Dualities from dualities in 2d $\mathcal{N} = (0, 2)$

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Context

Dualities and Building Blocks

- Confinement in absence and presence of superpotential in 4d $\mathcal{N} = 1$
  [Csaki et al., 1997, Bajeot et Benvenuti, 2022, Benvenuti et al, 2023,
  Amariti, **M.F.** and Morgante, 2023];
- Dualities from dualities in 4d $\mathcal{N} = 1$
  [Pasquetti et al, 2023, Bajeot et Benvenuti, 2022, Amariti et **M.F.**, 2024];
- Confinement and dualities in 3d $\mathcal{N} = 2$
  [Pasquetti et Sacchi, 2019, Benvenuti et al., 2022, Amariti et Rota, 2022, Amariti et **M.F.**, 2024,
  Benvenuti et al., 2024, Hwang et Kim, 2024]

$\longrightarrow$ Evidence for an organizing principle: set of fundamental dualities in terms of which the others can be obtained.

What about 2d $\mathcal{N} = (0, 2)$?

Analogies

- Minimal supersymmetric case equipped with holomorphy;
- Abelian $U(1)_R$ symmetry that has to be obtained through an extremization procedure in order to have a well defined SCFT [Benini et Bobev, 2012];
- Well defined prescription to obtain 2d dualities from 4d: topological twisting [Gadde et al, 2015]

Problems

Absence of a fundamental duality for USp(2N)

$\longrightarrow$ Restricting to the SU(N) and the USp(2N) limiting cases, where the dual gauge group vanishes and where the dual description corresponds to a Landau-Ginzburg (LG) model.

Topological twist I

2d $\mathcal{N} = (0, 2)$ from 4d $\mathcal{N} = 1$

- 2d dualities are obtained by compactifying 4d theories on $\mathbb{S}^2 \times \mathbb{R}^2$.
- Turning on a background flux for the R-symmetry $\longrightarrow$ preserving $\mathcal{N} = (0, 2)$ susy.
- Choosing non-negative integer R-charges for all fields $\longrightarrow$ avoid sum over theories and gives a single well defined 2d theory.

Topological twist II

Matter Content Reduction

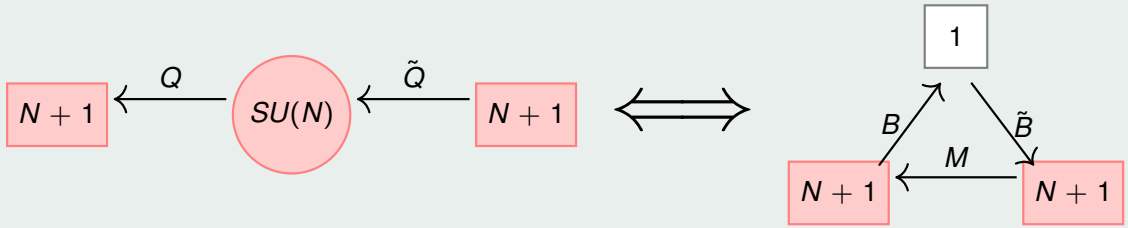
Single Chiral Multiplet: For a 4d $\mathcal{N} = 1$ chiral multiplet with R-charge r, the resulting 2d fields depend on r:

- $r < 1 : 1 - r$ $\mathcal{N} = (0, 2)$ chiral multiplets.
- $r > 1 : r - 1$ $\mathcal{N} = (0, 2)$ fermi multiplets.
- $r = 1$: No contribution.

Gauge Multiplet: A 4d $\mathcal{N} = 1$ vector multiplet reduces to a 2d $\mathcal{N} = (0, 2)$ vector multiplet. The gauge group remains the same.

Building Blocks in 2d I

Seiberg confining limiting case $N_f = N_c + 1$



$W = 0$

$W = BM\tilde{B} + \det M$

$Q^N \longleftrightarrow \Phi_B$

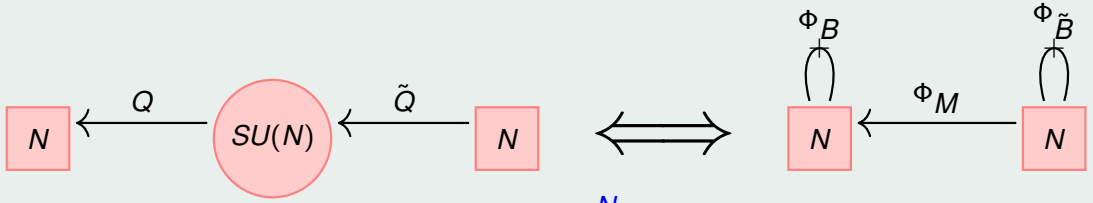
$\tilde{Q}^N \longleftrightarrow \Phi_{\tilde{B}}$

