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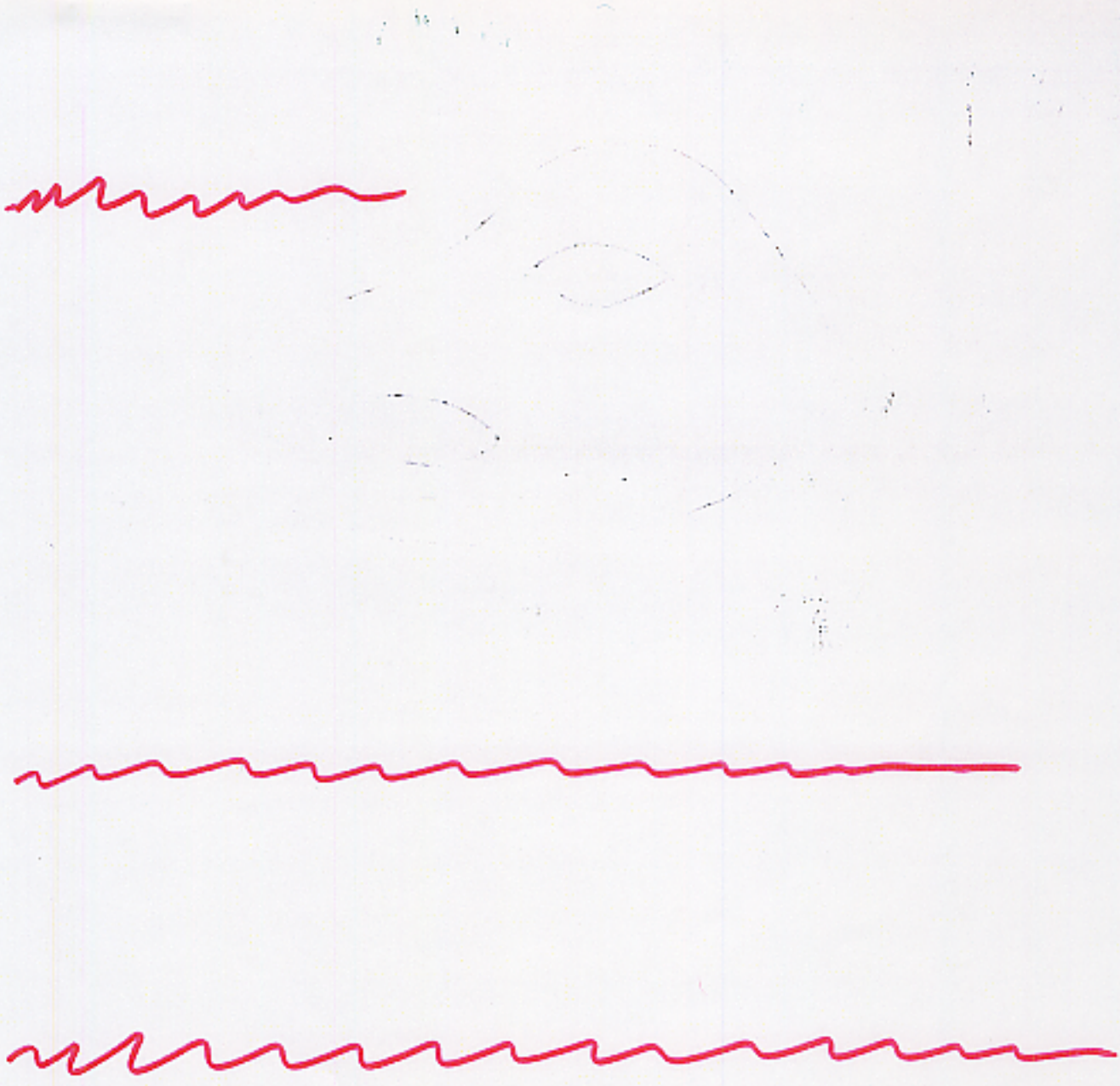
Does string theory have vacua "like ours"?

