

# Positive cosmological constant in string theory and supergravity

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<http://itf.fys.kuleuven.be/~koerber/talks.html>

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- String theory lives in ten dimensions:
  - Compactification: 10D  $\rightarrow$  4D (space-time)  $\times$  6D  
(small=compactification scale) **old Kaluza-Klein idea**
  - The notorious problem of **stabilizing the moduli**  
moduli: scalar fields describing shape/size/potentials 6D internal manifold
  - Effective theory: 4D gauged supergravity

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  - Model of the late-time universe
  - Starting point for models of inflation  
inflaton: one of the moduli fields

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for instance, models of inflation: KKLMMT  
(*Kachru, Kallosh, Linde, Maldacena, McAllister, Trivedi*)
- However:
  - Lost control 10D solution in step 2 and 3
  - Stabilizing moduli required classical and quantum effects  
Can we trust our knowledge non-perturbative corrections?

# Goal of our work

Completely explicit and simple dS solution

- Classical in  $\alpha', g_s \rightarrow$  solution of supergravity eoms
- Clear 10d interpretation: compact 6D manifold
- Limit ingredients to what is well-understood

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Or more exotic ingredients: NS5-branes, KK-monopoles (e.g. *Silverstein*) or non-geometric fluxes (e.g. *de Carlos et al.*)
  - *Flauger, Paban, Robbins, Wrase*: rules out specific models with geometric fluxes; *Caviezel, PK, Körs, Lüst, Tsimpis, Zagermann*: rules out some coset models, retains **SU(2)×SU(2)**

# Our playground: coset manifolds

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- Simple class of examples: group manifold  $G$  and coset manifolds  $G/H$ 
  - Differential equations reduce to algebraic equations
  - Know susy  $\text{AdS}_4$  solutions  
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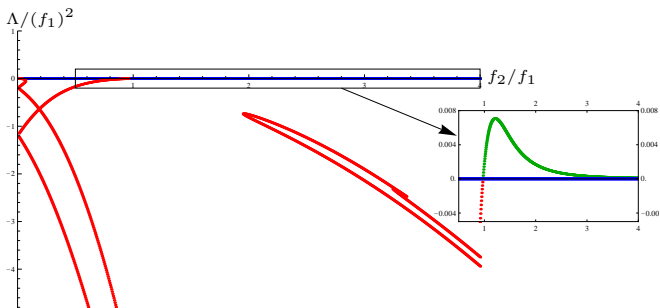
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  - Differential equations reduce to algebraic equations
  - Know susy  $\text{AdS}_4$  solutions
    - $\text{AdS}_4$ : maximally symmetric Lorentzian manifold with constant negative curvature, admits susy
- Strategy: keep some ingredients of the susy AdS solutions
  - O-planes do not break susy (it is broken by the fluxes)
  - Use so-called  $\text{SU}(3)$ -structure (related to susy) on these manifolds

# Solution on $SU(2) \times SU(2)$

On  $SU(2) \times SU(2)$  we found dS solutions

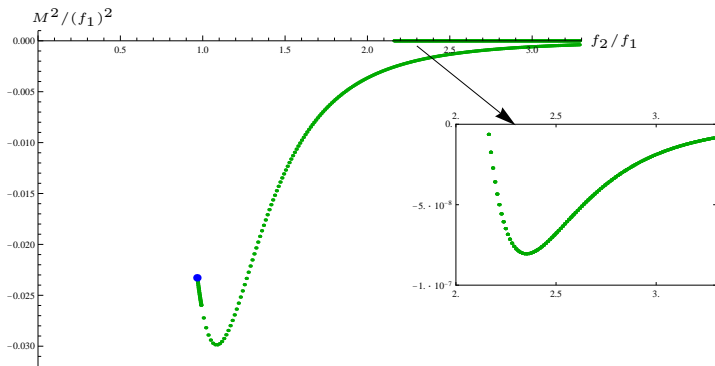
Three parameters: overall scale,  $g_s$ , one shape parameter

Take e.g.  $f_2/f_1$



# Drawbacks

- Model has tachyonic mode



- Investigation of flux quantization = to be done

Scan for other examples = work in progress



# Conclusions

- Constructing solutions with positive cosmological constant, or models of inflation in string theory is very difficult
- KKLT works because it stays very close to susy, but construction is not completely explicit
- Good to have an alternative to models like KKLT
- Solution we proposed: completely classical and explicit, but has problem with stability (tachyon)
- Proof of concept, but still much work to be done

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The end... The end... The end...