WRAPPED BRANES IN ROMANS $F(4)$ GAUGED SUPERGRAVITY

Myungbo SHIM,[1] Nakwoo Kim[1,2] arXiv:190x. [hep-th] August 2019

[1]Department of Physics and Research Institute of Basic Science, Kyung Hee University.
[2]School of Physics, Korea Institute for Advanced Study

YUKAWA INSTITUTE FOR THEORETICAL PHYSICS

ABSTRACT

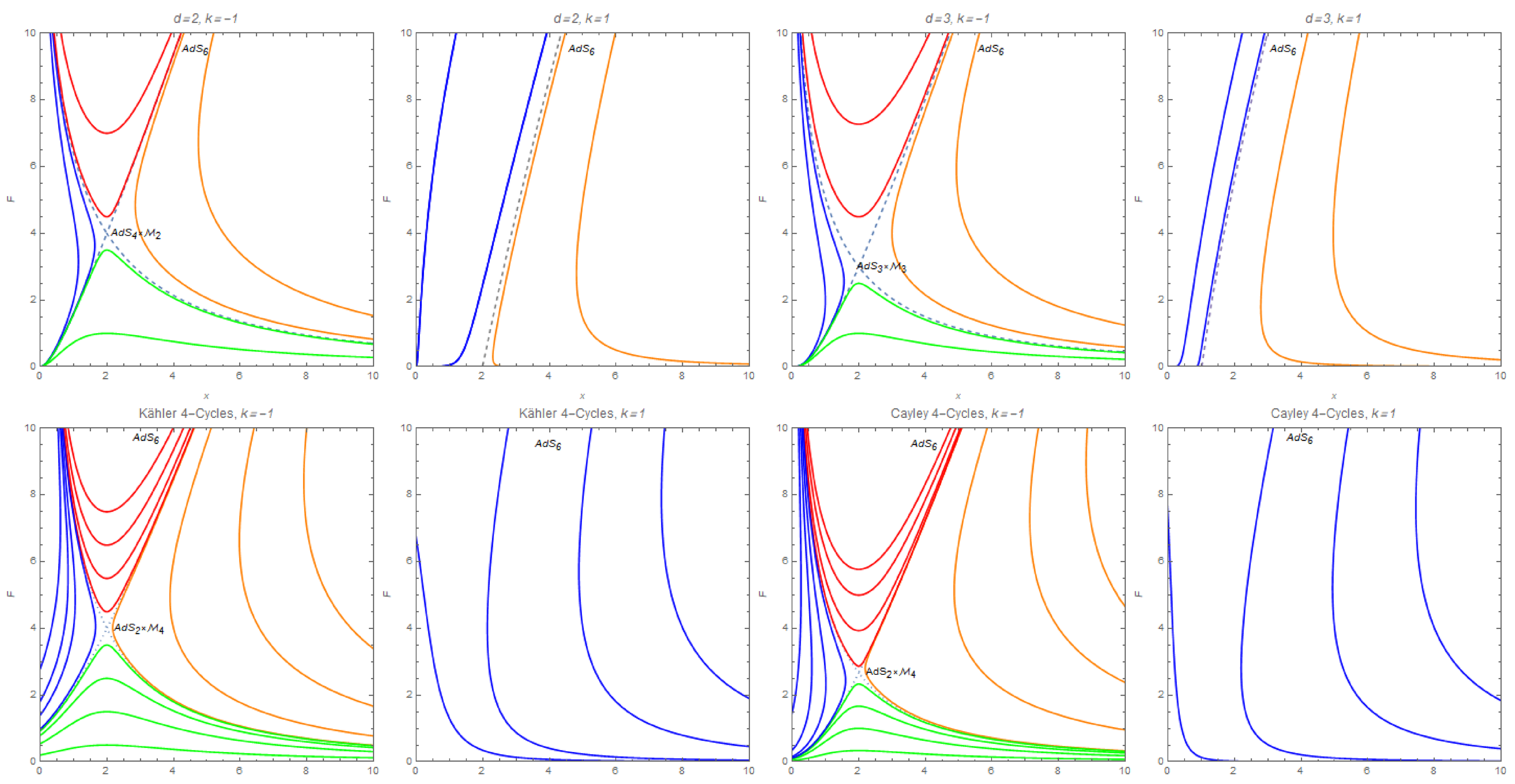
We explore the spectrum of lower-dimensional anti-de Sitter (AdS) solutions in $F(4)$ gauged supergravity in six dimensions. The ansatz employed corresponds to D4-branes partially wrapped on various supersymmetric cycles in special holonomy manifolds. We also report on non-supersymmetric AdS vacua, and check their stability using the Breitenlohner-Freedman bound.

