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Hidden continuous symmetries
1) Hidden global bosonic symmetries
2) Hidden supersymmetry

Example

$\mathcal{N}=4$, $d=3$ SQED
$G=U(1)$, $N_f=2$ (2 hypermultiplets)
hyper $=(Q, \tilde{Q})$
$W=\sqrt{2}\,\tilde{Q}\,\phi\, Q$

symmetries: $SU(2)_{fl}\times U(1)_T \xrightarrow{\text{RG flow}} SU(2)_{fl}\times SU(2)_T$

$$J_\mu=\varepsilon_{\mu\nu\rho}\frac{1}{2\pi}F^{\nu\rho}$$

$$\partial_\mu \partial^\mu=0 \Longleftrightarrow dF=0.$$

Example 2 $\quad \mathcal{N}=4,\ d=3$

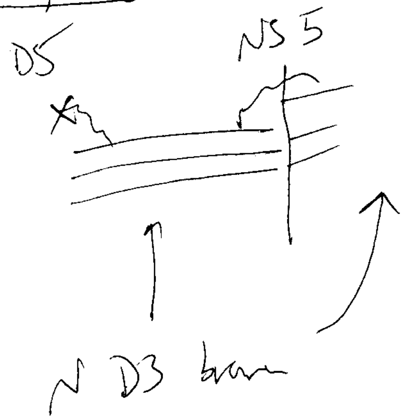
$U(N)$, 1 hyper in the fundamental
1 hyper in the adjoint

UV: $\mathcal{N}=4$ SUSY

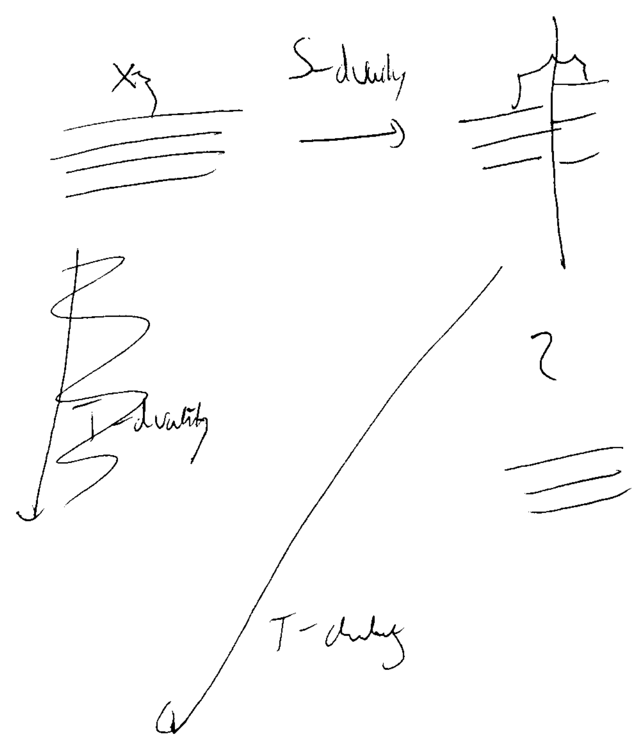
$$\downarrow$$

IR: $\mathcal{N}=8$ SUSY

string theory argument



or



Example 3

$\mathcal{N}=6 \to \mathcal{N}=8$

ABJM theory:

$$G = U(N)_k \times U(N)_{-k}$$

$(N,\bar{N}) + (N,\bar{N})$
(hyper + twisted hyper)

Claim

$\mathcal{N}=8$ for $k=1,2$

Field theory approach

operator on $\mathbb{R}^3$ $\longleftrightarrow$ states on $S^2 \times \mathbb{R}$

1) state-operator correspondence
2) controlled deformation to weak coupling
3) Look at BPS scalars (works for $\mathcal{N} \geq 4$).

$Q|\psi\rangle = 0$

$$S_t = t\int \mathrm{Tr}\,(*F_{S^2} - \sigma)^2\, d^3r + \cdots$$

$$\langle *F\rangle = \begin{pmatrix} n_1 & & & 0 \\ & n_2 & & \\ & & \ddots & \\ 0 & & & n_N \end{pmatrix}$$

n_i are GNO charges

$a^\dagger b^\dagger \cdots |n_1, \ldots, n_N\rangle$

$\underline{t=\infty}$

$Q_t|\psi_1\rangle = 0$

$Q_t|\psi_2\rangle = 0$

$\underline{t<\infty}$

$Q_t|\psi_1\rangle = f(t)|\psi_2\rangle$

!

$35 = 15 + 10_{+1} + 10_{-1}$

$$Q_T = \sum_{i=1}^{N} n_i$$

$SO(8)$

$\cup$

$SO(6)\times U(1)_T$

$\cup$

$SO(4)\times U(1)_R \times U(1)_T$

$k=2$

$a^\dagger a^\dagger|\pm1, 0, 0\cdots\rangle$

$k=1$

$a^\dagger a^\dagger|\pm2, 0, \ldots\rangle$

$a^\dagger a^\dagger|\pm1, \pm1, 0, \ldots\rangle$

$a^\dagger|\pm1, 0, \ldots\rangle$

Example 4

ABJ

$$U(N+1)_2 \times U(N)_{-2}$$

$$\xrightarrow{\text{parity}} \quad U(N+1)_{-2} \times U(N)_2$$

$$\Big\downarrow \text{ Seiberg duality}$$

$$U(N+1)_2 \times U(N)_{-2}$$

$\mathcal{N}=3$, $d=3$ Seiberg duality

$$U(N_c)_k + N_f \text{ funds} \longleftrightarrow U(N_f - N_c + |k|)_{-k} + N_f \text{ funds}$$

$N_c = N+1$

$N_f = 2N$

$\times U(N)_2$

$$U(2N-(N+1)+2)_2 = U(N+1)_2 \times U(N)_2$$

too naive: must think about flavor symmetry & Seiberg duality
for each flavor, shift by k.

$$\times U(N)_2 \to \times U(N)_{2-2\cdot 2} = U(N)_{-2}$$

$$U(M)_{k_1} \times U(N)_{k_2}$$