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## Ultra-steep diffuse emission outside the cluster core observed with LOFAR at 144 MHz in cool-core galaxy clusters

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Diffuse radio emission at the center of galaxy clusters is observed with different size and properties. Giant halos are Mpc-size sources predominantly found in massive merging clusters and are likely due to the re-acceleration of particles by turbulence injected in the intra cluster medium (ICM) during major merger. Mini halos are 100-500 kpc-size sources found in relaxed clusters with a cool-core. Their origin is still unclear, they could be either due to re-acceleration of particles by turbulence connected with the sloshing of the cluster core after a minor merger, or to the continuous injection of electrons by inelastic collisions of relativistic cosmic-ray protons with the cluster thermal proton population. Giant halos and mini halos are thought to be distinct classes of sources. However, recent observations have revealed the presence of diffuse emission on Mpc scales in clusters that are relaxed. These sources suggest that minor mergers –while not sufficiently energetic to disrupt the cool-core –could still trigger particle acceleration in the ICM on scales of hundreds of kpc, generating ultra-steep spectrum emission ( $\alpha \geq 1.5$ ). To test this hypothesis and the occurrence of this emission, we observed with the SKA precursor LOFAR (Low Frequency ARray) at 144 MHz a sample of eleven clusters with a cool-core and some level of dynamical disturbances, estimated from X-ray observations. In this talk, I will present the results we have obtained from LOFAR observations: we found that these sources are rare, three clusters ( $\sim 27\%$ ) present both a bright central mini halo and a fainter diffuse emission extending beyond the cluster core. We characterized the spectrum of these sources using follow-up observations, founding the emission outside the cluster core is ultra-steep, and we made a comparison between radio and X-ray emission.

### Research area

Extragalactic Continuum (galaxies/AGN, galaxy clusters)

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