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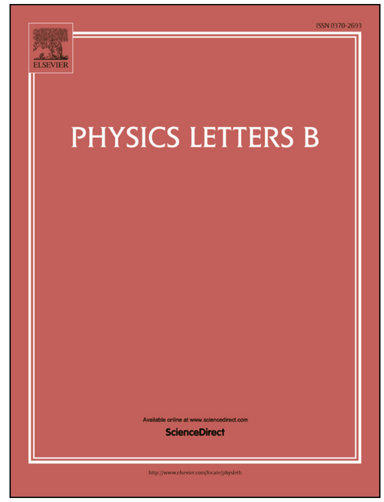

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Michael McAneny, Alexander K. Ridgway, Mikhail P. Solon, Mark B. Wise

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Stochastic Bias from Loops of Massive Particles During Inflation

Michael McAneny, Alexander K. Ridgway, Mikhail P. Solon and Mark B. Wise

Walter Burke Institute for Theoretical Physics,
California Institute of Technology, Pasadena, CA 91125

Primordial non-Gaussianities enhanced at small wavevectors can induce a power spectrum of the galaxy overdensity that differs greatly from that of the matter overdensity at large length scales. In previous work, it was shown that "squeezed" three-point and "collapsed" four-point functions of the curvature perturbation ζ can generate these non-Gaussianities and give rise to so-called scale-dependent and stochastic bias in the galaxy overdensity power spectrum. We explore a third way to generate non-Gaussianities enhanced at small wavevectors: the infrared behavior of quantum loop contributions to the four-point correlations of ζ. We show that these loop effects can give the largest contributions to the four-point function of ζ in the collapsed limit and be observable in the context of quasi-single field inflation.

I. INTRODUCTION

The inflationary paradigm [1] proposes an era in the very early universe during which the energy density is dominated by vacuum energy and the universe undergoes exponential expansion. Such a period elegantly explains why the universe is close to flat and the near isotropy of the cosmic microwave background (CMB). It also provides a simple quantum mechanical mechanism for generating energy density perturbations which have an almost scale-invariant Harrison-Zel'dovich power spectrum.

The simplest inflation models consist of a single scalar field ϕ, called the inflaton, whose time-dependent vacuum expectation value drives the expansion of the universe. The quantum fluctuations in the Goldstone mode π associated with the breaking of time translation invariance by the inflaton [2] source the energy density fluctuations. In the simplest of these single field models, the density perturbations are very nearly Gaussian [3]. One way to generate measurable non-Gaussianities is to introduce a second field s that interacts with the inflaton field during the inflationary era. A simple realization of such a model is quasi-single field inflation (QSFI) [4].

These non-Gaussianities affect the correlation functions of biased tracers of the underlying matter distribution such as galaxies. It was first pointed out in [5] and [6] that the power spectrum of the galaxy overdensity can become greatly enhanced relative to the Harrison-Zel'dovich spectrum on large scales if the primordial mass density perturbations are non-Gaussian.[1] These enhancements are known as scale-dependent bias and stochastic bias and were systematically explored in the context of QSFI in [7] and [8].[2]

[1] We refer to these effects as "enhancements" even though for certain model parameters they can interfere destructively with the usual Gaussian primordial density fluctuations.

[2] By stochastic bias, we mean the difference between the collapsed trispectrum and the squeezed bispectrum squared; see for example Eq. (2.7) of [7]. This stochastic bias can depend on the scale.