Looking for low radio-frequency afterglows of GRBs in the MWA data archive

Gamma-ray bursts (GRBs) are one of the most violent and energetic explosions observed in the Universe. They release energies of the order of 10^{53} - 10^{54} ergs in the intervals ranging from fraction of a second (short GRBs) up to several hundreds of seconds (long GRBs). They were serendipitously discovered during the Cold War era (specifically 1960s) by the VELA satellites monitoring the space for possible violations of nuclear ban treaty. Instead they discovered an entirely new astrophysical phenomena. Since then, several thousands of GRBs were discovered by a few generations of satellites dedicated to study these astrophysical processes (BeppoSAX, CGRO, HETE, Integral, Swift, Fermi and Polar). Their counterparts in optical, radio and other electromagnetic wavelengths have been observed including the recent observation of gravitational wave event GW170817 accompanied by a short (< 1 second) GRB 170817A. GRBs are truly one of the most fascinating astrophysical processes (Abbott at at, 2017).

Research Field
Radio Astronomy

Project Suitability
Honours (as appropriate) / Masters / 4th year with potential to be extended to a PhD

Project Supervisor
Dr Marcin Sokolowski
marcin.sokolowski@curtin.edu.au

Co-Supervisors
Dr Gemma Anderson
gemma.anderson@curtin.edu.au
Dr Paul Hancock
paul.hancock@curtin.edu.au

They are expected to produce low-frequency radio afterglows which could potentially be observed months or even years after the GRB explosions (when the GRB ejecta collides with the interstellar medium surrounding the progenitor). However, so far there has been no observational evidence of these predictions. This project aims in establishing existence or non-existence of GRB afterglows within the limitations of the Murchison Widefield Array (MWA; Tingay et al 2013) sensitivity. The main goal is to take advantage of large data archive from the MWA and the corresponding calibration database in order to search for low radio-frequency counterparts of the known, archive GRBs which can be found in the databases of the several satellite missions detecting GRBs. The idea is to analyse as many GRBs as possible, which have multiple MWA observations over the span of several years.

The potential positive detection of the first low radio-frequency afterglows of GRB would be a very important discovery. Alternatively, if there are no positive detections the upper limits can be derived, which given the known estimates of GRB energies and other characteristics, can lead to conclusions on the surroundings of the GRB progenitors. Such an analysis can lead to extension of this project even to a PhD level.

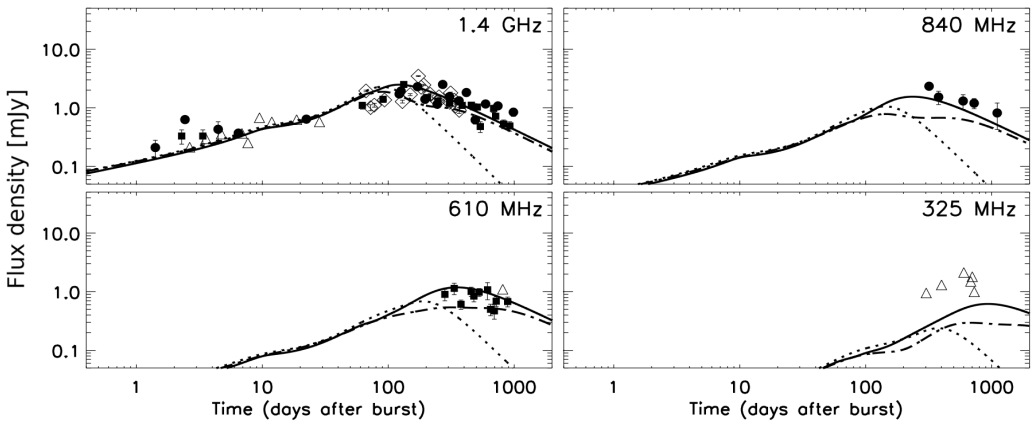

Figure 1. Observation (black filled data points) and modelling (solid or dotted curves) of lightcurve of radio afterglow of GRB 030329 by van der Horst et al (2008). Empty triangles in the right-bottom image at 325 MHz represent 3 sigma upper limits (non-detection