Preheating after N-flation

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N-flation[1] is a string-motivated implementation of assisted inflation where a large number – typically hundreds to thousands – of uncoupled scalar fields assist each other to drive inflation. A salient feature of this model is that it is not necessary to impose super-Planckian initial conditions of inflaton fields for the resolution of the horizon problem. The mass spectrum of inflaton fields of this model has been calculated using results from random matrix theory and is found to conform to the Marčenko-Pastur (MP) law[2]. Observable cosmological imprints – the tensor-to-scalar ratio, the non-Gaussianity parameter and the spectral index – have been computed for N-flation by several groups and are shown to take similar values to single-field inflation. This suggests that N-flation is compatible with current observational data. Can we, then, conclude that N-flation is nearly indistinguishable from single-field inflation?

We studied the late time dynamics of N-flation, assuming the MP mass distribution and equal-energy initial conditions at the beginning of inflation. We first followed the dynamics of N-flation after the slow-roll conditions are violated for some of the inflaton fields, and found that the evolution is driven by only a small number ($\sim 10\%$) of lightest fields, i.e. heavier fields quickly lose energy and become negligible before preheating commences. To study preheating we coupled a single massless bosonic matter field to the whole spectrum of inflatons with the same coupling strength. We analysed the preheating of N-flation within this setup, by solving the evolution of the matter field numerically, including the expansion of the universe. We found power-law like behavior in short time scales and occasional, not very frequent resonance amplifications in long time scales in the parameter region that would give rise to stochastic resonance in single field models. In particular, the growth of the matter field is generically not strong enough to resist redshifting due to cosmic expansion.

If the inflatons have the same mass, the equations of motion for the matter field reduce to those of single-field inflation, yielding non-perturbative preheating via parametric resonance[3]. The suppression of resonance effect in N-flation is due to the relative mass differences of the inflatons, causing dephasing in the effective mass term of the matter field. This apparently generic effect that seems to have been overlooked so far gives a rather unconventional prediction that the old theory of perturbative reheating applies to this scenario, and not parametric resonance.

This talk is based on a collaboration with D.Battefeld[4].

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