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Superstrings on $\mathrm{AdS}_4 \times \mathrm{CP}^3$ as a Coset Sigma Model

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Introduction

- Multiple M2 branes $\Longrightarrow$ $\mathcal{N}=6$ Chern-Simons Theory

  $\mathrm{AdS}_4 \times \mathrm{S}^7/\mathbb{Z}_k$ $\qquad$ $\mathrm{SU}(N)\times\mathrm{SU}(N)$ at level k

  Aharony, Bergman, Jafferis and Maldacena, hep-th/0806.1218

- Parameters of Chern-Simons theory N and k or

$$N \qquad \text{and} \qquad \lambda = 2\pi^2 N/k \qquad \leftarrow \qquad \text{'t Hooft coupling}$$

- 't Hooft limit $\quad N \to \infty\,, \qquad \lambda \quad \text{finite}$

Type IIA Strings $\Longrightarrow$ $\mathcal{N}=6$ Chern-Simons Theory

$\mathrm{AdS}_4 \times \mathbb{CP}^3$ $\qquad$ planar, perturbative in λ

The goal is to understand the dynamics of

Type IIA Strings on

$$\mathrm{AdS}_4 \times \mathbb{CP}^3$$

Plan

1. Coset Sigma Model
2. Brief Intro into $\mathfrak{osp}(2,2|6)$
3. Automorphism of Order Four
4. The Lagrangian and Eoms
5. Local Fermionic Symmetry
6. Integrability of the Coset Model
7. Plane-wave Limit
8. Conclusions

Sigma Model on the Coset Space

$$\frac{\mathrm{OSP}(2,2|6)}{\mathrm{SO}(3,1)\times\mathrm{U}(3)}$$

$\mathrm{OSP}(2,2|6)$ has a bosonic subgroup $\mathrm{USP}(2,2)\times\mathrm{SO}(6)$

$$\frac{\mathrm{USP}(2,2)}{\mathrm{SO}(3,1)}\times\frac{\mathrm{SO}(6)}{\mathrm{U}(3)}=\mathrm{AdS}_4\times\mathbb{CP}^3$$

The coset superspace contains 24 fermions – too little for Type IIA!

Superalgebra $\mathfrak{osp}(2,2|6)$

$\mathfrak{osp}(2,2|6)$ can be realized by 10×10 supermatrices

$$A = \begin{pmatrix} X_{4\times 4} & \theta_{4\times 6} \\ \eta_{6\times 4} & Y_{6\times 6} \end{pmatrix}$$

The matrix A must satisfy two conditions

$$A^{st} \begin{pmatrix} C_4 & 0 \\ 0 & \mathbb{I}_{6\times 6} \end{pmatrix} + \begin{pmatrix} C_4 & 0 \\ 0 & \mathbb{I}_{6\times 6} \end{pmatrix} A = 0 \quad \Rightarrow \quad A^{st} = -\check{C} A \check{C}^{-1}$$

$$A^{\dagger} \begin{pmatrix} \Gamma^0 & 0 \\ 0 & -\mathbb{I}_{6\times 6} \end{pmatrix} + \begin{pmatrix} \Gamma^0 & 0 \\ 0 & -\mathbb{I}_{6\times 6} \end{pmatrix} A = 0 \quad \Rightarrow \quad A^{\dagger} = -\check{\Gamma} A \check{\Gamma}^{-1}$$

- ✓ C_4 is real skew-symmetric matrix, $C_4^2 = -\mathbb{I}$
- ✓ Γ^μ represent the Clifford algebra for $\mathrm{SO}(3,1)$
- ✓ C_4 is charge conjugation matrix: $(\Gamma^\mu)^t = -C_4 \Gamma^\mu C_4^{-1}$

Automorphism of order 4

$\mathbb{Z}_4$-automorphism with a stationary algebra $\mathrm{SO}(3,1) \times \mathrm{U}(3)$?

