

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 (Mandrour 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 beginning 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 $1.5 \times 10^{22} \text{ atoms cm}^{-2}$, 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: $kT_e = 40^{+33}_{-3} \text{ keV}$, $\tau = 1.30^{+0.13}_{-0.62}$ ($\chi^2_{red} = 1.10$, 187 degrees of freedom). The 5–200 keV flux is $2.74 \times 10^{-9} \text{ ergs cm}^2 \text{ s}^{-1}$

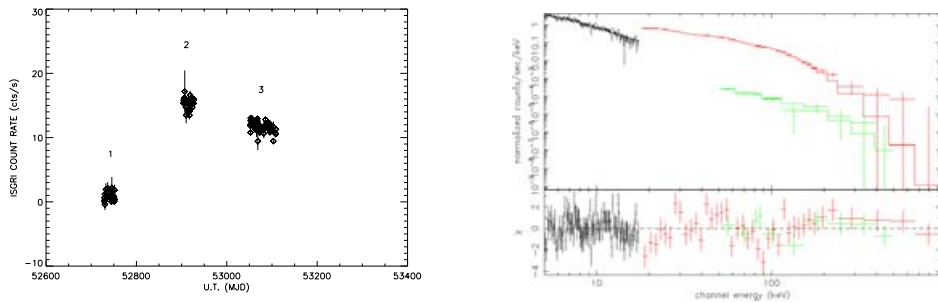


Figure 1. *Left:* The 20–140 keV IBIS/ISGR light curve of GRS 1758–258 from 2003 Mar 22 up to 2004 Apr 21 (epochs indicated). *Right:* Count spectra of GRS 1758–258 in 2003 September 22–25 with the JEM-X (black), IBIS/ISGR (red) and SPI (green) data along with the best-fit model. Residuals in σ units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