Thesis subject

Laboratory : LAM

Thesis supervisor : Eric JULLO

Co-supervisor : Emmanuel Nezri

Title of the thesis subject : Scalar field vs cold dark matter simulations and observational test with gravitational lensing and stellar kinematics data from DESI and Euclid.

Description of the thesis subject :
Numerical simulations predict that the inner profile of overdensities, and the mass function of subhalos are observables sensitive to the nature of dark matter (Robertson et al. 2019, Bose et al. 2017). Interestingly, these observables are also affected by baryonic physics, although in a different manner. For instance, axion-like particles produce a flat DM inner profile (Schive et al. 2014) and prevent the formation of low-mass halos. In contrast, baryons might counter act these effects, and result in observables very similar to the standard cold DM.
DESI and Euclid are currently surveying a large fraction of the sky, thus providing the largest sample of galaxies ever characterized in spectroscopy, photometry and morphology.
In this thesis, we will use a code to simulate dark matter halos assuming either scalar field or cold dark matter and explore in both cases the impact of baryons on the inner slope of the matter density field. We will also analyze data from DESI, Euclid and MUSE to model some strong lensing systems, measure the inner matter density profile, and compare to the simulated objects (see e.g. Newman et al. 2013). The analysis will be based on existing codes, either developed by the supervisors, or by close collaborators. Good programming skills are recommended.

References :
Robertson et al. 2019, https://arxiv.org/abs/1810.05649
Bose S. et al. 2017, https://arxiv.org/abs/1604.07409
Schive et al. 2014, https://arxiv.org/abs/1406.6586
Newman et al. 2013, https://arxiv.org/abs/1209.1391