New gravity duals for higher-dimensional superconformal theories

Alessandro Tomasiello

based on
1309.2949 with F.Apruzzi, M. Fazzi, D. Rosa
1404.0711 with D. Gaiotto
1406.0852 with F.Apruzzi, M. Fazzi, A. Passias, D. Rosa

Introduction

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  - intersecting branes

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In this talk, we will see some holographic classification results for superconformal theories in $d = 5, 6$:

- A classification of AdS_7 BPS solutions in type II sugra.
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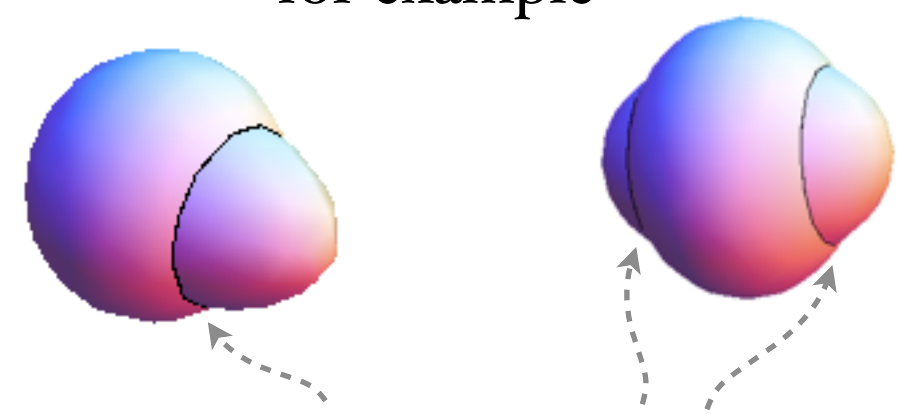
no lift to 11d

$\mathrm{AdS}_7 \times M_3$

M_3 = 'distorted S^3'

for example



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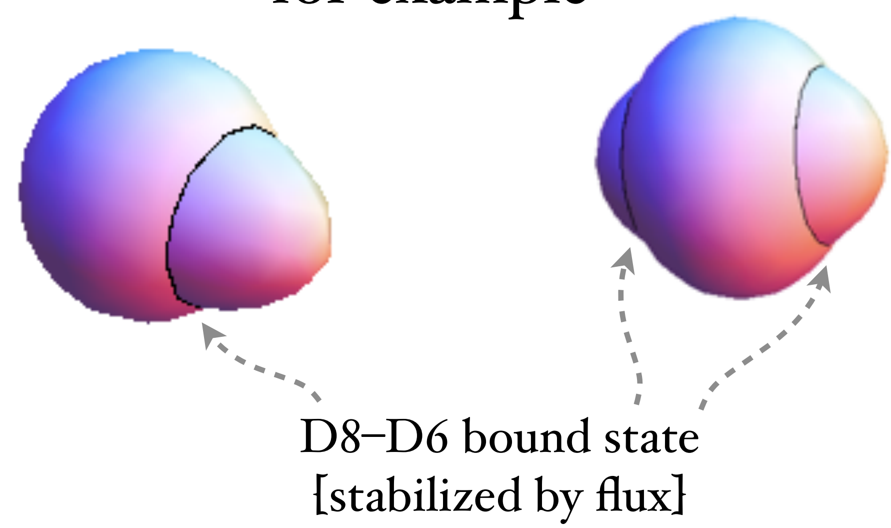
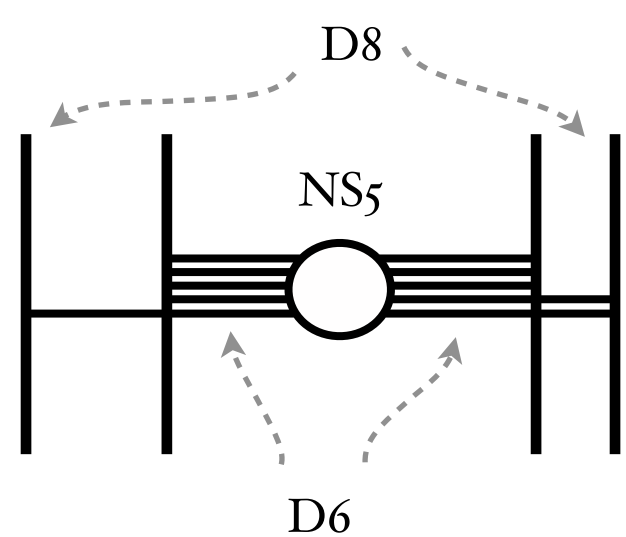


- Their $\mathcal{N} = (1,0)$ CFT_6 duals.
  - near-horizon limits of brane systems
  - quiver descriptions on tensor branch
  - via T-duality: 'Hitchin pole' extension of F-theory classification in [Heckman, Morrison, Vafa '13]



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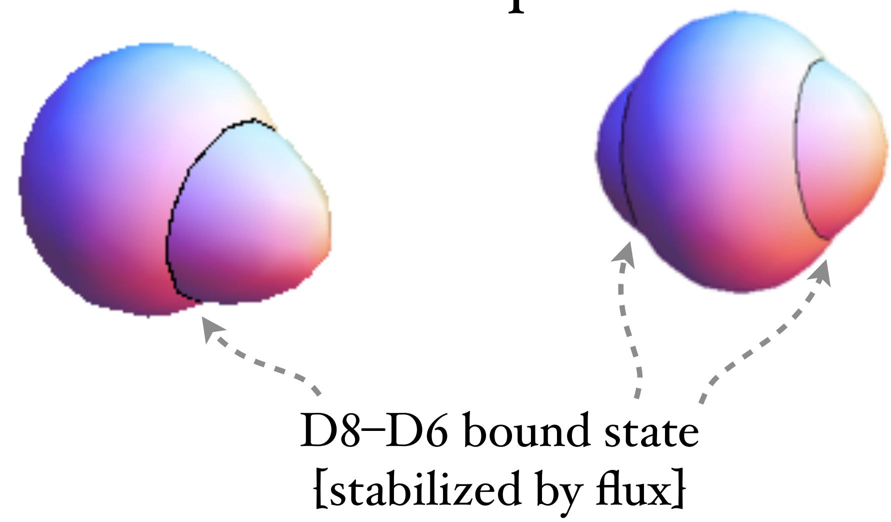

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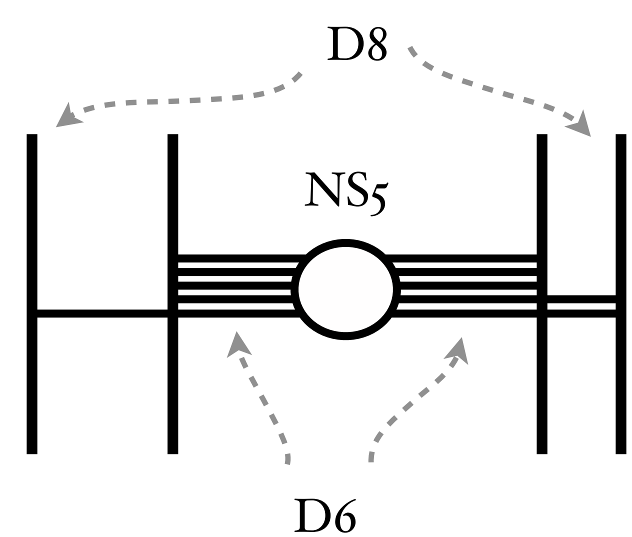

- A similar (but less complete) classification of AdS_6 solutions.

Plan

1. Methods: Pure spinors
2. Classification of AdS_7 solutions
3. CFT_6 duals
4. AdS_6 solutions

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'generalized tangent bundle': vectors $\oplus$ 1-forms

forms obeying algebraic constraints:

often 'pure spinors'

nicer equations; easier classifications

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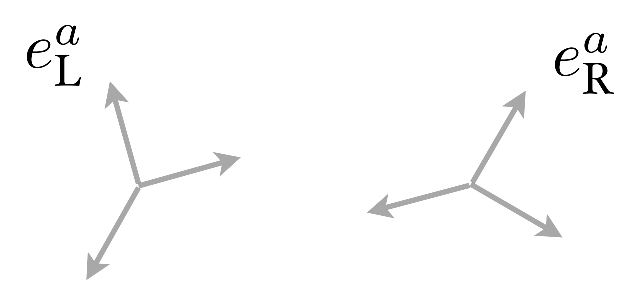

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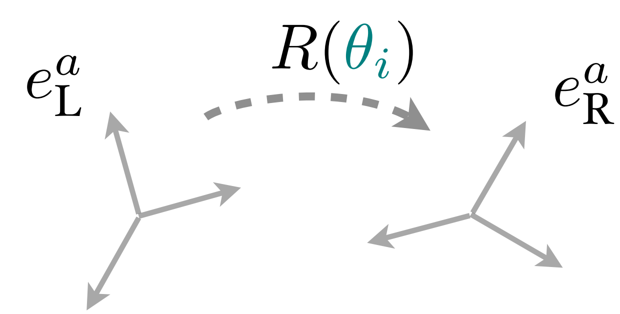
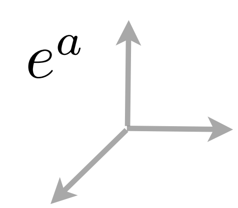


we prefer working with one 'average' of the two



+ some 'Euler angles' θ_i (functions on M_3)

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When the dust settles:
we have a local solution
provided we solve a system of 3 ODEs

warping

$$\begin{cases} \partial_r A = \ldots \\ \partial_r v = \ldots \\ \partial_r \phi = \ldots \end{cases}$$

dilaton

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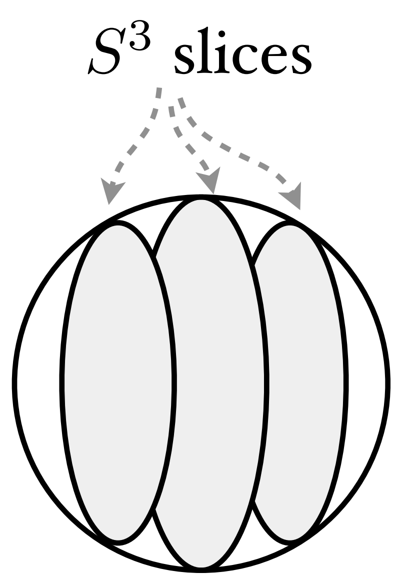
$S^4 =$ 

