AdS$_3$ SOLUTIONS WITH $(0,5)$ AND $(0,6)$ SUPERSYMMETRY & HOLOGRAPHY

ANAYELI RAMÍREZ

UNIVERSITÀ DI MILANO-BICOCCA

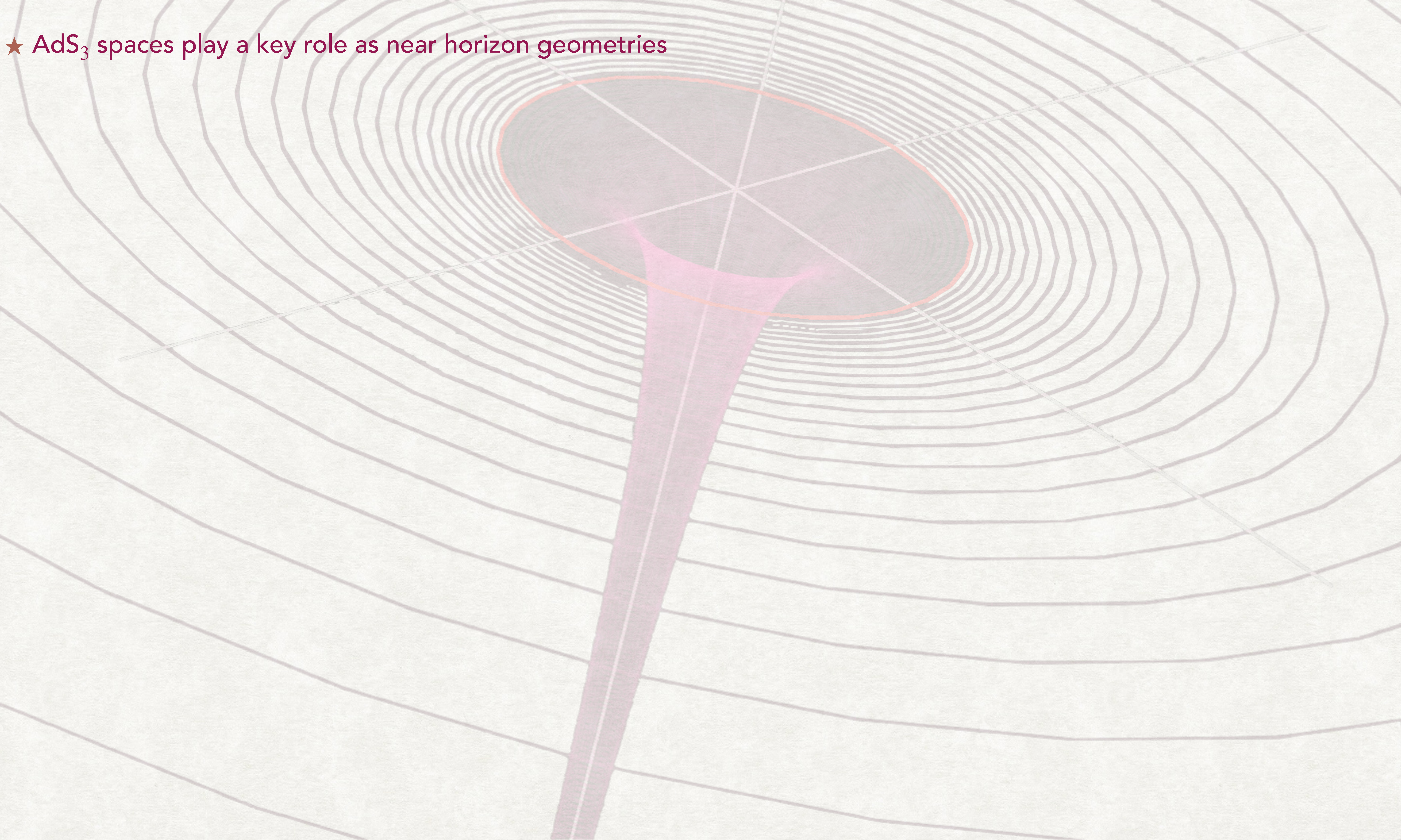
GEN-HET MEETING IN STRING THEORY

APRIL 28, 2024

INTRO & MOTIVATION: why are AdS_3 solutions relevant?

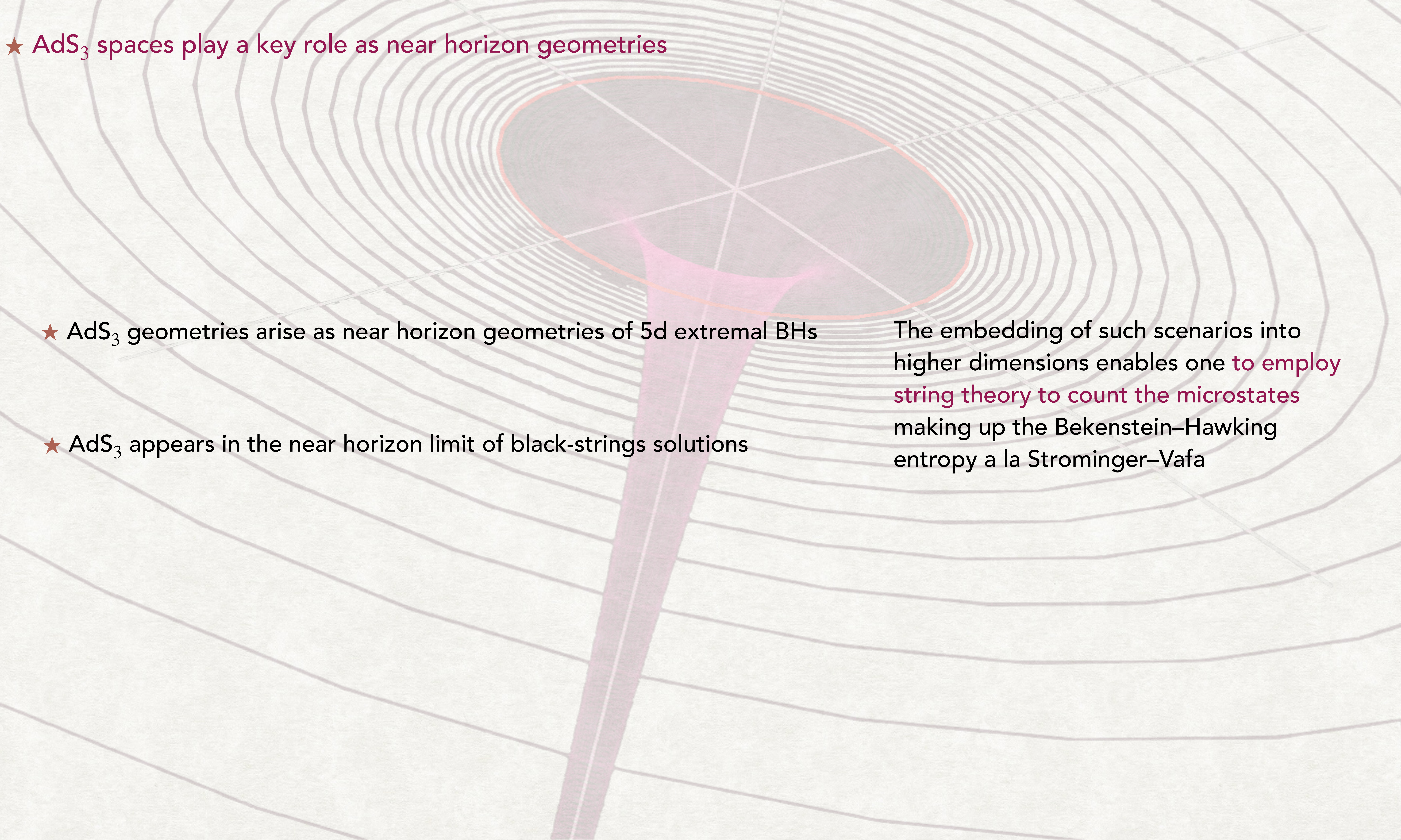
INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★ AdS_3 spaces play a key role as near horizon geometries



INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★ AdS_3 spaces play a key role as near horizon geometries



★ AdS_3 geometries arise as near horizon geometries of 5d extremal BHs

★ AdS_3 appears in the near horizon limit of black-strings solutions

The embedding of such scenarios into higher dimensions enables one to employ string theory to count the microstates making up the Bekenstein–Hawking entropy a la Strominger–Vafa

INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★ AdS_3 spaces play a key role as near horizon geometries

★ AdS_3 geometries arise as near horizon geometries of 5d extremal BHs

★ AdS_3 appears in the near horizon limit of black-strings solutions

The embedding of such scenarios into higher dimensions enables one to employ string theory to count the microstates making up the Bekenstein–Hawking entropy a la Strominger–Vafa

★ Through the AdS-CFT correspondence one might presume that there is a 2d CFT

★ 2d CFTs play a prominent role in string theory and provide the best arena to test the AdS/CFT correspondence.

