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INTEGRAL Observations of GRS 1758−258

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Abstract. Since its launch in October 2002, the *INTEGRAL* satellite has observed the X-ray binary and black hole (BH) candidate GRS 1758−258, for more than 2 Ms. Between 2003 and 2004 *INTEGRAL* could follow its spectral and temporal behaviour: while it was weak and soft in spring 2003 it was detected up to 150 keV at the end of 2003 August, in a hard state similar to the one observed between 1990 and 1997 by previous high energy missions.

Keywords. Black hole physics – Stars: individual: GRS 1758−258 – Gamma rays: observations – X-rays: binaries – X-rays: general.

1. Introduction

GRS 1758−258 was discovered in 1990 with the *SIGMA*/GRANAT telescope (Mandrou 1990). Together with 1E 1740.7−2942, it is the brightest persistent source above 50 keV in the Galactic Bulge (Sunyaev *et al.* 1991). The strong and variable hard X-ray emission of GRS 1758−258 and its broad band spectral characteristics (Kuznetsov *et al.* 1999) suggest the presence of a BH in a binary system. Smith *et al.* (2002) measured an orbital period of 18.45 ± 0.10 days and suggested a red giant as companion star. GRS 1758−258 also shows two double-sided radio jets of ∼1 arcminute size (Rodriguez *et al.* 1992) and it is often observed in the typical hard state (HS) of BH X-ray binaries (Kuznetsov *et al.* 1999, Sidoli *et al.* 2002). We present evidences of spectral evolution of this BH as seen by *INTEGRAL*.

2. Observations and Results

We have analyzed *INTEGRAL* public data of 3 observation periods of GRS 1758−258: epoch 1 (2003 Mar 22-Apr 21), 2 (2003 Sep 22–Oct 18) and 3 (2004 Feb 16–Apr 21). Figure 1(Left) shows the IBIS/ISGRI light curve of GRS 1758−258: the source was almost undetectable in epoch 1 but the average 20–140 keV count rate increased to the level of 16 cts s^{-1} (∼80 mCrab) in epoch 2 and decreased slightly in epoch 3. Fitting the reconstructed spectra with a power law, we obtain a photon index of 2.55 ± 0.36 for epoch 1 and 1.90 ± 0.08 for epochs 2 and 3, indicating that the source transited to a harder state. As spectra for epochs 2 and 3 are generally compatible, we have modelled the data of begining of epoch 2 (2003 Sep 22–25) (for which simultaneous JEM-X, IBIS/ISGRI and SPI data were available) with an absorbed (fixed column density of 1.5×10^{22} atoms cm^{-2}, Mereghetti *et al.* 1997) multicolour disc black body (Mitsuda *et al.* 1984) and a Comptonization model (Titarchuk 1994, spherical geometry). Fig. 1 (Right) shows the derived count spectrum and best-fit model for these GRS 1758−258 data. The derived spectral parameters are consistent with the source being in a HS: $kT_{\rm e} = 40\ ^{+33}_{-3}$keV, $\tau = 1.30\ ^{+0.13}_{-0.62}$ ($\chi^2_{red} = 1.10$, 187 degrees of freedom). The 5–200 keV flux is 2.74×10^{-9} ergs cm^2 s^{-1}

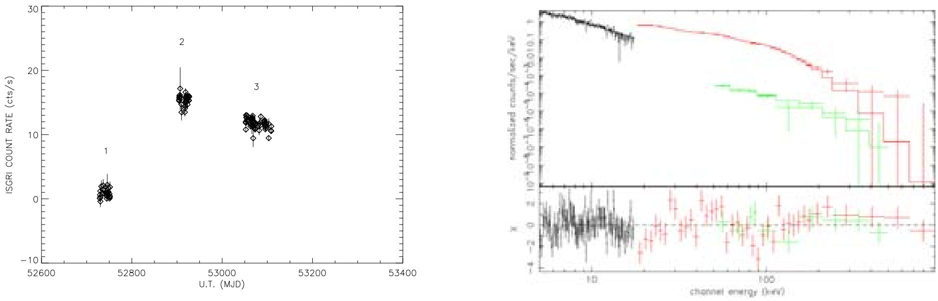

Figure 1. *Left:* The 20–140 keV IBIS/ISGRI light curve of GRS 1758−258 from 2003 Mar 22 up to 2004 Apr 21 (epochs indicated). *Right:* Count spectra of GRS 1758−258 in 2003 September 22–25 with the JEM-X (black), IBIS/ISGRI (red) and SPI (green) data along with the best-fit model. Residuals in σ units are also shown.

and the bolometric luminosity, for a distance of 8 kpc, is 2.70×10^{37} ergs s^{-1}. Our results are compatible with the values recently reported by Pottschmidt *et al.* (submitted).

3. Conclusions

We conclude that from epoch 1, when the source was much weaker and softer in hard X-rays but at a similar level in the 2–12 keV ASM/RXTE light curve, the source transited towards its typical hard state in epochs 2 and 3. It then showed spectral parameters and luminosities compatible with those observed by previous missions. Given the low ASM flux, the epoch 1 period was probably not dominated by bright soft disc emission, unlike the standard high soft state of BH binaries. GRS 1758−258 is indeed known to undergo dim soft states, without showing an anticorrelation between hardness and soft X-ray flux (Smith *et al.* 2002).

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