Mem. S.A.It. Vol. 84, 624

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Disk-Jet connection in outbursting Black Hole sources

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Abstract. We explored the 'spectro - temporal' behaviour of outbursting Black Hole sources in X-rays, at the time of jet ejections which are observed as radio flares. The energy dependent evolution of the properties of all the sources studied, shows that during the ejections the QPO frequencies 'disappear' as well as the disk (thermal) emission increases, implying the soft nature of the spectrum. These results can be understood based on the TCAF model (Chakrabarti & Titarchuk 1995), in the presence of magnetic field.

Key words. Black holes, Accretion physics, X-ray sources, Radiation hydrodynamics

1. Introduction

Galactic Black hole (BH) sources are interesting objects to study as the process of accretion gets very complex as the disk evolves with time, especially when the sources undergo an outburst and Jet ejections take place. It is observed that the peak of the radio emission is associated with the hard to soft state transition (Fender et al. 2009). We study the disk-jet connection of the outbursting BH sources (e.g. XTE J1859+226, XTE J1752−223, XTE J1748−288 and H1743−322) based on their 'spectro-temporal' properties.

2. Observations and results

We analyzed the archival data of RXTE PCA/HEXTE in the energy band of 2 - 150 keV during the radio flares (i.e., Jets) of the outbursting BH sources. We observe an increase in thermal flux and the ratio of soft (3 - 20 keV) to hard (20 - 50 keV) flux in all the sources during the ejections, which implies the softening of the spectra. Energy dependent study was done to understand the evolution of QPOs, nature of PDS, rms etc. during the radio flares, and the interesting features that we observed are summarized below.

2.1. XTE J1859+226: 1999 outburst

- Partial disappearance of QPO (in 2 - 5 keV) during the first flare. Complete vanishing of QPOs during all the other flares (Panel a of Fig. 1).
- Possible detection of 6^{th} flare (Radhika & Nandi 2012).

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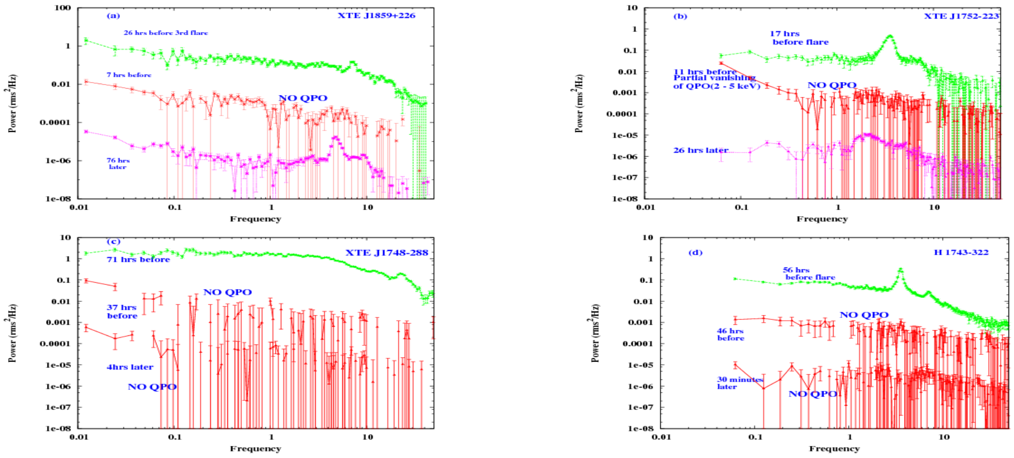

Fig. 1. PDS evolution observed during the flares indicating absence of QPOs (No QPO!), for the sources XTE J1859+226, XTE J1752−223, XTE J1748−288 and H1743−322 (y-axis scaled in each plot for better representation).

2.2. XTE J1752–223: 2009 outburst

– Partial vanishing of QPO in 2 - 5 keV
– Confirmation of the possible Jet ejection predicted in earlier observations (Panel b of Fig. 1).

2.3. XTE J1748–288: 1998 outburst

– Disappearance of QPO, increase in spectral index, softening of spectra occurs (Panel c of Fig. 1).
– QPO disappearance & spectral softening suggests presence of another flare, although no radio obs are available.

2.4. H 1743–322: 2009 outburst

– Complete vanishing of QPO in 2 - 25 keV spectral band (Panel d of Fig. 1)
– QPO reappears after 3 days of the prime ejection.

3. Conclusions

The disk-jet connection observed in outbursting BH sources, can be understood based on the Magnetized-TCAF model (Nandi et al. 2001). Detailed results will be presented elsewhere (Radhika, Nandi & Seetha, 2013, in prep.) and findings from the present work are summarized below:

– 'Disappearance' of QPO occurs due to the 'disruption' of inner part of the disk.
– Re-appearance of QPO after a few hours or days, suggests that the sub-Keplerian flow takes lesser time to refill the inner part of the disk.
– No re-appearance of QPOs after a flare suggest that the inner part of the disk has been disrupted resulting into Jets, with a thermally dominated spectra.

Acknowledgements. We are thankful to Dr. P. Sreekumar of ISRO Satellite Centre for support related to participation in this conference and to Dr. T. Belloni for the usage of GHATS package.

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