Search for Local Kink in the CMB Power Spectrum due to round trip of the modes in horizon during inflation

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We provide a new method to generate a feature in the power spectrum. The main property of this approach is that it also leads to a local kink in the angular power spectrum of the CMB. We'll show that some of such models doesn't lead to this local kink and we should search in other models.

Introduction

The observations of the cosmic microwave background (CMB) temperature fluctuations can be used to constraint accurately the cosmological models. The CMB data analysis is consistent with a primordial power spectrum parametrized by a nearly constant slightly red spectrial index from $k \approx 1 Mpc^{-1}$ to about $10^4 Mpc^{-1}$ Such a flat power spectrum is a generic prediction of a large class of inflationary models. In a more complicated situtation, the power spectrum can be produced with features or oscillations. These class of primordial power spectrums are predicted by several multi field and also single field inflationary models. In the single field case, the features generally come from an ad hoc manipulation of inflation potential. In the models with feature in the potential had driven inflation then how their effects can be detected in the observations of large scale structure (LSS) or the CMB?

Using the numerical codes developed during recent years, one can easily check the imprint of the feature in the power spectrum on the CMB angular power spectrum C_l The effects on C_l may be observed using the higher precision CMB data from Planck satellite.

Type I models

Some inflationary models with a locally featured potential can generalized local feature in the power spectrum. The feature of potential should be fine tuned at the value of inflaton field when the modes corresponding to our large scale universe exist the horizon.

$$P \approx \frac{H^2\varepsilon_\chi^2}{4\pi^2}\left(\frac{1}{2e\varepsilon_\chi}\right)^{2/3}\exp\left[-\frac{(n_t(k)-n_t(k_{\max}))^2}{2\sigma_{n_t}^2}\right]$$

$$n_t(k_{\max}) = \left(\frac{1}{2\varepsilon_\chi}\right)^{2/3} \qquad (1)$$

$$\sigma_{n_t} = \sqrt{\frac{2}{3}}\, n_t(k_{\max})$$

We proposed a function as a sample function for primordial power spectrums of such spiky models:

$$P = \exp\left[x(n_s-1)\right] + \frac{A}{\sqrt{2\pi\sigma^2}}\exp\left[-\frac{(|x|-mean)^2}{2\sigma^2}\right] \qquad (2)$$

$$x = \ln\left(\frac{k}{k_p}\right)$$

We compared this sample function with standard power spectrum :

$$P = \exp[x(n_s-1)] \qquad (3)$$

Which we compared these two power and show the domain of local feature of such models in Fig. 1

