AdS_6/CFT_5 in Type IIB

Part II: Dualities, tests and applications

Christoph Uhlemann
UCLA

Strings, Branes and Gauge Theories
APCTP, July 2018

arXiv: 1606.01254, 1611.09411, 1703.08186, 1705.01561, 1706.00433, 1802.07274, 1805.11914, 1806.07898, 1806.08374

with E. D'Hoker, M. Gutperle, A. Karch, C. Marasinou, A. Trivella, O. Varela, O. Bergman, D. Rodríguez-Gómez, M. Fluder

Introduction

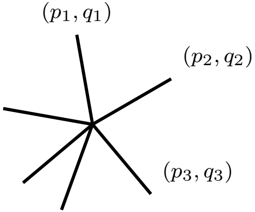
Higher-dimensional CFTs are interesting:

- mysterious, non-Lagrangian
- interesting implications for $d \leq 4$
- string/M-theory connections ...

5d SCFTs: often fixed points for asymptotically safe gauge theories, large classes engineered in Type IIB via 5-brane webs

Recap

Any planar 5-brane junction realizes 5d SCFT on intersection point



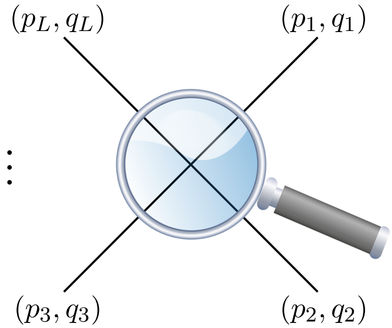
$p_i, q_i \in \mathbb{Z}$

$$\sum p_i = \sum q_i = 0$$

Characterized entirely by external 5-brane charges. May or may not have gauge theory deformations.

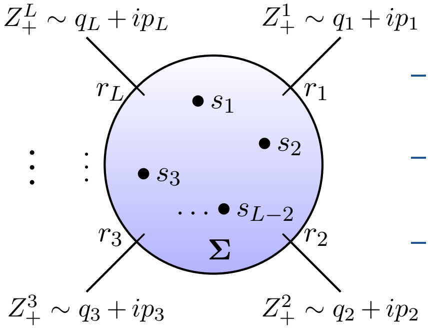
Recap

Supergravity solutions for fully localized 5-brane intersections, constructed directly as "near-horizon" limit:



Recap

Supergravity solutions for fully localized 5-brane intersections, constructed directly as "near-horizon" limit:

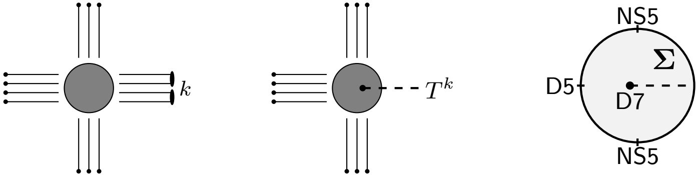


- $AdS_6 \times S^2 \times \Sigma$ with $\Sigma = \mathrm{disc}$
  5-branes emerge at poles on $\partial\Sigma$
- parametrized entirely by residues $=$conserved 5-brane charges
- $\mathrm{AdS}_6 + 16$ susies $= F(4)$

Naturally fit to string theory picture. "Large N": all (p_i, q_i) large.

Recap

Claim: poles $\sim$ groups of 5-branes that are unconstrained by s-rule.
Constrained junctions realized by bringing 7-branes into web:



Supergravity: $\Sigma =$ disc with puncture(s), $[p, q]$ 7-brane monodromy

Position of puncture on $\Sigma \longleftrightarrow$ choice of face in which 7-brane is placed with no 5-branes attached(?)

$\mathrm{AdS}_6/\mathrm{CFT}_5$ in Type IIB

Goal of this talk: convincing case for proposed identifications and dualities, first lessons on 5d SCFTs

AdS_6/CFT_5 in Type IIB

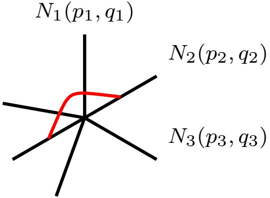
Outline

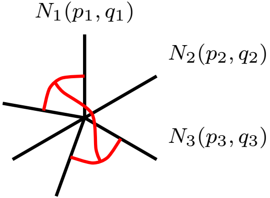
- Testing AdS_6/CFT_5 with stringy operators
- Holographic S^5 partition functions and EE, # d.o.f.
- QFT partition functions: Precision test of AdS_6/CFT_5
- (Massive) spin-2 fluctuations

– Testing AdS_6/CFT_5 with strings –

Testing AdS_6/CFT_5 with strings

5-brane picture: gauge invariant operators from strings and string junctions connecting external 5-branes

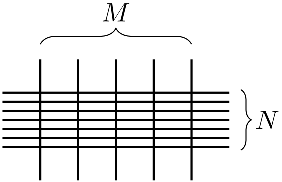




Supergravity: operators with $\Delta = \mathcal{O}(N) \leftrightarrow$ probe strings or string junctions in supergravity background $(1 \ll \Delta \ll \mathcal{F}(S^5))$.

