How Jet Contributes and Behaves in Hard state, XTE J1752-223

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- abstract -

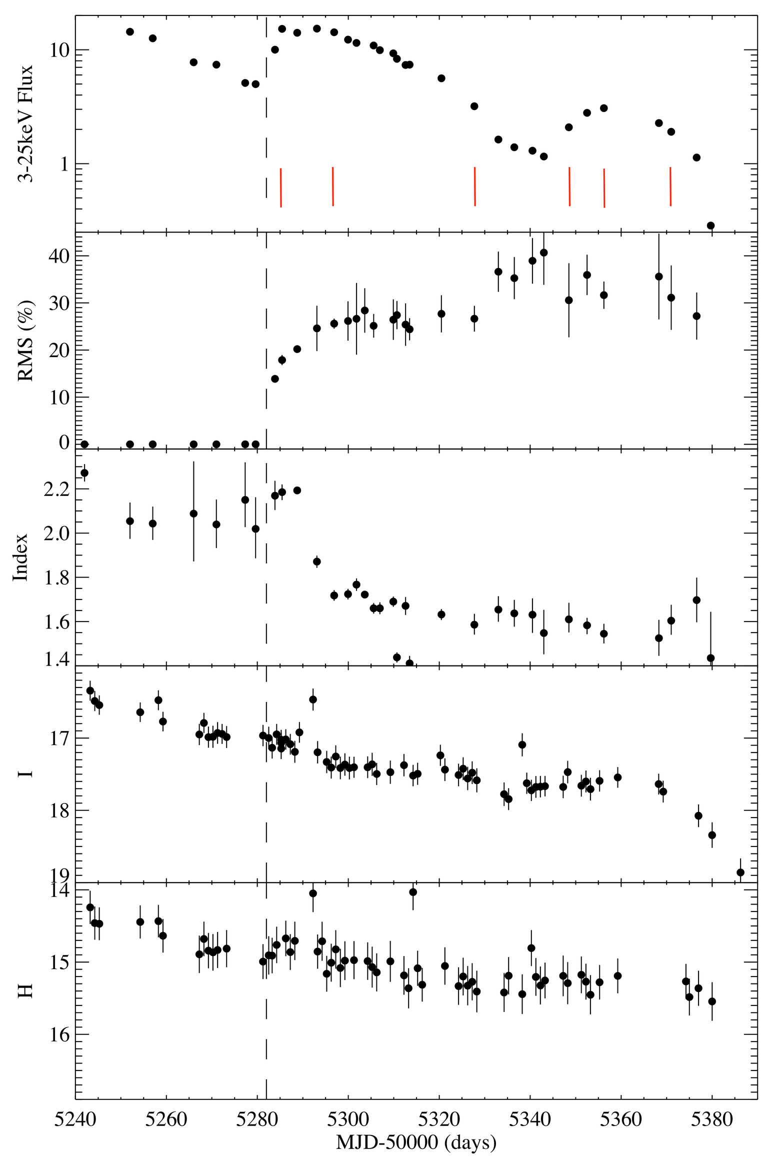
A GBHT, XTE J1752-223, is studied from radio to X-rays using ATCA/VLBI, SMARTS, Swift, RXTE and INTEGRAL, covering the whole outburst decay in 2010, i.e. the transition from the soft to hard spectral state. The 177.4 ks INTEGRAL observation allowed an investigation of the source in hard X-rays. The results of the multiwavelength work make this source interesting, showing two flares in O/NIR, first one appears about 20 days after the transition and second one follows when the X-rays also re-brightened. The ATCA observations showed flat radio spectra within 1-σ during the second peak. The timing analysis also provided an interesting result, that there is no significant change before and after jet domination that was claimed by Russell et. al. 2012. Furthermore, using the simultaneous broad band X-ray spectra, we found that a high energy cut-off is necessary with a folding energy about 250keV when the jet seems forming. The broad band spectrum is also fit with Comptonization model. These results might be helpful to understand the physical conditions of jet formation and/or its contribution to X-rays in the hard state.

