Novel transient radio sources in MWA surveys

Supervisors: Natasha Hurley-Walker, Sammy McSweeney (SC1, SC4)

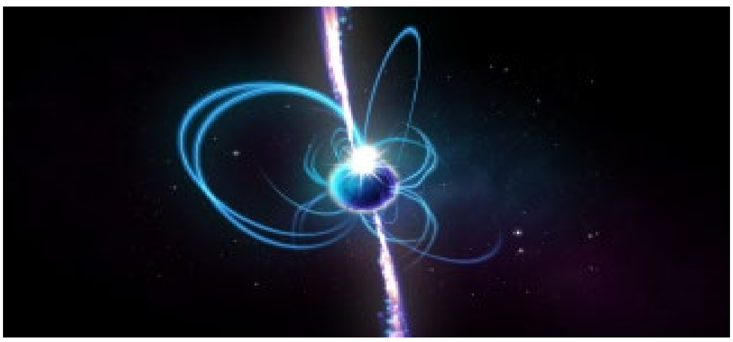
Description: The Murchison Widefield Array (MWA) is a low frequency (80 — 300 MHz) radio telescope operating in Western Australia and the only SKA_Low precursor telescope. The MWA has collected more than 20PB of data spanning nearly a decade of operations. As part of undergraduate projects in 2020 and 2022, we have detected two examples of a new type of radio source, which we have localised to our own Milky Way, and repeat on the very unusual cadence of once every twenty minutes. These objects may be an unusual type of neutron star, or possibly highly magnetic white dwarfs: either way, the discoveries were unexpected, and show the power of searching these data. Both have been published in *Nature* as their properties defy our existing understanding of radio emission in stellar remnants.

Now that we know such sources exist, it is imperative to find more of them in order to study their nature and their astrophysics. Fortunately, there are thousands of hours of MWA data, representing large volumes of the Galaxy, which have not yet been searched, as well as new monitoring campaigns being conducted with the upgraded instrument. The supervisors also have access to the Variables And Slow Transient (VAST) survey data taken with the Australian Square Kilometre Array Pathfinder, a radio telescope operating at 700 to 1000 MHz, which offers a complementary view. Both these datasets are expected to contain many more examples of this new type of source. The project uses existing pipelines to search data for these transients, with a particular focus on data covering our own Galaxy, where we expect more periodic radio transients to reside. Additionally, we are obtaining more data on these sources, including from the southern hemisphere's most powerful radio telescope, MeerKAT. This rich data allows detailed magnetospheric modelling and an investigation into the emission mechanism producing the radio waves.

The aims of the project are:

- Understand the population attributes of the sources (where are they in our Galaxy, how often do they produce radio emission, how long do they live for?)
- Uncover their physical nature of such sources (are they neutron stars, white dwarfs, or something never seen before, such as quark stars?)
- Understand how they produce radio waves (the mechanism is currently not understood!)
- Do they connect to other astrophysical phenomena? For instance: do they produce Fast Radio Bursts?

The position involves processing a large quantity of data on supercomputers and analysing the results, so an analytical and organised mindset is essential. Programming experience, especially in python, is strongly desirable. The student should have a very good grounding in astronomy, an interest in radio astrophysics, and willingness to learn interferometric techniques and pulsar astronomy. Experience in mathematics, statistics, and simulations is also useful. Machine learning techniques can be used to explore the large number of candidate sources. There are opportunities for co-supervision and internships at CSIRO and the Square Kilometre Array Observatory.



An artists' impression of an ultra-long period magnetar, the type of extreme source that this project aims to detect.