Strategy: study gauge theory deformations, identify stringy BPS operators, extrapolate to SCFT, compare to supergravity

Stringy operators in $+_{N,M}$ theories

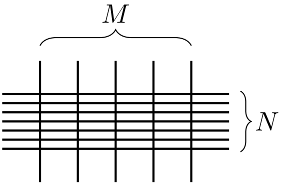


$$[N] - SU(N)^{M-1} - [N]$$

$$SU(N)^2 \times U(1)_B^M \times U(1)_I^{M-1}$$

$$\subset SU(N)^2 \times SU(M)^2 \times U(1)$$

Stringy operators in $+_{N,M}$ theories



$$[N] - SU(N)^{M-1} - [N]$$

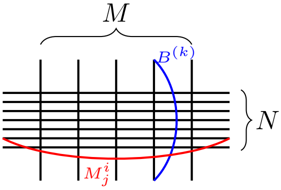
$$SU(N)^2 \times U(1)_B^M \times U(1)_I^{M-1}$$

$$\subset SU(N)^2 \times SU(M)^2 \times U(1)$$

$$M^i_j = (x^{(1)} \cdots x^{(M)})^i_j \qquad (\mathbf{N}, \bar{\mathbf{N}}, \mathbf{1}, \mathbf{1}) \qquad \Delta = \frac{3}{2}M \qquad Q = \frac{1}{2}M$$

$$B^{(k)} = \det(x^{(k)}) \qquad \subset (\mathbf{1}, \mathbf{1}, \mathbf{M}, \bar{\mathbf{M}}) \qquad \Delta = \frac{3}{2}N \qquad Q = \frac{1}{2}N$$

Stringy operators in $+_{N,M}$ theories



$$[N] - SU(N)^{M-1} - [N]$$

$$SU(N)^2 \times U(1)_B^M \times U(1)_I^{M-1}$$

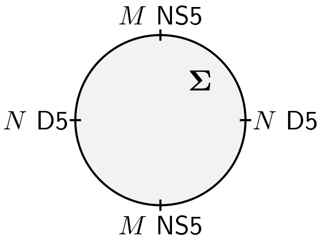
$$\subset SU(N)^2 \times SU(M)^2 \times U(1)$$

$$M^i_j = (x^{(1)} \cdots x^{(M)})^i_j \qquad (\mathbf{N}, \bar{\mathbf{N}}, \mathbf{1}, \mathbf{1}) \qquad \Delta = \frac{3}{2}M \qquad Q = \frac{1}{2}M$$

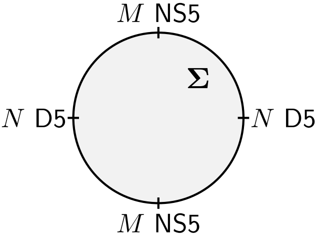
$$B^{(k)} = \det(x^{(k)}) \qquad \subset (\mathbf{1}, \mathbf{1}, \mathbf{M}, \bar{\mathbf{M}}) \qquad \Delta = \frac{3}{2}N \qquad Q = \frac{1}{2}N$$

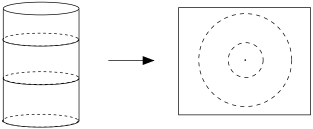
$M^i_j \sim$ F1 between D5, $B^{(k)} \subset$ D1 between NS5. S-dual quiver deformation realizes all D1 operators, subset of F1 operators.

Stringy operators in $+_{N,M}$ solution



Stringy operators in $+_{N,M}$ solution

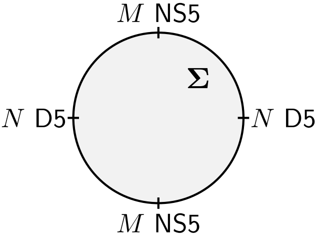


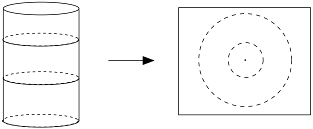


global AdS$_6$/CFT$_5$ on $\mathbb{R} \times S^4$

AdS_6 $\partial_t \leftrightarrow$ dilation: $\Delta = \mathcal{H}$

Stringy operators in $+_{N,M}$ solution





global $\mathrm{AdS}_6/\mathrm{CFT}_5$ on $\mathbb{R}\times S^4$

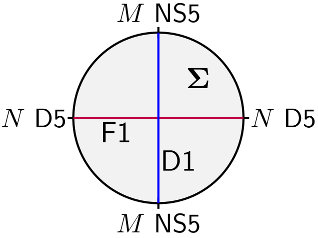
AdS_6 $\partial_t \leftrightarrow$ dilation: $\Delta = \mathcal{H}$