★ The conformal group in 2d is infinite dimensional and this makes two dimensional CFTs much more tractable than their higher dimensional counterparts.

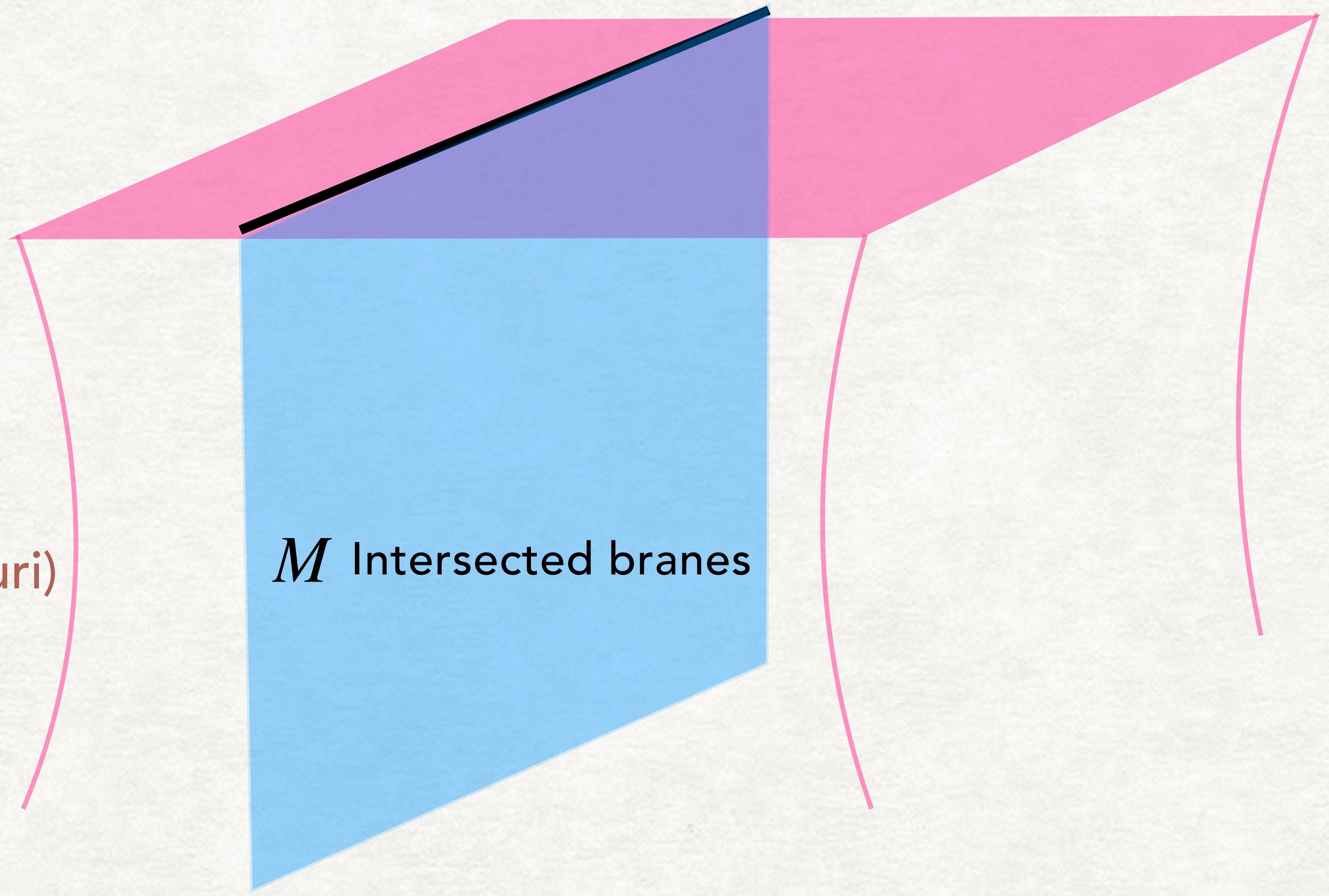
INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★The description of conformal defects in higher dimensional CFTs

They are typically understood as operator insertions that realise a deformation of the ambient CFT

Probe brane approximation:

(Karch, Randall; DeWolfe, Freedman, Ooguri)



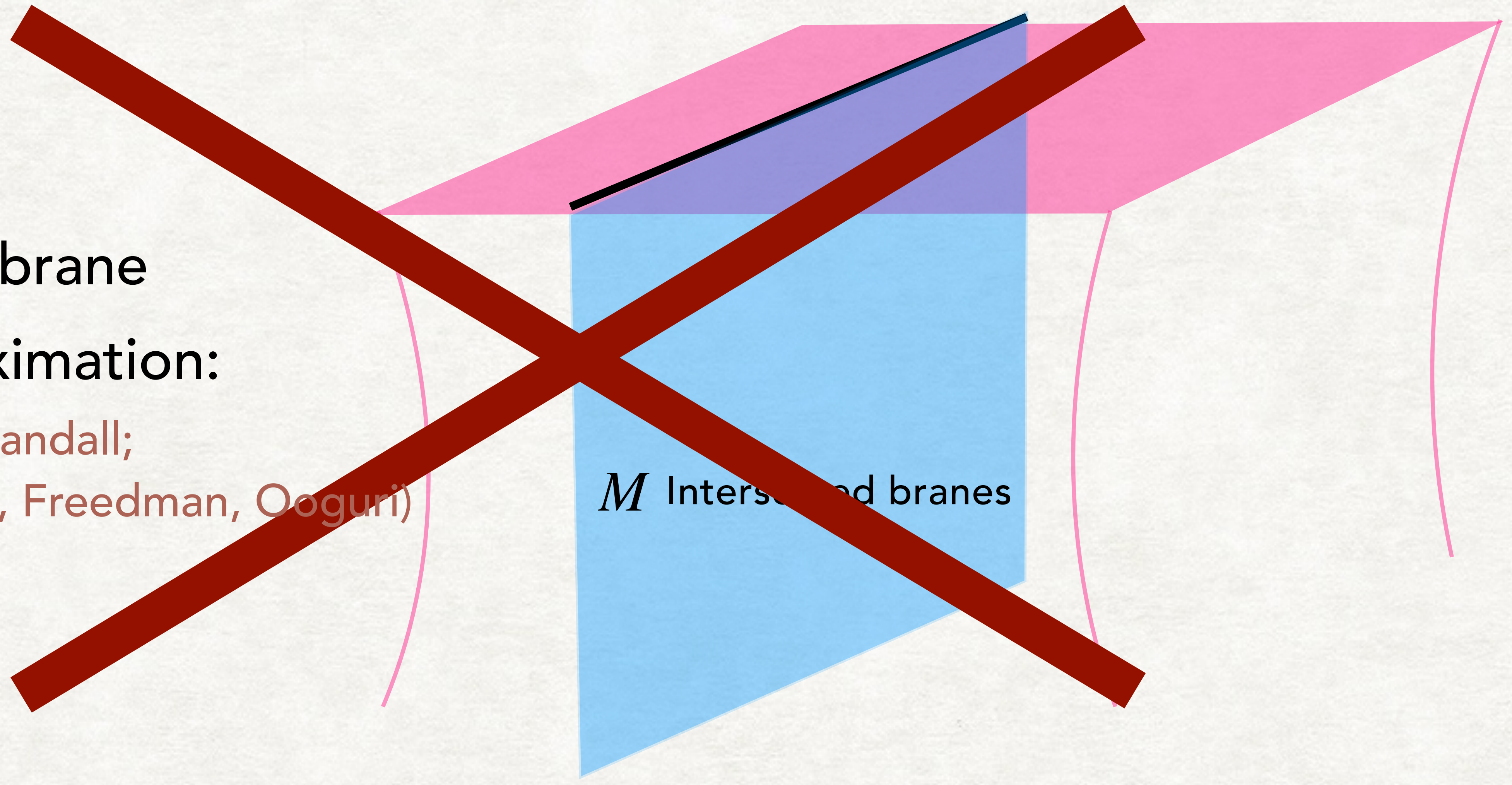
INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★The description of conformal defects in higher dimensional CFTs

