

Title: Introduction to Pure Spinor Formalism of the Superstring - Lecture 3

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Abstract: Multiloop amplitude computations

Massless Tree Loop

No sum over spin } spacetime susy
 R vertex op. as comp of NS }

Flat

3 pt. $\langle \lambda^\alpha A_\mu(x, \theta) \lambda^\beta A_\nu(x, \theta) \lambda^\gamma A_\rho(x, \theta) \rangle$

$\langle (e^{ik \cdot x})^\alpha \rangle$

$A_\mu(x, \theta) = e^{ik \cdot x} (a_\mu(\lambda, \theta) + (\lambda \gamma^\mu \theta) \lambda_\mu + \dots)$

$\mathcal{Z} = \int d^{10}x \int d^{11}\lambda \int d^{16}\theta (1A)^2$

χ, ϕ

Massless Tree Loop

No sum over spin

R vertex op. as comp. of NS

"manifest spacetime susy"

Flat

3 pt. $\langle \lambda^\alpha A_\mu(x, \theta) \lambda^\beta A_\nu(x, \theta) \lambda^\gamma A_\rho(x, \theta) \rangle$

$\langle \dots \rangle$

$$A_\mu(x, \theta) = e^{ik \cdot x} \left(a_\mu(\lambda, \theta) + (\lambda \gamma^\mu \theta) a_\nu(\lambda, \theta) + \dots \right)$$

$$Q = \int d^{10}x \int d^4\lambda \int d^4\theta (\lambda A)^2 \rightarrow \int d^5\theta \left(\frac{\partial}{\partial \lambda} \right)^3 (\lambda A)^2$$

$$= \text{Tr} \left(\lambda_1 (\not{k}_1 \lambda_2 \lambda_3) + \hat{a}_1 \hat{a}_2 \partial_\mu \hat{a}_3 + \text{perm} \right) \delta^4(k_1 + k_2 + k_3)$$

$$= \text{Tr} \left(\chi_1(\phi_2, \chi_3) + \hat{a}_1 \hat{a}_2 \partial_{\mu} a_{\nu} + \text{perm} \right) \delta^{(k_1+k_2+k_3)}$$

Prescription

$$\langle (\lambda \gamma^{\mu} \theta) (\lambda \gamma^{\nu} \theta) (\lambda \gamma^{\rho} \theta) (\theta \gamma_{\mu\nu\rho} \theta) \rangle = 1$$

$$\left(\frac{\partial}{\partial \theta} \gamma^{\mu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\nu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\rho} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma_{\mu\nu\rho} \frac{\partial}{\partial \theta} \right)$$

}

$$= \text{Tr} \left(\chi_1 (\phi_{21} \chi_3) + \hat{a}_1^* \hat{a}_2 \partial_{\alpha} a_{j_{n_1} + \text{perm}} \right) \delta^{(k_1 + k_2 + k_3)}$$

Prescription

$$\langle (\lambda \gamma^{\mu} \theta) (\lambda \gamma^{\nu} \theta) (\lambda \gamma^{\rho} \theta) (\theta \gamma_{\mu\nu\rho} \theta) \rangle = 1$$

$$\begin{array}{c} \text{coef.} \downarrow \quad \text{coef.} \downarrow \\ \left(\bar{\lambda}_r, \bar{\omega}^r \right) \\ \left(r_s, s^s \right) \end{array}$$

$$\bar{\lambda} \gamma^{\mu} \bar{\lambda} = 0$$

$$\left(\frac{\partial}{\partial \theta} \gamma^{\mu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\nu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\rho} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma_{\mu\nu\rho} \right)$$

$$S = \int d^4x d^4\bar{x} \left(S_0 + \bar{\omega}^r \partial_{\mu} \bar{\lambda}_r + s^s \partial_{\mu} r_s \right)$$

$$Q = \int (\bar{\lambda}^r d_r + r_s \bar{\omega}^s)$$

$$= \text{Tr} \left(\chi_1 (\phi_{L_1} \chi_3) + a_1^* a_2^* \partial_{\mu} a_{3, \mu} + \text{perm} \right) \delta^{(k_1+k_2+k_3)}$$