Introduce

$$K_4 = -\Gamma^1\Gamma^2 = \begin{pmatrix} 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & -1 & 0 \end{pmatrix} \qquad K_6 = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & -1 & 0 \end{pmatrix}$$

These matrices obey $K_4^2 = -\mathbb{I}$ and $K_6^2 = -\mathbb{I}$ and also

$$(\Gamma^\mu)^t = K_4 \Gamma^\mu K_4^{-1}$$

for all gamma-matrices

Automorphism of order 4

$$\Omega(A) = \begin{pmatrix} K_4 X^t K_4 & K_4 \eta^t K_6 \\ -K_6 \theta^t K_4 & K_6 Y^t K_6 \end{pmatrix}$$

For any two supermatrices A and B

$$\Omega(AB) = -\Omega(B)\Omega(A)$$

i.e. it is an automorphism of $\mathfrak{osp}(2,2|6)$

$$\Omega([A,B]) = -[\Omega(B),\Omega(A)] = [\Omega(A),\Omega(B)]\,.$$

Automorphism of order 4

The algebra relations imply

$$\Omega(A) = \begin{pmatrix} K_4C_4 & 0 \\ 0 & -K_6 \end{pmatrix} \begin{pmatrix} X & \theta \\ \eta & Y \end{pmatrix} \begin{pmatrix} K_4C_4 & 0 \\ 0 & -K_6 \end{pmatrix}^{-1} \equiv \Upsilon A \Upsilon^{-1}$$

- Since $(K_4C_4)^2 = \mathbb{I}$ and $K_6^2 = -\mathbb{I}$ one finds $\Upsilon^4 = \mathbb{I}$
- K_4C_4 coincides with Γ^5 given by $\Gamma^5 = -i\Gamma^0\Gamma^1\Gamma^2\Gamma^3$
- Υ takes values in the complexified $\mathrm{OSP}(2,2|6)$,
  i.e. it is orthosymplectic but not unitary: $\Upsilon^\dagger \check{\Gamma} \Upsilon \check{\Gamma}^{-1} = -\mathbb{I}$

$\mathbb{Z}_4$-grading of $\mathfrak{osp}(2,2|6)$

As the vector space $\mathbf{A} = \mathfrak{osp}(2,2|6)$ can be decomposed as

$$\mathbf{A} = \mathbf{A}^{(0)} \oplus \mathbf{A}^{(1)} \oplus \mathbf{A}^{(2)} \oplus \mathbf{A}^{(3)}$$

such that $[\mathbf{A}^{(k)}, \mathbf{A}^{(m)}] \subseteq \mathbf{A}^{(k+m)}$ modulo $\mathbb{Z}_4$.

Each $\mathbf{A}^{(k)}$ is an eigenspace of Ω

$$\Omega(\mathbf{A}^{(k)}) = i^k \mathbf{A}^{(k)}$$

A projection $A^{(k)}$ of a generic element $A \in \mathfrak{osp}(2,2|6)$ is

$$A^{(k)} = \frac{1}{4}\Big(A + i^{3k}\Omega(A) + i^{2k}\Omega^2(A) + i^k\Omega^3(A)\Big) \in \mathfrak{osp}(2,2|6)$$

Stationary subalgebra of Ω

The stationary subalgebra of Ω is determined by

$$[\Gamma^5, X] = 0\,, \quad [K_6, Y] = 0$$

and it coincides with $\mathfrak{so}(3,1) \times \mathfrak{u}(3)$.

- X is generated by $\frac{1}{2}[\Gamma^\mu, \Gamma^\nu]$
- Y can be parametrized as follows

$$Y = \begin{pmatrix} 0 & y_{12} & y_{24} & -y_{23} & y_{26} & -y_{25} \\ -y_{12} & 0 & y_{23} & y_{24} & y_{25} & y_{26} \\ -y_{24} & -y_{23} & 0 & y_{34} & y_{46} & -y_{45} \\ y_{23} & -y_{24} & -y_{34} & 0 & y_{45} & y_{46} \\ -y_{26} & -y_{25} & -y_{46} & -y_{45} & 0 & y_{56} \\ y_{25} & -y_{26} & y_{45} & -y_{46} & -y_{56} & 0 \end{pmatrix}$$

This 9-parametric matrix describes an embedding $\mathfrak{u}(3) \subset \mathfrak{so}(6)$.