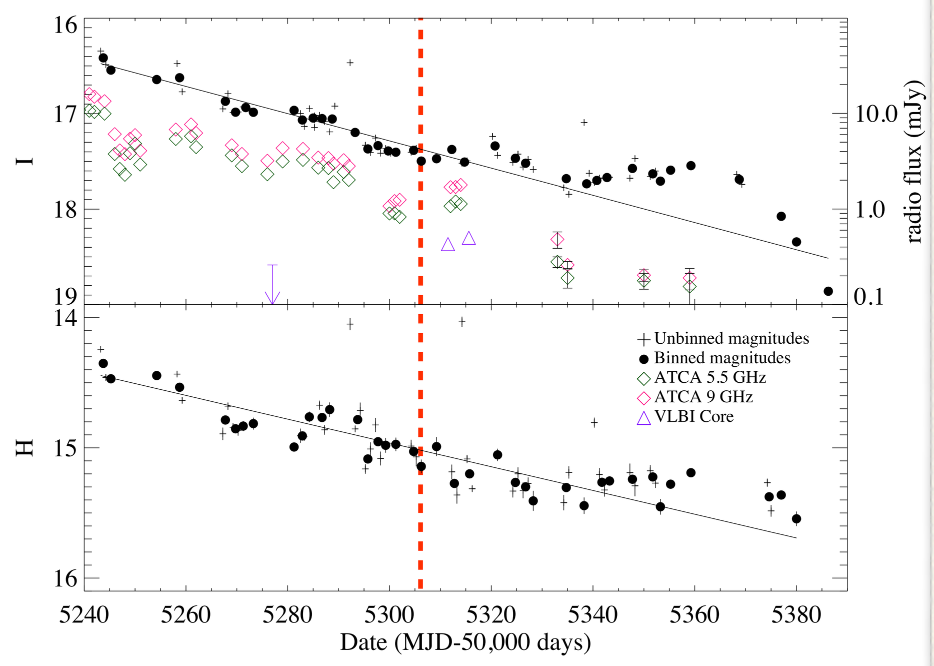
1. Introduction to GBHT & XTE J1752-223

GBHTs show distinct spectral and temporal properties changing during the whole outburst, leading to spectral states. In the hard state, the sources often have low flux and hard spectral index (<2.0) in X-rays, whilst the soft state shows low luminosity and softer spectral index. During the outburst decays with the state transitions in spectral and temporal properties, the transients in the hard state may also show jet signatures, which can be detected in radio, near infrared, and optical. The studies on how or in what conditions the jet forms and how the jets contributes to X-rays are still under debate.

XTE J1752-223 has been studied in depth through many astronomical instruments since discovered in Oct 2009. It was determined as a black hole transient source as its spectral and timing properties are similar to other known galactic black hole systems through intensive monitoring by RXTE, Swift, and MAXI. The jet core was detected by VLBI about 30 days after transition to hard state, and ATCA facilities also allowed multiwavelength monitoring in radio, O/NIR in addition to X-rays. The contribution of jet to X-ray and its behaviour in LHS were well discussed by Russell et. al. (2011).

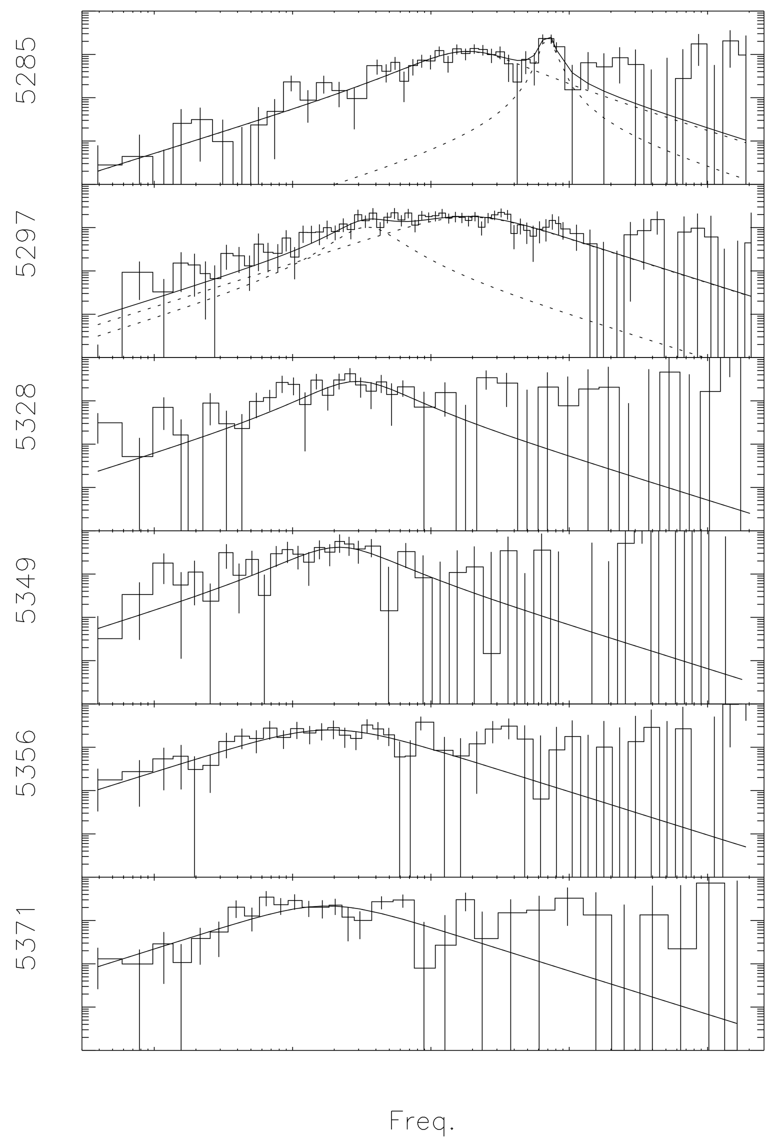
2. Spectral/Temporal multiwavelength evolution during the decay





