Transplanckian axion field ranges and string theory

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Strings 2015, Bangalore

Plan

- Motivation

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- Transplanckian axion decay constants...
  ... and the weak gravity conjecture

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  ... and a late twist on an early model

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- Conclusions

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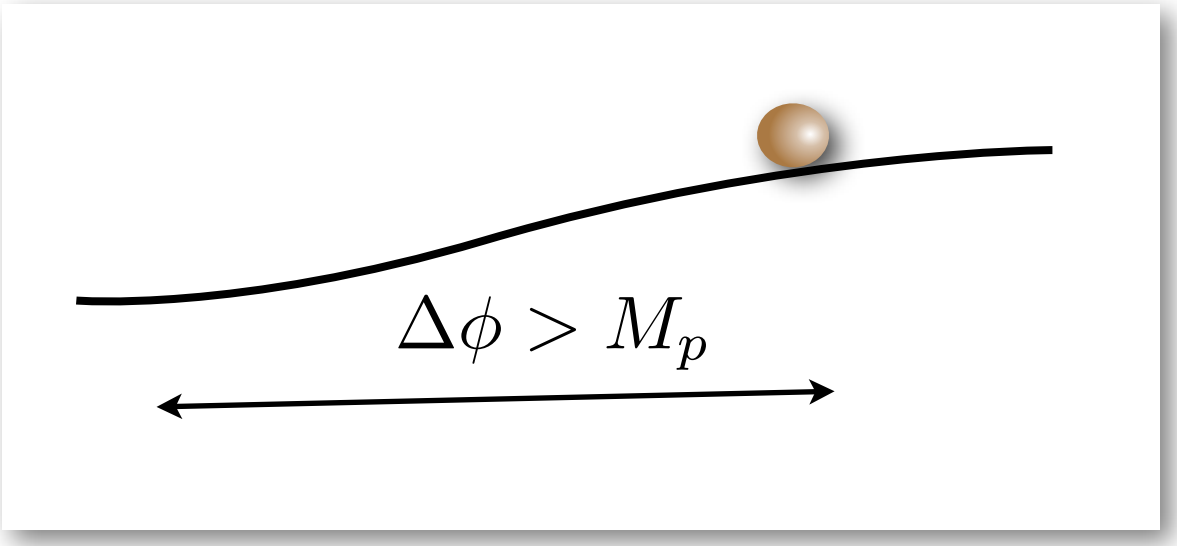

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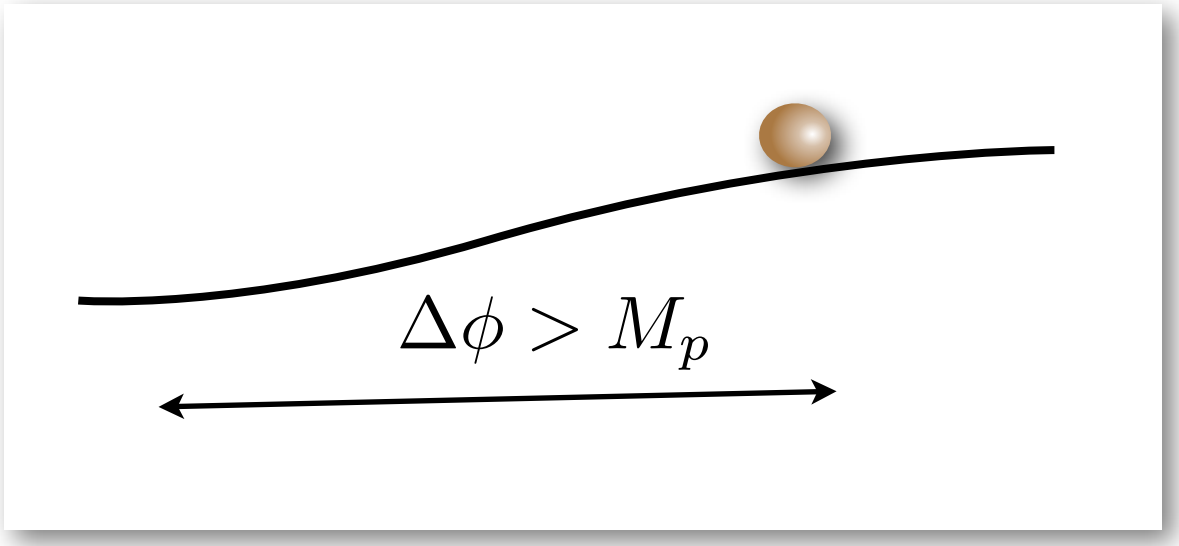

General question of consistency in quantum gravity

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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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- Proposals to avoid, in multiple axion models

  - N-flation — Dimopoulos, Kachru, McGreevy, Wacker
  - Kinetic alignment — McAllister et al
  - Lattice alignment — Kim, Nilles, Peloso

Gravitational instantons & axion potential

Montero, AU, Valenzuela

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- Consider solutions of GR+axion with instanton charge n

$$S \sim \frac{nM_P}{f}$$

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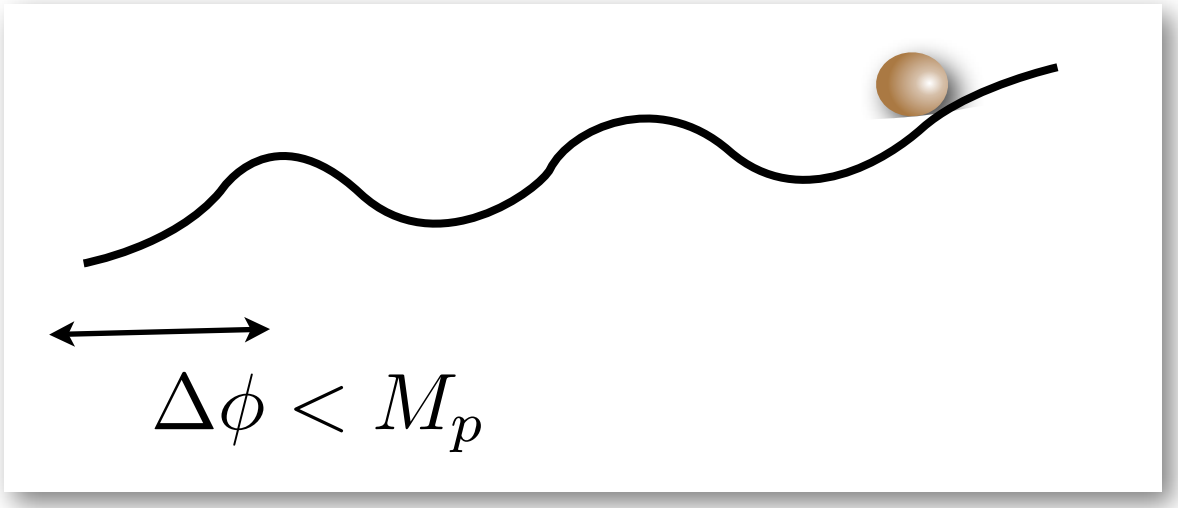

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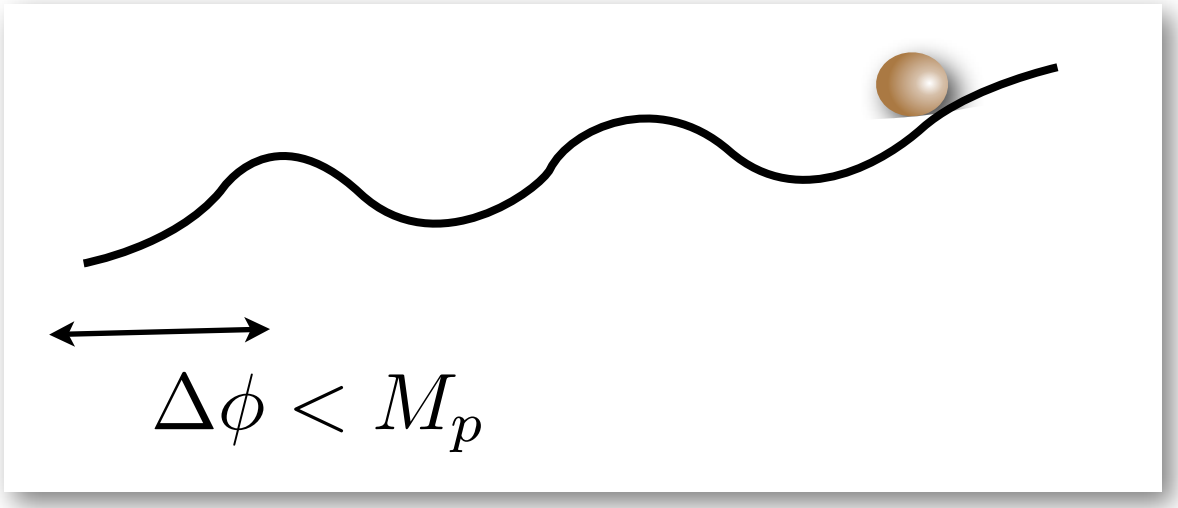

