

non-abelian Born-Infeld and κ -symmetry

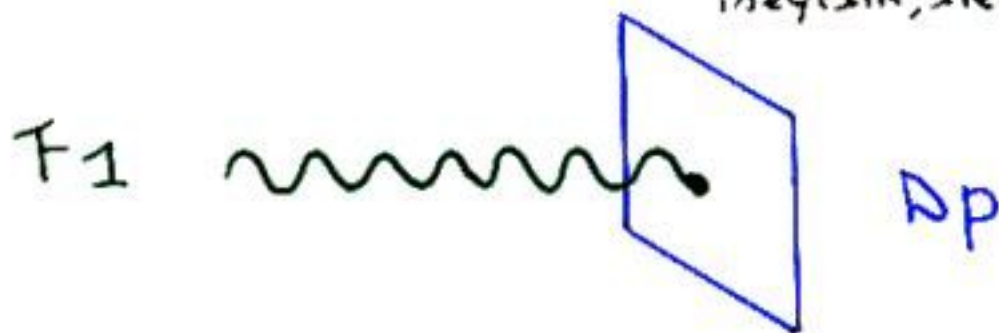
with Mees de Roo and Alexander Seurin

- ① abelian Born-Infeld
- ② Non-Abelian κ -symmetry
- ③ Strategy + Results
- ④ Summary

Ann Arbor, July 11, 2000

① Abelian Born-Infeld

Tseytlin, hep-th/9908105



$$(V_i, \Sigma^m; \tau) : 8 + 8$$



$$(V_i, \Sigma^m; \mathcal{J}) : 8 + 8$$

A red arrow points from the \mathcal{J} in the equation above to the κ -symmetry text below.

WV Diff.

κ -symmetry

IIB D9-brane

(V_μ, χ) : D=10 SUSY Maxwell

Fradin, Tseytlin

$$\mathcal{L}_{BI}(\text{bosonic}) = -\sqrt{-\det(\eta_{\mu\nu} + \alpha' F_{\mu\nu})}$$

Abouelsaad, Callen, Nappi, Yost



Gross, Witten ; Tseytlin

$$\mathcal{L}_{BI}(\text{SUSY}) = \boxed{\text{tr } F^2} + \alpha'^2 \left[\text{tr } F^4 - \frac{1}{4} (\text{tr } F^2)^2 \right] + \dots$$

$$\boxed{\chi \partial \chi} + \alpha'^2 F^2 \chi \partial \chi + \dots$$



Rahowski, Sezgin + E.B.
Metsaev, Rahmanov

D=4 : Cecotti, Ferrara

κ -symmetry

Cederwall, von Gussich, Nilsson, Sundell, Westenberg
Aganagic, Popescu, Schwarz; Townsend + E.B.

$$\mathcal{L}_{BI} = -e^{-\phi} \sqrt{-\det(g + \mathcal{F})} + C e^{\mathcal{F}}$$

$$(\Sigma^\mu, g^\alpha) \quad V_i$$

$$\delta \mathcal{L}_{BI} = \underbrace{\bar{\chi} (1 + T)}_{\delta \bar{\theta}} \underbrace{(1 - T)}_{\substack{\hat{N} \\ \text{KIN.}}} T \quad T^2 = 1$$

W.Z.

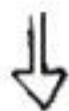
$$T(\Sigma, \mathcal{F}) \sim T_0(\Sigma) \left[\sigma_1 + \frac{1}{2!} \gamma^{ij} \mathcal{F}_{ij} \sigma_2 + \frac{1}{4!} \gamma^{ijkl} \mathcal{F}_{ij} \mathcal{F}_{kl} + \dots \right]$$

Flat Background

Aganagic,
Popescu,
Schwarz

$$e_{\mu}^a = \delta_{\mu}^a$$

- $\mathcal{G}_2 = 0$ fixes κ $\mathcal{G} = \begin{pmatrix} \mathcal{G}_1 \\ \mathcal{G}_2 \end{pmatrix}$
- $X^{\mu} = \sigma^{\mu}$ static gauge



$$\mathcal{L}_{BI}(SUSY) = -\sqrt{-\det(\eta_{\mu\nu} + F_{\mu\nu} + \bar{\chi} T_{\mu}^{\alpha} \partial_{\nu} \chi + \frac{1}{4} \bar{\chi} T^{\alpha}_{\mu} \partial_{\nu} \chi \bar{\chi} T_{\alpha}^{\beta} \partial_{\nu} \chi)}$$

SUSY Born-Infeld

$$\delta \mathcal{G} = \varepsilon \quad \begin{array}{l} \text{--- 16 linear SUSY} \\ \text{--- 16 nonlinear SUSY} \end{array}$$