They are typically understood as operator insertions that realise a deformation of the ambient CFT

Probe brane approximation:

(Karch, Randall;
DeWolfe, Freedman, Ooguri)



The probe brane approximation breaks down when $M >> 1$, due to their backreaction on the original geometry

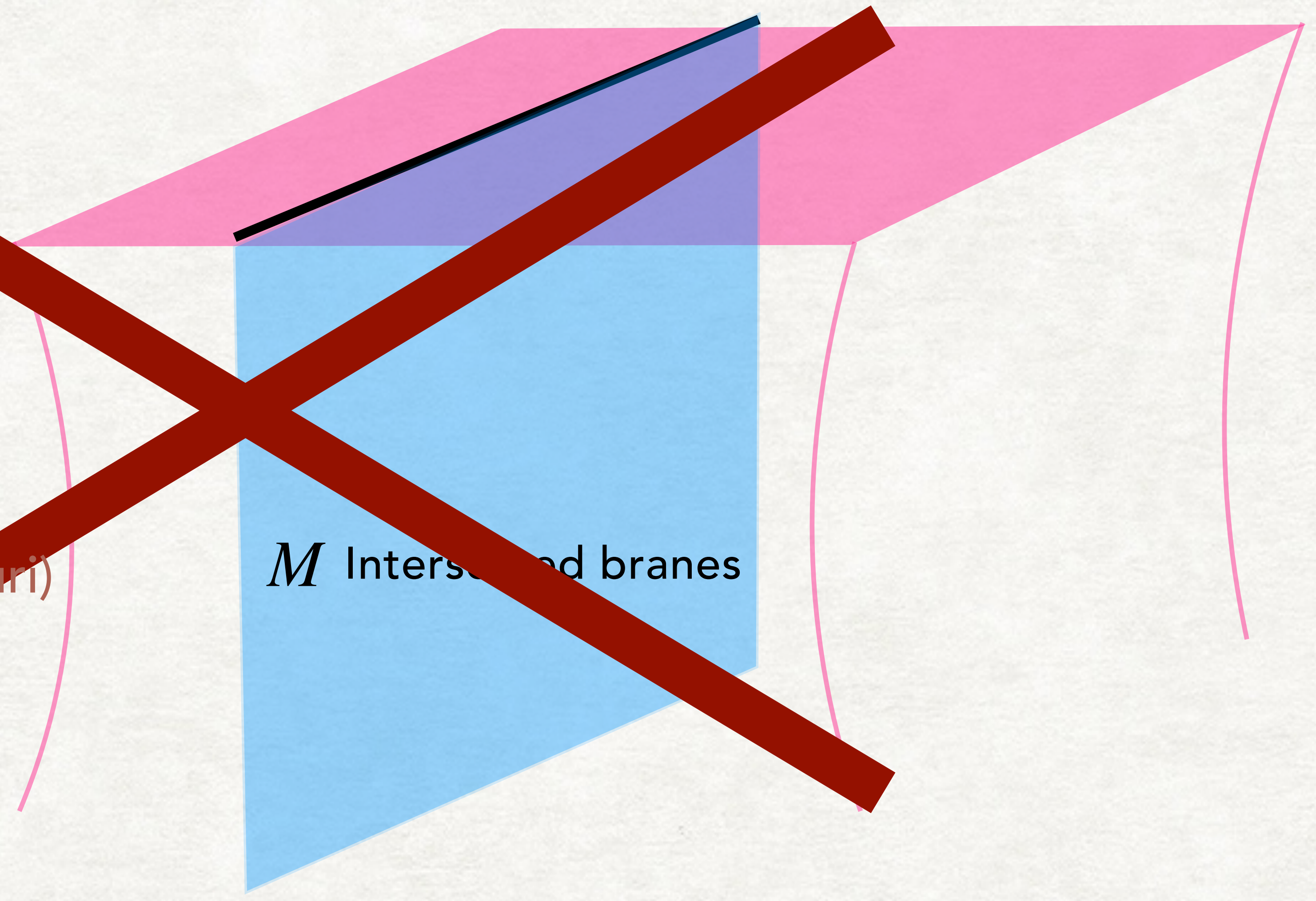
INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★The description of conformal defects in higher dimensional CFTs

They are typically understood as operator insertions that realise a deformation of the ambient CFT

Probe brane approximation:

(Karch, Randall; DeWolfe, Freedman, Ooguri)



The probe brane approximation breaks down when $M >> 1$, due to their backreaction on the original geometry

In this scenario:

Defect branes intersects the original brane system,

which is known to be described by an AdS in the NHL and where the higher dimensional CFT lives

$M >> 1$ ⇒

Some of the isometries of the AdS space are broken, producing lower-dimensional AdS backgrounds in the NHL

These are dual to low dimensional CFTs, that retake a defect CFTs interpretation within the higher-dimensional CFTs.

(Hoker, Estes, Gutperle, Krym; Dibitetto, Petri; Faedo, Lozano, Petri; Lozano, Macpherson, Petri, Risco; Anabalon, Chamorro-Burgos, A. Guarino)

INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS$_3$ solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N} = (p, q)$ AdS$_3$ solutions in 10 or 11 dim, where $p + q \leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

N_R \ N_L	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	–	–	ℓ: – / s: Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				ℓ: Cl / m: – / s: Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS_3 solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N} = (p, q)$ AdS_3 solutions in 10 or 11 dim, where $p + q \leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

N_R \ N_L	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	–	–	ℓ: – / s: Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				ℓ: Cl / m: – / s: Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

Two maximal cases are completely classified

(D'Hoker et.al. and Mapherson)
(Legramandi, Lo Monaco and Mapherson)

INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS_3 solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N}=(p,q)$ AdS_3 solutions in 10 or 11 dim, where $p+q\leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

N_R \ N_L	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	–	–	ℓ – / s Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				ℓ Cl / m – / s Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

Canonical example: Near horizon of D1-D5 system.

$AdS_3 \times S^3 \times CY_2$ realising small (4,4) superconformal symmetry

$\updownarrow$

Symmetric Product Orbifold (Giveon, Kutasov and Seiberg) (Eberhardt, Gaberdiel, Gopakumar ....)

INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS$_3$ solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N} = (p, q)$ AdS$_3$ solutions in 10 or 11 dim, where $p + q \leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

$N_R \backslash N_L$	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	–	–	ℓ – / s Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				ℓ Cl / m – / s Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

Notably, most known solutions rely on $\mathcal{N} = (p, q)$ or (0, q) with $p, q \leq 4$ supersymmetry

Canonical example: Near horizon of D1-D5 system.

AdS$_3 \times$ S$^3 \times$ CY$_2$ realising small (4,4) superconformal symmetry

$\updownarrow$

Symmetric Product Orbifold

(Giveon, Kutasov and Seiberg)
(Eberhardt, Gaberdiel, Gopakumar ....)

INTRO & MOTIVATION: why are AdS_3 solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS_3 solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N} = (p, q)$ AdS_3 solutions in 10 or 11 dim, where $p + q \leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

N_R \ N_L	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	–	–	l: – / s: Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				l: Cl / m: – / s: Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

Notably, most known solutions rely on $\mathcal{N} = (p, q)$ or (0, q) with $p, q \leq 4$ supersymmetry

This sector has been relatively unexplored so far

Canonical example: Near horizon of D1-D5 system.

$\mathrm{AdS}_3 \times \mathrm{S}^3 \times \mathrm{CY}_2$ realising small (4,4) superconformal symmetry

$\updownarrow$

Symmetric Product Orbifold

(Giveon, Kutasov and Seiberg)
(Eberhardt, Gaberdiel, Gopakumar ....)

INTRO & MOTIVATION: why are AdS$_3$ solutions relevant?

★There is a broad effort towards classifying supersymmetric AdS$_3$ solutions in type II or M-theory, but at this time many gaps remain:

For $\mathcal{N} = (p,q)$ AdS$_3$ solutions in 10 or 11 dim, where $p + q \leq 8$ (Haupt, Lautz, Papadopoulos) (Macpherson, Tomasiello)

N_R \ N_L	1	2	3	4	5	6	7	8
0	PC	PC	Exe	PC	PC	PC	ℓ: – ; s: Exe	Cl
1	PC	Exe	–	–	–	–	–	
2		Exe	–	Exe	–	–		
3			Exe	–	–			
4				ℓ: Cl ; m: – ; s: Exe				

–	No examples
Exe	Some examples
PC	Partial classification
Cl	Complete classification

A main aim of this work is to fill in this gap:

★ We provide two new AdS$_3$ classes of solutions to massive type IIA supergravity realising an $\mathfrak{osp}(n|2)$ superconformal algebra for n = 5,6.

