Title: Wilson Line Inflation

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Abstract: I will present a model of inflation in string theory, where the inflaton field corresponds to a Wilson line in the worldvolume of a D-brane, and in the presence of magnetic flux. Inflation ends in a hybrid fashion, when the Wilson line achieves a critical value and an open string mode becomes tachyonic. This scenario predicts a nearly flat, or red tilted, spectrum of scalar perturbations, with negligible primordial gravitational waves. Interestingly, there is a simple compactification in which the eta-problem, appearing in models of brane inflation, is absent.

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- Horizon, Flatness, Monopole problems,…

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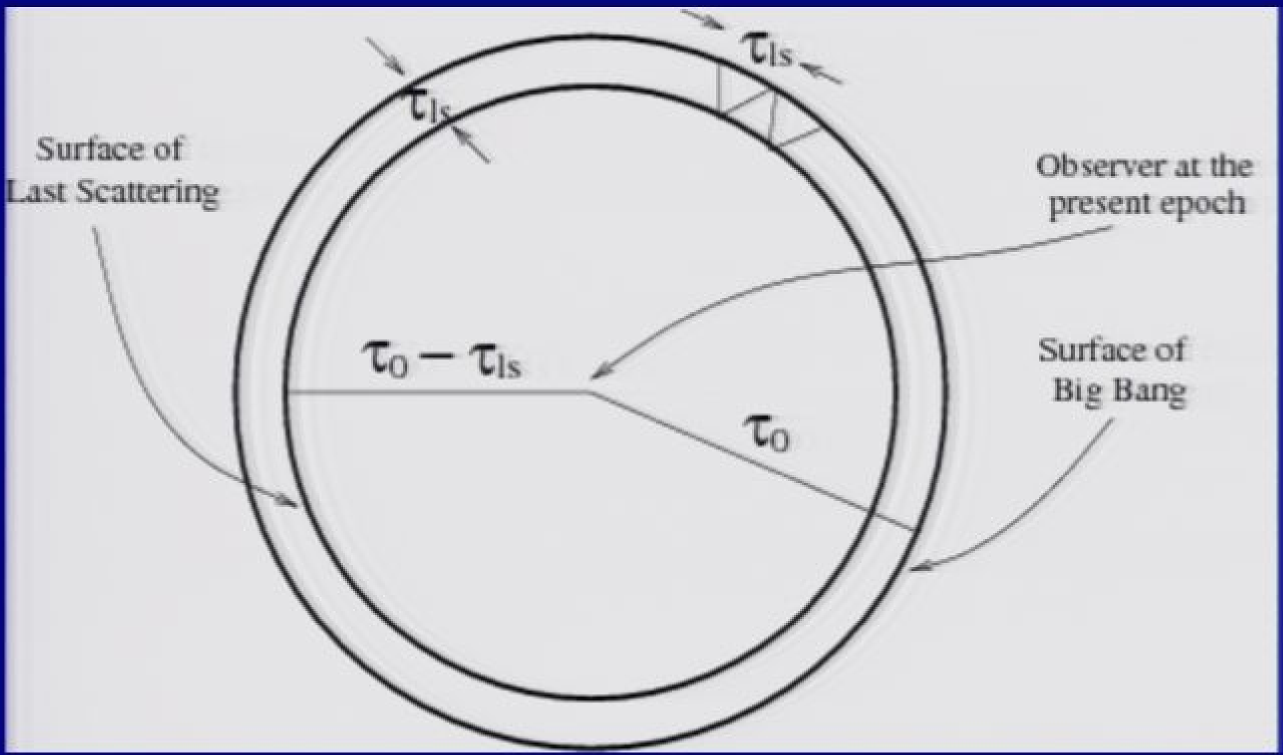