Prescription

$$\langle (\lambda \gamma^{\mu} \theta) (\lambda \gamma^{\nu} \theta) (\lambda \gamma^{\rho} \theta) (\theta \gamma_{\mu\nu\rho} \theta) \rangle = 1$$

$$\left(\frac{\partial}{\partial \theta} \gamma^{\mu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\nu} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^{\rho} \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma_{\mu\nu\rho} \frac{\partial}{\partial \theta} \right)$$

conf. int \downarrow \downarrow conf. int

$$\left(\bar{\lambda}_{\nu}, \bar{\omega} \right)$$

$$\left(r_{\nu}, s^{\mu} \right)$$

$$S = \int d^4 x d^4 \bar{\lambda} \left(S_0 + \bar{\omega} \partial \bar{\lambda}_x + s^{\mu} \partial r_{\mu} \right)$$

$$Q = \int (\bar{\lambda}^{\mu} d_{\mu} + r_{\mu} \bar{\omega}^{\mu})$$

$$\partial_{\nu}^{\mu} p_{\mu} + (\gamma^{\mu} \theta)_{\nu}$$

$$\boxed{\begin{aligned} \bar{\lambda} \gamma^{\mu} \bar{\lambda} &= 0 \\ \bar{\lambda} \gamma^{\mu} r &= 0 \end{aligned}}$$

$$\int d^n \lambda \int d^n \theta \int d^n \bar{\lambda} \int d^n r \quad e^{-\{Q, \theta^T \bar{\lambda}_2\}} \quad (1A)^3$$

$$e^{-\{ \bar{\lambda}_2^T r_2 + \theta^T r_2 \}}$$

$$\mathcal{Z}$$

$$\bar{\lambda} = \begin{pmatrix} 0 \\ 0 \\ \bar{\lambda}_1 \dots \bar{\lambda}_n \end{pmatrix}$$

$$r = \begin{pmatrix} \cancel{r_1} \\ r_2 \\ r_1 \end{pmatrix} \begin{matrix} \text{size} \\ \text{is} \\ \text{1} \end{matrix}$$

$$\int d^n \lambda \int d^{2n} \theta \int d^{2n} \bar{\lambda} \int d^{2n} r \quad e^{-f(Q, \theta^i \bar{\lambda}_i, \bar{\lambda}_i \theta^i)} \quad (\det A)^3$$

$$e^{-\left(\sum_i \bar{\lambda}_i \theta^i + \theta^i r_i \right)}$$

(P(15))

$$\bar{\lambda} = \begin{pmatrix} 0 \\ 0 \\ \dots \\ \lambda^{1+1+1+1} \end{pmatrix}$$

$$r = \begin{pmatrix} \cancel{\lambda^1} \\ r^2 \\ \dots \\ r^1 \end{pmatrix} \begin{matrix} 2n \\ \vdots \\ 1 \end{matrix}$$

- \mathbb{R}^4
- $\partial^4 \mathbb{R}^4$

Humberto Gomez
Carlos Mafra

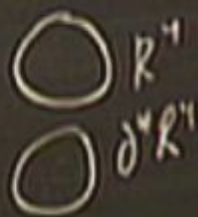
$$\int d^n \lambda \int d^{2n} \theta \int d^{2n} \bar{\lambda} \int d^n r \quad e^{-\{Q, \theta^r \bar{\lambda}_r\}} \quad (1A)^3 \rightarrow \langle (1A)^2 \rangle$$

$$e^{-\{(\lambda^r \bar{\lambda}_r) + \theta^r r_r\}}$$

CP(1|1)

$$\bar{\lambda} = \begin{pmatrix} 0 \\ 0 \\ \bar{\lambda}^{1+1+1+1} \end{pmatrix}$$

$$r = \begin{pmatrix} r_1 \\ r_2 \\ r^1 \\ r^1 \end{pmatrix} \begin{matrix} \text{SIR} \\ \text{IR} \\ \text{IR} \\ \text{IR} \end{matrix}$$