- Consistent with Weak Gravity Conjecture

Arkani-Hamed, Motl, Nicolis, Vafa

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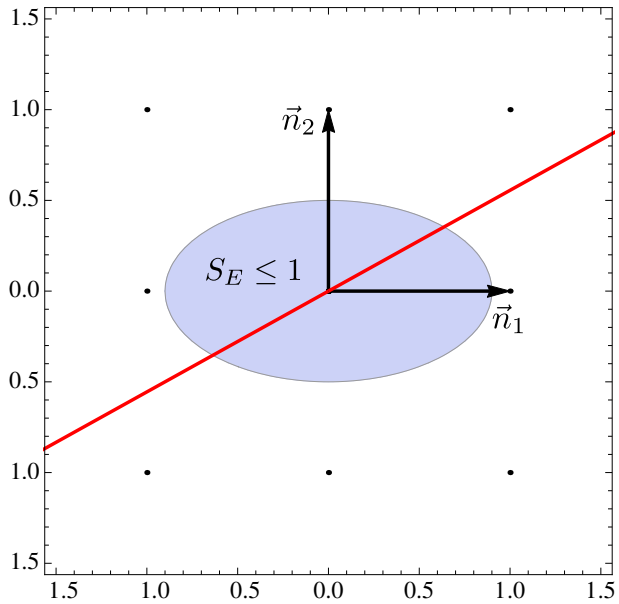

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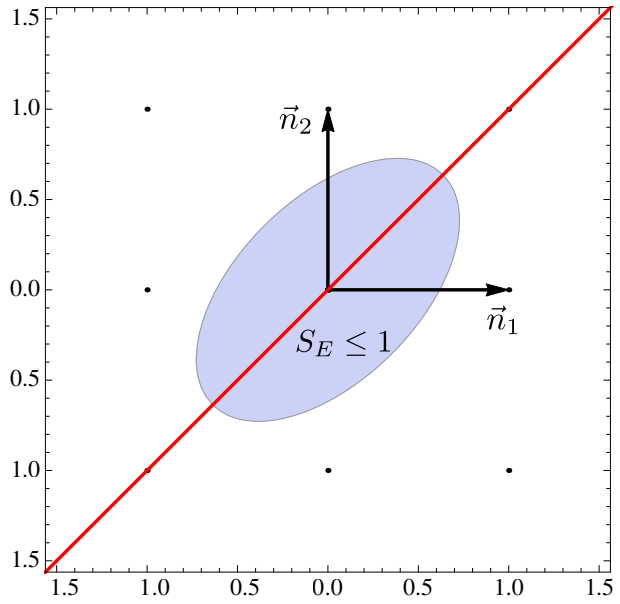
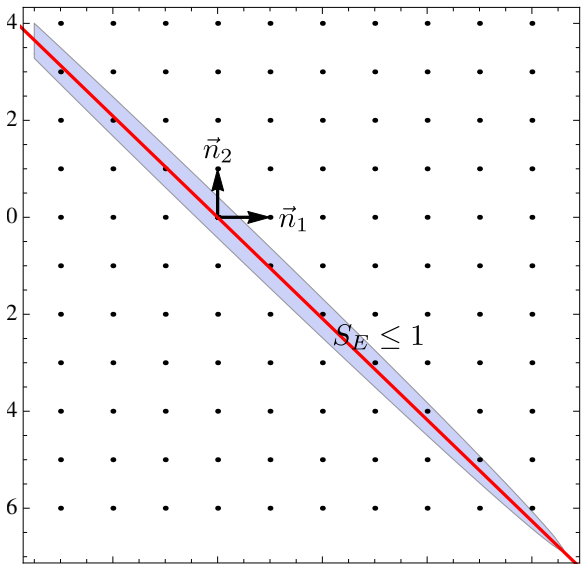


kinetic alignment



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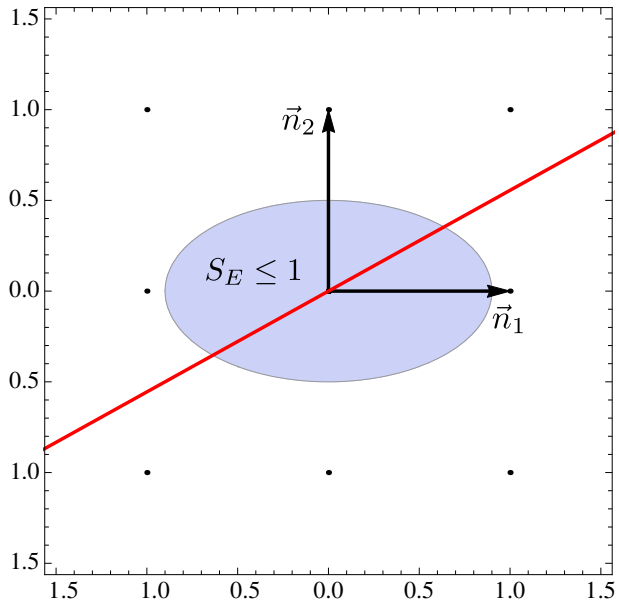

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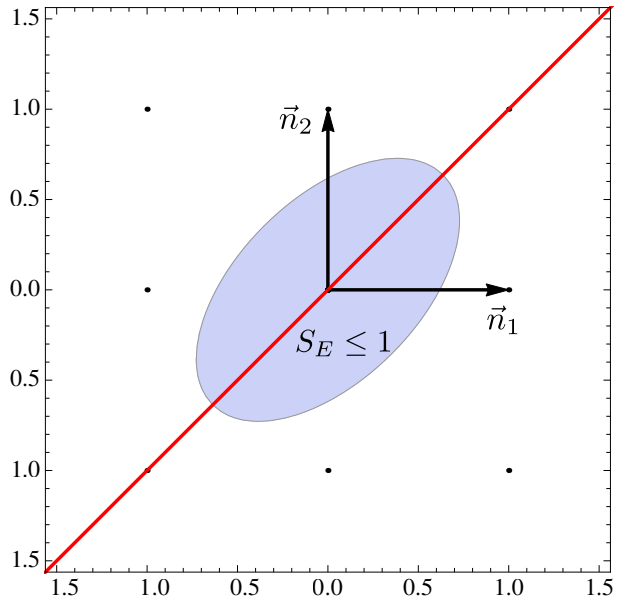

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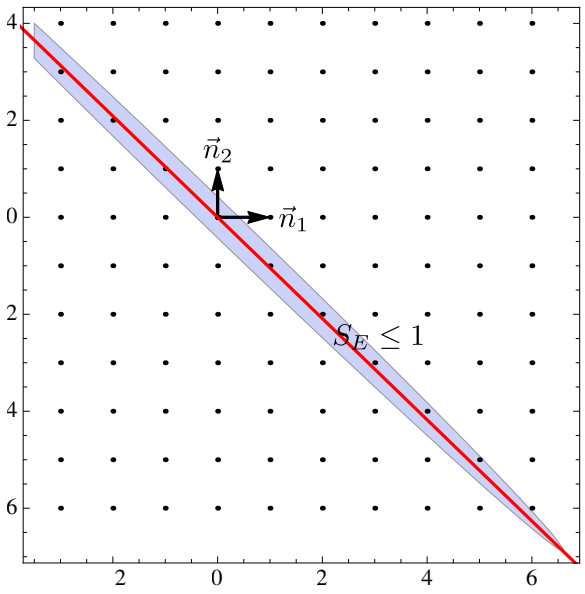

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- Absence of wormholes necessary, not sufficient

Weak gravity conjecture

Arkani-Hamed, Motl, Nicolis, Vafa

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- Strong form very stringent for multi-axion models

WGC and multi-axions

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- Vigorous activity (and in interplay with strings)

  Rudelius; Brown, Cottrell, Shiu, Soler; Bachlechner, Long, McAllister; Hebecker, Mangat, Rompineve, Witkowski; Junghans; ...

