Weak gravity conjecture and axion phenomenology

Angel M. Uranga
IFT-UAM/CSIC, Madrid

Strings 2016

c.f. Harlow, Shiu

Motivation

- Compatibility of gauge field theory with quantum gravity

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- Cancellation of gravitational anomalies

- Absence of global symmetries

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- Applications to model building?

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  Classification of discrete gauge symmetries in MSSM

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  Non-abelian discrete gauge symmetries contrain Yukawas
  in certain D-brane models

  Berasaluce, Cámara, Marchesano, AU

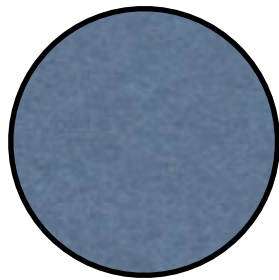# Weak gravity conjecture

Arkani-Hamed, Motl, Nicolis, Vafa

Weak gravity conjecture

Arkani-Hamed, Motl, Nicolis, Vafa

Argument

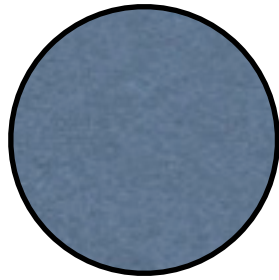Allow for extremal charged black holes to decay...

Q, M

Weak gravity conjecture
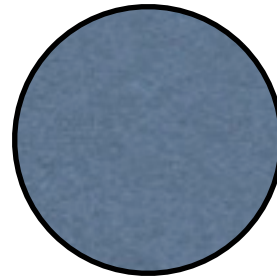
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$Q-q, M-m$

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...without getting superextremal $m \leq gq$ (Planck units)

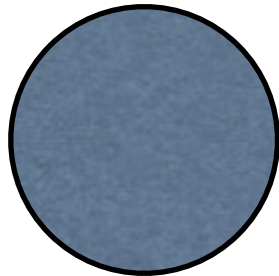# Weak gravity conjecture

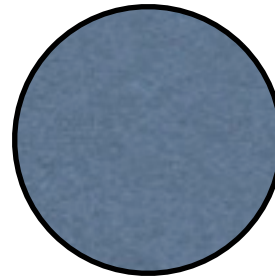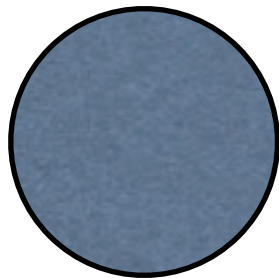Arkani-Hamed, Motl, Nicolis, Vafa

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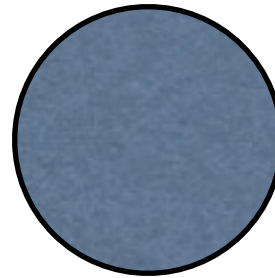Magnetic version   Cutoff $\leq gq$

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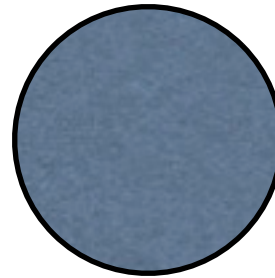
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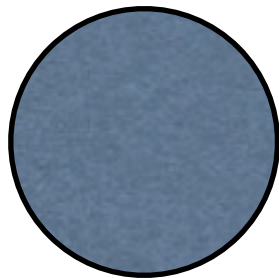**Magnetic version**   Cutoff $\leq gq$

Generalize to p-form gauge fields: eg. 0-form, 3-form

("T-duality")

