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A long term hard X-ray analysis of GRS 1758-258 using INTEGRAL data

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Abstract. We present our initial results on out study of GRS 1758-258, using all the publicly available INTEGRAl/ ISGRI and JEMX data, spanning a period of 15 years covering revolutions 46 – 2004. For our IGRI spectral analysis we used a power law model in order to estimate the 22 – 100 keV flux and photon index. The results are later used for the creation of a phenomenological spectral state classification system of this target, based only on hard X-rays. We move on, by splitting the hard special state into 4 hard substates and perform a separate spectral analysis using JEM-X1, ISGRI and PICsIT spectra, binned per revolution, and Comptonization spectral models such as COMPPS and EQPAIR. Finally, we present the evolution of the models most important parameters as the source behavior varies between the softest and hardest spectral state.

Key words. stars:individual: GRS 1758-258 - stars: binaries - X-rays

1. Introduction

GRS 1758-258 is a bright and persistent hard X-ray microquasar discovered in 1990 (Muñoz et al. 2010) and is located very close to the Galactic center. Its location makes it difficult to observe in soft X-rays because of the large interstellar absorption. Moreover, due to the targets proximity to GX 5-1 it is not possible to isolate it using all sky monitor observations. According to Pottschmidtet al. (2006) a soft thermal component exists when the source is in the dim or the softest hard states, whereas the hard state is power-law dominated (Soria al. 2011).

2. Objective

We study the variability of the GRS 1758-258 using all the available INTEGRAL observations spanning a period of 16 years. Our purpose is to check the existence and properties of thermal and non-thermal plasma regions and test their dependence on flux and other physical parameters. This is achieved by focusing on hard X-ray emission extending higher than 200 keV, which is not has been studied intensively in the past, in particular when the source is faint.

3. Data

The available INTEGRAL/ISGRI data between the years 2003 - 2018 with a total exposure time of 40/15 Ms for ISGRI and JEMX1 respectively. For our analysis we binned the data, daily. In Fig. 1 the daily binned 22-100 keV light curve is presented.

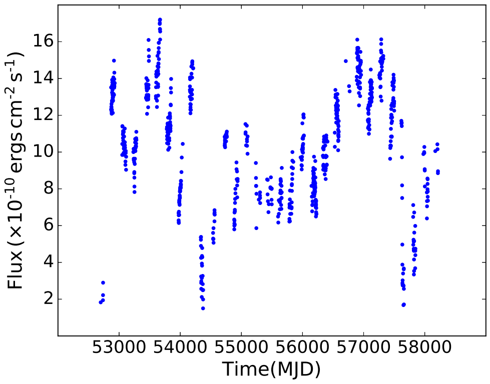

Fig. 1. Fig. 1: The INTEGRAL/ISGRI light curve of GRS 1758-258 over 15 years of observations.

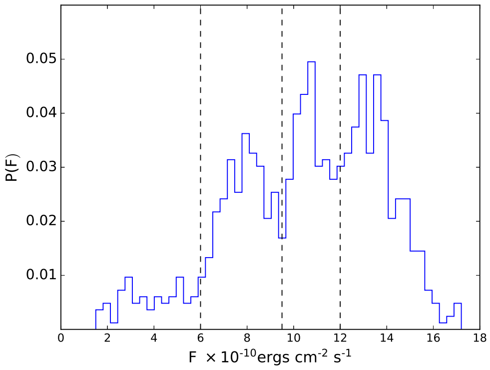

Fig. 3. The 22-100 keV flux histogram, calculated from daily binned INTEGRAL/ISGRI data.

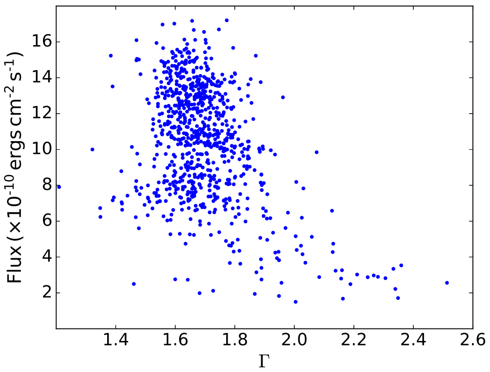

Fig. 2. The Γ-F diagram using daily binned INTEGRAL/ISGRI data.

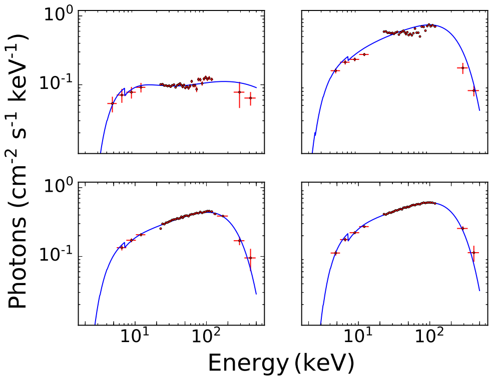

Fig. 4. The summed JEM-X1, ISGRI and PICsIT spectra of the four flux states together with the fitted model.

4. Analysis

Daily-binned ISGRI spectra were created and fitted in the 22-100 keV energy band with a power-law model. The photon index (Γ) - flux (F) diagram and the Γ distribution are shown in Fig. 2 and 3, respectively. The data of Fig. 3 can be separated into four groups. For each peak and each of the ISGRI, JEMX1 and PICsIT instruments summed spectra were created and simultaneously fitted with the Comptonization COMPPS plus an absorption model. JEM-X1 spectra were used for the first time for this source, thanks to the long exposure time of the summed spectra.

5. Results

Fig. 4 shows the spectral models corresponding to each each state from Fig. 3, following clockwise from the leftmost to the rightmost state. The model parameters such as the Compton parameter (y), reflection(R), plasma temperature(kT_e) and normalization(K) are shown.

6. Conclusions

- The hard X-ray photon index for three bright states is concentrated in a relatively narrow range around 1.65.

- There is a different behavior of the plasma parameters for the dimmest state.
- Despite a strong variation of the source flux within the bright states the plasma parameters remain stable.
- The dim state shows strong non-thermal component and changed Comptonization conditions, presumably related to the change of the systems geometry.

7. Future Work

- Use of the hybrid Comptonization EQPAIR model to study the non-thermal emission especially for the dimmest state.
- Use of Neil Gehrels Swift Observatory/XRT data to constrain better the accretion disk parameters and absorption component.

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