★ We will investigate AdS$_3$/CFT$_2$ holography with (0,6) supersymmetry

TALK OUTLINE

- ★ Introduction & motivation
- ★ AdS_3 solutions realising $\mathfrak{osp}(n|2)$ superconformal symmetry (2304.12207: N.Macpherson, AR)
- ★ Aspects of the CFT (2404.17469: Y. Lozano, N. Macpherson, N. Petri, AR)
- ★ Conclusions & Open problems

GEOMETRY

We seek AdS_3 solutions of massive type IIA supergravity with a superconformal algebra

$$\mathfrak{sl}(2) \oplus \mathfrak{so}(n) \quad \text{for} \quad n = 5{,}6$$

We want supersymmetric solutions,

$(0,6)$: $SO(6)$ R-symmetry $\rightarrow$ $\mathbb{CP}^3$

$(0,5)$: $SO(5)$ R-symmetry $\rightarrow$ $S^2 \to \mathbb{CP}^3 \to S^4$ $\rightarrow$ $\widehat{\mathbb{CP}}^3$: squashed $\mathbb{CP}^3$

Geometrically,

$$ds^2 = e^{2A} ds^2_{\mathrm{AdS}_3} + \frac{1}{4}\Bigg(\overbrace{e^{2C} ds^2_{\mathrm{S}^4} + e^{2D} \underbrace{(Dy_i)^2}_{\textit{fibered } S^2}}^{\widehat{\mathbb{CP}}^3}\Bigg) + e^{2k} dr^2$$

The rest of NSNS and RR fields are turned on.

GEOMETRY

We will set up our study in terms of the pure spinor formalism.

we reformulate supersymmetry in terms of equations that involve pure forms and exterior algebra.

Our strategy

★ Construct spinors that ensure consistency with superconformal algebra $\mathfrak{sl}(2) \oplus \mathfrak{so}(n)$

★ Exploit an existing AdS classification to obtain sufficient conditions on the geometry and fluxes for a solution with $\mathcal{N} = (0,5)$ and $\mathcal{N} = (0,6)$ in IIA to exist (Dibitetto, Lo Monaco, Passias, Petri, Tomasiello; Passias, Prints; Macpherson, Tomasiello)

$$
\begin{aligned}
&(d-H)\wedge(e^{A-\Phi}\Psi_{\mp}) = 0,\\
&(d-H)\wedge(e^{2A-\Phi}\Psi_{\pm}) \mp 2me^{A-\Phi}\Psi_{\mp} = \frac{e^{3A}}{8}\star_7\lambda(f_{\pm}),\\
&(\Psi_{-}, f_{\pm})_7 = \mp\frac{m}{2}e^{-\Phi}\mathrm{vol}_{M_7},
\end{aligned}
$$

★ Study the classes consistent with our assumptions.

GEOMETRY

The local solutions are defined in terms of two functions, $h(r)$ and $u(r)$,

$$\frac{ds^2}{2\pi} = \frac{|hu|}{\sqrt{\Delta_1}} ds^2_{\mathrm{AdS}_3} + \frac{\sqrt{\Delta_1}}{4|u|}\left[\frac{2}{|h''|}\left(\overbrace{ds^2_{\mathrm{S}^4} + \frac{1}{\Delta_2}(Dy_i)^2}^{\widehat{\mathbb{CP}}^3}\right) + \frac{1}{|h|}dr^2\right], \qquad e^{-2\Phi} = \frac{|u||h''|^3\Delta_1}{4\pi\sqrt{\Delta_2}}$$

$$B_2 = 4\pi\left[\left(\frac{uh' - hu'}{uh''} - (r-k)\right)J_2 + \frac{u'}{2h''}\left(\frac{h}{u} + \frac{hh'' - 2(h')^2}{2h'u' + uh''}\right)(J_2 - \tilde{J}_2)\right],$$

$$\Delta_1 = 2hh''u^2 - (uh' - hu')^2, \qquad \Delta_2 = 1 + \frac{2h'u'}{uh''}.$$

the RR sector:

$$F_0 = -\frac{1}{2\pi}h''',$$

$$F_2 = B_2F_0 + 2(h'' - (r-k)h''')J_2,$$

$$F_4 = -\pi \mathrm{vol}_{\mathrm{AdS}_3} \wedge d\left(h' + \frac{hh''u(uh' + hu')}{\Delta_1}\right) + \text{mag. terms.}$$

GEOMETRY

The local solutions are defined in terms of two functions, $h(r)$ and $u(r)$,

$$\frac{ds^2}{2\pi} = \frac{|hu|}{\sqrt{\Delta_1}} ds^2_{\mathrm{AdS}_3} + \frac{\sqrt{\Delta_1}}{4|u|}\left[\frac{2}{|h''|}\overbrace{\left(ds^2_{\mathrm{S}^4} + \frac{1}{\Delta_2}(Dy_i)^2\right)}^{\widehat{\mathbb{CP}}^3} + \frac{1}{|h|}dr^2\right], \qquad e^{-2\Phi} = \frac{|u||h''|^3\Delta_1}{4\pi\sqrt{\Delta_2}}$$

$$B_2 = 4\pi\left[\left(\frac{uh' - hu'}{uh''} - (r-k)\right)J_2 + \frac{u'}{2h''}\left(\frac{h}{u} + \frac{hh'' - 2(h')^2}{2h'u' + uh''}\right)(J_2 - \tilde{J}_2)\right],$$

$$\Delta_1 = 2hh''u^2 - (uh' - hu')^2, \qquad \Delta_2 = 1 + \frac{2h'u'}{uh''}.$$

the RR sector:

$$F_0 = -\frac{1}{2\pi}h''',$$

$$F_2 = B_2F_0 + 2(h'' - (r-k)h''')J_2,$$

$$F_4 = -\pi \mathrm{vol}_{\mathrm{AdS}_3} \wedge d\left(h' + \frac{hh''u(uh' + hu')}{\Delta_1}\right) + \text{mag. terms.}$$

NS5
D8
D6
D4
D2

GEOMETRY

The local solutions are defined in terms of two functions, $h(r)$ and $u(r)$,

$$\frac{ds^2}{2\pi} = \frac{|hu|}{\sqrt{\Delta_1}} ds^2_{\mathrm{AdS}_3} + \frac{\sqrt{\Delta_1}}{4|u|}\left[\frac{2}{|h''|}\overbrace{\left(ds^2_{\mathrm{S}^4} + \frac{1}{\Delta_2}(Dy_i)^2\right)}^{\widehat{\mathbb{CP}}^3} + \frac{1}{|h|}dr^2\right], \qquad e^{-2\Phi} = \frac{|u||h''|^3\Delta_1}{4\pi\sqrt{\Delta_2}}$$

$$B_2 = 4\pi\left[\left(\frac{uh' - hu'}{uh''} - (r-k)\right)J_2 + \frac{u'}{2h''}\left(\frac{h}{u} + \frac{hh'' - 2(h')^2}{2h'u' + uh''}\right)(J_2 - \tilde{J}_2)\right],$$

$$\Delta_1 = 2hh''u^2 - (uh' - hu')^2, \qquad \Delta_2 = 1 + \frac{2h'u'}{uh''}.$$

the RR sector:

$$F_0 = -\frac{1}{2\pi}h''',$$

$$F_2 = B_2F_0 + 2(h'' - (r-k)h''')J_2,$$

$$F_4 = -\pi \mathrm{vol}_{\mathrm{AdS}_3} \wedge d\left(h' + \frac{hh''u(uh' + hu')}{\Delta_1}\right) + \text{mag. terms.}$$

NS5
D8
D6
D4
D2

Solutions are governed by 2 ordinary diff eqs:

SUSY demands: $u'' = 0$
Bianchi identities: $h'''' = 0$

GEOMETRY

★ Supersymmetry implies $u''=0$ globally

$$\begin{cases} u'=0 \text{ we have a round } \mathbb{CP}^3 & \Rightarrow \ \mathfrak{osp}(6|2) \text{ AdS}_3 \text{ solutions} \\ u'\neq 0 \text{ we have the } \widehat{\mathbb{CP}}^3 & \Rightarrow \ \mathfrak{osp}(5|2) \text{ AdS}_3 \text{ solutions} \end{cases}$$