Goal

① Find non-abelian version of T

- full SUSY rule of \mathcal{G}
- SUSY condition: $(1-T)\varepsilon = 0$

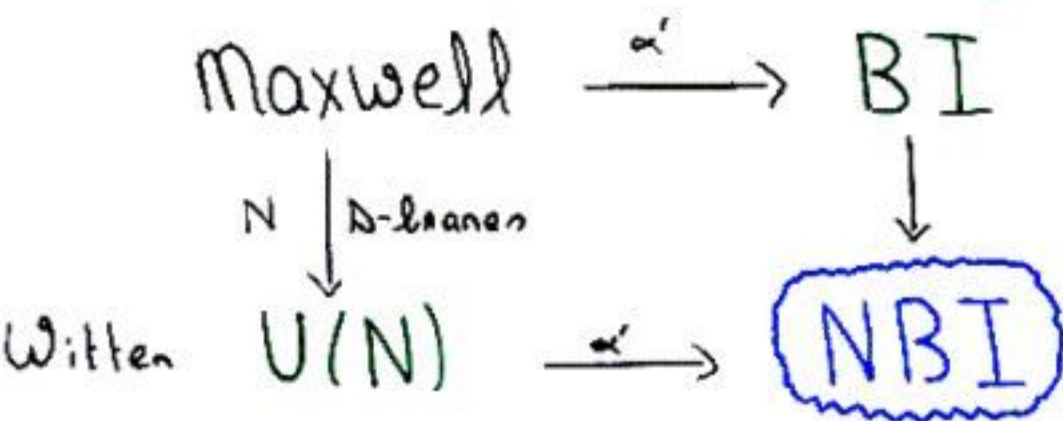
Ketov; Refolli, Terzi, Zanon

② Construct \mathcal{L}_{BI} (non-abelian, SUSY)

NBI $\xrightarrow{T\text{-duality}}$ NDBI

Taylor, van Raamsdonk; Myers

② Non-Abelian κ -Symmetry



$$\bullet [D_i, D_j] F_{kl} = [F_{ij}, F_{kl}]$$

Argyres, Nappi

• Symmetrized trace Tseytlin

Hashimoto, Taylor ; Bain ; Denef, Seiberg, Troost

$$- U(N) \longrightarrow U(1)^N \longrightarrow U(1)$$

$$- T_A T_B = d_{ABC} T_C + i f_{ABC} T_C \quad A=1 \dots N^2$$

"Non-Abelian" Superspace

$$(\Sigma^\mu, \mathcal{G}), V_i \xrightarrow[\text{diff.}, \kappa]{\text{fix}} \text{BI}$$

$$\delta \mathcal{G} = -\varepsilon \quad \delta \Sigma^\mu = \frac{1}{2} \varepsilon T^\mu \mathcal{G}$$



$$\Sigma^\mu, \mathcal{G}^A, V_i^A \xrightarrow[\text{diff.}, \kappa^A]{\text{fix}} \text{NBI}$$

non-abelian κ -symmetry

$$\delta \mathcal{G}^A = -\varepsilon^A ?$$

③ Strategy + Results

$$\mathcal{L}(\mathcal{D}\mathcal{G}) = -\sqrt{-\det(\mathcal{G} + \mathcal{F})} + C_{(10)} + C_{(8)} + \dots$$

$$\bullet C_{(8)} = \bar{\mathcal{D}} \sigma_2 T_{(7)} \mathcal{D} \mathcal{G} \rightarrow C_{(8)}^A = d^{ABC} \bar{\mathcal{D}}^B \sigma_2 T_{(7)} \mathcal{D} \mathcal{G}^C$$

Iterative Procedure

$$\delta \mathcal{L}_{\text{NBI}}(\text{SUSY}) = \bar{\eta} (1 + T) \times$$

$$\left[\underset{\uparrow}{1} - T_0(X) \left(\underset{\uparrow}{\sigma_1 + T_1 + T_2 + \dots} \right) \right] \left[\underset{\uparrow}{\mathcal{D}\mathcal{G} + T_1 + T_2 + \dots} \right]$$

Results

$O(1)$	$O(F)$	$O(F^2)$		$O(1)$	$O(F)$	$O(F^2)$
-	F^2	-		-	F^2	-
$\chi\partial\chi$	$F\chi\partial\chi$	$F^2\chi\partial\chi$		$\chi\partial\chi$	$F\chi\partial\chi$	

nonlinear SUSY linear SUSY

$$\delta \mathcal{L}_{CSA} = -\varepsilon \quad \text{or} \quad \delta \mathcal{L}_{U(1)} = -\varepsilon$$

$$T^{AB} \sim \delta^{AB} + \frac{1}{2} d^{ABC} \gamma^{i\bar{j}} F_{i\bar{j}}^C + \frac{1}{8} d^{ABE} d^{CDE} \gamma^{i\bar{j}} F_{i\bar{j}}^C F_{\bar{j}l}^D + \text{"more"}$$

④ Summary

We have embedded
 $U(N)$ YM + all $F_{\chi\partial\chi}, F^2_{\chi\partial\chi}$
 terms into a
 κ -symmetric system

- $[F, \bar{\chi}]_{\partial\chi}$ terms \rightarrow
no symmetrized trace

Complete result?

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$$\textcircled{1} T = e^{-a/2} T_{(0)} e^{a/2}$$

$$a = \frac{1}{2} \sum_{ij} \gamma^{ij} \sigma_3$$

Kiaferak, Ostin, Papadopoulos + E.B.

$$T = \text{"tan"} \gamma$$

branes with $T \neq 0 \Leftrightarrow$ branes at angles

Reid, Douglas, Leigh

↙ Hatanu, Hatanu, Leigh

non-abelian generalization?

② Superembedding Approach?

Hove, Sezgin, West

③ Dp-branes

$$p < 9$$

Open issues

- ① $G \neq U(N)$?
- ② SUSY curved background?
- ③ New (non-abelian) superspace geometry?