NORTHERN CROSS OBSERVATIONS OF RADIO BLASTS FROM COSMOLOGICAL SOURCES

PhD SST Space Science and Technology

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POSTER

CURRICULUM 1: OBSERVATION OF THE UNIVERSE **ABSTRACT ID: 266**

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INAF ISTITUTO NAZIONALE DI ASTROFISICA

IUSS Scuola Universitaria Superiore Pavia

FAST RADIO BURSTS

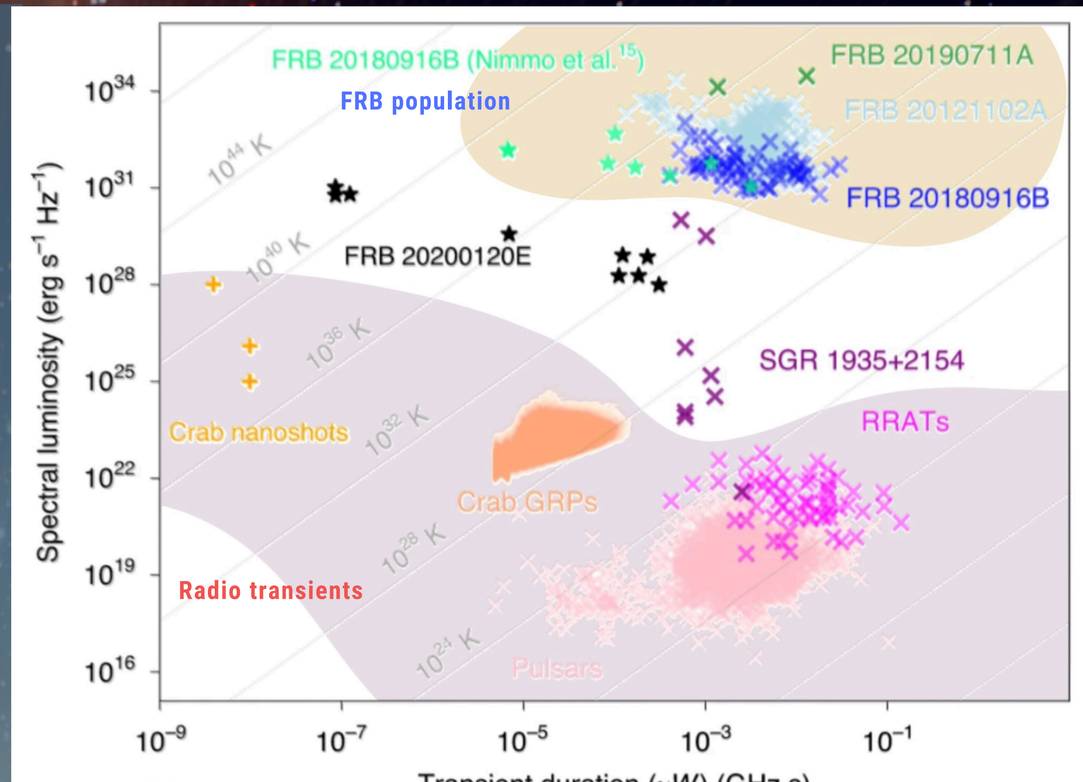
Fast radio bursts (FRBs) are millisecond cosmological powerful blasts detected only at radio frequencies whose origin is still unknown.

Most FRBs are one-off events but a fraction (~8.5%) are observed to repeat. Their high luminosities and associated brightness temperatures (10^{36} K) suggest coherent emission mechanisms around compact objects.

FRBs are on average brighter and shorter with respect to other short-duration transient events.

Few FRB-like events from the Galactic super-magnetic neutron star (magnetar) SGR J1935+2154 suggest a link between FRBs and magnetars.

The closest FRB repeater detected is FRB20200120E, spatially coincident with a globular cluster (which would be an unusual environment for magnetars!).