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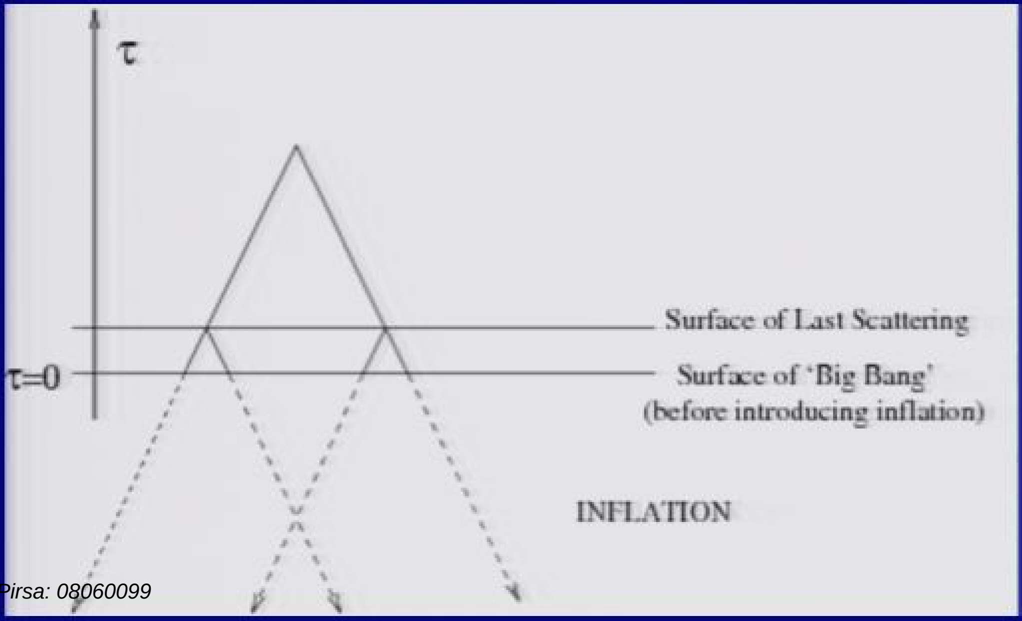
- Exponential expansion with H~const

Comoving horizon shrinks

Expansion dilutes curvature and monopoles



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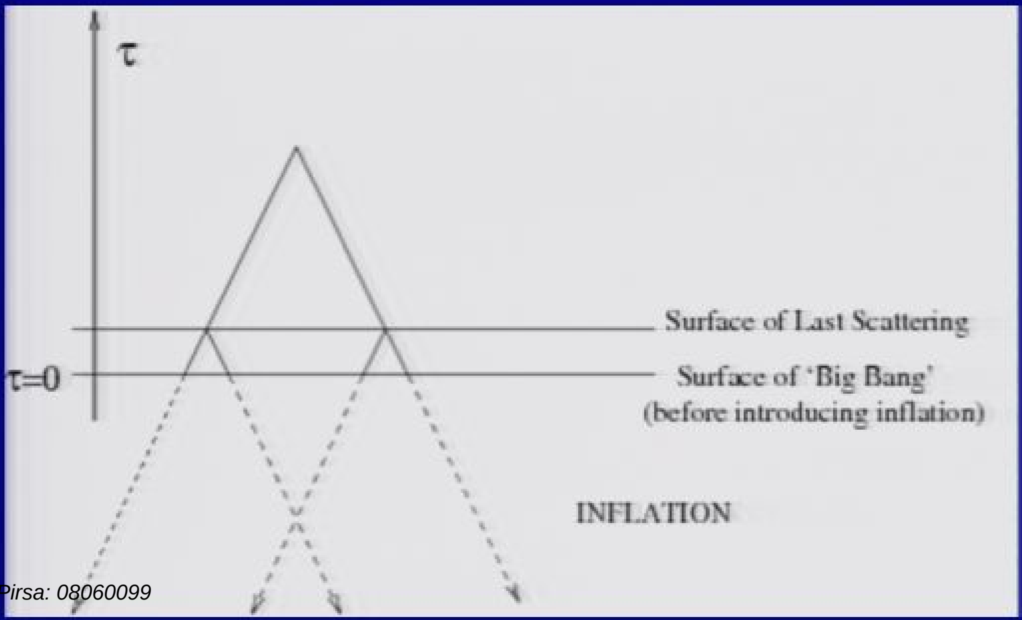

