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New LOFAR detection in the galaxy cluster A1413: connection between non-thermal and thermal emission

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Clusters of galaxies are the largest virialized systems in the Universe and thus are ideal laboratories to study the formation and evolution of cosmic structures. The baryonic matter of clusters consists of stars and galaxies, and of the intracluster medium (ICM). At the same time, radio observations have proved that the ICM is mixed with a non-thermal component, i.e. highly relativistic particles and large-scale magnetic fields, detected through their synchrotron emission.
Studying the connection between the cluster dynamical state and the properties of the diffuse radio emission is one of the main approaches to understand the origin of relativistic particles in galaxy clusters. In the last years, with the advent of new generation low-frequency radio telescopes, the classical dichotomy that connects merging events with giant halos and relaxed cool-core systems with mini-halos, has started to be questioned.
The galaxy cluster Abell 1413 is a very interesting example, of a peculiar galaxy cluster hosting a non-common radio emission. It was studied with two main goals: (i) to characterize separately the thermal and non-thermal properties of the cluster; (ii) to understand the origin of the radio-emitting electrons through a combined radio and X-ray analysis.
By performing a dedicated 2D spectral analysis of archived XMM-Newton observations, we examine the dynamical state of the cluster. The general properties derived for A1413 suggest that this system is a weak cool core cluster, i.e., not a completely relaxed system. determine the type and the properties of the extended radio emission hosted by the cluster.
The radio data allows to discover a new radio diffuse emission,more extended than previously know and constisting in a superposition of two different sources: the more compact mini-halo emission, at the cluster centre; surrounded by a low-brightness giant-halo on larger scales.
Finally, we carried out a point-to-point correlation between the physical quantities of the thermal emission and the radio surface brightness of A1413 to shed light on the connection between the re-acceleration processes, which give rise to radio emission, and the cluster dynamical state.

Reasearch area

Extragalactic Continuum (galaxies/AGN, galaxy clusters)

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