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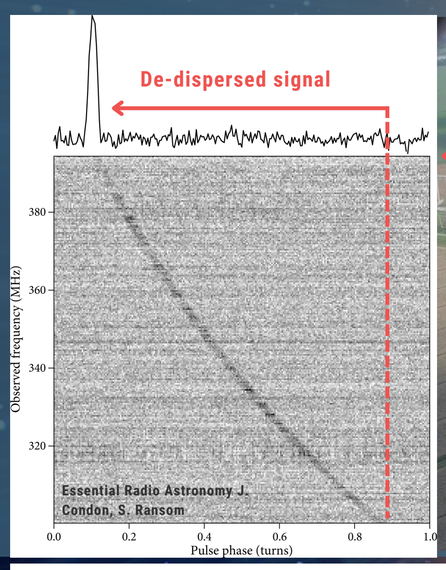
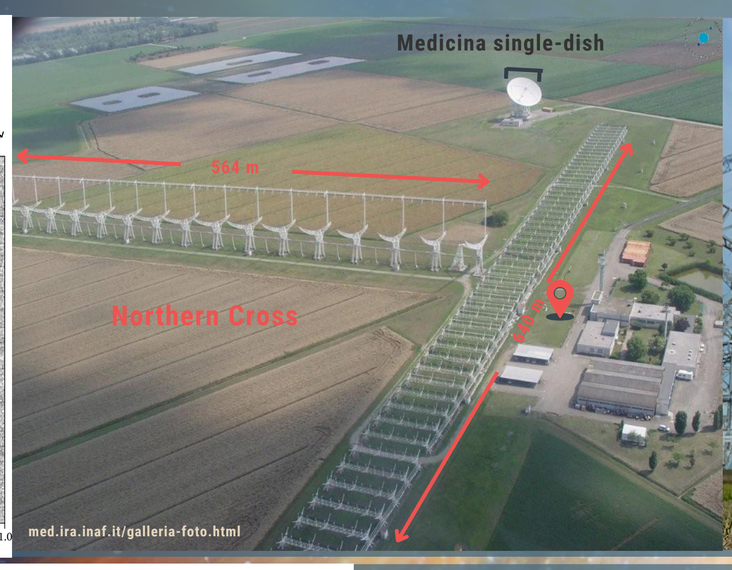
SEARCH WITH THE NORTHERN CROSS & SINGLE-DISHES

The observations are performed using the high-sensitivity Northern Cross transit telescope (at 0.4 GHz) and the 32-m parabolic dish (1.4 GHz) in Medicina, near Bologna, and the 32-m dish (2.3 GHz) in Noto, Sicily.

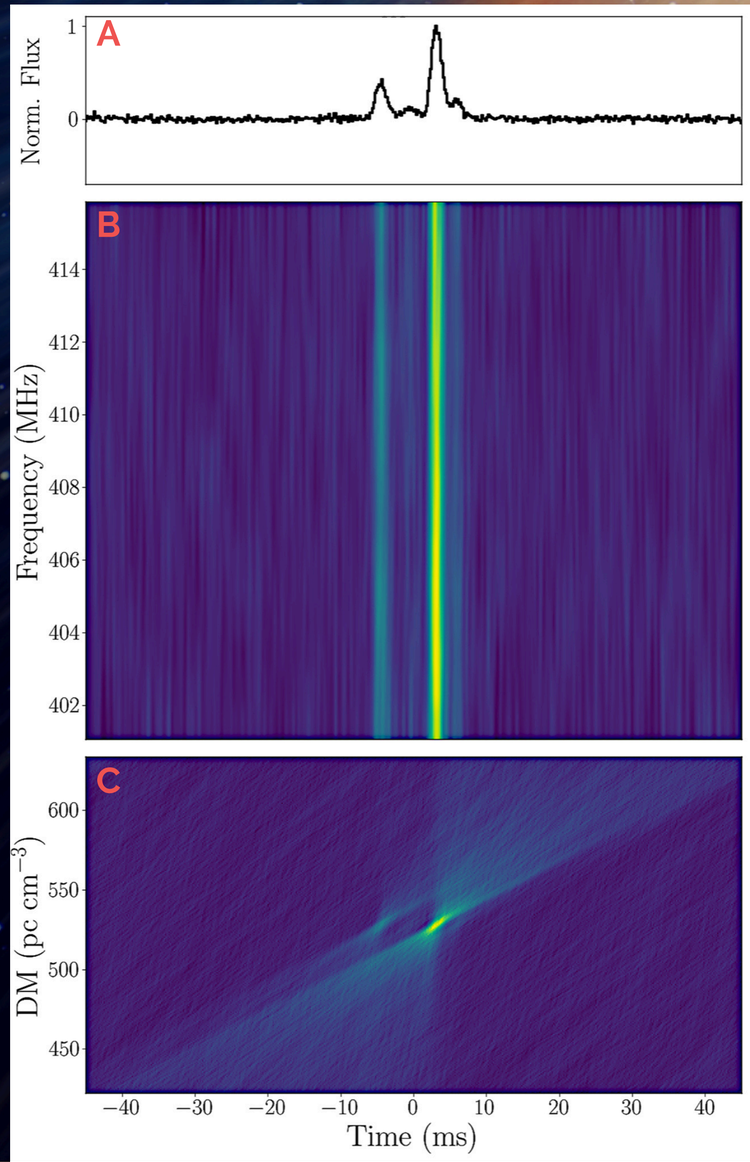
High time-sampling searches of FRBs produce a huge amount of data (TB per hour) corresponding to an enormous number of spurious FRB candidates (10^3 per hour) that need to be analysed with custom machine-learning techniques.

