Supersymmetric AdS_3 vacua and holography

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Holography and the Swampland,

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Motivation

- AdS_3 solutions play an important role in string theory

  - Black string near horizons, relation to lower dim black-holes, micro-state counting

  - Dual to two dimensional conformal field theories through AdS_3/CFT_2 correspondence

- Canonical example D1-D5 near horizon, small $\mathcal{N}=(4,4)$

$$\text{AdS}_3 \times \text{S}^3 \times \text{CY}_2 \quad \longleftrightarrow \quad \text{SPO}(\text{CY}_2) + ...$$

  - Significant progress in understanding tensionless limit (also for large $\mathcal{N}=(4,4)$ $\text{SPO}(\text{S}^1 \times \text{S}^3)$) [Eberhardt-Gaberdiel-Gopakumar-Li...]

- AdS_3/CFT_2 most promising avenue to exploit and study the correspondence

  - Better understanding of how to quantise strings on AdS_3 generically [Maldacena-Ooguri-...]

  - CFT_2 under greater control than higher dimensional counter parts

- But has been little **systematic** effort to classify and construct AdS_3 vacua of string theory

  - Maximal SUSY cases not even all known!

- Aim to redress this with a view towards holography

- **Supersymmetric $\mathbf{AdS_3}$ vacua**
  - *Brief review on their construction*
- **All $\mathcal{N}=(8,0)$ vacua**
  - *Relation to Chern-Simons matter theories*
- $\mathfrak{osp}(n|2)$ **vacua for** $n>4$
  - *Evidence for $(6,0)$ and $(5,0)$ SCFTs*
- **Small $\mathcal{N}=(4,0)$ vacua**
  - *Conformal CY_2 class and dual linear quivers*

Supersymmetric AdS_3 vacua

- An AdS_3 string vacua is a solution of $d=10,11$ supergravity decomposing a warped $\text{AdS}_3\times\text{M}_{7,8}$

  - For $d=10$ type IIA/IIB, bosonic fields

$$ds^2=e^{2A}ds^2(\text{AdS}_3)+ds^2(\text{M}_7),\qquad H=e^{3A}h_0\text{vol}(\text{AdS}_3)+H_3,$$
$$F=f_\pm+e^{3A}\text{vol}(\text{AdS}_3)\wedge\star_7\lambda f_\pm$$

  where $(A,f_\pm,H_3)$ and dilaton Φ are AdS_3 independent $(d(e^{3A}h_0)=0)$

  - For $d=11$, M-theory, bosonic fields

$$ds^2=e^{2A}ds^2(\text{AdS}_3)+ds^2(\text{M}_8),\qquad G_4=e^{3A}\text{vol}(\text{AdS}_3)\wedge F_1+F_4.$$

- For a true string vacuum $\text{M}_{7/8}$ should be compact (or more generally bounded)

  - Holographic duals to CFT_2 should be thus.

- In this talk by vacua I simply mean SO(2,2) invariant.

  - This weaker definition includes holographic dual to conformal defects in higher dim CFTs.

- Want supersymmetric solutions, but many ways to achieve this for AdS_3

  - i.e many $d=2$ superconformal algebras can live on boundary of AdS_3

- Type II AdS_3 solutions support two MW spinors. Both $\mathcal{N}=(1,0)$ or $\mathcal{N}=(0,1)$

$$\epsilon_1=\zeta\otimes\theta_+\otimes\chi_1,\qquad \epsilon_2=\zeta\otimes\theta_\mp\otimes\chi_2,\qquad \zeta:\underbrace{\nabla_\mu\zeta_\pm=\pm\frac{m}{2}\gamma_\mu\zeta_\pm}_{\mathbf{2}\text{ of }\mathfrak{sl}(2)_\pm\subset\mathfrak{so}(2,2)}$$

- SUSY preservation defined in terms of bi-spinor on M_7

$$\chi_1\otimes\chi_2^\dagger=\frac{1}{8}\sum_{n=1}^{7}\frac{1}{n!}\chi_2^\dagger\gamma_{a_n\dots a_1}\chi_1\gamma^{a_1\dots a_n}=\cos\theta(\slashed{\Psi}_++i\slashed{\Psi}_-)$$

