Contribution ID: **184** Type: **Poster**

Reheating by Parametric Resonance in the ϕ^4 Model of Chaotic Inflation

Kofman, Linde and Starobinsky had showed that preheating can occur due to a huge amount of particle creation by parametric resonance after the inflationary era of the Universe. In the ϕ^2 model, they confirmed the existence of narrow and broad resonances as well as stochastic resonance in the presence of an expanding background, by means of exact numerical computation of the corresponding Mathieu equation. On the other hand, they obtained a Lam\'e-type equation for the ϕ^4 model in an approximate scheme, which showed resonance bands quite different in nature from their previous study.

In the present work, we reconsider the ϕ^4 model of inflation and study the parametric resonance patterns in the preheating stage after the inflationary era. Hence we construct the dynamical equation for the mode functions of the created particles coupled with the oscillatory dynamics of the inflaton field in the reheating regime. We solve these coupled equations exactly by numerical integration.

We find resonance patterns quite different from those of ϕ^2 model obtained earlier by Kofman et al. The mode functions gain in amplitude only in the initial stage of decay of the inflaton field and thereafter their amplitude remains almost constant for a long time. This shows that the resonance in the ϕ^4 model is maintained for a longer time than in the ϕ^2 model. We have verified this feature by numerical computation for a time-span of five times higher than in the existing literature.

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Session Classification: Cosmology

Track Classification: Cosmology