PhD project in ASTROPHYSICS

Title: The large scale structure of the Universe at ultra low radio frequencies

Supervisor: Francesco de Gasperin
Co-supervisor: Annalisa Bonafede

Scientific case: Within the large scale structure of the Universe, enormous amounts of energy linked to the formation and growth of the cosmic web and the activity of powerful active galactic nuclei (AGN) are dissipated through processes such as turbulence and shock waves. These processes have a fundamental impact on the evolution of galaxy clusters. Their effect can be traced with radio telescopes.
In particular, the ultra-low radio frequencies are unique probes to study galaxy clusters. In this regime, cluster-scale radio sources can be traced for hundreds of megayears, allowing us to explore their long-term impact on the cluster environment. Furthermore, low-efficiency processes, invisible at higher frequencies, shine bright at these wavelengths. However, because of the complexity of the observations, the ultra low-frequencies are one of the last uncharted observational windows of the cosmic electromagnetic spectrum.

Outline of the project:
The candidate will use data from the Low Frequency Array (LOFAR; www.lofar.org) at ultra-low frequencies (<100 MHz or several metre wavelength) to study galaxy clusters and the large scale structure of the Universe. The student will have to work with a massive amount of data, using and developing advanced computing techniques in supercomputers. A certain skill/interest in coding and using novel technologies such as machine learning is an asset.
For the interpretation of the results, and depending on the candidate's attitude, the project can be tuned to leverage the observational (radio, X-ray), computational (MHD simulations) or theoretical (plasma physics and models of radio sources) part.
The PhD candidate will have privileged access to unique data from LOFAR and other radio telescopes as well as from eRosita. The candidate will be part of the LOFAR collaboration that includes >200 scientists from several European countries.

Collaborators: F. Vazza (simulations) and G. Brunetti, R. Cassano (theory).

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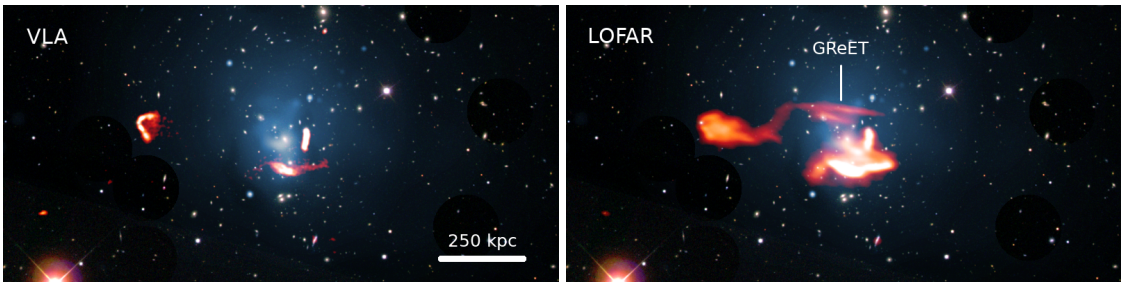

Radio observation of the galaxy cluster Abell 1033 at canonical frequencies (1400 MHz, VLA) and at low-frequencies (144 MHz, LOFAR). New phenomena are visible only at LOFAR frequencies. Credits: de Gasperin et al. (2017, Sci. Adv. e1701634)