The INTEGRAL/IBIS view of IGR J16318-4848. Possible detection of its spin period

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ABSTRACT

IGR J16318-4848 is the archetype of the new class of intrinsically obscured high-energy sources revealed by INTEGRAL. Many campaigns and multi-wavelength studies have been performed in order to understand its nature. This system is still a source of many uncertainties, such as the knowledge of its orbital parameters; besides, its scenario is still not clear, although some suggestions have been made so far. In this poster we report on a continuum spectral and a detailed timing analysis carried out with INTEGRAL/IBIS, from GPS and public observations up to date. Our goal is to characterize the source in the 20-300 keV regime. The main result of the study is the discovery of persistent modulations of around 9000 s throughout the light curve in the 20-40 keV energy range, which could constitute the spin period of the source. We also show the hard x-ray spectra of this source, which seems to have different behaviour during flares.

1. INTRODUCTION

Courvosier et al. 2003 performed the first source discovery with INTEGRAL (INTERnational Gamma-Ray Astrophysics Laboratory, Winkler et al. 2003). Soon after, the extreme obscure nature of IGR J16318-4848 was revealed (Schartel et al. 2003, Matt & Guainazzi 2003), with a column density $N_H \sim 2 \times 10^{24}$ cm^{-2}. Filliarte & Chaty (2004) found its optical counterpart, proposed the source to be a High Mass X-Ray Binary system at 1-6 kpc with a a B Supergiant emiting prohibited lines (SgB[e]) and showed a significant NIR excess in their photometric and spectral study. They suggested that the material absorbing in the X-rays was around the compact object, whereas the whole system was enveloped in the material absorbing in the optical/NIR. Succeeding studies have shown that this source also exhibits MIR excess, likely to the presence of warm dust around the system (Kaplan et al. 2006, Rahoui et al. 2008).

IGR J16318-4848 represents a new class of obscured HMXRB for which multi-wavelength studies become necessary in order to understand the whole picture of its nature. On this poster we present the results obtained from a hard x-ray spectral and timing study performed on this source with the instrument IBIS/ISGRI (Lebrun 2003) onboard INTEGRAL. Persistent modulations around 9000 s have been found, which are likely to be the spin period of the system.

2. SPECTRAL ANALYSIS

The data analysed correspond to the first 5 years of INTEGRAL and have been reduced with the Off-line Science Analysis (0SA) Software release 7.0. Only pointings with off-axis angle below 5º were considered.

We first carried out a spectral analysis with XSPEC considering three flux ranges, in order to look for variability between faint and bright regimes. We extracted three spectra from pointings whose 20-100 keV lies below 20 counts/s (A), between 20 and 30 c/s (B) and above 30 c/s (C). The spectra can be represented by a broken power law with Γ ~ 1.5-1.9 and Ec ~ 35 keV. According to this results, shown in table I, the brightest states (B and C) are likely to be harder than the fainter one, as it can be inferred from the values of Γ. In figure I (top), all three spectra can be seen.

We also analyzed the average spectrum up to 300 keV, in order to have enough statistics to fit the data with analytical models such as the comptonization model comptt.

Range	Tot Int Time (ks)	Γ	ϵ_{c1} keV	ϵ_{c2}	T0 , KT, τ keV, keV	red χ^2 /dof	Flux 20-300 keV x 10^{-10} erg cm^{-2}s^{-1}
A	965	$1.93^{+0.09}_{-0.04}$	39 ± 3	-	-	1.14/12	5.3
B	36.3	$1.6^{+0.2}_{-0.4}$	34^{+2}_{-3}	-	-	1.52/12	17
C	11.9	$1.68^{+0.22}_{-0.18}$	36 ± 3	-	-	1.65/12	22
Average	1013	-	-	-	5.2 ± 0.3, $8.77^{+0.12}_{-0.16}$, $4.3^{+0.5}_{-0.4}$	0.93/13	5.8
"	"	$1.37^{+0.18}_{-0.26}$	$29.7^{+1.3}_{-1.9}$	46^{+4}_{-3}	-	0.86/10	5.8

Table 1. Best-fit spectral parameters for the three intervals and the average spectrum

The best-fit spectral parameters are reported in table I, and the spectrum shown in figure I (bottom). As it can be seen, the source spectrum it is well explained by a componization model with temperature KT ~ 8.8 keV, similar parameter values to those obtained in Walter et al. 2004. It can also be fitted with a powerlaw with two breaks.

