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Lorentz factors of compact jets in black hole X-ray binaries

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Compact, continuously launched jets in black hole X-ray binaries (BHXBs) produce radio to optical–infrared (OIR) synchrotron emission. These jets are launched in the hard X-ray state, and are quenched in the soft state. They are not spatially resolved except in a few cases using VLBI radio observations. One of the basic properties of these jets is the bulk Lorentz factor, which defines how fast and how relativistic these jets are. The bulk Lorentz factor is notoriously difficult to measure, with to date only weak constraints for a few BHXBs. Here, we adopt simple models to constrain the Lorentz factor of the compact jets in several BHXBs using the amplitude of the jet fade and recovery at infrared (IR) wavelengths over state transitions. We investigate why some BHXBs have prominent IR excesses and some do not, quantified by the amplitude of the IR quenching or recovery over the transition from/to the hard state. Using the amplitude of the IR fade/recovery, known orbital parameters and simple analytical models, we constrain for the first time the Lorentz factor of compact jets in several BHXBs. We also find that the very high amplitude IR fade/recovery seen repeatedly in GX 339–4 requires a much lower inclination angle than previously expected. Our results are strongly supportive of the IR excess being produced by synchrotron emission in a relativistic outflow, and demonstrates how useful OIR monitoring of BHXB is for studying jet properties.

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