlaw, plus the gaussians for the emission lines of Fe Kα, Fe Kβ, and Ni Kα. The spectrum also shows a soft excess below 5 keV.

The lightcurve varies significantly in hours; however the source remains always in a hard state, with very slight changes on the hardness ratio.

As a result of the fitting to our model, we obtain a huge value for the column density ($N_\mathrm{H} = 2.13 \times 10^{24}\,\mathrm{cm}^{-2}$), corresponding to a moderately Compton thick column, a folding energy of 26.7 keV and a hard photon index (0.96). The average flux is $3.5 \times 10^{10}\,\mathrm{erg\,cm^{-2}\,s^{-1}}$ in the 0.1–60 keV energy band.

The spectral characteristics of the source suggest a neutron star as the compact object in the binary system.

IGR J16318-4848

IGR J16318−4848 was discovered on 2003 Jan 29 with the IBIS/ISGRI soft gamma-ray detector onboard *INTEGRAL*. It has been proposed (e.g. Filliatre & Chaty, 2004; Revnivtsev, 2003; Walter et al., 2004) that the source is a High Mass X-ray Binary (HMXB) with an sgB[e] star as the mass donor (also Revnivtsev, 2003) surrounded by a dense and absorbing circumstellar material. The distance is estimated to be between 0.9 and 6.2 kpc.

Observations of some of the other newly-discovered *INTEGRAL* sources have revealed that some of them share similar spectral properties (Rodriguez et al., 2003; Patel et al., 2004; Bodaghee et al., 2007, see also Fig. 1 and Fig. 2). IGR J16318−4848 would then be one of the most extreme examples of this new class of highly absorbed X-ray binaries (see, e.g., Kuulkers, 2005).

We observed IGR J16318−4848 with *Suzaku* on August 14 to 17 for a total net exposure of 70 ks.

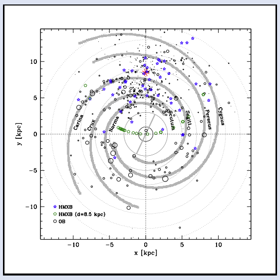

Figure 1: Galactic distribution of HMXBs (those ones whose distances are known are plotted with star symbols, otherwise they are placed at 8.5 kpc and represented by pentagons) and the locations of star-forming complexes from Russeil (2003) (circles). The symbol size of the latter is proportional to the activity of the complex (Fig. from Bodaghee et al., 2007).

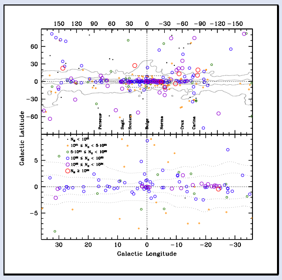

Figure 2: Spatial distribution of *INTEGRAL* sources in Galactic coordinates. The symbol size is proportional to the published column density. The lower figure is a zoom of the boxed region, where the extragalactic sources have been excluded (Fig. from Bodaghee et al., 2007).

Spectral Analysis

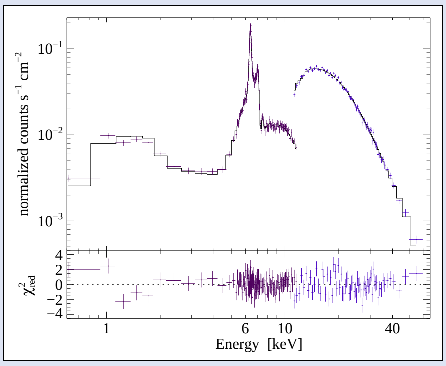

Figure 3: Broad-band spectrum of IGR J16318-4848 covered by the Suzaku instruments XIS (0.293–11.7 keV) and PIN (12–60 keV) showing strong fluorescent emission lines from Iron lines (Kα and Kβ) and Ni Kα and a soft X-ray (0.2–3 keV) excess (which could be due to a serendipitous source Ibarra et al. 2007). Its characteristics suggest the compact object of the system to be a Neutron Star

Fig. 3 shows the broad-band *Suzaku* spectrum modeled by a partial covering model with an exponentially cutoff power law. The absorption was described using an improved version of `TBabs` (Wilms et al., 2000, 2006).

The spectrum shows strong fluorescent emission lines: the Iron Kα and Kβ and Ni Kα (Fig. 4) and a soft excess in 0.2–3 keV.

