PRIMORDIAL POWER SPECTRUM AND LOCAL FEATURES

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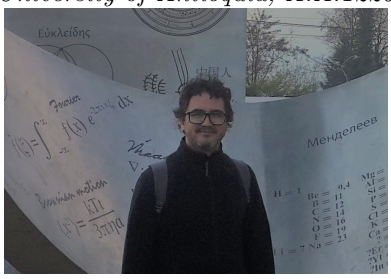

We study the effects of local features (LF) of the inflaton potential on the spectrum of primordial curvature perturbations. We show that the LF affect the potential in a narrow range of the scalar field value. We compute the primordial spectrum and show that it is only affected in a limited range of scales, which leave the horizon during the time interval corresponding to the modification of the potential. Due to their local nature these features could be used to model local glitches found in the primordial spectrum without affecting other scales.

1 Introduction

The study of features of the primordial spectrum of perturbations is one of the most exciting extensions of the ΛCDM model [1,2,3,4,5]. In the past years a remarkable attention has been given to the detection of primordial features since it could pin down details of the inflationary theory, from discriminating between different models to improving the fit to CMB temperature data [1,2,5].

2 The inflationary model

We consider inflationary models with a single scalar inflaton field ϕ according to the action

$$S = \int d^4x\sqrt{-g}\left[\frac{1}{2}M_{Pl}^2 R - \frac{1}{2}g^{\mu\nu}\partial_\mu\phi\partial_\nu\phi - V(\phi)\right], \tag{1}$$

where $g_{\mu\nu}$ is the flat FLRW metric, M_{Pl} the reduced Planck mass, R the Ricci scalar, and V is the inflaton potential. To study the effects of the feature we consider the potential [4,5]

$$V(\phi) = V_0(\phi) + V_{LF}(\phi)\,, \tag{2}$$

where $V_0(\phi) = \gamma\phi^2$ is the chaotic potential used to model the featureless behavior and

$$V_{LF}(\phi) = \lambda e^{-(\frac{\phi-\phi_0}{\sigma})^2}\,, \tag{3}$$

The parameters λ, σ, and $\phi_0 \equiv \phi(t_0)$, where t_0 is the feature time, are related to the amplitude, width, and scale of the feature, respectively. This type of modification of the potential corresponds to LF [4,5], where V deviates from the featureless case only in a limited range of the field

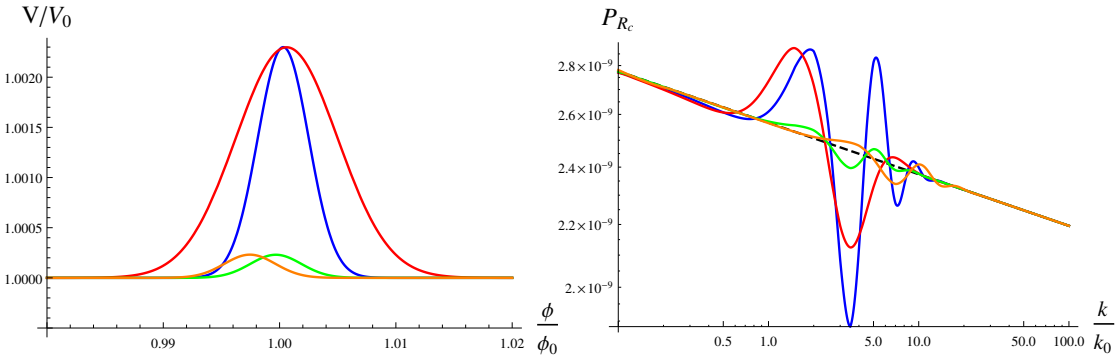

Figure 1 – We plot the effects of the features on the inflaton potential (left) and on the power spectrum of primordial curvature perturbations (right). For the features we use $\lambda = 10^{-11}, \sigma = 0.05$, and $\phi_0 = 16.16$ (blue), $\lambda = 10^{-11}, \sigma = 0.1$, and $\phi_0 = 16.16$ (red), $\lambda = 10^{-12}, \sigma = 0.05$, and $\phi_0 = 16.16$ (green), and $\lambda = 10^{-12}, \sigma = 0.05$, and $\phi_0 = 16.12$ (orange). The dashed lines correspond to the featureless case. In all cases we use $\gamma = 1.66 \times 10^{-11}$.

value around ϕ_0. The effects of the feature on the potential are shown in Fig. 1. From now on we use units in which $c = \hbar = M_{Pl} = 1$.

3 Primordial power spectrum of curvature perturbations

The power spectrum of primordial curvature perturbations is defined as [4]

$$P_{\mathcal{R}_c}(k) \equiv \frac{2k^3}{(2\pi)^2}|\mathcal{R}_c(k)|^2, \tag{4}$$

where $\mathcal{R}_c$ is the comoving curvature perturbation and k its comoving wave number. As can be seen in Fig. 1, $P_{\mathcal{R}_c}$ is affected by oscillations only around the scale k_0 exiting the horizon. This is opposed to branch features (BF) [3,4] which produce a step with respect to the featureless spectrum at large or small scales.

4 Conclusions

We have shown the effects of LF of the inflaton potential on the spectrum of primordial curvature perturbations. We have seen that the LF affect the spectrum in a narrow range of scales. The amplitude and width of the oscillations depend on the parameters defining the feature. In the future it would be interesting to study phenomenologically the combined effects of LF and BF on the primordial spectrum for different inflationary models.

References

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