- Right: Whole evolution of X-ray flux, variability, powerlaw photon index, and SMARTS O/NIR (I, H), from the top. Fluxes and rms values are ridge emission corrected in low luminosity level. The dashed line indicates fast transition.
- Up: O/NIR magnitudes re-binned. The disk decay is indicated by solid lines to bring out the excess, that is thought to be from the jet. ATCA/VLBI observations are also shown, indicating jet appearance.

3. Timing properties during the decay

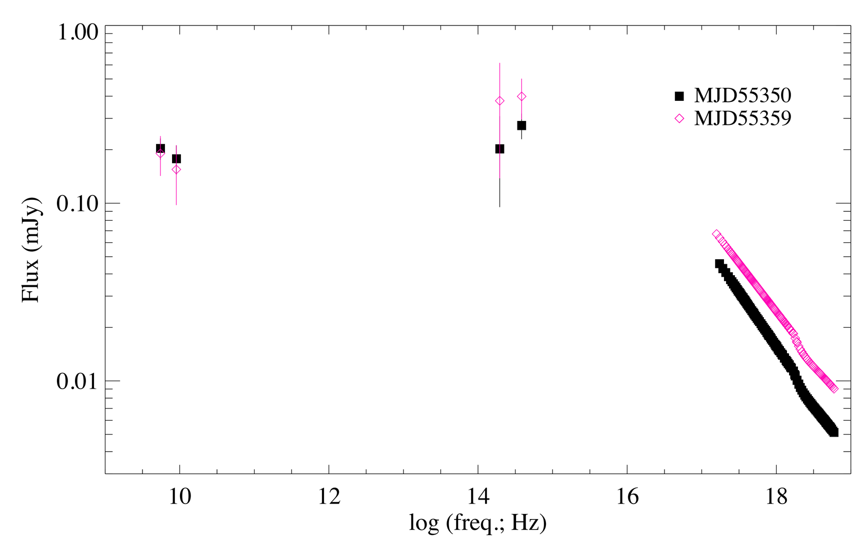


PDS in power versus frequency, their observations are indicated by red lines on the figure in Section 2 and dates are also indicated on the left.

The top panel shows a PDS right after the transition, i.e. the intermediate state when the PL component is still soft and the luminosity instantaneously increased, and the second one is on the peak. Whilst the other four indicate ones around the second peak in X-rays, one before and another at the turning point, and another at the second peak and the other after peak when luminosity decreased.

It is noted that there is no clear difference in PDS before and after the second peak, and the peak of Lorentzian curve gradually decreases.

