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Study of type I X-ray bursts from 4U 1705-44 using IXAE and PCA data

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1. Introduction

4U 1705-44 is a bright low-mass x-ray binary (LMXB) in the direction of galactic bulge, which exhibits type I x-ray bursts (Sztajno et al., 1985), kilo Hz quasi-periodic oscillations (Ford et al. 1998) and long term periodicities. EXOSAT observations indicate a correlation between persistent flux and burst properties (Langmeier et al. 1987). Thermonuclear flash model has been found to be suitable to explain the observed properties of type I x-ray bursts. The spectrum from the GSPC and the ME experiment on-board EXOSAT was best fitted by a blackbody component plus a cutoff power law and an additional iron line centered at 6.47 ± 0.05 keV and an equivalent width of 109 ± 22 eV was also detected with GSPC observations (White et al. 1986).

2. Observations

Indian X-ray Astronomy Experiment (IXAE) on-board IRS P-3 observed 4U 1705-44 from 17 August 1999 to 28 August 1999 when the ASM on-board RXTE showed average flux 7.5×10^{-9} erg s^{-1} cm^{-2} in 2-10 keV energy band. IXAE consists of 3 gas filled proportional counters operating in the energy band 2-18 keV with a field of view of $2.3^\circ \times 2.3^\circ$ (Agrawal et al 1997). IXAE detected 3 type I x-ray bursts during the observations. Proportional counter array (PCA) on-board RXTE observed 3 type I x-ray bursts from 1 April 1997 to 3 April 1997, when the source was in island state (cf. van der Klis 1989 for the definition of "island state") The publicly available data on these observations were also analyzed.

3. Data Analysis

Time series analysis of x-ray bursts was carried out using IXAE and PCA data. IXAE has two independently measured energy bands at 2-6 keV and 2-18 keV using which 6-18 keV count rate was derived to calculate a hardness ratio. It was observed that spectrum hardens near the peak of the bursts and softens quickly as the burst decays. PCA data also shows clear evidence of hardening during the peak of bursts followed by a sharp softening, resulting in a hardness dip just after the bursts (Fig. 1). To investigate spectral evolution during the burst PCA data sets were divided into four parts, pre-bursts (A), during the burst (B), near the hardness dip (C)

and the post-burst (D) (see Fig. 1). For each part spectral fitting was performed using science event and standard-2 mode data. A cutoff power-law with a Gaussian line component provides the best fit for the pre-burst (A) and post-burst (D) spectrum. The spectra during the burst (B) and the hardness dip (C) were best modeled by blackbody emission, a cutoff power law and a Gaussian line component. Spectral properties are listed in Table 1.

4. Results

We find that spectrum of 4U 1705-44 hardens during the burst and softens quickly as the burst decays. Detailed spectral analysis revealed that cutoff power-law component hardens and cutoff energy decreases during the burst compared to pre-burst and post-burst value. It was also noticed that blackbody emission present during the burst cools off in the post-burst phase. A detailed discussion of the results and its interpretation will be presented in a forthcoming paper.

Table 1. Spectral properties of the bursts observed with PCA

S. No.	Parameter	A	B	C	D
Burst 1.	Γ	1.86 ± 0.4	0.13 ± .68	1.57 ± .21	1.82 ± .06
01/04/97	E_C(keV)	52.61 ± .09	4.88 ± 1.00	15.33 ± 4.65	27.99 ± .04
	E_L(keV)	6.27 ± .14	6.07 ± .738	6.20 ± .33	6.05 ± .26
$14^h14^m18^s$	σ(keV)	1.29 ± .12	1.43 ± .59	1.00 (frozen)	1.28 ± .28
	kT_{bb}(keV)		1.29 ± .08	1.17 ± .100	
Burst 2.	Γ	1.85 ± .017	0.26 ± .42	1.14 ± .96	1.94 ± .07
01/04/97	E_C(keV)	45.55 ± 4.43	5.24 ± .91	10.71 ± 6.99	51.64 ± .26
$17^h06^m11^s$	E_L(keV)	6.25 ± .09	6.53 ± .25	6.91 ± 1.18	5.95 ± .35
	σ(keV)	1.29 ± .09	0.84 ± .32	1.52 ± .93	1.40 ± .34
	kT_{bb}(keV)		1.34 ± .05	0.94 ± .19	

Γ - Photon Index, E_C - Cutoff energy, E_L - Energy of line emission, σ - FWHM of line emission

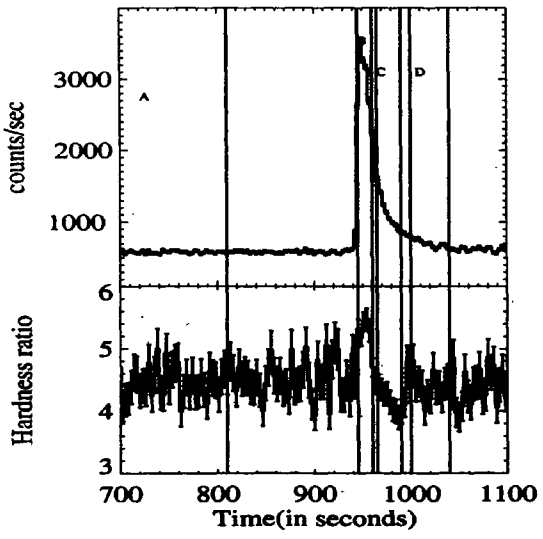

Figure 1. Type I first x-ray burst observed with RXTE

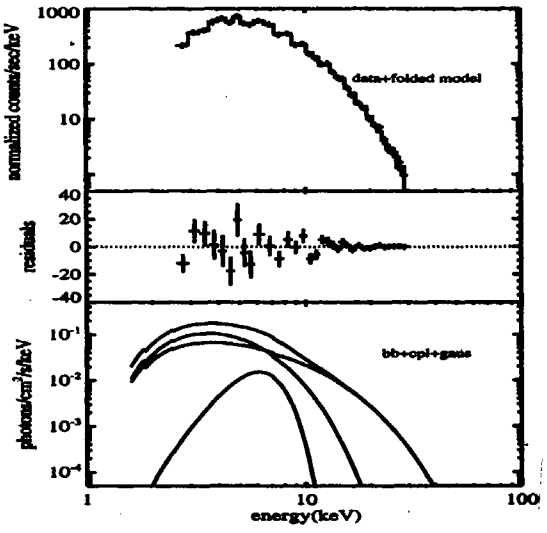

Figure 2. The best fit spectrum during the RXTE

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