X-RAY AND SOFT GAMMA-RAY BEHAVIOUR OF THE GALACTIC SOURCE 1E 1743.1–2843

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ABSTRACT

The X-ray persistent source 1E 1743.1–2843, located in the Galactic Centre region, has been detected by all X-ray telescope above 2 keV, whereas it is not visible in the soft X-rays (i. e. *Rosat*) because of the high column density along the line-of-sight. Moreover, the nature of this source remains still unknown. The gamma-ray satellite *INTEGRAL* has long observed the Galactic Centre region in the framework of the Core Programme. We report on results of two years of *INTEGRAL* observations of 1E 1743.1–2843 detected for the first time in the soft gamma-ray band. Since the source does not show any evidence for strong variability, we present the broad-band spectral analysis using not simultaneous *XMM-Newton* observations.

Key words: X-ray and gamma-ray: observations; X-rays: binaries; stars: individual: 1E 1743.1–2843.

1. INTRODUCTION

1E 1743.1-2843 is one of the most absorbed ($N_H > 10^{23}$) X-ray sources of the Galactic Centre (GC) region, suggesting a distance close or even greater than the GC. In the last years the source has been observed by numerous X-ray telescopes up to 20 keV, but it has never been detected in the hard X-rays, because of the lack of combined high spatial resolution and good sensitivity instruments at high energies. *BeppoSAX* has long observed the Galactic Centre region, but it has never detected any bursting activity (in't Zand 2000), nor periodic pulsation from this source (Cremonesi et al. 1999). Also *XMM-Newton* observations reported by Porquet et al. (2003), limited to the range below 10 keV, did not solved the mystery of the source nature; they underlined that high energy observations could help in the determination of the compact object nature. We report here on the first detection in the soft gamma-ray domain (up to 70 keV) obtained during a two years monitoring with the gamma-ray imager IBIS, on-board the *INTEGRAL* satellite. A broad band spectral analysis has been also performed using re-analysed *XMM-Newton* data.

2. OBSERVATIONS AND DATA ANALYSIS

We have analysed public IBIS/ISGRI observations of the Galactic Centre region performed in 2003 and the 2004 observations of Core Programme. The 2003 effective exposure time is ∼2 Ms; ∼1 Ms in 2004. Data were reduced using OSA 5.0. The 20-40 keV temporal behaviour has been extracted from the whole data set while spectral analysis concern only the 2003 pointings. Searching the source field in the *XMM-Newton* public archive we found 2 *XMM-Newton* observations performed on 2000 September 19^{th} (obs. 401) and 21^{th} (obs. 501). Among these, only one of the *XMM-Newton* observations (obs. 401) has been reported in literature (Porquet et al. 2003). Here we present a re-analysis of this observation, now non-affected by pile-up problems. *XMM-Newton* data have been analysed by SAS 6.5. In order to exclude pile-up effects, we selected an annular region with inner radius of 10" and outer radius of 40". Background spectra were obtained from source-free regions of the same observations.

3. RESULTS AND DISCUSSION

The Galactic Centre is pointed by *INTEGRAL* during two visibility windows per year. The temporal behaviour of 1E 1743.1–2843 over 2 years of IBIS observations for a total of about 3 Ms is shown (Fig. 1). The source shows marginal variability over few months times scale,

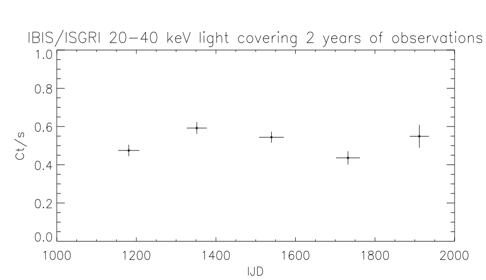

Figure 1. 20-40 keV temporal behaviour of 1E 1743.1–2843 with INTEGRALstarting from February 2003 till April 2005.

