Understanding the non-thermal emission from the black hole X-ray binary MAXI J1820+070

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ABSTRACT

The accreting black holes in X-ray binaries (XRBs) are well established to exhibit a highly energetic, ionized environment around them. They also show sub-relativistic or relativistic outflows, vigorously moving outwards, having significant imprints of the ionizing environment. We have been investigating X-ray spectra of XRB MAXI J1820+070, which showed prolonged multi-wavelength activities starting in 2018, to model the non-thermal emission from the disk, corona and possible signatures of ionized outflows or transient X-ray jets during state transitions. This poster presents highlights of our current results.

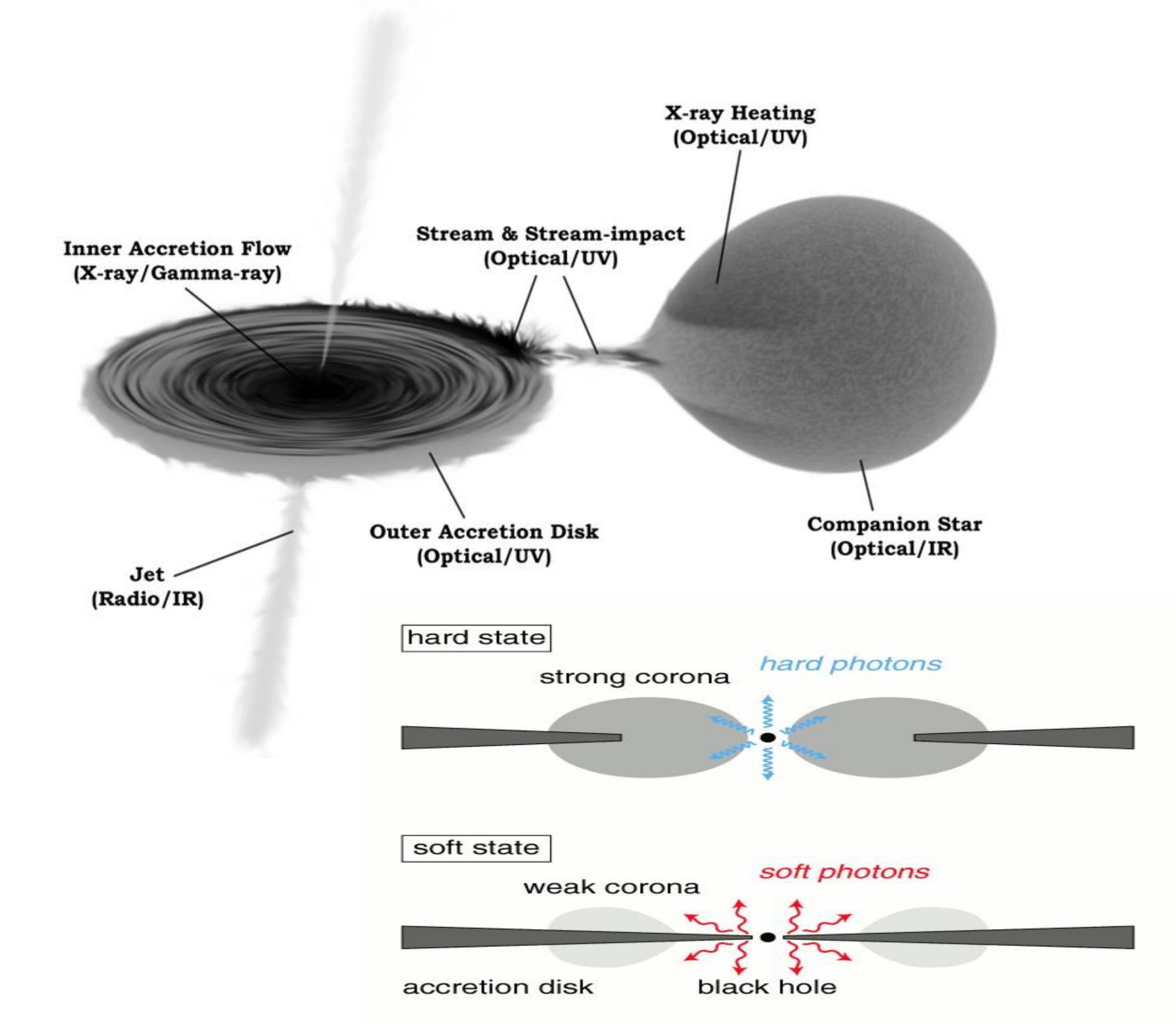

Figure-1: Top: Geometry of the accretion mechanism, Roche lobe overflow, in a low-mass X-ray binary (Credits: R.I Hynes, 2010) Bottom: Illustration of the different X-ray spectral states during a typical outburst (Credit: B.F Liu et. al,2009)

INTRODUCTION AND MOTIVATION

- Low-mass black hole X-ray binaries (LMXRBs) are observed to undergo recurrent outbursts on the timescales of a year to a decade during which the transition in accretion states takes place (*T. Belloni et al. 2000*, *Remillard & McClintock 2006*)
- X-ray emission from XRBs are attributed to the accretion disk, hot corona and the reflection of coronal emission by the disk.
- Another non-thermal component is expected due to the synchrotron emission from the transient jet, whenever it is active. Also, the non-collimated ionized outflows during other states should imprint spectral signatures in the form of absorption.
- MAXI J1820+070 was discovered on 11 March 2018 by the MAXI undergoing an outburst which lasted more than 100 days (*Kawamuro et al. 2018*).