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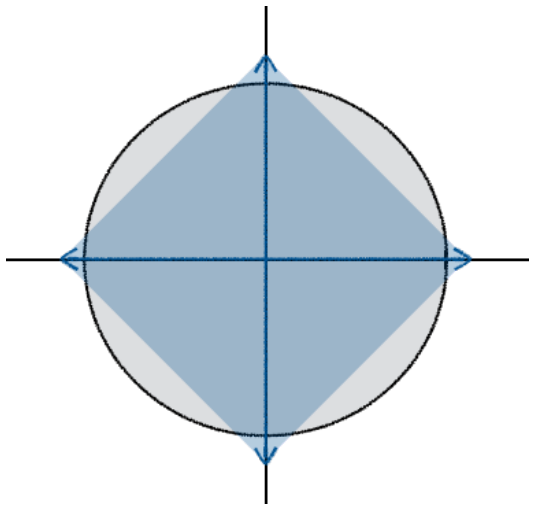

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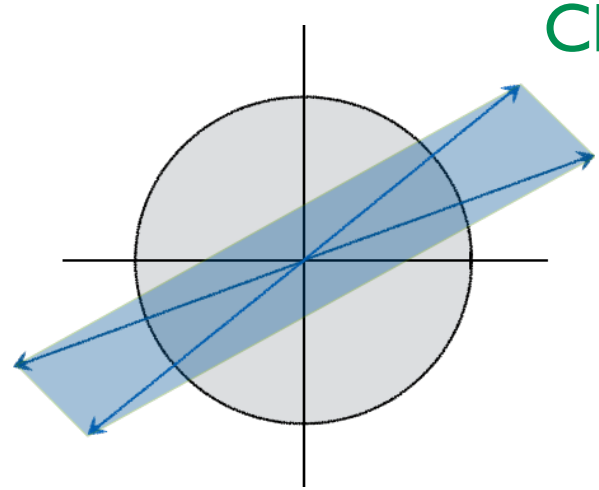

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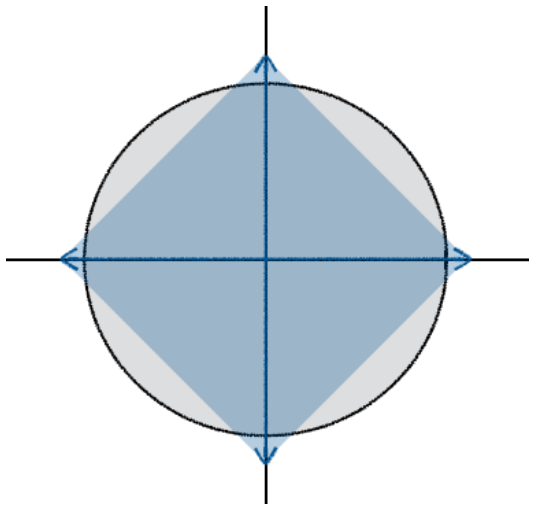

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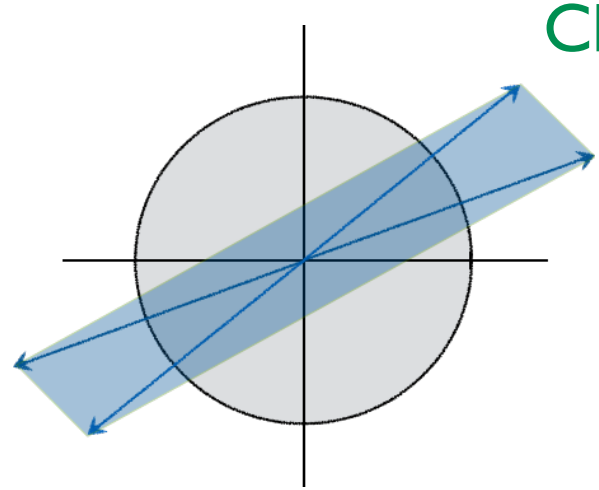

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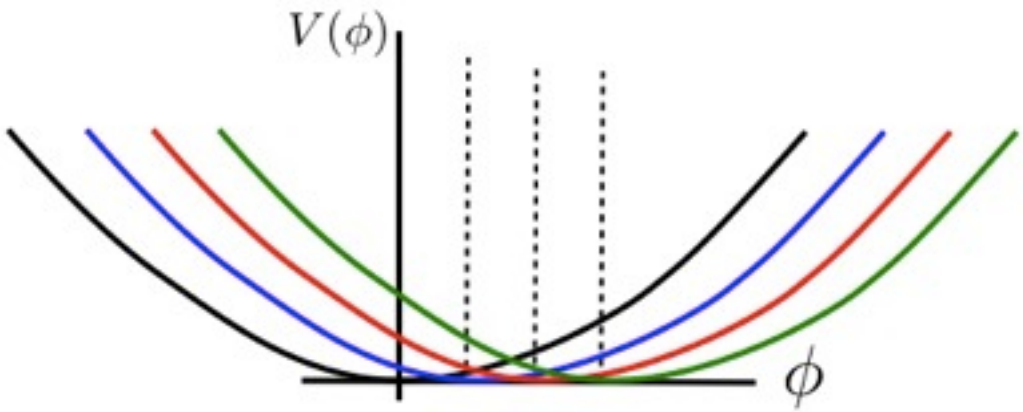
- Strings seems to satisfy strong version ⇒ constraining
- Open challenge to show otherwise

  & realize transplanckian natural inflation

Axion monodromy

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

Silverstein, Westphal



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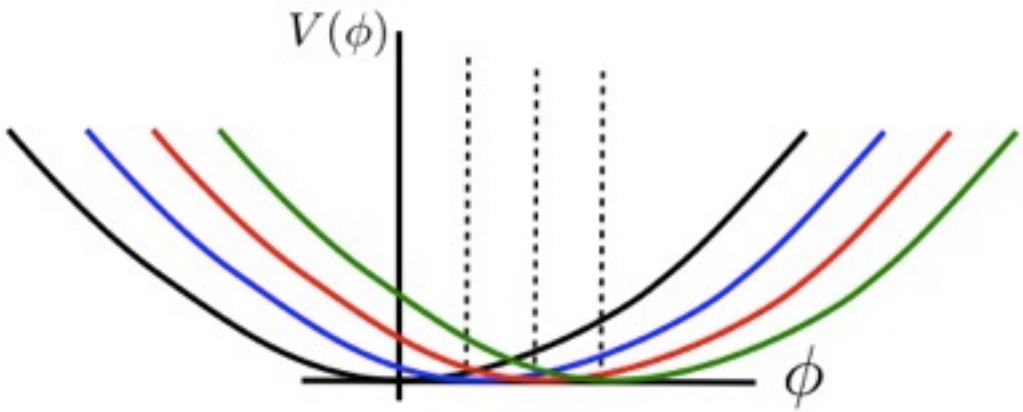

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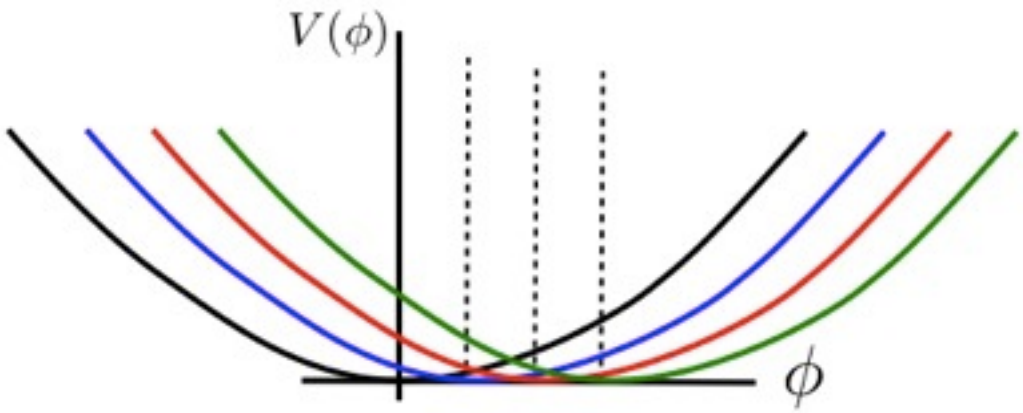

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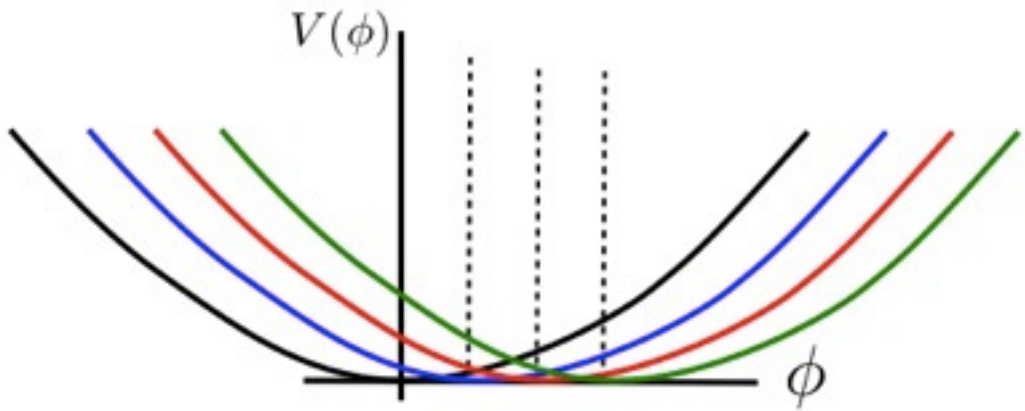