Table 1. Model parameters obtained by the broad-band spectral fit using XMM-Newton (two observations) and ISGRI (2003 mean spectrum). The meaning of the symbols is the following: pow=*power-law,* bb=*blackbody,* dbb=*disk-blackbody in* XSPEC*; α is the power-law photon index, kT is the blackbody temperature or the inner disk temperature, depending on the adopted model.*

Model	$N_{\rm H}$ (10^{22} cm^{-2})	kT (keV)	α	$F^{a}_{(2-10)}$	$F^{b}_{(1-100)}$	χ^2/dof
Obs. 401						
bb+po	$19.5^{+1.1}_{-0.9}$	$1.8^{+0.1}_{-0.1}$	$3.1^{+0.1}_{-0.1}$	3.9	7.3	468/375
diskbb+po	$18.6^{+0.8}_{-0.7}$	$3.1^{+0.1}_{-0.1}$	$2.5^{+0.1}_{-0.2}$	3.5		475/375
Obs. 501						
bb+po	$18.0^{+1.3}_{-1.0}$	$1.6^{+0.1}_{-0.1}$	$3.3^{+0.1}_{-0.1}$	3.2	5.9	392/323
diskbb+po	$19.8^{+0.9}_{-0.9}$	$2.6^{+0.2}_{-0.2}$	$2.9^{+0.1}_{-0.1}$	3.3		401/323

a The 2–10 keV flux of the unabsorbed fit model in units of 10^{-10} erg cm^{-2} s^{-1}.
b The broad-band flux (1–100 keV) of the unabsorbed best-fit model in units of 10^{-10} erg cm^{-2} s^{-1}.

in agreement with results reported by Belanger et al. (2005). Because of its rather constant high energy behaviour, we fitted the average IBIS/ISGRI spectrum of 2003 with non-simultaneous PN, MOS1 and MOS2 data (Fig. 2). We used two models: a black body plus a power law and a multi-temperature disc plus a power law. Spectral parameters are presented in Tab. 1. The two observations show parameters consistent within the errors. The steepness of the power law component indicates a soft hard-X-ray spectrum for this source. We confirm the further indication by Cremonesi et al. (1999) which rules out the HMXB nature. So far, the observational scenario seems to be in favour of a LMXB system. Starting from this hypothesis, the nature of the compact object needs to be discussed. We have estimated luminosities and related fractions in Eddington luminosity both for Neutron Star (NS) and Black Hole (BH), considering three possible distances for 1E 1743.1–2843. We assumed M_{NS} = 1.4 $M_\odot$ and M_{BH} = 10 $M_\odot$.

Let's suppose that the accreting object is a NS.
During more than 20 years of observations, the lack of type-I X-ray bursts is noteworthy. Nevertheless it is in agreement with the estimated luminosities in Eddington luminosity fractions (Tab. 2). Type-I X-ray bursts become rare going up a few percent of Eddington luminosity (Lewin et al. 1995). So, in this first case we have 2 possibilities: the NS is a rare burster from which we did not detect any thermonuclear flash or the system is a bright LMXRB located behind the Galactic Centre at a distance at least >15 kpc.

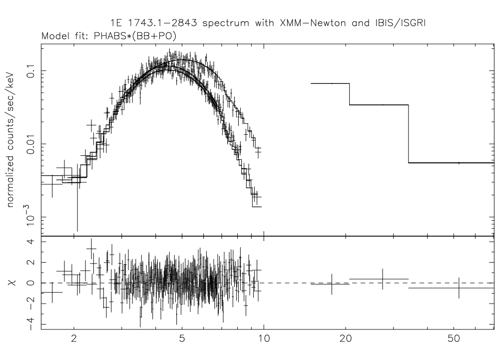

Figure 2. Count rate absorbed spectrum, BB+PO model fit and residuals of MOS1, MOS2, PN (obs. 501) and ISGRI data.

Table 2. Luminosities of 1E 1743.1–2843 at different distances calculated both for a NS and BH.

Distance	$L_{1-100keV}$ (erg/s)	L/L_{Edd} (BH)	L/L_{Edd} (NS)
8.5 kpc	5.2×10^{36}	0.3%	3%
12 kpc	1.0×10^{37}	0.8%	5%
20 kpc	2.9×10^{37}	2.0%	11%

Let's suppose that the accreting object is a BH.
By our spectral parameters, 1E 1743.1–2843 should be a BH binary in the canonical high/soft state, contrary to the low/hard state proposed by Porquet et al. (2003). BH binaries in the soft state show luminosities as at least a few percent of L_{Edd} (Maccarone 2003). In this case the source distance cannot be less than 20 kpc. Considering that nearly all LMXRBs with persistent X-ray emission contain a NS (van der Klis 2004) and the strong variability usually associated to BH binary systems, this assumption seems to be less strong than the NS one.
Persistency, BB temperatures and faint and steep power law component support the NS nature for this source.

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