The space $A^{(2)}$ – bosonic coset $\mathrm{AdS}_4 \times \mathbb{CP}^3$

The space $A^{(2)}$ is spanned by matrices

$$\Omega(A) = \Upsilon A \Upsilon^{-1} = -A$$

Any such matrix satisfies the remarkable identity

$$A^3 = \frac{1}{8}\,\mathrm{str}(\Sigma A^2)\,A + \frac{1}{8}\,\mathrm{str}(A^2)\,\Sigma A$$

or

$$A^3 = \tfrac{1}{8}(\mathrm{tr}A^2_{\mathrm{AdS}} + \mathrm{tr}A^2_{\mathbb{CP}})\,A + \tfrac{1}{8}(\mathrm{tr}A^2_{\mathrm{AdS}} - \mathrm{tr}A^2_{\mathbb{CP}})\,\Sigma A$$

Here Σ is a diagonal matrix $\Sigma = \Upsilon^2 = (\mathbb{I}_4, -\mathbb{I}_6)$

The Lagrangian

Let g be a coset representative. Construct the one-form

$$A = -g^{-1}\mathrm{d}g = A^{(0)} + A^{(2)} + A^{(1)} + A^{(3)}$$

It has zero curvature

$$\partial_\alpha A_\beta - \partial_\beta A_\alpha - [A_\alpha, A_\beta] = 0$$

The sigma model action

$$S = -\frac{R^2}{4\pi\alpha'}\int \mathrm{d}\sigma\mathrm{d}\tau\,\mathscr{L}$$

with the Lagrangian density

$$\mathscr{L} = \gamma^{\alpha\beta}\mathrm{str}\big(A^{(2)}_\alpha A^{(2)}_\beta\big) + \kappa\epsilon^{\alpha\beta}\mathrm{str}\big(A^{(1)}_\alpha A^{(3)}_\beta\big)$$

Here $\gamma^{\alpha\beta} = h^{\alpha\beta}\sqrt{-h}$ with det$\gamma = -1$

Equations of motion

- Bosons

$$\partial_\alpha(\gamma^{\alpha\beta}A^{(2)}_\beta) - \gamma^{\alpha\beta}[A^{(0)}_\alpha, A^{(2)}_\beta] + \tfrac{1}{2}\kappa\epsilon^{\alpha\beta}\Big([A^{(1)}_\alpha, A^{(1)}_\beta] - [A^{(3)}_\alpha, A^{(3)}_\beta]\Big) = 0$$

- Fermions

$$\mathrm{P}_-^{\alpha\beta}[A^{(2)}_\alpha, A^{(3)}_\beta] = 0\,,$$
$$\mathrm{P}_+^{\alpha\beta}[A^{(2)}_\alpha, A^{(1)}_\beta] = 0\,.$$

The tensors $\mathrm{P}_\pm^{\alpha\beta} = \frac{1}{2}(\gamma^{\alpha\beta} \pm \kappa\epsilon^{\alpha\beta})$

For $\kappa = \pm 1$ the tensors $\mathrm{P}_\pm$ are orthogonal projectors:

$$\mathrm{P}_+^{\alpha\beta} + \mathrm{P}_-^{\alpha\beta} = \gamma^{\alpha\beta}\,, \qquad \mathrm{P}_\pm^{\alpha\delta}\mathrm{P}_{\pm\delta}{}^{\beta} = \mathrm{P}_\pm^{\alpha\beta}\,, \qquad \mathrm{P}_\pm^{\alpha\delta}\mathrm{P}_{\mp\delta}{}^{\beta} = 0$$

The Lagrangian must be invariant under a local fermionic symmetry (κ-symmetry) which should be capable to remove 8 out of 24 fermions

How to exhibit this symmetry?

Local Fermionic Symmetry

- The action of the global symmetry group $\mathrm{OSP}(2,2|6)$ is realized on a coset element by multiplication from the left

- κ-symmetry transformations can be understood as the *right local action* of a fermionic element $G = \exp\epsilon \in \mathrm{OSP}(2,2|6)$ on a coset representative g

$$gG(\epsilon) = g' g_c \,,$$

where $\epsilon \equiv \epsilon(\sigma)$ is a local fermionic parameter. Here g_c is a compensating element from $\mathrm{SO}(3,1) \times \mathrm{U}(3)$