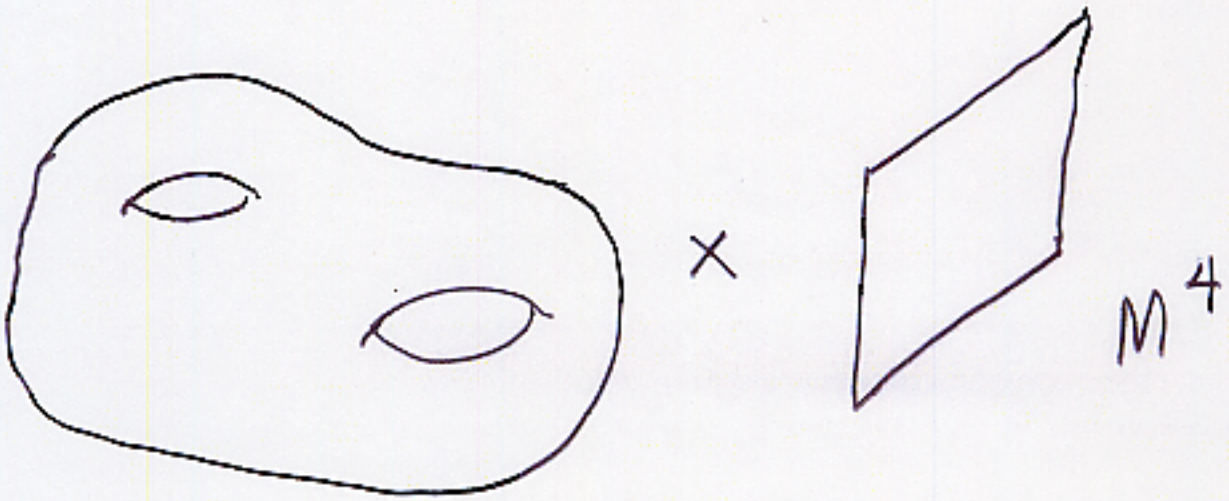
- Zero cosmological constant
- Stable (or long-lived)
- No Brans-Dicke-like scalars ($\sim V'' > 0$).
- Nonsupersymmetric particle spectrum.

?

Small positive c.c., or dark energy



yes



$R_{\mu\nu} = 0$ solves vacuum Einstein

$\supset$ $N=1$ SUSY, solves classical string

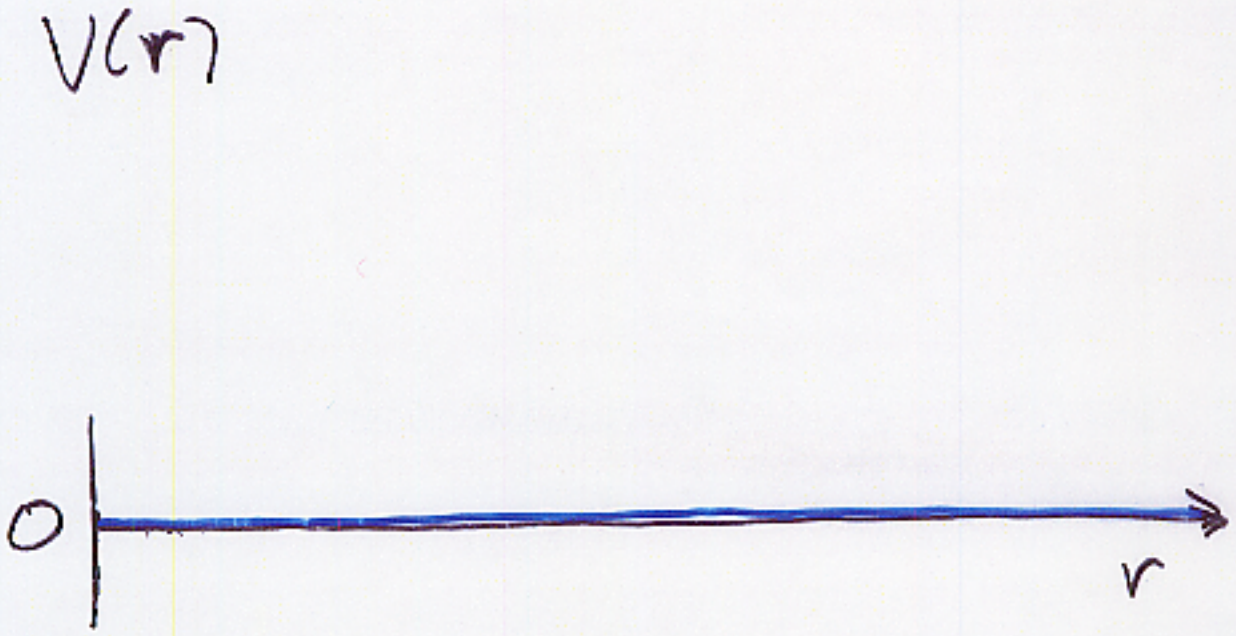
$\supset$ $N=2$ SUSY, solves exact string