Axion: Motivation
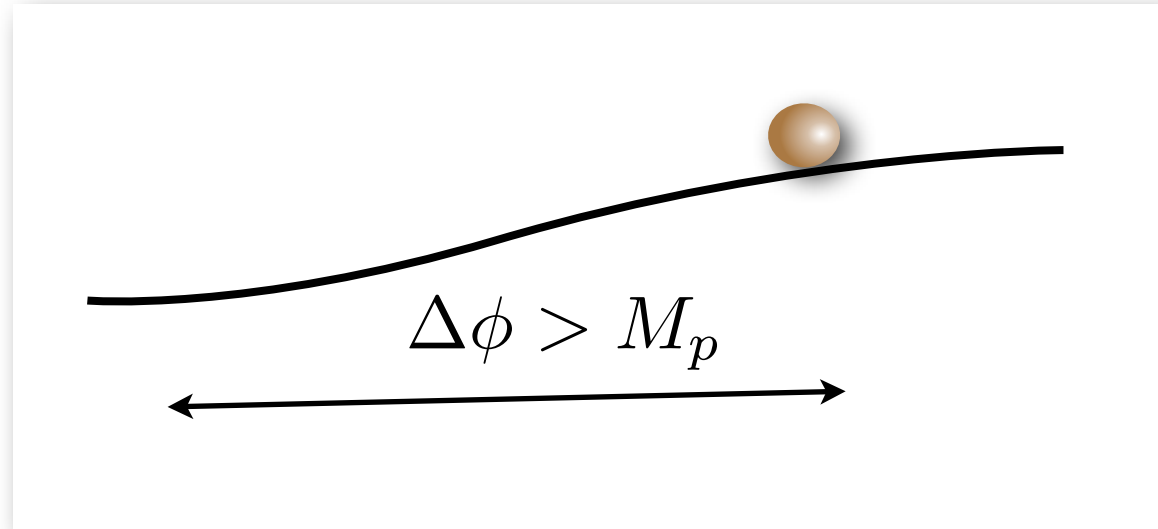
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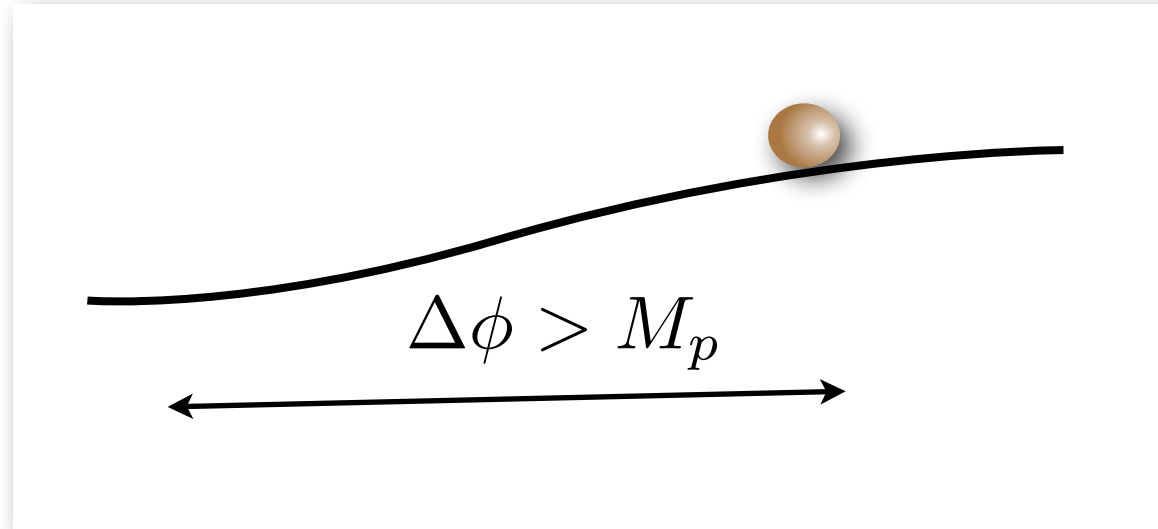
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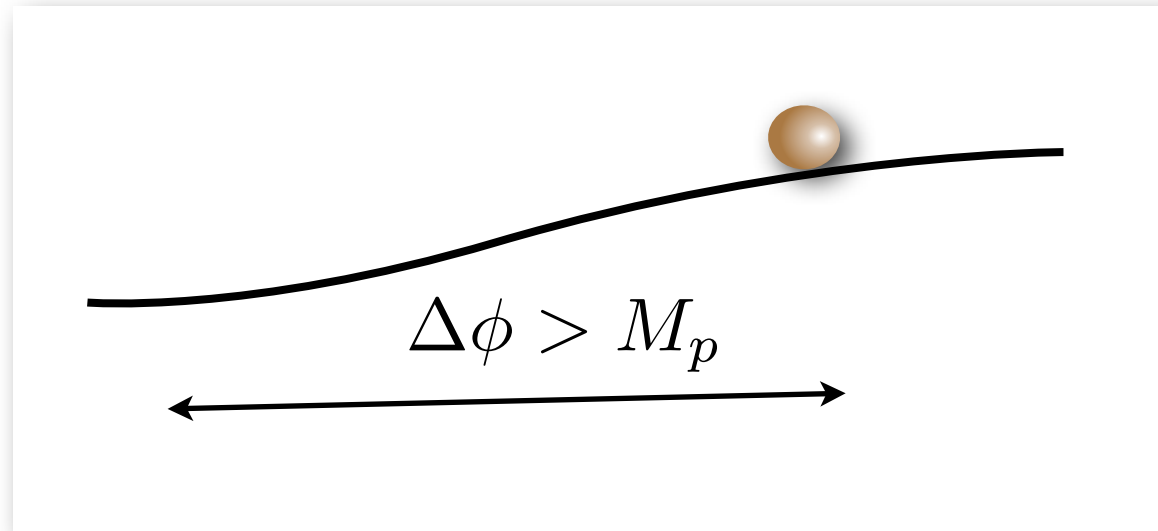