The fit to the model was good (χ^2/dof = 210.4/209), and revealed a very high column density ($2.13(2) \times 10^{24}\,\mathrm{cm}^{-2}$), as expected for this kind of source, and a hard Photon Index (0.960(1)). The folding energy, 26.6 ± 0.6 keV, together with the other spectral characteristics derived from the fit are typical parameters for an accreting neutron star (e.g., Naik & Paul, 2004; Hill et al., 2008), suggesting this might be the nature of the compact object of the binary system.

Despite the large N_H, no clear Compton shoulder was detected in the spectrum (Fig. 4).

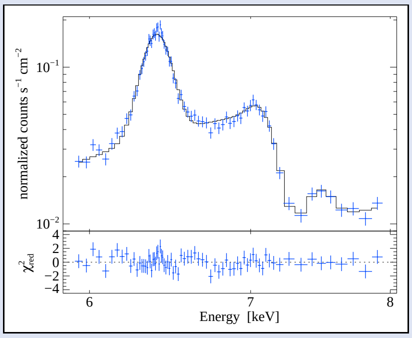

Figure 4: Close up on the global spectrum emission lines interval [6–8 keV] The spectrum shows fluorescent emission lines Fe Kα, Fe Kβ and Ni Kα lines from neutral material (measured line energies in keV: $E_{\mathrm{Fe\,K}\alpha_1}$ = 6.396(2), $E_{\mathrm{Fe\,K}\alpha_2}$ = 6.404(4), $E_{\mathrm{Fe\,K}\beta_1}$ = 7.08(5), $E_{\mathrm{Fe\,K}\beta_2}$ = 7.09(3), $E_{\mathrm{Ni\,K}\alpha}$ = 7.49(3)). No clear Compton Shoulder was detected in the spectrum.

Variability

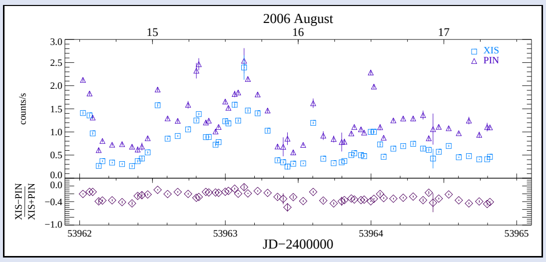

Figure 5: Light curve for the XIS (0.293–11.7 keV) and the HDX PIN (11–60 keV), together with the Hardness Ratio. Variations are seen on timescales of hours, but the source remains always in a hard state (although slight variations on the Hardness ratio can be observed). No pulsation between 1 s and 10 ks was found.

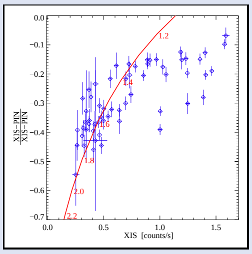

Figure 6: Hardness Ratio versus counts detected on the XISs. The theoretical behavior is plotted in red, where the absorption column is indicated in units of $10^{24}\,\mathrm{cm}^{-2}$.

The lightcurves for the energy range 0.293–11.7 keV of the combined XISs (on good time intervals of XIS0) and for the HDX PIN (11–60 keV) are shown on (Fig. 5).

The source is significantly varying in time, but it always remains in a hard state (as can be seen in the Hardness Ratio graphic plotted below the lightcurve).

No pulsations were found between 1 s and 10 ks, so we could not conclude unambiguously that the compact object on the binary system of IGR J16318−4848 is a neutron star (despite the spectral values point to this fact).

In Fig. 6, the Hardness Ratio (HR) is plotted against the combined count rate for the XIS. The red line indicates the theoretical HR assuming pure absorption. The agreement of the data and the model for higher values of N_H indicates the variation of the hardness ratio is mainly related to the variation of N_H, although a slight intrinsic source variability cannot be ruled out.

Outlook

We will carry out a deeper analysis on the observation, in particular we will:

- do a spectral analysis for each of the 43 revolutions of the satellite in this observation, studying the variation of the parameters with time.
- study the relation between the absorption column and the hardness ration with a more consistent model.
- extend the analysis to other IGR sources, and compare the results obtained.

Acknowledgments
We acknowledge support from DLR grant 50OR0701.

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