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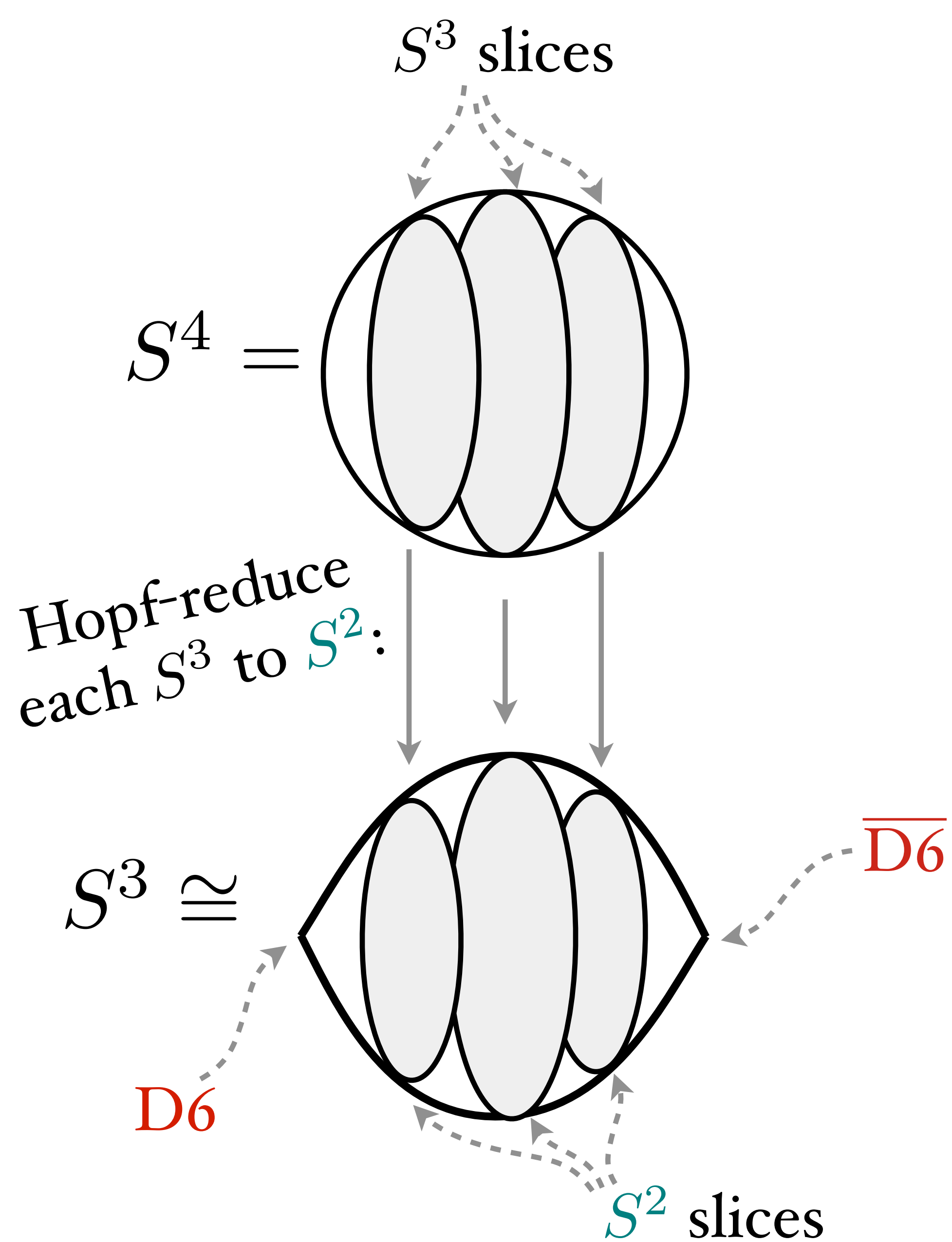

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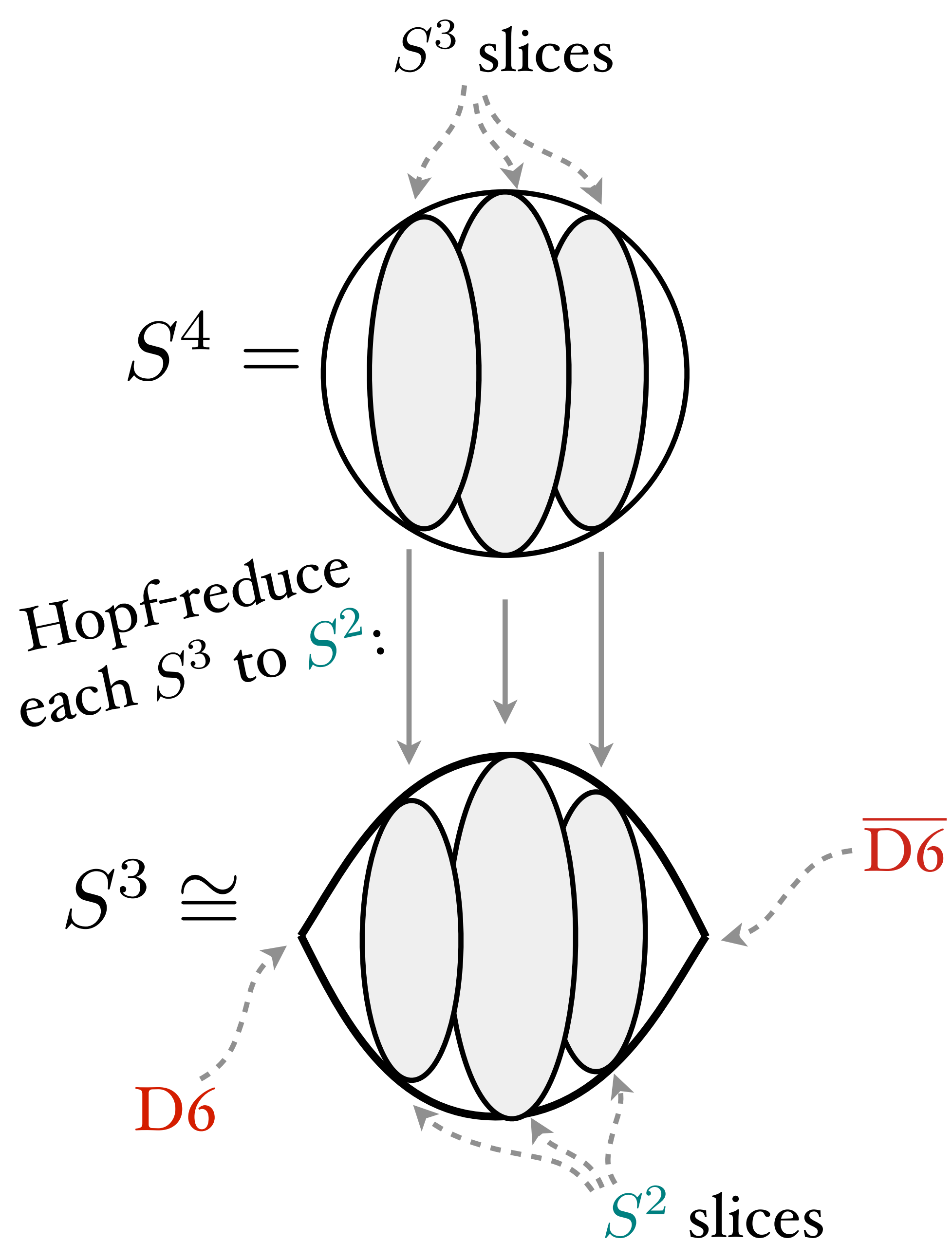

[agrees with results in previous slide]

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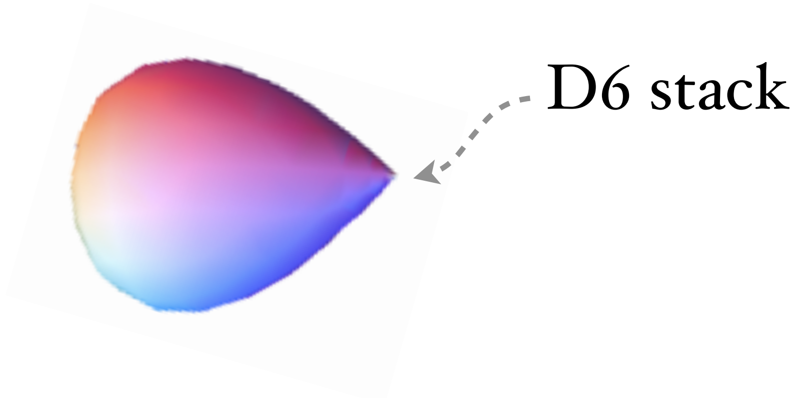

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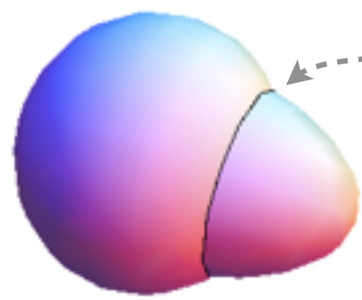

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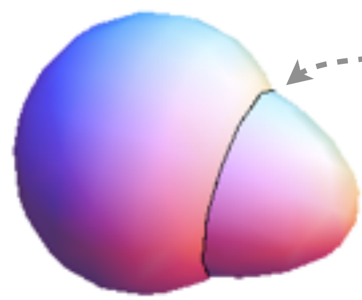

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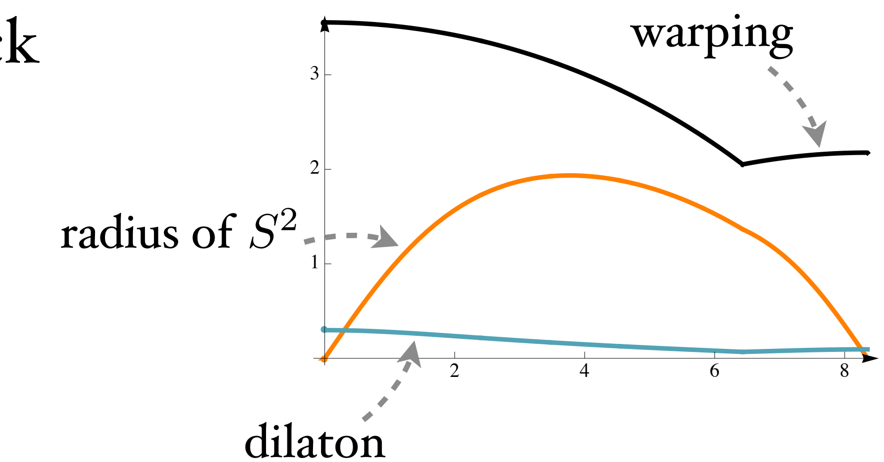

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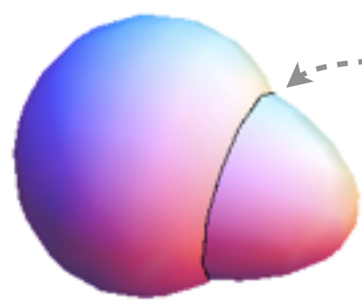
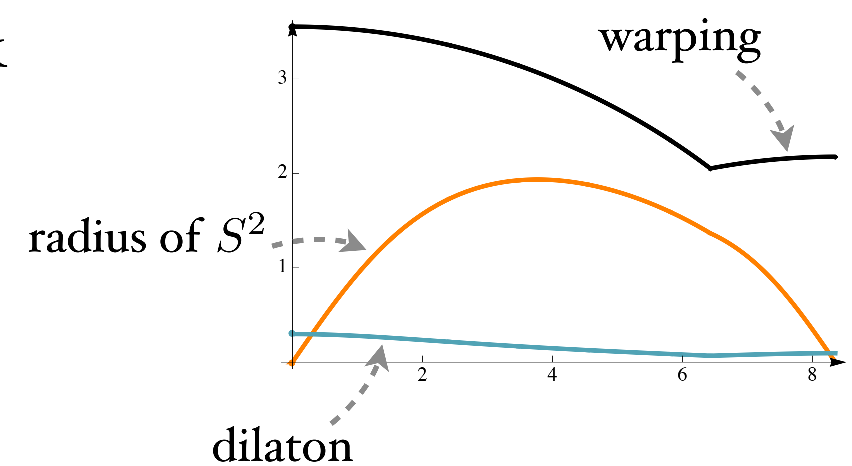
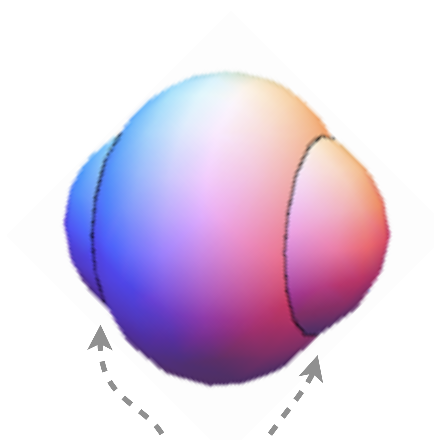




or include several
D8/D6 stacks:



intuitively: D8's don't slip off
because of electric attraction

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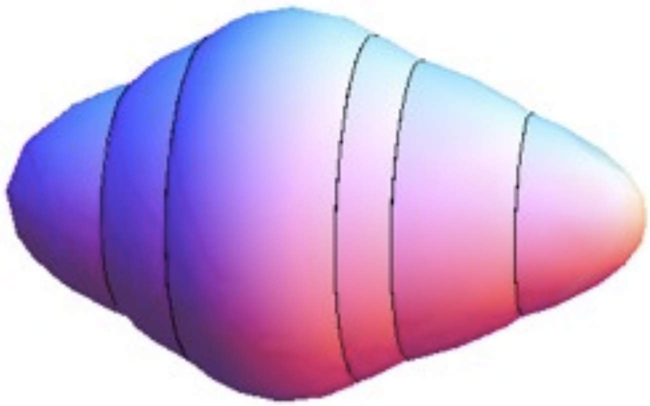