- Several studies in literature have modelled X-ray emissions to be best represented by a combination of (or similar to) diskbb+nthcomp+reflection (*P. Bharali et al. 2019*, *Y. Xu et al. 2020* , *D.J.K Buisson et al. 2019*).
- The work *of D.J.K Buisson et al. 2019* presents multi-epoch spectral analysis to show the behaviour of physical parameters over the course of its prolonged outburst.
- Other published literature has measured a distance of 2.96±0.03 kpc, with a black-hole mass estimate of 7-8 $M_\odot$ (*Y. Xu et al. 2020*).
- Signatures of X-ray jets have also been detected from November 2018 to June 2019 (*M. Espinasse et al. 2020*).

OBJECTIVES

- Our primary aim is to model the X-ray emission form MAXI J1820+070 to identify possible contributions of relativistic and highly-collimated ouflows (jet), or sub-relativistic isotropic outflows (ionized outflows or failed jet) during various accretion states of the XRB.
- This requires an understanding of other dominating emission components such as disk, corona and reflection.

ANALYSIS AND RESULTS

- We simultaneously fit contemporary spectra from *XMM-Newton* (0.5-10 kev) and *NuSTAR* (3.0-79 kev) at two different epochs, first where the XRB was undergoing a 'rebrightening' and second where it was undergoing a 'mini-outburst'.
- The fit was performed using two sets of models which both include:
  - interstellar absorption due to neutral hydrogen
  - a multi-coloured disk black body
  - a thermal comptionization
  - a relativistic reflection component.
- Our spectral analysis of the selected epochs confirmed MAXI J1820+070 being in the hard state during both epochs - 05-06/10/2018(rebrightening) and 25-26/03/2019 (mini-outburst).