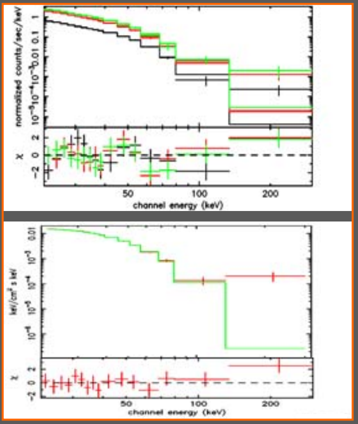

Figure 1. Top: Fitted spectrum for the 3 intervals. **Bottom:** comptt fiited average spectrum

3. TIMING ANALYSIS

Using the same pointings as before, we obtained the 20-40 keV light curve with a time binning of 16 s. We can see that the source is very variable, exhibiting many flares with duration between few hours until days.

A search for any modulation was carried out. In figure 2 (top) an extract of the light curve rebinned to 300 s, between MJD 53228 and 53229, is shown. A modulation around 10^4 s has been found. Actually, similar modulations are observed throughout the light curve. We obtained the power spectrum (figure 2 middle) of the extracted light curve, which shows a peak at around 0.11 mHz (~ 10^4 s). We then found a possible period using the FTOOL efsearch, at around 9320 s. The wide peak shown in figure 2 (bottom) was fitted with a Lorentzian, giving a FHWM of ~ 1800 s, which implies that the modulation is quite badly determined. This is likely due to large error bars in data and that our extracted light curve only covers 3-4 periods.

We interpret this modulation as the possible spin period of IGR J16318-4848 because:

* Similar variability has been found at different intervals of the light curve (MJD 53228-53229, 53412-53412, 5347-5347).

* If we fold the extracted and the overall light curve, as displayed on figure 3, with that value, the result is a periodic shape curve (instead of random). This is what would be expected if the spin period of the system were roughly 9300 s.

Future telescopes and studies with better resolution and time integration will be the clue to confirm or reject this discovery.

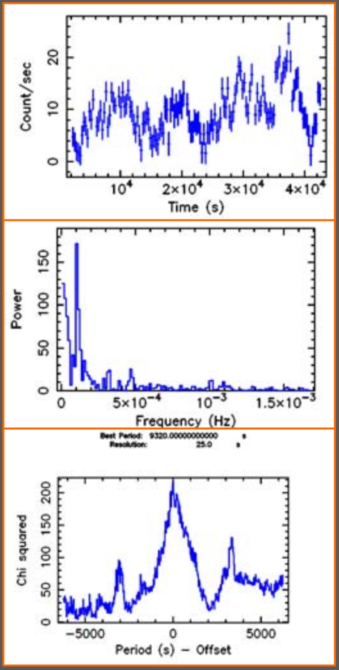

Figure 2. Top: Extract of the light curve rebinned to 300 s corresponding to the interval analyzed. **Middle:** Power Spectrum of the previous light curve. **Bottom:** Result of the search period for the previous light curve.

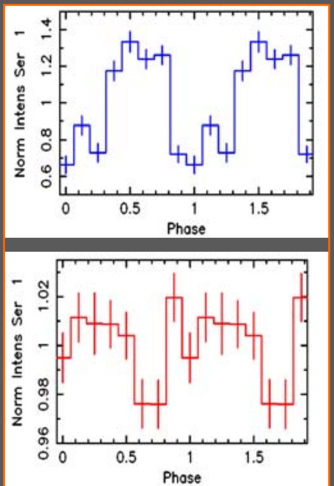

Figure 3. Top: Folded curve for the extracted light curve. **Middle:** Folded curve for the entire 20-40 keV. In both cases a period of 1920 s was tested.

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