INTEGRAL AND RXTE OBSERVATIONS OF THE FAST X-RAY TRANSIENT XTEJ1901+014

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ABSTRACT

We present results of spectral and timing analysis of the fast X-ray transient XTE J1901+014 based on data of the RXTE and INTEGRAL observatories. With the INTEGRAL/ISGRI the source was detected at a significance level of 20σ with the persistent flux of $\sim$2.7 mCrab in a 17-100 keV energy band in 2003-2004 (during long observations of the Sagittarius arm region). We added the RXTE/PCA (3-20 keV) data obtained in 1998 to the INTEGRAL/ISGRI data to build the broadband spectrum of the source in a quiescent state. It was found that the spectrum can be well approximated by a simple power-law with a photon index of $\sim$2.15. From timing analysis we found short time scale aperiodic variations which can be connected with instabilities in the accretion flow.

Key words: fast X-ray transients, binaries.

1. INTRODUCTION

The fast X-ray transient source XTE J1901+014 was discovered [4] by the all-sky monitor ASM on board the RXTE observatory during the powerful outburst on April 6, 2002 lasted from 3 min to 3.15 hours and reached the peak flux $\sim$0.9 Crab in the 1.5-12 keV energy band (Fig.1, right panel). The source position was determined as RA = $19^h\ 01^m\ 45^s.95$, DEC = $+1^\circ 24' 15.7''$ (J2000; $3'$ uncertainty). The analysis of the archival ASM data [5] revealed a previous outburst from the same position on June 21, 1997. This outburst was longer than 6 min and shorter than 8 hr, with a peak flux of $\sim$0.4 Crab (Fig. 1, left panel). The obtained information about XTE J1901+014 was not enough to make any confident conclusions about its nature, but it was noted that the time scale of this flare is similar to those of such events observed from the black hole binary V4641 Sgr.

In this report we briefly present results of observations of XTEJ1901+014 with the INTEGRAL and RXTE observatories. More detail analysis will be presented separately (see [2]).

2. OUTBURSTS AND QUESCENT STATE

During the outburst in June 1997 the source flux in the 1.5 - 3 keV energy band did not exceed the background level whereas in the harder energy bands, 3-5 keV and 5-12 keV, it reached $\sim$0.13 Crab and $\sim$0.7 Crab, respectively. During the outburst in April 2002 the peak fluxes in these three bands were detected at the levels of $\sim$0.8, $\sim$1.1 and $\sim$1.2 Crab, respectively. Thus both observed outbursts were hard.

We analyzed RXTE/ASM archive data from January 1996 to July 2006 and did not find other such powerful outbursts from the source.

XTEJ1901+014 was detected in the quiescent state (outside of outbursts) by both the spectrometer RXTE/PCA in September 1998 and April 2002, with the full exposure

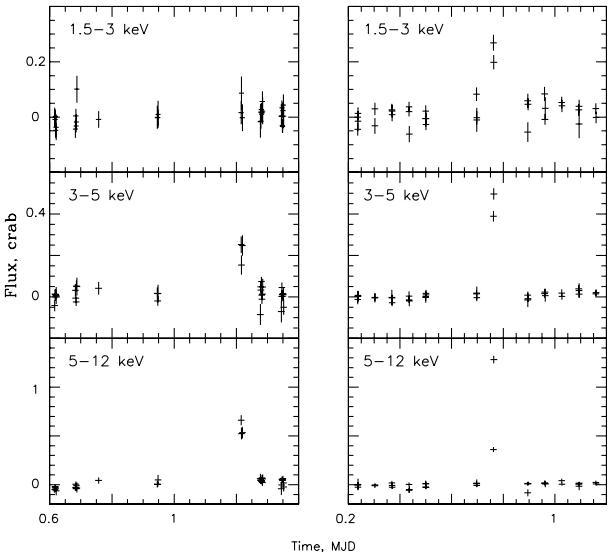

Figure 1. Lightcurves (1.5-12 keV) of XTE J1901+014 measured by RXTE/ASM during outbursts: in June 1997 (left panel: 0 corresponds to UT 20/06/97 00:00:00) and in April 2002 (right panel: 0 corresponds to UT 06/04/02 00:00:00). One dwell is 90 s.

