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Advances in AdS_6/CFT_5 correspondence

based on **arXiv:1209.3267 [hep-th]** and **arXiv:1406.0852 [hep-th]**
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First Period of Activity: 1996-2000

[Seiberg '96] First examples of five-dimensional supersymmetric fixed points with global symmetry E_{N_f+1}[1], $N_f \leq 7$, obtained in the limit of infinite bare coupling of an $\mathcal{N} = 1$ supersymmetric gauge theory with $Sp(1)$ gauge group and N_f "quark" hypermyltiplets in the fundamental representation.

This theory appears as the effective field theory on the worldvolume of a D4-brane near N_f D8-branes on top of a single O8 orientifold plane in type I' string theory.

In the case of multiple D4-branes the gauge group becomes $Sp(N)$ and there is an extra massless hypermultiplet in the anti-symmetric representation.

These theories also appear as effective field theories on a web of (p, q) 5- and 7-branes in type IIB string theory [DeWolfe, Hanany, Iqbal, Katz '99]

[1] $E_5 = \mathrm{Spin}(10)$, $E_4 = SU(5)$, $E_3 = SU(3) \times SU(2)$, $E_2 = SU(2) \times U(1)$, $E_1 = SU(2)$

First Period of Activity: 1996-2000

[Ferrara, Kehagias, Zaffaroni '98] The fixed points correspond to $F(4)$ gauged supergravity coupled to matter vector multiplets[2] in the adjoint representation of E_{N_f+1}.[3] Evidence for a D4-D8-brane configuration in massive type IIA supergravity, with an AdS_6 near horizon geometry, preserving 8 supercharges.

[Brandhuber,Oz '99] A warped $AdS_6 \times S^4$ solution of massive type IIA supergravity is found, arising as the near horizon limit of a localised D4-D8-brane configuration.

[Cvetic, Lu, Pope '99] $F(4)$ gauged supergravity is obtained upon Kaluza-Klein reduction of massive IIA supergravity on S^4.

[2] $F(4)$ gauged supergravity coupled to vector multiplets was constructed in [D'Auria, Ferrara, Vaulá '00].
[3] $F(4)$ is the unique anti-deSitter superalgebra in six dimensions.

The Brandhuber-Oz solution

Near horizon geometry of a localised D4-D8-brane configuration with N_f D8-branes located to one O8 plane and $16 - N_f$ D8-branes to the other O8 plane.

$$ds^2 = e^{-\frac{\phi}{10}} N^{\frac{3}{5}} C^{-\frac{2}{5}} \left(\frac{9}{4} ds^2_{\mathrm{AdS}_6} + d\alpha^2 + \cos^2\alpha d\Omega_3^2 \right)$$

$$F_4 = \frac{5}{12} N^{\frac{9}{10}} C^{-\frac{3}{5}} e^{-\frac{2}{5}\phi} \cos^3\alpha d\alpha \wedge \mathrm{vol}_{S^3} \,, \qquad e^{\phi} = N^{-\frac{1}{4}} C^{\frac{1}{6}} (3F_0 \sin\alpha)^{-\frac{5}{6}}$$

- The space has a boundary at $\alpha = 0$ which corresponds to the location of the O8 orientifold plane. The dilaton and the curvature diverge at the boundary.

- The $SO(5)$ isometry of S^4 is reduced to $SO(4) \simeq SU(2) \times SU(2)$ corresponding to the $SU(2)_R$ R-symmetry and to an $SU(2)$ global symmetry of the dual field theory.

Second Period of Activity 2012 -

[Bergman, Rodríguez-Gómez '12] D4-branes at orbifold singularities; supersymmetric quiver gauge theories (the gauge group is a product of symplectic and unitary groups) dual to $AdS_6 \times S^4/\mathbb{Z}_p$ backgrounds of massive type IIA supergravity.

