Asymmetric CFTs and GSUGRA

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based on 1608.00595 (Fortsch.Phys. 65 (2017) no.3-4, 1700006) and 1611.04617 (JHEP 1701 (2017) 105) by R. Blumenhagen, MF, E. Plauschinn

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Recall your string theory course 1:

The Polyakov action of string theory (in conformal gauge)

$$S_B \sim \int_\Sigma d^2\sigma \left(G_{\mu\nu}(X)\,\eta^{ab} - B_{\mu\nu}(X)\epsilon^{ab}\right)\partial_a X^\mu \partial_b X^\nu + \ldots$$

One keeps the background fields G and B-field etc. fixed and quantizes only the string, X.

In case the β functions vanish, one finds a 2D CFT describing quantized strings in the given classical background.

Therefore:

Background $\leftrightarrow$ CFT

But: Only few examples are available, e.g.

- Torus (orbifolds) $\leftrightarrow$ free CFTs (orbifolds)
- Group manifolds $\leftrightarrow$ WZW models
- Certain hypersurface Calabi-Yaus $\leftrightarrow$ Gepner models

Reasons:

- The Polyakov action contains only the NS background fields.
- Most CFTs are highly abstract.
- The metric of most interesting compactifications is not known.

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Furthermore: The Polyakov action is left-right symmetric.

Topic of this talk:

What background corresponds to a L-R asymmetric CFT?

One can stabilize the moduli by perturbing the internal space with fluxes.
$\Rightarrow$ The fluxes gauge some part of the global symmetry group of the moduli space.

But: In a SUGRA there are **not only** the gaugings expected from usual **(geometric) fluxes**, but **also their T-dual fluxes**
$\Rightarrow$ non-geometric fluxes.

Recall: T-duality is a L-R asymmetric operation $X_R \to -X_R$.

Work on L-R asymmetric torodial orbifolds suggests a connection:
After introducing the asymmetry one finds the flux algebra!

[Dabholkar, Hull '02,05; Condeescu, Florakis, Kounnas, Lüst '12,13]

<u>G</u>SUGRA $\sim$ <u>A</u>CFT?!

Overview

What we did:

Look at Gepner models + L-R asymmetric simple currents

[Gepner; Schellekens, Yankielowicz; Schellekens, Gato-Rivera]

Compare the result to a SUGRA with NSNS gaugings

Two papers together with R. Blumenhagen and E. Plauschinn:

- 1608.00595 Very concrete examples in 4D with $\mathcal{N} = 1$ SUSY
- 1611.04617 Classification of asymmetric Gepner models in 4D, 6D, 8D with extended SUSY to support conjecture.

Our results suggest: Yes! <u>G</u>SUGRA $\sim$ <u>A</u>CFT !

Recap: The 3^5 Gepner model

Gepners idea: Use tensored minimal SCFTs as the internal CFT of a string compactification.

Example: Take the CFT $(k=3)^5$ to describe a 6D internal space. The massless states look like e.g.

$$(\mathbf{3},4,1)(\mathbf{2},3,1)(\mathbf{0},1,1)^3 C \rightarrow x_1^{\mathbf{3}} x_2^{\mathbf{2}}$$
$$(\mathbf{2},3,1)(\mathbf{1},2,1)^3(\mathbf{0},1,1) C \rightarrow x_1^{\mathbf{2}} x_2 x_3 x_4$$

$\Rightarrow$ **The massless states reveal the combinatorics of complex structure deformations** in $\mathbb{P}_{1,1,1,1,1}[5]$.
$\Rightarrow$ 3^5 model is IIB on the quintic at a certain point in moduli space.
$\Rightarrow$ $\mathcal{N}=2$ target space SUSY.

In general: More complicated $W\mathbb{CP}$

Now: Add a certain L-R asymmetric simple current in the first factor of the 3^5 model:

Note: Roughly said a simple current produces a new partition function thus new CFT from an given one.

Result:

- One supercharge from the left-movers, none from the right-movers $\rightarrow$ L-R asymmetry, $\mathcal{N} = 1$ **target space SUSY.**
- **The massless modes still reveal the structure of a $W\mathbb{CP}$ with $w_i = 1, 1, 1, 1, 2, 2$ and polynomials of degree 5!**

Educated guess: Is this the CFT to the $\mathcal{N} = 2$ SUGRA of IIB on $\mathbb{P}_{1,1,1,1,2,2}[5, 3]$ with SUSY breaking fluxes?

$\mathcal{N}=2 \to \mathcal{N}=1$ **breaking:** [Louis, Smyth, Triendl '09,10; Louis, Hansen '13]

- Needs **simultaneous geometric + non-geometric gaugings**
  No surprise: Our model is L/R asymmetric
- Resulting $\mathcal{N}=1$ **spectrum is highly constrained**. For the above $P_{1,1,1,1,2,2}[5,3]^{h_{12},h_{11}=83,2}$ only 6 possibilities:

$$(N_V, N_{\rm ax}) \in \{(80,0),(80,1),(81,0),(81,1),(82,1),(82,2)\}$$

Compare: Our model has $(N_V; N_{\rm ax}) = (80,0)$ ✓

Observation:

This ACFT looks like the string uplift of the GSUGRA of IIB on $P_{1,1,1,1,2,2}[5,3]$ + (SUSY breaking) fluxes!

More examples in our paper.

More evidence by adding more SUSY

Advantage: No superpotential, masses only through Higgs.
$\Rightarrow$ **Perfect to test the conjecture in a more controlled setup**

What we did in the second paper:

Using a stochastic computer search we classified all asymmetric Gepner models with more than eight supercharges and tried so interpret them. $\mathcal{O}(10^8)$ models!

Few mechanisms explain all models. Two most important ones:

- Asymmetric $(-1)^{F_L}$ orbifolds
- Super Higgs effect of GSUGRA ✓

Conclusion

ACFT/GSUGRA conjecture:

A certain class of asymmetric Gepner models can be identified with the fully backreacted minima of GSUGRA with geometric + non-geometric gaugings/fluxes

Important comment:

Non-geometric (thus winding) fluxes generically have a $\mathcal{O}(1)$ backreaction onto the geometry ("want so shrink their cycle"). $\Rightarrow$ The SUGRA + non-geometric fluxes is **not an LEEA**!

[Blumenhagen, Font, MF, Herschmann, Plauschinn, Sekiguchi, Wolf '15]

Rather: Under a suitable (non-geometric) pertubation the geometry adjusts into the non-geometric background of the ACFT. The topological data seems preserved under this flow $\Rightarrow$ The GSUGRA predicts the spectrum correctly.