



Decameter astronomy with LOFAR: a new window on the Universe

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1 Extended Abstract

The largely unexplored decameter radio band (10-30 MHz) provides a unique window for studying a range of astronomical topics, such as auroral emission from exoplanets, inefficient cosmic ray acceleration mechanisms, fossil radio plasma, and free-free absorption. The scarcity of low-frequency studies is mainly due to the severe perturbing effects of the ionosphere. Correcting for the ionosphere is challenging as it changes rapidly in time and across the sky at low frequencies (1). Here we present a calibration strategy that can correct for the ionosphere in the decameter band. We apply this to an observation from the Low Frequency Array (LOFAR) between 16–30 MHz. The resulting image covers 330 square degrees of sky at a resolution of $45''$, reaching a sensitivity of 12 mJy beam^{-1} . Residual ionospheric effects cause additional blurring ranging between 60 to $100''$. This represents an order of magnitude improvement in terms of sensitivity and resolution compared to previous decameter band observations(2; 3). Our work shows that sensitive sub-arcminute resolution decameter wide-field imaging is possible with ground-based arrays. In the region we surveyed, we have identified four fossil plasma sources. These rare sources are believed to contain old, possibly re-energised, radio plasma originating from previous outbursts of active galactic nuclei. At least three of them are situated near the center of low-mass galaxy clusters. Notably, two of these sources display the steepest radio spectral index among all the sources detected at 23 MHz. This indicates that fossil plasma sources constitute the primary population of steep-spectrum sources at these frequencies, emphasising the large discovery potential of ground-based decameter observations.

References

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