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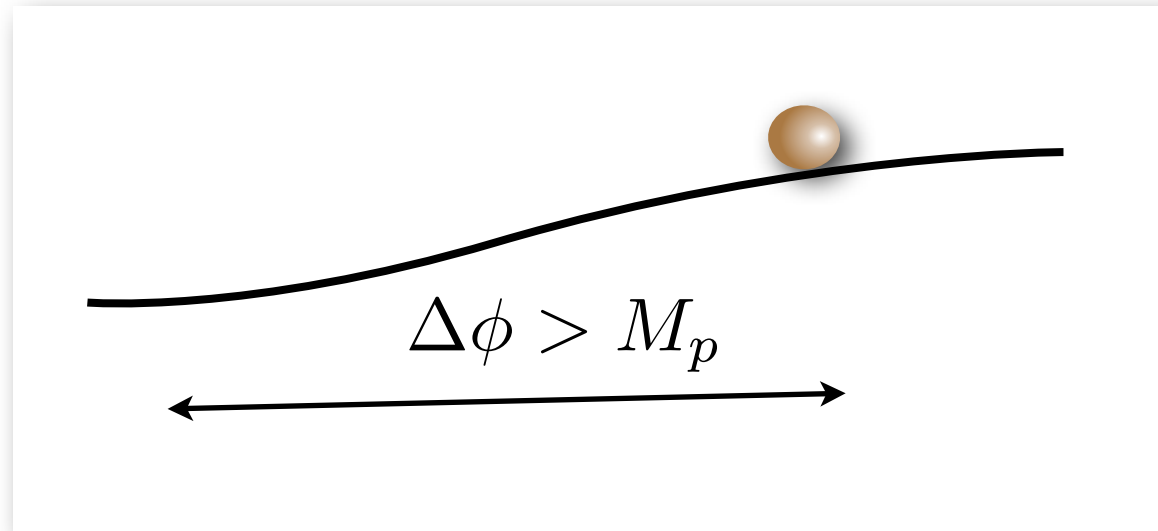
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📌 General question of consistency in quantum gravity

