

Primordial Non-Gaussianity from Galaxy Surveys

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Level: MSc. Project

Galaxy surveys give us information about the distribution of galaxies in the Universe and the galaxy distribution contains information about the initial conditions of the Universe. One of the most important signatures we can search for is primordial non-Gaussianity (PNG), which arises from the physics of inflation in the very early Universe. Measuring PNG can give vital information about inflationary models and discriminate between different theories of the early Universe.

This project will investigate the observational signatures of primordial non-Gaussianity in galaxy surveys, focusing on how it affects the galaxy distribution through scale-dependent bias and how current and future surveys can constrain PNG. The project involves both theoretical and computational work. With guidance and support, you will explore properties of the galaxy distribution, including the galaxy power spectrum, and investigate the effects of local non-Gaussianity (f_{NL}) on large-scale structure.

Particular attention will be given to the unique advantages of HI intensity mapping with SKA for probing ultra-large scales where PNG signatures are strongest, as well as the multi-tracer technique which uses multiple galaxy populations to reduce cosmic variance and improve constraints on f_{NL} . Students will learn Fisher forecast techniques for constraining f_{NL} parameters and assessing the constraining power of different survey configurations.

Key aspects to explore include: the statistical properties of primordial density fluctuations, scale-dependent bias as a signature of local-type PNG. The project will examine current observational constraints, and future prospects with Dark Energy Survey Instrument (DESI), Euclid Telescope, Large Legacy Survey of Space and Time (LSST), and Square Kilometre Array (SKA).

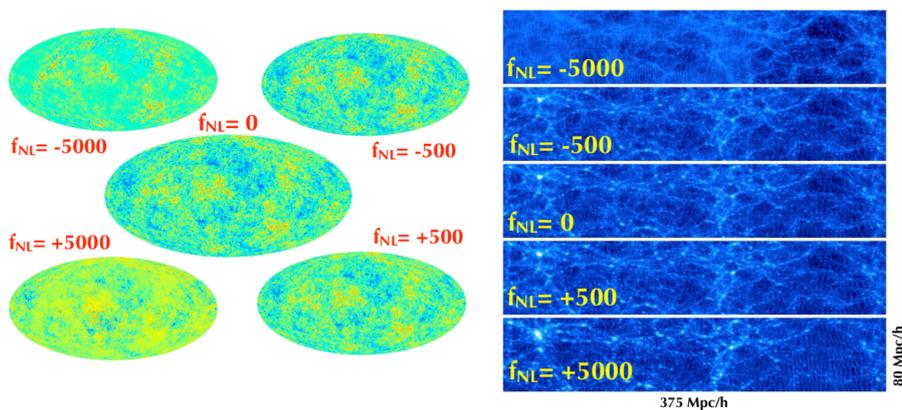


Figure 1: Illustration of the effects of primordial non-Gaussianity on cosmic structure. Left: CMB temperature fluctuations for different values of f_{NL} . Right: Large-scale structure distribution in a $375 \times 80 \text{ Mpc}/h$ slice showing how different f_{NL} values affect the clustering of matter. Non-zero f_{NL} modifies the statistical properties of density fluctuations, leading to observable signatures in both the CMB and galaxy distribution.