Faculty of Science and Engineering

2020 Australian Government Research Training Program Scholarships

Strategic Project Profile

PROJECT TITLE: Probing fast radio bursts on nanosecond timescales

FIELD OF RESEARCH CODE: 0201

PROJECT SYNOPSIS:

Fast radio bursts are bright microsecond- to millisecond-timescale events that occur at cosmological distances. The energetics of their radio emission push the limits of our understanding: their ultra-luminous radio emission is some twelve orders of magnitude greater than that observed in radio pulsars.

This project will examine the properties of FRBs at ultra-high time resolution to investigate the origin of their outrageously luminous radio emission. It 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.

Other radio telescopes (e.g. UTMOST) have already revealed FRBs with astounding temporal structure on timescales of tens of microseconds. 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?

The student would 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.

FEASIBILITY AND RESOURCING – DESCRIPTION OF THE SUPPORT THIS PROJECT WILL RECEIVE:

FRB research is one of the official ICRAR science project themes, and currently supports one postdoctoral fellow (Dr. Clancy James), with another postdoctoral fellowship to be advertised later this year under the auspices of ICRAR-III.
Macquart also receives support (as the principal CI) from ARC DP grant DP180100857 ("Weighing the Universe using fast radio bursts"). Technical aspects of the project dovetail with the research interests of the electrical engineering group (including Drs Adrian Sutinjo, Ian Morrisson, Marcin Sokolowski and Greg Helbourg).

WHAT MINIMAL ATTRIBUTES AND SKILLS EXPECTED BY THE CANDIDATE BE COMPETITIVE:

The candidate must have:

- Excellent mathematical skills, with a sound knowledge of theoretical physics
- An ability to communicate at a high level
- Ideally, experience in time domain processing, or experience in wave optics or a related field.

THE SIGNIFICANCE OF THE PROJECT/ PROGRAM FOR THE ENROLLING SCHOOL OR INSTITUTION:

Fast radio bursts are one of the most high-profile areas of current astrophysics. The discovery of these extremely bright milli-second duration flashes was entirely unanticipated, and their origin is unknown. This project aims to shed light on the phenomenon by examining the structure of their radiation on nanosecond timescales, showcasing the capabilities of the Australian SKA Pathfinder. It will address: 1. Is the emission from rotating systems? 2. What is the shortest-timescale burst substructure observed, and how does this relate to the various emission mechanisms that have been proposed to explain the extreme properties of their radiation?

Students are advised to contact the Project Lead listed below prior to submission of their scholarship application to discuss their suitability to be involved in this strategic project.

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