GEOMETRY

★ Supersymmetry implies $u'' = 0$ globally

$$\begin{cases} \boxed{u' = 0 \text{ we have a round } \mathbb{CP}^3 \quad \Rightarrow \quad \mathfrak{osp}(6|2) \ \text{AdS}_3 \text{ solutions}} \\ u' \neq 0 \ \text{ we have the } \widehat{\mathbb{CP}}^3 \quad \Rightarrow \quad \mathfrak{osp}(5|2) \ \text{AdS}_3 \text{ solutions} \end{cases}$$

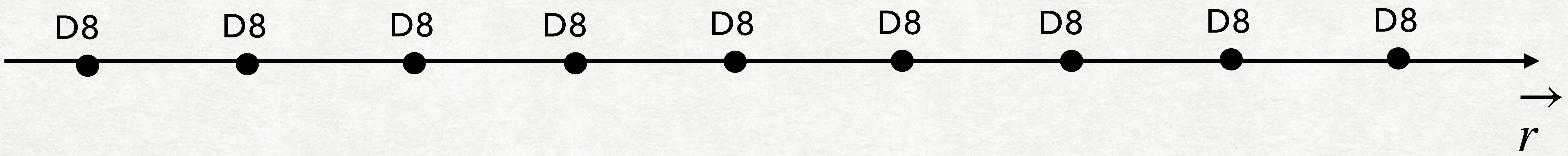
GEOMETRY

★ Supersymmetry implies $u'' = 0$ globally

- $u' = 0$ we have a round $\mathbb{CP}^3$ ➡ $\mathfrak{osp}(6|2)$ AdS$_3$ solutions
- $u' \neq 0$ we have the $\widehat{\mathbb{CP}}^3$ ➡ $\mathfrak{osp}(5|2)$ AdS$_3$ solutions

★ Bianchi identities, $dF_0 = -\frac{1}{2\pi} h''''dr$, imply

- Locally $h'''' = 0 \quad \rightarrow \quad \mathcal{O}(3)$ polynomial
- Globally $h'''' \sim \delta(r - r_0)$ can be discontinuities which imply D8 sources



One can glue local solutions together with D8 sources

Metric and dilaton fields are continuos at $r = r_0$. NS 2-form is also continuous modulo large gauge transformations

$$B_2 \rightarrow B_2 + \Delta B_2$$

GEOMETRY

★ Supersymmetry implies $u'' = 0$ globally

- $u' = 0$ we have a round $\mathbb{CP}^3$ ➡ $\mathfrak{osp}(6|2)$ AdS$_3$ solutions
- $u' \neq 0$ we have the $\widehat{\mathbb{CP}}^3$ ➡ $\mathfrak{osp}(5|2)$ AdS$_3$ solutions

★ Bianchi identities, $dF_0 = -\frac{1}{2\pi} h'''' dr$, imply

- Locally $h'''' = 0$ $\rightarrow$ $\mathcal{O}(3)$ polynomial
- Globally $h'''' \sim \delta(r - r_0)$ can be discontinuities which imply D8 sources

★ In the massless $\mathcal{N} = (0,6)$ case, we obtain the AdS$_4 \times \mathbb{CP}^3$

GEOMETRY

★ In the massless $\mathcal{N} = (0,6)$ case, we obtain the $\text{AdS}_4 \times \mathbb{CP}^3$

$$u' = 0 \quad \text{and} \quad h = Q_2 + Q_4\, r + \frac{1}{2} Q_4\, r^2 \quad \Rightarrow \quad F_0 = 0$$

$$ds^2 = \frac{L^2}{4} ds^2_{\text{AdS}_4} + L^2 ds^2_{\mathbb{CP}^3} \,, \qquad e^{-\Phi} = \frac{Q_6}{L} \,, \qquad B_2 = -4\pi \frac{Q_4}{Q_6} J_2 \,, \qquad b = -\frac{Q_4}{Q_6}$$

$$L^2 = \frac{4\pi}{Q_6}\sqrt{2Q_2Q_6 - Q_4^2} \,, \qquad H_3 = 0, \qquad \hat{f}_4 = -\hat{f}_2 \wedge B_2,$$

GEOMETRY

★ In the massless $\mathcal{N} = (0{,}6)$ case, we obtain the $\mathrm{AdS}_4 \times \mathbb{CP}^3$

$$u' = 0 \quad \text{and} \quad h = Q_2 + Q_4\, r + \frac{1}{2} Q_4\, r^2 \;\Rightarrow\; F_0 = 0$$

$$ds^2 = \frac{L^2}{4} ds^2_{\mathrm{AdS}_4} + L^2 ds^2_{\mathbb{CP}^3}\,, \qquad e^{-\Phi} = \frac{Q_6}{L}\,,$$

$$L^2 = \frac{4\pi}{Q_6}\sqrt{2Q_2Q_6 - Q_4^2}\,,$$

✤ fractional charges appear (Aharony, Bergman, Jafferis)

$$\boxed{B_2 = -\,4\pi \frac{Q_4}{Q_6} J_2\,, \qquad b = -\,\frac{Q_4}{Q_6}}$$

$$\boxed{H_3 = 0, \qquad \hat{f}_4 = -\,\hat{f}_2 \wedge B_2,}$$

✤ The NS5 and D4 branes are not physical, since they annihilate to nothing (Aharony, Bergman, Jafferis)

GEOMETRY

★ In the massless $\mathcal{N} = (0,6)$ case, we obtain the $\mathrm{AdS}_4 \times \mathbb{CP}^3$

$$u' = 0 \quad \text{and} \quad h = Q_2 + Q_4 r + \frac{1}{2} Q_4 r^2 \quad \Rightarrow \quad F_0 = 0$$

$$ds^2 = \frac{L^2}{4} ds^2_{\mathrm{AdS}_4} + L^2 ds^2_{\mathbb{CP}^3} , \qquad e^{-\Phi} = \frac{Q_6}{L} ,$$

$$L^2 = \frac{4\pi}{Q_6} \sqrt{2 Q_2 Q_6 - Q_4^2} ,$$

- fractional charges appear (Aharony, Bergman, Jafferis)

$$\boxed{B_2 = -4\pi \frac{Q_4}{Q_6} J_2 , \qquad b = -\frac{Q_4}{Q_6}}$$

$$\boxed{H_3 = 0, \qquad \hat{f}_4 = -\hat{f}_2 \wedge B_2,}$$

- The NS5 and D4 branes are not physical, since they annihilate to nothing (Aharony, Bergman, Jafferis)

- We compute the charges $\frac{1}{2\pi} \int_{\mathbb{CP}^1} \hat{f}_2 = Q_6$, $\frac{1}{(2\pi)^3} \int_{\mathbb{CP}^2} \hat{f}_4 = Q_4$, $\frac{1}{(2\pi)^5} \int_{\mathbb{CP}^3} \hat{f}_6 = Q_2$ and realise that these are associated with the # of branes in the following way: $Q_6 = k,$ $Q_4 = M - \frac{k}{2},$ $Q_2 = N + \frac{k}{12},$ due to the effects of the Freed-Witten anomaly and the higher curvature terms, (Aharony, Hashimoto, Hirano, Ouyang)

GEOMETRY

★ In the massless $\mathcal{N} = (0,6)$ case, we obtain the $\mathrm{AdS}_4 \times \mathbb{CP}^3$

$$u' = 0 \quad \text{and} \quad h = Q_2 + Q_4 r + \frac{1}{2} Q_4 r^2 \quad \Rightarrow \quad F_0 = 0$$

$$ds^2 = \frac{L^2}{4} ds^2_{\mathrm{AdS}_4} + L^2 ds^2_{\mathbb{CP}^3}\,, \qquad e^{-\Phi} = \frac{Q_6}{L}\,,$$

$$L^2 = \frac{4\pi}{Q_6}\sqrt{2Q_2Q_6 - Q_4^2}\,,$$

✤ fractional charges appear (Aharony, Bergman, Jafferis)

$$\boxed{B_2 = -4\pi \frac{Q_4}{Q_6} J_2\,, \qquad b = -\frac{Q_4}{Q_6}}$$

$$\boxed{H_3 = 0, \qquad \hat{f}_4 = -\hat{f}_2 \wedge B_2,}$$

✤ The NS5 and D4 branes are not physical, since they annihilate to nothing (Aharony, Bergman, Jafferis)

✤ We compute the charges $\frac{1}{2\pi}\int_{\mathbb{CP}^1} \hat{f}_2 = Q_6\,,\quad \frac{1}{(2\pi)^3}\int_{\mathbb{CP}^2} \hat{f}_4 = Q_4\,,\quad \frac{1}{(2\pi)^5}\int_{\mathbb{CP}^3} \hat{f}_6 = Q_2$ and realise that these are associated with the # of branes in the following way: $Q_6 = k,\quad Q_4 = M - \frac{k}{2},\quad Q_2 = N + \frac{k}{12},$ due to the effects of the Freed-Witten anomaly and the higher curvature terms, (Aharony, Hashimoto, Hirano, Ouyang)