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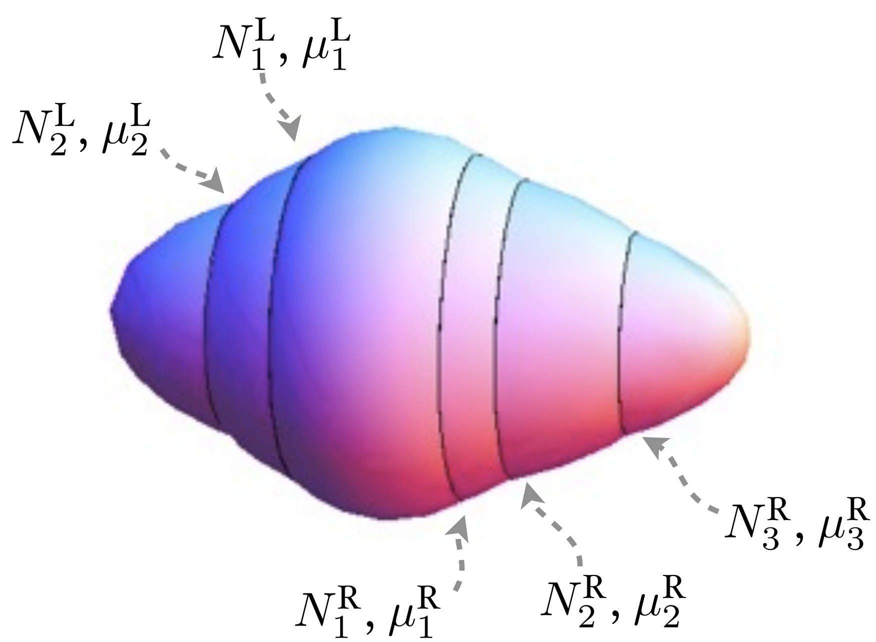

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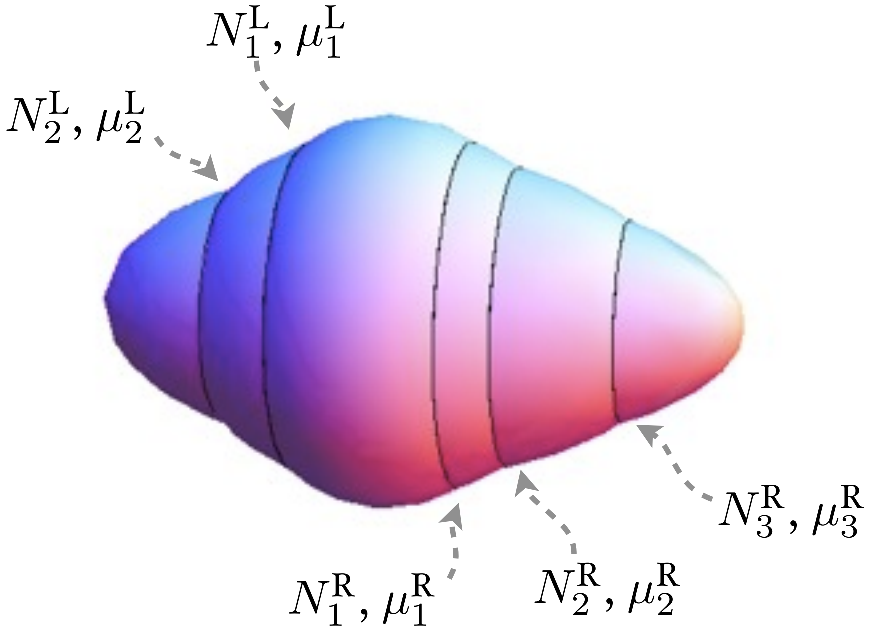

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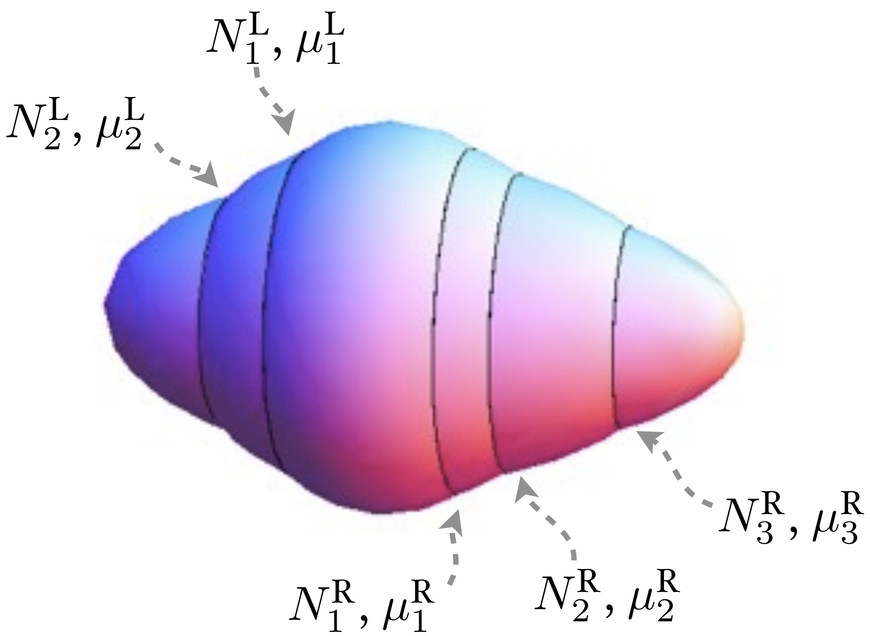

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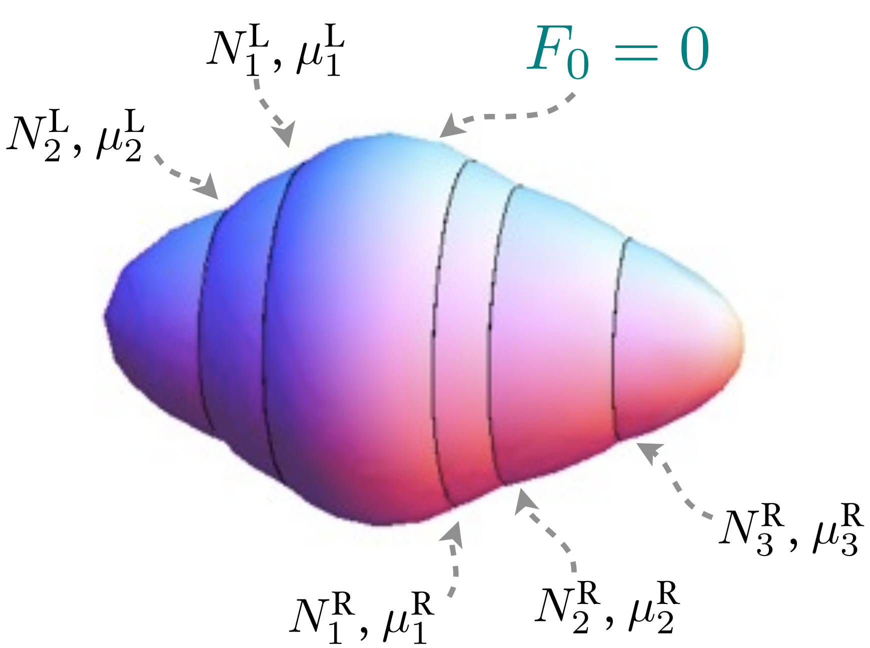

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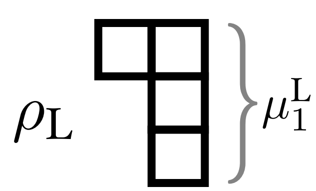