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$$|F_4|^2 + |dC_2 - nC_3|^2 \qquad C_3 \to C_3 + d\Lambda_2 \quad ; \quad C_2 \to C_2 + n\Lambda_2$$

$$|F_4|^2 + n\,\phi F_4 + |d\phi|^2$$

$$|d\phi|^2 + \phi^2$$

Kaloper, Sorbo+Lawrence

An early model

McAllister, Silverstein, Westphal

- Axion from IIB RR 2-form over 2-cycle

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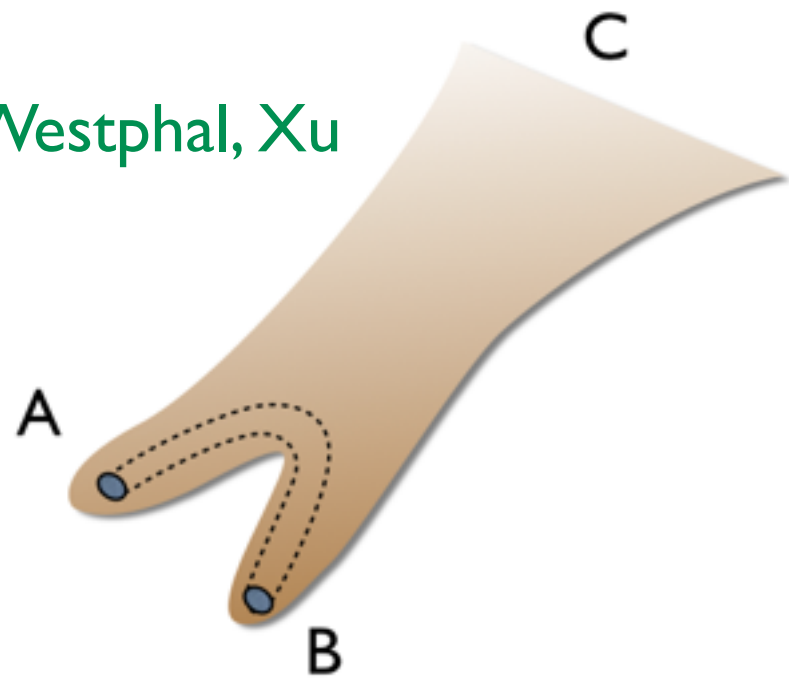

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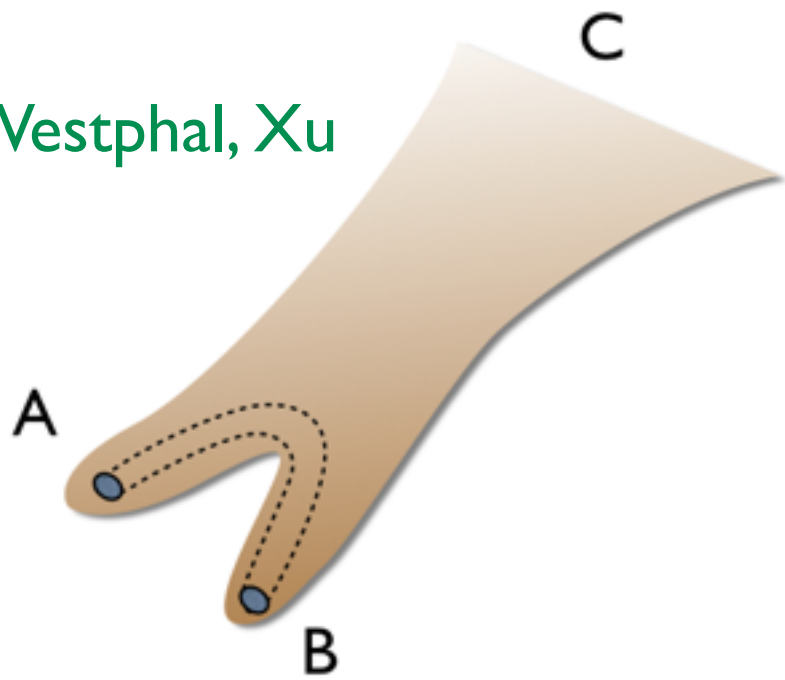
- Bifid throat looks "ugly", but
  - hosted by simple geometries
  - has tractable holographic dual

Retolaza, A.U, Westphal



Simple geometries hosting bifid throat

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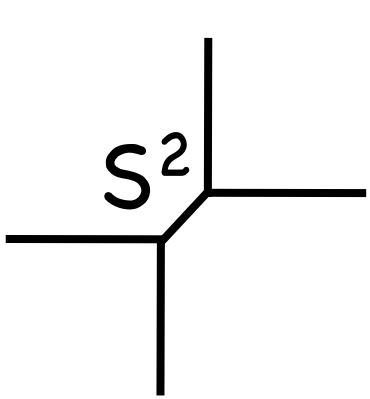
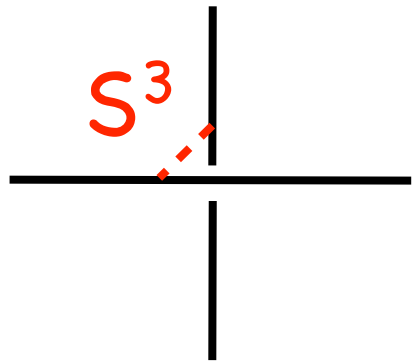
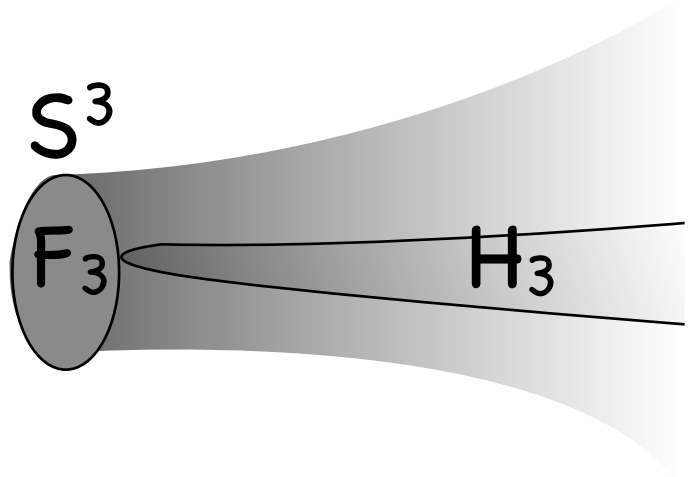
- Recall warped deformed conifold throat Klebanov, Strassler







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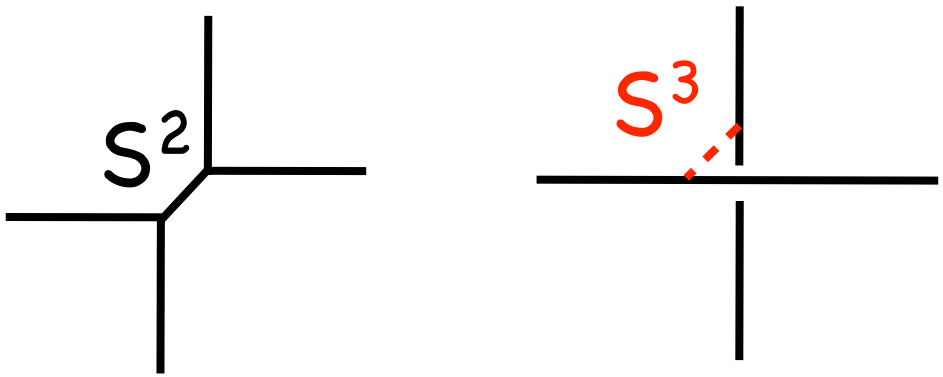