Humberto Gomez
Carlos Mafra

$$Q = \int d^4x \int d^4\lambda \int d^4\theta (\lambda A)^2 \Rightarrow \left(\int d^5\theta \right) \left(\frac{\partial}{\partial \lambda} \right)^2 (\lambda A)^2$$

$$= \text{Tr} \left(\chi_1 (\not{x}_2 \chi_3) + \hat{a}_1 \hat{a}_2 \partial_{\mu} a_{\nu} + \text{perm} \right) \delta^{(k_1+k_2+k_3)}$$

$$S = \int d^4x d^4\lambda \left(S_0 + \dots \right)$$

$$Q = \int (\lambda d_{\nu} \dots)$$

$$\gamma^{\mu} \bar{\lambda} = 0$$

$$\gamma^{\mu} r = 0$$

$$= \text{Tr} \left(\chi_1 \chi_2 \chi_3 + a_1 a_2 a_3 + \text{perm} \right) \delta^{(k_1+k_2+k_3)}$$

$$\langle (\gamma^\mu \theta) (\gamma^\nu \theta) (\gamma^\rho \theta) (\theta \gamma_{\mu\nu\rho} \theta) \rangle = 1$$

$$\left(\frac{\partial}{\partial \theta} \gamma^\mu \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^\nu \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma^\rho \frac{\partial}{\partial \lambda} \right) \left(\frac{\partial}{\partial \theta} \gamma_{\mu\nu\rho} \frac{\partial}{\partial \theta} \right)$$

$$S = \int d^4x \left(S_0 + \bar{\psi} \vec{\partial} \vec{\lambda} + S^x \vec{\partial} r_x + \hat{\psi}^x \vec{\partial} \hat{\lambda}_x + \hat{S}^x \vec{\partial} \hat{r}_x \right)$$

$$Q = \int (\lambda^x d_x + r_x \bar{\psi}^x) \quad \partial_x = \partial_x + (\not{x} \theta)$$

$$\gamma^\mu \vec{\lambda} = 0$$

$$\gamma^\mu r = 0$$

$$\int d^5\theta \frac{\partial}{\partial\theta} f = 0$$

$$\int d^4\theta \frac{\partial}{\partial\theta} f = \left(\frac{\partial}{\partial\theta}\right)^4 \frac{\partial}{\partial\theta} f$$

$$S_g = \int d^3x \sqrt{g} \left[\frac{1}{2} R - \frac{1}{2} (\partial_\mu \phi)^2 - \frac{1}{2} (\partial_\mu \psi)^2 - \frac{1}{2} (\partial_\mu \lambda)^2 - \frac{1}{2} (\partial_\mu \bar{\lambda})^2 - \frac{1}{2} (\partial_\mu \eta)^2 \right]$$

g.n. 3-3g

$$\xi Q, \delta \mathcal{L} = T = \partial_X \partial_X + p \partial_\theta + \omega \partial_\lambda + \bar{\omega} \partial_{\bar{\lambda}} + s \partial_\eta$$

$$S_g = \int_{\Sigma} d^3x \sqrt{\gamma} \left\langle \left(\int_{\Sigma} d^3x \right)^{3-3g} \prod_{i=1}^N \int_{\mathcal{C}_i} d\psi \mathcal{Y} \right\rangle$$

g.n. 3-3g

$$\xi Q, b \mathcal{Y} = T = \partial x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial r$$

$$b = \frac{\int_{\Sigma} (\sqrt{\gamma} d) + (\omega \bar{\omega} \lambda \bar{\lambda} \partial \theta)^2}{\int_{\Sigma} \sqrt{\gamma}}$$

$$S_g = \int d^3x \sqrt{g} \left[\frac{1}{2} \left(\int d^3x \right)^{g-3} \prod_{i=1}^N \int d\psi_i \mathcal{L} \right] \quad \text{g.n. } 3-3g$$

$$\xi Q, b \xi = T = \partial x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial \tau$$

$$b = \frac{\bar{\lambda} \left(\frac{\partial}{\partial \lambda} \right) + (\omega \lambda^{-1} \partial_\lambda + \bar{\omega} \partial_\lambda)}{\lambda \bar{\lambda}} + \frac{(\bar{\lambda} \lambda^{-1} \partial_\lambda + (\lambda \lambda^{-1} \partial_\lambda))}{(\lambda \bar{\lambda})^2} + \frac{\bar{\lambda}^2 (\omega \lambda^{-1} \partial_\lambda + \bar{\omega} \partial_\lambda)}{(\lambda \bar{\lambda})^2} + \frac{(\omega \lambda^{-1} \partial_\lambda + \bar{\omega} \partial_\lambda)^2 \bar{\lambda}^2}{(\lambda \bar{\lambda})^2} + s \partial \tau$$

