On supersymmetric AdS_4 orientifold vacua

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SEMINAR SERIES ON STRING PHENO

Contents

A bit of context: motivating the problem

- String theory supports many AdS vacua, solutions of the form $AdS_d \times M_p$

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Mathematically: ✓

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- Strong AdS distance conjecture. Infinite tower of states with mass m:

SUSY vacua

$$m \sim \Lambda^{1/2}$$

Lüst, Palti, Vafa '19

Usually KK scale $\longrightarrow$ $\boxed{R_{KK} \sim R_{AdS}}$

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DeWolfe, Giryavets, Kachru, Taylor '05; Camara, Font, Ibáñez '05 …

- "DGKT vacua ", IIA on CY **orientifold** with fluxes:

$$\boxed{R_{KK} \sim R_{AdS}^{7/9}}$$

Counterexample?

SAdSDC

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⚠ But... These vacua are not solving the 10D equations of motion. Difficulties arise because of the O-planes.

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Counterexample?

Recent related work:
Junghans '20;
Buratti, Calderón, Mininno, Uranga '20

We find an approximate solution to the uplift problem.
Approximate: at first order in an expansion parameter.

SUSY AdS_4 IIA flux vacua

- Two complementary approaches:

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- 4D description:

1) Compactify IIA in an orientifold of $X_4 \times X_6$ being X_6 a CY manifold. Give a vev to the RR p-forms the NS 3-form.

2) Minimize (SUSY preserving) the potential, impose Bianchi identities.

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- 10D description:

1) We want a solution to the e.o.m with a metric: $ds^2 = e^{2A} ds^2_{AdS_4} + ds^6$

2) Preserved SUSY in 4d:

Graña , Minasian , Petrini , Tomasiello '04,...

2.1) Restricts X_6 to be a manifold with either $SU(3)$ or $SU(3) \times SU(3)$ structure

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DGKT vacua?

- A key characteristic of this family of vacua is

$$\langle G_6 \rangle \propto \int_{X_6} G_6 = 0$$

($\rho_0 = 0$ in the language of Herráez, Ibáñez, Marchesano, Zoccarato, '18)

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- This is a 4d property... But it restricts the possible 10d uplift:

$\cancel{SU(3)}$ or $\boxed{\boldsymbol{SU(3) \times SU(3)}}$

Not compatible with this property

Inside this branch, this property puts also some technical constraints

SUSY AdS_4 IIA flux vacua

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- Also:

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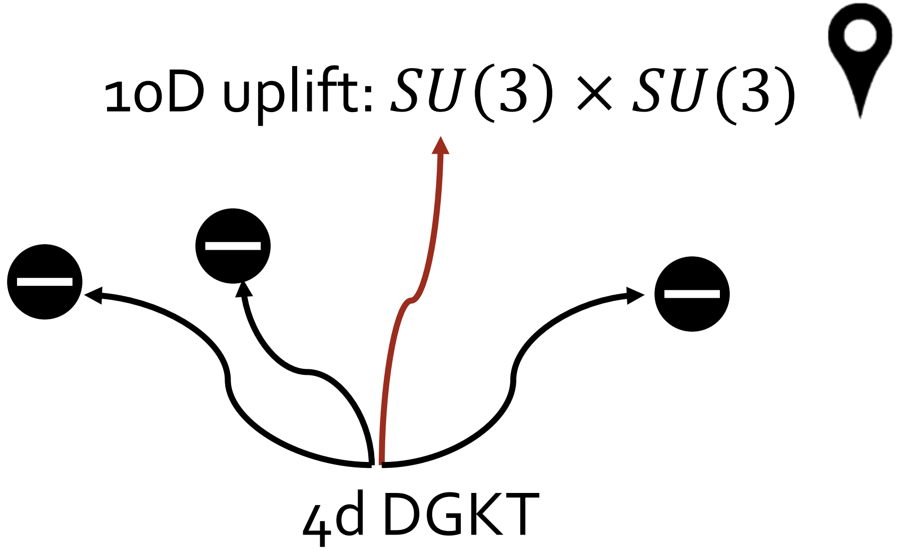
  ❖ Preserved SUSY in 4D constrains the possible internal 6D manifolds