- Necessary and sufficient condition purely geometric - RR flux output not input [Dibitetto-Lo Monaco-Passias-Petri-Tomasiello], [NTM-Tomasiello]

$$e^{3A}h_0=2me^{2A}\sin\theta,\qquad d(e^{2A}\sin\theta)=0,\ \ d_{H_3}(e^{3A-\Phi}\cos\theta\Psi_\pm)\mp 2me^{2A-\Phi}\cos\theta\Psi_\mp=\frac{e^{3A}}{8}\star_7\lambda(f_\pm),$$

$$d_{H_3}(e^{2A-\Phi}\cos\theta\Psi_\mp)=\pm\frac{1}{8}e^{2A}\sin\theta f_\pm,\qquad e^A(\Psi_\mp,\ f_\pm)_7=\mp\frac{m}{2}e^{-\Phi}\cos\theta\text{vol}(M_7),$$

- Two spinors may be decomposed in common basis $||V||^2=||\chi||^2=1$

$$\begin{aligned}\chi_1&=||\chi_1||\chi,\\ \chi_2&=||\chi_2||(\cos\alpha+i\sin\alpha\slashed{V})\chi\end{aligned}\qquad\Rightarrow\qquad \Psi_{+/-}=\frac{1}{8}\begin{cases}\text{Re}(e^{i\alpha}e^{-iJ_2}-\Omega_3\wedge V),\\ \text{Im}(e^{i\alpha}e^{-iJ_2}\wedge V+\Omega_3)\end{cases}$$

- SU(3)-structure (J_2,Ω_3) unless $\alpha=0$, then G_2-structure, 3-form

$$\Phi_3=J_2\wedge V-\text{Im}\Omega_3$$

Supersymmetric AdS$_3$ vacua: 2d superconformal algebras

- Rich variety of superconformal algebras $\mathcal{SCA}$ exists for $d = 2$.

  - Direct sums of chiral algebras $\mathcal{SCA} = \mathcal{SCA}_+ \oplus \mathcal{SCA}_-$, preserving $\mathcal{N} = (n_+, n_-)$.

- (Simple) $\mathcal{SCA}_\pm$ are classified [Fradkin-Linetsky] in terms of their bosonic part:

$$\underbrace{\mathfrak{sl}(2)_\pm}_{\mathfrak{sl}(2)_\pm \subset \mathfrak{so}(2,2)} \quad \oplus \quad \underbrace{\mathfrak{g}}_{\text{R-symmetry}}$$

  and a rep of $\mathfrak{g}$, ρ, which supercurrents transform in.

- Those embeddable into $d = 10, 11$ AdS$_3$ supergravity are [Beck-Gran-Gutowski-Papadopoulos]

$n_\pm$	$\mathcal{SCA}_\pm$	$\mathfrak{g}$	ρ	comment
n	$\mathfrak{osp}(n\|2)$	$\mathfrak{so}(n)$	$\mathbf{n}$	Series
$2n,\ n > 2$	$\mathfrak{su}(1,1\|n)$	$\mathfrak{su}(n) \oplus \mathfrak{u}(1)$	$\mathbf{n} \oplus \overline{\mathbf{n}}$	Series
8	$\mathfrak{osp}^*(4\|4)$	$\mathfrak{sp}(2) \oplus \mathfrak{sp}(1)$	$(\mathbf{4}, \mathbf{2})$	unique for M$_{7/8}$
8	$\mathfrak{f}(4)$	$\mathfrak{spin}(7)$	$\mathbf{8}$	unique
7	$\mathfrak{g}(3)$	$\mathfrak{g}_2$	$\mathbf{7}$	unique
4	$\mathfrak{d}(2,1,\alpha)$	$\mathfrak{su}(2) \oplus \mathfrak{su}(2)$	$(\mathbf{2}, \mathbf{2})$	Large $\mathcal{N} = 4$
4	$\mathfrak{su}(1,1\|2)/\mathfrak{u}(1)$	$\mathfrak{su}(2)$	$\mathbf{2} \oplus \overline{\mathbf{2}}$	Small $\mathcal{N} = 4$

- Many more possibilities than higher dim cases, intimately related to Virasoro algebra.
  -*c.f* CFT$_3$ which has just $\mathfrak{osp}(n|4)$

