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Isolating the jet in broadband spectra of XBs

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Abstract. Most accretion-powered relativistic jet sources in our Galaxy are transient X-ray binaries (XBs). Efforts to coordinate multiwavelength observations of these objects have improved dramatically over the last decade. Now the challenge is to interpret broadband spectral energy distributions (SEDs) of XBs that are well sampled in both wavelength and time. Here we focus on the evolution of the jet in their broadband spectra. Some of the most densely sampled broadband SEDs of a neutron star transient (IGR J00291+5934) are used to constrain the optically thick–thin break in the jet spectrum. For the black hole transient XTE J1550-564, infrared – X-ray correlations, evolution of broadband spectra and timing signatures indicate that synchrotron emission from the jet likely dominates the X-ray power law at low luminosities ($\sim (2 \times 10^{-4} - 2 \times 10^{-3})\ L_{\rm Edd}$) during the hard state outburst decline.

Keywords. accretion, accretion discs, X-rays: binaries, ISM: jets and outflows

1. Introduction

In X-ray binaries, both black hole (BH) and neutron star (NS) systems are capable of launching powerful jets to relativistic velocities through the process of accretion (e.g. Fender *et al.* 2004). When the X-ray spectrum is hard (the hard state; see Belloni 2010) a continuous jet is thought to be produced, which can radiate synchrotron emission from radio frequencies to at least the optical/near-infrared (OIR) regime (e.g. Hjellming *et al.* 1990, Russell *et al.* 2007, Coriat *et al.* 2009). Multiwavelength studies are required to attempt to isolate the synchrotron jet emission from other components such as thermal emission from the accretion disc and companion star or Comptonized radiation from the corona. Here we focus on two recent results where the jet emission has been revealed and the spectrum constrained at higher energies than the radio; one from a BH system and one from a NS.

2. Evidence for a compact jet dominating the broadband spectrum of the black hole accretor XTE J1550-564

XTE J1550–564 was monitored continuously throughout its outburst in 2000 (Tomsick *et al.* 2001, Jain *et al.* 2001, Corbel *et al.* 2001). We are able to separate the OIR emission from the disc (exponential decay) and jet (excess in hard state, absent in soft state). We find that on the hard state decline of the outburst, the OIR spectral index of the jet component is $\alpha \sim -0.7$, where $F_\nu \propto \nu^\alpha$, which is the same as the measured X-ray and OIR–to–X-ray power law index. Moreover, the OIR jet and X-ray fluxes are linearly correlated. The OIR and X-ray data are consistent with a single power law with a common origin: the synchrotron jet. When the synchrotron jet appears to dominate the X-ray flux, (I) there is an excess in the X-ray light curve over its previous exponential decay, (II) there is possible evidence for a shift in the high energy cut-off to a lower energy, (III) the X-ray timing properties do not change significantly except the possible disappearance of a quasi-periodic oscillation (E. Kalemci, these proceedings). This may be the strongest evidence to date of synchrotron emission from the compact, steady jet dominating the X-ray flux of an XB. For XTE J1550-564, this is likely to occur at $\sim (2\times10^{-4} - 2\times10^{-3})$ $L_{\rm Edd}$ in the hard state. However, the synchrotron jet can only provide a small fraction ($\sim$ a few per cent) of the X-ray flux at other times in the hard state. Both Comptonization and the synchrotron jet can therefore produce the hard X-ray power law in accreting black holes. These results are published in Russell *et al.* (2010).

3. The double-peaked 2008 outburst of the accreting milli-second X-ray pulsar, IGR J00291+5934

After its 2004 outburst, the NS XB IGR J00291+5934 again became active in 2008. However, instead of returning to quiescence, the system performed a second, more prolonged outburst peak. The double-peaked outburst was monitored extensively, with data collected at X-ray, UV, OIR and radio frequencies. A near-IR excess is commonly seen in outbursts of accreting milli-second X-ray pulsars, which has been attributed to synchrotron emission from the jet. We are able to fit the broadband SEDs with a blackbody (likely the irradiated accretion disc) plus X-ray power law and a simple jet model. If the jet produces the near-IR excess, the models suggest the optically thick–thin break in the jet spectrum resides around the H-band (in the near-IR). This is a higher frequency than previously reported for NS jets (Migliari *et al.* 2010) implying that their jet powers may vary between sources or luminosities. This work is published in Lewis *et al.* (2010).

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