(e.g. type II on Calabi-Yau)

$\exists$ moduli:

* overall size r
  shape moduli
  dilaton ϕ

$\phi \to \infty$, $r \to 0$


V(r)
0
r

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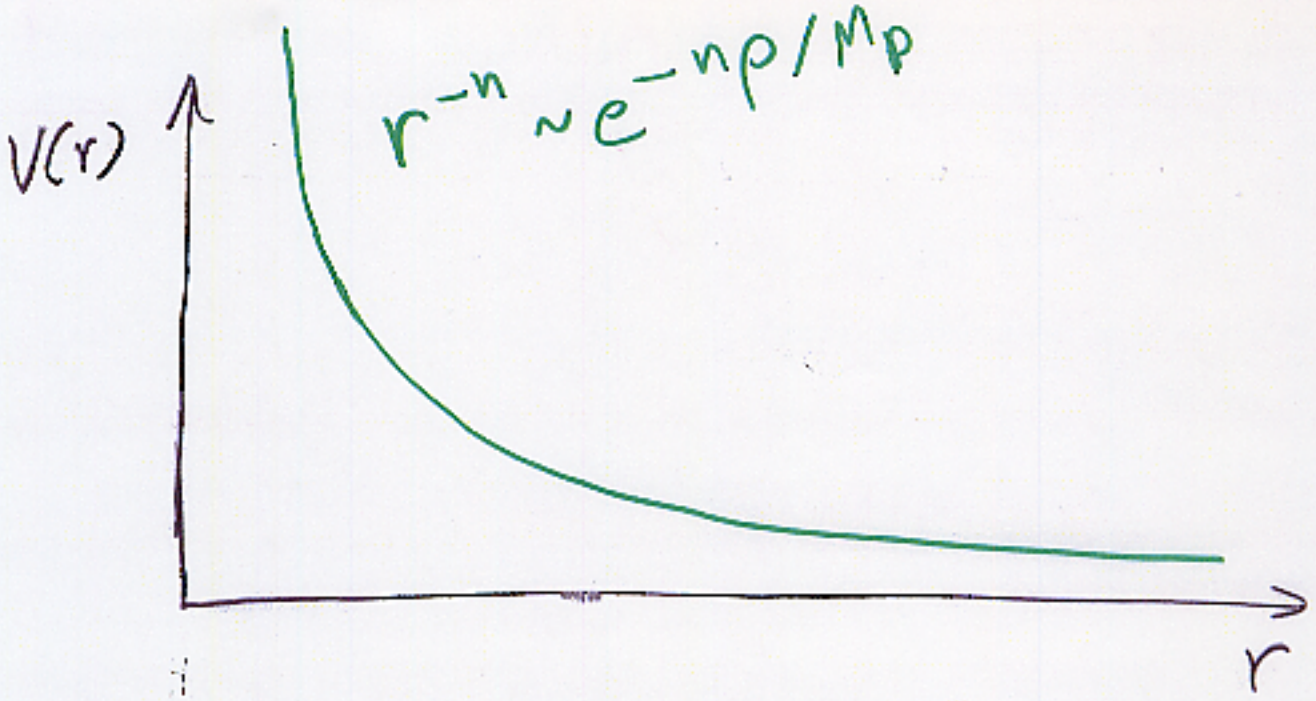
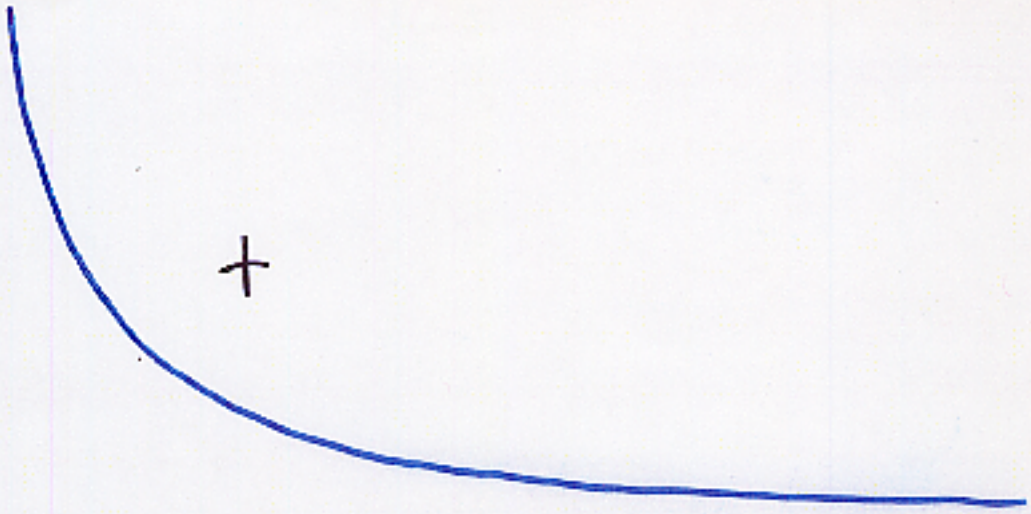