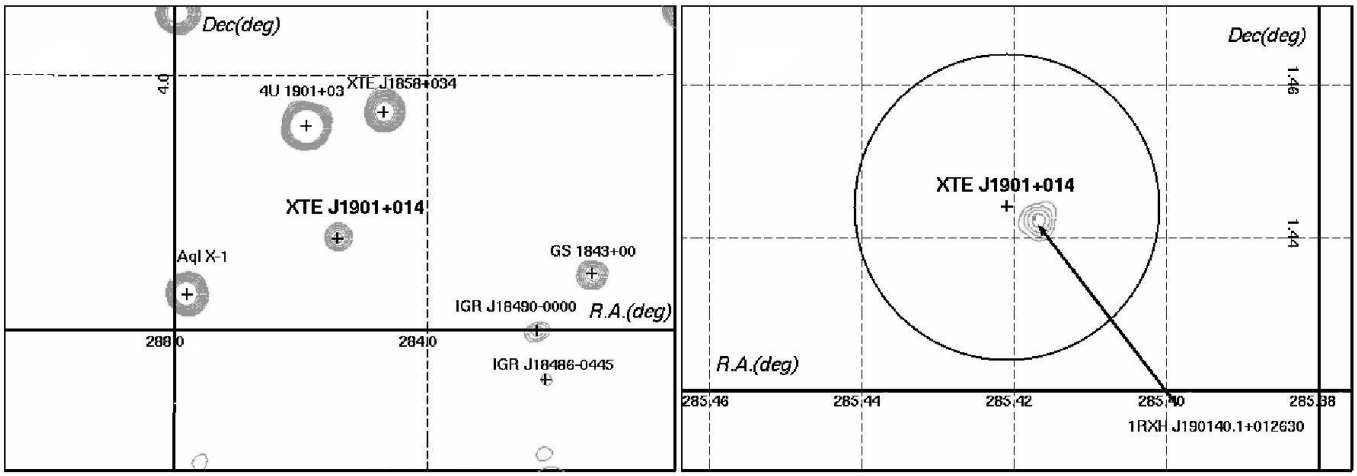

Figure 2. Maps of the region of the sky that includes XTE J1901+014 (obtained by INTEGRAL/ISGRI, 17-100 keV, left panel) and 1RXH J190140.1+012630 (obtained by ROSAT/HRI, 0.1-2.4 keV, right panel), with the INTEGRAL/ISGRI error box for XTEJ1901+014 (the circle has a radius of 1.2′).

∼1650 s and an average 3-100 keV flux of ∼2.8 mCrab (it was the same in different years) and the detector INTEGRAL/ISGRI in 2003 - 2004 (see above) with an average flux of ∼2.8 mCrab in the 17-100 keV energy band.

Some aperiodic variability of the source flux was detected in all RXTE observations. We found a number of small flares with a duration of 40 - 60 s and a maximal flux of ∼6 - 8 mCrab. The origin of such variability is most likely connected with nonsteady accretion (Fig.3).

3. REFINEMENT OF THE POSITION

The analysis of the ROSAT All-Sky Survey Source Catalogue has shown that the source 1RXS J190141.0+012618 is located in the RXTE/ASM error box (3′) of XTE J1901+014. During the pointed ROSAT/HRI observation performed on October 3, 1994, the source was also detected, its position was refined and the source was renamed as 1RXH J190140.1+012630 [7].

Using the INTEGRAL/ISGRI data we improved an accuracy of the XTE J1901+014 localization to ∼1.2′. As it clearly seen from Fig.2 the ROSAT source 1RXH J190140.1+012630 confidently (the distance between positions of XTE J1901+014 and 1RXH J190140.1+012630 is about 0.3′) falls into the INTEGRAL/ISGRI error box for XTEJ1901+014, that points that XTE J1901+014 and 1RXH J190140.1+012630 are the same source.

