Slow Roll in String Inspired Inflationary Models

June 07 2014

Outline

- Review of Slow Roll Inflation
- String Inspired Models Analized

Slow Roll Inflation

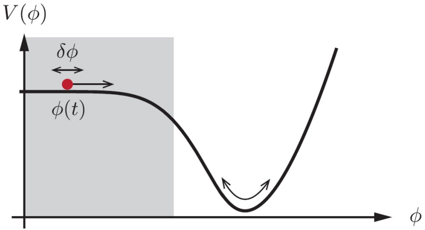
Inflation is an era when the rate of increase of the scale factor accelerates so that we have $\ddot{a} > 0$

$$\epsilon_V = \frac{{M_{Pl}}^2}{2}\left(\frac{\partial_\phi V}{V}\right)^2 \qquad (1)$$

$$\eta_V = {M_{Pl}}^2\left(\frac{\partial_{\phi\phi} V}{V}\right) \qquad (2)$$

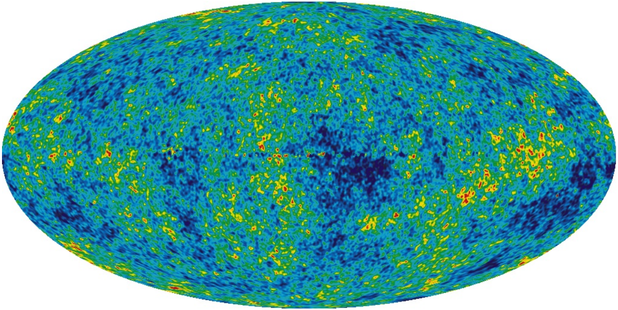
$$N_e = \int_{\phi_{end}}^{\phi} \frac{V}{\partial_\phi V} \qquad (3)$$

$\epsilon, \eta << 1$



Non Gaussianities

Figure: CMB from WMAP



Several Models have been proposed for the inflaton, some observational constraints have been imposed due to the results from different telescopes and experiments.

Power Spectrum

For the curvature perturbations we consider the following ζ is a measure of the spatial curvature, a pretty naive way to see ζ is as a gravitational potential pertubration.

$$\langle \zeta_{K_1} \zeta_{K_2} \rangle \equiv \delta^{(3)}(\mathbf{k_1} + \mathbf{k_2}) \frac{2\pi^2}{k^3} P_\zeta(k) \tag{4}$$

$$P_\zeta(k) = A_s (\frac{k}{k_*})^{n_s - 1 + \frac{1}{2} dn_s/dlnk ln(k/k_*) + \frac{1}{6} d^2 n_s/dlnk^2 (ln(k/k_*))^2 + \ldots} \tag{5}$$

$$\langle \zeta_{K_1} \zeta_{K_2} \zeta_{K_3} \rangle \equiv \delta^{(3)}(\mathbf{k_1} + \mathbf{k_2} + \mathbf{k_3}) \frac{6}{5} \frac{f_{NL}}{(2\pi)^{3/2}} (P_\zeta(k_1) P_\zeta(k_2) + \ldots) \tag{6}$$

Chaotic Inflation

$$V(\phi) = \lambda M_{pl}^4 (\frac{\phi}{\mu})^n \quad (7)$$

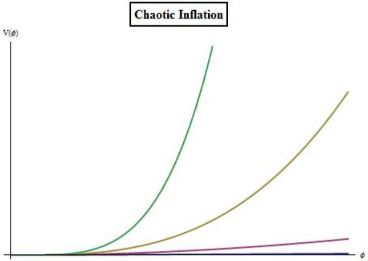


Figure: Natural Inflation for n=1,2,3,4

Simplifications

All the Analysis that will be presented is considering

- Single Field Inflation
- Slow Roll
- Consider The model is correctly Stabilized

The scalar potential can be computed from

$$V = e^{\frac{K}{{M_{Pl}}^2}}(K^{i\bar{j}} D_i W D_{\bar{j}} \overline{W} - 3\frac{|W|^2}{{M_{Pl}}^2}) \tag{8}$$

Whereas the Kinetic term is

$$-K_{i\bar{j}} \partial_\mu \phi^i \partial_\mu \phi^{\bar{j}} \tag{9}$$

Model I

This model is presented in "Kahler Moduli Inflation", Joseph Conlon and Fernando Quevedo

- Superpotential

$$W = W_0 + \sum_{i=2}^{n} A_i e^{-a_i T_i} \tag{10}$$

- Kahler Potential

$$K = -2ln[\alpha(T_1^{3/2}) - \sum_{i=2}^{n} \lambda_i \tau_i^{3/2}) + \zeta/2] \tag{11}$$

After Calculating the Scalar Potential for this Model we get

$$V = \frac{-3W_0^2}{2Vol^3}\left(\sum_{i=2}^{n-1}\left[\frac{\lambda_i \alpha}{a_i^{3/2}}\right](lnVol)^{3/2} - \frac{\zeta}{2}\right) + \frac{\gamma W_0^2}{Vol^2} \qquad (12)$$

