PhD project in ASTROPHYSICS

Title of the Project: *Observations of Fast Radio Bursts with the Northern Cross*

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Scientific Case: Fast Radio Bursts (FRBs) are one of the most recent mysteries of our Universe: enigmatic, bright, ms-long bursts only observable at radio wavelengths (so far). Discovered 15 years ago, their extragalactic nature has now been well established, with a handful of them being localized in host galaxies with fairly different characteristics. They are believed to be associated with energetic phenomena (i.e. endpoints of stellar evolution, mergers of compact objects), but their real nature is still largely unknown. Recently an FRB has been associated with the Galactic magnetar SGR1935+2154, suggesting that magnetars may be progenitors of (at least some) FRBs. Observations of larger samples are needed to understand the FRB phenomenon.
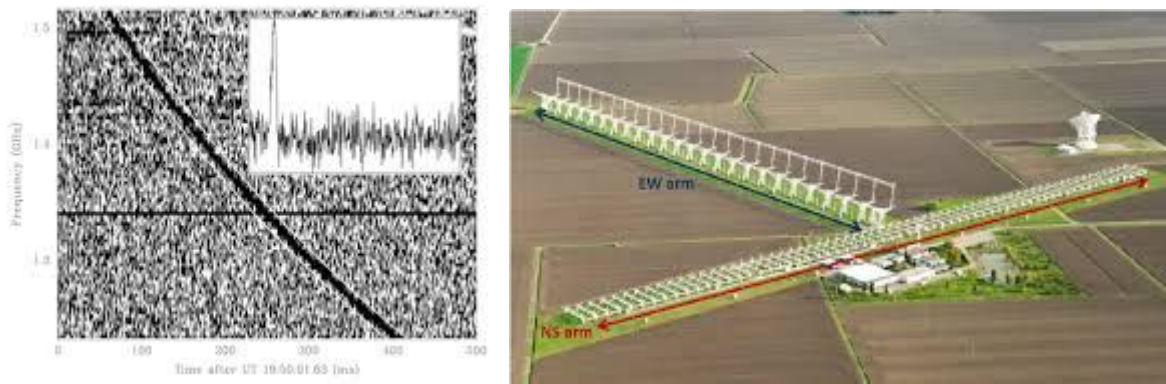

Figure 1. Left: the first FRB observed (Lorimer et al., 2007). The characteristic signature of FRBs is the dispersed profile (the black curve in the waterfall plot), i.e., the signal is delayed as it propagates through the interstellar medium, with lower frequencies arriving later than higher frequencies. Right: aerial view of the Northern Cross telescope.

Outline of the Project:

In the last two years, the Northern Cross (NC) radio telescope at the Medicina station near Bologna has been outfitted to carry out FRB surveys at 408 MHz. The NC is the first-built Italian radio telescope, and it is now competing on the international scene to help solve the FRB mystery.

In their PhD project, the candidate will analyse observations taken with the NC in order to detect FRBs, study their physical properties and constrain their formation model. In particular the candidate will be involved in two projects:

- NC observations of repeating FRBs. A fraction of FRBs are repeating sources, indicating that their progenitors may reside in binary systems. The candidate will help carrying out observations, will analyse and use them to constrain FRB models;
- NC observations of the Virgo clusters. Some models relate the FRB cosmological evolution with the cosmic star formation rate. The Virgo cluster has a well measured star formation rate that is used to predict the FRB event rate (e.g., Fialkov et al., 2018) and our group is currently surveying it. The candidate will

help carrying out observations and analyse them in order to constrain models of cosmological evolution of FRBs;

This project will lead the candidate to shed light on the FRB mystery and offer the chance to develop cutting edge data analysis pipelines, including machine learning algorithms to detect and classify FRBs.

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