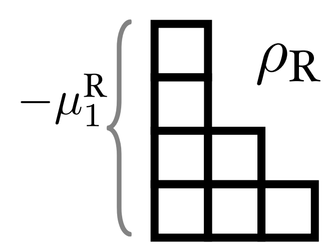

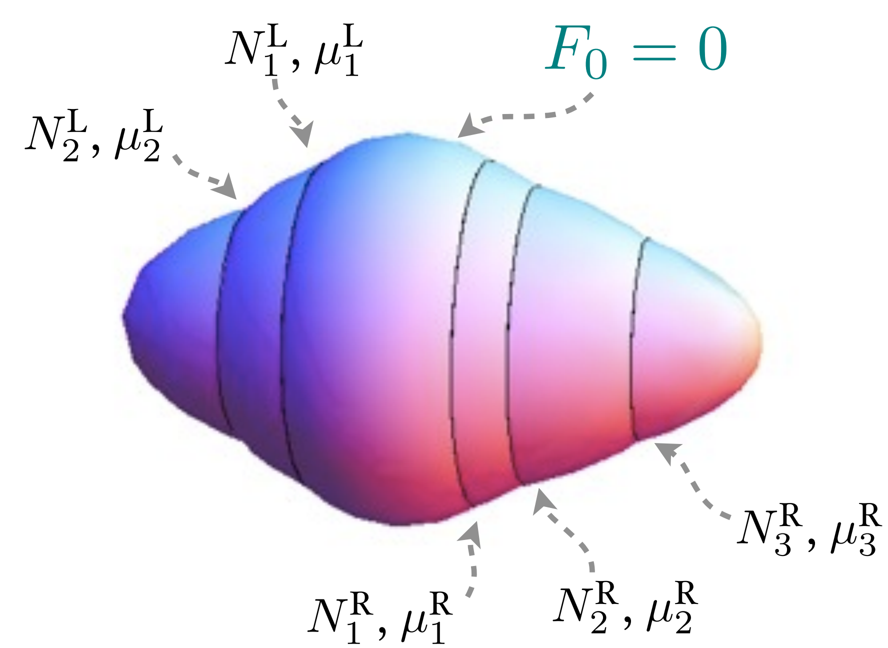

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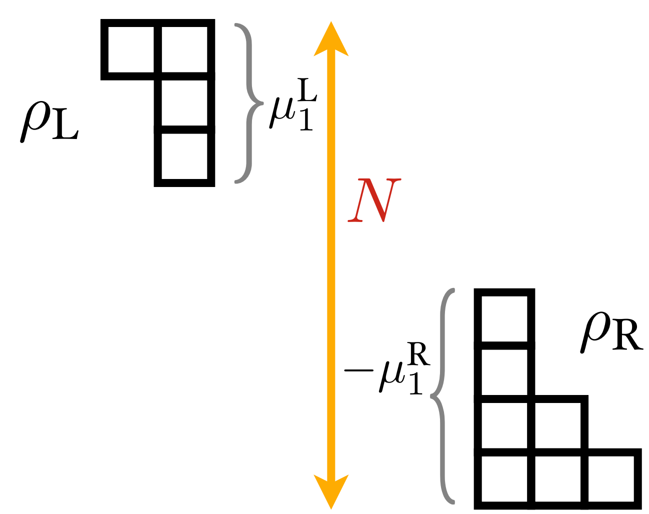
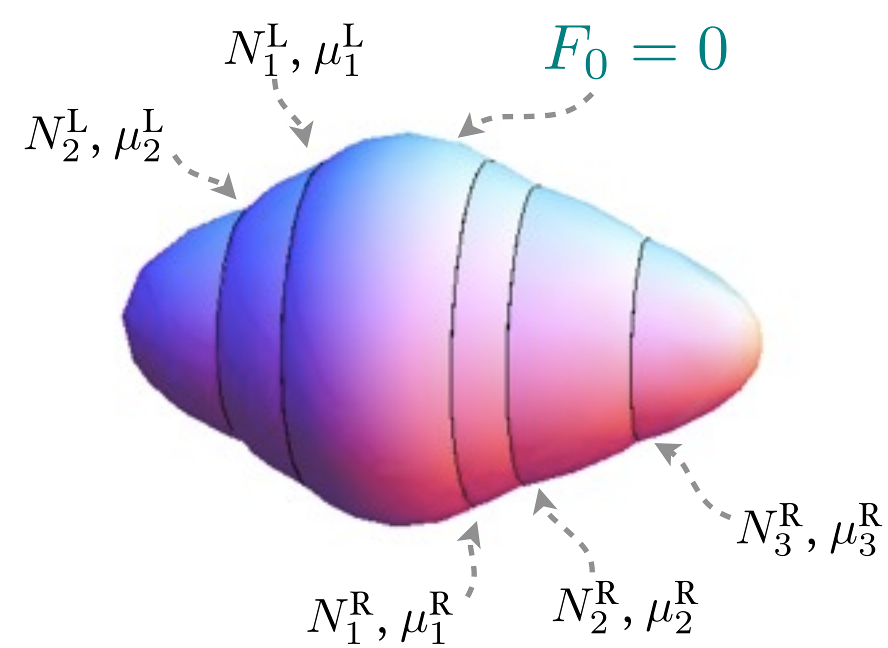
- $N \geq |\mu_1^{\rm L}| + |\mu_1^{\rm R}|$

bordering $F_0 = 0$ region.





III. CFT_6 duals

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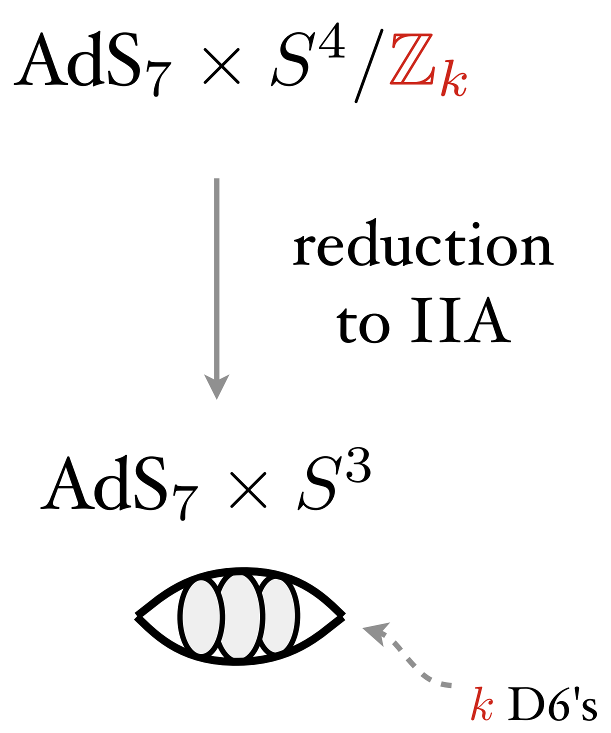

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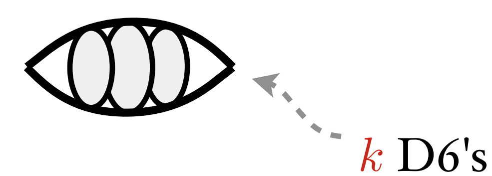
N M5-branes at $\mathbb{R} \times \mathbb{R}^4/\mathbb{Z}_k$ sing. —near-horizon→ $AdS_7 \times S^4/\mathbb{Z}_k$

↓ reduction to IIA

$AdS_7 \times S^3$



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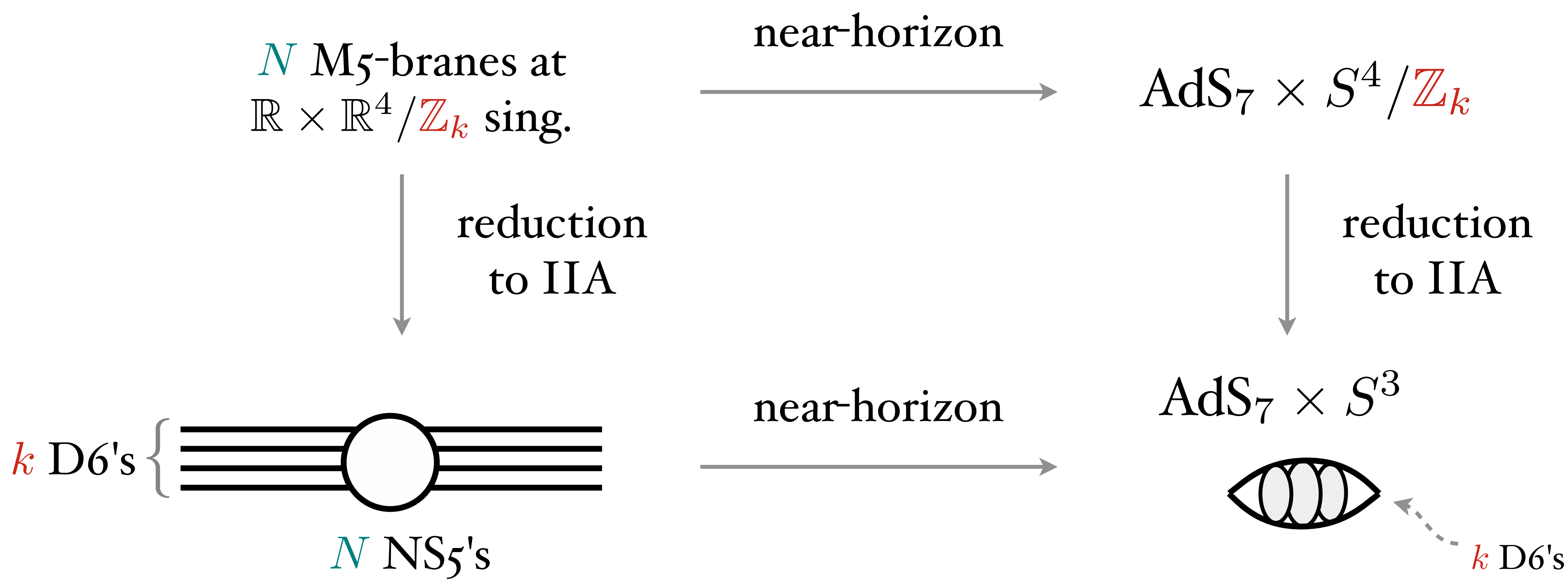

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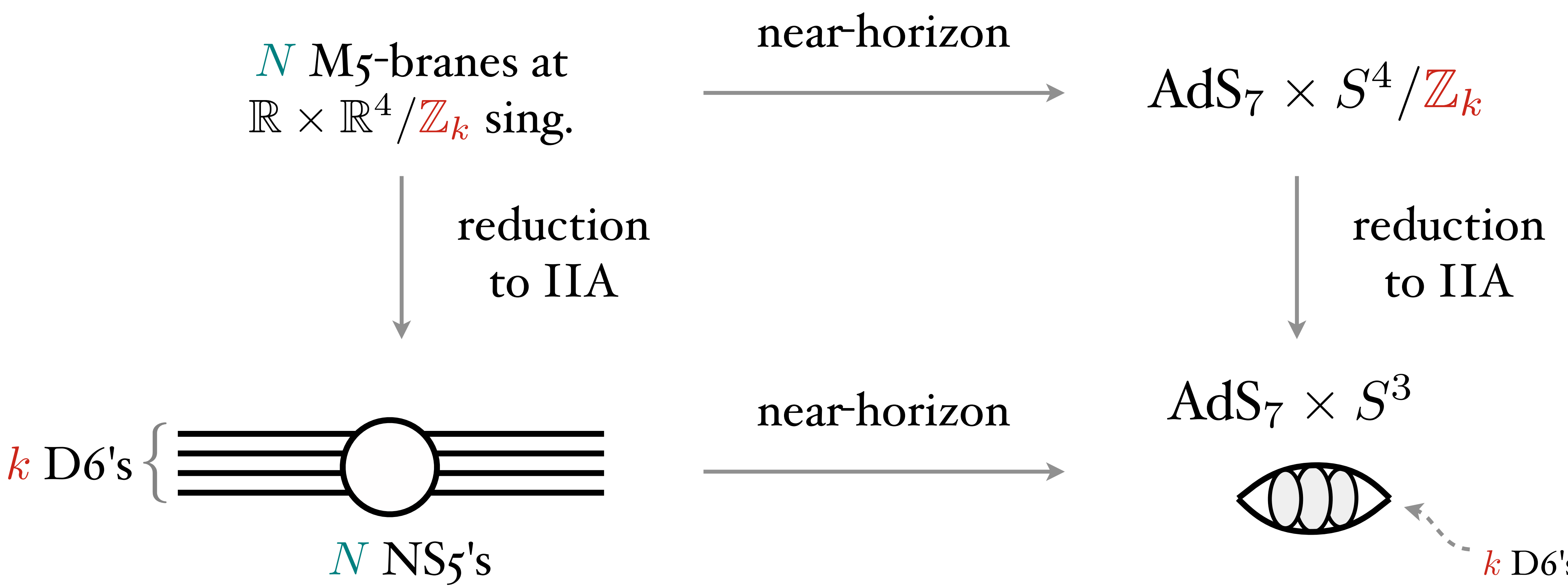

CFT_6 with

- $(1,0)$ supersymmetry
- N^3k^2 degrees of freedom
- $\text{SU}(k) \times \text{SU}(k)$ flavor symmetry

To include $F_0 \neq 0$, we should introduce D8-branes

Adapting methods developed
in [Gaiotto, Witten '08] for 3d theories

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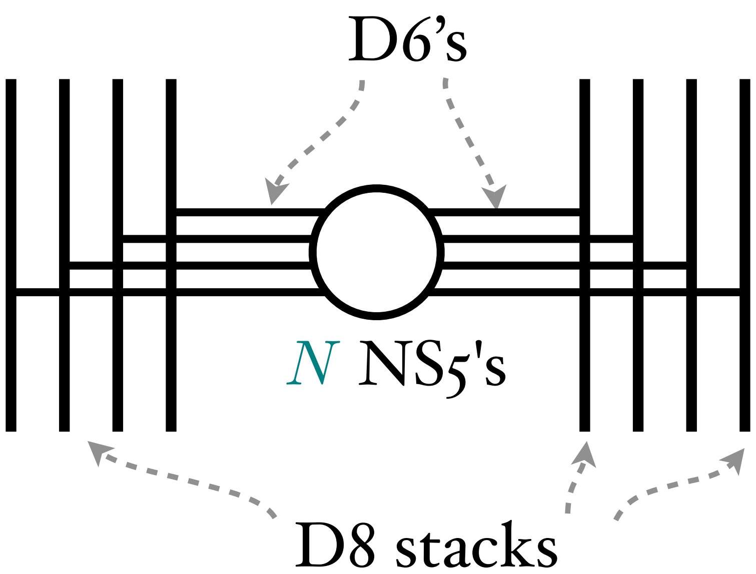

Each D6 on a separate D8:
Dirichlet b.c. for fields on the D6.