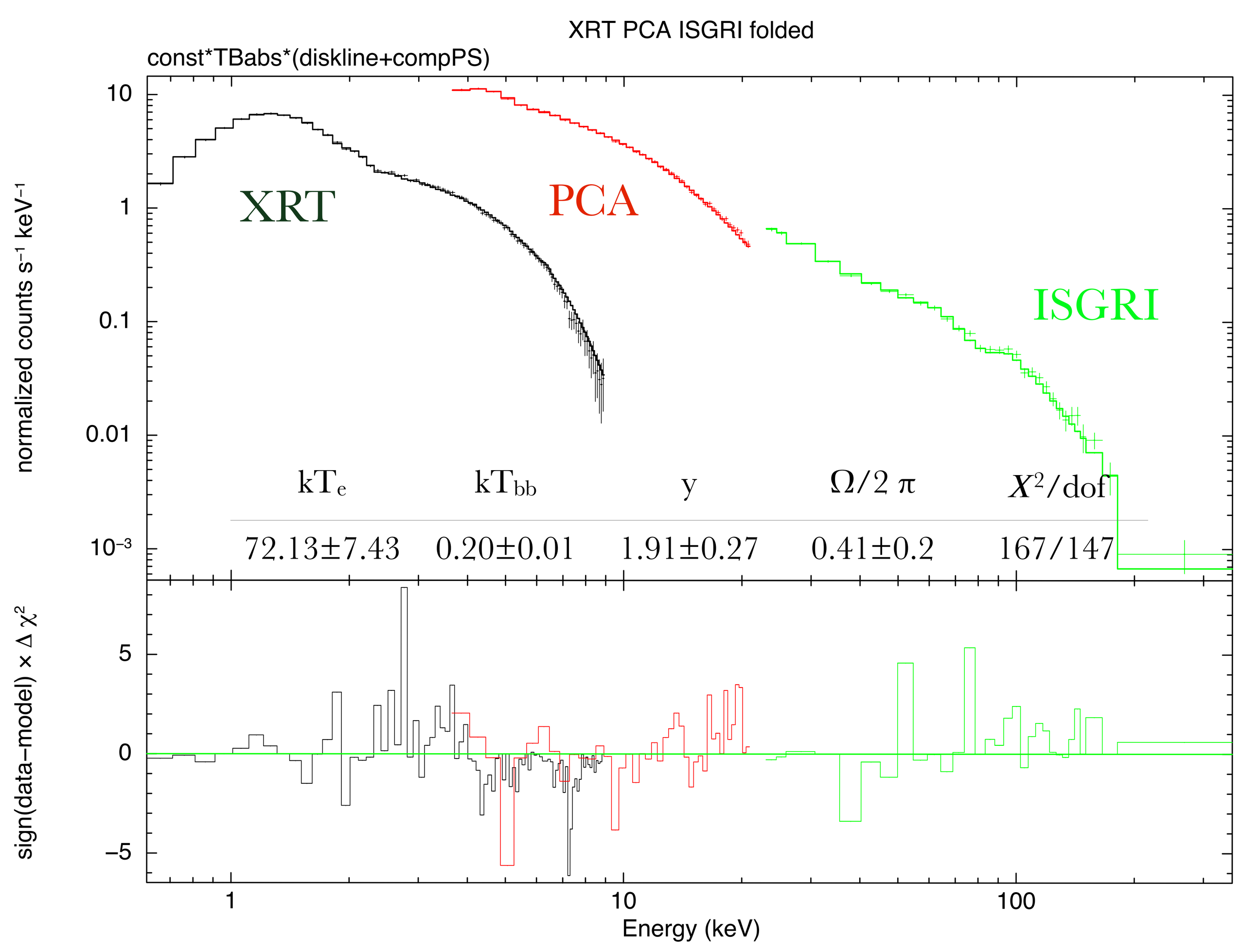
4. Spectral Energy Distributions



SEDs when X-ray/O/NIR re-brighten in LHS nearing quiescence are consistent with radio-optical, but there are not enough data to assert the contribution of jets in X-rays.

Finding the jet break frequency was not possible with these data sets, due to low quality of SMARTS data or residing above optical as claimed by Russell (2012).

5. Broad X-ray Spectrum



X-ray spectral fit (X^2/dof=167/147) when the jet seems starting to form

(MJD55305, the red dotted line on the figure in Section 2)

Fe line and CompPS might constrain the inner radius with lower limit (≥ 50Rg)

6. Conclusion

1. Jet forms (or starts to form) about 20 days after transition to hard state, and its contribution is more significant in the optical I band than in X-rays.
2. PDS show no clear differences between the first and second flare in optical, whilst ATCA data yielded flat radio spectra only during the second flare (i.e. jet domination).
3. Compotonization is well fitted in X-ray broad band spectrum, before or more or less when jet starts to form. (High energy cutoff was also needed)

7. References

- Kalemci, E., et al., 2005, ApJ, 622, 508
- Russell, D. M., et al., 2012, MNRAS, 419, 1740
- Yang, J., et al., 2010., MNRAS, 409, L64