Observations of Fast Radio Bursts with the the SKA and its pathfinders: from neutron stars to cosmology

Supervisors: Gianni Bernardi, Maura Pilia

Fast Radio Bursts (FRBs) are bright (> 1 Jy @ 1.4 GHz), millisecond-long radio flashes whose origin is still largely unknown. They show the typical pulsar-like dispersion signal, where high frequencies arrive earlier than low frequencies, and this delay is proportional to the electron column density between the source and the observer - known as dispersion measure (DM). At the time of writing, ~1000 FRBs are known, a few tens of them are localized to a host galaxy and ~5% of them are repeating sources. As they trace the baryon content up z ~ 2 (the highest redshift FRB observed to date), they are promising cosmological probes.

In 2020, an FRB was observed from the Galactic magnetar SGR 1935+2154, providing evidence that magnetars may be the progenitor source of (a fraction of) FRBs. FRBs are, therefore, probes of extreme environments (extreme magnetic and gravitational fields, dense plasmas, stellar explosions) as well as the large scale structure of the Universe. The goal of the PhD project is indeed to study extreme astrophysical environments and cosmology with FRBs using the Square Kilometre Array Observatory (SKAO; https://www.skao.int/en) and its pathfinder telescopes. In particular the student will work on:

- the localization and redshift characterization of FRBs observed with the CHORD radio telescope (https://www.chord-observatory.ca/home). CHORD is a new radio interferometer under construction in Canada and the will have ~30 dishes by the end of 2026, with a few outrigger dishes that will provide thousand-kilometre baselines, allowing for a sub-arcsecond location of FRBs. Such precise localization will enable the identification of the host galaxies and, consequently, the FRB redshift. The student will work on analysis of CHORD data and constrain cosmological parameters using localized FRBs;
- A new FRB catalogue obtained from a blind FRB survey at 408 MHz with the Northern Cross radio telescope. The Northern Cross will have an 8000 square meter collecting area by the end of 2026 and will be one of the few, wide-area FRB observatories. The student will work on the catalogue definition and will search for the highest redshift FRBs;

The student will use the first SKAO science data (expected to come in 2027-2028) to study FRBs: given its arcsec angular resolution, extreme time resolution and large bandwidth, SKAO

observations will instantaneously localize any FRB detected, allowing to both study them as a cosmological probes and as laboratories of extreme environments.