High-resolution imaging of time-variable radio jets from feeding black holes

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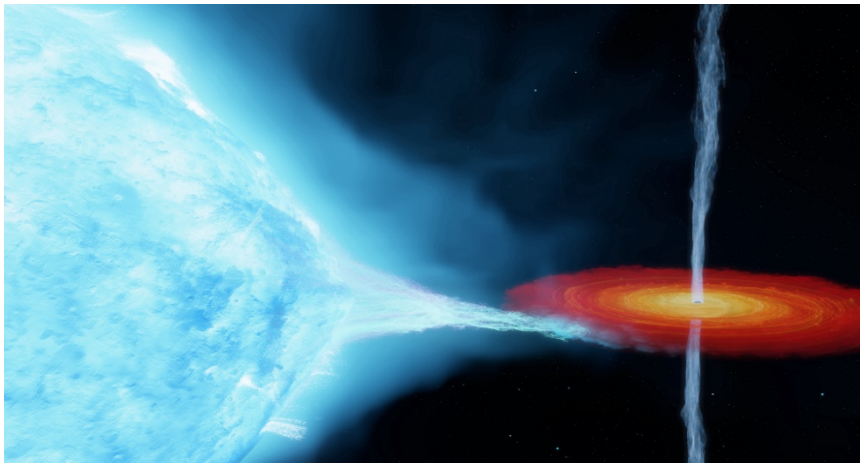
Description:
Powerful, relativistic jets are seen across the visible Universe, from stellar-mass objects in our own Milky Way to supermassive black holes at the centres of external galaxies. They play a crucial role in providing feedback of matter and energy to their surroundings, which in the case of supermassive black holes can affect an entire galaxy cluster. However, it is only in smaller, stellar-mass black holes that we can observe these jets evolve in real time, providing a unique window into their properties.

To track the evolution of these jets, we need extremely high angular resolution. The highest-resolution astronomical images are produced by combining the signals produced by radio telescopes separated by thousands of kilometres. Such telescope arrays were recently used by the Event Horizon Telescope consortium to produce the first direct images of black holes. To image the dynamic, rapidly-changing environments of these black holes, researchers had to develop new algorithms to compensate for the variations in the radio signals over the course of the observation period, effectively removing the blurring effect caused by source motion or brightness changes.

The rapid variability of the jets from stellar-mass black holes and neutron stars within our own Milky Way galaxy has hindered previous observations seeking to study the jets on the smallest angular scales, close to their launching point. The new techniques developed for the Event Horizon Telescope will allow us to overcome some of these challenges, providing higher-fidelity reconstructions of the evolving jets from stellar-mass compact objects, and yielding new and unique insights into their properties.



Artist's impression of a stellar-mass black hole accreting matter from a donor star and launching relativistic jets, which we can image in real time using high-resolution radio telescopes. Credit: ICRAR.

This project aims to determine the physical properties of the jets and outflows from stellar-mass compact objects in our Milky Way galaxy. In this project you will test cutting-edge analytical techniques developed by the EHT team, and use them to derive valuable new information from existing high-resolution radio data, providing new insights into the structure, variability, and propagation of energetic jets launched by stellar-mass compact objects. Imaging these systems will provide a novel and unique view of how stellar-mass black holes and neutron stars accrete matter and how energy is released and recycled via relativistic jets.

These systems make up an important class of transient events, which over the coming decades will be studied by world-class astronomical facilities such as the Square Kilometre Array. This project will provide an important link between the jet-launching region on the smallest scales, and the larger-scale jets that are currently tracked by SKA precursor facilities, and which will be prime targets for the SKA.