The explosive outbursts of black holes

Research Field
Accretion Physics

Project Suitability
PhD

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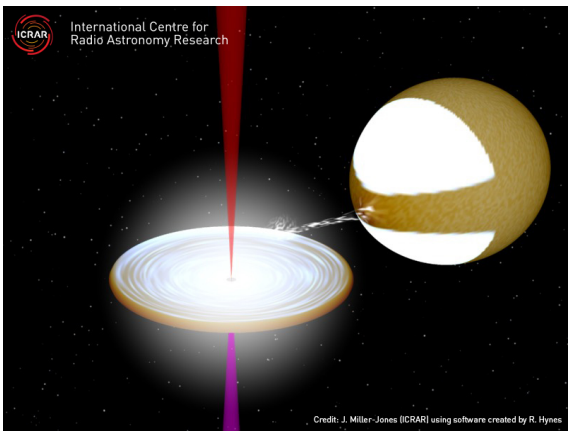
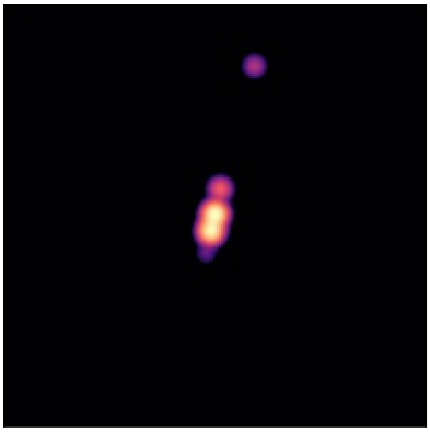
The release of gravitational potential energy as matter falls onto a compact object such as a black hole powers the most energetic phenomena in the Universe, allowing us to study higher energies and stronger gravitational fields than could ever be reproduced in a laboratory here on Earth.

As matter falls onto a black hole, its angular momentum causes it to form a rotating accretion disc around the central object. However, matter does not only flow inwards. Some fraction of the infalling material can be diverted outwards in relativistically-moving, oppositely directed, bipolar jets, or in slower, more massive, equatorial winds. Different geometries of the inflowing gas appear to be associated with these different types of outflow. With multiwavelength observations, we can probe all these different components of the system; jets, winds and accretion flow. On occasion, the accretion rate onto the central black hole increases by several orders of magnitude, changing both the inflow geometry and the nature of the outflows, and causing a dramatic increase in the amount of light emitted at all wavelengths.

We believe that the same physics governs the behaviour of these stellar-mass compact objects as governs their more massive analogues in the supermassive black holes seen at the centres of galaxies (Active Galactic Nuclei; AGN). However, since stellar-mass objects evolve on much faster timescales (days and weeks rather than millennia), they act as unique probes of the physics governing the accretion and outflow around black holes. We can study the explosive outbursts of these systems as they evolve in real time, providing new insights into their radiative and kinetic feedback that has an impact on cosmological scales

In this project, you will work as part of a large international team conducting multi-wavelength observational studies of the explosive outbursts of black hole X-ray binary systems, aiming to understand how these powerful events evolve, and in particular the connection between the changing conditions in the inflow and the launching of relativistic jets.





Left: A schematic of a black hole accreting matter from a donor star via an accretion disk. Relativistic jets (shown in red and purple, as observed in right panel) are launched from the inner regions of the accretion flow.