TABLE 0 : FIXED POINT SOLUTIONS

Cycles	k	BPS solution	Non-BPS solution	Does non-BPS solution violate the BF Bound?
2-Cycles	1	X	X	-
	-1	O	O	Yes
3-Cycles	1	X	X	-
	-1	O	O	Yes
$\mathbb{H}_2 \times \mathbb{H}_2$	$(-1,-1)$	O	X	-
$S^2 \times S^2$	$(1,1)$	X	O	No
$S^2 \times \mathbb{H}_2$	$(1,-1)$	X	X	-
Kähler 4-Cycles	1	X	O	No
	-1	O	X	-
Cayley 4-Cycles	1	X	X	-
	-1	O	X	-

A summary of existence of wrapped brane solutions in $F(4)$ gauged supergravity. k denotes the sign of scalar curvature of the cycles branes are wrapped on.

FIGURE 1 : HOLOGRAPHIC RG FLOWS



Flow Diagrams for Each Cases : UV AdS_6 and $AdS_{6-d} \times \mathcal{M}_d$ fixed points are identified.

UV EXPANSION : ($d = 2, 3, 4$) NEAR $x \longrightarrow \infty$

$$\frac{dF}{dx} = \frac{F(4kx + 2mgx^2)}{x[x(g^2F - mgx + (4-d)k) + 4\sqrt{2}g\Upsilon]}, \qquad F = 3\frac{m}{g}x + \frac{3dk}{g^2} + \sum_{n=1}^{\infty} C_n^{(F)} x^{-\frac{n}{2}}$$

$$\Upsilon_{d=2,3} = 0, \qquad \Upsilon_{\text{Cayley}} = -\frac{1}{3\sqrt{2}g^2m}, \qquad \Upsilon_{\text{Kähler}} = -\frac{1}{\sqrt{2}g^2m}$$

$$C_2^{(F)} = 12\left(\frac{\sqrt{2}}{g}\Upsilon - \frac{d}{mg^3}\right), \qquad C_3^{(F)} = -\frac{(6+d)k}{2mg}C_1^{(F)}, \qquad C_{4,\,d=4}^{(F)} = \frac{-\frac{1}{2}g^2C_1^{(F)}C_1^{(F)} - 16kC_2^{(F)}}{3mg}$$

$$C_{n+2}^{(F)} = -\frac{2(2n+dn+4)kC_n^{(F)} + 4\sqrt{2}(n-2)g\Upsilon C_{n-2}^{(F)} + \sum_{a=1}^{n-1} ag^2C_a^{(F)}C_{n-a}^{(F)}}{2(1+n)mg}, \qquad (n \geq n^*),$$

where $n^* = 2$ for $d = 2, 3$ and $n^* = 3$ for $d = 4$

LAGRANGIAN OF $F(4)$ GAUGED SUPERGRAVITY

$$\begin{aligned} S_{F(4)} = &\frac{1}{2(\kappa_6)^2}\int d^6x\sqrt{-g}\,\Big[\frac{1}{4}R - \frac{1}{2}\partial_\mu\phi\,\partial^\mu\phi + \frac{1}{8}(g^2e^{\sqrt{2}\phi} + 4gme^{-\sqrt{2}\phi} \\ &- m^2e^{-3\sqrt{2}\phi}) - \frac{1}{4}e^{-\sqrt{2}\phi}(\mathcal{H}_{\mu\nu}\mathcal{H}^{\mu\nu} + F^I_{\mu\nu}F^{I\mu\nu}) - \frac{1}{12}e^{2\sqrt{2}\phi}G_{\mu\nu\rho}G^{\mu\nu\rho} \\ &- \frac{1}{8}\epsilon^{\mu\nu\rho\sigma\tau\kappa}B_{\mu\nu}(\mathcal{F}_{\rho\sigma}\mathcal{F}_{\tau\kappa} + mB_{\rho\sigma}\mathcal{F}_{\tau\kappa} + \frac{1}{3}m^2B_{\rho\sigma}B_{\tau\kappa} + F^I_{\rho\sigma}F^I_{\tau\kappa})\Big] \end{aligned}$$