✤ Taking this identifications into account and performing large gauge transformation, $b \to b + 1$, (Bergman and Lifschytz)

$$N \to N + k - M, \qquad M \to M - k,$$

(Benini, Canoura, Cremonesi, Nunez, Ramallo; Aharony, Hashimoto, Hirano, Ouyang)

and these transformations generate Seiberg dualities relating the IR behaviour of different 3d N = 3 CSm theories

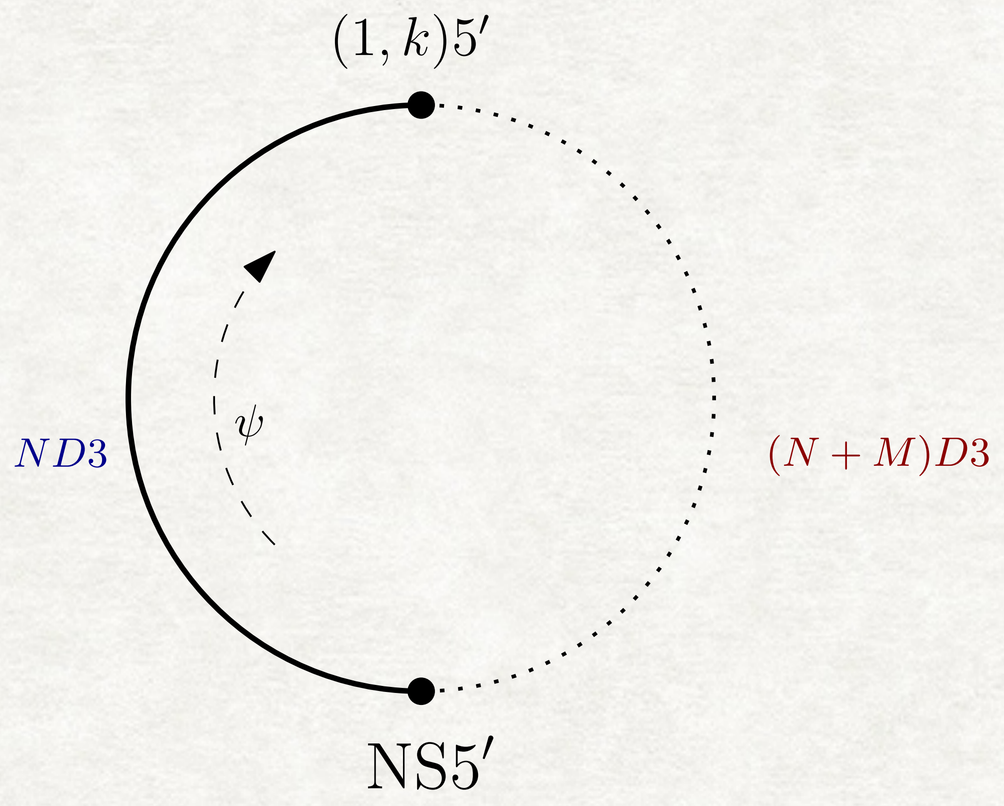
$$U(N+M)_k \times U(N)_{-k} \;\to\; U(N)_k \times U(N-M+k)_{-k}$$

GEOMETRY

Its brane construction (type IIB realization)

Branes	0	1	2	3	4	5	ψ	7	8	9
N D3	x	x	x	-	-	-	x	-	-	-
NS5′	x	x	x	x	x	x	-	-	-	-
(1,k)5′	x	x	x	$\cos\theta$	$\cos\theta$	$\cos\theta$	-	$\sin\theta$	$\sin\theta$	$\sin\theta$

The brane system preserves $\mathcal{N} = 3$ supersymmetry in 3d, and this is enhanced to $\mathcal{N} = 6$ in the IR



The D3-branes stretch on the ψ-circle, intersecting one NS5′-brane and one (1, k) 5′-brane

On top of this there are M fractional branes stretched just along one segment of the circle, which as mentioned are not physical

ASPECTS OF THE CFT

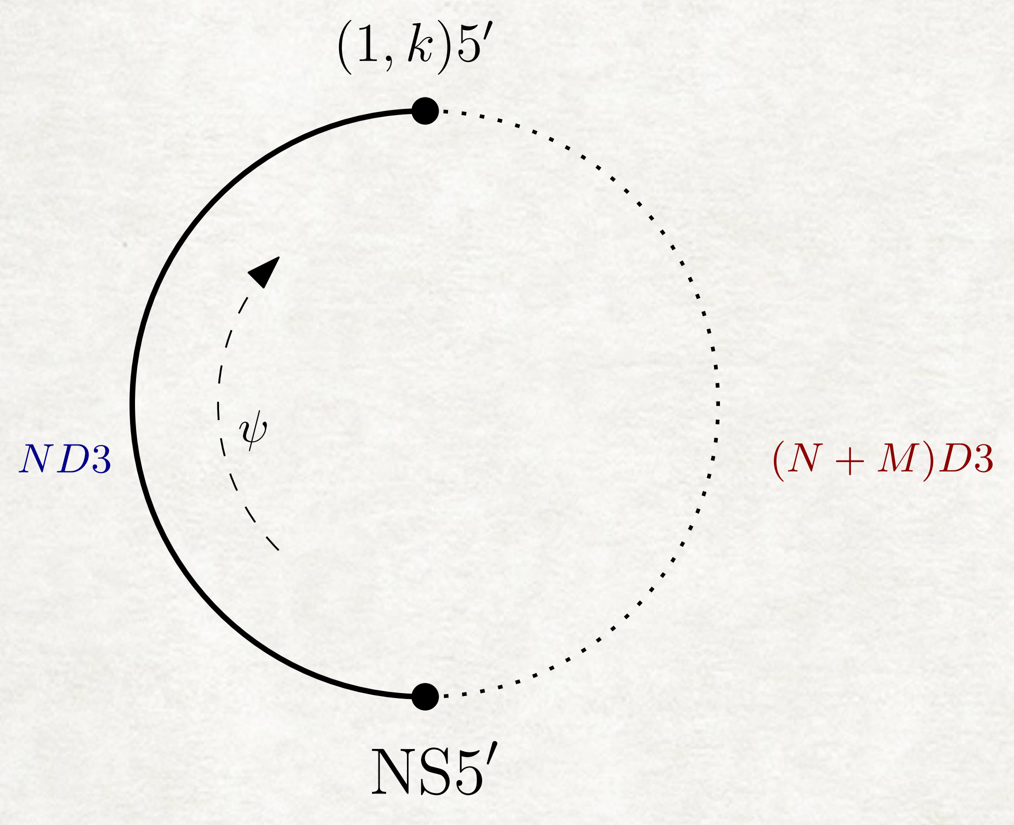
Its brane construction (type IIB realization)

Branes	0	1	2	3	4	5	ψ	7	8	9
N D3	x	x	x	-	-	-	x	-	-	-
NS5′	x	x	x	x	x	x	-	-	-	-
(1,k)5′	x	x	x	$\cos\theta$	$\cos\theta$	$\cos\theta$	-	$\sin\theta$	$\sin\theta$	$\sin\theta$

Massive case, $F_0 \neq 0$,

$$h_l(r) = Q_2^l - Q_4^l\,(r-l) + \frac{1}{2}Q_6^l\,(r-l)^2 - \frac{1}{6}Q_8^l(r-l)^3$$

D8(D7)-branes localized



ASPECTS OF THE CFT

Its brane construction (type IIB realization)