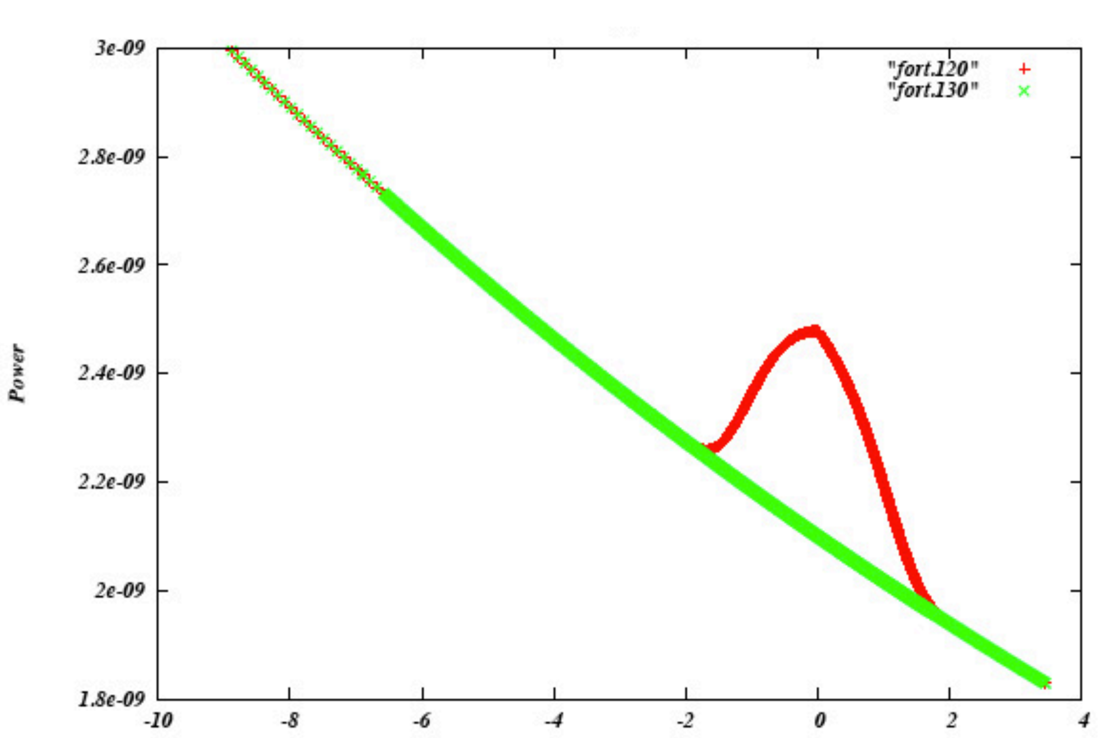

Figure1: Comparing sample spiky model with standard power spetrum

We modified the CAMB publicly available code for this sample model and we calculated the CMB power spectrum. In Fig. 2 you can see the power spectrum of this model in comparison with LCDM model. As you see in this plot there is no local feature in multipoles less than **ℓ < 200** .

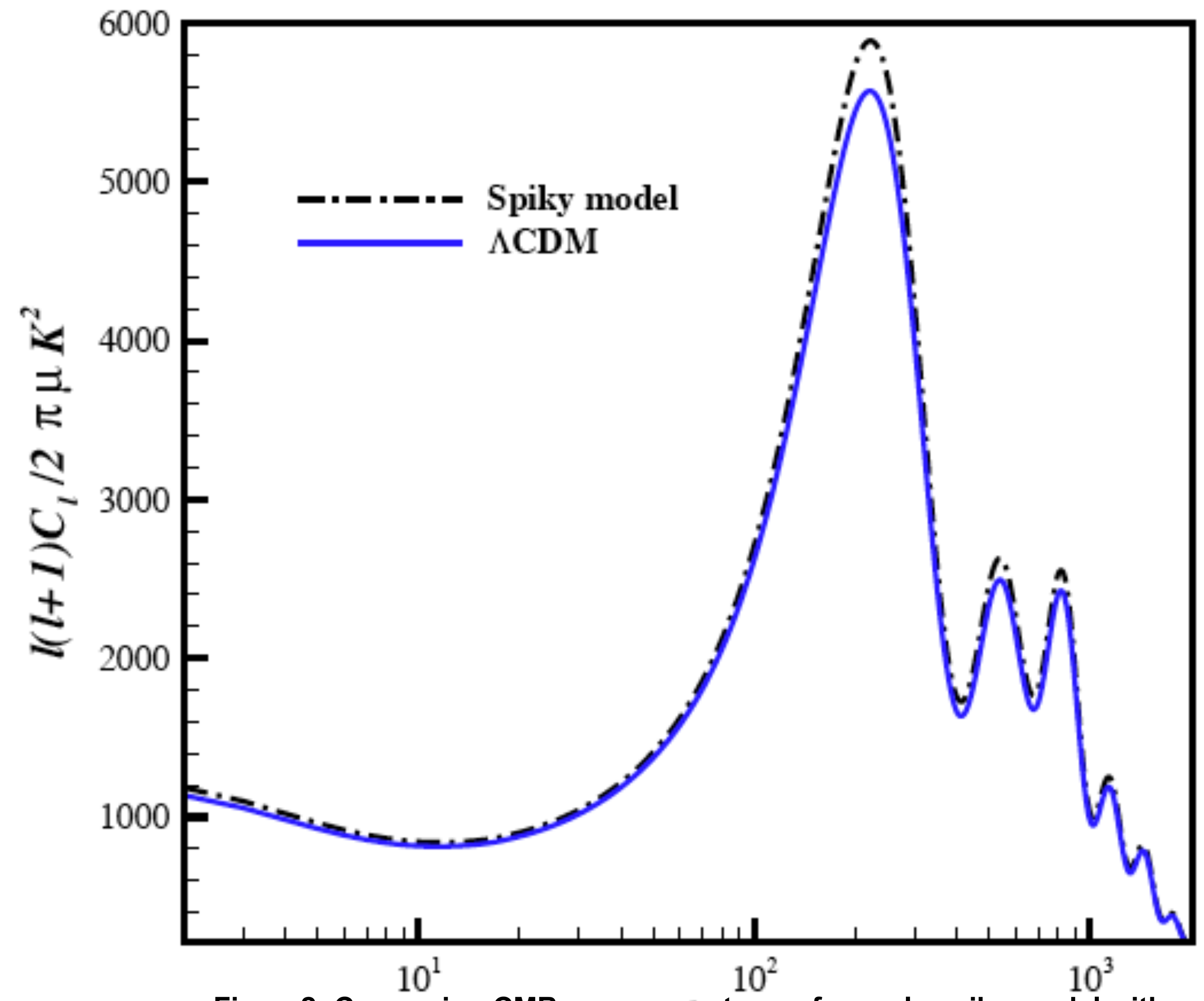

Figure2: Comparing CMB power spectrum of sample spiky model with LCDM power spectrum

Type III models

In these models a second stage in inflation follows the first one. The inflationary phases may be separated by a matter or radiation phase. It can also be assumed that large scales exist the horizon during first phase or second phase.

