Transplanckian axion monodromy and the swampland

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G. Buratti, J. Calderón & A. Uranga,
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Planck '19

Motivation

- Compatibility of gauge field theory with quantum gravity

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- Swampland distance conjecture, ...

- Swampland vs Landscape

- Applications to model building?

Swampland distance conjecture

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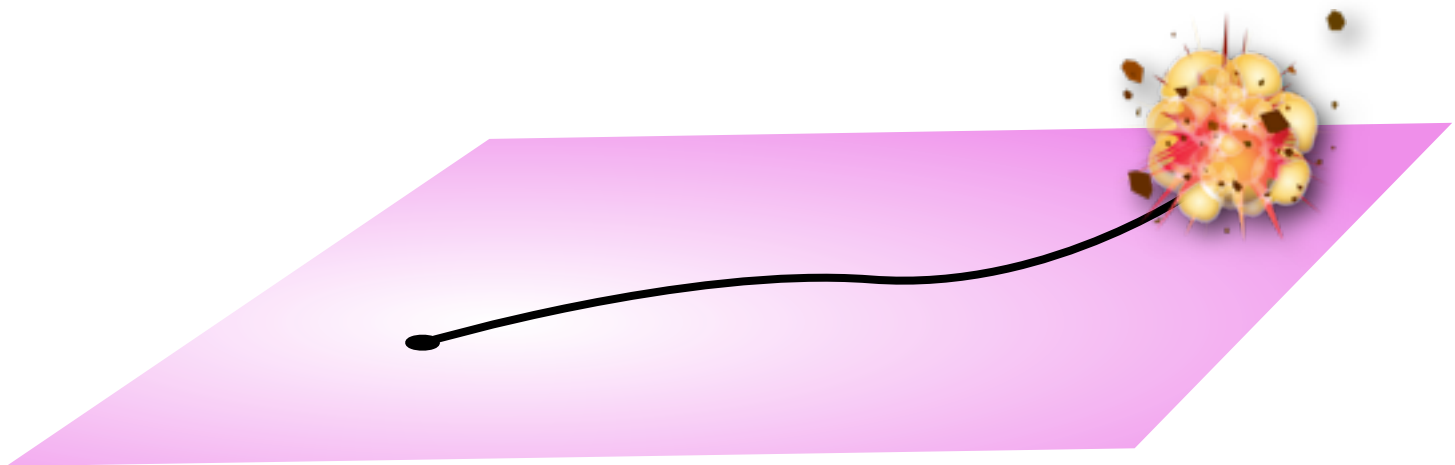
- More precise [Ooguri, Vafa; Palti;...]

Adiabatic motion in moduli space over transplanckian (geodesic) distances leads to breakdown of effective field theory



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- Appearance of infinite tower of light modes
- Other disasters

- Deep implications for inflation: unobservable tensor modes?
- Must deal with potential and backreaction!

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$$\phi \to \phi + \lambda$$

broken to discrete periodicity by:

- Non-perturbative effects ⇒ natural inflation

- Monodromic effects ⇒ axion monodromy

Natural inflation

- Single axion with 1-instanton generated potential

Freese, Frieman, Olinto

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- In deep trouble with WGC swampland constraints

- Single field Arkani-Hamed, Motl, Nicolis, Vafa

- Multifield Rudelius; Montero, AU, Valenzuela; ...

- Work & proposals go on, but...

