INAF
ISTITUTO NAZIONALE
DI ASTROFISICA

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

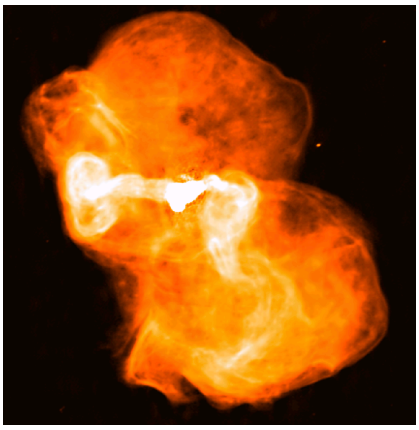
DIPARTIMENTO DI FISICA E ASTRONOMIA
Department of Physics and Astronomy - DIFA

erc
European Research Council

PhD project in ASTROPHYSICS

Title of the Project: The cosmic ray lifecycle in galaxy clusters using novel radio telescopes
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. 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.



The extended radio emission surrounding M87, generated by the supermassive black hole at its centre across many tens of mega years.

Outline of the Project:
The candidate will use data from the Low Frequency Array (LOFAR; www.lofar.org) at low and ultra-low frequencies (<100 MHz or several metre wavelength) as well as data from the MeerKAT radio telescope to study galaxy clusters and the emission from radio sources in that environment. The student will work with massive amounts of data, developing advanced *data analysis* techniques and using supercomputers. A certain 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 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) or the University of Hamburg (DE) can be discussed.

Collaborators: A. Bonafede, R. van Weeren (radio), F. Vazza (simulations) and G. Brunetti (theory)
Contacts: Francesco de Gasperin <fdg@ira.inaf.it>