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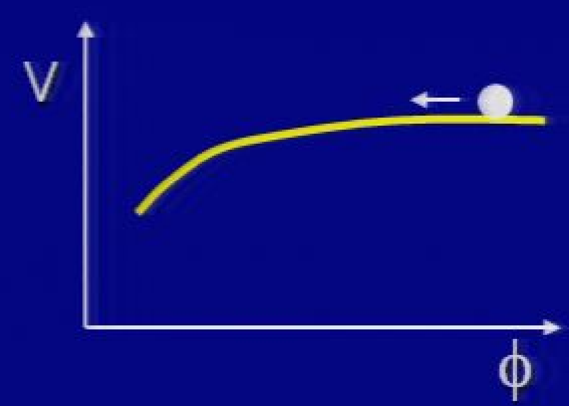

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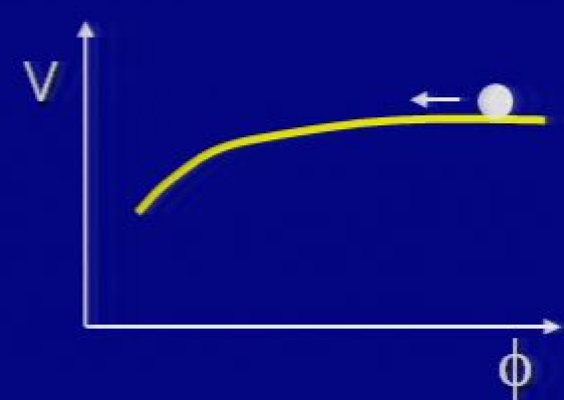

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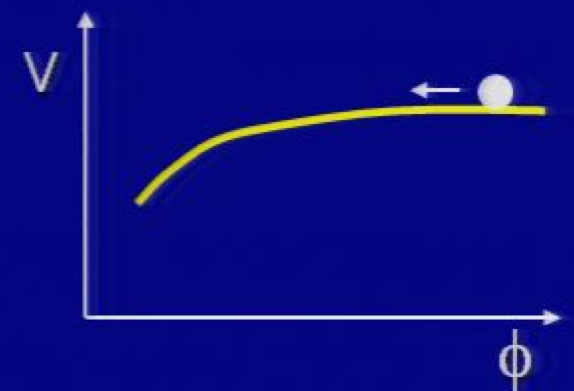

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- Where does V(ϕ) come from?

Stringy Inflation

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- Inflaton candidates
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- All other moduli fields must be fixed, so that they do not interfere with inflationary dynamics & perturbations

The (η) problem

- Potential is of the form: $V = V_0 + V_{\text{int}}(\varphi)$

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- Fine tuning!

(KKLMMT 03, BDKMS 07)

Models

- Kahler Moduli

  Racetrack (B-PBCEG-RKLQ 2004, 2006)

  Kahler moduli Inflation (Conlon & Quevedo 2005)

- Brane separations

  Brane Inflation (Dvali & Tye 1999)

  Brane-Antibrane (BMNQRZ 2001, DSS 2001, BMQRZ 2001)

  Branes @ angles (G-BRZ 2001, JST 2002, G-RZ 2002)

  D3-D7 (Hsu, Kallosh & Prokushkin 2003)

  DBI (Silverstein & Tong 2003, AST 2004)

- String Tachyon

  Warped tachyonic Inflation (Cremades, Quevedo & Sinha, 2005)

Complex Structure?

Volume?

Wilson Lines?