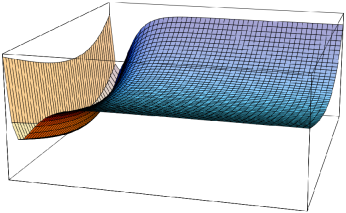


Figure: Connlon-Quevedo

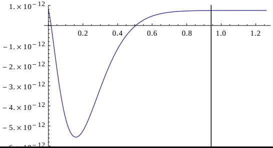
Inflaton

$$V_\phi = \frac{3\zeta W_0^2}{4Vol^3} - \frac{g_s W_0 a_n A_n}{2\pi Vol^2}\left(\frac{3Vol}{4\alpha\gamma_n}\right)^{2/3}(x)^{4/3} exp\left[-a_n\left(\frac{3Vol}{4\alpha\gamma_n}\right)^{2/3}(x)^{(4/3)}\right] \quad (13)$$

Table: Values for the Studied Case

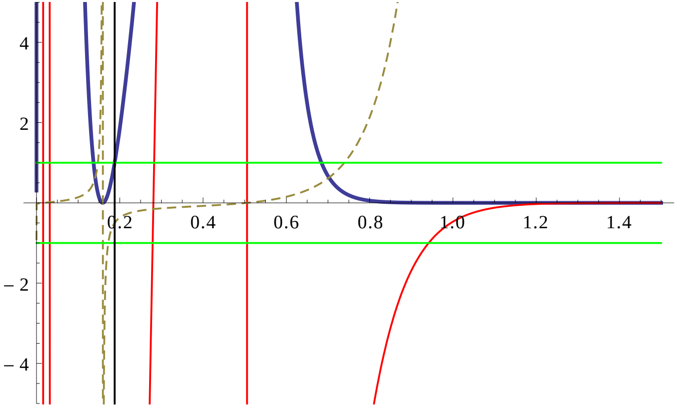
Vol	a	ζ	g	α	A	γ	W
10^3	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{100}$	6	$\frac{1}{10}$	$\frac{1}{10}$	$\frac{1}{10}$

Figure: Inflaton Potential



N_e

Figure: ϵ_V, η_V



The values are calculated for a range of N_e from 40 to 70

Non Gaussianities:

$$0.0342 < f_{NL} < 0.0575$$

Spectral Index :

$$0.884877 < n_s < 0.931434$$

Tensor to Scalar Ratio :

$$0.0000211564 < r < 0.000061409$$

Model II

This model is presented in "Moduli stabilization and SUSY breaking in heterotic orbifold string models", Ben Dundee, Stuart Raby and Alexander Westphal.

- Superpotential

$$W = e^{-bT}(\omega_0 + \chi(\phi_1^{10} + \lambda\phi_1\phi_2^2)) + A\phi_2^p e^{-aS-b_2T} \tag{14}$$

- Kahler Potential

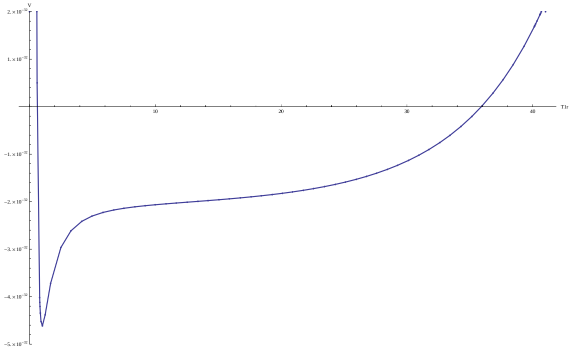
$$K = -log[S + \bar{S}] - 3log[T + \bar{T}] + \bar{\phi}_1\phi_1 + \bar{\phi}_2\phi_2 + \bar{\chi}\chi \tag{15}$$

They propose 4 different cases by changing some parameters that they leave free in their models, I will be considering

Table: Values for the Studied Case

b	b_2	λ	R	p	r	A	ω_0
$-\frac{\pi}{120}$	$\frac{-\pi}{40}$	40	64	$\frac{2}{3}$	1	$\frac{1}{10}$	-5×10^{-15}

If we consider that after all the moduli except for 1 Kahler moduli are stabilized and get to VEV we would obatain a potential of the form.



N_e

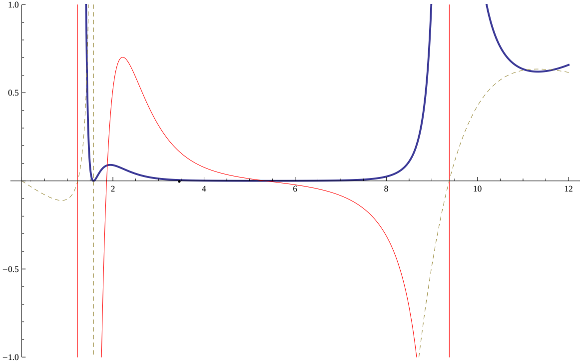


Figure: ϵ_V η_V

Results

For this model the number of efolds considered are from 40 to 60

Non Gaussianities :

$0.0061821 < f_{NL} < 0.0543427$

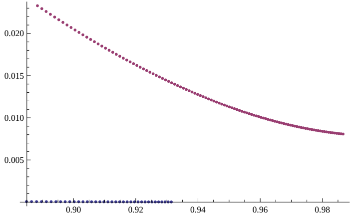
Spectral Index :

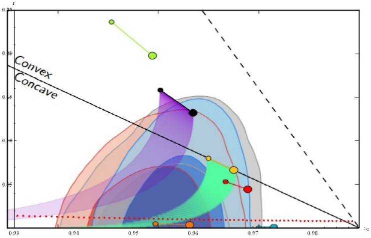
$0.00807573 < r < 0.0232883$

Tensor to Scalar Ratio :

$0.88404 < ns < 0.986626$

Results





Thank You