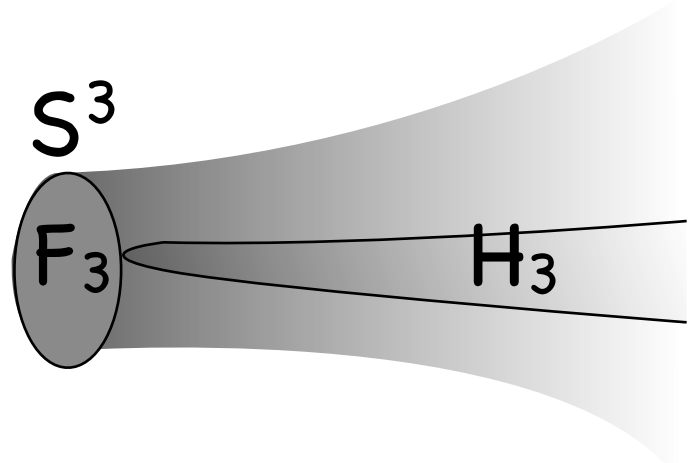

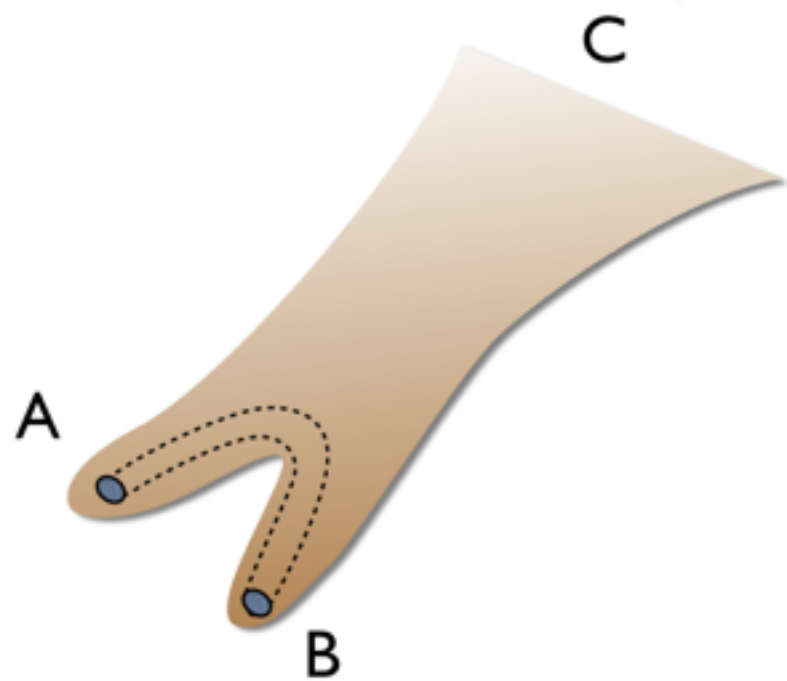

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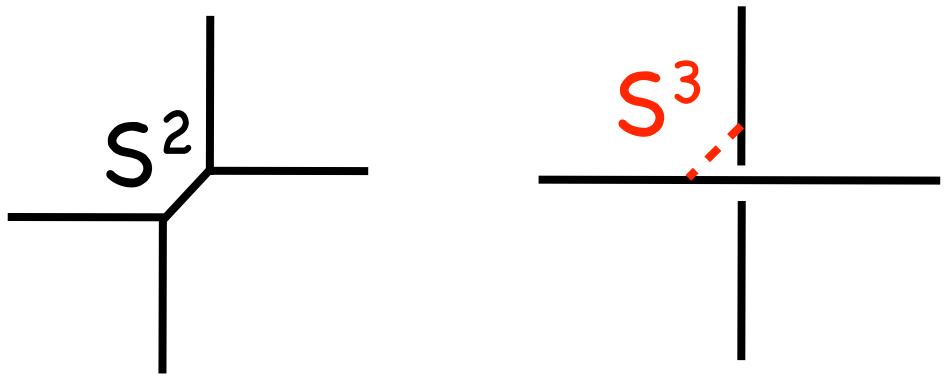
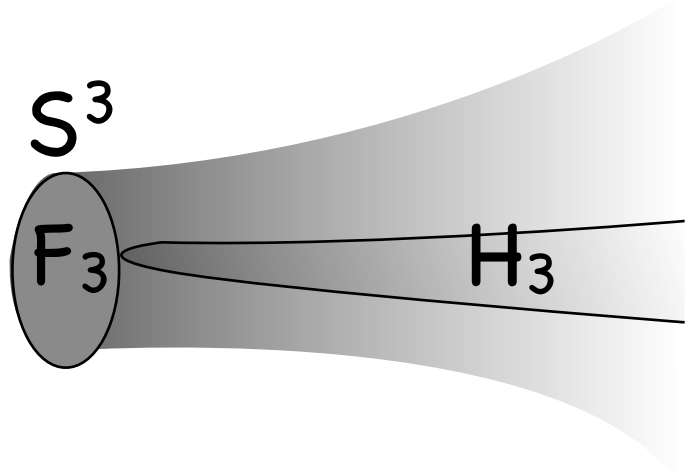
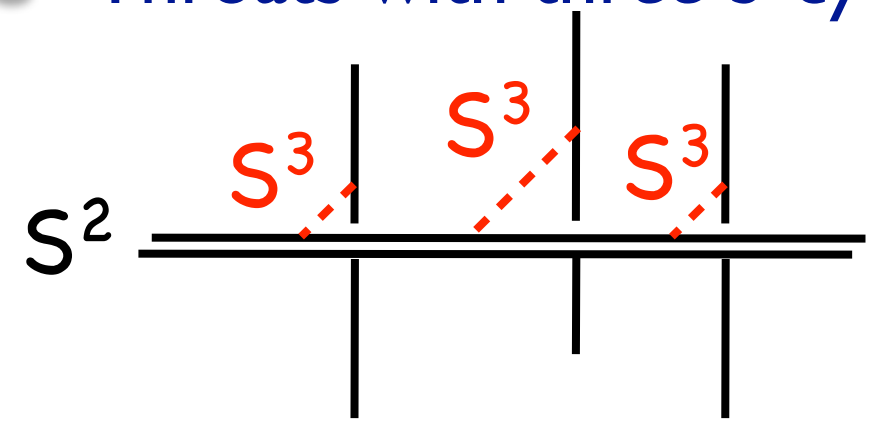
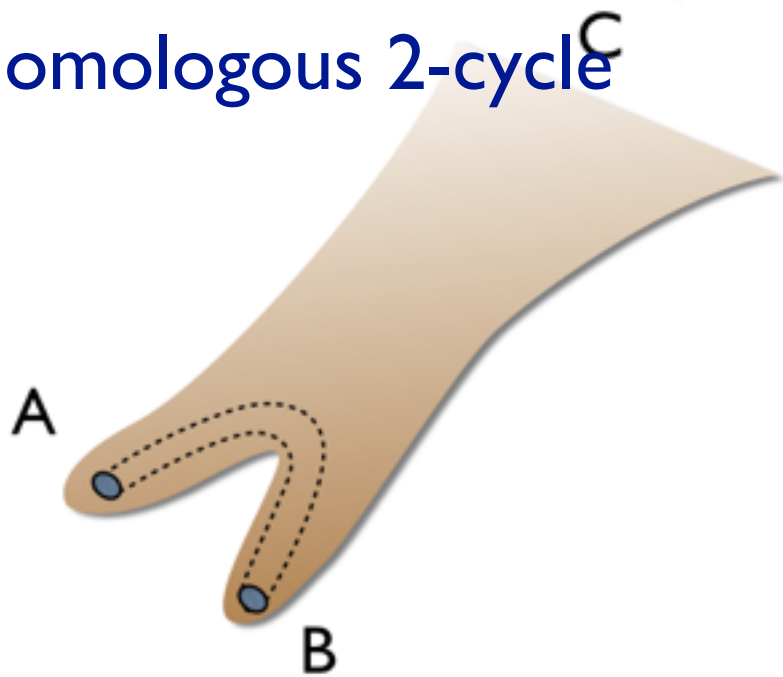




- Throats with three 3-cycles and homologous 2-cycle





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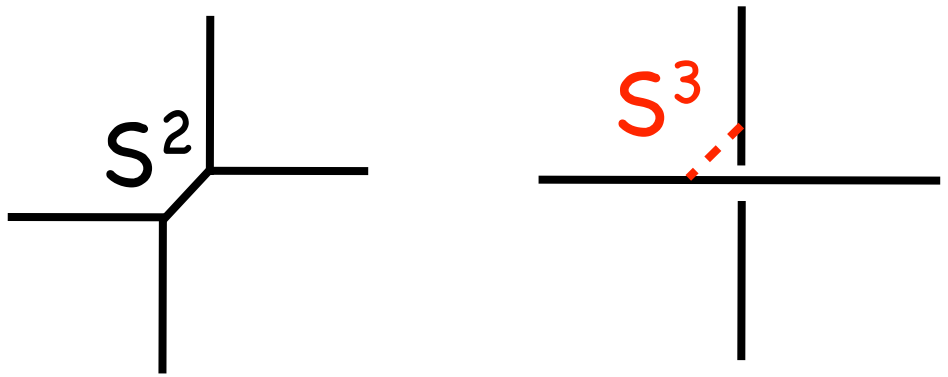

