Inflationary Cosmology in RS-I

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In this work, I intend to show a possible candidate of inflaton potential $V(\phi)$ in a scenario of a brane world defined by a pair of branes (RS-I).

The *Inflationary Cosmology* describes a phase in which our Universe evolves through accelerated expansion in a short time period at high energy scales. During this phase, our Universe is dominated by a potential $V(\phi)$ generated by a homogeneous scalar field $\phi(t)$ called *inflaton*. This potential must obey *slow-roll conditions* $\{\varepsilon, |\eta| \ll 1\}$ where ε and η are the *slow-roll parameters*. These parameters are given by [1]

$$\varepsilon(\phi) = \frac{M_{PL}^2}{2}\left(\frac{V'}{V}\right)^2 \tag{1}$$

and

$$\eta(\phi) = M_{PL}^2 \frac{V''}{V}\,. \tag{2}$$

We can calculate the spectral index $n(\phi)$ and its derivate for this potential $V(\phi)$

$$n - 1 = -6\varepsilon + 2\eta \tag{3}$$

and

$$\frac{dn}{dlnk} = -16\varepsilon\eta + 24\varepsilon^2 + 2\zeta \tag{4}$$

where

$$\zeta = M_{PL}^4 \frac{V'V'''}{V^2}\,. \tag{5}$$

The amount of inflation that occurs is described by the *number of e-foldings N*, is given by

$$N \equiv ln\frac{a(t_{end})}{a(t)} \equiv \int_t^{t_{end}} Hdt \approx \frac{1}{M_{PL}^2}\int_{\phi_{end}}^{\phi} \frac{V}{V'}d\phi, \tag{6}$$

where ϕ_{end} is defined by $\varepsilon(\phi_{end}) = 1$ if inflation ends through violation of the slow-roll conditions.

The *Brane Cosmology* describes cosmological models with extra dimensions. A lot of interest in brane cosmology arose with a publication of two papers by *Randall* and *Sundrum* in the 90s. They propose a new higher-dimensional mechanism for solving the hierarchy problem building two models, *RS-I* [2] and *RS-II* [3]. In these two models, they consider that the Standard Model particles and forces, with exception of gravity are confined to a *four-dimensional subspace*, within the *five-dimensional spacetime (bulk)*, referred to as *3-brane*. Many researches have been done around this new cosmology as e.g. [9]. We choose the *inflation in branes* [4], [6], [7], [8].

In this study, we consider that inflation might arise from the interaction potential between a 3-brane and anti-3-brane which are parallel and widely separated in five-dimensional Anti de Sitter space (AdS_5). The background is identical to that considered in the RS-I model [2].

The potential between the branes is given by [4]

$$V(\phi) \sim M_{5D}^4 \xi(\phi/M_{5D})(1 - e^{(-|\phi|/m)}). \tag{7}$$

The figures 1 and 2 show us the behaviours of the potential $V(\phi)$ and of the slow-roll parameters as a function of ϕ.

The spectral index n and its derivate $dn/dlnk$ can be related to N, respectively, as

$$\frac{1}{2}(n-1) = -\frac{1}{N}, \tag{8}$$

and

$$\frac{1}{2}\frac{dn}{dlnk} = -\frac{1}{N^2}. \tag{9}$$

Setting $N = 70$ (as usually done in inflationary scenarios) leads to

$$n \approx 0,9714 \tag{10}$$

and

$$\frac{dn}{dlnk} \approx -0,0004, \tag{11}$$

in excellent agreement with observational data from WMAP ($0.94 \leq n \leq 1.00$ and $-0.02 \leq dn/dlnk \leq 0.02$, [5])

Acknowledgement

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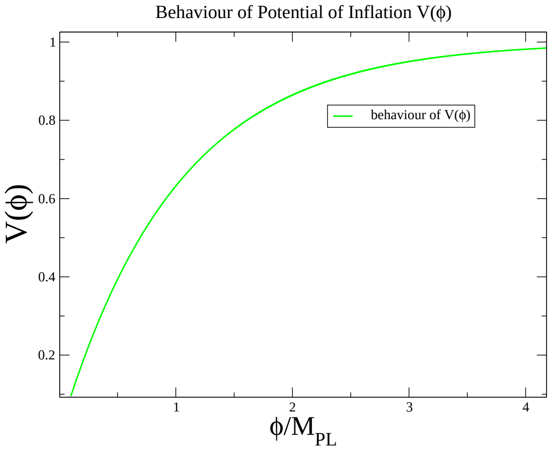

FIG. 1: Behaviour of the potential $V(\phi)$ as a function ϕ.

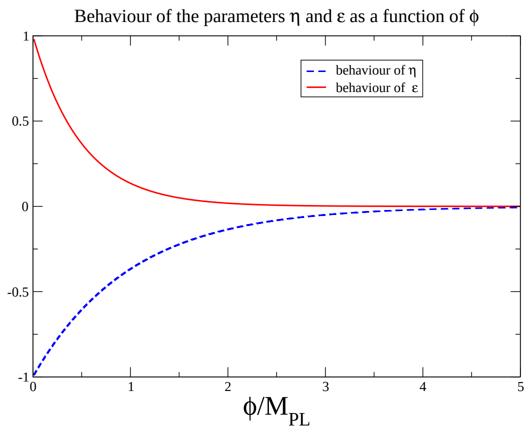

FIG. 2: Behaviour of the slow-roll parameters ε and η as a function of ϕ.

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