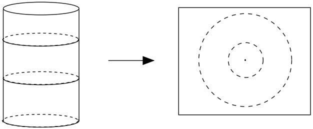
Action and EOM for (p,q) string along t and Σ:

$$S_{(p,q)} = -2T\int d^2\xi f_6\rho|w'|\sqrt{\mathfrak{q}\mathcal{M}\mathfrak{q}} \qquad \mathfrak{q}\mathcal{M}\mathfrak{q} = e^{2\phi}\begin{pmatrix}p\\q\end{pmatrix}\begin{pmatrix}1 & -\chi\\ -\chi & \chi^2+e^{-4\phi}\end{pmatrix}\begin{pmatrix}p\\q\end{pmatrix}$$

$$0 = \frac{\bar{w}''}{\bar{w}'} - \frac{w''}{w'} + \left(\bar{w}'\partial_{\bar{w}} - w'\partial_w\right)\ln\left(f_6^2\rho^2\mathfrak{q}^T\mathcal{M}\mathfrak{q}\right)$$

Stringy operators in $+_{N,M}$ solution





global $\mathrm{AdS}_6/\mathrm{CFT}_5$ on $\mathbb{R}\times S^4$

AdS_6 $\partial_t \leftrightarrow$ dilation: $\Delta = \mathcal{H}$

F1 between D5 poles, D1 between NS5 poles:

$$\Delta_{\mathrm{F1}} = \frac{3}{2}M \qquad\qquad \Delta_{\mathrm{D1}} = \frac{3}{2}N$$

Solve EOM, scaling dimensions match field theory exactly ✓✓

Stringy operators in $+_{N,M}$ solution

R-charge of string states from coupling to $SU(2)$ bulk gauge field fluctuation dual to R-symmetry current (S^2 isometries).

Relevant part from KK ansatz + $SU(2)$ gauge invariance:

$$dx^\mu \to dx^\mu + K_I^\mu A^I \qquad K_I \sim S^2 \text{ Killing vector fields}$$

$$\delta C_{(2)} = d\mathcal{C} \wedge f_I A^I + \ldots \qquad df_I = \star_{S^2} K_I$$

Stringy operators in $+_{N,M}$ solution

R-charge of string states from coupling to $SU(2)$ bulk gauge field fluctuation dual to R-symmetry current (S^2 isometries).

Relevant part from KK ansatz + $SU(2)$ gauge invariance:

$$dx^\mu \to dx^\mu + K_I^\mu A^I \qquad K_I \sim S^2 \text{ Killing vector fields}$$

$$\delta C_{(2)} = d\mathcal{C} \wedge f_I A^I + \dots \qquad df_I = \star_{S^2} K_I$$

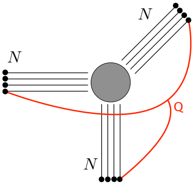
(p, q) strings couple to $\delta C_{(2)}$ through WZ term

$$Q_{(p,q)} = T \int_{\Sigma_{(p,q)}} \left(p\,\mathrm{Re}(d\mathcal{C}) - q\,\mathrm{Im}(d\mathcal{C}) \right)$$

$$\implies \quad Q_{\mathrm{F1}} = \frac{1}{2} M \qquad Q_{\mathrm{D1}} = \frac{1}{2} N$$

✓✓

Stringy operators in T_N [Benini,Benvenuti,Tachikawa '09]



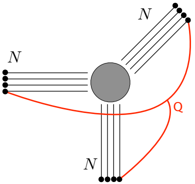
ext. 5-branes can be connected with D1-F1-$(1,-1)$ triple string junction

$$\Delta = \frac{3}{2}(N-1) \qquad Q = \frac{1}{2}(N-1)$$

$(\mathbf{N},\mathbf{N},\mathbf{N})$ of $SU(N)^3$ global symmetry

4d version in [Gaiotto,Maldacena]