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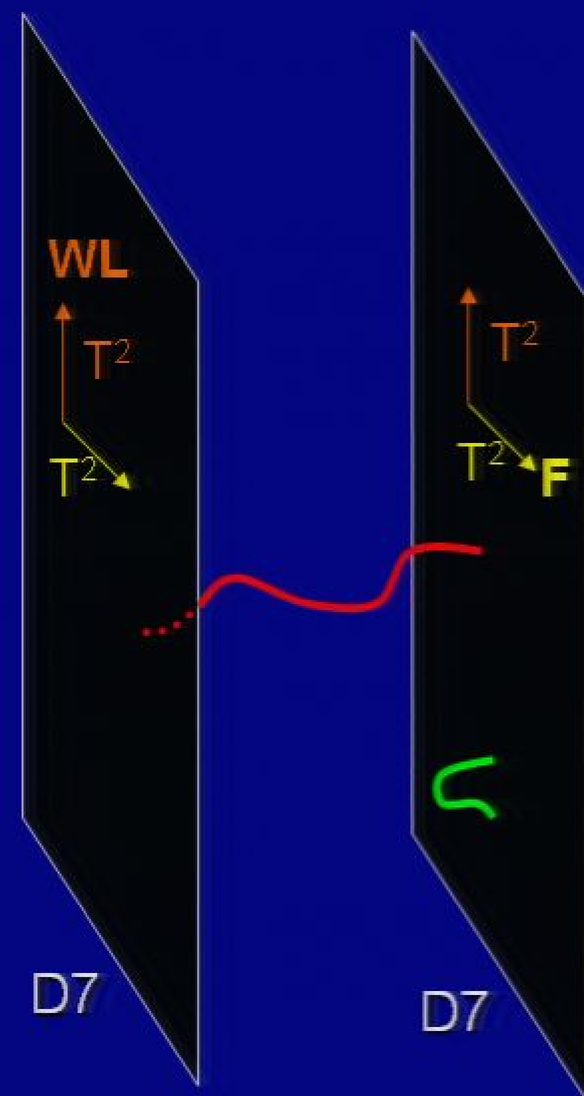
$$F=\frac{m}{2\pi R_3 R_4}dx^3\wedge dx^4$$



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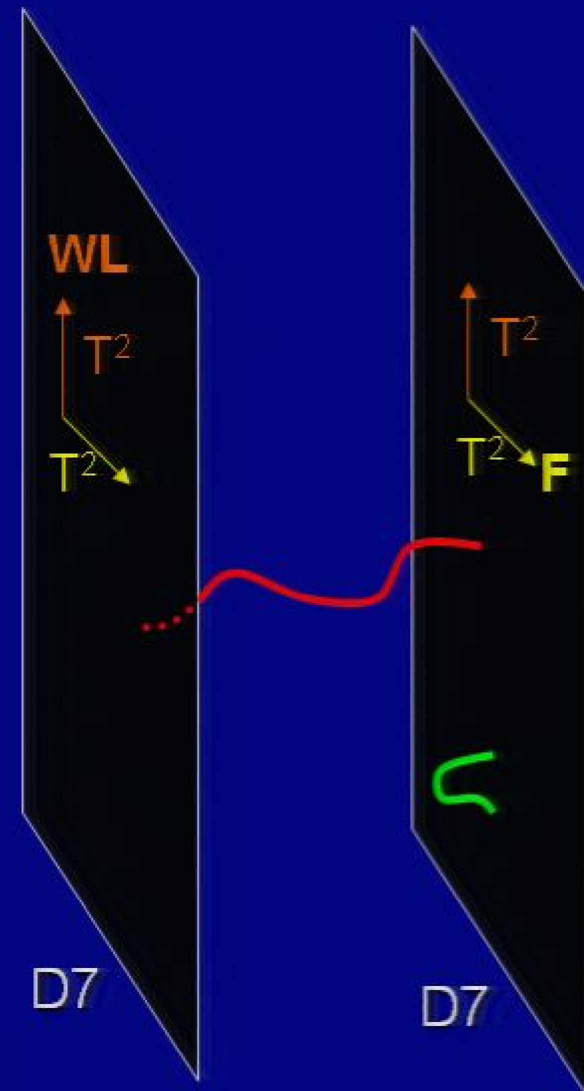
- Open Strings: BCs, mode expansion, Virasoro operators, **MASS**



Wilson Line Inflation: Potential

- BCs lead to twisted mode expansions (cf Branes @ angles)

$$\partial_\sigma x^3 = \partial_\tau x^4 = 0, \quad \sigma = 0$$

$$\begin{cases} \partial_\sigma x^3 + 2\pi\alpha' F_{34} \partial_\tau x^4 = 0 \\ 2\pi\alpha' F_{34} \partial_\tau x^3 - \partial_\sigma x^4 = 0, \quad \sigma = \pi \end{cases}$$