$$n =$$

$$\int_{\mathcal{D}} d^3x \langle n \left(\int_{\mathcal{D}} d^3x \right)^{3-3g} \prod_{i=1}^N \int_{\mathcal{D}} d^3x \gamma \rangle \quad \text{g.n. } 3-3g$$

$$\xi Q, b \xi = T = \partial x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial \tau$$

$$b = \frac{\bar{\lambda} \left(\frac{\partial}{\partial \lambda} \right) + (\omega \lambda^{-1} \partial + \bar{\omega} \partial)}{\bar{\lambda} \lambda} + \frac{(\bar{\lambda} \lambda^{-1} \partial + (\omega \lambda^{-1} \partial + \bar{\omega} \partial) \pi p)}{(\lambda \bar{\lambda})^2} + \frac{\bar{\lambda}^2 (\omega \lambda^{-1} \partial + \bar{\omega} \partial)}{(\lambda \bar{\lambda})^2} + \frac{(\omega \lambda^{-1} \partial + \bar{\omega} \partial)^2 \bar{\lambda}^2}{(\lambda \bar{\lambda})^2} + s \partial \lambda$$

$$\mathcal{N} = e^{-\int \mathcal{L}(\phi, \partial \phi, \lambda, \bar{\lambda}, \psi, \bar{\psi})} = e^{-\int \mathcal{L}(\phi, \partial \phi, \lambda, \bar{\lambda}, \psi, \bar{\psi})}$$

$$S_g = \int d^3x \sqrt{g} \langle \mathcal{N} \left(\int_{\mathcal{I}^3} \psi \right)^{3-3g} \prod_{i=1}^n \int_{\mathcal{C}_i} \psi \rangle \quad \text{g.n. } 3-3g$$

$$\xi \mathcal{Q}, \text{ b } \mathcal{L} = \mathcal{T} = \partial x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial \tau$$

$$b = \frac{\bar{\lambda} \left(\frac{\partial}{\partial \lambda} \right) + (\omega \bar{\lambda}^{-1} \partial_{\lambda^{-1}})}{\bar{\lambda} \bar{\lambda}^2} + \frac{(\bar{\lambda} \bar{\lambda}^{-1} \partial_{\lambda^{-1}})}{(\bar{\lambda} \bar{\lambda})^2} \left(\partial_{\lambda^{-1}} \bar{\lambda} + (\omega \bar{\lambda}^{-1} \partial_{\lambda^{-1}}) \right) \\ + \frac{\bar{\lambda}^2 (\omega \bar{\lambda}^{-1} \partial_{\lambda^{-1}})}{(\bar{\lambda} \bar{\lambda})^2} + \frac{(\omega \bar{\lambda}^{-1} \partial_{\lambda^{-1}})^2 \bar{\lambda}^2}{(\bar{\lambda} \bar{\lambda})^2} + s \partial \bar{\lambda}$$