- For AdS$_3$ $\mathcal{N} = (n, 8 - n)$ is maximal, 4 ways to realise just $\mathcal{N} = (8, 0)$

- $\mathcal{N}=(n,0)$ AdS$_3$ vacua schematically realises $\mathcal{SCA}_+(n,\mathfrak{g},\rho)$ as

$$\epsilon=\sum_{I=1}^{n}\underbrace{\zeta_+^I}_{\mathfrak{sl}(2)_+}\otimes\ \chi^I,\qquad \underbrace{\mathcal{L}_{K^a}(\mathfrak{g})\chi^I=\Big[T_a(\mathfrak{g},\rho)\Big]^I{}_J\chi^J}_{(\mathfrak{g},\rho)\ \text{data}}$$

$$0=\mathcal{L}_{K^a}(\mathfrak{g})(\text{bosonic fields}),\quad [T_a,T_b]=f_{abc}T_c,\quad [K_a,K_b]=f_{abc}K_c$$

- ζ_+^I formed of AdS$_3$ Killing spinors $\nabla_\mu\zeta_+=+\frac{m}{2}\gamma_\mu\zeta_+$,
- In many cases problem is largely an exercise in group theory

  - i.e. what M$_{7,8}$ can support $\mathfrak{g}$ with spinors in $(\mathfrak{g},\rho)$?

- In high SUSY cases doing this carefully leaves not much left to be solved for with your favorite technique.
- SUSY implied by single $\mathcal{N}=(1,0)$ sub-sector and action of $\mathfrak{g}$

  - allows one to apply existing low SUSY classifications to extended SUSY.

- $\mathcal{N}=(n_+,n_-)$ works analogously $\epsilon=\zeta_+^I\otimes\chi_+^I+\zeta_-^j\otimes\chi_-^j$

  - But also need $\mathcal{L}_{K(g_-)}\chi_+^I=\mathcal{L}_{K(g_+)}\chi_-^i=0$

All $\mathcal{N} = (8, 0)$ solutions in 10 and 11 dimensions

A. Legramandi, G. Lo Monaco, NTM

All $\mathcal{N}=(8,0)$ vacua in 10 and 11 dimensions

- Possible $\mathcal{N}=(8,0)$ SCAs are the following

Superconformal algebra	$\mathfrak{g}_R$	ρ
$\mathfrak{osp}(8\|2)$	$\mathfrak{so}(8)$	$\mathbf{8}$
$\mathfrak{f}(4)$	$\mathfrak{spin}(7)$	$\mathbf{8}_s$
$\mathfrak{su}(1,1\|4)$	$\mathfrak{su}(4)\oplus\mathfrak{u}(1)$	$\mathbf{4}_{-1}\oplus\overline{\mathbf{4}_1}$
$\mathfrak{osp}(4^*\|4)$	$\mathfrak{sp}(2)\oplus\mathfrak{sp}(1)$	$(\mathbf{4},\mathbf{2})$

- R-symmetries need large manifold, the problem of finding all solutions is tractable.

  - $ds^2(\text{M}_{7/8})=ds^2(\text{M}_{\mathfrak{g}})+ds^2(\text{M}_{\text{co-dim}})$, $\quad$ $\dim(\text{M}_{\text{co-dim}})$ is small.

- Considering only products of group spaces the (minimal) possibilities are

$$\text{M}_{\mathfrak{g}_R}=\text{S}^7,\ \text{S}^6,\ \text{S}^5\times\text{S}^1,\ \text{S}^4\times\text{S}^2$$

  - These can all be realised by simply classifying $\text{AdS}_3\times\text{S}^4$ solutions in 10 and 11d

- However, to find all solutions we must also consider all possible fiber bundles

  - Here we are greatly aided by the restriction that $\dim(\text{M}_{\mathfrak{g}})\leq 8$

  - It turns out the only additional possibilities are 3 squashing* of the 7-sphere preserving

$$\text{U}(4),\quad \text{Spin}(7),\quad \text{SP}(2)\times\text{SP}(1)$$

- Solved for $\text{M}_{\text{co-dim}}$ data with existing geometric conditions for $\mathcal{N}=1$ AdS_3

[Martelli-Sparks,Dibitetto-Lo Monaco-Passias-Petri-Tomasiello]