Local Fermionic Symmetry

Under the local multiplication from the right the connection A transforms

$$\delta_\epsilon A = -\mathrm{d}\epsilon + [A, \epsilon]$$

The $\mathbb{Z}_4$-decomposition of this equation gives

$$\begin{aligned}
\delta_\epsilon A^{(1)} &= -\mathrm{d}\epsilon^{(1)} + [A^{(0)}, \epsilon^{(1)}] + [A^{(2)}, \epsilon^{(3)}] \\
\delta_\epsilon A^{(3)} &= -\mathrm{d}\epsilon^{(3)} + [A^{(0)}, \epsilon^{(3)}] + [A^{(2)}, \epsilon^{(1)}] \\
\delta_\epsilon A^{(2)} &= [A^{(1)}, \epsilon^{(1)}] + [A^{(3)}, \epsilon^{(3)}]
\end{aligned}$$

where we have assumed that $\epsilon = \epsilon^{(1)} + \epsilon^{(3)}$

Local Fermionic Symmetry

κ-symmetry variation of the Lagrangian

$$\delta_\epsilon \mathscr{L} = \delta\gamma^{\alpha\beta}\mathrm{str}\big(A^{(2)}_\alpha A^{(2)}_\beta\big) - 4\,\mathrm{str}\Big(\mathrm{P}_+^{\alpha\beta}[A^{(1)}_\beta, A^{(2)}_\alpha]\epsilon^{(1)} + \mathrm{P}_-^{\alpha\beta}[A^{(3)}_\beta, A^{(2)}_\alpha]\epsilon^{(3)}\Big)$$

Vanishes on-shell due to the Virasoro constraints

$$\mathrm{str}(A^{(2)}_\alpha A^{(2)}_\beta) - \tfrac{1}{2}\gamma_{\alpha\beta}\gamma^{\rho\delta}\mathrm{str}(A^{(2)}_\rho A^{(2)}_\delta) = 0$$

and $\gamma_{\alpha\beta}\delta\gamma^{\alpha\beta} = 0$

Take $\kappa = \pm 1$ and for any vector V^α introduce the projections $V^\alpha_\pm$

$$V^\alpha_\pm = \mathrm{P}_\pm^{\alpha\beta} V_\beta$$

so that the variation of the Lagrangian acquires the form

$$\delta_\epsilon \mathscr{L} = \delta\gamma^{\alpha\beta}\mathrm{str}\big(A^{(2)}_\alpha A^{(2)}_\beta\big) - 4\,\mathrm{str}\big([A^{(1),\alpha}_+, A^{(2)}_{\alpha,-}]\epsilon^{(1)} + [A^{(3),\alpha}_-, A^{(2)}_{\alpha,+}]\epsilon^{(3)}\big)$$

Local Fermionic Symmetry

Some technicalities:

- The condition $\mathrm{P}_{\pm}^{\alpha\beta} A_{\beta,\mp} = 0$ the components $A_{\tau,\pm}$ and $A_{\sigma,\pm}$ are proportional

$$A_{\tau,\pm} = -\frac{\gamma^{\tau\sigma} \mp \kappa}{\gamma^{\tau\tau}} A_{\sigma,\pm}$$

  As the result, tensorial structures

$$A^{(2)}_{\alpha,-} \ldots A^{(2)}_{\beta,-} \ldots A^{(2)}_{\delta,-}$$

  do not depend on the order of indices

- To simplify the treatment, we put $\epsilon^{(3)} = 0$

Local Fermionic Symmetry

Ansatz for the κ-symmetry variation

$$\epsilon^{(1)} = A^{(2)}_{\alpha,-} A^{(2)}_{\beta,-} \kappa^{\alpha\beta}_{++} + \kappa^{\alpha\beta}_{++} A^{(2)}_{\alpha,-} A^{(2)}_{\beta,-} + A^{(2)}_{\alpha,-} \kappa^{\alpha\beta}_{++} A^{(2)}_{\beta,-} - \frac{1}{8} \mathrm{str}(\Sigma A^{(2)}_{\alpha,-} A^{(2)}_{\beta,-}) \kappa^{\alpha\beta}_{++}$$

Requirements on $\kappa^{\alpha\beta}_{++}$

- $\kappa^{\alpha\beta}_{++} \in \mathfrak{osp}(2,2|6)$
- $\kappa^{\alpha\beta}_{++} \in \mathbf{A}^{(1)}$

