Attractor mechanism in gauged supergravity

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Introduction

- Gauged supergravities are the low energy effective theories that describe flux compactifications of string theory.[1]
- In the AdS/CFT correspondence, the supergravity regime of the bulk theory is described by a gauged supergravity.[2]
- For AdS supergravity, there exist extremal black brane solutions with Lifshitz like near-horizon geometries.[3]
- For ungauged supergravities ($\mathcal{N} = 2, d = 4$) the attractor mechanism[4] characterizes the near horizon geometries of extremal BPS black hole solutions.
- Studying the attractor mechanism in generic gauged supergravities may be useful to understand generic properties of extremal solutions in these theories.

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[1] Samtelbean 0808.4076
[2] Aharony et.al hep-th/9905111
[3] Goldstein et. al 0911.3586, 1007.2490
[4] hep-th/9602136

Attractor mechanism for gauged supergravities

- Recently[5] there has been a generalization of the attractor mechanism for $\mathcal{N} = 2$ $d = 4$ gauged supergravities coupled to vector and hyper multiplets.

"Generalized Attractors": Features

- The scalars z^i, quarternions q^u, gauge fields A_a, field strengths F_{ab} all take constant values in tangent space.
- The attractor geometries are characterized by constant anholonomy coefficients ${c_{ab}}^c \Rightarrow {R_{ab}}^{cd} = \text{const} \Rightarrow$ regular geometries.
- All the field equations become algebraic at the attractor points.

- Examples for ${c_{ab}}^c$ =const include AdS$_4$, dS$_4$, Lifshitz, Schrodinger geometries and other planar geometries.

[5] Kachru et.al 1104.2882

Scalar potential and Attractor potential

- For $d = 4$ $\mathcal{N} = 2$ gauged supergravity the scalar potential[6] is expressed in terms of squares of fermionic shifts $\delta_A \chi^\alpha$ that arise in susy transformations due to gauging.

$$\delta_A{}^B V(z, \bar{z}, q) = Z_{\alpha\beta} \delta_A \chi^\alpha \delta^B \bar{\chi}^\beta - 3\mathcal{M}_{AC} \bar{\mathcal{M}}^{CB}$$

- The attractor potential[7] also has a similar structure

$$\delta_A{}^B \mathcal{V}_{attractor}(z, \bar{z}, q) = Z_{\alpha\beta} \tilde{\delta}_A \chi^\alpha \tilde{\delta}^B \bar{\chi}^\beta - 3\tilde{\mathcal{M}}_{AC} \tilde{\bar{\mathcal{M}}}^{CB}$$

  where the shifts $\tilde{\delta}_A \chi^\alpha$ and $\tilde{\mathcal{M}}_{AC}$ include terms depending on constant gauge fields and constant field strengths.

- The variation of the scalars in the theory is an extremum of the attractor potential.

$$\frac{\partial \mathcal{V}_{attractor}[\phi]}{\partial \phi} = 0$$

- We are in the process of generalizing this construction to $\mathcal{N} = 2$ $d = 5$ gauged supergravity.

[6] Adrianopoli et.al. hep-th/9605032
[7] Kachru et.al 1104.2882

5d gauged sugra

- The 5d $\mathcal{N}=2$ gauged sugra[8] has the field content gravity coupled to vector, tensor and hyper multiplets.
- The scalars of the theory parametrize a manifold

$$\mathcal{M}_{scalar} = \mathcal{S}(n_V + n_T) \otimes \mathcal{Q}(n_H)$$

- gauging: a) by $K \subset G$ of $\mathcal{M}_{scalar}$: $K = U(1)^{n_V+1}$ with gauge coupling g, b) R-symmetry $SU(2)_R$ with coupling g_R.
- Gauging by K amounts to replacing the derivatives of the scalars and fermions with K-covariant derivatives. Gauging the R symmetry replaces the $SU(2)_R$ connection with its gauged counterpart.
- The scalar potential is again expressed as squares of fermionic shifts that arise in the supersymmetry transformations due to gauging.

$$\delta^{\tilde{a}}_{\tilde{b}}\mathcal{V}(h,q) = 2g^2 W^{\tilde{a}} W_{\tilde{b}} + 2g^2 \mathcal{N}_{iA}\mathcal{N}^{iA}\delta^{\tilde{a}}_{\tilde{b}} - g_R^2[2P_{ij}P^{ij} - P^{\tilde{a}}_{ij}P^{ij}_{\tilde{a}}]$$

[8]Ceresole, Dall'Agata hep-th/0004111

Results+In Progress...

- The ansatz used by Kachru[9] et.al to derive the $\mathcal{N} = 2, d = 4$ generalized attractors also works in 5d.
- The attractor potential can be expressed in terms of shifts and mass matrix that depend on the constant scalars and gauge fields.
- The attractor points are similar to the ones obtained in the 4d case. In particular, planar geometries ($C^a{}_{bc} = \text{const}$).
- Further checks in progress.
- presence of tensor field + chern-simons term, possibilities of more general ansatzes for getting the attractor equations ?
- eg, instead of having scalars and quarternions as constants, one could also have scalars and quarternions to be covariantly constant. Are there interesting solutions in the theory with such properties ?
- It would be nice if this procedure gives some insight towards the classification of extremal black brane geometries.

[9] 1104.2882

Thank You!