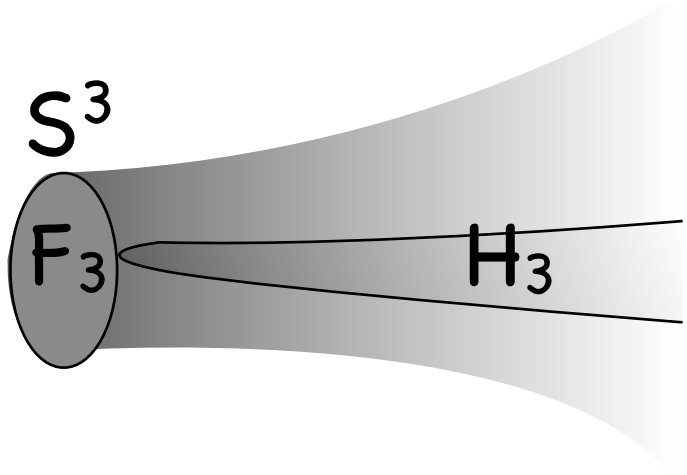

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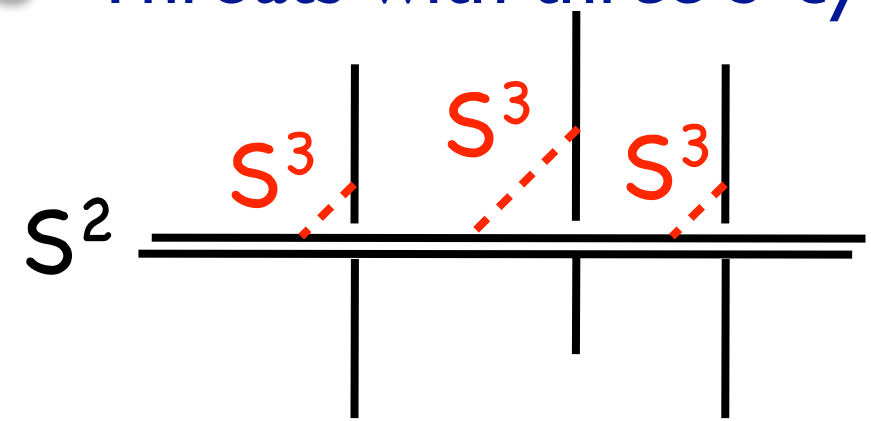

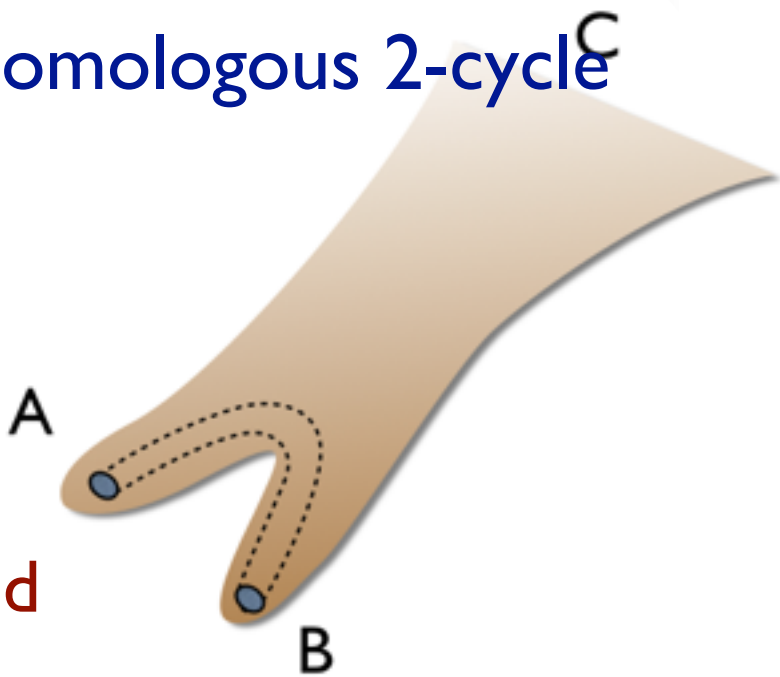

Just a Z2 x Z3 orbifold of the conifold

Holographic dual of bifid throat

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- D3 at toric singularities: use dimer diagram techniques

  Franco, Kennaway, Hanany, Vegh, Wecht

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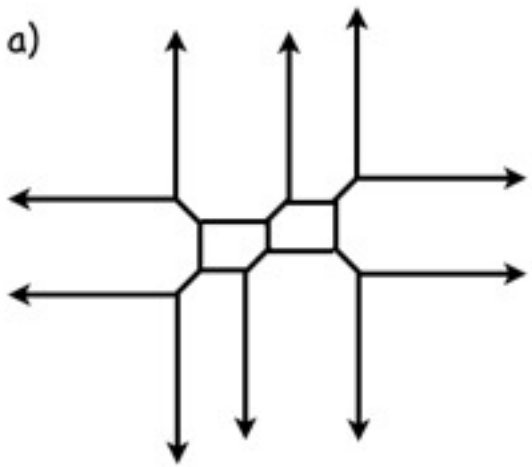
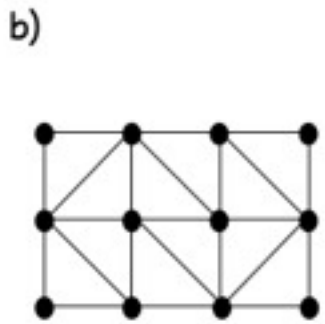
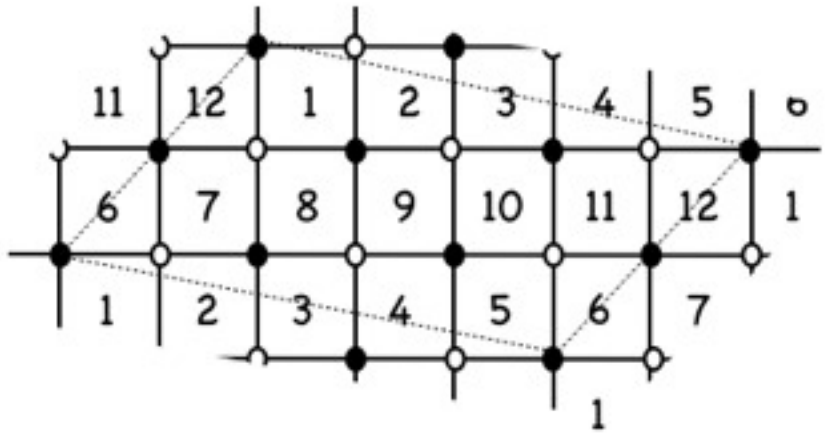