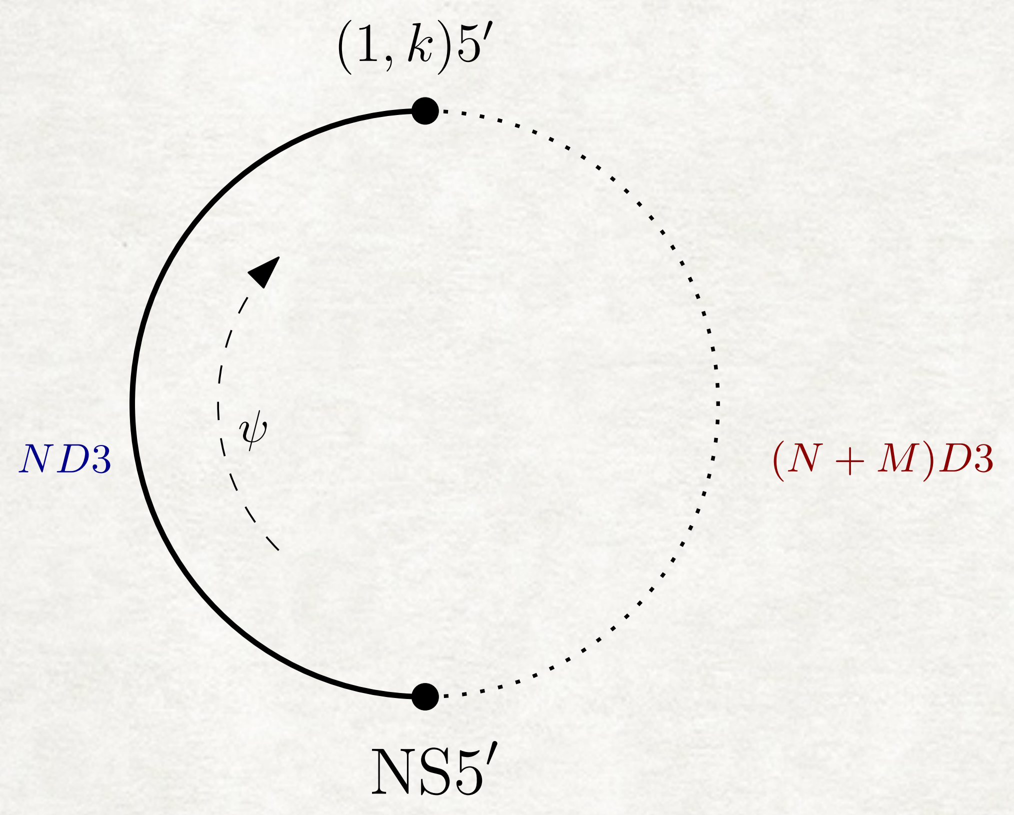
Branes	0	1	2	3	4	5	ψ	7	8	9
N D3	x	x	x	-	-	-	x	-	-	-
NS5′	x	x	x	x	x	x	-	-	-	-
(1,k)5′	x	x	x	$\cos\theta$	$\cos\theta$	$\cos\theta$	-	$\sin\theta$	$\sin\theta$	$\sin\theta$
D7	x	x	-	x	x	x	-	x	x	x
NS5	x	x	-	-	-	-	x	x	x	x

Massive case, $F_0 \neq 0$,

$$h_l(r) = Q_2^l - Q_4^l(r-l) + \frac{1}{2}Q_6^l(r-l)^2 - \frac{1}{6}Q_8^l(r-l)^3$$

➜ D8(D7)-branes localized

Where the D7-NS5 defect branes create a domain wall in the 3d theory living in the D3-NS5′- (1,k)5′ branes.



ASPECTS OF THE CFT

Its brane construction (type IIB realization)

Branes	0	1	2	3	4	5	ψ	7	8	9
N D3	x	x	x	-	-	-	x	-	-	-
NS5′	x	x	x	x	x	x	-	-	-	-
(1,k)5′	x	x	x	$\cos\theta$	$\cos\theta$	$\cos\theta$	-	$\sin\theta$	$\sin\theta$	$\sin\theta$
D7	x	x	-	x	x	x	-	x	x	x
NS5	x	x	-	-	-	-	x	x	x	x

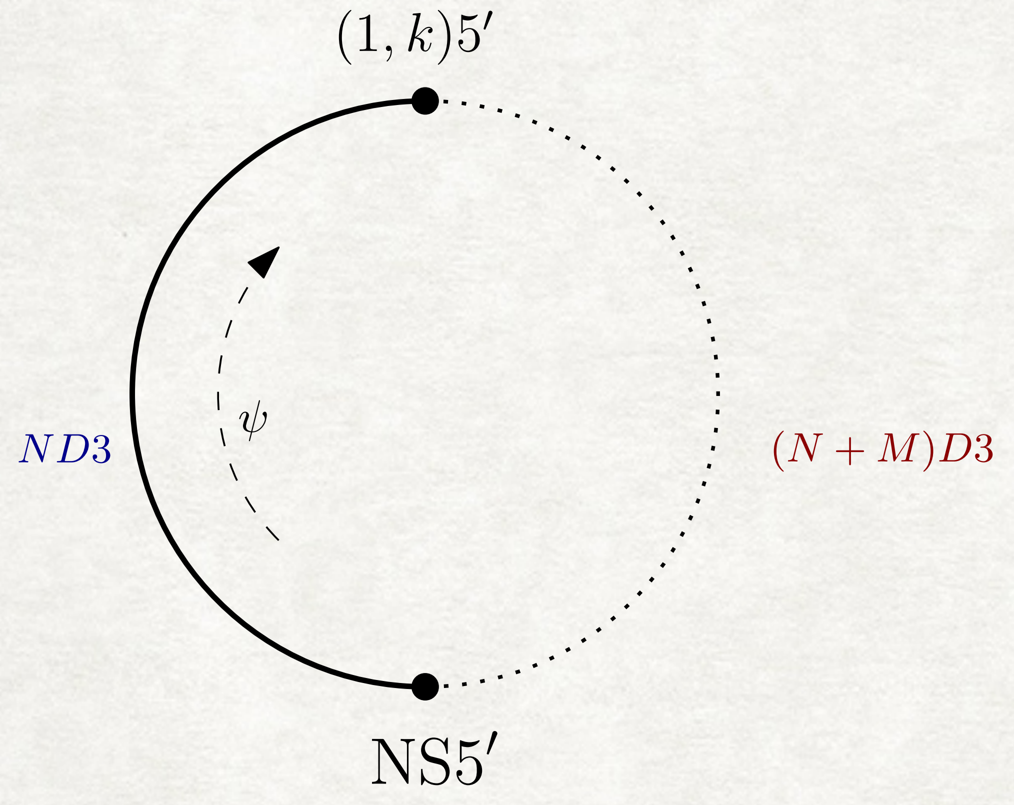
Massive case, $F_0 \neq 0$,

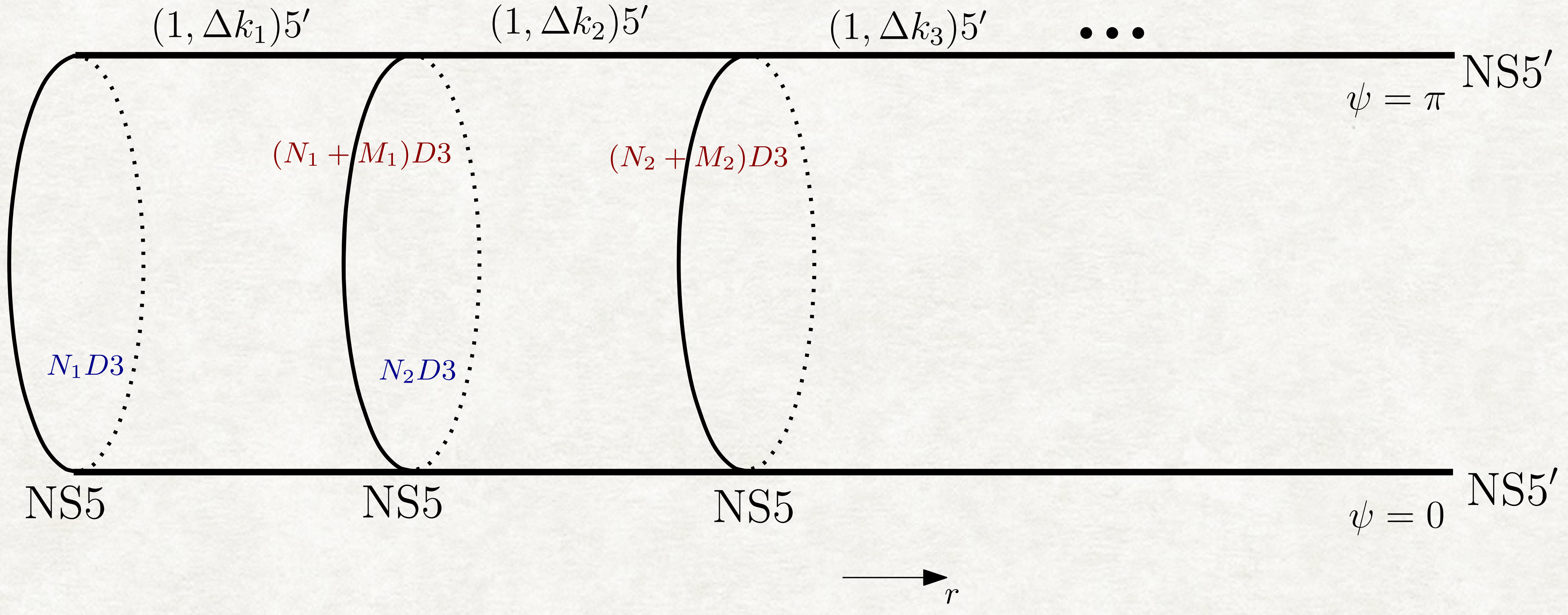
$$h_l(r) = Q_2^l - Q_4^l\,(r-l) + \frac{1}{2}Q_6^l\,(r-l)^2 - \frac{1}{6}Q_8^l(r-l)^3$$

➜ D8(D7)-branes localized

Where the D7-NS5 defect branes create a domain wall in the 3d theory living in the D3-NS5′- (1,k)5′ branes.