All $\mathcal{N} = (8,0)$ solutions in 10 and 11 dimensions

- Summary of $\mathcal{N} = (8,0)$ solutions

Geometry	Algebra	Supergravity	Comment
$AdS_4 \times S^7$	$\mathfrak{osp}(8\|2)$	M-theory	locally higher dim AdS
$AdS_3 \times \widehat{S}^7 \times I$	$\mathfrak{f}(4)$	M-theory	conformal defect
$AdS_3 \times S^6 \times I$	$\mathfrak{f}(4)$	IIA	[Dibitetto-Lo Monaco-Passias-Petri-Tomasiello]
$AdS_3 \times \widehat{S}^7 \times I$	$\mathfrak{su}(1,1\|4)$	M theory	conformal defect
$AdS_5 \times S^5$	$\mathfrak{su}(1,1\|4)$	IIB	locally higher dim AdS
$AdS_3 \times \widehat{S}^7 \times I$	$\mathfrak{osp}(4^*\|4)$	M-theory	conformal defect
$AdS_7/\mathbb{Z}_k \times S^4$	$\mathfrak{osp}(4^*\|4)$	M-theory	locally higher dim AdS
$AdS_3 \times S^4 \times S^2 \times I$	$\mathfrak{osp}(4^*\|4)$	IIA	reduction of former

- Here $\widehat{S}^7$ indicates a squshing of the 7-sphere
- Several solutions are simply the embedding of AdS_3 into higher dim AdS spaces
  - or related to this via orbifolds and dimensional reduction.
- Exception is $AdS_3 \times S^6 \times I$ sol [Dibitetto-Lo Monaco-Passias-Petri-Tomasiello]
- More interestingly we find 3 new solutions in $d = 11$ on squashed 7-spheres!
- It turns out that no $\mathcal{N} = (8,0)$ solution has a compact internal space
  - disappointing for AdS_3/CFT_2
- But new solutions do have attractive AdS/CFT interpretation

All $\mathcal{N}=(8,0)$: Squashed 7-spheres

- U(4) preserving squashed S^7, $dV^0 = 2J^0$ are U(4) invariants

$$\frac{ds^2}{L^2} = \overbrace{\cosh^2(2r) ds^2(\mathrm{AdS}_3) + dr^2}^{\mathrm{AdS}_4,\ \text{radius } 2} + ds^2(\mathbb{CP}^3) + \tanh^2(2r)(V^0)^2,$$

$$G = 6\tanh(2r)\mathrm{vol}(\mathrm{AdS}_3)\wedge dr - \frac{2L^2}{\cosh(2r)} J^0\wedge J^0 - \frac{2L^2\sinh(2r)}{\cosh^2(2r)} dr\wedge V^0\wedge J^0$$

- Regular zero at $r=0$ $\mathrm{AdS}_4\times S^7$ at $r=\infty$
- Dual to $\mathfrak{su}(1,1|4)$ surface defect in $\mathcal{N}=8$ Chern-Simons matter theory

- Spin(7) preserving squashed* S^7, $d\Phi^0 = 4\star_7\Phi^0$ Spin(7) invariants

$$ds^2 = \frac{L^2}{\cos^2(r/2)\sin^{4/3}(r/2)}\left((5+3\cos r)ds^2(\mathrm{AdS}_3) + \frac{9}{4}\frac{\sin^4(r/2)}{5+3\cos r}dr^2 + \frac{9}{2}\sin^2 r\, ds^2(S^7)\right),$$

$$G = -L^3\frac{(5+3\cos r)(1+7\cos r)}{2\sqrt{2}\sin^3(r/2)\cos^4(r/2)}\mathrm{vol}(\mathrm{AdS}_3)\wedge dr + 54\sqrt{2}L^3\, d\left(\cos(r/2)\Phi^0\right)$$

- Interpolates between O2 plane on AdS_3 and $\mathrm{AdS}_4\times S^7$ - $\mathfrak{f}(4)$ conformal defect dual.

- In above could use any weak G_2 or SE_7 manifold, less SUSY
- 3rd defect on SP(2)×SP(1) preserving squshed S^7. Most complicated, still closed form.

