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The short, high-DM FRB sky as revealed by Apertif + LOFAR

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Identifying the physical nature of Fast Radio Burst (FRB) emitters requires good localisation of more detections, and broadband studies enabled by real-time telescope combinations. I will present the results from our Apertif FRB survey (ALERT), focusing on what we learned so-far about the connection between FRBs and neutron stars. ALERT performed wide-field, fully coherent, real-time FRB detection and localisation on the Westerbork interferometer. We detected a new FRB every week of observing, interferometrically localised to ˜0.4-10 sq.arcmin, leading to confident host associations.

The 24 discovered FRBs are broad band and very narrow, of order 1ms duration. Only through our very high time and frequency resolution are these hard-to-find FRBs detected, producing an unbiased view of the intrinsic population properties. Combining these results with powerful population synthesis using FRBPOPPY allows us to determine the spectral index and the fluence distributions, constraining the emission mechanism. The fraction of Apertif bursts with multiple components is much larger than seen by CHIME/FRB: this morphological evolution with frequency is an important clue for, e.g., a magnetospheric origin. Temporal, 'micro-structure'-like behavior corroborates the hypothesis for the nature of the emission.

We further demonstrated that Apertif can localise one-off FRBs with an accuracy that maps magneto-ionic material along well-defined lines of sight. The solid detection rate next ensures a considerable number of new sources are detected for such study. The combination of detection rate and localisation accuracy exemplified by these ALERT FRBs thus marks a new phase in which a growing number of bursts can be used to probe our Universe.

We cojoined Apertif and LOFAR through real-time alerting. Using simultaneous radio data spanning over a factor 10 in wavelength, we detected FRB emission below 300 MHz for the first time. We thus show that the chromatic behavior of periodically repeating FRB 20180916B strongly disfavors scenarios in which absorption from strong stellar winds causes FRB periodicity. We establish that low-frequency FRB emission can escape the local medium and thus demonstrate that some FRBs live in clean environments – a prerequisite for certain FRB applications to cosmology.

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