Thus, generically $\kappa^{\alpha\beta}_{++}$ depends on 12 fermionic variables

Local Fermionic Symmetry

Consider now the commutator

$$
\begin{aligned}
[A^{(2)}_{\alpha,-}, \epsilon^{(1)}] &= A^{(2)}_{\alpha,-}A^{(2)}_{\beta,-}A^{(2)}_{\delta,-}\kappa^{\beta\delta}_{++} + A^{(2)}_{\alpha,-}\kappa^{\beta\delta}_{++}A^{(2)}_{\beta,-}A^{(2)}_{\delta,-} + A^{(2)}_{\alpha,-}A^{(2)}_{\beta,-}\kappa^{\beta\delta}_{++}A^{(2)}_{\delta,-} \\
&- A^{(2)}_{\beta,-}A^{(2)}_{\delta,-}\kappa^{\beta\delta}_{++}A^{(2)}_{\alpha,-} - \kappa^{\beta\delta}_{++}A^{(2)}_{\beta,-}A^{(2)}_{\delta,-}A^{(2)}_{\alpha,-} - A^{(2)}_{\beta,-}\kappa^{\beta\delta}_{++}A^{(2)}_{\delta,-}A^{(2)}_{\alpha,-} \\
&- \frac{1}{8}\,\mathrm{str}(\Sigma A^{(2)}_{\beta,-}A^{(2)}_{\delta,-})A^{(2)}_{\alpha,-}\kappa^{\beta\delta}_{++} + \frac{1}{8}\,\mathrm{str}(\Sigma A^{(2)}_{\beta,-}A^{(2)}_{\delta,-})\kappa^{\beta\delta}_{++}A^{(2)}_{\alpha,-}
\end{aligned}
$$

Most of the terms are cancelled out

$$
[A^{(2)}_{\alpha,-}, \epsilon^{(1)}] = [A^{(2)}_{\alpha,-}A^{(2)}_{\beta,-}A^{(2)}_{\delta,-} - \tfrac{1}{8}\,\mathrm{str}(\Sigma A^{(2)}_{\beta,-}A^{(2)}_{\delta,-})A^{(2)}_{\alpha,-}, \kappa^{\beta\delta}_{++}]
$$

Due to the remarkable identity

$$
[A^{(2)}_{\alpha,-}, \epsilon^{(1)}] = \frac{1}{8}\mathrm{str}(A^{(2)}_{\beta,-}A^{(2)}_{\delta,-})[\Sigma A^{(2)}_{\alpha,-}, \kappa^{\beta\delta}_{++}]\,.
$$

Local Fermionic Symmetry

The κ-symmetry variation of the action

$$\delta_\epsilon \mathscr{L} = \delta\gamma^{\alpha\beta}\mathrm{str}\big(A^{(2)}_\alpha A^{(2)}_\beta\big) - 4\,\mathrm{str}\Big([A^{(1),\alpha}_+, A^{(2)}_{\alpha,-}]\epsilon^{(1)}\Big)$$

implies the following transformation law for the metric

$$\delta\gamma^{\alpha\beta} = \frac{1}{2}\mathrm{str}\Big(\Sigma A^{(2)}_{\delta,-}[\kappa^{\alpha\beta}_{++}, A^{(1),\delta}_+]\Big)$$

The condition $\gamma_{\alpha\beta}\delta\gamma^{\alpha\beta}$ is automatically obeyed as

$$\gamma_{\alpha\beta}\delta\gamma^{\alpha\beta} = \gamma^{\alpha\beta}P^+_{\alpha\delta}P^+_{\beta\eta}\kappa^{\delta\eta} = 0$$

Full variation of the metric

$$\delta\gamma^{\alpha\beta} = \frac{1}{2}\mathrm{str}\Big(\Sigma A^{(2)}_{\delta,-}[\kappa^{\alpha\beta}_{++}, A^{(1),\delta}_+]\Big) + \frac{1}{2}\mathrm{str}\Big(\Sigma A^{(2)}_{\delta,+}[\varkappa^{\alpha\beta}_{--}, A^{(3),\delta}_-]\Big)$$

Local Fermionic Symmetry

Rank of κ-symmetry transformations on-shell?

$$A^{(2)} = \begin{pmatrix} ix\Gamma^0 & 0 \\ 0 & yT_6 \end{pmatrix}$$

The constraint $\mathrm{str}(A^{(2)}_{\alpha,-}A^{(2)}_{\beta,-}) = 0$ then demands that $x = \pm y$