Stringy operators in T_N [Benini,Benvenuti,Tachikawa '09]



ext. 5-branes can be connected with D1-F1-$(1,-1)$ triple string junction

$$\Delta = \frac{3}{2}(N-1) \qquad Q = \frac{1}{2}(N-1)$$

$(\mathbf{N},\mathbf{N},\mathbf{N})$ of $SU(N)^3$ global symmetry

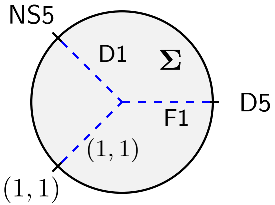
4d version in [Gaiotto,Maldacena]

Triple junction in supergravity:

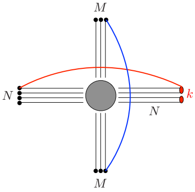
$$z_{\mathrm{F1}} = \xi \quad z_{\mathrm{D1}} = e^{\pi i/3}\xi \quad z_{(1,1)} = e^{2\pi i/3}\xi$$

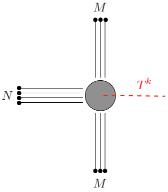
$$\Delta = \frac{3}{2}N \qquad Q = \frac{1}{2}N$$

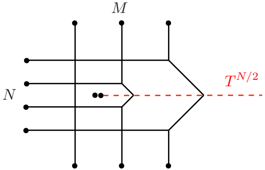
Agrees with T_N operator at large N. ✓✓



Stringy operators in $+_{N,M,k}$

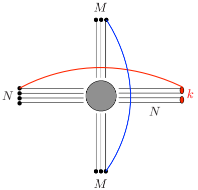


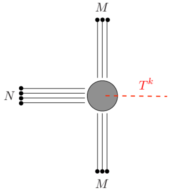


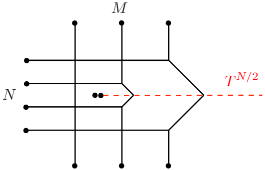


$$
\begin{array}{c}
[N] - (N)^{M-\frac{N}{k}-1} - \underset{\displaystyle \begin{array}{c} \big|\, y \\ [k] \end{array}}{(N)} - (N-k) - (N-2k) - \cdots - (k)
\end{array}
$$

Stringy operators in $+_{N,M,k}$





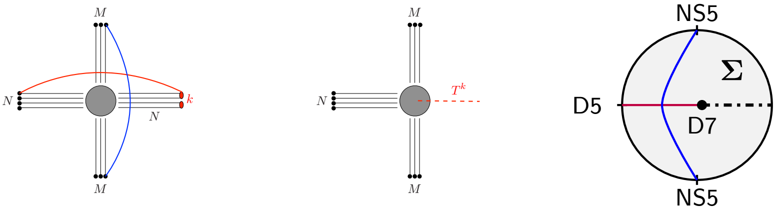


$$
\begin{array}{c}
[N] - (N)^{M-\frac{N}{k}-1} - \underset{\displaystyle \overset{|\, y}{[k]}}{(N)} - (N-k) - (N-2k) - \cdots - (k)
\end{array}
$$

$$\mathcal{O}^a_{\tilde{b}} = [x_1 \cdots x_{M-\frac{N}{k}}\, y]^a_{\tilde{b}} \qquad \Delta = \frac{3}{2}\left(M - \frac{N}{k} + 1\right) \qquad Q = \frac{1}{3}\Delta$$

$$\mathcal{O}_{(i)} = \det x_i \qquad \Delta = \frac{3}{2}N \qquad Q = \frac{1}{2}N$$

Stringy operators in $+_{N,M,k}$



$$[N] - (N)^{M-\frac{N}{k}-1} - \underset{\substack{|\, y \\ [k]}}{(N)} - (N-k) - (N-2k) - \cdots - (k)$$

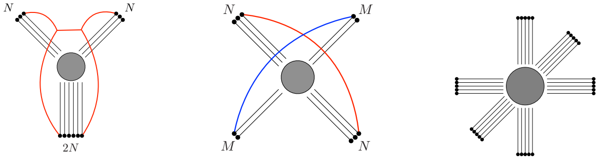
$$\mathcal{O}^a_{\tilde{b}} = [x_1 \cdots x_{M-\frac{N}{k}}\, y]^a_{\tilde{b}} \qquad \Delta = \frac{3}{2}\left(M - \frac{N}{k} + 1\right) \qquad Q = \frac{1}{3}\Delta$$

$$\mathcal{O}_{(i)} = \det x_i \qquad \Delta = \frac{3}{2}N \qquad Q = \frac{1}{2}N$$

D1, F1 in supergravity agree on Δ and Q at large N, M ✓✓

Spectrum of high-dimension operators

Similar stories for Y_N, $X_{N,M}$, $\not+_N$



Precise quantitative agreement of field theory analyses and supergravity results on scaling dimensions at large N ✓

Confirms brane junction interpretation for solutions without and for solutions with monodromy. ✓

Holographic S^5 partition functions and entanglement entropies, # d.o.f.