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- Interaction Energy given by Coleman-Weinberg formula:

$$V_{\rm int} = 2\int \frac{d^4k}{(2\pi)^4} \int_0^\infty \frac{dt}{t} Tr \exp[-2\pi\alpha' t(k^2 + M^2)]$$

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- Leads to:

$$V_{\mathrm{int}}(\lambda, y) = -\frac{\sin^2(\theta/2)\tan(\theta/2)}{8\pi^3 \alpha'^2 \|Y,\Lambda\|^2}$$

where $$\|Y,\Lambda\|^2 = \sum_{i=1}^{2} \frac{y_i^2 \tilde{R}_i^2}{\alpha'} + \frac{\lambda^2 \alpha'}{R_1^2} \equiv Y^2 + \Lambda^2$$

Wilson Line Inflation: Results

- Total potential: $$V = V_0 + V_{int}(\lambda) = \frac{Vol(T^4)}{8\pi^3\alpha'^4 g_s}\frac{\tan^2(\theta)}{4} - \frac{\sin^2(\theta/2)\tan(\theta/2)}{8\pi^3\alpha'^2(Y^2+\Lambda^2)}$$

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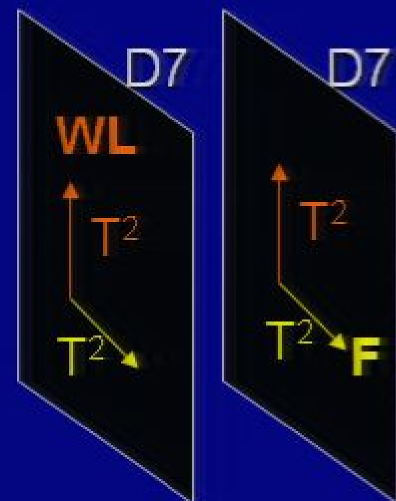
- Fine tuning: 1/1000

Quick Recap

- Work in IIB compactified on T^6
- Consider two parallel D7 branes, wrapping a T^4, at a fixed distance apart in the remaining T^2



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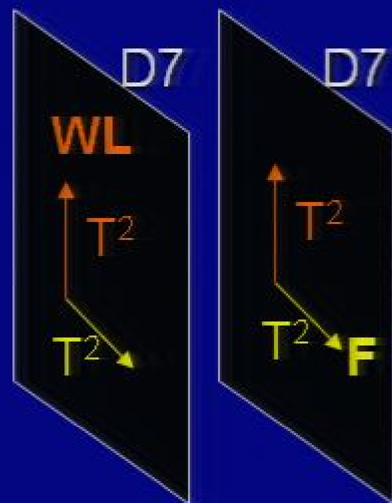

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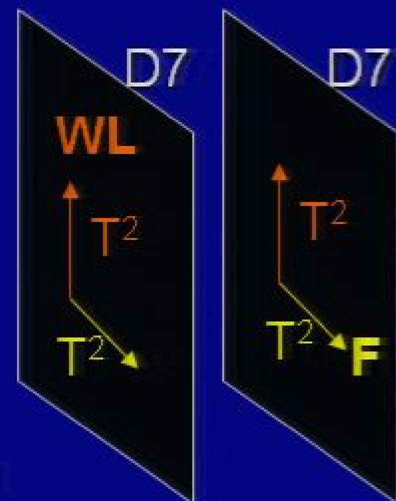