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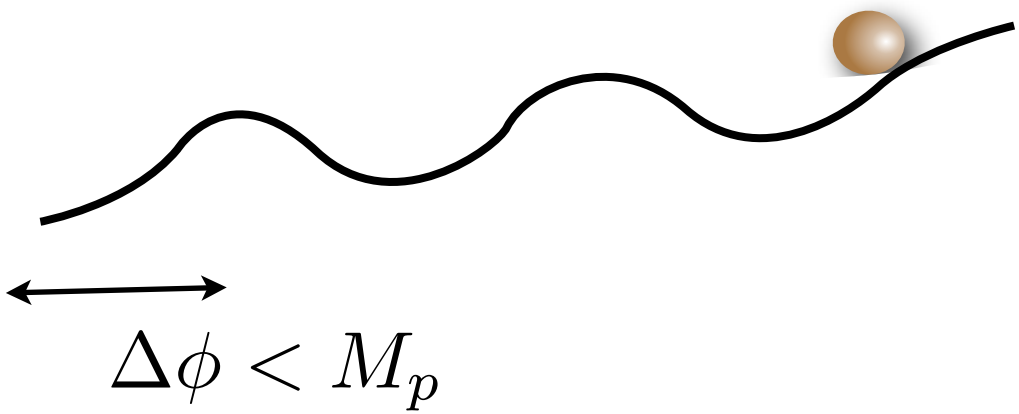
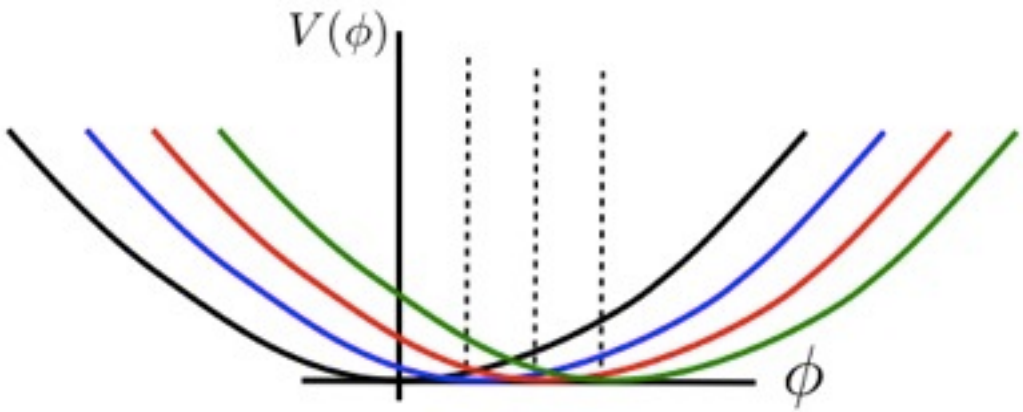
⇒ higher harmonics reduce the rolling range < Mp



Axion monodromy

- Alternative: Transplanckian field range with subplanckian periodicity, through multivalued potential

Silverstein, Westphal



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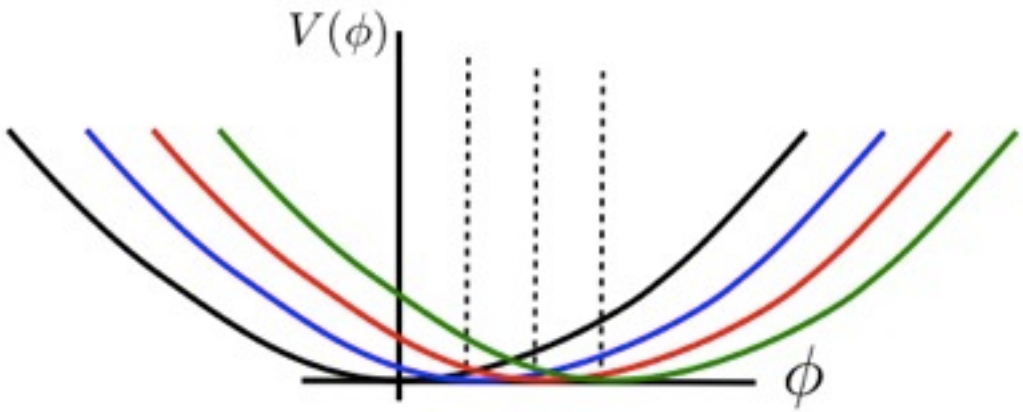