Entanglement entropy vs. free energy

First steps in AdS/CFT: Holographic interpretation consistent?
Warped product, poles, renormalization?

Entanglement entropy vs. free energy

First steps in AdS/CFT: Holographic interpretation consistent?
Warped product, poles, renormalization?

$$S_{\mathrm{EE}}(\mathrm{disc})\Big|_{\mathrm{finite}} \stackrel{?}{=} -\mathcal{F}(S^5)$$

8d min. surface wrapping S^2 and Σ (→ S_{EE})

on-shell action, $C_{(4)} = 0$ total derivative [Okuda,Trancanelli '08] (→ $\mathcal{F}(S^5)$)

Entanglement entropy vs. free energy

First steps in AdS/CFT: Holographic interpretation consistent?
Warped product, poles, renormalization?

$$S_{\mathrm{EE}}(\mathrm{disc})\Big|_{\mathrm{finite}} \stackrel{?}{=} -\mathcal{F}(S^5)$$

8d min. surface
wrapping S^2 and Σ

on-shell action, $C_{(4)} = 0$
total derivative [Okuda,Trancanelli '08]

– translates to non-trivial identities on Σ, both sensitive to entire geometry, including poles on Σ

Entanglement entropy vs. free energy

First steps in AdS/CFT: Holographic interpretation consistent?
Warped product, poles, renormalization?

$$S_{\mathrm{EE}}(\mathrm{disc})\big|_{\mathrm{finite}} \overset{?}{=} -\mathcal{F}(S^5)$$

8d min. surface wrapping S^2 and Σ

on-shell action, $C_{(4)} = 0$
total derivative [Okuda,Trancanelli '08]

– translates to non-trivial identities on Σ, both sensitive to entire geometry, including poles on Σ

Computations free from conceptual subtleties – No divergences from poles, no finite contributions. ✓

Entanglement entropy vs. free energy

EE factorizes into geometric and theory-dependent part

$$S_{\mathrm{EE}} = \frac{1}{4G_{\mathrm{N}}} \times \mathrm{Area}(\gamma_4) \times \frac{8\mathrm{Vol}_{\mathrm{S}^2}}{3} \int_\Sigma d^2w\, \kappa^2 \mathcal{G}$$

S^5 partition function from renormalized on-shell action

$$S^{\mathrm{E}}_{\mathrm{IIB}} = -\frac{5\mathrm{Vol}_{\mathrm{S}^2}}{3G_{\mathrm{N}}} \mathrm{Vol}_{\mathrm{AdS}_6,\mathrm{ren}} \sum_{\ell\neq k, m\neq n} Z^{[\ell k]} Z^{[mn]} \times \int_{-\infty}^{r_\ell} dx\, \ln\left|\frac{x-r_k}{r_\ell - r_k}\right| \ln\left|\frac{x-r_m}{r_m-r_n}\right| \frac{1}{x-r_n}$$

Entanglement entropy vs. free energy

EE factorizes into geometric and theory-dependent part

$$S_{\rm EE} = \frac{1}{4G_{\rm N}} \times {\rm Area}(\gamma_4) \times \frac{8{\rm Vol}_{\rm S^2}}{3} \int_\Sigma d^2w\, \kappa^2 \mathcal{G}$$

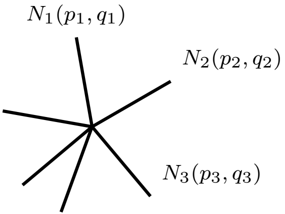
S^5 partition function from renormalized on-shell action

$$S^{\rm E}_{\rm IIB} = -\frac{5{\rm Vol}_{\rm S^2}}{3G_{\rm N}} {\rm Vol}_{{\rm AdS}_6,{\rm ren}} \sum_{\ell\neq k, m\neq n} Z^{[\ell k]} Z^{[mn]} \times \int_{-\infty}^{r_\ell} dx\, \ln\left|\frac{x-r_k}{r_\ell - r_k}\right| \ln\left|\frac{x-r_m}{r_m-r_n}\right| \frac{1}{x-r_n}$$

Related as expected, $S_{\rm EE}({\rm disc})\big|_{\rm finite} = -\mathcal{F}(S^5)$ ✓

General scaling of # d.o.f.

