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X-ray bursts from GRS 1915+105 observed with the IXAE

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Abstract. The light curves of the galactic superluminal X-ray transient source GRS1915+105 observed with the pointed proportional counters (PPC) of Indian X-ray Astronomy Experiment (IXAE) on board IRS-P3 have revealed the presence of four types of intense X-ray bursts : regular persistent bursts, quasi-regular bursts and irregular bursts. Two of the four types of bursts are regular in occurrence and persist over extended durations. All the observed bursts have a slow exponential rise and a sharp linear decay. The regular bursts show two peak structure while the other type of bursts show multi-peak structure. The burst spectrum is hardest at the end of the decay.

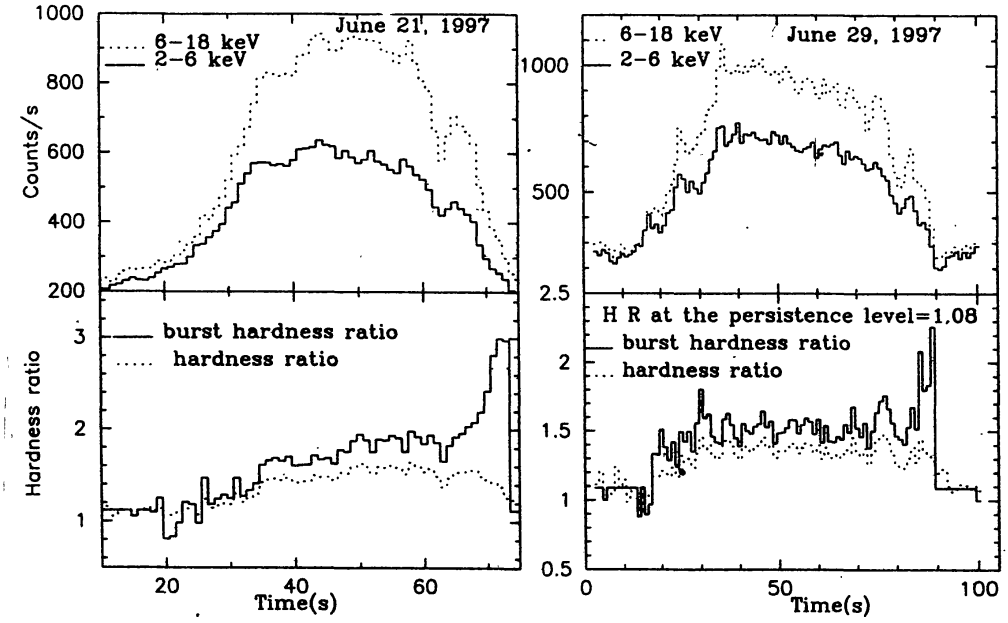

Figure 1. The average burst profiles in two different energy bands and the hardness ratio for the bursts observed on June 21 & June 29 1997.

1. Introduction

The black hole candidate GRS 1915+105 (Castro - Tirado et al., 1994) is one of two galactic X-ray sources that exhibit superluminal radio jets (Mirabel and Rodriquez 1994). GRS 1915+105 is a transient X-ray source. Large intensity variations over time scales of a few hours to a few days were detected. During two years of hard X-ray observations by WATCH, two powerful bursts were discovered during which source luminosity was as high as 10^{39} erg s^{-1}. The hard X-ray spectrum was found to fit well with a power law spectrum with photon index of - 2.5 (Sazonov et al., 1994).

The X-ray luminosity increased to a very high level in 1996 and the source was observed on several occasions by the pointed proportional counters (PPCs) on board the Indian satellite IRS-P3 (Agrawal et al., 1996a, 1996b) and also by PCA and ASM detectors on board the RXTE (Bradt 1996). PPC observations of GRS 1915+105 in 1996 July detected intensity variations by a factor of 2 to 3 at 100 – 400 ms time scale (Paul et al., 1997). But at time scale of a minute or more, very little intensity variations were observed. In recent observations of this source with the PPCs (in July - August 1997), we have detected four types of intense bursts. We discuss here various properties of these bursts like photon flux in different energy bands, hardness ratio, power spectra etc.