METRIC ANSATZ

$$ds_6^2 = e^{2f}(-dt^2 + dr^2 + \sum_{\alpha=1}^{4-d} dx_\alpha^2) + \sum_i e^{2\lambda_i}ds^2_{\mathcal{M}_{i,d}}$$

- This $AdS_{6-d} \times \mathcal{M}_d$ describes partially wrapped supersymmetric branes.
- $\mathcal{M}_d$ should be a calibrated cycle in special holonomy manifolds.
- 2 and 3 Cycles are a special Lagrangian cycles
- Three types of 4-cycles : Cayley, Kähler, and two Riemann surfaces(Kähler)
- It is also called holographic RG geometry : $r \longrightarrow 0$ is UV
- There are non-supersymmetric fixed points

TABLE 1 : GAUGE FIELD ANSÄTZE

Cycles	$\mathcal{F}$	$F^{\hat{I}}_{\mu\nu}$	$B_{\mu\nu}$
2-Cycles	0	$F^{\hat{3}}_{45} = \frac{k\zeta}{g}e^{-2\lambda}$	0
3-Cycles	0	$F^{\hat{I}}_{\text{non-zero}} = \frac{k\zeta_I}{2g}e^{-2\lambda}$	0
Cayley 4-Cycles	0	$F^{\hat{I}}_{\text{non-zero}} = \frac{k\zeta_I}{3g}e^{-2\lambda}$	$B_{01} = -\frac{2}{3m^2g^2}e^{\sqrt{2}\phi-4\lambda}$
Kähler 4-Cycles	0	$F^{\hat{3}}_{23} = F^{\hat{3}}_{45} = \frac{k\zeta}{g}e^{-2\lambda}$	$B_{01} = -\frac{2}{m^2g^2}e^{\sqrt{2}\phi-4\lambda}$
Kähler $\Sigma_{\mathfrak{g}_1} \times \Sigma_{\mathfrak{g}_2}$	0	$F^{\hat{3}}_{23} = \frac{k_1\zeta}{g}e^{-2\lambda_1}$, $F^{\hat{3}}_{45} = \frac{k_2\zeta}{g}e^{-2\lambda_2}$	$B_{01} = -2\frac{k_1k_2}{m^2g^2}e^{\sqrt{2}\phi-2(\lambda_1+\lambda_2)}$

The ansatz for gauge fields in orthonormal bases for each case. $\zeta_{(I)}$ is ±1, representing the choice of orientation of wrapped branes. It is also constrained by $\zeta_1\zeta_2\zeta_3 = 1$. $k = \pm1$ gives the sign of scalar curvature of the supersymmetric cycles.

ENTROPY OF NON-SUSY AdS_6 BLACK OBJECTS

$$S_{BH} = \frac{2\pi(7 \pm 2\sqrt{6})}{25g^2m^2\kappa_6^2} \times \begin{cases} 16\pi^2 & S^2 \times S^2 \text{ horizon} \\ 18\pi^2 & \mathbb{CP}^2 \text{ horizon} \end{cases}$$

$$s^6_{\text{BS}} = \frac{A_H^5}{4G_N^5(2\pi\Theta)} = \frac{2\pi RA_H^5}{\kappa_6^2} \approx \frac{14.7122\pi}{g^3m\kappa_6^2}\mathrm{Vol}(\mathcal{M}_3),$$

$$s^6_{\text{BB}} = \frac{A_H^4}{4G_N^4(4\pi^2\Theta^2)} = \frac{2\pi R^2A_H^4}{\kappa_6^2} \approx \frac{31.9417\pi}{g^3m\kappa_6^2}\mathrm{Vol}(\mathcal{M}_2)$$

LOWER DIMENSIONAL EFFECTIVE THEORIES AND MORE

The more detailed analysis including entropy of supersymmetric black objects and stability is in our paper. For more, please take a look at it.

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