In general $\mathcal{F}(S^5)$ depends on all 5-brane charges in junction



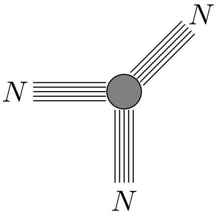
$$Z_\pm^\ell \sim N_\ell(q_\ell + ip_\ell)$$

Simple behavior under homogeneous rescaling of all charges:

$$N_i \to \alpha N_i \quad \forall i \qquad \Longrightarrow \qquad \mathcal{F}(S^5) \to \alpha^4 \mathcal{F}(S^5)$$

Compare $\alpha^{5/2}$ for $USp(N)$ theory from D4/D8/O8 [Jafferis,Pufu]

Examples



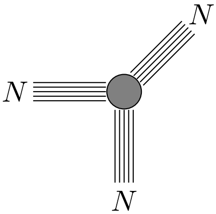
5d T_N theory w/ gauge theory deformation

$$N - SU(N-1) \times \cdots \times SU(2) - 2$$

[Benini,Benvenuti,Tachikawa '09;Bergman,Zafrir '14]

$$\mathcal{F}_{\text{sugra}}(S^5) = -\frac{27}{8\pi^2}\,\zeta(3)N^4$$

Examples



5d T_N theory w/ gauge theory deformation

$$N - SU(N-1) \times \cdots \times SU(2) - 2$$

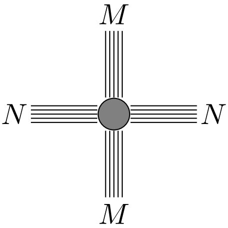
[Benini,Benvenuti,Tachikawa '09;Bergman,Zafrir '14]

$$\mathcal{F}_{\text{sugra}}(S^5) = -\frac{27}{8\pi^2}\,\zeta(3)N^4$$

NS5/D5 intersection: [Aharony,Hanany,Kol '97]

$$N - SU(N)^{M-1} - N$$

$$\mathcal{F}_{\text{sugra}}(S^5) = -\frac{189}{16\pi^2}\,\zeta(3)N^2M^2$$



Field theory partition functions and precision tests of AdS_6/CFT_5

Field theory partition functions

Strategy: study gauge theory deformation to obtain SCFT results.
5d SYM partition function on (squashed) S^5 [Källen et al.; H.-C. Kim, S. Kim;Imamura;Lockhart,Vafa]

Expected large-N simplifications: instantons exponentially suppressed, saddle point approximation exact

Field theory partition functions

Strategy: study gauge theory deformation to obtain SCFT results.
5d SYM partition function on (squashed) S^5 [Källen et al.; H.-C. Kim, S. Kim;Imamura;Lockhart,Vafa]

Expected large-N simplifications: instantons exponentially suppressed, saddle point approximation exact

Remaining challenge for zero instanton partition functions:

$$\mathcal{Z}_0 = \int_{-\infty}^{\infty} \prod_{i,j} \mathrm{d}\lambda_i^{(j)} \exp\left(-\mathcal{F}\right)$$

Gauge group node becomes effectively continuous parameter at large N. Scaling of $\lambda_i^{(j)}$ not necessarily homogeneous.

Field theory partition functions

Numerical evaluation [Herzog,Klebanov,Pufu,Tesileanu]: Replace saddle point eq. by set of particles w/ coordinates $\lambda_i^{(j)}$ in potential $\mathcal{F}$

$$\frac{\partial \mathcal{F}}{\partial \lambda_i^{(j)}} = 0 \qquad \longrightarrow \qquad \frac{\partial \mathcal{F}}{\partial \lambda_i^{(j)}(t)} = -\frac{d\lambda_i^{(j)}(t)}{dt}$$

Equilibrium configurations are solutions to saddle point equation. Approximate solutions from late-time behavior of $\lambda_i^{(j)}(t)$.

Field theory partition functions

Numerical evaluation [Herzog,Klebanov,Pufu,Tesileanu]: Replace saddle point eq. by set of particles w/ coordinates $\lambda_i^{(j)}$ in potential $\mathcal{F}$

$$\frac{\partial \mathcal{F}}{\partial \lambda_i^{(j)}} = 0 \qquad \longrightarrow \qquad \frac{\partial \mathcal{F}}{\partial \lambda_i^{(j)}(t)} = -\frac{d\lambda_i^{(j)}(t)}{dt}$$

Equilibrium configurations are solutions to saddle point equation. Approximate solutions from late-time behavior of $\lambda_i^{(j)}(t)$.

