ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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

# Pos-Doctoral Fellowship in ASTROPHYSICS

**Title of the Project:** ***A high resolution view of electron acceleration in simulated radio relics***
**Supervisor :** Prof. F. Vazza (DIFA)

**Scientific Case:**
Radio relics are the most spectacular evidence of particle acceleration by weak shock waves in the Universe. Despite their existence is known since a few decades, only since recently deep and high resolution radio observations have started to expand our understanding of the complex processes behind the dissipation of shock kinetic , from the Megaparsec scales down to the sub-kiloparsec regime where magnetic field fluctuations and particles get closely coupled through Fermi acceleration.
However, the same observations are routinely providing new challenges to our physical model of such objects as non-trivial spectral and morphological features are detected across shocks - enforcing the idea that the acceleration of electrons develops in a complex and dynamical environment, with a distribution of Mach numbers even across a single radio relic, and with turbulent magnetic field fluctuations already present in the shock upstream.
At present, advanced numerical simulations are the only approach in which the production of radio relics can be modelled in detail, coupling macroscopic matter accretion features and small scale plasma dynamics. They are also crucial to connect the radio emission from shocked plasma within galaxy cluster to the (soon to be imaged) diffuse emission from even more rarefied shocked plasma in filaments of the cosmic web, a main task for the MAGCOW project.

**Outline of the Project:**
This Post-Doctoral Fellowship project is aimed to develop a physically motivated method for the simulation of radio relics at high resolution, including the effects of a realistically turbulent intracluster medium and of an inhomogeneous Mach number distribution across shock fronts injected by mergers. A necessary ingredient to be modelled with care is the evolution of relativistic electrons accelerated across the shock front, and the link between shock acceleration efficiency and the local topology of the intracluster magnetic field. Moreover, synthetic radio observations of simulations produced during the project will represent a fundamental output to compare with existing radio observations (available to members of the MAGCOW group) as well as to propose observing strategies for new radio observations.

Given its topic and expected workflow, this project calls for candidates who are comfortable with *coding and numerics*, in particular with evidence of a strong track record in in a) cosmological eulerian MHD simulations; b) physics of the intracluster medium; c) experience with the interpretation/comparison with real radio observations of diffuse emissions in galaxy cluster (including polarised emission); d) Fokker-Planck methods for the evolution of relativistic particle spectra.

**Development and formative plan**
The Post-Doctoral fellow will be involved in all existing scientific activities and lines of research of the MAGCOW group (https://cosmosimfrazza.myfreesites.net/erc-magcow).

He/she will have access to all numerical method and physical models developed by the group, which will be helpful to model the ageing and re-acceleration of fossil plasmas in complex objects.
The Post-Doctoral fellow will have the opportunity to lead this line of research, by coordinating specific observing campaigns tailored to identify interesting and peculiar diffuse radio sources linked to ageing lobes of radiogalaxies.
The candidate will be encouraged to keep all existing collaborations alive, to present new results to conferences and workshops (in presence or remotely), to be the lead author or publications resulting from this line of research as well as to perform any possible outreach activity to maximise the project's impact on the general public.

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https://cosmosimfrazza.myfreesites.net/erc-magcow