$\mathfrak{osp}(n|2)$ for $n > 4$

NTM-Ramirez

- $\mathfrak{osp}(n|2)$: $(n,0)$ $\mathcal{SCA}$ with $\mathfrak{g}=\mathfrak{so}(n)$ and $\rho=\mathbf{n}$ [Bershadsky,Knizhnik]:

  - Central charge: $c=\frac{k}{2}\frac{n^2+6k-10}{k+n-3}$

  - Free field realisation: 1 free scalar, n real fermions, $\mathfrak{so}(n)$ current algebra [Mathieu]

- $n=1,2$ are the unique $(1,0)$ and $(2,0)$ SCA's, see talk of Achilleas Passias

- $n=3$ releasable with oribifolds of $\text{AdS}_3\times\text{S}^3\times\text{S}^3\times\text{S}^1$ also with $\text{S}^{2,3}$ fibered over $\text{S}^{2,3}$. [Eberhardt-Zadeh], [Legramandi-NTM].

- $n=4$ is simply a special case of Large $(4,0)$: $\mathfrak{d}(2|1;\alpha=1)=\mathfrak{osp}(4|2)$

  - ie D1-D5 + D1-D5 near horizon with $N^{(1)}_{D1}N^{(1)}_{D5}=N^{(2)}_{D1}N^{(2)}_{D5}$

- $n=8,7$ are locally the same and unique, ie only orbifolds of $\text{AdS}_4\times\text{S}^7$ available.

- What remains is $n=5,6$, have very recently found

  - $(6,0)$ with SO(6) R-symmetry necessitates $\mathbb{CP}^3$ (*c.f* $\text{AdS}_4\times\mathbb{CP}^3$)

  - Can break SO(6) to SO(5) by squashing $\text{S}^2\to\mathbb{CP}^3\to\text{S}^4$ and realise $(5,0)$

  - $\mathbb{CP}^3$ can appear with a U(1) fibered over it, only works in $d=11$, simply the lift of IIA cases with no U(1) fiber.

  - Sufficient ansatz is $\text{AdS}_3\times\mathbb{CP}^3$ foliated over an interval.

- $\mathbb{CP}^3$: SO(6) inv J_2, SO(5) inv $(\tilde{J}_2, \Omega_3)$ - define two SU(3)-structures
  - $dJ_2 = 0,\ \ d\tilde{J}_2 = 4\text{Re}\Omega_3,\ \ d\text{Im}\Omega_3 = (J_2\wedge J_2 + 3\tilde{J}_2\wedge\tilde{J}_2),\ \ 2J_2\wedge\tilde{J}_2 = J_2\wedge J_2 + \tilde{J}_2\wedge\tilde{J}_2$
  - Sufficient to construct 2 SO(6) and 4 SO(5) spinors starting from Killing spinor on S^7
  - Can then construct $d = 7$ spinors and exploit $(1,0)$ G-structure conditions.

- No solutions in IIB. Local $\mathcal{N} = (5,0)$ IIA solutions defined by just $u(r), h(r)$

$$\frac{ds^2}{L^2} = \frac{hu}{\sqrt{\Delta}}ds^2(\text{AdS}_3) + \frac{\sqrt{\Delta}}{4}\Bigg[\underbrace{\frac{2}{uh''}ds^2(\text{S}^4) + \frac{2}{2h'u' + uh''}\overbrace{(Dy_i)^2}^{\text{Fibered S}^2}}_{\text{Squashed }\mathbb{CP}^3} + \frac{1}{hu}dr^2\Bigg],\quad e^{-\Phi} = \frac{Lh''\sqrt{2h'u' + uh''}}{\sqrt{2}\Delta^{\frac{1}{4}}},$$

$$H = L^2 d\Bigg[\left(r - \frac{uh' + hu'}{2h'u' + uh''}\right)(-J_2 + \tilde{J}_2) + \left(r - \frac{uh' - hu'}{uh''}\right)(J_2 + \tilde{J}_2)\Bigg],\quad \Delta = 2hh''u^2 - (uh' - hu')^2$$

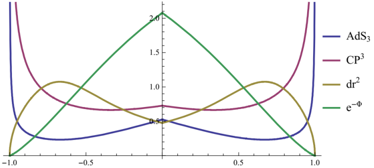
- F_0, F_2, F_4 non trivial, solutions governed by 2 ODEs
  - SUSY demands: $u'' = 0$ globally, $u =$ constant implies enhancement to $\mathcal{N} = (6,0)$
  - BI's: Romans mass defined as $F_0 = -h'''$, $\quad$ *c.f* AdS_7 in massive IIA