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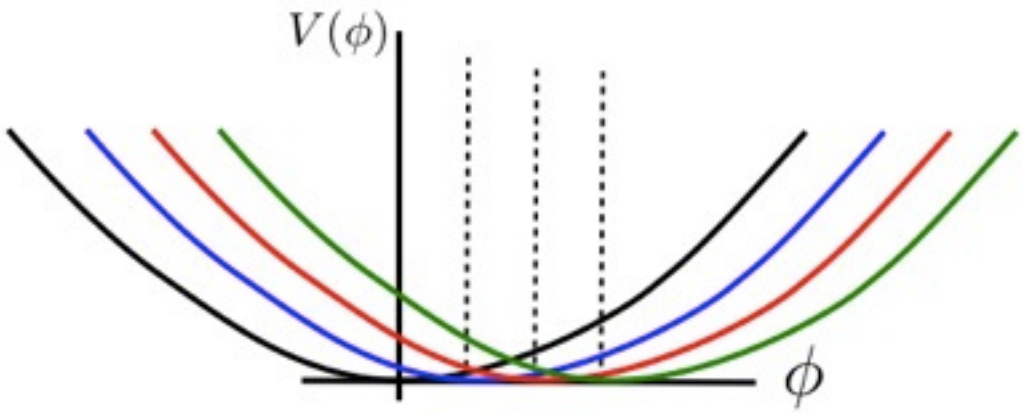

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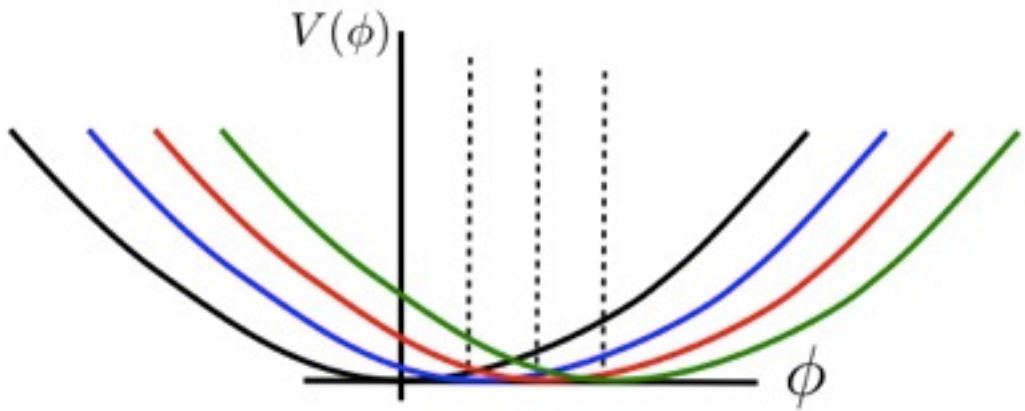

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$$|F_4|^2 + |dC_2 - nC_3|^2 \qquad C_3 \to C_3 + d\Lambda_2 \quad ; \quad C_2 \to C_2 + n\Lambda_2$$

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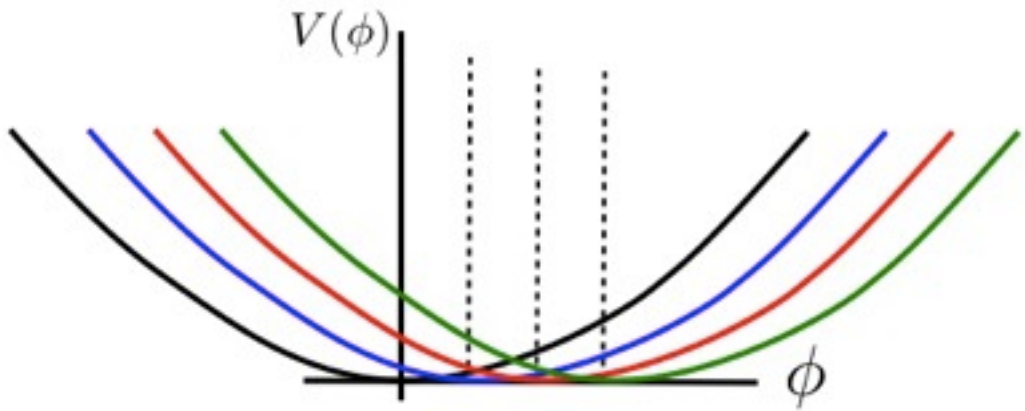

