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No need for speed: Placing upper limits on Lorentz factors of large-scale XRB jets informed by hydrodynamic simulations

Measuring the Lorentz factors of jets from black holes is essential for understanding the jet launching mechanisms and overall energy budget of the black holes themselves. However, this is a notoriously difficult task due to special relativistic effects which are exacerbated for off-axis sources, namely X-ray binary (XRB) jets. In fact, from kinematics alone we find that, remarkably, we can only place lower limits on their bulk Lorentz factor and thus, we cannot constrain the Lorentz factor distribution of jets from stellar-mass black holes as different from AGN.

In this talk, we present novel methods for estimating upper-limits of XRB jet Lorentz factors from observational data, as well as perspectives on the dynamics of these systems from hydrodynamic simulations. We show how off-axis jets are often de-boosted, and therefore high Lorentz factors imply intrinsically brighter sources, which under basic assumptions implies higher internal energy in the ejecta. This allows us to place two independent upper limits on the Lorentz factors through constraining the allowed values of internal energy –the internal energy is likely lower than the kinetic energy, and the total energy is also likely lower than the maximum jet power integrated over the associated flare period. The upper limits on internal energy also limit the maximum Lorentz factor given an observed flux and known inclination. We apply these limits to several known XRBs.

In conjunction with Lilje et al., this work develops our understanding of the key differences (or lack thereof) between black holes across the mass range.

Contribution

Oral talk

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