The primordial power spectrum of this model can be written in this form:

$$P = \frac{2^{\nu-3/2}}{\pi M_p^2}\frac{\Gamma(\nu)}{\Gamma(3/2)}\left(\nu-\frac{1}{2}\right)^{-2\nu+1}\left(\frac{H^2}{\varepsilon}\right)_{k=aH} \qquad (5)$$

As you see in Fig. 4 this model produces local feature in CMB power spectrum which follow WMAP 7 data correctly.

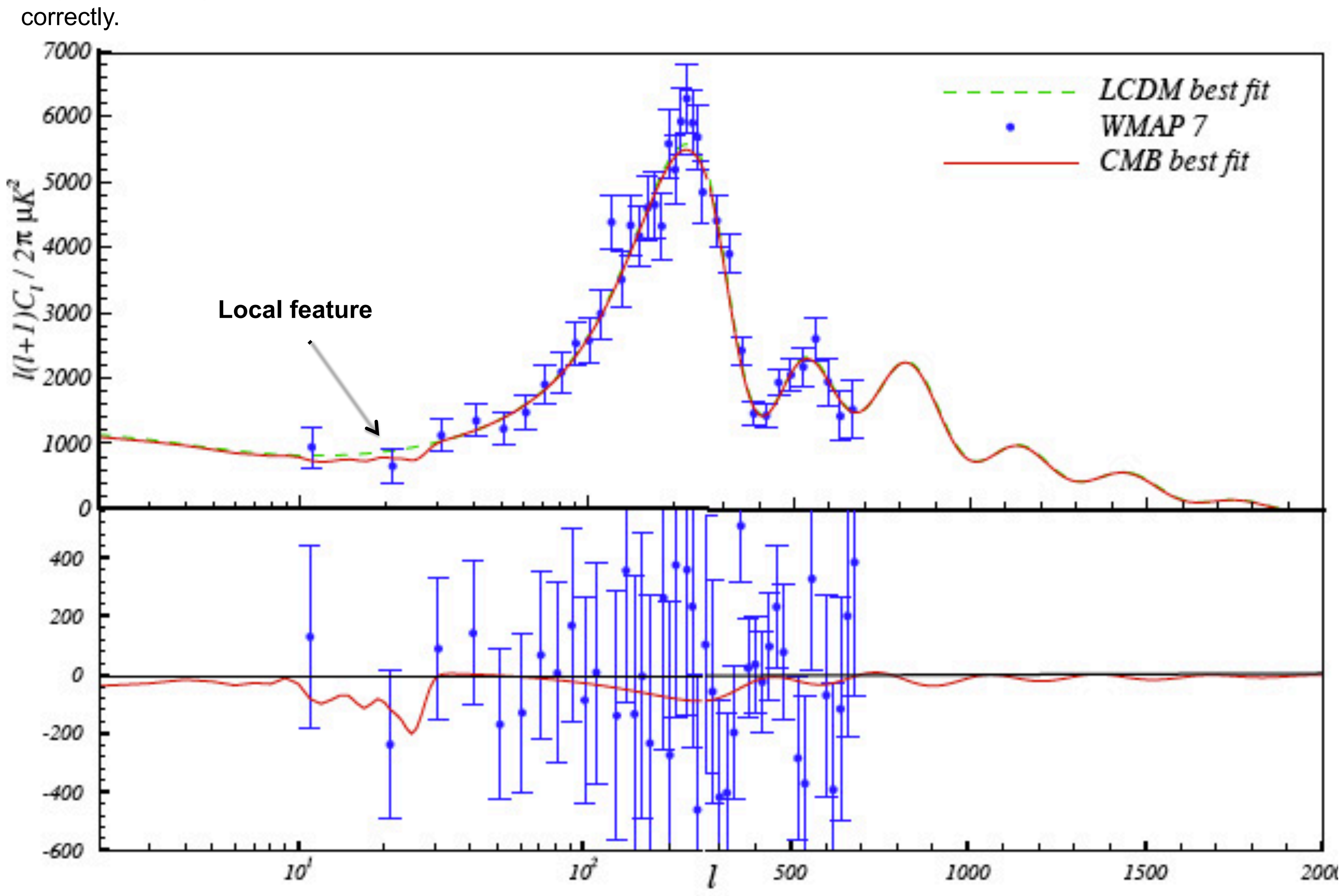

Figure4: Comparing CMB best fit power spectrums of model with WMAP 7 years data. You can see local feature in this power spectrum

