

# MASTER THESIS PROJECTS @ IFAE COSMOLOGY GROUP

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**TITLE:** Understanding the cosmic web with galaxy clusters, filaments, and voids

**PROJECT DESCRIPTION:** The large-scale structure of the Universe shows a rich and complicated structure of galaxy clusters, filaments, and voids. The formation and evolution of this cosmic web is governed by unknown substances, dark matter and dark energy, that cosmologists wish to map and analyze. The IFAE observational cosmology group is analyzing simulations and data taken by large galaxy surveys to understand the properties of these mysterious dark components. In the first part of the project, the student will be able to participate in developing cosmic web decomposition methods with python programming and machine learning. The final goal of this project is to understand how the high galaxy density of the PAU survey can be beneficial to learn about the environment-dependence of colors and masses of galaxies and their dark matter halos.

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**TITLE:** Gravitational Redshifts systematics from assigning galaxies into halos

**PROJECT DESCRIPTION:** Galaxies live in dark matter halos. In a given halo, the galaxies that live at the center of the halo sit on a deeper gravitational potential than the ones that live at the outskirts of the halo. The difference in the gravitational potential of these galaxies produces a shift in the measurement of the galaxy redshifts. This shift is known as gravitational redshift, and it has the potential to test gravity models. Unfortunately, due to the peculiar velocities of galaxies, sometimes, when we observe a galaxy that is nearby two dark matter halos, we are not confident to which of the halos the galaxy belongs to. As a consequence, the measurement of the gravitational redshift becomes less accurate. In this project, the student will look at how the measurements of Gravitational Redshifts are affected by our incomplete understanding of the galaxy assignment to halos. This project requires a considerable amount of coding which can be done either in Python, Fortran or C.

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