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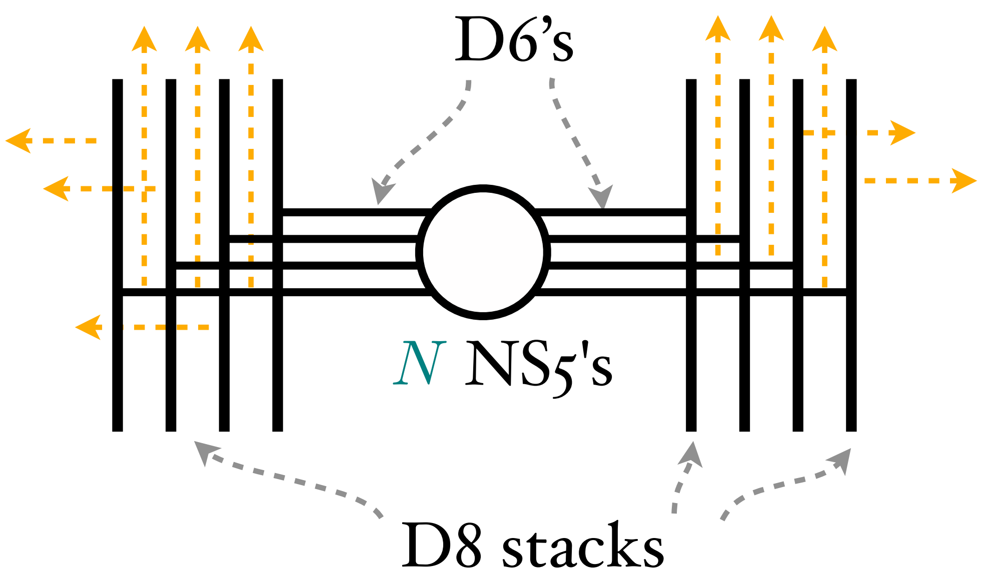

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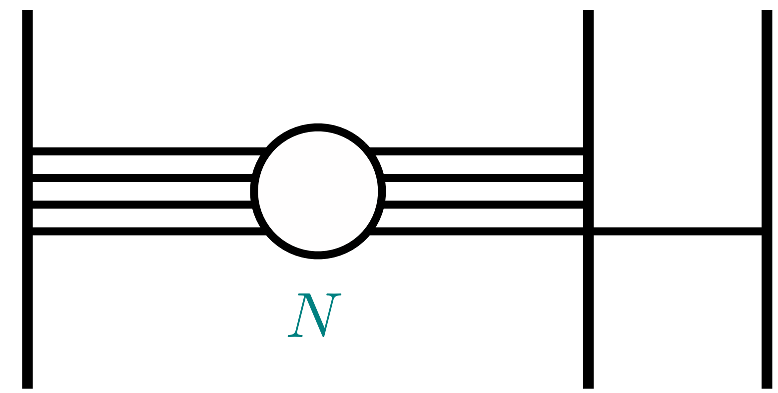

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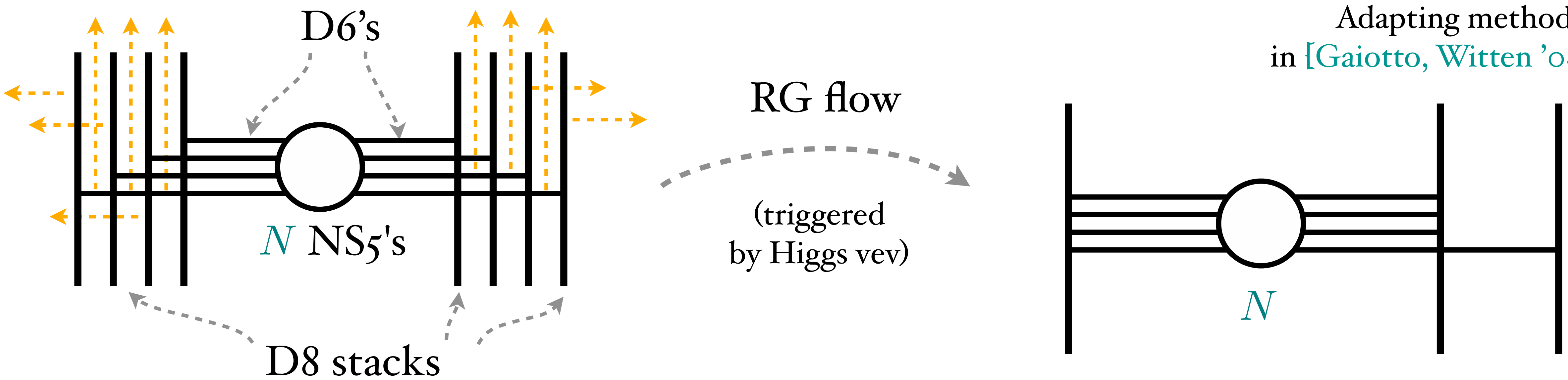

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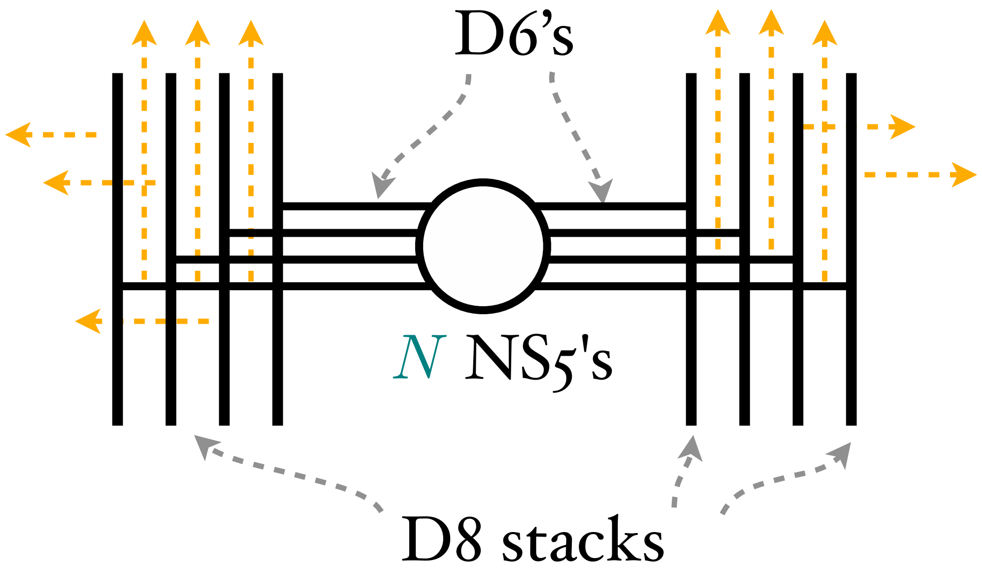

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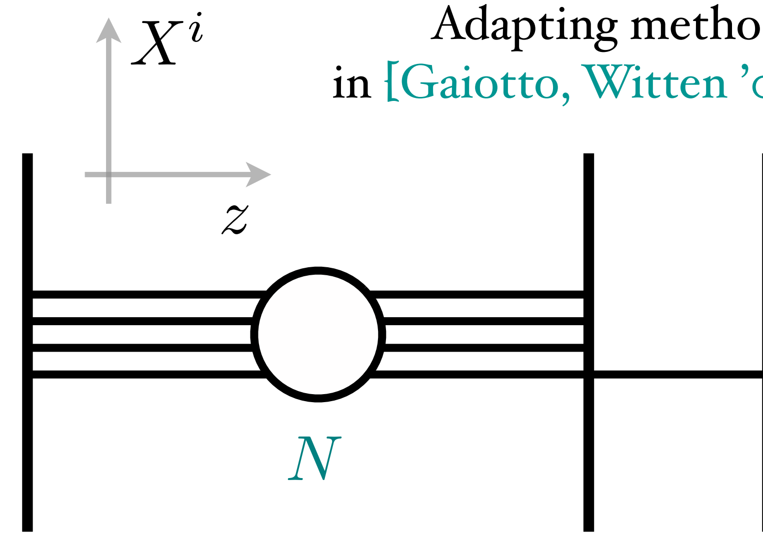

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$$X^i \sim \frac{t_i}{z}$$

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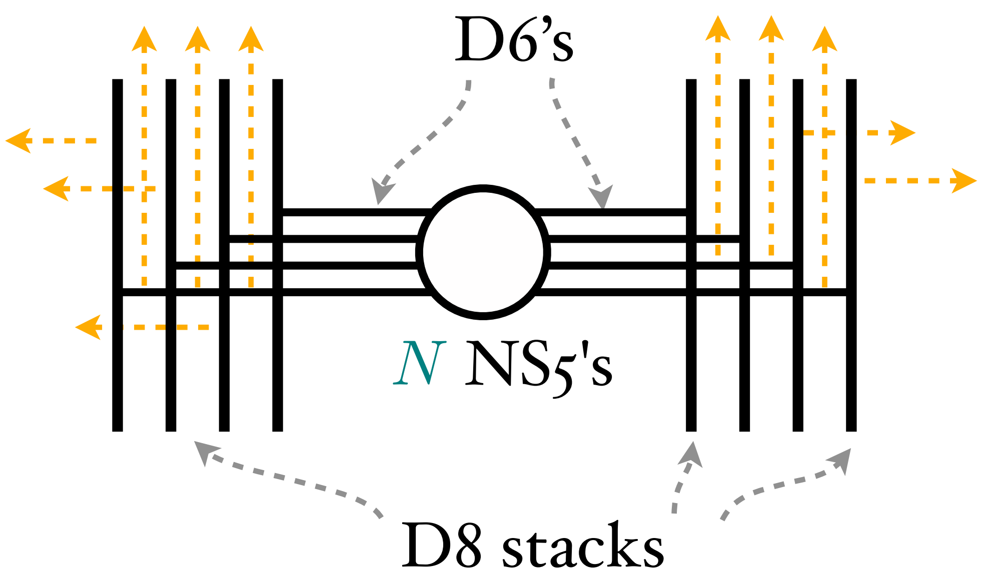

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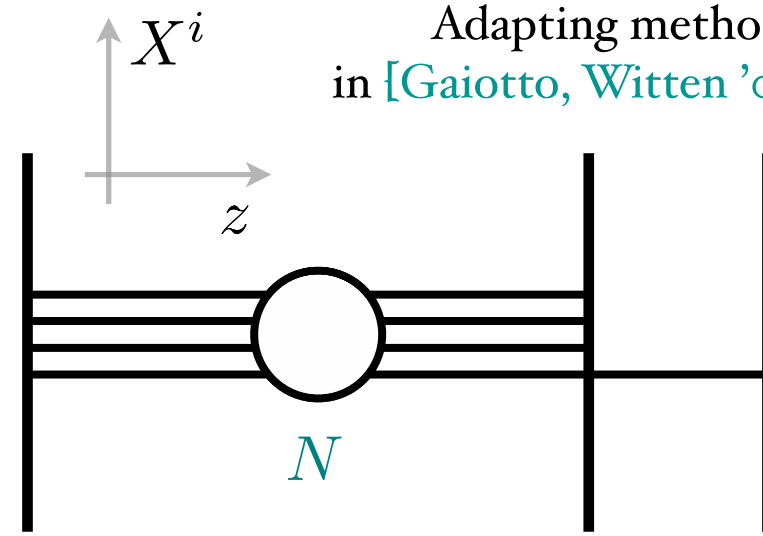

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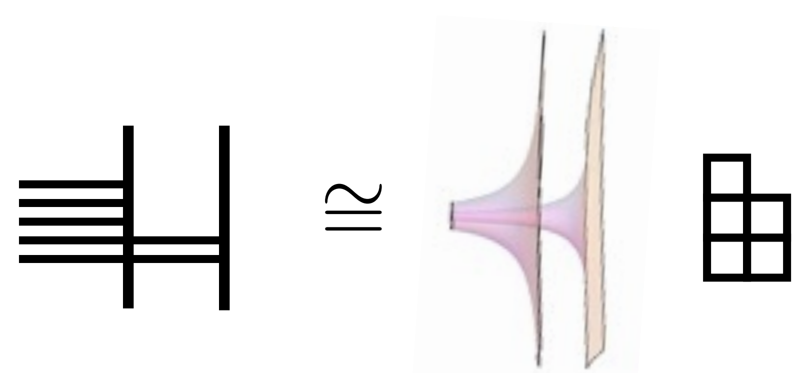

