A unified modeling of Microquasars spectro-polarimetry data from INTEGRAL

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Abstract

In this new era of high-energy spectro-polarimetry, our understanding of Black Hole X-ray Binaries (BHXBs), also known as microquasars, has the potential to be significantly improved. By complementing spectroscopy with polarization measurements, we gain key insights of the particle acceleration mechanisms, the geometry of the emitting regions near the compact object, and, in turn, into the accretion-ejection processes. One of the major open questions concerns the origin of the hard X-ray/soft gamma-ray tail extending above 100 keV. In most BHXBs, the emission detected by INTEGRAL is thought to arise from a combination of inverse Compton scattering and optically thin synchrotron radiation. However, the relative contribution of these two processes remains uncertain. A quantitative analysis that combines spectral and polarization information is therefore required to disentangle these components. We developed a general-purpose method to model the broadband high-energy spectro-polarimetric data and fit physical parameters in a statistically rigorous way (T. Bouchet et al. 2026b, submitted). In this first study, we focused on the bright and persistent microquasar Cygnus X-1. We were able to constrain the cut-off energy from synchrotron emission, which links back to the non-thermal electron population. Additionally, we applied a MCMC algorithm to refine the model predictions. Finally, we further provided a new explanation for the hard-tail polarization angle, based on magnetic field helicity and Doppler boosting. We are currently in the process of extending this study to more BHXBs, in particular bright transient systems such as Swift J1727.8-1613, MAXI J1820 and MAXI J1348. This will rely on an updated analysis of the SPI instrument data which will allow us to measure the hard-tail spectrum, and potentially polarization, in a systematic way. Since our method is not specific to BHXB, it could easily include other targets such as the Crab Nebula.

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