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# Constraining Primordial Non-Gaussianity: Analysis of the Relativistic Galaxy Bispectrum with Euclid and SKA

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Initial matter density perturbations during the primordial era are set in motion by inflation, subsequently dictating the formation and evolution of the large-scale structure of the universe. In this research, we explored primordial non-Gaussianity in large scale structures of the universe at redshifts z = 1.0 and z = 1.5, focusing on the improvements the new and upcoming Euclid and SKA surveys will provide in refining non-Gaussianity (f_nl) measurements, a critical test for inflationary theory and the standard model. Developing and applying an an advanced model of the bispectrum, we analyzed how systematic uncertainties due to observational biases such as galaxy bias, redshift space distortions, and gravitational lensing constrain non-Gaussianity measurements, under the framework of complex statistical analysis based on two-point and three-point correlators. Probing the bispectrum up to the largest currently measurable scale (k ≤ 10e-4/Mpc) from Euclid and SKA surveys, we included matter density perturbations from the observed background up to the second order, ensuring theoretical predictions accurately match with observations of large scale structure and evolution. SKA was shown to achieve tighter constraints on f_nl up to 5.65 from our analysis, outperforming the constraint set by Euclid at f_nl = 25.0. These improved constraints are attributed to the distinct observational biases present in SKA's 21-cm neutral hydrogen background signatures, which differ from the galaxy clustering measurements made by Euclid. Despite these advancements, the simplest models of inflation predict an f_nl ≈ 1, a benchmark that remains challenging to achieve even with the upcoming state-of-the-art instruments such as SKA. Nevertheless, this research underscored the importance of SKA's improved systematics to further clarify cosmic inflation. Moreover, it confirmed established key features of non-Gaussianity, including peaks in the bispectrum of both instruments at equality scales, the downward trend in non-Gaussianity at larger k-scales, and signatures of Baryonic Acoustic Oscillations (BAO) at sub-horizon scales. Finally, the need for higher order correlators and contributions to GR effects is established, along with the potential use of cosmological gravitational waves, to enhance observational precision and expand the range of observable scales. Steps towards these advancements will further refine the constraints on non-Gaussianity (f_nl).

**Authors:** Mr CLARKSON, Chris (Queen Mary University of London); BHATNAGAR, Mihir (Queen Mary University of London)

**Presenter:** BHATNAGAR, Mihir (Queen Mary University of London)

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