Astrophysical radio signals experience a frequency-dependent delay, with the lower frequency photons lagging the higher frequency ones. This is caused by their interaction with free electrons and therefore it is dependent on their column density along the path, which is called dispersion measure (DM). The DM obtained from the de-despersion of FRB signals bring information on their journey.





- HIGH TIME-SAMPLING DATA ACQUISITION
- RADIO FREQUENCY INTERFERENCES EXCISION
- DE-DISPERSION & TRANSIENT DETECTION ALGORITHM
- CANDIDATES CLASSIFICATION WITH MACHINE LEARNING
- HUMAN INSPECTION & FRB ANALYSIS



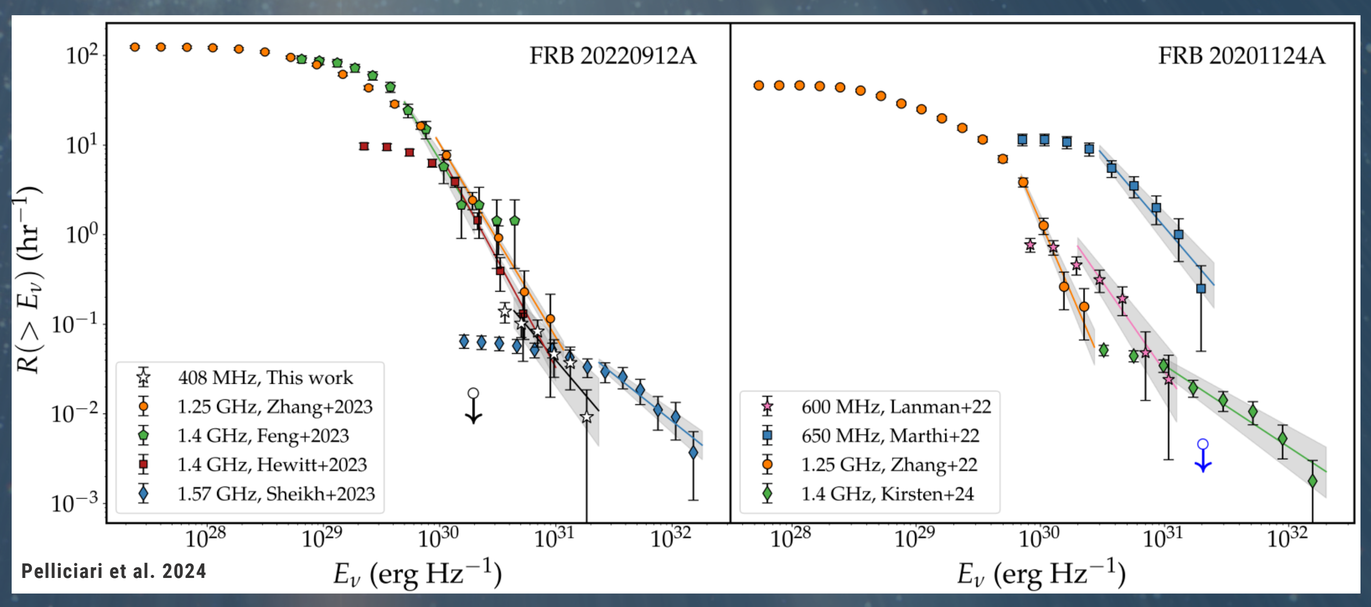
OBSERVING CAMPAIGN AND FIRST RESULTS

The left figure shows a detection of FRB20240114A with the Northern Cross on 2024-03-17 using our pipeline. The panels display the light curve (A), the de-dispersed dynamical plot (B) and the DM-Time plot (C) of a bright burst and multiple sub-burst components. The best fit of the main spike returns a fluence of 115 Jy ms, a duration of 2.2 ms, and a DM of 527.8 pc cm^{-3}.

Currently, we are monitoring 3 repeating FRBs, including the newly discovered and very active FRB20240114A, and 8 Galactic magnetars.

Long-term monitoring of repeating FRBs is crucial to constrain their activity patterns, bursts energetic distribution and overall properties. Furthemore, an increasing number of detections is crucial to shed light on the possible differences between FRB repeaters and one-off events.

Below we show the cumulative spectral energy rate distribution of two repeaters. Their similarity could indicate that they share the same emission mechanism.



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REFERENCES