Pulsar Science with the FAST and the First SKA-Low Precursor Telescopes

Research Field
Observational Pulsar Astronomy

Project Suitability
PhD
Masters

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Pulsars – i.e., rapidly-spinning neutron stars, produced by massive stellar explosions – are proven laboratories of nature for advancing fundamental physics. Those with spin periods of the order of a few milliseconds, or in compact orbits with another star, are particularly promising for a wide variety of science. Specifically, the clock-like stability of their pulse arrival times can be exploited for applications ranging from searching for ultra-low frequency gravitational waves to probing the state of ultra-dense matter. This array of exciting science is enabled by discoveries of exotic pulsars that allow us to probe new physics, in particular physics under extreme conditions, such as strong-field gravity, or matter at nuclear densities. Indeed, *fundamental physics* with pulsars is a recognised headline science theme for the upcoming Square Kilometre Array (SKA) telescope.

The unprecedented collecting area of the newly-built Five-hundred metre Aperture Spherical Telescope (FAST) in China makes it the most sensitive instrument to search for pulsars. This is vividly demonstrated by an increasing number of new discoveries and candidates that are emerging from early science projects with the FAST. On the other hand, the massively large field of view of the Australian Murchison Widefield Array (MWA) – hundreds of square degrees at frequencies 100-200 MHz – makes it an excellent survey instrument at low radio frequencies. High time resolution digital archives of the full southern sky will be produced by an all-sky survey program underway at the upgraded MWA, and these data can be readily mined for important confirmation and/or follow-up observations of new pulsar discoveries/candidates from the FAST. Similarly, potential pulsar candidates and discoveries from the MWA can be efficiently followed up using the high-frequency capabilities of FAST.

This project will capitalise on the unique, and highly complementary, capabilities of two major radio facilities, i.e. the FAST and the MWA, to undertake rapid follow-up and confirmation of promising pulsar candidates. Besides the prospects of discovering exotic pulsars in the large common skies of the two facilities, this will constrain the spectral, scattering and emission of properties of numerous pulsars, which is valuable to predict pulsar survey yields expected with SKA1-Mid and SKA1-Low.

The Five-hundred metre Aperture Spherical Telescope (FAST) in China (left) and Australia's Murchison Widefield Array (MWA; right) have substantial common skies and contemporaneous sky visibilities, to enable some unique pulsar science.