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Axions: Periodic scalars with (perturbative) shift symmetry

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broken to discrete periodicity by:

- Non-perturbative effects $\Rightarrow$ natural inflation

- Monodromic effects $\Rightarrow$ axion monodromy

Natural inflation

Single axion with 1-instanton generated potential

Freese, Frieman, Olinto

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- Proposals to avoid, in multiple axion models

  - N-flation   Dimopoulos, Kachru, McGreevy, Wacker

  - Kinetic alignment   McAllister et al

  - Lattice alignment   Kim, Nilles, Peloso

WGC & axion potential

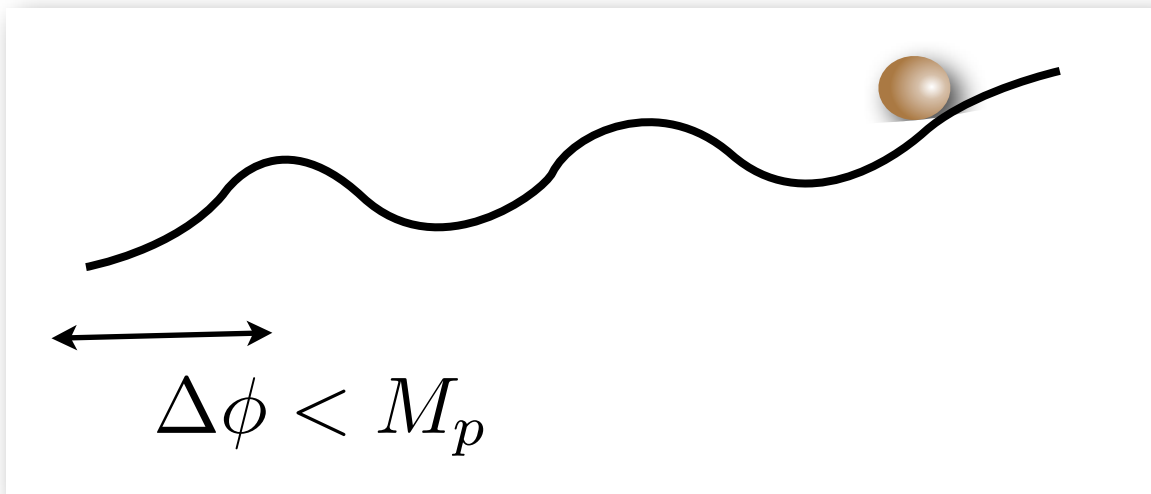# WGC & axion potential

WGC demands instantons inducing higher harmonics

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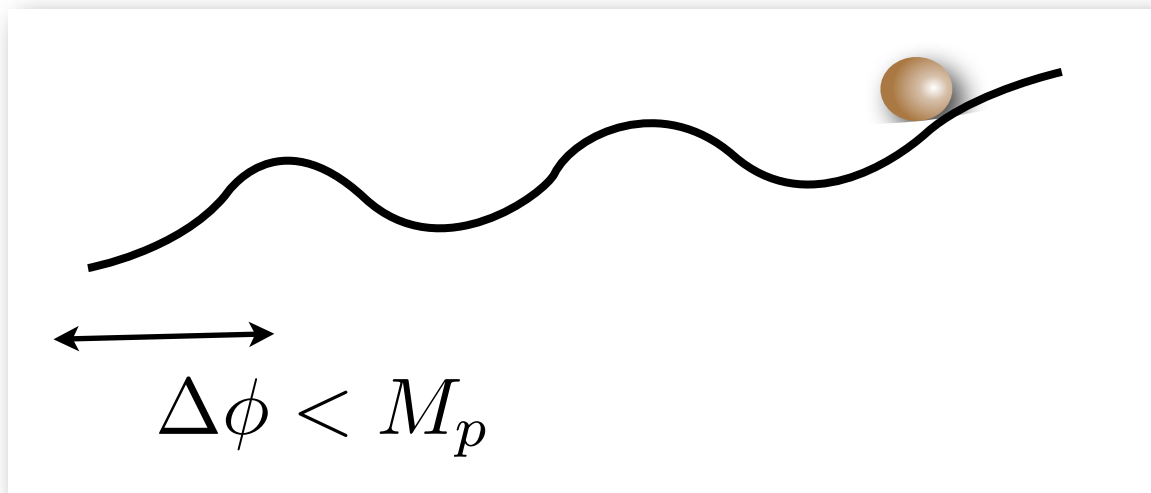📌 Tough time for multiple axions, too!

delaFuente, Saraswat, Sundrum; Rudelius; Montero, AU, Valenzuela; Brown, Cottrell, Shiu, Soler; Bachlechner, Long, McAllister; Hebecker, Mangat, Rompineve, Witkowski; Junghans; Heidenreich, Reece, Rudelius; ...