2. Results and discussions

Observations were made with the three pointed proportional counters (PPCs) of IXAE. The IXAE was launched on 1996 March 21 on board Indian satellite IRS-P3. For details of the PPCs and observation procedure see Rao et al. (1998) and Agrawal et al. (1996a). We present results here from all PPCs together (data from individual PPC is added together). The observations were carried out from 1997 June 12 to June 29 and August 7 to August 10 in the energy range of 2-18 keV which have revealed four types of very intense X-ray bursts.

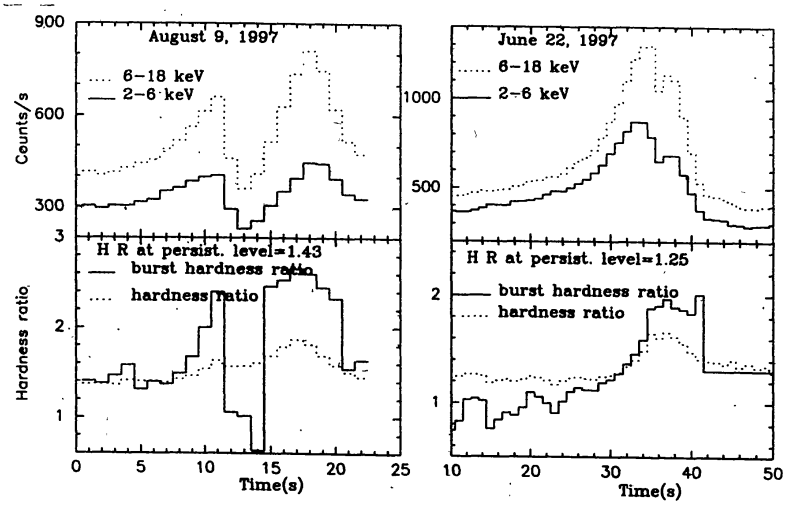

Figure 2. The average burst profiles in two different energy bands and the hardness ratio for the bursts observed on August 9, 1997 & June 22, 1997.

Two out of four types of bursts are quite regular in occurrence with a recurrence time of ~ 21 s (August 9), and of ~ 46 s (June 22). The bursts on June 21 are quasi-regular in occurrence while irregular bursts with varying width of the bursts as well as of dips were observed on 1997 June 27 and June 29. The regular bursts of duration ~ 46 s have been discussed in detail earlier (Paul et al., 1998). The average profiles of all the types of observed bursts in 2-6 keV and 6-18 keV energy bands are shown in Figures 1 & 2 (upper panels). The hardness ratio is shown in the bottom panels. The dotted line shows the over all hardness ratio while solid line shows the burst hardness ratio which is calculated after subtracting quiescent time contribution. The rise in intensity is by a factor of about 2 for the regular bursts (this factor is higher for energy interval 6-18 keV than for energy interval 2-6 keV). In the case of quasi-regular and irregular bursts, intensity rises by a factor of 3 or more. The hardness ratio increases during secondary peaks in the case of the regular bursts. In the case of longer bursts, hardness ratio shows a plateau during the burst. For all type of bursts, spectrum becomes harder in the later part of the burst. The burst spectrum is hardest at the end of the decay. The power density spectra PDS for June 29, 1997 show power law in the frequency range 0.01 to 0.5 Hz. While PDS for August 9, 1997 is flat below frequency 0.1 Hz and it steepens at higher frequencies.

All type of the bursts are consistent with the slow exponential rise followed by a sharp linear decay. The spectrum hardens as burst progresses (solid line in the bottom panels). These bursts are different in temporal structure from the classical bursts in Low Mass X-ray Binaries (LMXB). The sharp decay, which is the most significant difference from the bursts in the neutron star sources, and the hardening of the spectrum as the burst progresses, indicate a possibility that we are observing the advection of matter into the black hole horizon which is most direct 'proof' that an object is a black hole. The results from detailed analysis of these observations are under publication (Yadav et al., 1998).

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