For a large number of NS5-D7 defect branes the resulting field theory becomes 2d, preserving one half of the supersymmetries and a subgroup of the superconformal group



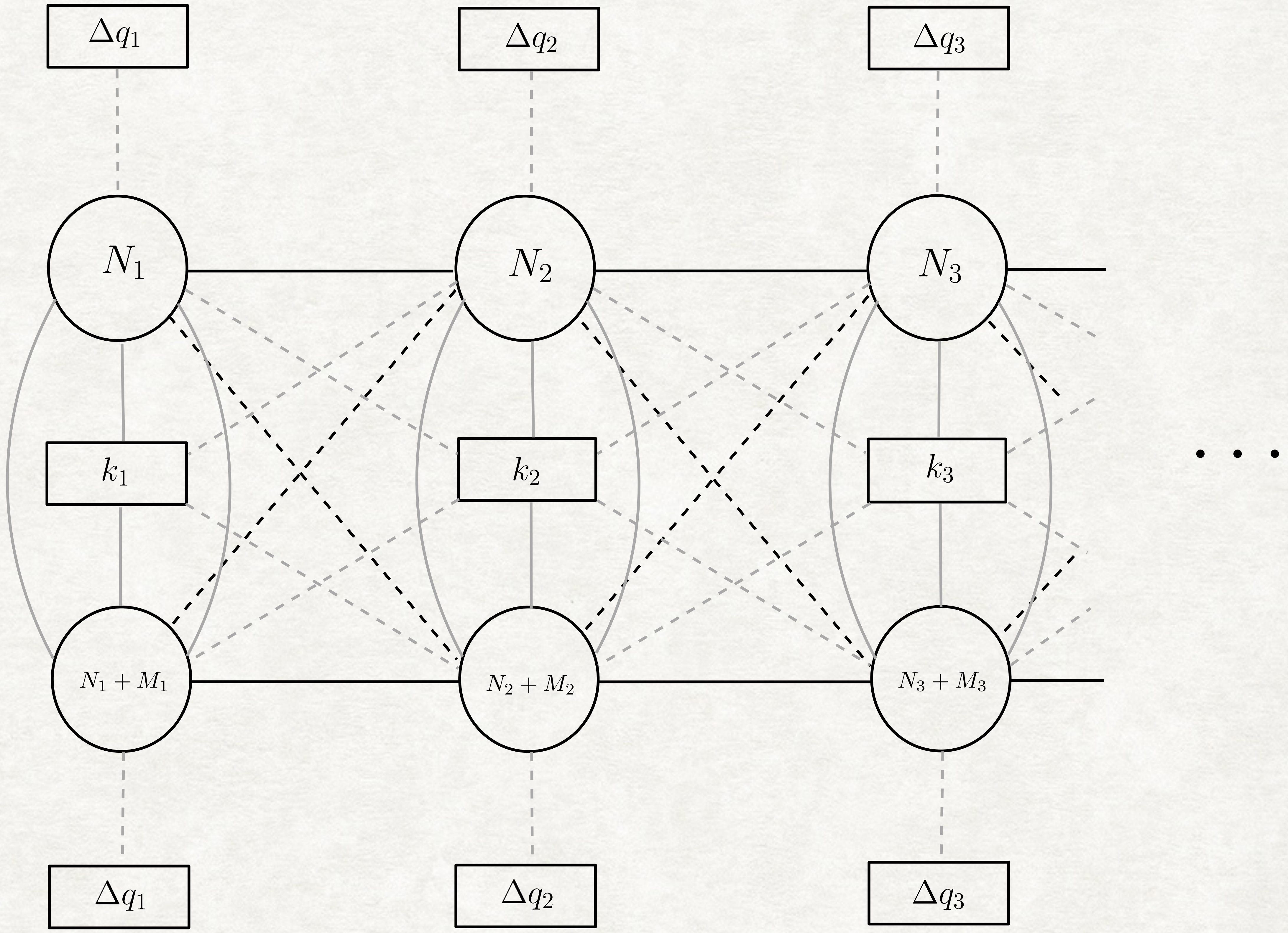


ASPECTS OF THE CFT

The intersection describes a brane box with D3 colour

String	Multiplet	Interval	
D3-D3	(0,4) vector	Same stack	
D3-D3	(0,4) twisted hyper bifundamental	Separated by a NS5	
D3-D3	(0,4) hyper bifundamental	Separated by a NS5′	
D3-D3	(0,2) Fermi	Separated by both and NS5 and NS5′	
two D3-D3	two (0,2) Fermi =(0,4) Fermi	Separated by both and NS5 and NS5′	
D3-D5′	(0,4) hyper bifundamental	Same interval	
D3-D5′	(0,2) Fermi	Adjacent interval	
D3-D7	(0,2) Fermi	Same interval	

Taking into account the field content arising from the different branes in the brane box configuration, we can now build up the quiver:



ASPECTS OF THE CFT

★ We obtain a generalisation of Seiberg duality to the massive case

$$U(N+M)_k \times U(N)_{-k+q} \quad \rightarrow \quad U(N)_{k+q} \times U(N-M+k)_{-k}$$

after the identification of the number of branes with the quantised charges $(N_l, M_l, k_l, q_l) \rightarrow (Q_2^l, Q_4^l, Q_6^l, Q_8^l)$ and the transformation of the field numbers $N \rightarrow N - M + k,\quad M \rightarrow M - k$ and $k \rightarrow k + q$ due to the large gauge transformations.

★ We can compute the holographic central charge of the 2d (0, 6) SCFTs

$$c_{hol} = \sum_{l=0}^{P} (2N_l k_l - M_l^2 + M_l k_l - \frac{1}{12} k_l^2 + q_l (N_l - \frac{1}{2} M_l + \frac{5}{12} k_l - \frac{13}{720} q_l))$$

and this result constitutes a very non-trivial prediction on the field theory side. However, we have not been able to check this result against a field theory calculation since we are unaware of a general result in the literature that relates the level of the superconformal algebra with the R-symmetry anomaly for (0,3) supersymmetry.

CONCLUSIONS & OPEN PROBLEMS

- ★ We present two new AdS_3 solutions to massive type IIA, for the case of an $\mathfrak{osp}(n|2)$ superconformal algebra with $n = 5{,}6$
- ★ We have made progress towards the understanding of AdS_3/CFT_2 holography with $\mathcal{N} = (0{,}6)$ supersymmetry, opening up the interesting new possibility of investigating the AdS_3/CFT_2 correspondence in less standard supersymmetric settings.
- ★ We have proposed a brane set-up and, associated to it, a quiver field theory emerging from the quantisation of the open strings. According to our proposal this field theory should flow in the IR to the 2d CFT dual to the $AdS_3 \times \mathbb{CP}^3$ solutions.
- ★ We interpret our solutions as describing $1/2$-BPS backreacted surface defects within the ABJM theory. This defects consist on D8-NS5 branes that reduce the supersymmetries of the ABJM brane set-up by a half and the superconformal algebra to $\mathfrak{osp}(6|2)$.
- ★ We have shown that large gauge transformations in the brane set-up induce the generalisation to the massive case of Seiberg duality in ABJM theories. This shows that Seiberg duality can be understood geometrically in terms of large gauge transformations.

- ★ We have not been able to check the holographic central charge against a field theory calculation. We are unaware of a general result in the literature, so we hope that our results stimulate further investigations in this direction.
- ★ It would be interesting to compute other observables
- ★ It would be interesting to further extend the analysis in this paper to the solutions with $\mathcal{N} = (0{,}5)$ supersymmetries.

THANKS!