

Uncovering Southern-sky Pulsars with a Next-generation Low-frequency Radio Telescope

Pulsars – rapidly-rotating, highly-magnetized neutron stars that emit beams of radiation like cosmic light houses – are nature’s premier laboratories for advancing fundamental physics. With applications ranging from testing strong-field gravity to probing the state of ultra-dense matter, they enable us to push the boundaries of physics. While > 2500 pulsars are currently known, a vast majority were found in surveys using large single-dish telescopes such as the Parkes and Green Bank telescopes. Historically, pulsar surveys are proven to be highly rewarding, with a multitude of science enabled by the discoveries of exotic objects and specialised targets, including pulsars in relativistic binary systems, millisecond pulsars, and those with extreme magnetic fields. Not surprisingly, *fundamental physics with pulsars* is a headline science theme for the Square Kilometre Array (SKA), and conducting a full cosmic census of the Galactic pulsar population is a high-profile key science driver for the SKA.

Research Field

Observational Pulsar Astronomy

Project Suitability

PhD

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However, finding pulsars with SKA precursor and pathfinder telescopes pose numerous challenges. The computational costs involved in beamforming and signal processing with these next-generation facilities are prohibitive, besides the inherent complexity in realising their full potential given the large field of view and attainable survey efficiency. Australia’s Murchison Widefield Array (MWA) – a low-frequency (80-300 MHz) telescope in Western Australia, and official precursor for the low-frequency SKA – is no exception. Fortunately, with a major recent upgrade (the Phase 2 MWA), it has become possible to conduct sensitive pulsar searches with the MWA, reaching a survey efficiency ~2-3 orders magnitude higher than that possible with any other currently operational facilities around the world.

This project will involve processing large volumes of (~Petabyte scale) high time resolution data from an all-sky pulsar survey under way at the MWA – the **Southern-sky MWA Rapid Two-metre (SMART)** pulsar survey. It is an ambitious program to search the vast southern skies with a high sensitivity at low radio frequencies. The survey is expected to discover hundreds of pulsars including dozens of millisecond pulsars (Figure 1), and will serve as an important reference for future surveys planned with the upcoming SKA. The MWA’s unique access to the southern sky provides the opportunities to explore a new parameter space, and thence potential for making exciting discoveries, and prospects for high impact science.

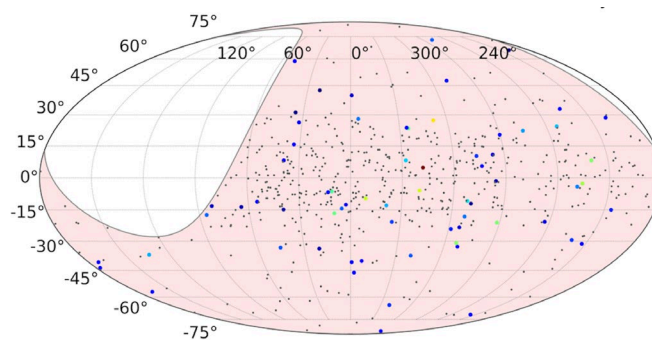


Figure 1: The pulsar population detectable with the SMART pulsar survey under way at the MWA. The filled circles in grey are long-period pulsars (i.e. spin periods ~ seconds) whereas those in colour represent millisecond pulsars.