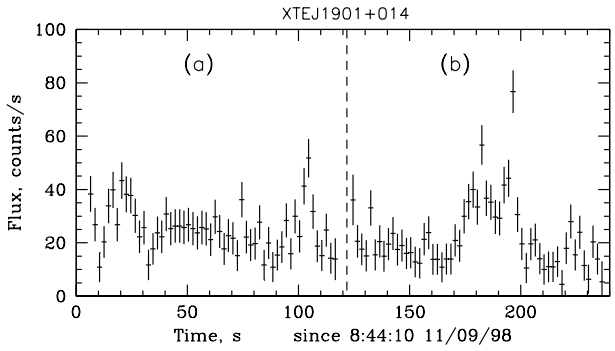

Figure 3. PCA/RXTE (3-20 keV) light curves of XTE J1901+014 for observations nos. 30186-01-21-01Z (a) and 30186-01-21-01A (b), which reflect the source's aperiodic variability. The time resolution is 2 s.

4. SPECTRAL ANALYSIS

We have only very poor information of the source spectral evolution during the outbursts (see below), but can precisely reproduce its spectrum in the quiescent state.

4.1. Quiescent state

To obtain the broadband spectrum of the source in the quiescent state we used RXTE/PCA data in the 3 - 20 keV energy band and INTEGRAL/ISGRI data in the hard energy band (>20 keV). It is important to note, that the PCA/RXTE observations were performed in 1998, 2002 and the ISGRI/INTEGRAL ones - in 2003-2004. Thus our spectral reconstruction is correct in the suggestion that the spectral shape of the source did not change during this time interval.

The broadband (3-100 keV) spectrum of XTEJ1901+014

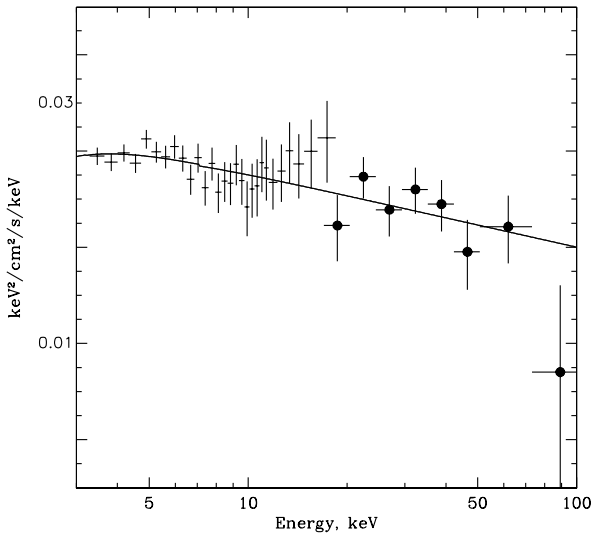

Figure 4. Broadband (3-100 keV) energy spectrum of XTEJ1901+014 obtained by RXTE/PCA and INTEGRAL/ISGRI.

was approximated by a simple power law model with the interstellar absorption fixed at the value of N_H = 0.7 × 10^{22} atom/cm^2 that is typical for this direction to the sky (it was evaluated from the N_H map). The best-fit photon index was Γ=2.15 ± 0.03 (Fig. 4).

We analyzed small short flares registered by RXTE/PCA from the source (see above) and found that the source spectral shape did not changed during the flares.

XTEJ1901+014 is located near the Galactic plane (l = 35.38 deg, b =-1.62 deg), thus the Galactic Ridge emission could strongly affect the result of spectral measurements with RXTE/PCA [3]. In this report the spectrum and lightcurves of XTEJ1901+014 were obtained taking into account this contamination. In order to estimate the Galactic ridge emission intensity we used the data obtaned during pointed observations of nearby transient sources performed during their "turned off" state.