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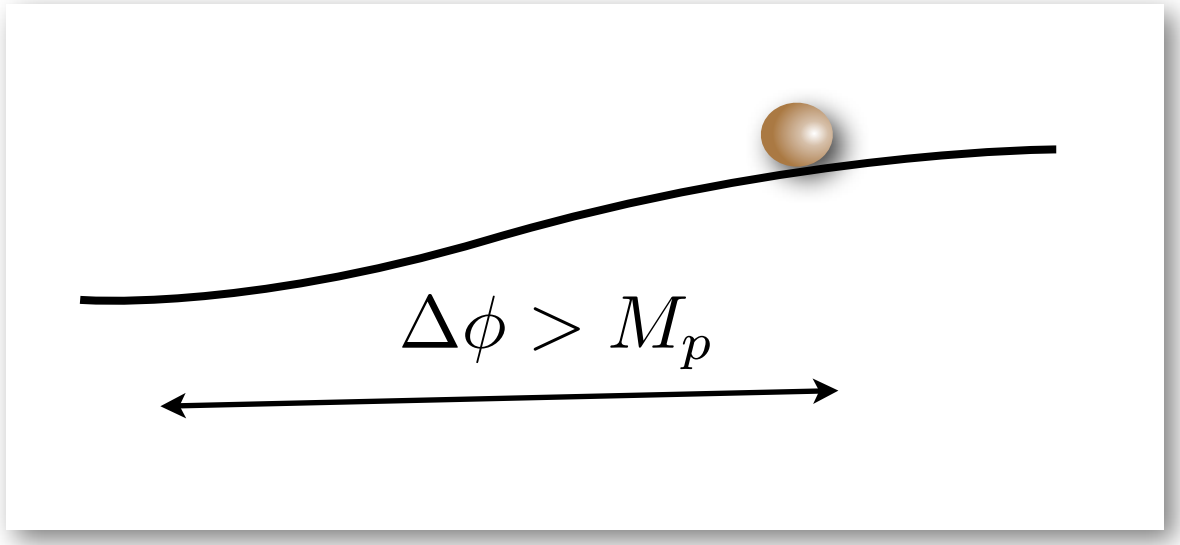
Transplackian vs backreaction?

Palti et al

Potentials and backreaction

- Adiabatic motion in field space with potential is "offshell"

Equations of motion
don't allow for constant vev!



- In general, hard problem

  What potential? What dynamics? ...?

- Address in concrete setup: fully backreacted 10d solution

The KS warped throat

Klebanov, Tsetlyn
Klebanov, Strassler

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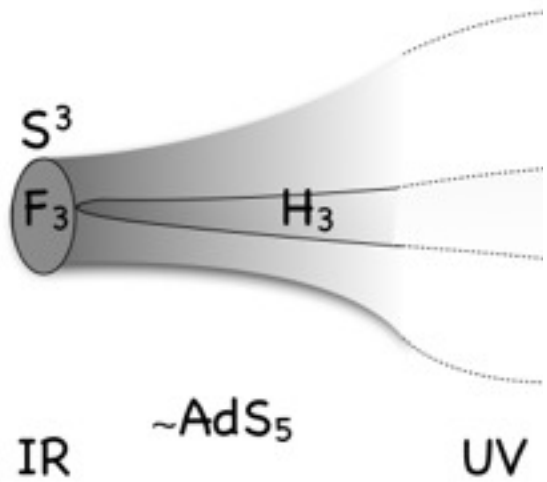

F5 flux$\Rightarrow$ $N \sim N_0 + M \log r$

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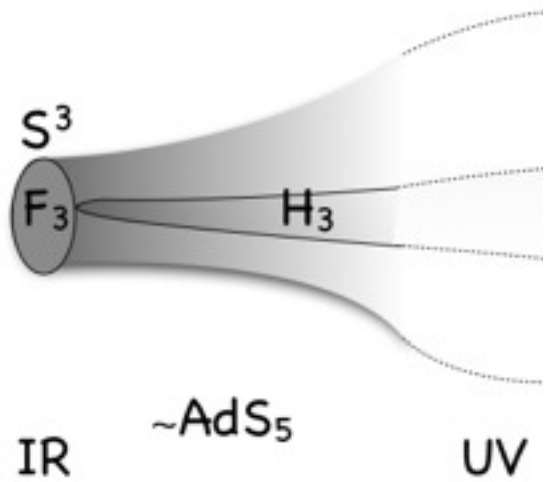