  ❖ DGKT vacua have vanishing G_6 → selects one of the allowed internal geometries



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Having set the framework we are ready to deal with the equations

equations

Large volume approximation

- Inspired by Saracco, Tomasiello '12 we will solve the equations in the limit $\hat{\mu} = \mathrm{l_s}\ \mu = l_s\sqrt{-\Lambda/3}$ small or, equivalently, g_s small, R_{internal} big:

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Acharya, Benini, Valandro '06

- If the source is smeared $\delta_{O6} \to \#\mathrm{Re}\Omega$ one has the following scaling:

$$F_4 \sim N\,, \qquad R_{\mathrm{X}_6} \sim N^{1/4}\,, \qquad g_s \sim \mu \sim R_{\mathrm{X}_6}^{-3} \sim N^{-3/4}$$

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- We will expand the solution to the vanishing SUSY variations in terms of g_s in the limit $g_s \sim 0$

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4) For example, at leading order the dilaton ϕ and the warp factor A are no longer constant

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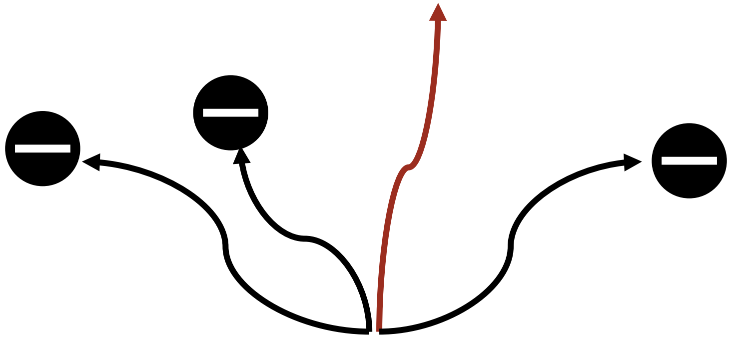
Vanishing SUSY variations

Bianchi identities

10D uplift: $SU(3) \times SU(3)$. 10d E.O.M



4d DGKT

Large volume approximation

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Expand in g_s

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$0th$ order: smearing

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Solving the equations: B.I.

- Forget for the moment the SUSY equations. Let us solve the B.I. for DGKT. Then we will use the expansion of the SUSY solution to accommodate this result ☺. Consider:

$$H = 2\mu \mathrm{Re}\,\Omega_{CY}$$

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- The solution for the previous equation can be written as:

$$l_s^2\, \widetilde{F_2} = -J_{CY} \cdot d(\, 4\varphi \mathrm{Im}\, \Omega_{CY} - \star_{CY} K) + \widetilde{F_2^h} + dC_1$$

with dC_1 exact, $\widetilde{F_2^h}$ CY harmonic and $\Delta K = 2m\hat{\mu}\mathrm{Re}\, \Omega_{CY} + \delta(\Pi_{06})$

- The rest of BI follows easily from this solution.

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This H is an approximation of the *actual* H. In the expansion it will correspond to the leading term

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- Strategy: express the terms of the expansion in terms of CY quantities solving the B.I

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SUSY equations + expansion $$F_2 = -\frac{1}{g_s} J \cdot d(e^{-3A_0} \mathrm{Im}\Omega) \; + \mathcal{O}(\mathrm{g}_s)\,,$$ (Ω, J) defining an $SU(3)$ structure,

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- Same procedure for the rest of functions…
- Explicit toroidal example in section 6.2

