Curtin University

Catching Fast Radio Bursts with the MWA

Research Field

Time-domain Astronomy

Project Suitability

PhD

Masters

Honours

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Since the landmark discovery of Fast Radio Bursts (FRBs) by the Parkes radio telescope (Thornton et al. 2013), this new field of radio transients has flourished to the extent that astronomers are now beginning to use them for science. The discovery also triggered a world-wide hunt to find many more, with the recent breakthrough by the Canadian CHIME telescope marking another major milestone, i.e. hundreds of bursts detected down to ~400 MHz. These intense bursts are thought to originate from cosmological distances, and they are potential new probes for cosmology; e.g, to measure the baryonic content of the Universe (Macquart et al. 2020), and the magnetic field of the Intergalactic Medium (Caleb et al. 2019).

Yet, the physics governing the origin of these energetic bursts still remains a mystery, despite a continuing flurry of theoretical ideas, including exotic possibilities including dark matter, and even cosmic strings; and even after their interferometric localisations at sub-arcsecond resolution. The plot further thickens with *no* burst emission seen to date at frequencies below ~300 MHz.

Prompt follow-up of FRBs is technically challenging due to their extremely short time durations (of the order of a few milliseconds). The co-location of the Australian SKA Pathfinder (ASKAP) telescope and the Murchison Widefield Array (MWA) was exploited extensive shadowing campaigns (Sokolowski et al. 2018), placing the most stringent constraints on the low-frequency emission from these enigmatic bursts. Over the past year, the high-time resolution capabilities of the MWA have been pushed to enable voltage trigger and buffer modes. Along with the rapid-response observing mode now possible with the MWA, this is now allowing receiving and responding to the trigger alerts from facilities such as the ASKAP and the Five-hundred metre Aperture Spherical Telescope (FAST) in China.

This project will exploit these new and advanced capabilities of the MWA to undertake some exciting science relating to FRB emission physics, as well as their propagation and progenitor models, which will contribute to advancing our understanding of these mysterious bursts.

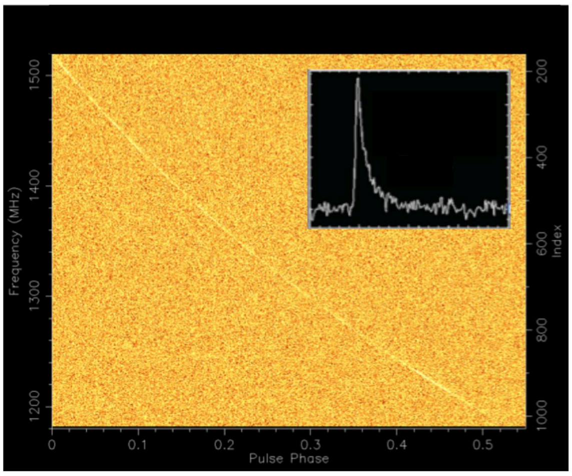

Figure 1: FRB 110220 – one of the brightest FRBs discovered in the Parkes high time resolution Universe survey (Thornton et al. 2013). The burst's dispersion measure of 945 pc cm^{-3} results in an arrival time spread of approximately 1100 milliseconds across the 400 MHz observing band of Parkes survey observations. The burst would have arrived at the MWA 185 MHz band approximately 112 seconds after its time of detection at Parkes. The inset shows the shape of the pulse, where an exponential tail resulting from multi-path scattering through the intergalactic medium is clearly visible, and follows the expectations based on a Kolmogorov-type turbulence.