Feeding Compact Objects: Accretion on All Scales
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Fast co-evolving behavior of the corona with type-I X-ray bursts in Aql X-1

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Abstract. Taking advantage of the type-I X-ray bursts from the hard surface of a NS of the NS XRB Aql X-1 to probe the purported corona, we found, during the bursts, a clear anti-correlation between the soft and the hard X-rays, which indicates an additional cooling of the corona with the soft X-ray shower fed by the bursts. The phenomenon was also found in IGR J17473-2721, 4U 1636-536 and 4U 1608-522. The time delay between the burst emission and corona emission are different each other, but the time delay are all within 5 seconds. The similarity and difference may be understood that the corona have same mechanism but behave different structure or scale.

Keywords. Stars: coronae — stars: neutron — X-rays: individual(Aql X-1) — X-rays: binaries — X-rays: bursts

1. Introduction

In spectra of the outbursts of a LMXB, a hard X-ray power law with a cutoff energy of tens keV in their spectra was produced via inverse Compton scattering of the soft photons off the hot electrons in the corona, e.g. 4U 1608−522 (Zhang *et al.* (1996)). However, it also remains a puzzle on how the corona is formed and where it is located. Plasmas may be energized to form a corona via either evaporation (Meyer *et al.* 1994) or magnetic re-connections (Zhang *et al.* 2000).

Chen *et al.* (2011) and Chen *et al.* (2011) take advantage of the type-I X-ray bursts from the hard surface of a NS of the NS XRB IGR J17473−2721 to probe the purported corona, under a circumstance of outburst and accompanying spectral evolution, find that

• The corona seems to be located above the disk, but not around the NS, so that emission from type-I X-ray bursts can escape from the NS surface without suffering Comptonization.

• A tiny life cycle of the corona may serve as the first evidence of directly seeing the rapid disappearance and formation of a corona in an XRB with a cooling/heating timescale of less than a second, which can strongly constrain the accretion models in XRBs at work.

Aql X-1 is a transient X-ray binary which undergoes outbursts about once per year. Tens of type-I bursts were detected during the outbursts. Among them, roughly one third of the bursts are PRE bursts (Galloway *et al.* 2008). In this paper, we report the results by analysis all of the RXTE/PCA observations data on Aql X-1 using the similar procedure in Chen *et al.* (2011).

2. Data analysis and results

All of the RXTE/PCA observations data on Aql X-1 are adopted in this analysis. The dead time correction is made to all the spectra and lightcurves under the standard procedure described at the HEASARC website.

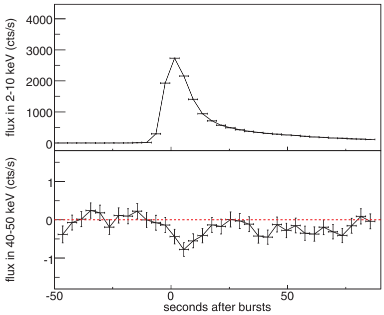

Figure 1. The 1s-bin lightcurves for the bursts. Each data point is the sum over the net lightcurve after subtracting off the persistent emissions at 2-10 keV (top panel) and 40-50 keV (top panel), respectively.

The burst spectrum is well modeled by a blackbody model of a characteristic temperature of less than 3 keV. The burst emission can reach $L_{\rm Edd}$, and dominates the total emission at energies well below $\sim$40 keV, above which the persistent emission from the purported corona dominates. We therefore take the emission in the 40-50 keV energy band to investigate the possible influence of the bursts upon the corona, which is different from the energy band we used in IGR J17473-2721, because the hard X-ray emission is fainter than IGR J17473-2721.

Only the non-PRE burst with the PCA observation mode $E\_125u\_64M\_1s$ were choosed to analyse, which have enough energy bands and good time resolution. For all, 28 bursts were selected.

Those X-rays recorded 48 seconds before and 80 seconds after the reference time are regarded as the background and are subtracted off for each burst in timing and spectral analysis. The average of 40-50 keV persistent count rate recorded by RXTE/PCA are $\sim$1.0 cts/s. After the persistent emission is subtracted off, bursts are combined. As shown in Figure 1, the 40-50 keV flux of the combined burst in the preceding LHS is mostly negative during the burst and around zero elsewhere.

The 40-50 keV decrement reaches a maximum of $\sim$1 cts/s at the 2-10 keV burst peak, all of the 40-50 keV persistent flux. This suggests that all of the corona were cooled by the soft photons of the bursts. A cross-correlation analysis between the two lightcurves shows that the 30-50 keV X-rays lag the 2-10 keV X-rays by 4.5$\pm$1.4s. This suggests that the recovering of the corona lag the burst flux with 4.5$\pm$1.4s.

The phenomenon was also found in IGR J17473-2721, 4U 1636-536 (Ji *et al.* 2012) and 4U 1608-522 (Chen *et al.* 2012a). The time delay between the burst emission and corona emission are different each other, but the time delay are all within 5 seconds. The similarity and difference may be understood that the corona have same mechanism but behave different structure or scale.

References

Chen, Y. P., Zhang, S., Torres, D. F., *et al.* 2011, *A&A*, 534, A101
Chen, Y. P., Zhang, S., Zhang, shuang-Nan, *et al.* 2012, *ApJ*, 752, L34
Chen, Y. P., *et al.* 2012, to be submitted
Ji, L., *et al.* 2012, to be submitted
Galloway, D. K., Muno, M. P., Hartman, J. M., *et al.* 2008, *ApJS*, 179, 360
Meyer, F. & Meyer-Hofmeister, E. 1994, *A&A*, 288, 175
Zhang, S. N., Harmon, B. A., & Paciesas, W. S. 1996, *A&AS*, 120, 279
Zhang, S. N., Cui, W., Chen, W., *et al.* 2000, *Science*, 287, 1239

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