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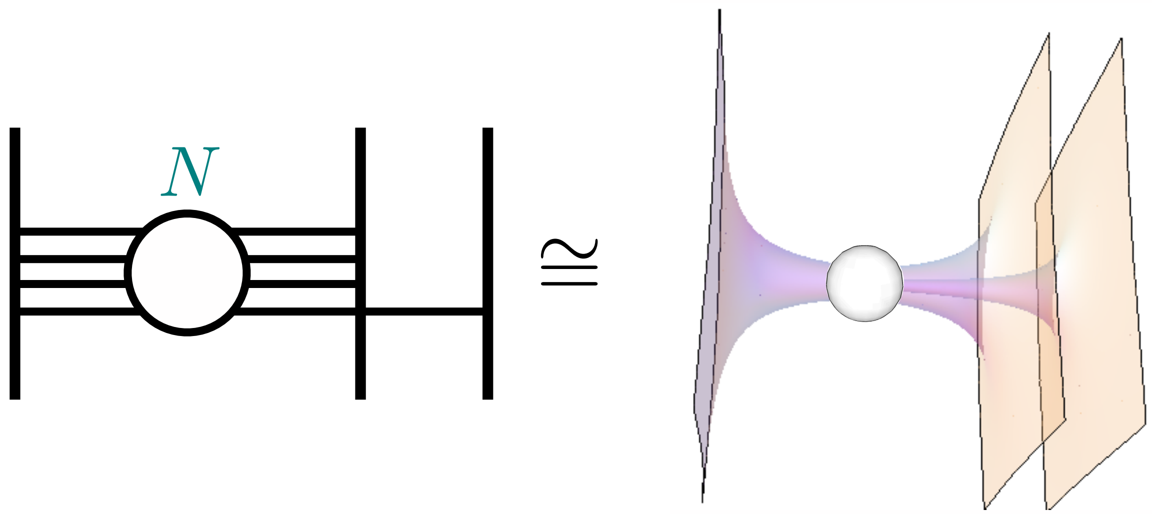

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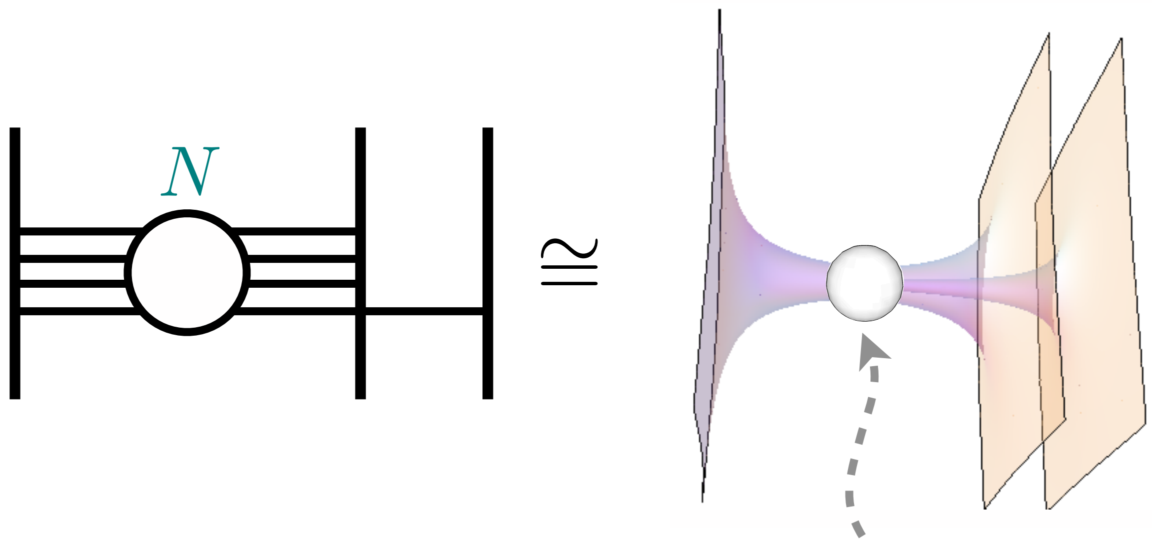

near-horizon
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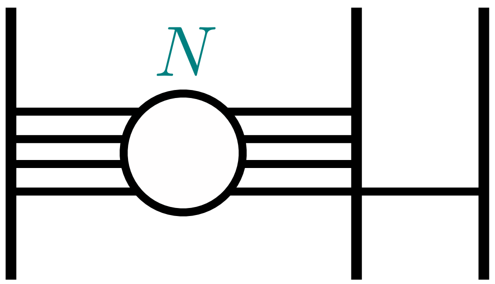

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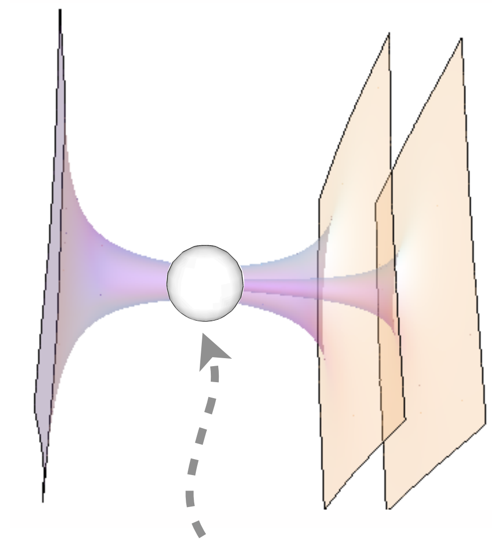

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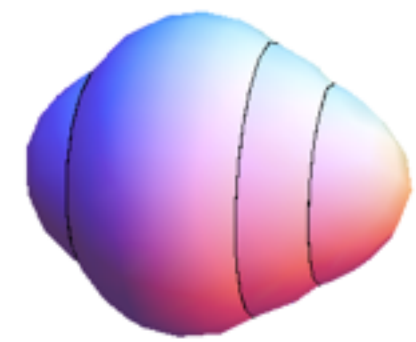

...and the funnels become
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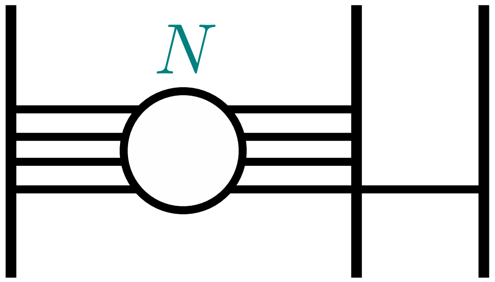

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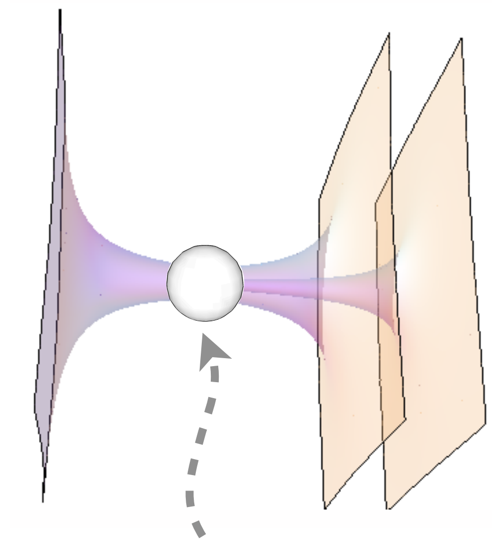

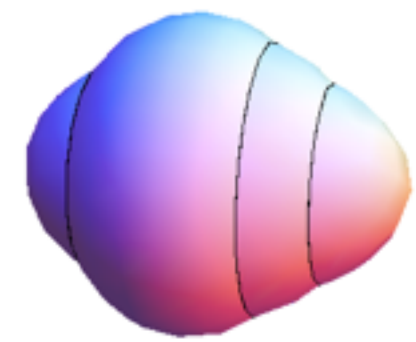

Conjecture:

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More precisely:

D6's ending on a D8 $\longleftrightarrow$ $\mu \equiv$ D6 charge of the D8

N = # NS5's $\longleftrightarrow$ flux integer $\int_{M_3} H$

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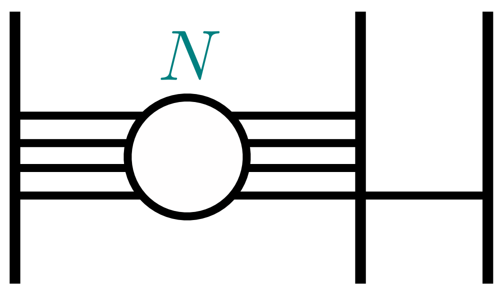

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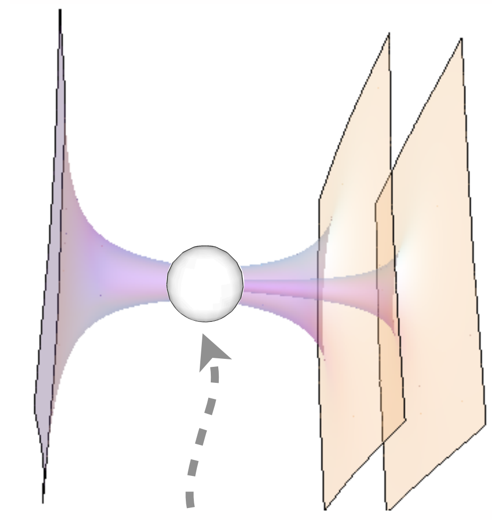

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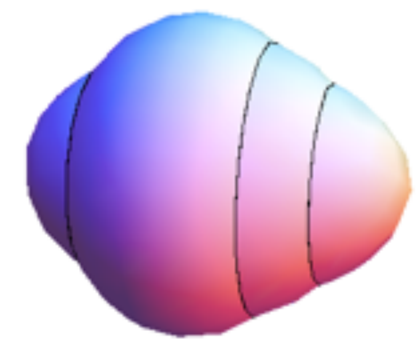

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Indeed the brane pictures would generically lead to predict a CFT:

- coinciding NS5's ⇨ tensionless strings [Hanany, Zaffaroni '97; Brunner, Karch '97]
- nontrivial moduli spaces [singularities in the Higgs moduli space of massless theory]

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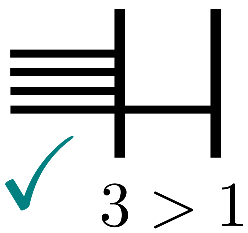
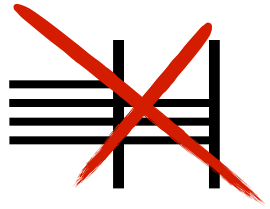
- ordering constraint in [Gaiotto, Witten '08]