Computing $\epsilon^{(1)}$ one gets

$$\epsilon^{(1)} = x^2 \begin{pmatrix} 0 & \varepsilon \\ -\varepsilon^t C_4 & 0 \end{pmatrix},$$

where ε is the following matrix

$$\varepsilon = \begin{pmatrix} 0 & 0 & i(ik_{13} - k_{16}) & i(ik_{14} - k_{15}) & ik_{14} - k_{15} & ik_{13} - k_{16} \\ 0 & 0 & i(ik_{23} - k_{26}) & i(ik_{24} - k_{26}) & ik_{24} - k_{25} & ik_{23} - k_{26} \\ 0 & 0 & -i(-ik_{33} - k_{36}) & -i(-ik_{34} - k_{35}) & -ik_{34} - k_{35} & -ik_{33} - k_{36} \\ 0 & 0 & -i(-ik_{43} - k_{46}) & -i(-ik_{44} - k_{45}) & -ik_{44} - k_{45} & -ik_{43} - k_{46} \end{pmatrix}$$

Integrability: The Lax Connection

No difference in construction of the Lagrangian $\mathrm{AdS}_5 \times \mathrm{S}^5$, the Lax connection found by Bena, Polchinski and Roiban is applicable to our model as well

$$L_\alpha = \ell_0 A_\alpha^{(0)} + \ell_1 A_\alpha^{(2)} + \ell_2 \gamma_{\alpha\beta} \epsilon^{\beta\rho} A_\rho^{(2)} + \ell_3 A_\alpha^{(1)} + \ell_4 A_\alpha^{(3)}$$

- L_α is flat due to e.o.m and this determines all ℓ_i in terms of one parameter z
- L_α is flat provided $\kappa = \pm 1$
- κ-symmetry variation of L_α is a gauge transformation on-shell
- $L_\alpha(z)$ is used to build infinite sets of integrals of motion

Plane-wave Limit

Let z_i be homogenious coordinates on $\mathbb{CP}^3$.

Parametrize

$$z_4 = e^{-i\phi/2}\,, \quad z_3 = (1-x_4)e^{i\phi/2}\,, \quad z_1 = \frac{1}{\sqrt{2}}y_1\,, \quad z_2 = \frac{1}{\sqrt{2}}y_2$$

ϕ is a parameter along the geodesics and the complex y_1, y_2 and the real x_4 denote the five physical fluctuations in $\mathbb{CP}^3$

The $\mathrm{AdS}_4 \times \mathbb{CP}^3$ background metric admits the following expansion

$$ds^2_{\mathrm{AdS}_4\times\mathbb{CP}^3} = -dt^2(1+x_i^2) + dx_i^2 + d\phi^2(1 - x_4^2 - \frac{1}{4}\bar{y}_r y_r) + dx_4^2 + d\bar{y}_r dy_r + \cdots$$

Plugging in the point-like string solution with $t=\tau\,,\ \phi=\tau$ in the string Lagrangian one gets four fields of mass 1/2 and four fields of mass 1.The field x_4 from $\mathbb{CP}^3$ joins three fields from AdS_4.

Plane-wave Limit

The bosonic action around particle trajectory $t = \tau\,,\ \phi = \tau$ is

$$S_B^{(2)} = -\frac{R^2}{4\pi\alpha'} \int \mathrm{d}\sigma \mathrm{d}\tau \left(\partial^\alpha x_k \partial_\alpha x_k - x_k^2 + \partial^\alpha \bar{y}_r \partial_\alpha y_r - \frac{1}{4} \bar{y}_r y_r \right)$$

Develop now the whole quadratic action (including fermions) starting from the coset representative

$$g = e^\chi \, g_B$$

Gauge-fixing κ-symmetry we find that

the sum of the quadratic bosonic and fermionic actions coincides with the light-cone Green-Schwarz action for Type IIA superstrings on the pp-wave background with 24 supersymmetries!

Conclusions

- *Green-Schwarz superstring on* $\mathrm{AdS}_4 \times \mathbb{CP}^3$ *with* κ*-symmetry partially fixed is the coset sigma model*

$$\frac{\mathrm{OSP}(2,2|6)}{\mathrm{SO}(3,1) \times \mathrm{U}(3)}$$

- *The coset sigma model has* κ*-symmetry of rank 8*
- *The coset sigma model is classically integrable*
- *Is it a quantum integrable model?*
- *What is the light-cone S-matrix?*