Advanced Calibration and Imaging with the MWA

The Murchison Widefield Array (MWA) is a low frequency (80 — 300 MHz) radio telescope operating in Western Australia and the only SKA_Low precursor telescope. Its design has many small antennas rather than fewer larger antennas as is typical for radio telescopes working at higher frequencies.

Forming high-fidelity images with the MWA can be challenging. The issues include: the very wide field of view of the MWA, the large data volume due to having many antennas, the corrupting effect of the ionosphere, the unusual reception pattern of the antennas (they are fixed on the ground), among others. Processing MWA data can often violate assumptions inherent in conventional radio astronomy data processing software. More accurate techniques are available but often come at a huge computational cost. Because of this, supercomputers are required to process large quantities of MWA data.

Research Field
Radio Astronomy

Project Suitability
Honours
Masters
PhD

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To deal with these different effects, astronomers need computationally-efficient and clever algorithms to make better use of the large volumes of data. This project aims to investigate and develop novel techniques in radio astronomy data processing to improve the performance and/or fidelity of calibration and imaging algorithms, with a focus on MWA and future SKA_Low data. In particular, we can combine different observations together by taking into account their different instrumental effects, creating deeper images with more sensitivity to different angular scales.

Aims of project

i. Investigate and develop novel techniques in radio astronomy data processing
ii. Apply to real data for particularly challenging areas of the sky, e.g. the Galactic Plane
iii. (Masters, PhD): derive novel science from the new images, e.g. resolved spectral index maps

The application of these techniques has the potential to impact the Epoch of Reionisation (EoR) and GaLactic and Extragalactic All-sky MWA (GLEAM) survey science programs of the MWA, which have each collected several PB of raw data. These techniques will be vital for exploiting the full potential of the new long baselines of the MWA, installed in 2017. This project is suited to a student with a strong interest in the fundamentals of radio astronomy and a solid background in computer science, maths and/or physics.

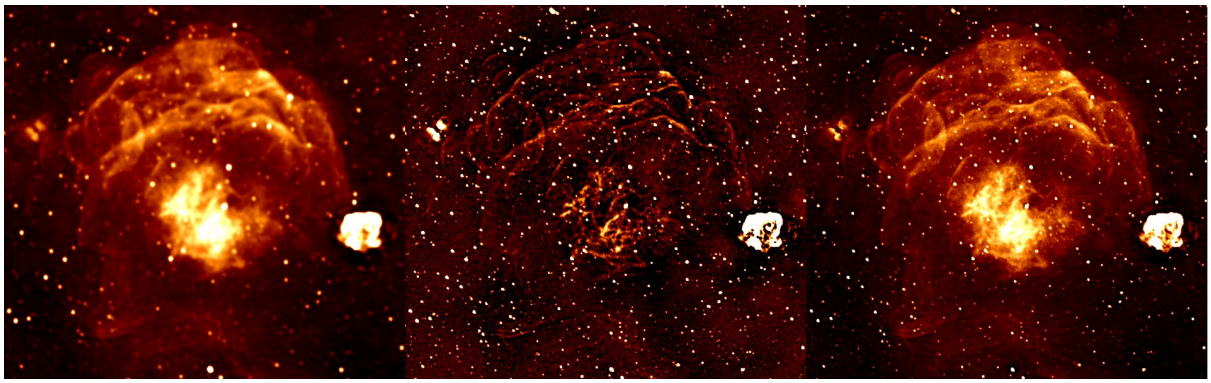

Figure 1 Example MWA data combining large angular scales (left) with fine details (middle) to create a better image of the Vela supernova remnant