quintessence? no.

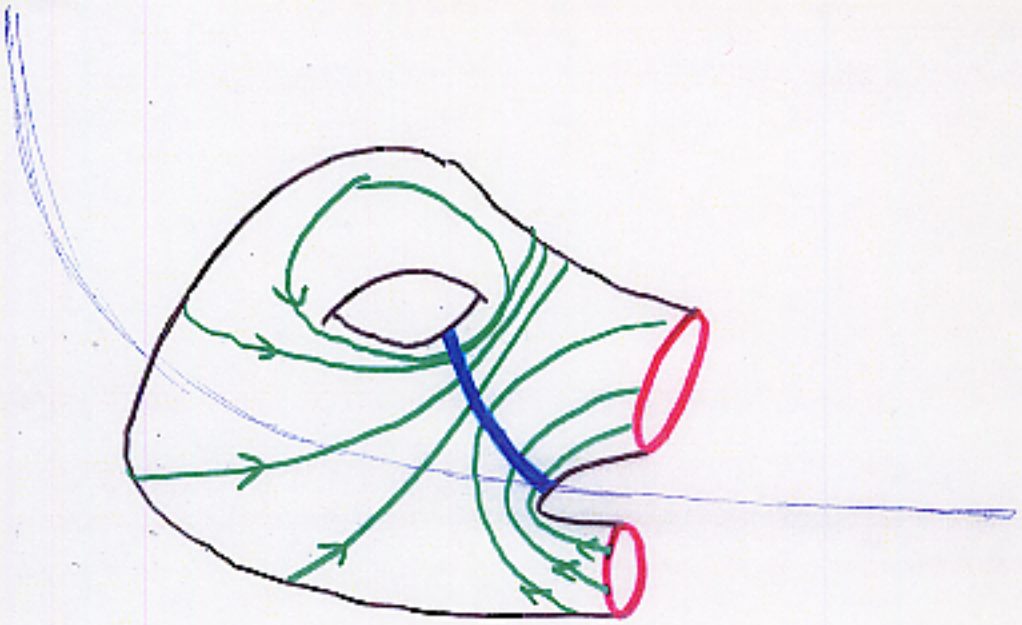
—— wrapped brane (e.g. D4)



