ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

DIPARTIMENTO DI FISICA E ASTRONOMIA
DEPARTMENT OF PHYSICS AND ASTRONOMY - DIFA

Title of the Project: Substructures in Galaxy Clusters: a testbed for the Cold Dark Matter scenario

Supervisors: Lauro Moscardini

Duration: 2 years

Scientific Case:

The aim of this project is to investigate the nature of dark matter by studying the small-scale structure in galaxy clusters. It is well known that dark-matter halos in the standard cold-dark-matter (CDM) scenario are expected to contain a large number of satellite haloes (sub-haloes). Numerical hydrodynamical simulations allow us to study the properties of these sub-haloes in different cosmological scenarios, also exploring alternative models for dark matter.
Recently, deep observations with the Hubble Space Telescope allowed us to obtain models of the mass distribution in the core of several massive galaxy clusters with unprecedented accuracy (Frontier Fields, CLASH). The comparison of these reconstructions with expectations in the framework of the CDM scenario revealed a puzzling picture. On one hand, the mass function of the cluster sub-haloes is consistent with the theoretical expectations, on the other, a significant discrepancy is found between theory and observations in terms of other sub-halo properties, such as their radial distribution within the cluster or their compactness.
The goal of this project is to understand if such discrepancies can be alleviated by assuming a different form of dark matter (self-interacting or axionic) or by changing some of the assumptions commonly adopted in hydrodynamical cosmological simulations (energy feedback and star formation).

Outline of the Project:

The project will be carried out through different steps that can be summarised on those lines of research:

- develop a pipeline to study the multi-mass components of existing simulated hydrodynamical clusters: subhalo population, density profiles

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of the various constituents, their mass segregations and distributions around the cluster centre;
- identify the best methodology and statistics to compare satellite properties between simulations and observations;
- run an analogous suite of hydrodynamical simulated clusters using non-standard dark matter models;
- compare clusters and satellite properties in the different cosmological scenarios trying to fill the gap between theory and observations.

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