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- Full 10 supergravity solution is explicitly known

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- "Roll" up to arbitrarily large distance in field space

$$G_{\phi\phi} \sim (N_0 + M\phi)^{-1} \qquad \Delta = \int G_{\phi\phi}^{1/2} d\phi \sim \int \frac{d\phi}{\phi^{\frac{1}{2}}} \sim \phi^{\frac{1}{2}}$$

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- Comments:

Admittedly 5d, but 4d examples from M-theory on AdS4 x X7

Admittedly AdS, and susy, but tractable for a fundamental question

"Rolling", but required from backreaction. In fact, essential see later

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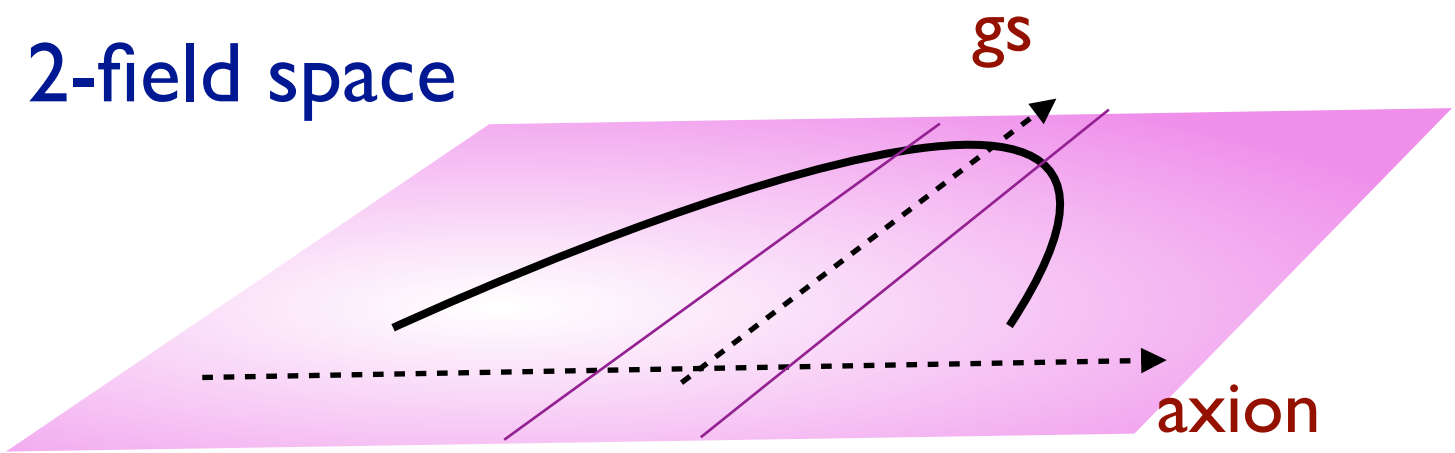

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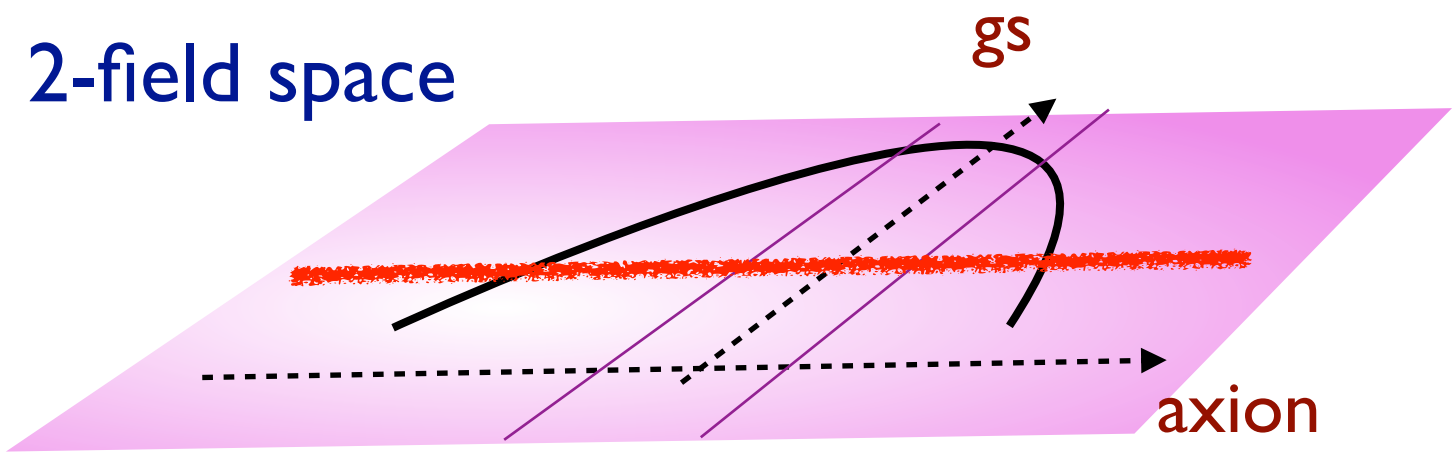