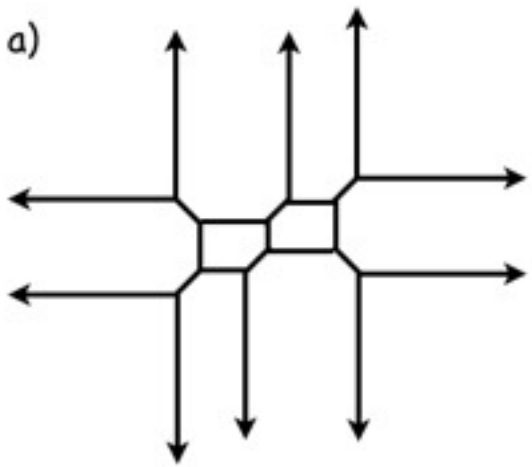


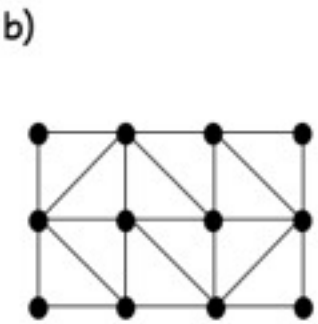


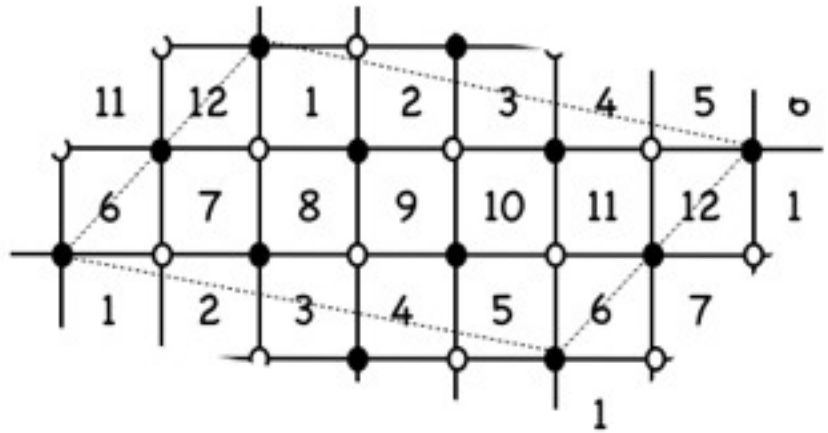
Holographic dual of bifid throat

- D3 at toric singularities: use dimer diagram techniques

Franco, Kennaway, Hanany, Vegh, Wecht







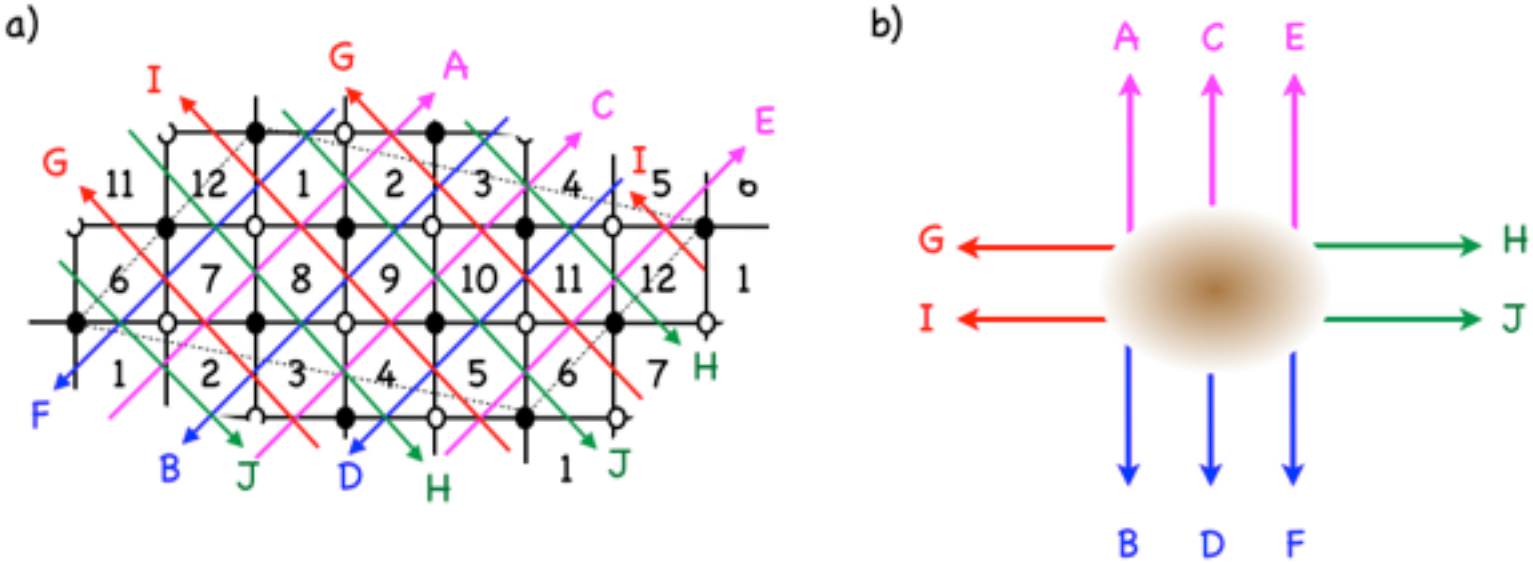
- Allows for completely explicit choice of fractional branes triggering an RG flow dual to the bifid throat

Give a sketch of the main steps

Holographic dual of bifid throat

Holographic dual of bifid throat

- UV of overall throat: Duality cascade on conifold/(Z2xZ3)



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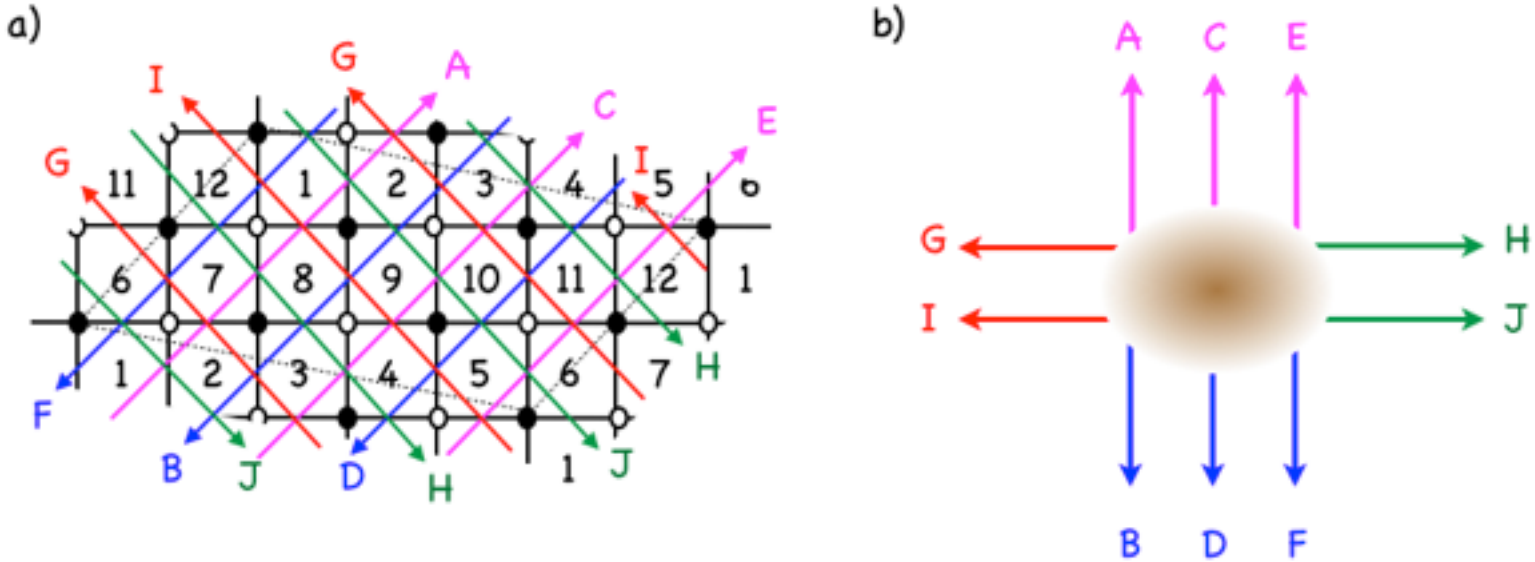
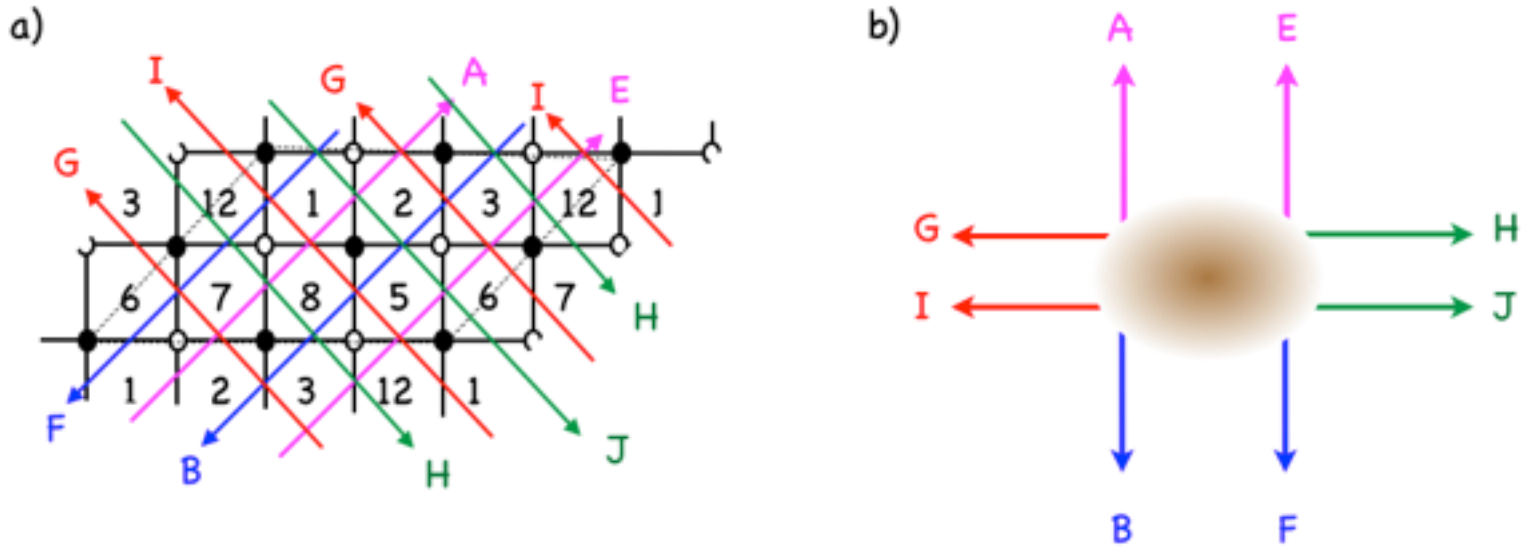