Divergences when $\lambda\bar{\Lambda} \rightarrow \infty$ are regularized by η

$$\boxed{\lambda\bar{\Lambda} \rightarrow 0}$$

$\tilde{\eta}$

$$(\lambda\bar{\Lambda})'' \left(\frac{1}{\lambda\bar{\Lambda}}\right)''$$

$$\boxed{\frac{(25)}{2} R^4}$$

3-loops

$$\int d^{10}d$$

Need to absorb $\log d_2$ zero modes

Divergences when $\lambda \rightarrow 0$

$$\boxed{\lambda \bar{\lambda} \rightarrow 0}$$

$\tilde{\lambda}$

$$\bar{\lambda} \left(\frac{1}{\lambda \bar{\lambda}} \right)$$

$$\boxed{\partial^2 R^4}$$

3-loop

Need to absorb log d_2 zero modes

Divergences when $\lambda \rightarrow 0$

$$\boxed{\lambda \bar{\Lambda} \rightarrow 0}$$

$\tilde{\eta}$

$$(\lambda \bar{\Lambda})'' \left(\frac{1}{\lambda \bar{\Lambda}} \right)''$$

$$\boxed{\frac{(2\epsilon)}{d} R^4}$$

3-loop

Need to absorb $16g^2 d_2$ zero modes

$$\int d^{16}g d$$

Divergences when $\lambda \rightarrow 0$

$$\boxed{\lambda \bar{J} \rightarrow 0}$$

$\tilde{\eta}$

$$(\lambda \bar{J})'' \quad \left(\frac{1}{\lambda \bar{J}} \right)''$$

$$\boxed{\partial^2 R''} \sim \partial^2 R''$$

$$\boxed{\partial^2 R''}$$

Need to
absorb log d_i zero nodes

AdS₅ × S⁵ Lagrangian is PSU(2,2|4) inv

Flat background

$$Q\bar{Q}L = \partial\bar{\partial}(\lambda\sigma^{\mu\nu}\hat{\gamma}_\mu\hat{\gamma}_\nu\hat{\theta})$$

AdS

$$\hat{\lambda}_\mu = \int_{S^2} \hat{\lambda}^{\mu\nu} \hat{\gamma}_\nu$$

$$Q\bar{Q}L = \partial\bar{\partial}(\lambda^{\mu\nu}\hat{\gamma}_\mu\hat{\gamma}_\nu)$$

radius mod 1

$V = \int_{S^2} \lambda^{\mu\nu} \hat{\gamma}_\mu \hat{\gamma}_\nu$ is isohom \Rightarrow can identify $\hat{\lambda}_\mu = \bar{\lambda}_\mu$

$$\lambda^{\mu\nu} \hat{\gamma}_\mu \hat{\gamma}_\nu \geq 0$$

Divergences when $\lambda \bar{\Lambda} \rightarrow \infty$ are regularized by η

$\lambda \bar{\Lambda} \rightarrow 0$

$\tilde{\eta}$

$(\lambda \bar{\Lambda})''$ $(\frac{1}{\lambda \bar{\Lambda}})''$

∂^2



Niel

kommit

$$\mathcal{N} = e^{-\xi Q, \theta \lambda + s \omega_x} = e^{-\dots}$$

$$S_g = \int_{\mathbb{R}^3} d^3x \sqrt{-g} \langle \mathcal{N} \left(\frac{\delta}{\delta \phi} \right)^{3-g} \prod_{i=1}^g \int d\phi_i \mathcal{Y}_i \rangle \quad \text{g.n. } 3-3g$$

$$\xi Q, b \xi = T = \partial_x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial r$$

$$b = \underbrace{\bar{\lambda} \left(\frac{\delta}{\delta \lambda} \right)}_{\left(\frac{\delta}{\delta \lambda} \right)} + (\omega \lambda^{-1} \frac{\delta}{\delta \lambda} - \partial \theta) + \frac{(\bar{\lambda} \omega^{-1} \frac{\delta}{\delta \lambda})}{(\lambda \bar{\lambda})} \left(\left(\frac{\delta}{\delta \lambda} \right) \omega \left(\frac{\delta}{\delta \lambda} \right) (\lambda \bar{\lambda}) \Pi_p \right) + \frac{\bar{\lambda} r^2 (\omega \lambda^{-1} \frac{\delta}{\delta \lambda})}{(\lambda \bar{\lambda})} + \frac{(\omega \lambda^{-1})^2 \bar{\lambda} r^2}{(\lambda \bar{\lambda})} + s \partial r$$

$$\mathcal{N} = e^{-\int \mathcal{L}(\varphi, \partial \varphi, \lambda, \bar{\lambda}, \psi, \omega, \dots)} = e^{-\int \mathcal{L}(\varphi, \partial \varphi, \lambda, \bar{\lambda}, \psi, \omega, \dots)}$$

$$S_g = \int d^3x \sqrt{-g} \langle \mathcal{N}(\varphi) \prod_{i=1}^n \int d\varphi_i \mathcal{Y}_i \rangle \quad \text{g.n. } 3-3g$$

$$\xi \mathcal{Q}, \delta \mathcal{Z} = T = \partial x \partial x + p \partial \theta + \omega \partial \lambda + \bar{\omega} \partial \bar{\lambda} + s \partial \tau$$

