All-sky real-time searches for low-frequency Fast Radio Bursts

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Description: Fast Radio Bursts (FRB) are one of the most intriguing transient phenomena discovered less than 15 years ago. Recent localisations and redshift measurements of several FRBs confirmed their extragalactic origin and extreme energies of the order of 10^{39} ergs emitted in millisecond intervals. However, full understanding of FRB sources and physical mechanisms powering these extreme events still awaits explanation. Although, FRBs were discovered and initially observed at frequencies around 1.4 GHz, multiple detections by Canadian CHIME telescope down to 400 MHz, Green Bank Telescope discovery of FRB 20200125A at 350 MHz and LOFAR detections of FRB 20180916B down to 110 MHz prove that there exists a population of FRBs, which can be detected at frequencies below 350 MHz. Estimates based on the FRB rates measured by various telescopes indicate that even a single station of the low-frequency Square Kilometre Array (SKA-Low) can detect even hundreds FRBs per year in high-time resolution all-sky images. Hence, the main goal of this PhD project is to use the existing SKA-Low prototype station, the Engineering Development Array 2 (EDA2) to perform an all-sky low-frequency FRB survey and interpret the results. Even a single low-frequency FRB discovery guarantees high-impact scientific results, while non-detections will result in more robust constraints on FRB rates at these frequencies (currently highly uncertain). Depending on interests of the candidate the project can also be steered towards Search for Extraterrestrial Intelligence (SETI), as similar data processing and analysis techniques are applicable to both. Finally, successful demonstration of the all-sky capabilities will justify deployment of similar real-time systems on future SKA-Low stations.

Image based FRB searches at low radio-frequencies can be computationally very challenging. For example, forming 180x180 pixels images in 10 millisecond time resolution and 1280 frequency channels will generate about 10^5 images per second (order of a few billion pixels per second, or 17 GB/second). Thus, the student will use novel software processing pipelines utilising Graphical Processing Units (GPUs), which are currently being developed in collaboration with the Pawsey Supercomputing Centre and Australian SKA Regional Centre (*AusSRC*). Depending on candidate's background and interests they can also contribute to the software development side of the project. Especially, if they have interests in GPU software programming.

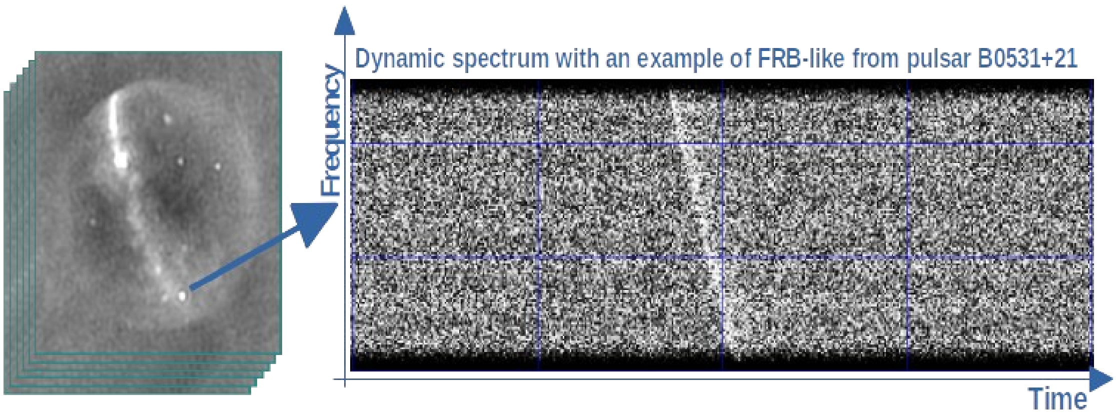

Image Caption: *Left image visualises a data cube of all-sky images (of entire visible hemisphere) for multiple time steps and frequency channels. For all directions in the sky (i.e. every pixel in an image) dynamic spectra (like example in the right image) are formed and searched for dispersed pulses like the the one from the Crab pulsar (PSR B0531+21) in the centre of the right image (detected with the EDA2 station).*

This project will be supervised by researchers from the Curtin Institute of Radio Astronomy (CIRA). The ideal candidate should have background in astrophysics and physics, solid software programming background (at least in python and/or other programming language), and interests in data processing and analysis. Experience in GPU programming is desirable but not essential. The prospective applicants should contact one of the future supervisors listed below to start the application process as soon as possible.

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