Supersymmetry Enhancement

Federico Carta

DESY

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Based on...

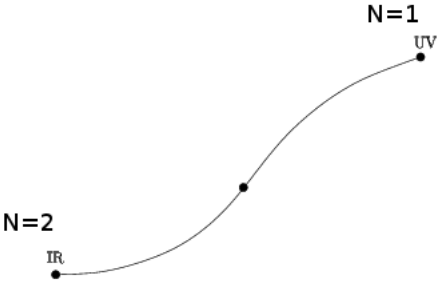
1. Supersymmetry enhancement from T-branes
   - F.C., S. Giacomelli, R.Savelli. 2018
2. Supersymmetry enhancement from Hitchin Systems
   - (Work in progress)
     F.C., A.Collinucci, S. Giacomelli, H. Hayashi, R.Savelli

For earlier related works in Susy Enhancement see

- K. Maruyoshi, J. Song, 2016
- P. Agarwal, K. Maruyoshi, J. Song, 2016
- P. Agarwal, A, Sciarappa, J. Song, 2017
- S. Giacomelli, 2018

Supersymmetry enhancement.

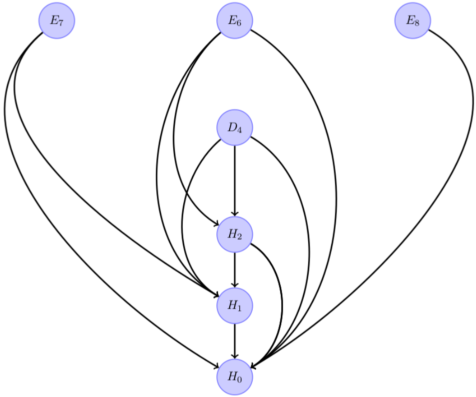
- A UV QFT follows an RG flow to a IR QFT with more explicit supersymmetry.
- Intrinsically interesting phenomenon in QFT.
- Can use the lagrangian to compute RG-protected quantities.



Maruyoshi-Song flows

- Start in UV with a $4d\ \mathcal{N}=2$ SCFT $\mathcal{T}$ with flavor symmetry F.
- Add by hand a $\mathcal{N}=1$ chiral M.
- M is gauge singlet and in the adjoint of the F.
- Turn on a superpotential term $W_{def} = Tr\ Mq\tilde{q}$.
- Give a ***nilpotent vev*** to M. This triggers a RG flow.
- Depending on the choice of $\mathcal{T}$ and $\langle M \rangle$ sometimes we find that $\mathcal{T}[\langle M \rangle]$ flows in the IR a *new* $\mathcal{N}=2$ SCFT: call it $\mathcal{T}[\langle M \rangle]_{IR}$.
- “New" means $\mathcal{T}[\langle M \rangle]_{IR} \neq \mathcal{T}$

Enhancing flows connecting rank 1 theories



A figure summarizing all the existent MS connecting rank one theories. Multiple flows happen for different nilpotent orbit deformations.

The geometrical picture. Part 1

- Consider a F-theory setup, on $\mathbb{R}^8 \times K3$
- Put a D3 probing the elliptic fibration.
- Write the Weierstrass model for the elliptic fibration. The theory on the D3 will be the theory $\mathcal{T}$ in the UV. In particular the Weiestrass model fixes the flavor group F.
- We interpret the CB operator u as the coordinate in one of the $\mathbb{R}^2$ normal to $\mathbb{R}^4$.
- Elliptic fiber $\simeq$ Seiberg-Witten curve of the QFT.

The geometrical picture. Part 2

- The chiral M is geometrized by a T-brane deformation of the 7-brane stack. $\implies$ Nilpotent orbit + fluctuation.
- Ex. For the case in which $F = \mathfrak{sl}_2$, we can take a T-brane profile given by:

$$\varphi = \langle\varphi\rangle + \delta\varphi = \begin{pmatrix} 0 & 1 \\ x & 0 \end{pmatrix} \tag{1}$$

- $\delta\varphi$ will be the highest-spin singlet appearing in the decomposition of Adj.

The geometrical picture. Part 3

Singularity	Curve	Flavor group
II^*	$u^2 = v^3 + v(M_2 z^3 + M_8 z^2 + M_{14} z + M_{20}) + (z^5 + M_{12} z^3 + M_{18} z^2 + M_{24} z + M_{30})$	E_8
III^*	$u^2 = v^3 + v(z^3 + M_8 z + M_{12}) + (M_2 z^4 + M_6 z^3 + M_{10} z^2 + M_{14} z + M_{18})$	E_7
IV^*	$u^2 = v^3 + v(M_2 z^2 + M_5 z + M_8) + (z^4 + M_6 z^2 + M_9 z + M_{12})$	E_6
I_0^*	$u^2 = v^3 + v(\tau z^2 + M_2 z + M_4) + (z^3 + \tilde{M}_4 z + M_6)$	$SO(8)$
IV	$u^2 = v^3 + v(M_{1/2} z + M_2) + (z^2 + M_3)$	$SU(3)$
III	$u^2 = v^3 + vz + (M_{2/3} v + M_2)$	$SU(2)$
II	$u^2 = v^3 + v M_{4/5} + z$	no

Table: Maximally deformed Weierstrass models

- The parameters M_i are the versal deformations of the model
- They correspond to casimir operators of the Higgs field in the F-theory picture, which we take to be $\varphi = \langle M \rangle + \delta\varphi$

The geometrical picture. Part 4

- When the D3 probes the deformed Weiestrass model, the theory is $\mathcal{N} = 1$, due to the T-brane presence. Original K3 $\rightarrow$ CY3.
- RG flow is a local zoom at the singularity.
- In the IR, some terms in the Weiestrass become subleading. We throw them away and recover the Weierstrass for $\mathcal{T}^{IR}$

Conclusions

1. Can interpret geometrically the MS flows, for the rank 1 case.
2. We engineer the UV theory as a D3 probing the singularity locus of the elliptic fibration
3. We engeneer the nilpotent vev for M as a T-brane deformation of the 7-brane stack
4. We interpret the RG flow as a local zoom-in.
5. We recover the curve for the IR theory, in all cases which enhance.