$$b = \frac{\delta \mathcal{L}}{\delta \lambda} + (\omega \lambda^{-1} \partial \lambda - \partial \omega) + \frac{(\delta \mathcal{L})}{(\delta \bar{\lambda})} + \frac{(\partial \bar{\omega})}{(\delta \bar{\lambda})} + \frac{(\omega \lambda^{-1})^2 \bar{\lambda} r^2}{(\delta \bar{\lambda})} + s \partial \bar{\lambda}$$

$$\lambda \bar{\lambda} = 0 \Rightarrow \lambda = 0$$

$$\lambda^k = \frac{\text{Sol}(i)}{|\lambda^k|}$$

$$|\lambda^k| \geq 0$$

Divergences when $\lambda \bar{\lambda} \rightarrow \infty$ are regularized by η

$$\lambda \bar{\lambda} \rightarrow 0$$

$\tilde{\eta}$

$$(\lambda \bar{\lambda})'' \left(\frac{1}{\lambda \bar{\lambda}} \right)''$$

$$\left(\frac{\partial}{\partial \lambda} \right)^2 \left(\frac{\partial}{\partial \bar{\lambda}} \right)^2$$

$$\left(\frac{\partial^2}{\partial \lambda^2 \partial \bar{\lambda}^2} \right) \cdot 1 \sim \frac{(k\theta)_{(0)}}{(k\theta)_{(1)}} \sim \frac{1}{(k\theta)}$$

Niel

permanentes

$$\lambda^k = \frac{S_0(x)}{V(x)}$$

PSL(4,1)

$$|\lambda^T \lambda| \geq 0$$

$$\int d^4x \int d^4\theta (S_0(x)) \langle \left(\lambda^x \lambda^{\theta p} A_{x,p}(x, \theta, \bar{\theta}) \right)^2 \int V \rangle$$

$$\rightarrow \int d^4x \int d^4\theta \int d^4u (V(x, \theta, u))^2$$

$$\langle (\lambda^x \lambda^{\theta p})^2 \rangle = 1$$

$$b = \int \lambda_x \left(J^a (\gamma^a J)^x + (\gamma^a \lambda) (\gamma_a J)^x \right)$$

$$\partial_a b \neq 0, \quad \bar{\partial}_a b = 0, \quad \partial \bar{\partial} b = Q \lambda$$

$$= \text{Tr} \left(\chi_1(\hat{a}_1, \chi_2) + \hat{a}_1^* \hat{a}_2 \hat{a}_n \hat{a}_n^* + \text{perm} \right) \delta^{(k_1+k_2+k_3)}$$

$$g/g \leftarrow \frac{\text{psu}(2,2|4)}{\text{so}(4,1) \times \text{so}(5)} \xrightarrow{\text{radius deformation}} \text{AdS}_5 \times S^5$$

+ ghosts $\frac{\text{psu}(2,2|4)}{\text{so}(1,1) \times \text{so}(5)}$

$$= \text{Tr} \left(\chi_1(\phi_2, \chi_3) + \hat{a}_1 \hat{a}_2 \hat{a}_3 + \text{perm} \right) \int^{(k_1+k_2+k_3)} (\lambda A)$$

$$\frac{g}{g} \leftarrow \text{PSU}(2,2|4) \xrightarrow{\text{radius deformation}} \text{So}(4,1) \times \text{SU}(5)$$

+ ghosts $\frac{\text{PSU}(2,2|4)}{\text{So}(4,1) \times \text{SU}(5)}$

$\text{AdS}_5 \times S^5$

32 bosons
10 bosons
fermions

11 + 11
pure spinors

$$= \text{Tr} \left(\chi_1(\hat{a}_1, \chi_2) + \hat{a}_1^* \hat{a}_2 \hat{a}_3 + \text{perm} \right) S^*(k_1 + k_2 + k_3)$$

$$\frac{g}{g} \leftarrow \text{PSU}(2,2|4) \xrightarrow{\text{radius deformation}} \text{AdS}_5 \times S^5$$

$$\leftarrow \text{SO}(4,1) \times \text{SU}(5) \xrightarrow{\text{ghosts}} \frac{\text{PSU}(2,2|4)}{\text{SO}(4,1) \times \text{SU}(5)}$$

$$\langle v_1, v_2 \rangle_{\text{IR}}$$

32 bosons
~~10 = 1~~
 10 bosons
 fermions

11 + 11
 pure spinors