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Strong from — Lightest particle has larger q/m

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Interesting debate on which version realized in strings

Axion monodromy

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

Silverstein, Westphal
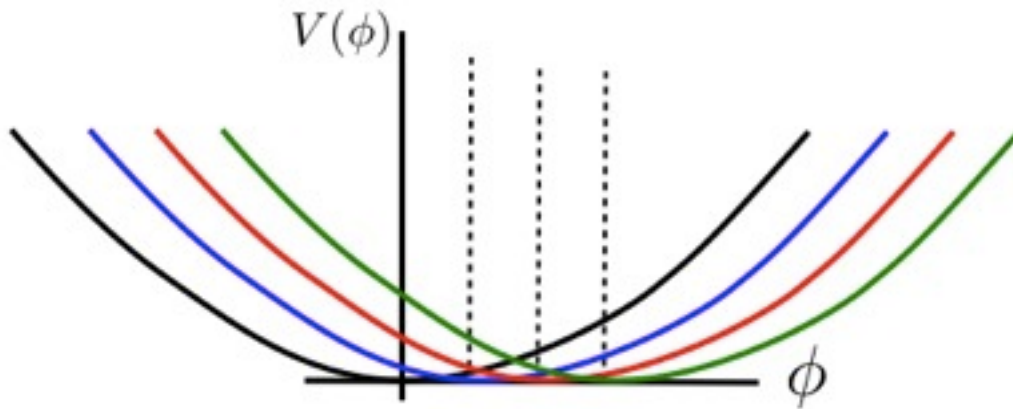
cf Witten's θ angle in large N pure YM

