Probing Magnetic Fields in the Low-Density Medium Around Galaxy Clusters

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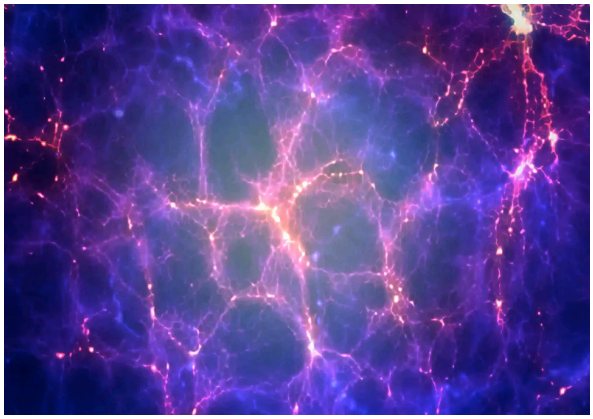
Galaxy clusters are massive and gravitationally bound objects that form by accretion of less massive clusters and groups. Mergers between clusters are the most energetic events in the Universe, with up to 10^{64} erg released in the intra-cluster medium. Part of this energy could be channeled into the amplification of the magnetic fields, which are are present on Mpc scale in the intra-cluster medium.
How magnetic field are amplified and up to which level is currently unknown. In particular, few constraints are available on the magnetic fields at the very periphery of clusters, beyond the cluster viral radii. Such contracts are fundamental to constrain the initial magnetic field seed, present in the medium before the matter collapses in to the cluster potential well.
Superclusters of galaxies are excellent laboratories for investigating low-density environments, which are not easily identified given the low signals and large scales involved.

The proposed PhD thesis will set for the first time limit to the magnetic field properties in the outskirts of galaxy clusters and outside the cluster virial radii, in the dilute medium around clusters, i.e. in superclusters.

With this project, we will be able to understand what is the magnetic field seed that is present in the matter before its collapse into the cluster potential well, setting a milepost for our understanding of magnetic field origin and evolution in clusters.

Data and methods:
This project will use new data and catalogs from the Low Frequency Array (LOFAR) The PhD candidate will learn how to analyse the radio observations ad catalogs, using the most updated tools.
To constrain the magnetic field properties, the PhD candidate will use and develop numerical techniques, starting from an existing numerical tool developed in the last years

Scientific context:
The PhD thesis is part of a larger project BELOVED (*B-fields evolution and origin in vast extragalactic domains*). financed by the European Research Council (ERC-2024-CoG 101169773). The PhD candidate will work in close contacts with the other group members, and will be involved in international working groups (LOFAR, and other SKA-pathfinders working groups).



Left: An illustration of the large-scale structure of the universe, showing galaxy clusters and superclusters connected by long filaments. (Image credit: Mark Garlick/Science Photo Libary/Getty Images) . Right: a picture of the LOFAR core.