



Radio NEXT: Diving into galaxy clusters with the most powerful radio telescopes

Supervisor: Virginia Cuciti

Scientific Case: On the largest scales, our Universe appears as an intricate, interconnected network of filaments known as the cosmic web (Fig. 1). Galaxy clusters form and evolve at the knots of the cosmic web. Mergers between clusters are the most energetic events in the Universe after the Big Bang. Part of this energy is channelled into relativistic particles and magnetic fields, producing spectacular diffuse synchrotron radio sources as large as clusters themselves. Current radio telescopes, such as LOFAR and MeerKAT allow us to study these sources with unprecedented detail and sensitivity. In a few cases, radio observations have been able to detect radio emission even beyond the scale of single clusters (e.g. Cuciti et al 2022, Nature; Govoni et al. 2019, Science), opening the exploration of the large scale structure of the Universe in the radio band, which will likely be one the major achievements of the SKA telescopes in the next decade.

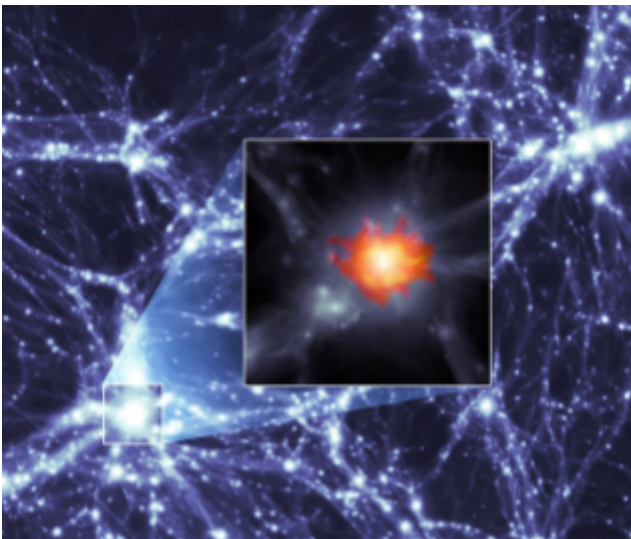


Figure 2. Background: Simulation of the Cosmic Web where the position of a galaxy cluster has been highlighted. Inset: Zoom-in with the LOFAR image of a radio source covering the whole volume of a cluster superimposed. Adapted by Cuciti et al. (2022, Nature).

Outline of the Project: The candidate will work on multifrequency MeerKAT data of galaxy clusters in order to search and characterise the radio diffuse emission within and around clusters. Polarization observations will be used to derive direct information about the strength and distribution of magnetic fields. The candidate will use state-of-the-art techniques and tools for interferometric radio data reduction.

Radio observations of galaxy clusters go hand in hand with X-ray observations which give us information about the thermal plasma. Depending on the candidate's interest, a more substantial part of the project can be devoted to X-ray analysis with the XMM-Newton and/or Chandra satellites.

With this project the candidate will 1) derive new constraints on the acceleration mechanisms in the periphery of galaxy clusters, 2) characterize

the distribution of magnetic fields from small to large scales and 3) understand the relative energetic contribution of thermal and non thermal components in the outer regions of clusters.

Scientific Context and Opportunities: The PhD project is part of the FIS3 project **Radio NEXT** financed by the Italian Ministry of University and Research. The PhD candidate will work in close contact with the other group members, and will be involved in International Collaborations, such as LOFAR and SKA. This gives the possibility of creating a large international network through visits and conferences as well as the access to state-of-the-art computing facilities.

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