$\rightarrow$ Zero instanton saddle point approximation to $\mathcal{F}(S^5)$, conformal central charge C_T from squashing deformations [Chang,Fluder,Lin,Wang]

Field theory partition functions

Explicit numerical results for S^5 partition functions for

$$T_N : \quad 2 \leq N \leq 52 \qquad +_{N,M} : \quad 2 \leq N, M \leq 30$$

Computationally more expensive conformal central charges:

$$T_N : \quad 2 \leq N \leq 22 \qquad +_{N,M} : \quad 2 \leq N, M \leq 15$$

Field theory partition functions

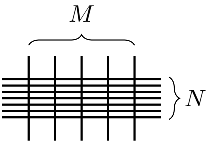
Explicit numerical results for S^5 partition functions for

$$T_N: \quad 2 \leq N \leq 52 \qquad +_{N,M}: \quad 2 \leq N, M \leq 30$$

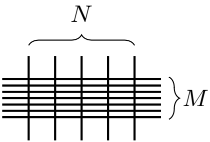
Computationally more expensive conformal central charges:

$$T_N: \quad 2 \leq N \leq 22 \qquad +_{N,M}: \quad 2 \leq N, M \leq 15$$

$+_{N,M}$ consistency check: SCFT partition functions obtained from quiver and S-dual quiver should agree



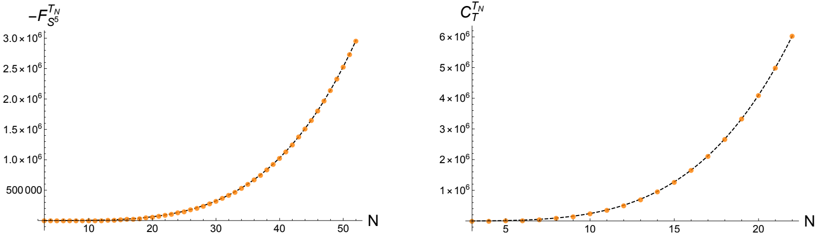
vs.



Relative "error" $\to 0$ for large N, M. Below 1% for $N, M \geq 16$ ✓

Field theory partition functions

Results for T_N:

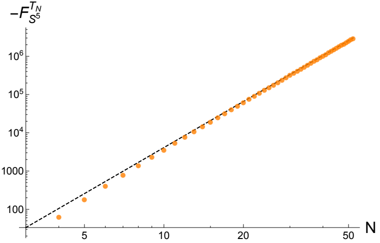


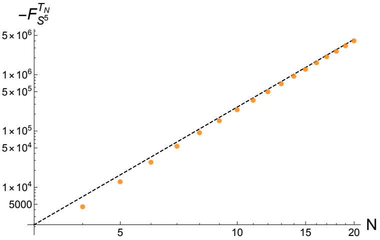
Numerical results as dots, degree-4 polynomial from least-squares fit as dashed line. F_{S^5} on the left, C_T on the right.

Clear quartic scaling, as predicted holographically. ✓

Precision test of $\mathrm{AdS}_6/\mathrm{CFT}_5$

Comparison to supergravity:



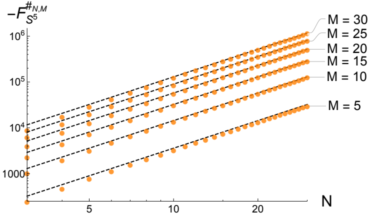


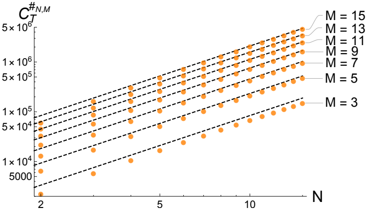
Supergravity: $$F_{\mathrm{S}^5} = -\frac{27}{8\pi^2}\,\zeta(3)N^4 \qquad C_T = \frac{2160}{\pi^4}\,\zeta(3)N^4$$

Coefficients of leading terms, extracted via fit of numerical results to degree-4 polynomial, agree within 1 ‰ ✓

Field theory partition functions

Results for $+_{N,M}$: for fixed N clear quadratic scaling with M, and for fixed M clear quadratic scaling with N ✓





Supergravity: $F_{S^5} = -\frac{189}{16\pi^2}\zeta(3)N^2M^2 \quad C_T = \frac{7560}{\pi^4}\zeta(3)N^2M^2$

Coefficients of leading terms, extracted via fit of numerical results to degree-2 polynomial in NM, agree within 2 ‱ ✓

– Massive spin-2 excitations –

Massive spin-2 excitations

Identifying fluctuations non-trivial: non-trivial background, weak symmetry constraints $\rightarrow$ large set of coupled PDE's on Σ.

Spin-2 fluctuations exclusively from metric $\rightarrow$ decoupling trivial. Used for warped AdS_4 fluctuations by [Bachas,Estes '11].

