Chasing Fast-spinning Pulsars with the First SKA-Low Precursor

Research Field
Observational Pulsar Astronomy

Project Suitability
PhD
Masters
Honours

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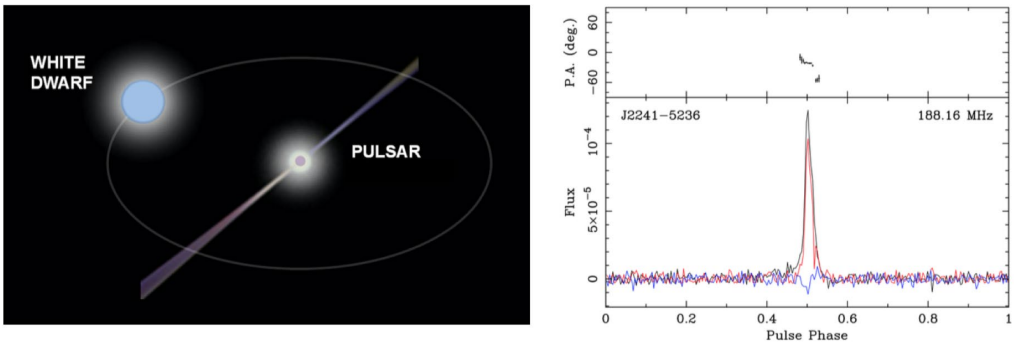
Pulsars are proven laboratories for advancing fundamental physics; those with spin periods of the order of a few to several milliseconds – the so-called *millisecond* pulsars – are particularly promising for a wide variety of science. Their clock-like stability can be exploited for applications ranging from detecting gravitational waves to probing the state of ultra-dense matter. As such, doing *fundamental physics with pulsars* is a headline science theme for the Square Kilometre Array (SKA) telescope, e.g. making a direct detection of nanoHertz gravitational waves is a key science driver for the Phase 1 SKA.

Pulsars are generally brighter at low radio frequencies (i.e. below 300 MHz), in which Australia's Murchison Widefield Array (MWA) operates. The MWA is a next-generation telescope, and an official Precursor for SKA-Low, i.e. the low-frequency component of the SKA. However, finding fast-spinning pulsars at low frequencies poses several major technical and computational challenges. In particular, traditional approaches involving tiling large areas of the sky and searching through thousands of pencil beams become computationally prohibitive. The superbly large field-of-view (500 sq. deg.) and interferometric advantages of the MWA, along with its unique capability to record high-time resolution voltage data from large parts of the skies at once, bring some exciting prospects to circumvent these formidable challenges.

This project will leverage a number of recent advances uniquely applicable to low-frequency wide-field interferometric arrays like the MWA. For example, implementing the hybrid approach of semi-coherent de-dispersion (cf. Bassa et al. 2017) to process high-time resolution voltage time series data from the MWA will enable achieving optimal detection sensitivity to short-period pulsars. The interferometric advantages of the MWA can be exploited for efficient identification of promising pulsar candidates. These strategies will help accelerate the process of discovery and confirmation of pulsars, their rapid sky localisation as well as detailed characterisation. A demonstrable success in this area will bolster the prospects of SKA-Low to emerge as an efficient pulsar discovery machine.



Left: an artist's impression of a fast-spinning (millisecond) radio-emitting pulsar, in binary orbit with a white-dwarf companion star. *Right*: MWA detection of a pulsar that spins at a rate of 456 times per second.