$$G_4 = r^{-6} G_{10}$$

$$G_4^2 V \sim r^{p-3} \times r^{-12}$$

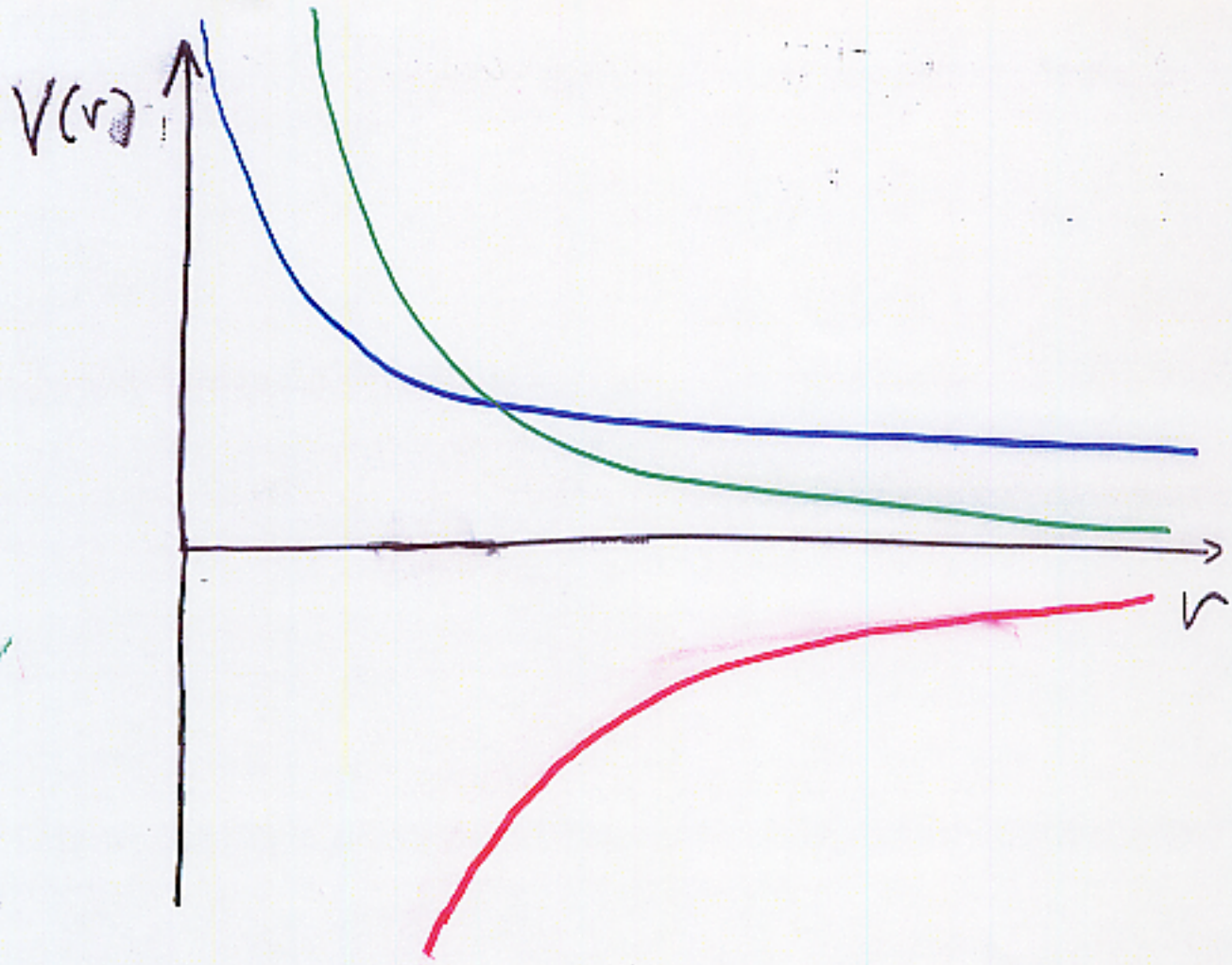
$$9 \geq p \geq 3$$



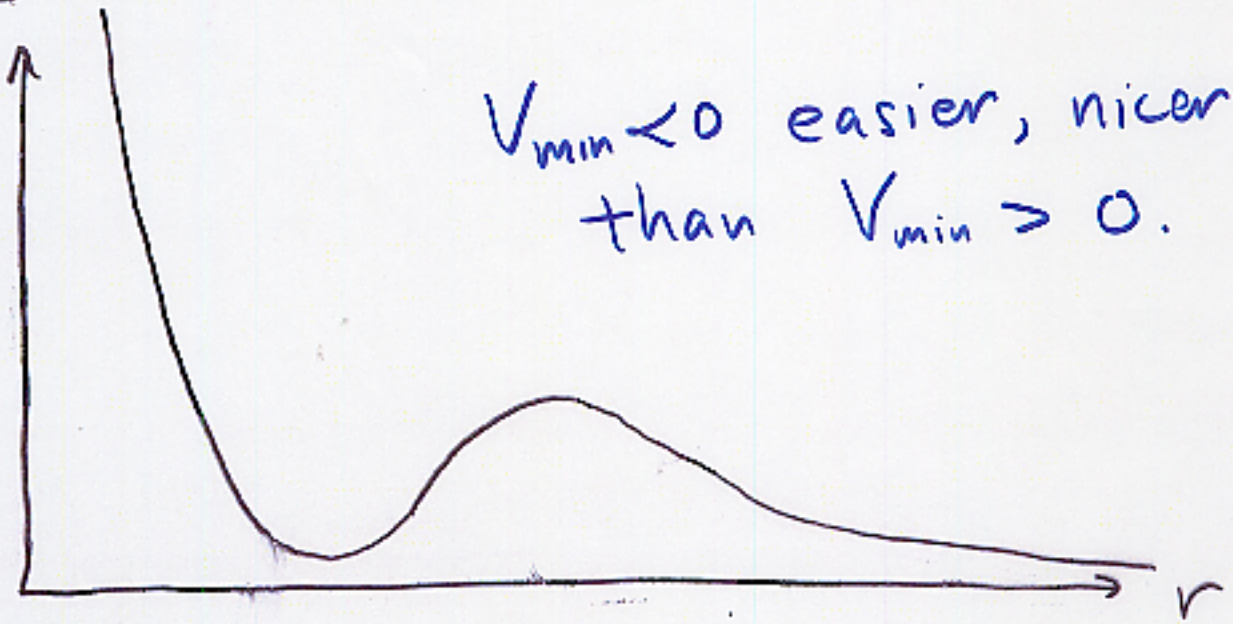
magnetic field

wrapped brane

orientifold plane



sum:



$V_{min} < 0$ easier, nicer than $V_{min} > 0$.

other ingredients –

- asymmetric orbifolds
- off-criticality
- Casimir energies
- Ricci curvature

...

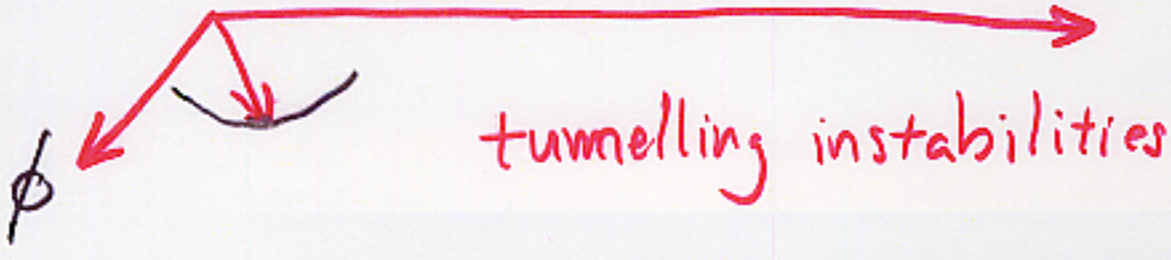
constructions –

- Silverstein; Maloney, Silverstein, Strominger
- Hellerman, McCreery, Williams

X Maldacena-Nunez

problems –

- calculability Dine-Seiberg
- tunnelling instabilities


ϕ
tunnelling instabilities

Scale of potential is at least

$(\mathrm{TeV})^4$.

Why is $\Lambda = V_{min} \lesssim 10^{-60}$ times this?

One possibility: $> 10^{60}$ vacua with randomly distributed Λ.

What selects our small-Λ vacuum-

dynamics?

anthropic prin.?

initial conditions?

What determines the wavefunction of the universe?

Is this even the right language?

Holographic principle - fundamental degrees of freedom are completely nonlocal, locality emerges at low energy ...

KITP Program

"Superstring Cosmology"

Aug. - Dec. 2003

T. Banks, S. Carroll, J. Maldacena,
J. Polchinski, G. Veneziano