5d SCFTs should have conserved $T_{\mu\nu} \sim$ massless AdS_6 graviton. Decoupling of states on external 5-branes?

Massive spin-2 excitations

Metric perturbation on unit-radius AdS_6:

$$ds^2 = f_6^2 \left(ds^2_{AdS_6} + \delta g \right) + \hat{g}_{ab} dy^a dy^b$$

With $h^{[tt]}_{\mu\nu}$ transverse-traceless

$$\delta g = h^{[tt]}_{\mu\nu} \phi_{\ell m} Y_{\ell m} dx^\mu dx^\nu \qquad \Box_{AdS_6} h^{[tt]}_{\mu\nu} = (M^2 - 2) h^{[tt]}_{\mu\nu}$$

Type IIB EOM reduce to:

$$6\partial_a \left(\mathcal{G}^2 \eta^{ab} \partial_b \phi_{\ell m} \right) - \ell(\ell+1) \left(9\kappa^2 \mathcal{G} + 6|\partial \mathcal{G}|^2 \right) \phi_{\ell m} + M^2 \kappa^2 \mathcal{G} \phi_{\ell m} = 0$$

Massive spin-2 excitations

Two families of *universal*, regular and normalizable solutions:

(i) $\phi_{\ell m} = \mathcal{G}^{\ell} \qquad M^2 = \Delta(\Delta - 5) \qquad \Delta = 5 + 3\ell$

(ii) $\phi^{(1)}_{\ell m} + i\phi^{(2)}_{\ell m} = \mathcal{G}^{\ell}\left(\mathcal{A}_+ - \bar{\mathcal{A}}_-\right) \qquad \Delta = 6 + 3\ell$

$M^2 \geq 3\ell(3\ell + 5)$ for regular solutions, saturated by (i).
Massless graviton for $M = \ell = 0 \sim$ 5d conserved $T_{\mu\nu}$. ✓

Massive spin-2 excitations

Two families of *universal*, regular and normalizable solutions:

(i) $\phi_{\ell m} = \mathcal{G}^{\ell}$ $\qquad M^2 = \Delta(\Delta - 5)$ $\qquad \Delta = 5 + 3\ell$

(ii) $\phi^{(1)}_{\ell m} + i\phi^{(2)}_{\ell m} = \mathcal{G}^{\ell}\left(\mathcal{A}_+ - \bar{\mathcal{A}}_-\right)$ $\qquad \Delta = 6 + 3\ell$

$M^2 \geq 3\ell(3\ell + 5)$ for regular solutions, saturated by (i).
Massless graviton for $M = \ell = 0 \sim$ 5d conserved $T_{\mu\nu}$. ✓

Match Q^4 descendants in B_2, A_4 multiplets with scalar primaries $\Delta^{\text{prim.}}_{B_2} = 3 + 3\ell$ and $\Delta^{\text{prim.}}_{A_4} = 4 + 3\ell$ [Cordova,Dumitrescu,Intriligator]

Universal part in spectrum of dual SCFTs. Similarities to massive IIA [Passias,Richmond '18], different in details and interpretation.

– Summary & Outlook –

Summary

Holographic interpretation of solutions appears consistent: poles/external 5-branes decouple, 5d conserved $T_{\mu\nu}$

Quantitative match of stringy operators in supergravity solutions to string theory picture and field theory predictions.

Field theory partition functions and conformal central charges match supergravity predictions for T_N and $+_{N,M}$.

First lessons: N^4 d.o.f., universal $\Delta = \mathcal{O}(1)$ operators, stringy spectrum for theories with no suitable gauge theory deformations.

Outlook

Compelling picture for $\mathrm{AdS}_6/\mathrm{CFT}_5$ in Type IIB: large classes of solutions, coherent string theory interpretation, match to SCFTs.

Full fluctuation spectrum $\sim \Delta = \mathcal{O}(1)$ operators. (Consistent) KK reduction to 6d gauged supergravity? Non-universal parts?

More stringy operators and op.'s corresponding to e.g. D3 branes.

Correlation functions, defects, Wilson lines, more tests, ...
Classification of large-N SCFTs?

Outlook

Compelling picture for $\mathrm{AdS}_6/\mathrm{CFT}_5$ in Type IIB: large classes of solutions, coherent string theory interpretation, match to SCFTs.

Full fluctuation spectrum $\sim \Delta = \mathcal{O}(1)$ operators. (Consistent) KK reduction to 6d gauged supergravity? Non-universal parts?

More stringy operators and op.'s corresponding to e.g. D3 branes.

Correlation functions, defects, Wilson lines, more tests, ...
Classification of large-N SCFTs?

Thank you!