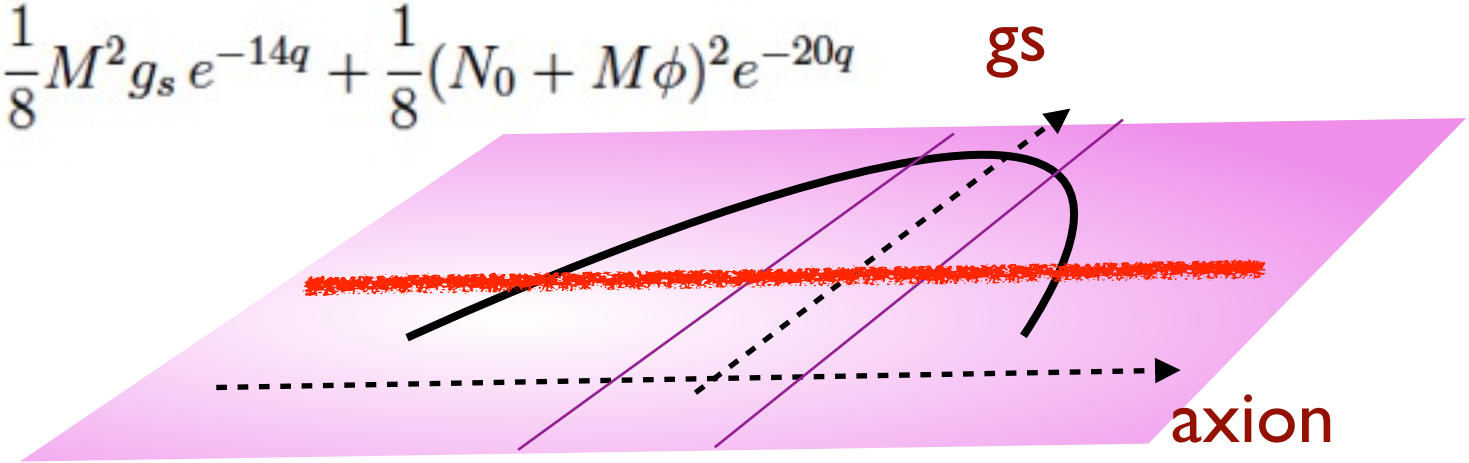
- Our path is not geodesic!

What about the distance conjecture?

- Constant dilaton from non-trivial balance
  - Potential from flux compactification
  - Effective potential from "rolling" axion

$$G_{ab}(\varphi)\partial\varphi^a\partial\varphi^b = 15(\partial q)^2 + \frac{1}{4}g_s^{-1}e^{-6q}(\partial\phi)^2 \ ,$$

$$V(\varphi) = -5e^{-8q} + \frac{1}{8}M^2 g_s\, e^{-14q} + \frac{1}{8}(N_0 + M\phi)^2 e^{-20q}$$



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- Future: Physical applications? Time dependent roll?

Instituto de Física Teórica UAM-CSIC presents:

Navigating the Swampland

Madrid, 25-27 September 2019

Swamp Gondoliers

L. E. Ibáñez
F. Marchesano
A. M. Uranga

Thank you!