Dottorato di Ricerca in Fisica – PhD in Physics
(XLII Ciclo)

Research Project:

Title: "New Physics from the Large-Scale Structure of the Universe"

Abstract:

Upcoming galaxy surveys such as Euclid, DESI, Rubin Observatory and Roman Space Telescope will measure galaxy clustering and weak gravitational lensing with unprecedented precision, opening a unique window on fundamental physics. This project aims to develop novel methods to search for signatures of physics beyond the standard cosmological model in a largely model-independent framework. A first research direction will focus on extending and applying the Large-Scale Structure Bootstrap approach to cosmological observables, enabling robust consistency tests of the ΛCDM paradigm and the identification of potential anomalies. A second line of investigation will explore advanced summary statistics capable of extracting the non-Gaussian information encoded in the matter distribution, including the bispectrum, marked statistics, wavelet-based observables, and related techniques. Finally, the project will investigate field-level inference methods, combining state-of-the-art numerical approaches—such as Hamiltonian Monte Carlo and machine-learning-assisted sampling—with field-theoretical techniques based on path-integral formulations of the full posterior distribution. The ultimate goal is to maximize the scientific return of next-generation surveys and enhance their discovery potential for new fundamental physics.

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