- Locally h $\mathcal{O}(3)$ polynomial, ie $h = c_2 + c_4 r + c_6 r^2 + c_8 r^3$
  - up to normalisation c_p are the Page charges of colour Dp branes

- Globally h''' can be discontinuous $\Rightarrow$ D8 sources: $dF_0 \sim \Delta c_8\delta(r - r_0)$

$\mathfrak{osp}(n|2)$: Global solutions $n = 5, 6$

- Can glue local solutions together with D8 branes, supersymmetric at fixed loci along r
  - requires $B_2 \to B_2 + \Delta B_2$ which induces shifts in Page charges as D8s are crossed
- Domain of r defined by upper/lower local solutions, have identified
  - $(6,0)$: Local D8/O8, O2 and $\text{AdS}_4 \times \mathbb{CP}^3$ ($F_0 = 0$ is locally this)
  - $(5,0)$: D6, O6, O2 and regular zero
- Can construct duals to CFT_3, but also duals to $\frac{1}{2}$ BPS defects in $\mathcal{N} = 6$ CSM theories
- Simplest $(6,0)$ sol: $-a \leq r \leq a$ bounded between D8/O8s, glued with D8s at $r = 0$,



- But generically can glue arbitrary $r \in [a_{l-1}, a_l]$ cells together with D8s
  - Suggestive of new $(6,0)$ and $(5,0)$, quiver SCFTs
  - CFT side appears undeveloped, but AdS/CFT suggests such constructions exist

Small $\mathcal{N} = (4, 0)$ vacua

Lozano-NTM-Nunez-Ramirez

Small $\mathcal{N}=(4,0)$: Conformal CY_2 solutions

- Interesting case is small $\mathcal{N}=(4,0)$: $\mathfrak{g}=\mathfrak{su}(2)$, $\rho=\mathbf{2}\oplus\overline{\mathbf{2}}$

  - Black string near horizons, relation to 5d black-holes and micro-state counting

- In recent years have classified $\mathrm{AdS}_3\times\mathrm{S}^2\times\mathrm{M}_4$ solutions in type II

  - Assume SUSY imposes no necessary isometries in M_4

  - Local form of 2 SU(2)-structure classes in IIA, 2 Identity-structure cases in IIB known [NTM-Ramirez]

  - Many options for solutions, allow me to focus on one.

- IIA conformal CY_2 class: $h_8(\rho), u(\rho), h_4(\rho,\mathrm{CY}_2)$, $u'=\partial_\rho u$

$$ds^2=\frac{u}{\sqrt{h_4h_8}}\bigg(ds^2(\mathrm{AdS}_3)+\frac{1}{4\Delta}ds^2(\mathrm{S}^2)\bigg)+\sqrt{\frac{h_4}{h_8}}ds^2(\mathrm{CY}_2)+\frac{\sqrt{h_4h_8}}{u}d\rho^2,$$

$$e^{-\Phi}=h_8^{\frac{5}{4}}h_4^{\frac{1}{4}}u^{-\frac{1}{2}}\sqrt{\Delta},\quad H=\frac{1}{2}d\bigg(-\rho+\frac{uu'}{4h_4h_8\Delta}\bigg)\mathrm{Vol}(\mathrm{S}^2)+\frac{d\rho}{h_8}\wedge\mathcal{F},\quad \Delta=1+\frac{(u')^2}{4h_4h_8}$$

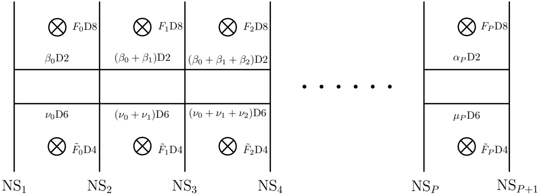
- $(F_0=h_8', F_2, F_4)$ non trivial. SUSY demands: $u''=0,\quad \star_4\mathcal{F}+\mathcal{F}=0$

