The operator spectrum of wrapped brane CFT's

Ritabrata Bhattacharya

Utah State University

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in collaboration with Dr. Oscar Varela and Abhay Katyal

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Motivation

- The application of Conformal Field Theories (CFTs) in Physics have existed for quite some time. Most notably it is used to describe the behaviour of systems near Phase transitions. Thus classifying CFTs is an essential task before talking about specific CFTs for solving specific problems.

Motivation

- The application of Conformal Field Theories (CFTs) in Physics have existed for quite some time. Most notably it is used to describe the behaviour of systems near Phase transitions. Thus classifying CFTs is an essential task before talking about specific CFTs for solving specific problems.
- In dimensions greater than 2 this is in general a tedious task. Our focus will be on holographic, supersymmetric 4D CFT's and the technology we develop is very useful.

- We find the Kaluza Klein spectrum of the light operators in AdS_5 backgrounds constructed using compactified gauged supergravity solutions in 11 dimensions. The dual 4D CFTs in our case are in the S-class put forward by *Gaiotto, Maldacena et al.*.

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- The operator spectrum of the boundary CFT is obtained by the holographic principle, ($L \equiv$ AdS radius),

$$\Delta(\Delta - d) = M^2 L^2 \text{ (for scalar/graviton)} \tag{1}$$

$\Delta \rightarrow$ Conformal dim. in CFT_d, $M \rightarrow$ mass of the corresponding field in AdS_{d+1}.

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- Some progress along this direction have already been achieved in the case of maximally supersymmetric compactifications. (*Malek, Samtleben (2019,2020), Cesaro, Larios, Varela (2021)*)

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- The solution we work with was obtained by *Maldacena, Núñez (2000)*. It is a solution with N=2 SUSY with R-symmetry group $SU(2) \times U(1)$. And the metric is given by,

$$ds_{11}^2 = 2^{-2/3}\tilde{\Delta}^{1/3}\Big[ds_{\mathrm{AdS}_5}^2 + 2(d\theta^2 + ds^2(H_2)) + \frac{2}{\tilde{\Delta}}\sin^2\theta(dz+V)^2 + \frac{\cos^2\theta}{\tilde{\Delta}}ds^2(S^2)\Big] . \tag{2}$$

- The configuration is that of a stack of K M5 branes. The metric describes the near horizon limit of the geometry formed when 2 directions of the M5 branes are wrapped around the the Hyperbolic surface H_2 (Riemann surface). And the rest of the compact coordinates has the topology of S^4. The S^4 is fibred over the H_2.
- When we zoom in near the horizon we see the AdS_5 background.

Spectrum of gravitons

- Following the approach of *Bachas, Estes* we solve the following Klein-Gordon equation for the Einstein frame metric with an overall warp factor e^{2A}, to get the KK graviton spectrum. For 11D Supergravity we have,

$$\frac{e^{-9A}}{\sqrt{g_6}}\partial_m \left(e^{9A}\sqrt{g_6}g_6^{mn}\partial_n\right) Y(\vec{x}_6) = -M^2L^2Y(\vec{x}_6) \qquad (3)$$

  where g_6 is the metric on the 6 dimensional compact space without the warp factor.
- In our case $e^{2A} = 2^{-2/3}\tilde{\Delta}^{1/3}$ with $\tilde{\Delta} = \cos^2\theta + \frac{1}{2}\sin^2\theta$.

With $u = \cos^2\theta$ and the substitution

$$Y(\vec{x}_6) = u^{\ell/2}(1-u)^{|n|/2}H(u)\varphi(x,y)e^{inz}\mathcal{Y}_{S_2},$$

the differential equation takes the form of a Hypergeometric equation for $H(u)$.

Demanding regularity of the solution at $u = 0$ and $u = 1$ we get the discrete spectrum which is given by,

$$M^2 L^2 = 2k(k+3) + 2\ell(\ell+1) + n^2 - 2(|n| - j)(|n| - j - 1). \quad (4)$$

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Here $k \geq \ell + |n|$ denotes the Kaluza Klein level.
The last term captures the effect of the fibration i.e. the branes wrapping around the H_2. More importantly, it captures the universal deformations of the Riemann surface.

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- This allows us to get the masses of fields algebraically instead of having to solve differential equations for the other fields as well.
- We match the graviton spectrum obtained from ExFT story with the result from the *Bachas, Estes* approach.

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- The allowed supermultiplets can be determined from representation theory.
- What we are able to check is that, at each KK level the masses of different fields along with their multiplicities obtained from the ExFT computation, does fill out the allowed supermultiplets, giving us the light operator spectrum of the theory.

Results

1. Our analysis shows that the *Maldacena, Nunez* solution actually has a consistent truncation to maximal SUGRA rather than the half maximal truncation as per earlier understanding.
2. We provide full spectrum which includes fibration along the Riemann surface. The work of *Gutperle et al.* (2019) discusses only a subset of the full spectrum.
3. Since we have the full light operator spectrum, we can compute the $N = 2$ superconformal index of the light operators as well as different limits of it. We match the Hall Littlewood Index for N=2, SU(K) gauge theories for large K (*Rastelli et al. (2011)*) and give predictions for the other limits at large K.

Future Directions

1. The natural question that arises from our analysis is whether this story of truncation to maximal SUGRA generalises to other supersymmetric solutions obtained by compactifying 11d SUGRA.
2. Now that we have the N=2 superconformal index for the light operators, it will be interesting to see if this helps in any way to figure out the microstate counting of extremal black holes for N=2.

THANK YOU