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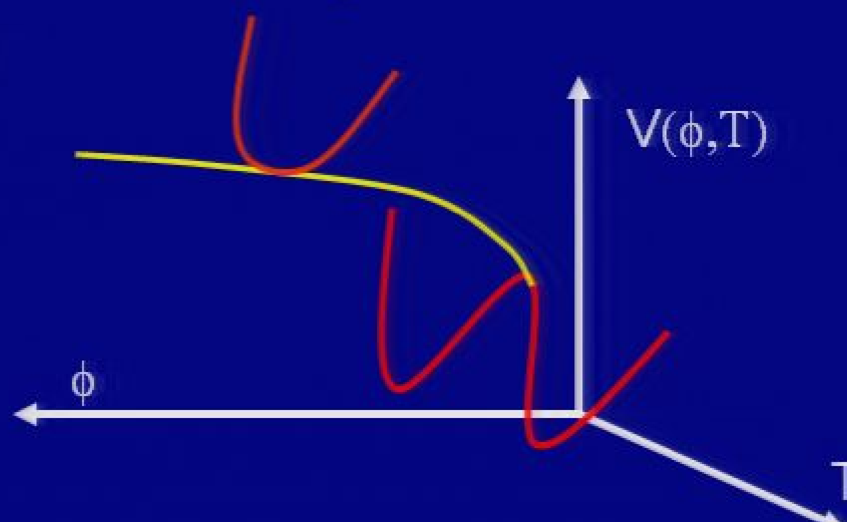
- Generate slow roll phase, ending in a tachyonic instability



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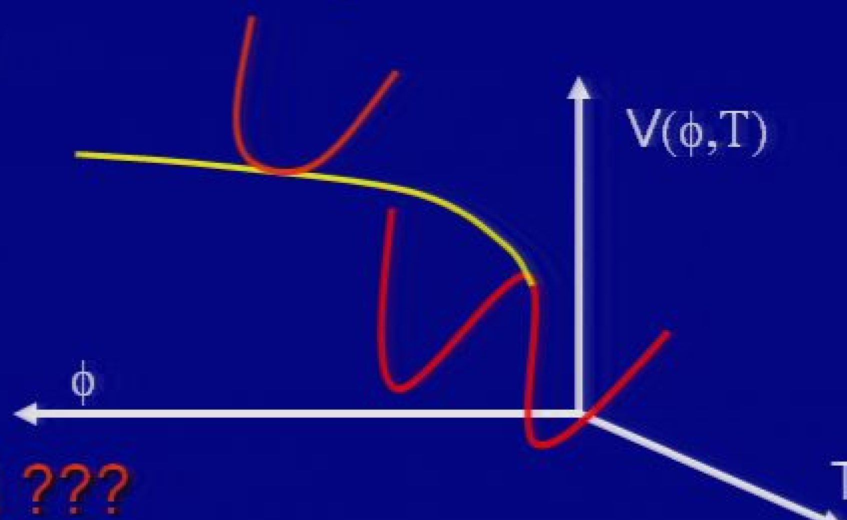

Fixing Distance, Moduli ???

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- Compute V_0 in the 4D Einstein frame:

$$V_0 = \frac{(2\pi)^{-3}m^2\alpha'^{-2}g_s^3}{4A_1^2A_2^3A_3}$$

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$$A_1 = \sqrt{\frac{2e^{\varphi}\,\mathrm{Re}\;T_3}{\mathrm{Re}\;T_1}\left(\mathrm{Re}\;T_2 - \frac{1}{2}|\phi|^2\right)}$$

$$A_2 = \sqrt{\frac{2e^{\varphi}\,\mathrm{Re}\;T_1\,\mathrm{Re}\;T_3}{\mathrm{Re}\;T_2 - \frac{1}{2}|\phi|^2}}$$

$$A_3 = \sqrt{\frac{2e^{\varphi}\,\mathrm{Re}\;T_1}{\mathrm{Re}\;T_3}\left(\mathrm{Re}\;T_2 - \frac{1}{2}|\phi|^2\right)}$$

- Compute V_0 in the 4D Einstein frame:

$$V_0 = \frac{(2\pi)^{-3} m^2 \alpha'^{-2} g_s^3}{4A_1^2 A_2^3 A_3}$$

SUGRA η problem

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- Independent of ϕ !!!

Summary & Future Work

- Model of inflation using WLs as inflatons
- Similar to Branes @ angles (T duality)
- Provides more tuning parameters
- Predictions: small ε (no gravitational waves)
  HZ or slightly red scalar spectrum
  Cosmic strings with $G\mu<10^{-7}$
- Example w/o η problem!
- Warped Compactification? Non-canonical kinetic terms? (with I. Zavala)
- Heterotic?