- IR of overall throat: Deformation to conifold/(Z2xZ2)



Holographic dual of bifid throat

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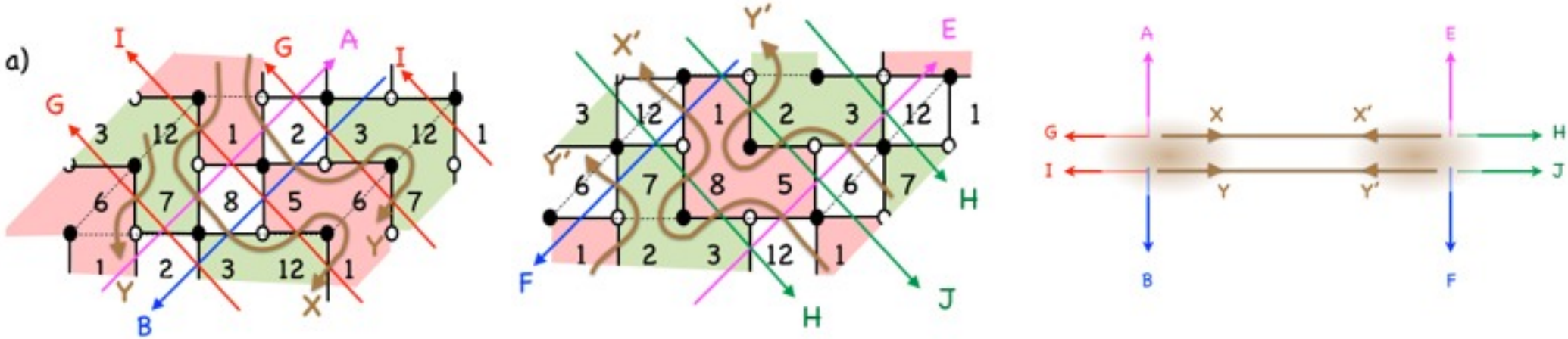
- Daughter throats: baryonic Higgsing to two conifold/Z2



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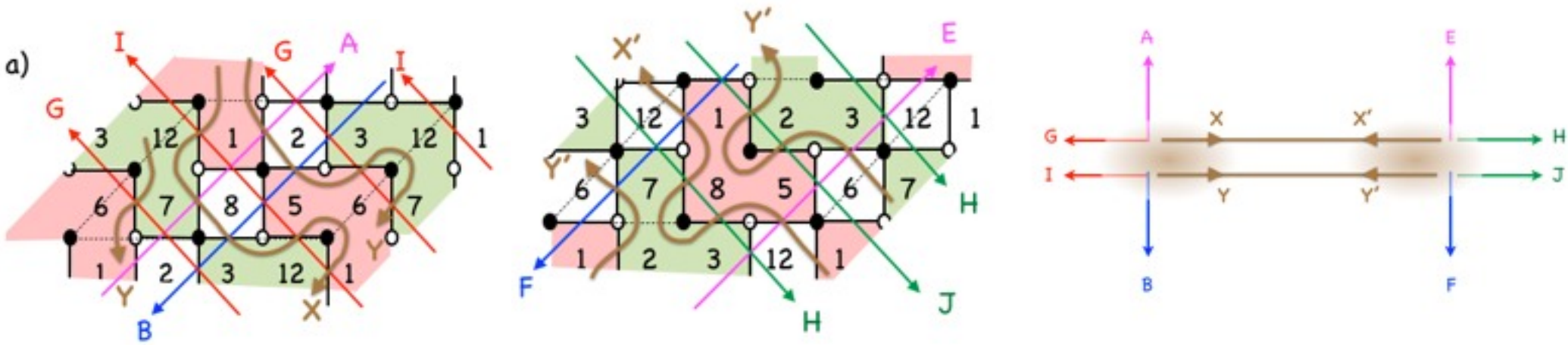

- IR of daughters: Deformation to complex curve of $C^2/Z2$

  Just a Z2 orbifold of Klebanov-Strassler

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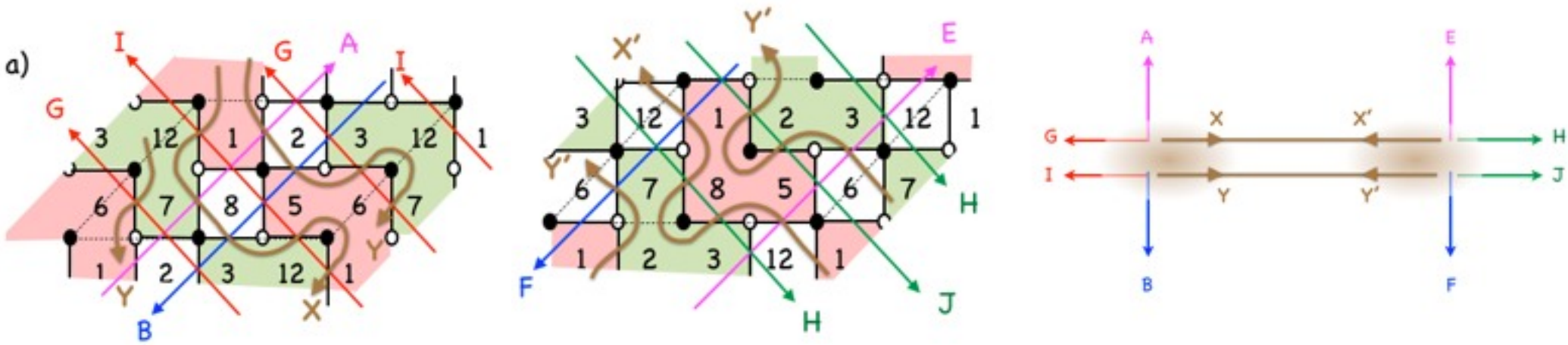

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  Already studied in N=2 fractional branes by Graña, Polchinski

Holographic dual of bifid throat

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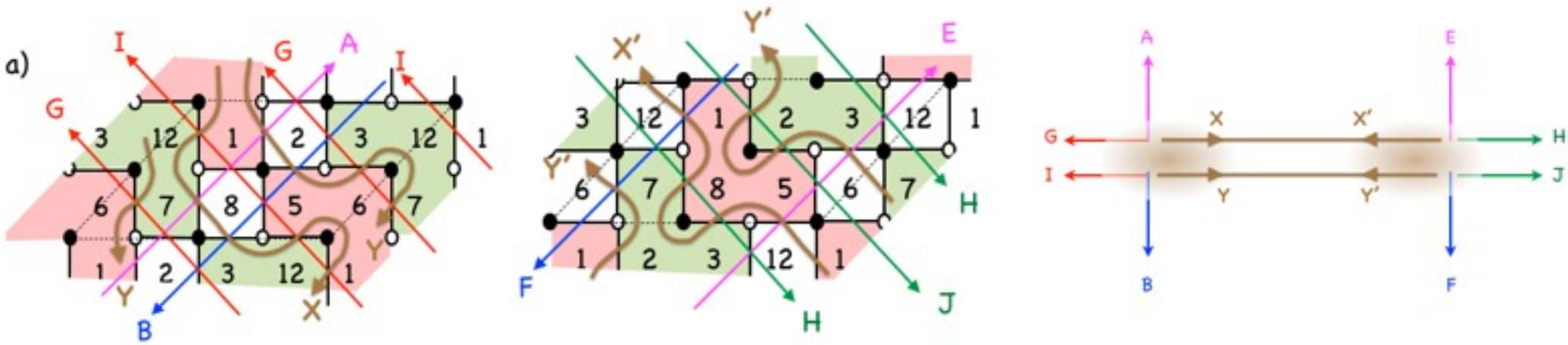

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- Induced D3 charge still subject to antibrane controversy

Conclusions

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- Transplanckian field ranges in axion monodromy ...

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- Transplanckian field ranges in axion monodromy ...
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- More work needed...
  - Important from first-principles perspective
  - but hopefully relevant to new cosmo data

Thank you!