ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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

PhD project in ASTROPHYSICS

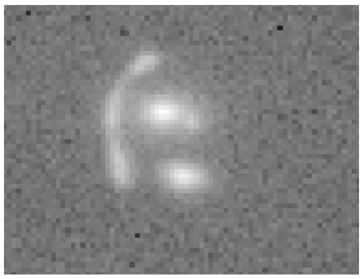
Title of the Project:
"Between Strong and Weak Gravitational Lensing in Cosmological Surveys"

Supervisor : Robert Benton Metcalf

Scientific Case:

Weak gravitational lensing is now a central probe of cosmology. Strong lensing has been instrumental in studying the distribution of dark matter around galaxies. In this project, we will explore the cosmological implications of strong lensing and the intersection between strong and weak lensing. The Euclid mission will discover perhaps 100,000 galaxy and group-scale strong lenses. The number and distributions of these lenses can tell us about cosmology and how baryons are related to dark matter if selection effects associated with the detection of the objects can be taken into account. In addition, we will investigate how new probes of galaxy-galaxy lensing at a little larger scales are affected by baryonic physics.

Outline of the Project:



Simulated Euclid image of a group scale strong gravitational lens.

I have been developing simulations of strong gravitational lensing for the Euclid mission using Nbody and ray-tracing simulations and a method of "baryonizing" them, i.e. modifying the mass distribution to account for stars and gas. We will use these simulations, and machine learning methods for detecting strong lenses, to make strong lensing observations in Euclid into an effective method for constraining cosmology and semi-analytic descriptions of galaxies formation. Probes such as the distribution of critical curve sizes, shapes and the association with visible galaxies will be investigated. The completeness of the sample and the existence of false detections need to be carefully taken into account.

Extensions of the same simulations will be used to investigate the galaxy-shear correlations at a scale and accuracy that has not been done before. The goal is to go beyond the "halo model" for galaxy-galaxy lensing and push the techniques to smaller scales where the approximations of weak lensing break down. Alternatives to the standard galaxy-shear 2-point statistic will be investigated.

This will require working with the products of large cosmological simulations and with our gravitational lensing code. The results should be directly applicable to Euclid data to which we will have access. Knowledge of C++ and python will be useful.

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