Curtin University

Radio transients in the Galactic Plane: Exploring the low-frequency properties of X-ray binaries with the MWA

Research Field
Radio Astronomy

Project Suitability
PhD

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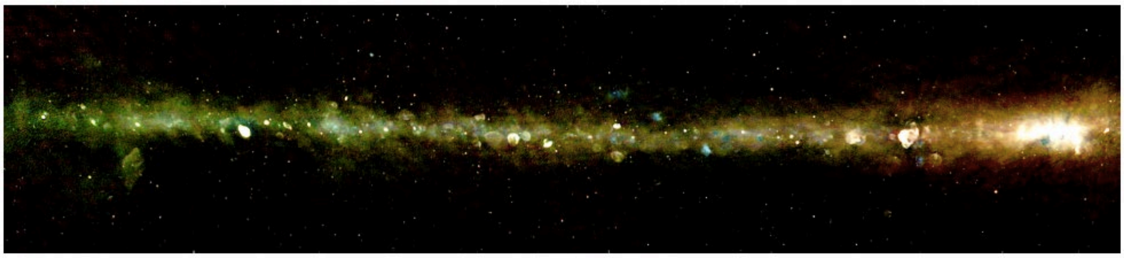
The process of accretion, whereby matter falls onto a compact object such as a black hole, is responsible for powering the most energetic phenomena in our Universe. The energetic radiation and powerful jets liberated by accretion onto supermassive black holes at the centres of radio galaxies are responsible for triggering or shutting off star formation, regulating the evolution of their host galaxies, and possibly even reionising the Universe. However, due to the long timescales on which such systems evolve, we cannot investigate how these processes of accretion, ejection and feedback proceed in individual supermassive black holes.

Since processes close to a black hole are governed by strong gravity, the physics should be very similar regardless of the black hole mass. We can therefore gain important insights into the physics of accretion and jet production by studying smaller black holes and neutron stars in our own Galaxy, with masses just a few times that of the Sun. If these stellar-mass compact objects accrete matter from a less-evolved donor star, the accreted mass builds up in a disc surrounding the central object until instabilities cause that mass to fall inwards, liberating gravitational energy, which powers a bright outburst in which the system increases in luminosity by several orders of magnitude, right across the electromagnetic spectrum. These outbursts lead to the ejection of powerful jets that can be studied at radio frequencies.

The Murchison Widefield Array (MWA) is a new, low-frequency radio telescope in Western Australia, which is operated by Curtin University as one of the precursor facilities to the Square Kilometre Array (SKA). The wide fields of view provided by the MWA enable us to efficiently survey the entire visible Galactic Plane and Galactic Bulge, where the majority of black hole and neutron star systems are located. The sensitivity of the MWA will allow us to detect outbursts of black hole or neutron star X-ray binaries anywhere in this region, determining how much kinetic energy is channelled into the jets in these outbursts, and allowing us to quantify their feedback effect on the surrounding environment. Over the past three years we have conducted fortnightly monitoring of the visible Galactic Plane and Bulge regions, and have been developing the software pipelines required to analyse the data in this technically challenging region of the sky.

In this project, you will use this Galactic Plane monitoring data to investigate the outbursts of known X-ray binary systems and search for new Galactic radio transients. You will use a newly developed technique to perform image subtraction to search for transients, therefore refining existing pipelines and implementing them on the powerful facilities available at the nearby Pawsey supercomputing centre. You will also test new techniques for transient detection, helping to inform the observing strategies for more sensitive monitoring campaigns with both the newly-upgraded MWA, and eventually the SKA.



Mosaicked MWA image of a section of the Galactic Plane, made at three different frequencies. The Galactic Centre is on the right, and the Plane is filled with supernova remnants. Image credit: David Kaplan and Steve Croft.