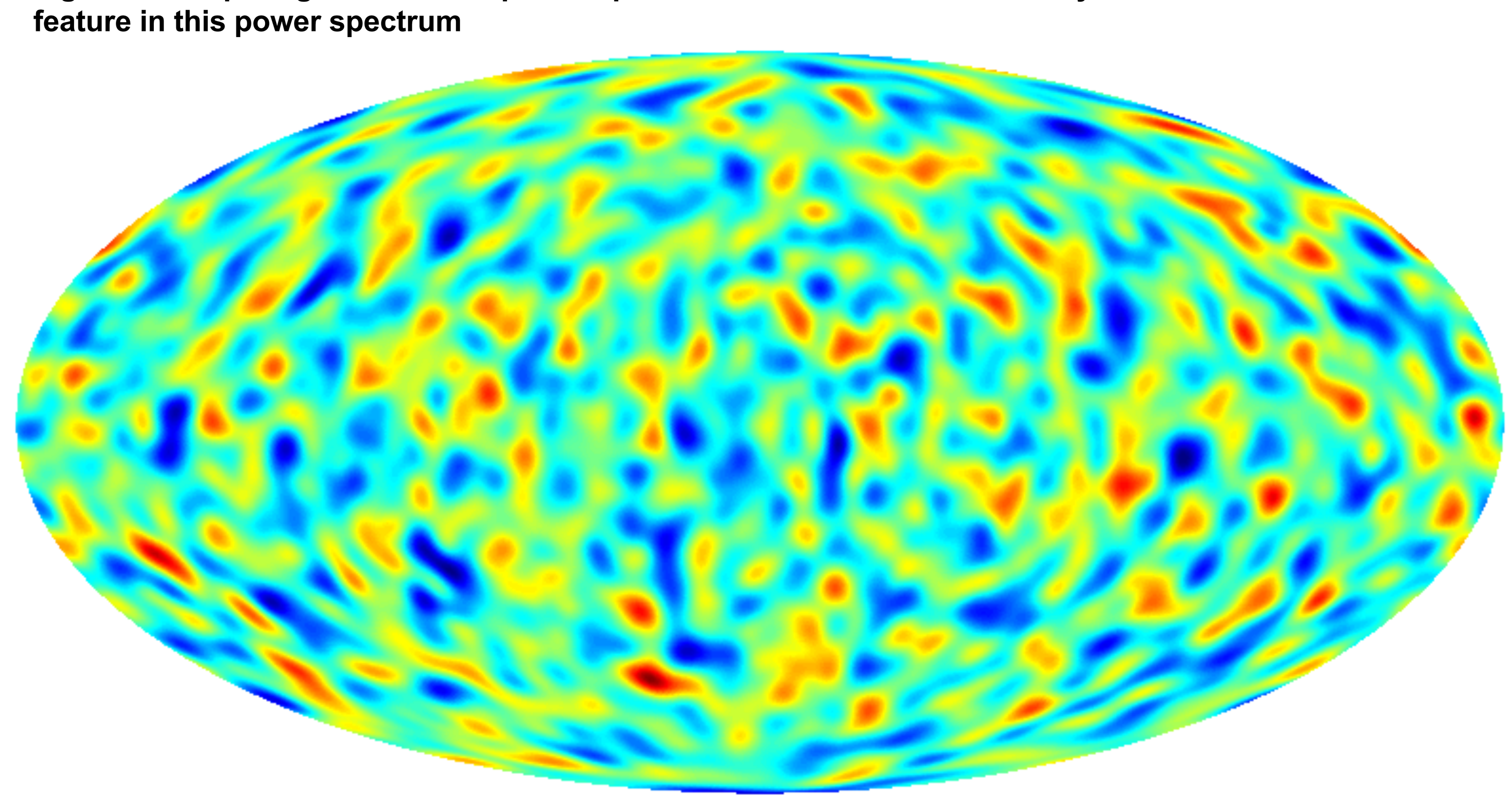

Figure5: Full sky map of CMB temperature anisotropies of this model produced by HEALPix code.