In particular we used observational data for GS 1843-02 (l = ∼31 deg, b = ∼-0.5 deg), the nearest transient X-ray pulsar. The analysis of these data allowed us to obtain the Galactic ridge spectrum near GS 1843-02. Due to the nature of the Galactic ridge emission its spectrum has the same form in different regions of the sky with -5 deg < b < +5 deg [3]. Therefore we can just renormalized this spectrum (using the scan data) to get the Galactic ridge spectrum at the XTEJ1901+014 position.

The importance of accounting the Galactic ridge emission is demonstrated by Fig.5, where the total PCA/RXTE spectrum is shown along with the Galactic ridge and source true spectra.

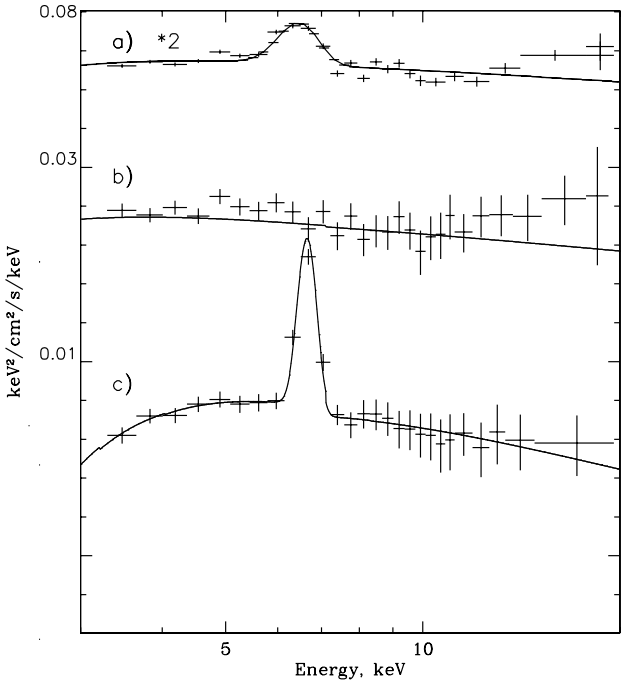

Figure 5. a) The rough spectrum measured by RXTE/PCA from the XTEJ1901+014 position (scaled by a factor of 2 for clarity); b) Reconstructed true spectrum of XTEJ1901+014 in the 3 - 20 keV energy range; c) The Galactic ridge spectrum at the XTEJ1901+014 position according to our estimate.

4.2. Outbursts

Using two energy bands of RXTE/ASM (3-5 and 5-12 keV) it is possible to roughly estimate evolution of the photon index during the outbursts. According to [6] the photon index Γ_{ASM} can be expressed as:

$$\Gamma_{ASM} = 1.499 \times R + 0.698 \qquad (1)$$

where R - the ratio between count rates in the 3-5 keV and 5-12 keV energy bands. Note that this equation was obtained for sources with powerlaw spectra.

For the outburst in June 1997, we found that Γ_{ASM} was not changed significantly (from 1.22 +/- 0.06 to 1.33 +/- 0.12), for the outburst in April 2002 - it changed from 2.4 +/- 0.1 to 1.4 +/- 0.1.

5. SUMMARY

- The broadband spectrum of XTEJ1901+014 in the quiescent state was obtained and investigated for the first time. It can be approximated by a simple power law model with the photon index of ∼2.15 without any high energy exponential cutoff.
- The powerful outbursts of the source in 1997 and 2002 are not the 1st type X-ray bursts because

they become harder with time, resembling the well-known outburst of V4641Sgr or outbursts from SAXJ1818.6-1703 [1].

- A number of small short flares were detected from the source during pointed RXTE/PCA observations.
- The accuracy of the XTEJ1901+014 localization was improved from $3'$ to $\sim 1.2'$ that strengthens the association of this source with the ROSAT soft source 1RXH J190140.1+012630.

Summarizing all the above we can suppose that XTEJ1901+014 belongs to the class of fast X-ray transient sources, but for the final answer on its origin, more observations at different wavelengths are necessary.

6. ACKNOWLEDGEMENTS

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