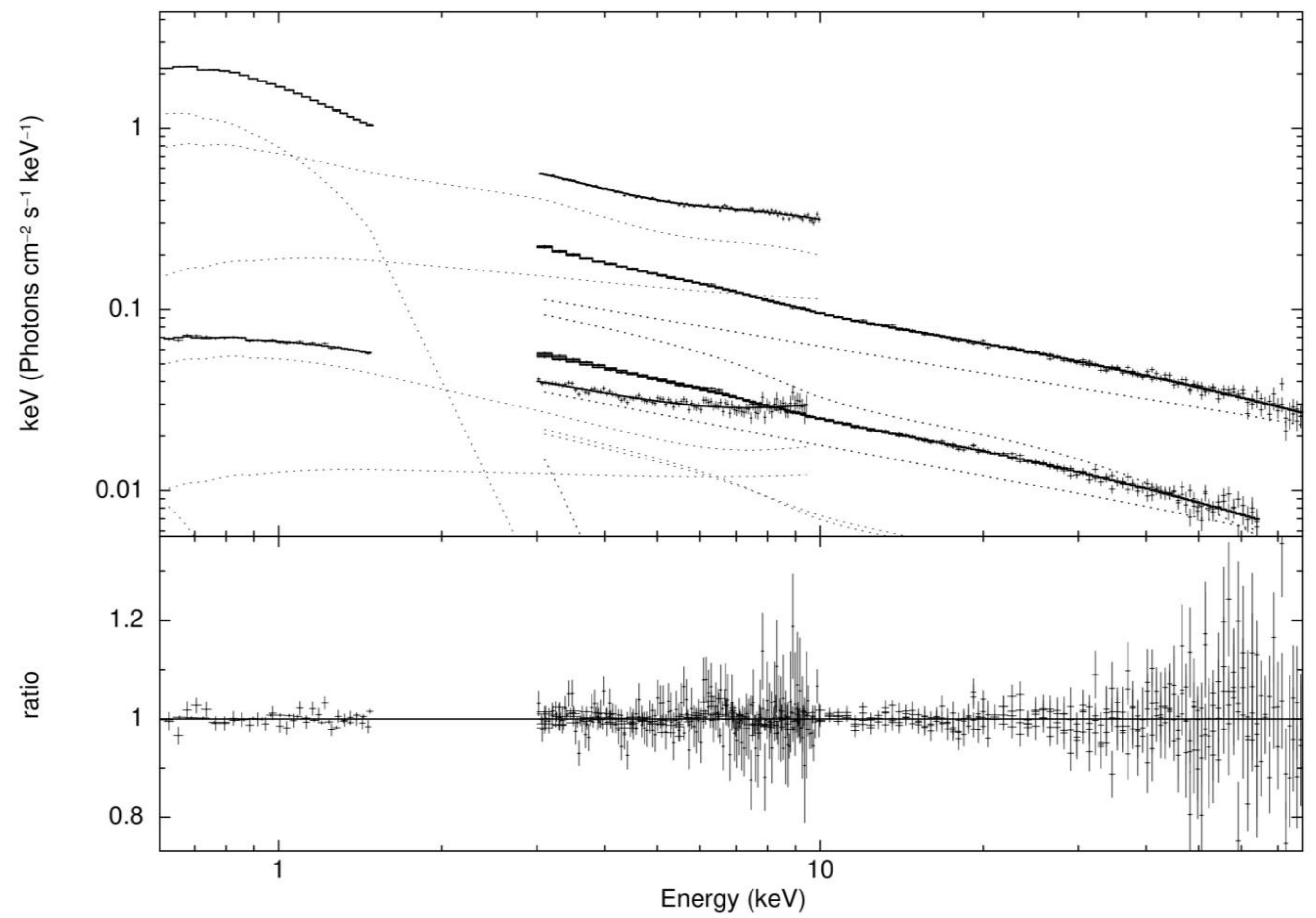

***Figure-2:** An example case of spectral modeling incorporating the model: TBaBs*(Diskbb+nthcomp+nthratio*relxillcp). **Top:** MAXI J1820+070 folded spectrum of two epochs. **Bottom:** Ratio of model to data.*

CONCLUSION

- Our results indicate that MAXI J1820+070 transitioned into the hard state during the rebrightening period, subsequently decaying into quiescence before entering the hard state again during the mini-outburst.
- We have successfully reproduced the common physical parameters as published in literature (*D.J.K Buisson, et al., 2019*, *P. Bharali et al. 2019*)
- No signatures of jets or isotropic outflows were detected.

FUTURE PLANS

- Our plan is to explore more observations, preferably close to the formation of radio and X-ray jets.
- We plan to extend this work including detailed timing analysis, which can be used to infer more physical properties.