Type II models

In this new class of approaches, we consider gauge vector fields with a coupling to the scalar inflaton field. The inflaton trajectory takes a glitch on the background due to the interaction with gauge fields. As will be shown this glitch leads to generation of a feature in the power spectrum.

$$n_s - 1 \approx \frac{-4}{p_c} + \frac{4p}{3}\,\frac{\alpha\left(\frac{k}{k_p}\right)^{\frac{4(p-p_c)}{p_c}}}{1+\alpha\left(\frac{p^2 p_c}{6(p-p_c)}\right)\left(\frac{k}{k_p}\right)^{\frac{4(p-p_c)}{p_c}}} \qquad (4)$$

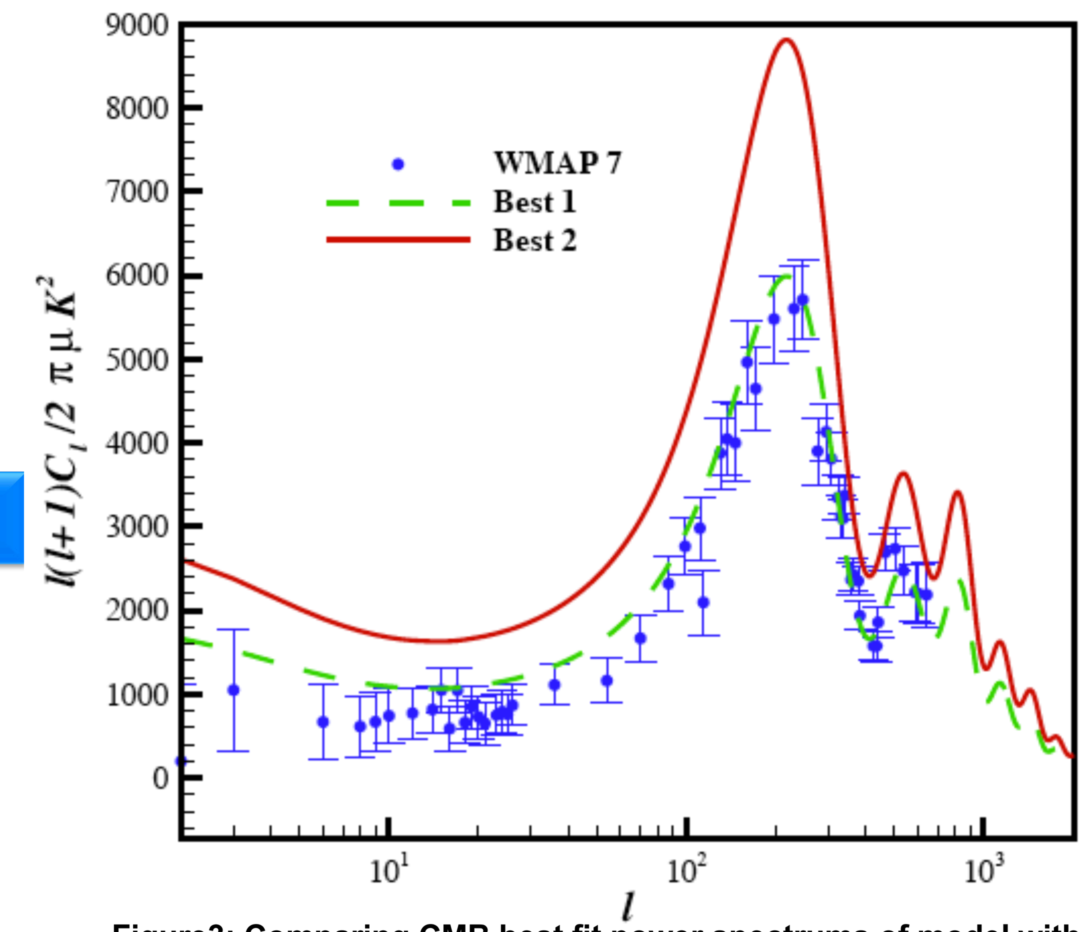

Figure3: Comparing CMB best fit power spectrums of model with WMAP 7 years data

Conclusion

In this work we were searching for some models which produce local feature seen in the WMAP data and power spectrum of CMB observations. We examined three type of inflationary models and we show that some models don't lead to such local feature in CMB power spectrum but some models like double inflation models could produce local feature in power spectrum.

Acknowledgements

In this wrok we used CAMB, CosmoMC and HEALPix public codes.

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