$3 > 1$



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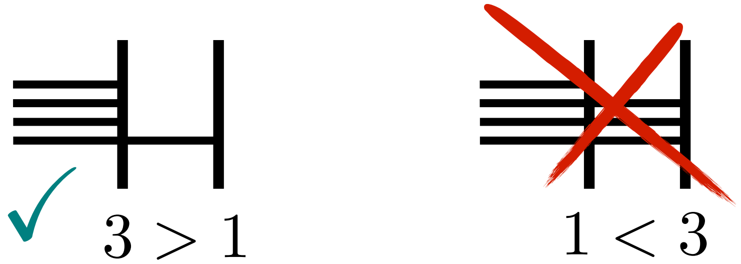
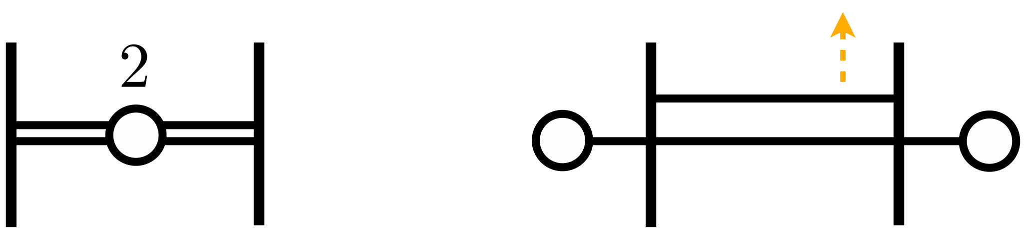
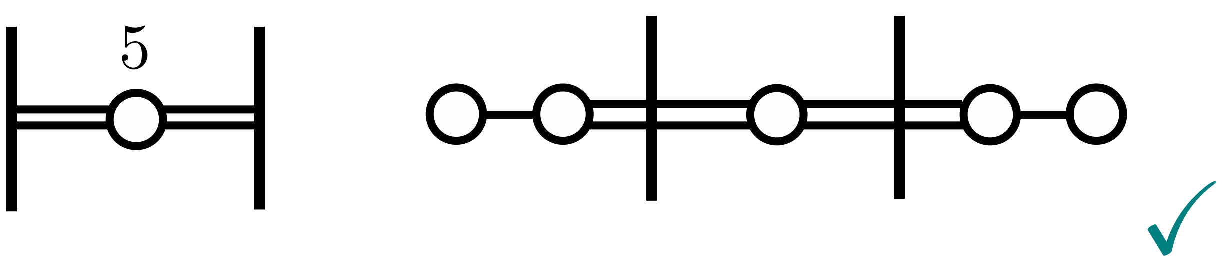


- separating the NS5’s ⟶ tensor branch, effective quiver description:



not a CFT: presence of free hypers



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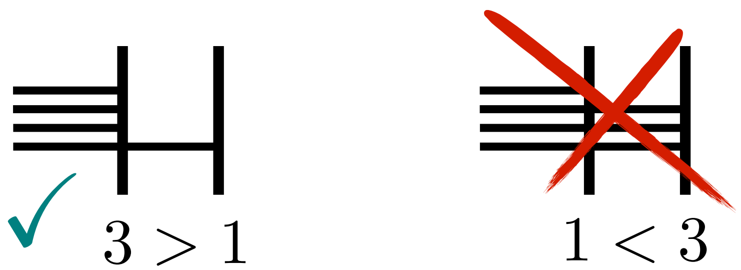

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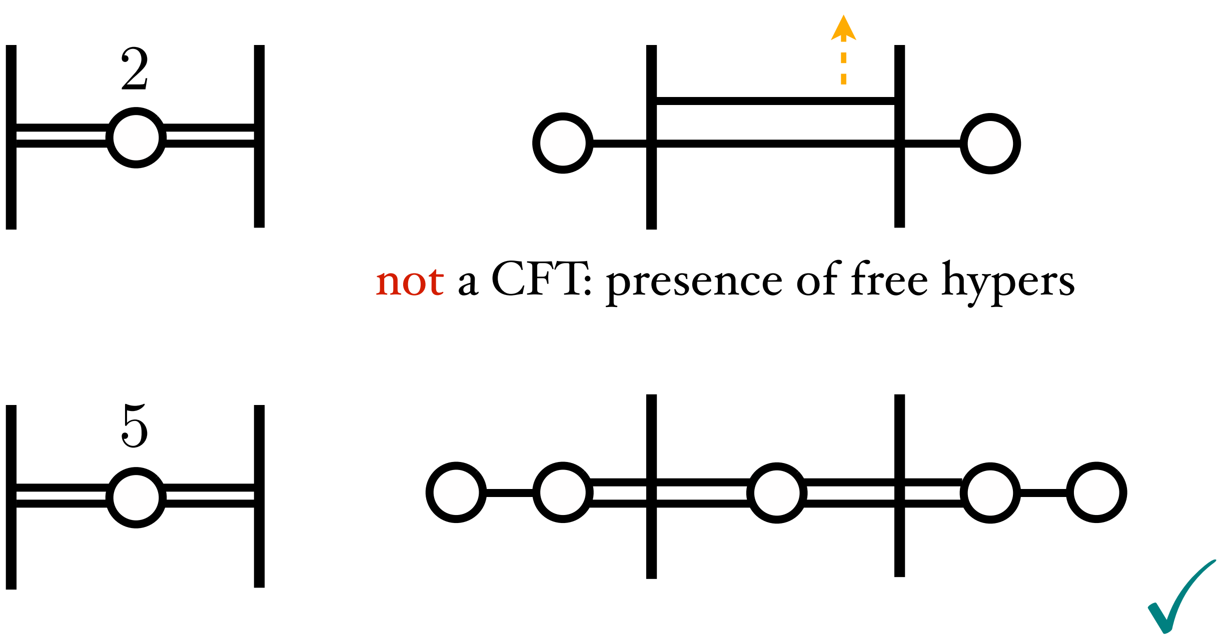

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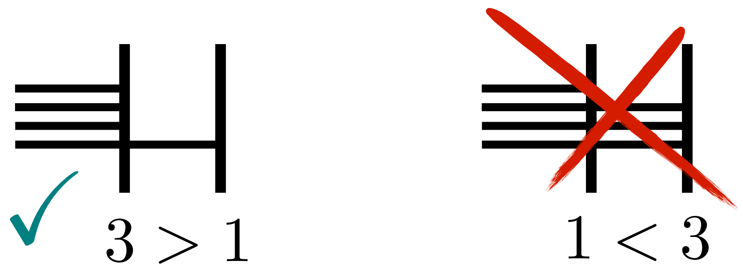

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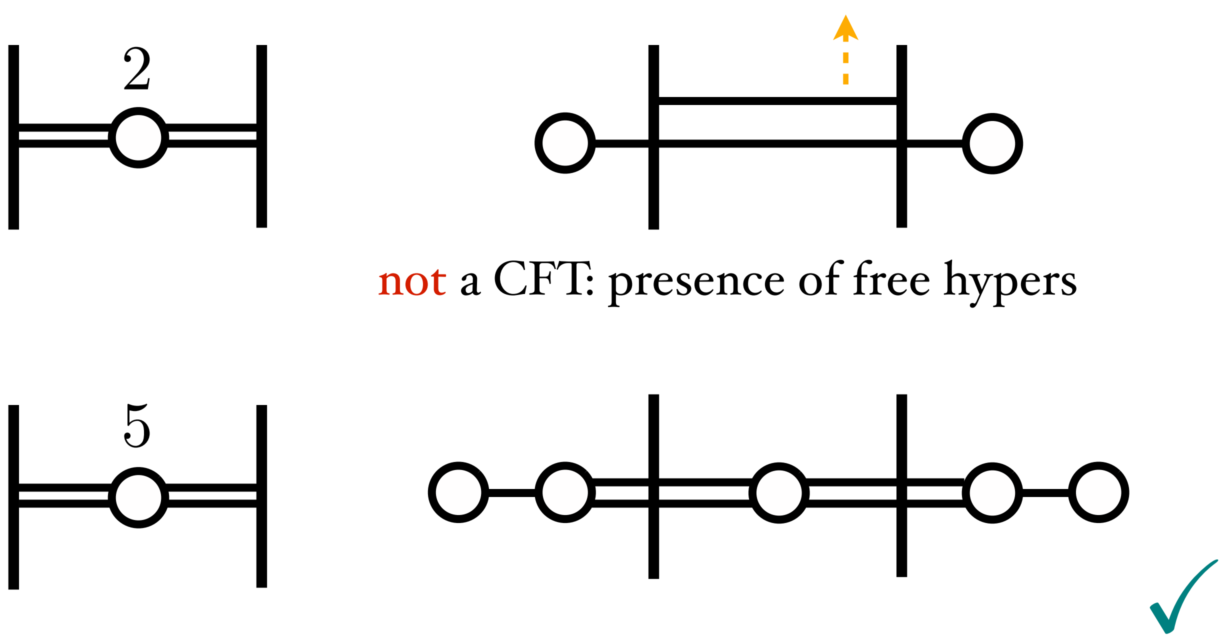

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One-to-one correspondence with AdS7 solutions!

Coda: Comparison to F-theory

[wip. with del Zotto, Heckman, Vafa];
see also Vafa's talk

Many new $(1,0)$ CFTs from chains of intersecting curves

[Heckman, Morrison, Vafa '13]

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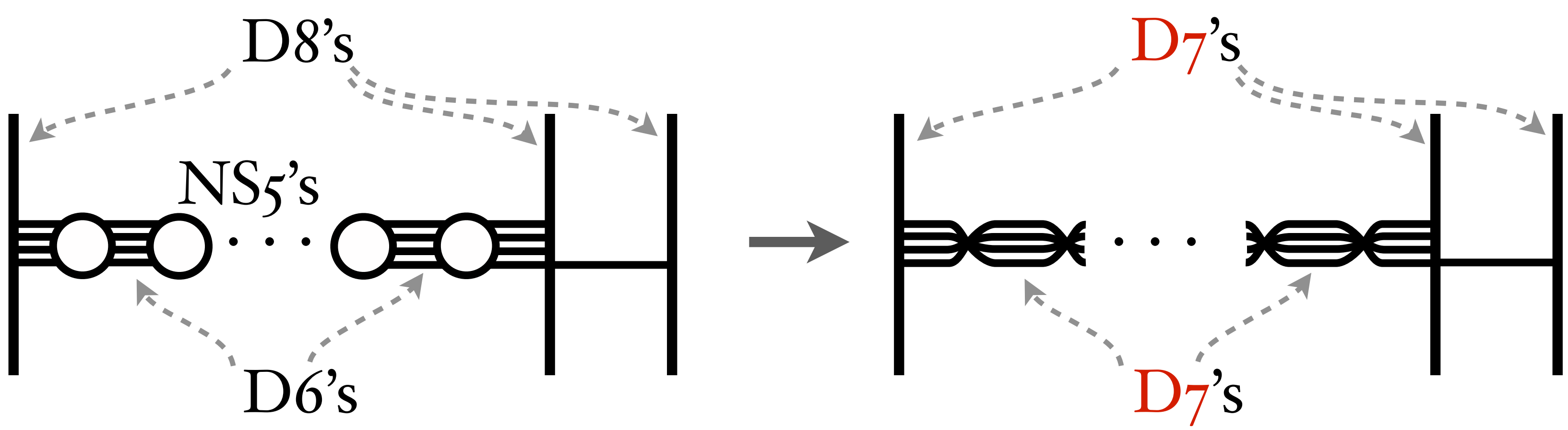

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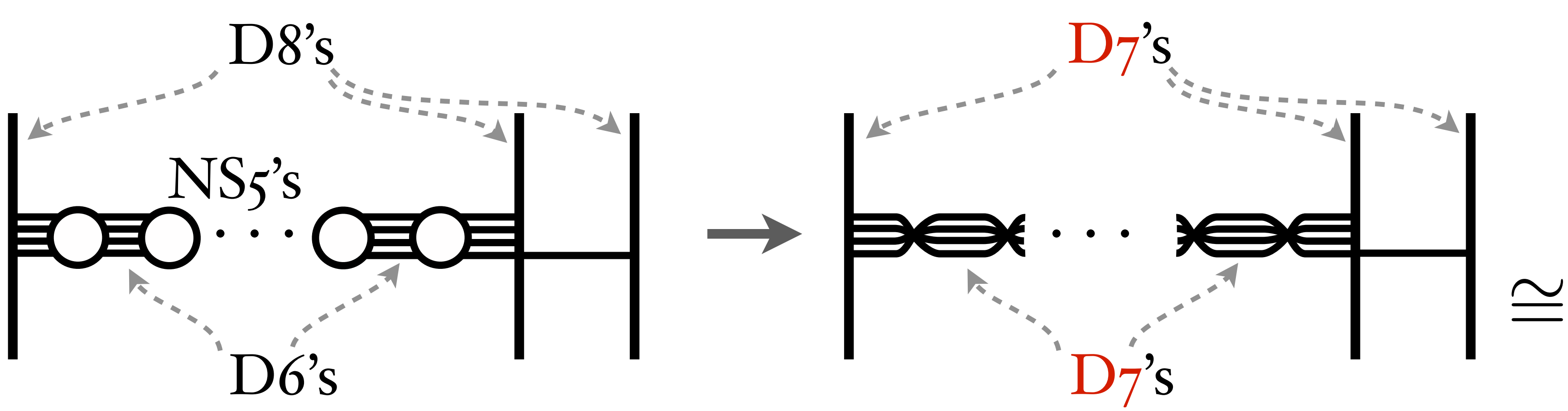