- BI's away form sources: $h_8''=0,\quad \frac{h_8}{u}\nabla^2_{\mathrm{CY}_2}h_4+h_4''+\frac{1}{h_8^3}|\mathcal{F}|^2=0,\quad d\mathcal{F}=0$

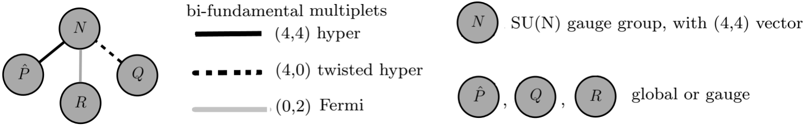
- Assume symmetries of CY_2 preserved $\Rightarrow$ $\mathcal{F}=0$ and $(h_8(\rho),h_4(\rho))$ piecewise linear

  - Discontinuous $(h_8',h_4')\Rightarrow$ (D8,D4) sources: $\partial_\rho^2 h_{8,4}\sim\sum_i Q_i^{8,4}\delta(\rho-\rho_i^{8,4})$

- Can glue arbitrarily many local solutions together with these D4s and D8s
  - Must arrange for the space to be bounded between regular zero or physical singularity.
  - Continuity of NS sector constrains $Q_i^{8,4}$ and Page charges (color branes) between them.
- We are essentially describing a Hanany-Witten brane setup of the form

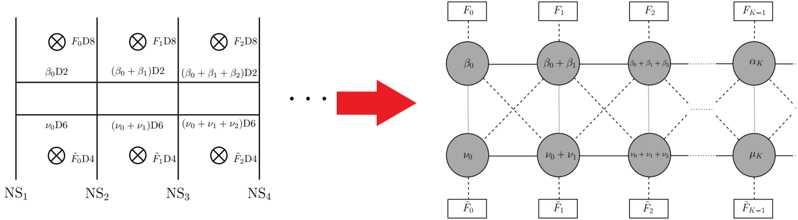


- Suggests a dual description in terms of linear quivers.
- Small $\mathcal{N} = (4,0)$ SCFTs realised as the IR fixed points of flows from weakly coupled quivers in UV
- Such UV quivers may be constructed in terms of blocks of the form



Small $\mathcal{N} = (4,0)$: CFT matching

- From the Hanany-Witten brane setup one can read off corresponding quiver



- Cancellation of gauge anomalies at $\alpha_k \Rightarrow F_{k-1} = \nu_{k-1} - \nu_k$
  - Condition reproduced by imposing continuity of NS sector in gravity!
- An important test of a duality is to confirm the central charges match. On the CFT side can use small SCA and R-symmetry anomaly to establish

$$c_{cft} = 6(n_{\text{hyp}} - n_{\text{vec}})$$

which can be read off the quiver.

- In gravity, the holographic central charge is

$$c_{hol} = \frac{3}{\pi}\int_0^{2\pi(P+1)} h_8(\rho)h_4(\rho)d\rho$$

- These quantities do indeed match in the limit that it makes sense to compare them!

-ie Large ranks and long quivers, making the gravity side (mostly) weakly coupled.

Conclusions

- **Much progress on classification of $\mathbf{AdS_3}$ vacua with extended SUSY**

  - Many AdS/CFT avenues to explore

- $\mathcal{N} = (8,0)$ **solutions now all known!**

  - Non compact, but include duals to defects in Chern-Simmons matter theories

  - Should be able to compute full KK spectra, spin(2) sector under way

- **Have constructed backgrounds realising** $\mathfrak{osp}(n|2)$ $\mathcal{SCA}$**'s for** $n > 4$

  - In the process of constructing duals to $(6,0)$ and $(5,0)$ linear quivers

  - Conspicuously absent from CFT literature, can make interesting predictions

- **Dual geometry/quiver pairs already constructed for small** $(4,0)$

  - Part of a small corner of 1 of 4 classes, expect many other things possible

- **Many interesting things left to attack for $\mathbf{AdS_3/CFT_2}$**

  - Only other maximal case completely classified is Large $\mathcal{N} = (4,4)$ [D'Hoker et-al], [NTM]

  - All $\mathcal{N} = (n-8, n)$ desired: small $\mathcal{N} = (4,4)$ next on the list

  - Status of large $(4,0)$ still mostly unknown, expect a fair bit more is possible

Thank you