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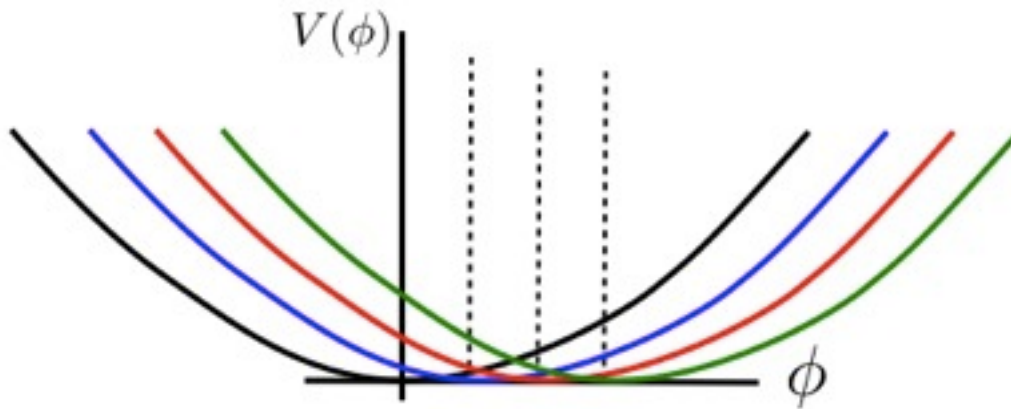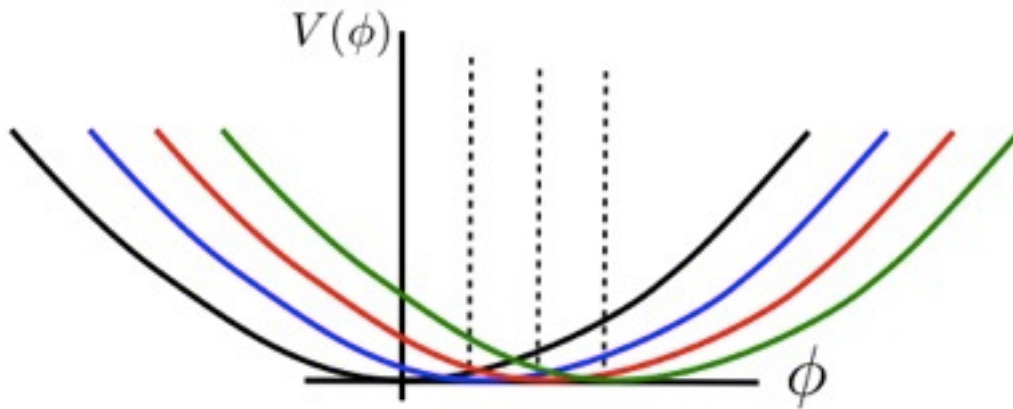
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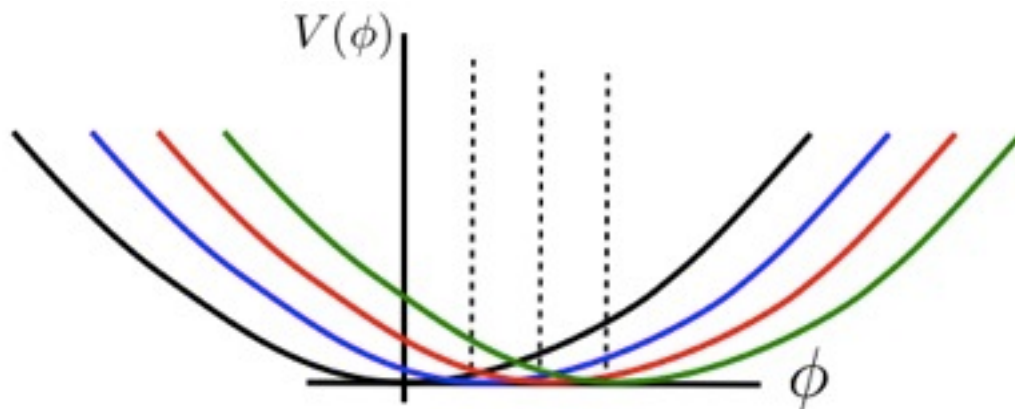

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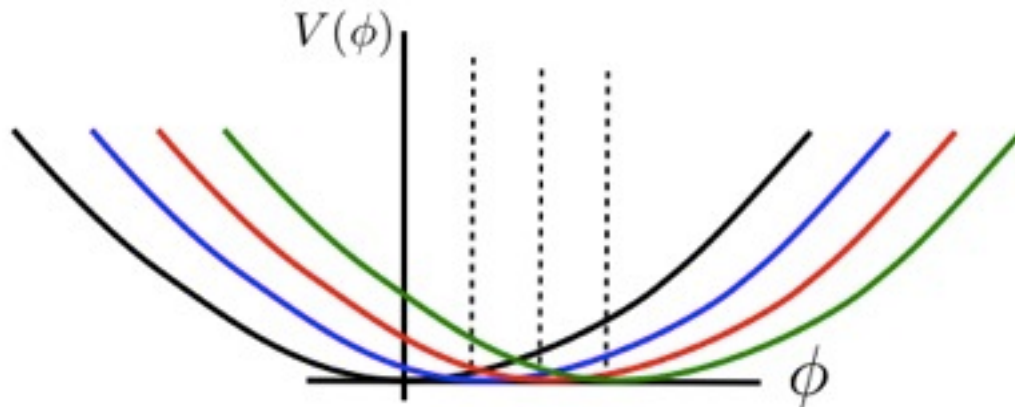$$|F_4|^2 \boxed{+\, n\,\phi F_4} + |d\phi|^2$$

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Transplackian vs backreaction?

Palti et al

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Montero, Ibáñez, AU, Valenzuela

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Rapid tunneling, rather than slow roll

see also Brown, Cottrell, Shiu, Soler '16

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- Interesting..

  QG constraints relevant to new cosmo + LHC data

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