Probing Fast Radio Bursts on nanosecond timescales

Fast Radio Bursts are bright microsecond- to millisecond-timescale events whose time-frequency characteristics prima facie indicate that they emanate at cosmological distances. Their remarkable properties have so enthralled astronomers that, in the decade since their discovery with the Parkes radio telescope, over 50 theories have been advanced to explain them! Recent work has now definitively confirmed that these events do occur at cosmological distances, thus pushing the energetics of their radio emission to the limits of our understanding. In short, we do not understand the mechanism by which their ultra-luminous radio emission – some twelve orders of magnitude greater than that observed in radio pulsars – is produced. Neither do we understand what the progenitors of these events are. Are they solitary neutron stars, black holes, mergers of dense stellar systems, or something altogether different?

Research Field
Radio Astronomy

Project Suitability
PhD

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In this project you will examine the properties of FRBs at ultra-high time resolution to investigate the origin of their outrageously luminous radio emission. You will take advantage of the Australian SKA Pathfinder's (ASKAP's) ability to both (i) interferometrically localise (to <1") and (ii) measure the electric field signal associated with each radio burst at extremely high signal-to-noise (>60). The voltage-capture system on ASKAP enables us to measure the pulse intensity and polarization on time resolutions of 3 nanoseconds.

Voltage capture systems with other radio telescopes (e.g. UTMOST) have already revealed FRBs with astounding temporal structure on timescales of tens of microseconds (see Figure 1). But what does this structure signify, and how does it relate to the emission mechanism? Does the position angle of the linear polarization often observed in FRBs change during the pulse? Do the emission characteristics indicate that the system is rotating, like a pulsar?

You will work with other members of the Commensal Real-Time ASKAP Fast Transients (CRAFT) team to examine the properties of FRBs and investigate what produces their emission. The FRB team at CIRA is a key component of the CRAFT team, which is currently detecting FRBs at a high rate.

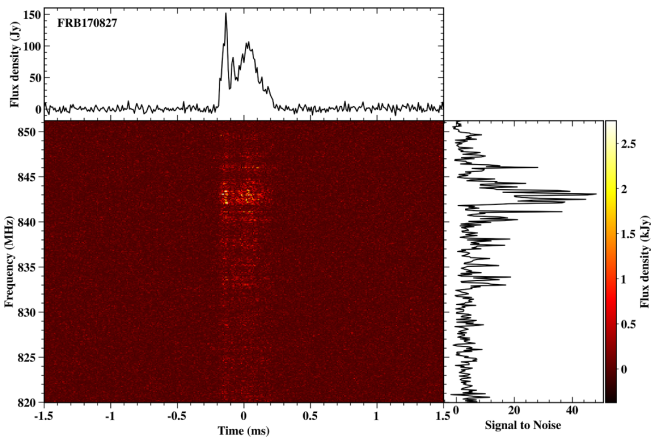

Figure 1: The remarkable temporal and spectral structure of FRB170827, reproduced from Farah et al. (2018). Several FRBs possess temporal structure on timescales as short as this.