INAF
ISTITUTO NAZIONALE
DI ASTROFISICA

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

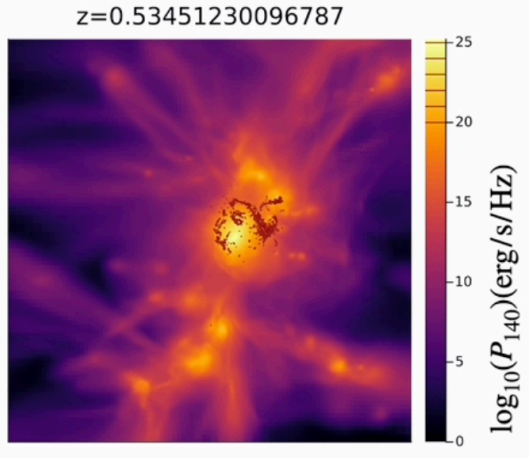
DIPARTIMENTO DI FISICA E ASTRONOMIA
Department of Physics and Astronomy - DIFA

erc
European Research Council

PhD project in ASTROPHYSICS

Title of the Project: Unveiling the cosmic web with the most powerful low-frequency radio telescope
Supervisor : De Gasperin Francesco

Scientific Case:
Within the cosmic web, enormous amounts of energy linked to the formation and growth of the largest structures of the Universe and the activity of 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 most spectacular effects can be seen through the observation of cosmic rays emitting radio waves and producing sources that are as large as clusters themselves. In particular, the ultra-low radio frequencies are able to trace these cosmic rays for up to a billion year from the moment of their acceleration, allowing us to explore their long-term impact in the cluster region. 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.



Simulated radio emission from a merging galaxy cluster in cosmological simulations

Outline of the Project:
The student will use data from the upcoming Low Frequency Array 2.0 (LOFAR 2.0; www.lofar.org) at low and ultra-low frequencies (<100 MHz) to study galaxy clusters and the emission from radio sources in that environment.
In the first part of the PhD, they will use mock images from cosmological simulations as models to simulate LOFAR 2.0 datasets. These dataset will be used to: 1. tune the LOFAR 1.0 pipelines to work with LOFAR 2.0 data; 2. derive realistic expectations for LOFAR 2.0 observations that will be used to improve the survey strategy. In the second part of the PhD the student will have privileged access to LOFAR 2.0 commissioning data to obtain the first images of galaxy clusters with the improved telescope.
The student will have the rare opportunity to work with both *observations* and *simulations*, developing advanced *data analysis* techniques and using supercomputers. Furthermore, they will have the chance to work with the first LOFAR 2.0 datasets.
The candidate will be part of the LOFAR collaboration that includes >200 scientists from several European countries and of the UltraLowUniverse research group that includes 4 PhDs and 5 postdocs financed by a European ERC Grant. 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. The possibility of spending one year of PhD at the University of Leiden (NL) can be discussed.

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