Moduli spaces of AdS_5 vacua in $\mathcal{N} = 2$ supergravity

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Motivation

- AdS ($\Lambda \leq 0$) vacua appear as solutions in SUGRA ...
- ... and from compactifications of string theory (prominent example: AdS/CFT correspondence)
- continuous deformations between different vacua?
  $\Rightarrow$ moduli space $\mathcal{M}$
- $\mathcal{M}$ is the space of scalar deformations which preserve the vacuum structure
- here: moduli space of $d = 5$ SUGRA with 8 supercharges ($\mathcal{N} = 2$)

Gauged $\mathcal{N} = 2$ supergravity: field content

see [E. Bergshoeff et al. '02]

- gravity multiplet

$$(g_{\mu\nu}, A^0_\mu, \psi^{\mathcal{A}}_\mu) \quad \mathcal{A} = 1, 2$$

- n_V vector multiplets

$$(A^i_\mu, \lambda^{\mathcal{A}i}, \phi^i) \quad i = 1, ..., n_V$$

- n_H hypermultiplets

$$(q^u, \zeta^\alpha) \quad u = 1, ..., 4n_H, \quad \alpha = 1, ..., 2n_H$$

- scalar target space $\mathcal{T}$ is a product

$$\mathcal{T} = \text{projective special real} \times \text{quaternionic Kähler} = \mathcal{T}_V \times \mathcal{T}_H$$

Gauged $\mathcal{N}=2$ supergravity: scalar potential

- gauging introduces fermionic shift matrices $S^{\mathcal{AB}}(\phi,q)$, $W^{i\mathcal{AB}}(\phi,q)$ and $N^{\alpha}_{\mathcal{A}}(\phi,q)$
- SUSY variations of fermions

$$
\begin{aligned}
\delta_\epsilon \psi^{\mathcal{A}}_{\mu} &= D_\mu \epsilon^{\mathcal{A}} - S^{\mathcal{AB}} \gamma_\mu \epsilon_{\mathcal{B}} + \ldots \\
\delta_\epsilon \lambda^{i\mathcal{A}} &= -W^{i\mathcal{AB}} \epsilon_{\mathcal{B}} + \ldots \\
\delta_\epsilon \zeta^{\alpha} &= N^{\alpha}_{\mathcal{A}} \epsilon^{\mathcal{A}} + \ldots
\end{aligned}
$$

- $\Rightarrow$ non-trivial scalar potential

$$
V(\phi,q) = 2W^{i\mathcal{AB}} W_{i\mathcal{AB}} + 2N^{\alpha}_{\mathcal{A}} N^{\mathcal{A}}_{\alpha} - 4S_{\mathcal{AB}} S^{\mathcal{AB}}
$$

Supersymmetric AdS backgrounds

- supersymmetric AdS backgrounds $\langle V\rangle = 2\Lambda \leq 0$:

$$\langle\delta\psi_\mu^{\mathcal{A}}\rangle = \langle\delta\lambda^{\mathcal{A}i}\rangle = \langle\delta\zeta^{\alpha}\rangle = 0$$

- in terms of shift matrices:

$$\langle W^{i\mathcal{A}\mathcal{B}}\rangle = \langle N_{\mathcal{A}}^{\alpha}\rangle = 0, \quad \langle S_{\mathcal{A}\mathcal{B}}\rangle \propto \sqrt{\Lambda}$$

- $\Rightarrow$ R-symmetry is gauged by the graviphoton [Tachikawa '06]
- $\Rightarrow$ gauge group in the AdS vacuum is of the form $H \times U(1)_R$

Scalar deformations of the vacuum

- looking for deformation space $\mathcal{M}$ of scalars that leave the AdS vacuum invariant
- expand
$$\phi \to \langle \phi \rangle + \delta\phi, \quad q \to \langle q \rangle + \delta q$$
- we find: $\delta\phi$ completely fixed, but δq only constrained
- $\Rightarrow$ moduli space $\mathcal{M} \subset \mathcal{T}_H$

Kähler structure of $\mathcal{M}$

- $\mathcal{M} \subset \mathcal{T}_H$ carries an induced metric G
- AdS vacuum conditions $\Rightarrow$ complex structure J on $\mathcal{M}$
- we prove: $(\mathcal{M}, G, J)$ is Kähler

Relation to the AdS/CFT correspondence

- conjectured gauge/gravity duality
- relates SUGRA on AdS_{d+1} to d-dimensional SCFT on boundary
- deformation spaces:

$$\text{SUGRA moduli space } \mathcal{M} \overset{?}{\cong} \text{deformation space of SCFT } \mathcal{C}$$

- $4d$ $\mathcal{N} = 1$ SCFTs: $\mathcal{C}$ is Kähler [Asnin '10]

Conclusions

- $\mathcal{N} = 2$ AdS_5 backgrounds admit gauge groups of the form $H \times U(1)_R$
- supersymmetric moduli space is non-trivial and carries a Kähler structure
- perfect agreement with conjectured dual SCFT in $d = 4$, $\mathcal{N} = 1$
- result still holds if we include tensor multiplets