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Spectral evolution of LMXB GX 349+2

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Abstract. Z sources are the brightest low-mass X-ray binaries (LMXB) believed to contain magnetized neutron stars. They trace a 'Z' shaped track in their X-ray colour-colour diagram. It is thought that the accretion rate increases systematically along this track. According to 'unified model' proposed to explain combined spectral and timing properties of this class of sources, the systematic variation with accretion rate of spectral parameters such as the optical depth and the comptonization parameter can explain the 'Z' shaped track. We have made detailed spectral and timing analysis of the Z source GX 349+2 using RXTE archival data of the period 29 September to 13 October 1998 to investigate the spectral variations along the Z track. We discuss the results in this paper.

1. Introduction

Low-mass X-ray binaries, containing neutron stars as the central accreting object are traditionally divided in two classes; namely Z and Atoll (Hasinger & van der Klis 1989). This classification is based on the shape of the path, traced by these sources on color-color diagram (CD) and hardness-intensity diagram (HID). Z sources trace a 'Z' shaped path and atoll sources trace a fragmented atoll shaped structure in their CDs. The Z-track consists of three spectral branches, horizontal branch (HB), normal branch (NB) and flaring branch (FB). The energy spectra of LMXBs are described by either a multicolor disk black body emission from optically thick disk plus a comptonized/blackbody component from boundary layer (Mitsuda et al. 1984) or a comptonized component from inner disk plus a black body emission from the optically thick boundary layer (White et al. 1988). In addition, a broad iron K_α line and reflected emission from ionized disk have also been observed.

2. Analysis and results

We analyze ~ 40 ks public archival data of the source GX 349+2, obtained with Proportional Counter Array (PCA) on board RXTE from September 29 to October 13, 1998. The CD is constructed using 256s bin size. The soft colour is defined as the count-rate-ratio between 3.5 – 6.4 keV and 2 – 3.5 keV energy bands and hard colour as that between 9.7 – 16 keV

and 6.4 – 9.7 keV energy bands. We use 'rank number' or 'S_z' parameter technique (Dieters and van der Klis 2000) to define the position of the source along the Z-track. To investigate the

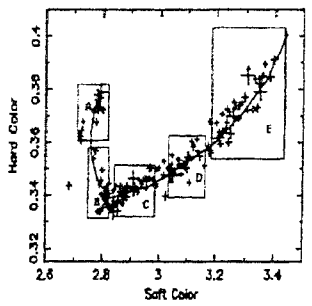

Figure 1. X-ray colour-colour diagram of the source GX 349+2. Boxes represent the regions where spectra have been created.

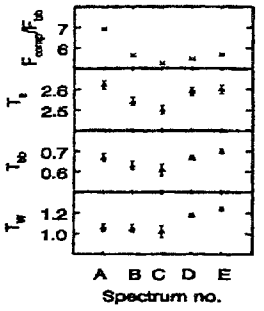

Figure 2. Variation of spectral parameters with position along the Z-track. Panel 1 shows the variation in the ratio of comptonized and blackbody components and panels 2, 3 and 4 show variation in the electron, blackbody and seedphoton temperatures respectively.

spectral variations along the Z-track, we divide the data in 5 parts; A (S_z = 1.8 – 1.9), B (S_z = 1.9 – 2.0), C (S_z = 2 – 2.2), D (S_z = 2.3 – 2.5), E (S_z = 2.5 – 3.0). The spectra are created for time intervals, within which the values of S_z do not change by more than 10%. Spectra within each of these five S_z groups were added using mathpha version 4.5.7. The complete X-ray color-color diagram for 14 days of observations is shown in Figure 1. It consists of an extended FB and comparatively smaller and vertical NB. The spectra are best fitted by a comptonization model (Titarchuk 1994) plus a blackbody. In addition, an iron $K\alpha$ line centred at ~ 6.5 keV and an iron absorption edge at ~ 8.5 – 9 keV are also observed. A systematic investigation of spectral evolution along the Z-track reveals that as the source moves from NB to the lower part of FB (spectrum no. A to C), the ratio of the comptonized component to the blackbody component decreases i.e., the source spectrum becomes softer and as the source moves further up, it remains almost constant. A slight decrease in electron and blackbody temperatures is also seen from NB to lower part of FB. The source GX 349 + 2 exhibits two kinds of noise in the power-spectra, very low frequency noise (VLFN) and peaked noise (PN). We find that the strength of very low frequency noise decreases as the spectrum becomes softer, which suggests possible origin of VLFN in comptonized disk.

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