Nahm's equations → Hitchin's equations

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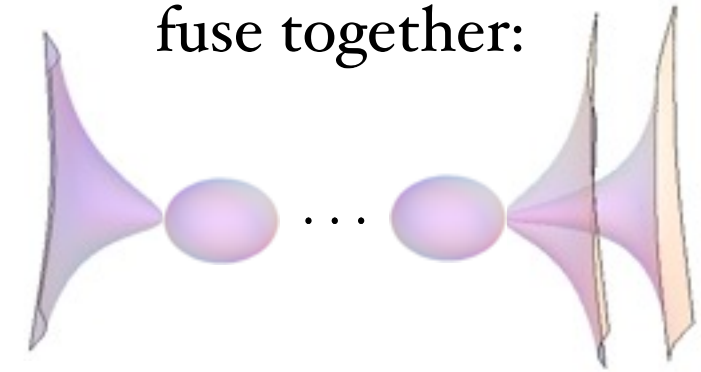

One of their chains of intersecting curves, decorated by Hitchin poles

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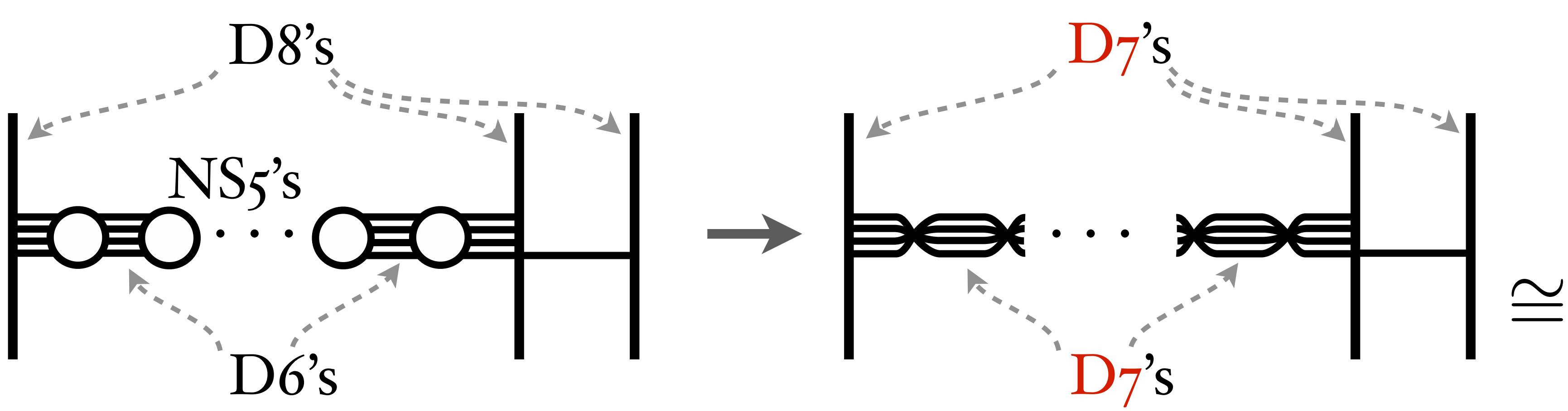

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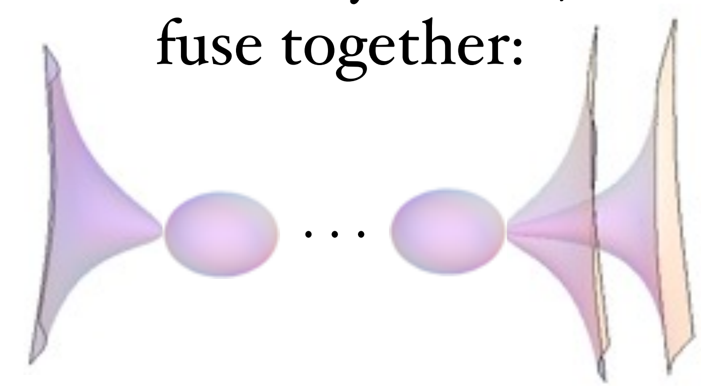

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This suggests that one should add Hitchin poles to the chains of non-perturbative F-theory 7-branes as well.

- some chains with exceptional gauge groups
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e.g. a chain of curves with self-intersection $12; \underbrace{1, 2, 2, 3, 1, 5, 1, 3, 2, 2, 1, 12}_{\text{pattern repeated } N \text{ times}}; 1, 2, 2, \ldots$

and gauge groups $\overbrace{\mathrm{SU}(2) \times G_2 \times F_4 \times G_2 \times \mathrm{SU}(2) \times E_8}^{} \times \mathrm{SU}(2) \times \ldots$

"fractional M5's"

is dual to $\mathrm{AdS}_7 \times S^4/\Gamma_{E_8}$

IV. AdS_6

{Apruzzi, Fazzi, Passias, Rosa, AT '13}

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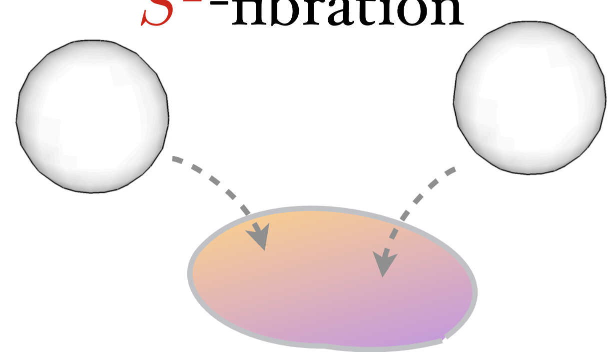
IIB: again we determined the local form of the metric:



the S^2 realizes the SU(2) R-symmetry of a 5d theory.

we also determined all fluxes; they obey Bianchi automatically

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to 2 first-order PDEs on Σ_2

for warping
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T-dual of D4–D8–O8

[Cvetic, Lu, Pope, Vazquez-Poritz '00;
Lozano, Colgain, Sfetsos, Rodriguez-Gomez '12]

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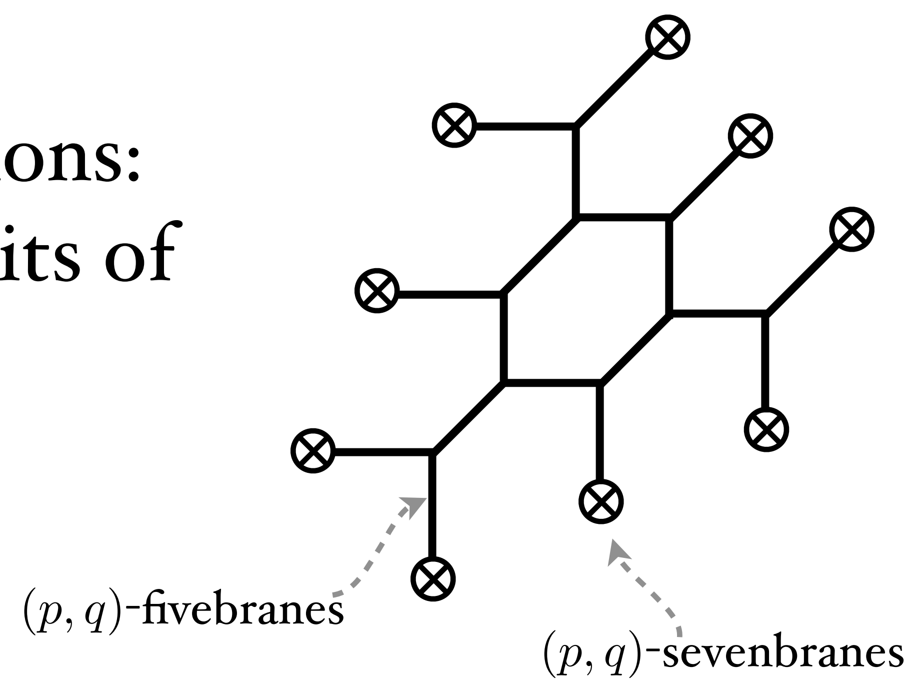
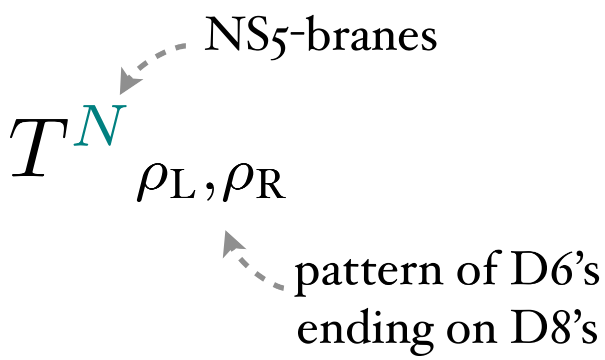
Expected solutions: near-horizon limits of (p, q)-webs

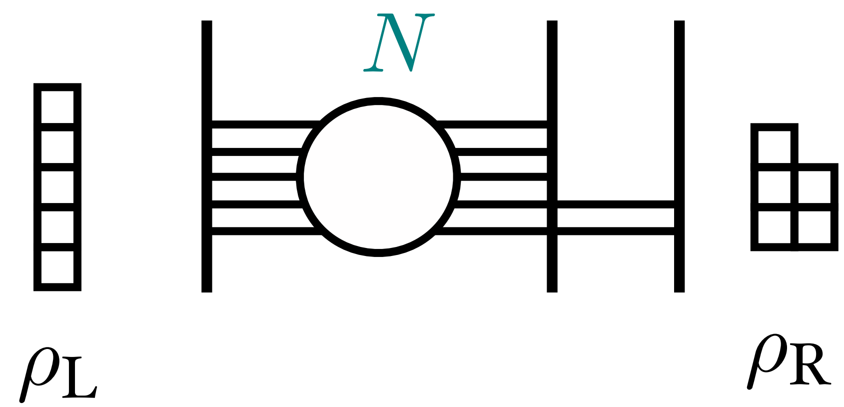


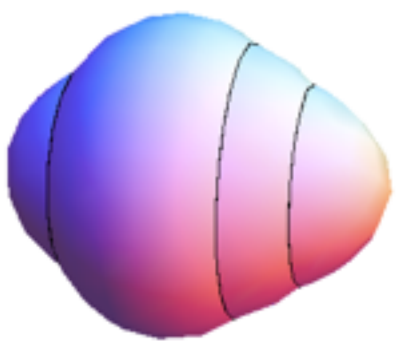
e.g. [Aharony, Hanany '97; deWolfe, Hanany Iqbal, Katz '99; Benini, Benvenuti, Tachikawa '08; Bergman, Rodriguez-Gomez '12]

Conclusions

- Gravity duals for infinite family of $(1,0)$ 6d CFTs







with effective quiver description on 'tensor branch'

- Possible generalizations: include O6's, O8's

- Hints of more general story from F-theory

- Gravity duals for 5d CFTs?