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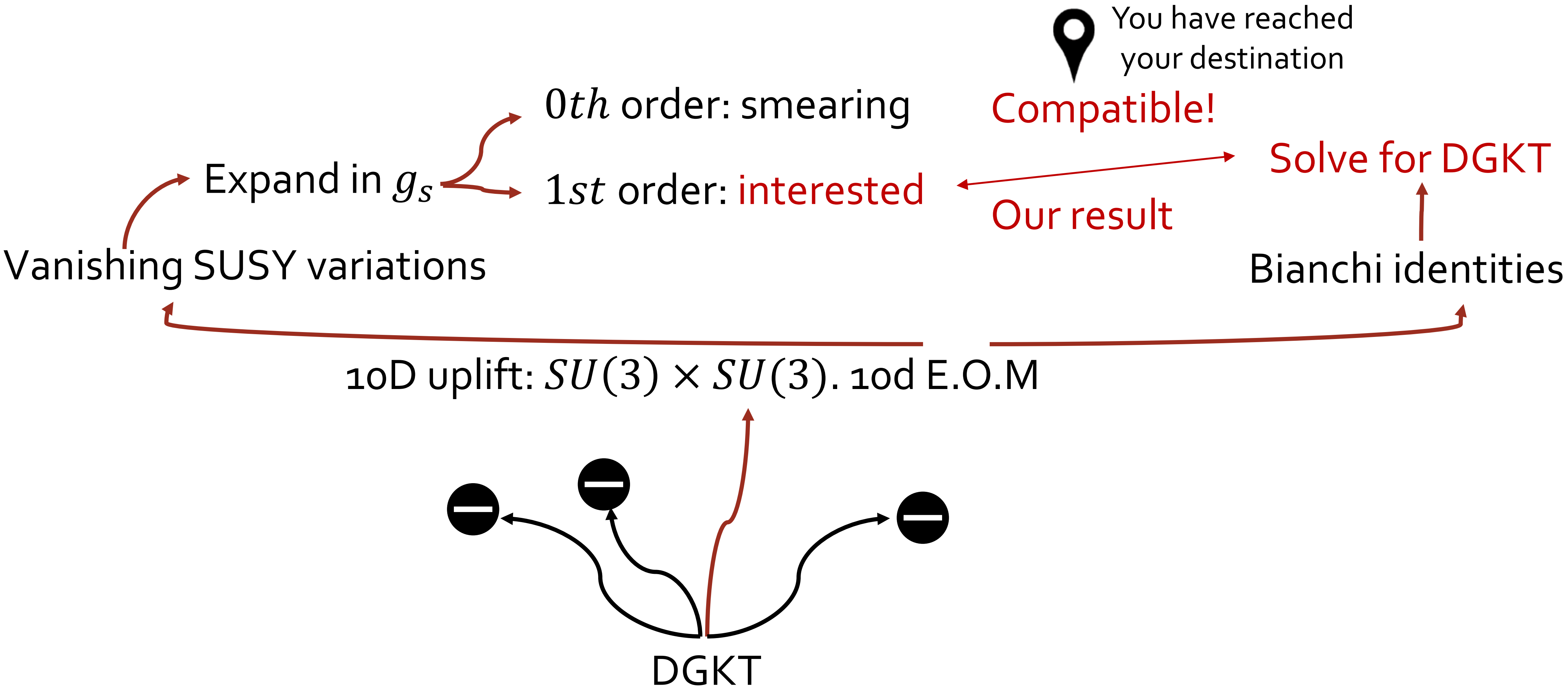

Solving the equations: B.I.+SUSY

- Final result:

$$H = g_s \frac{2}{5} G_0 \mathrm{Re}\, \Omega_{\mathrm{CY}} \left(1 + O\left(g_s^{4/3}\right)\right), \qquad e^{-A} = 1 + O\left(g_s^{4/3}\right),$$

$$G_2 = O\left(g_s^{2/3}\right), \qquad e^{\phi} = g_s\left(1 + O\left(g_s^{4/3}\right)\right),$$

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- At 0^{th} order we recover the usual smeared solution of Acharya, Benini, Valandro '06
- At first order corrections appear. The B.I. is solved with the *smeared* H
- The obstruction present for the $SU(3)$ case is avoided in this solution (at the level of approximation we are working) 👍

Conclusions

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Thank you for your attention! 🙂