

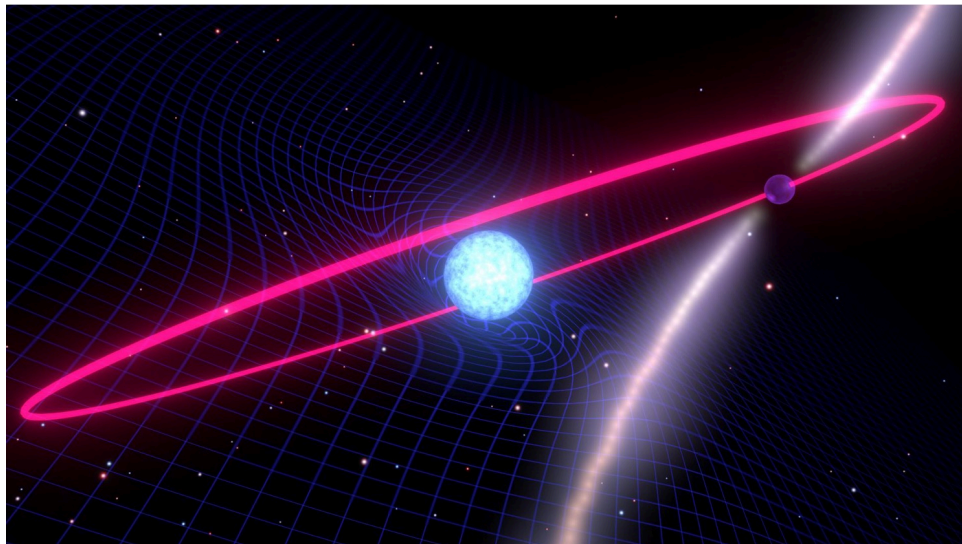
Searching for exotic pulsars in close binary systems

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Description: Pulsars have emerged as amongst the most indispensable astronomical objects to push the frontiers of physics; indeed pulsar astronomy is a headline science theme for the upcoming Square Kilometre Array (SKA) – the largest and most sensitive radio telescope in the world, now under construction in Australia and South Africa. In fact, performing a complete census of the Galactic pulsar population is a key science goal for the SKA. Pulsars in close binary systems are particularly sought after, given the unique roles they play in enabling some of the most exquisite tests of the theories of gravity, including Einstein's general relativity. Motivated by this, we have embarked on an ambitious survey for pulsars using the Murchison Widefield Array (MWA) – Australia's Precursor for the SKA. This Southern-sky MWA Rapid Two-metre (SMART) survey will be the most sensitive southern sky pulsar survey in the low-frequency band of the SKA, and it involves processing several Petabytes of high-time resolution data. Currently in early stages, the project is already showing its promise, with several new pulsar discoveries and over 200 known-pulsar detections. This project aims to take the SMART survey program to the next level, by vastly expanding the search parameter space, and including acceleration searches to target pulsars in close binary systems. The main objectives of the project include:

1. Systematic exploration of various search algorithms and processing strategies, as well as their implementation and benchmarking on HPC, to enable high-sensitivity searches at low-frequencies, using high-time-resolution data from the SMART survey.
2. Successful demonstration of search pipelines by performing a pilot survey (e.g., ~1000 square degrees sky) to search for binary pulsar systems to make the first discovery of such objects with the MWA.
3. Expand the scope to realise a full Galactic plane pulsar survey, the efficacy and success of which will inform the detectable population of such binary systems in the SKA-Low's frequency band – an important preparatory step for SKA science.

Successful advancement and demonstration of acceleration searches at low radio frequencies (100-300 MHz) will be a major milestone in gearing up for full-scale searches with the SKA. The discovery of even a single object of this rare (and exotic) class will be a significant milestone as they are highly sought after for advancing fundamental physics (e.g. testing strong-field gravity) and astrophysics (e.g. stellar binary evolution).



A pulsar in a compact binary system with another degenerate star (Credit: OzGrav)

This project is ideal for a candidate with a sound background in physics and astrophysics, as well as a strong inclination for software development, high performance computing, and signal processing aspects of radio astronomy. A background in radio astronomy with some research experience is an additional advantage.