Back to the origins of brane-antibrane inflation

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Baumann-McAllister'14

Inflation and the UV

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Baumann-McAllister'14

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- Inflation requires understanding of the UV!

Goals

- A consistent description of brane-antibrane inflation.

Dvali, Tye'99
Burgess, Majumdar, Nolte, Quevedo, Rajesh, Zhang'01
Dvali, Shafi, Solganik'01
Kachru, Kallosh, Linde, Maldacena, McAllister, Trivedi'03

Goals

- A consistent description of brane-antibrane inflation.
- Issues tackled in the paper:
  - Eta problem
  - EFT consistency
  - Experimental data
  - Late-time vacuum
- Today: eta problem

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KKLMMT: Kachru, Kallosh, Linde, Maldacena, McAllister, Trivedi'03

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- When the antibrane sits in a *warped throat*:

$$C_0 \sim D_0 \sim \frac{e^{-8\pi K/g_s M}}{\mathcal{V}^{4/3}} \qquad K, M \in \mathbb{Z}$$

Naturally flat with O(1) inputs!

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Kofman, Yi'05
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- Cons
  - Antibrane breaks SUSY.
  - Need to stabilize the WISP by excellence in string compactifications: the volume modulus.
  - Eta problem.

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WISPS in inflation: the volume

- Life is difficult because generically there is at least one further scalar: the volume modulus.
- Its potential is generically steep.
- So inflation can never occur far from a minimum of the potential in the volume direction.
- Need to find this minimum *(moduli stabilization)*.

Kachru, Kallosh, Linde, Trivedi'03
Balasubramanian, Berglund, Conlon, Quevedo'05

The eta problem

- The volume receives a correction due to brane backreaction:

$$\mathcal{V}^{2/3} = \rho - \bar{\varphi}\varphi$$

- In the original proposal only ρ is stabilized.

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- Which is a large mass term for the inflaton (eta problem)
- Solution: use corrections* that stabilize the whole quantity $\mathcal{V}$.

*For aficionados: perturbative corrections to the Kahler potential

Nonlinearly realized SUSY

- The antibrane breaks SUSY but its effects can be accommodated into an effective SUSY description.

Komargodski, Seiberg'09
Kallosh, Quevedo, Uranga'15

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- A description in terms of SUSY variables allows for a systematic classification of possible corrections.

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Nonlinearly realized SUSY

- The antibrane breaks SUSY but its effects can be accommodated into an effective SUSY description.
- A description in terms of SUSY variables allows for a systematic classification of possible corrections.
- We discover a new perfect square structure in the scalar potential which stabilises the volume.

Komargodski, Seiberg'09
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  - A (for current purposes) tunable constant W_0
  - A function of φ, but not $\mathcal{V}$ which contains the Coulomb potential W_X

Scalar potential and stabilization

- The most general scalar perturbative potential in the framework of nonlinearly realized SUSY reads*:

$$V = \frac{1}{U}\left[\left(f' W_X - 3g' W_0\right)^2 - f''\left(f W_X^2 - 6g W_X W_0 - 9h W_0^2\right)\right]$$

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- With U a function of f,g,h.
- Tree level reproduces standard uplift.
- Wx=g=0 reproduce standard breaking of no-scale structure (f″ is BBHL)

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Controlled SUGRA for small Wx!!

Brane-antibrane inflation reloaded!

- If $g' >> f''$ (typically BBHL), then the volume is integrated leaving a Coulomb potential*.
- Brane-antibrane inflation *can now occur*.

*In the paper we also propose a stabilization mechanism in the opposite case

Brane-antibrane inflation reloaded!

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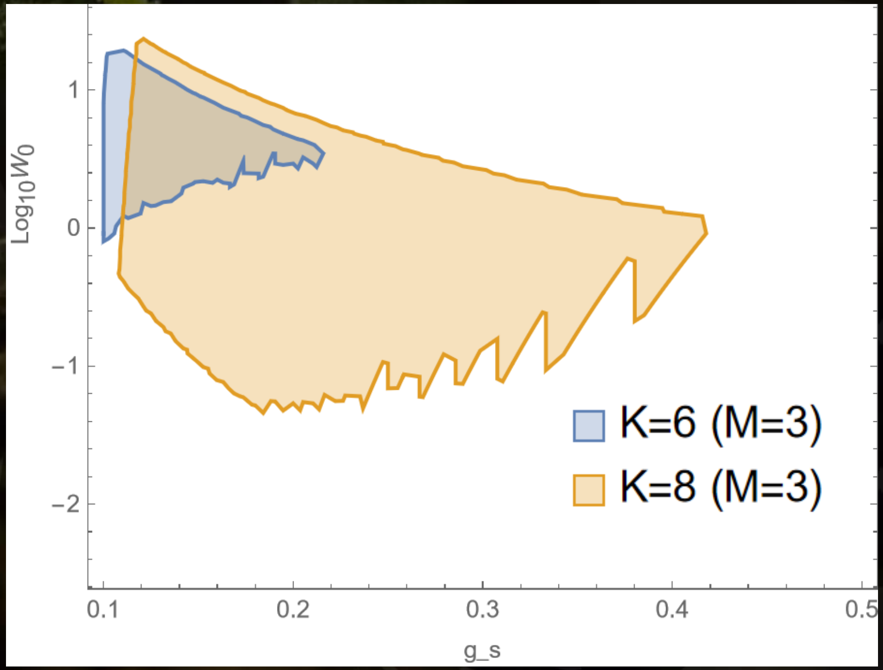
- Brane-antibrane inflation *can now occur*.
- After EFT and experimental constraints,

  for g~log[V]:



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Conclusions and future directions

- Perturbative corrections to the Kahler potential allow for brane-antibrane inflation.
- Nonlinearly realized SUSY uncovers a perfect-square structure in the scalar potential.
- In this talk, g plays a prominent role. It is a kinetic mixing goldstino-volume. EFT arguments suggest it's there, the question is at what power in 1/V.
- We find a parameter space of microscopic data where brane-antibrane inflation can take place.

Backup: Kahler and superpotential

- Most general* Kahler and superpotentials with constrained superfields X^2=0:

$$K = -3\log[f(\mathcal{V}^{2/3}) + g(\mathcal{V}^{2/3})(X+\bar{X}) + h(\mathcal{V}^{2/3})X\bar{X}]$$

$$W = W_0 + XW_X$$

*Contributions outside of the log can always be absorbed up to a higher order correction