[Jafferis, Pufu '12] S^5 partition function of large N superconformal field theories (localization); free energy of the dual gravity background (entanglement entropy); agreement between the two sides and reproduction of the $N^{\frac{5}{2}}$ scaling.

large N limit of vevs of Wilson loops [Assel, Estes, Yamazaki '12] and superconformal indices [Kim, Kim, Lee '12],[Bergman, Rodríguez-Gómez, Zafrir '13] on both sides of the AdS_6/CFT_5 correspondence.

RG flows [Karndumri '12],[Pini, Rodríguez-Gómez '14], giant gravitons in AdS_6 [Bergman, Rodríguez-Gómez '12] ...

Supersymmetric AdS_6 Solutions

type IIA (massive)

Brandhuber-Oz solution and orbifolds thereof; proven to be unique. [Passias '12]

M-theory

no solutions. [Apruzzi, Fazzi, Passias, Rosa, Tomasiello '14]

type IIB

- T-dual of the Branduber-Oz solution along the Hopf fiber in $S^3 \in S^4$; additional singularity at $\alpha = \frac{\pi}{2}$. [Cvetic, Pope, Vázquez-Poritz '00], [Lozano, Ó Colgáin, Rodríguez-Gómez, Sfetsos '12]

- non-Abelian T-dual of the Branduber-Oz solution with respect to the $SU(2) \in SU(2) \times SU(2)_R$; non-compact; additional singularity at $\alpha = \frac{\pi}{2}$. [Lozano, Ó Colgáin, Rodríguez-Gómez, Sfetsos '12]

Supersymmetric AdS_6 Solutions

We would like to perform a systematic search for supesymmetric $AdS_6 \times M_4$ backgrounds of type IIB supergravity.

Most general Ansatz: a warped product of AdS_6 and a Riemannian manifold M_4

$$ds_{10}^2 = e^{2A} ds_{AdS_6}^2 + ds_{M_4}^2$$

$SO(5,2)$ symmetry dictates:

- warp factor A and dilaton ϕ functions on M_4
- $F_5 = 0$; H, F_1, F_3 forms on M_4.

Supersymmetry: There exists a Spin(9, 1) Weyl spinor $\epsilon = \epsilon_1 + i\epsilon_2$ such that the gravitino and dilatino supersymmetry variations, $\delta_\epsilon \psi$ and $\delta_\epsilon \lambda$, vanish (ϵ_1 and ϵ_2 are Majorana-Weyl spinors of the same chirality).

Supersymmetric AdS_6 Solutions

ϵ_1 and ϵ_2 define a G-structure on M_{10} characterized by a set of differential forms, defining the metric and the fluxes, which can be summarised by the bispinor $\Phi = \epsilon_1 \otimes \overline{\epsilon_2}$, via the Clifford map $\gamma^{i_1 \dots i_n} \to dx^{i_1} \wedge \dots \wedge dx^{i_n}$.

The supersymmetry constraints translate to a system of differential equations obeyed by Φ. The precise form of this system was derived in [Tomasiello '11].

Spin$(5,1) \times$Spin(4) decomposition of ϵ_1, ϵ_2 yields a set of Spin(4) Weyl spinors

$$\eta^1_\pm \,, \qquad \eta^2_\pm$$

on M_4. Each $\eta^{1,2}$ defines an identity structure. The two identity structures can be parametrized by a vielbein e^a and a set of functions encoding the map between the two identity structures.

Reduction of the system of [Tomasiello '11] constraints e^a and the functions.

Supersymmetric AdS_6 Solutions

We have been able to determine the local form of the metric

S^2-fibration over a two-dimensional space Σ_2

- The isometry of S^2 corresponds to the $SU(2)$ R-symmetry
- The fluxes are determined in terms of the geometry. The equations of motion and Bianchi identities are automatically satisfied.
- The warp factor and the dilaton depend on Σ_2; they satisfy two first-order PDEs.
- We have recovered the abelian and non-abelian T-duals of the Brandhuber-Oz solution.

Conclusions and Outlook

- We have reduced the problem of supersymmetric AdS_6 solutions in type IIB to two first-order PDEs for the warp factor and the dilaton.

- We expect solutions arising as near-horizon geometries of of (p, q) five- and seven-brane webs.