RAPID X-RAY VARIABILITY OF CYG X-1

Observed with the Indian X-ray Astronomy Experiment (IXAE)

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Abstract: We have made observations of the black hole binary Cyg X-1 with the Indian X-ray Astronomy Experiment (IXAE). Observations made with time resolution ranging from 0.4 ms to 1 s showed variations and flaring activity on sub-sec and longer time scales. Results on time variability on different time scales and flaring characteristics in the two states of Cyg X-1 are presented.

1. Introduction

The bright X-ray binary Cyg X-1 considered to be a strong candidate for a black hole, has a bimodal behaviour with distinct 'soft' and 'hard' states and makes transition from one state to the other at irregular intervals. It exhibits rapid and chaotic intensity variations over time scales ranging from milliseconds to hours and days. Quasi-periodic oscillations have also been detected from it on several occasions. It has been found that changes in the PDS are associated with the spectral transition of the source. We report observations of Cyg X-1 made with the Indian X-ray Astronomy Experiment (IXAE) onboard the Indian Satellite IRS-P3 in both the hard and the soft states.

2. Observations

The observations were made with the three proportional counters in the pointed mode (PPCs) which form a part of the IXAE onboard the Indian Satellite IRS-P3 which was launched from India on 1996, March 21. Cyg X-1 was first observed during 1996, April 30 to May 11 period in a low-hard state and again during 1996, July 5–8 interval in a soft-bright state.

3. Results

The two plots in the left column of Figure 1 show the background subtracted light curves of the PPCs in the hard and the soft states respectively. Random and

K. Koyama et al. (eds.), The Hot Universe, 382-383.

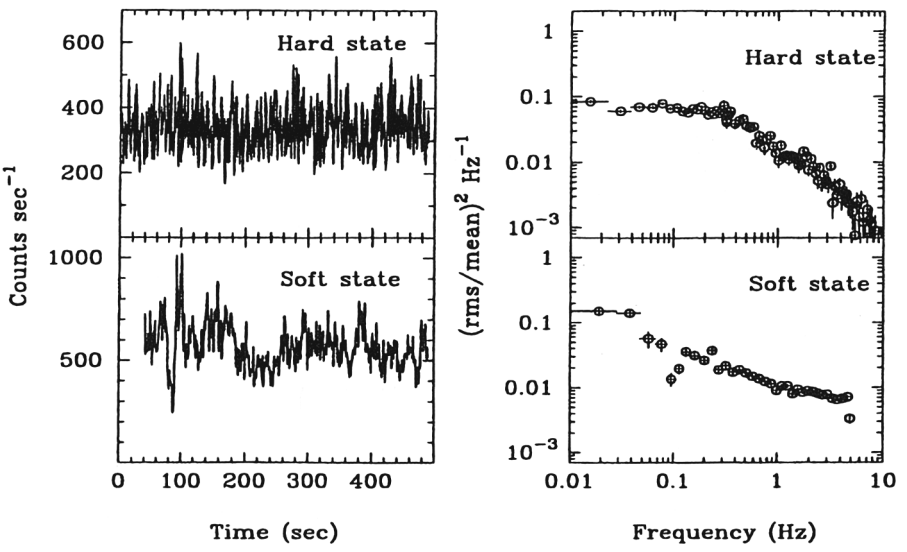

Figure 1. The light curves (left column) and power density spectra (right column) of Cyg X-1 in the two intensity states observed with the PPCs.

chaotic intensity variations on time scale of 1 s and longer are clearly visible in the figure. The short time scale variations are found to be more pronounced in the hard state compared to the soft one. Power density spectra (PDS) for the two states were obtained from individual data segments and then added together. The PDS obtained from our observations of Cyg X-1 in the two intensity states are shown in the two plots in the right column of Figure 1. The hard state PDS is based on data obtained with 1 s and 0.4 ms time resolution while the soft state PDS is based on data of 1 s and 0.1 s resolution. The high state PDS can be fitted by a power law with index of -1.1 between 0.3 to 10 Hz. Below 0.3 Hz the PDS is quite flat right upto .01 Hz with a break in the spectral slope at about 0.3 Hz. The PDS for the soft state can also be fitted with a power law of index -0.39 above a frequency of 0.03 Hz indicating that the soft state PDS is flatter compared to the hard state. There is an indication of flattening below 0.03 Hz similar to that seen in the hard state but no clear indication of the break in the slope.

The present observations confirm that the PDS characteristics are dependent on the intensity state of the source and change smoothly as the source makes transition from one state to another.

https://doi.org/10.1017/S0074180900115633 Published online by Cambridge University Press