$Q\tilde{Q} \longleftrightarrow \Phi_M$

$R[Q^{(N+1)}] = R[\tilde{Q}^{(N+1)}] = 1$

$R[Q^{(1)}] = \ldots = R[Q^{(N)}] = R[\tilde{Q}^{(1)}] = \ldots = R[\tilde{Q}^{(N)}] = 0$

$SU(N)$ with N fundamentals and N antifundamentals



$W = 0$

$Q^N \longleftrightarrow \Phi_B$

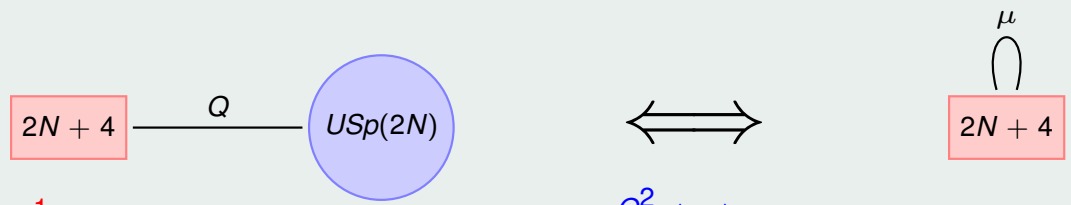
$\tilde{Q}^N \longleftrightarrow \Phi_{\tilde{B}}$

$Q\tilde{Q} \longleftrightarrow \Phi_M$

$W = \Psi(\Phi_B \Phi_{\tilde{B}} + \det \Phi_M)$

Building Blocks in 2d II

Intriligator-Pouliot confining case $2N_f = 2N_c + 4$



$R[Q^{(2N+3)}] = R[Q^{(2N+4)}] = 1$

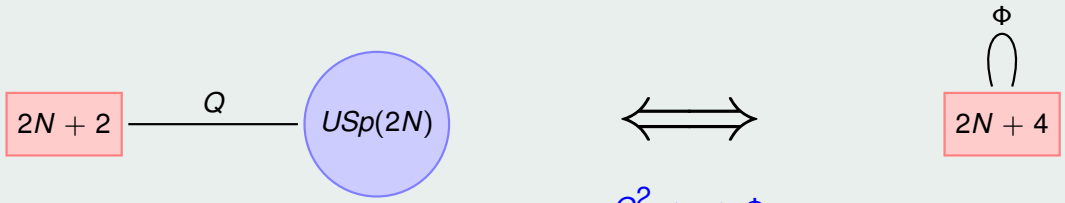
$R[Q^{(1)}] = \ldots = R[Q^{(2N+2)}] = 0$

$Q^2 \longleftrightarrow \mu$

$W = 0$

$W = \mathrm{Pf}\mu$

$USp(N)$ with $2N + 2$ fundamentals

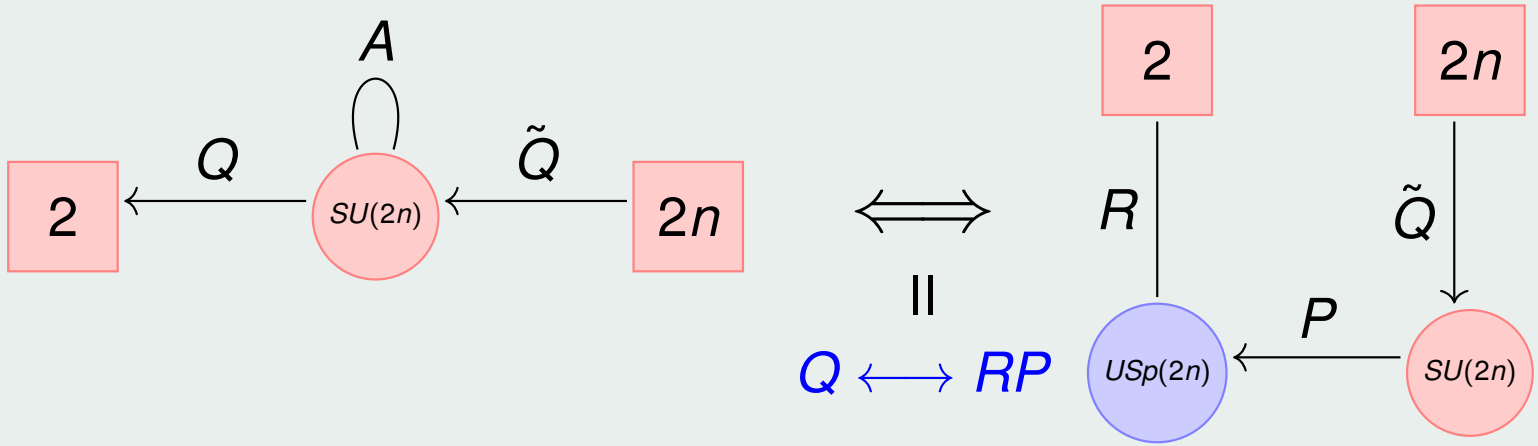


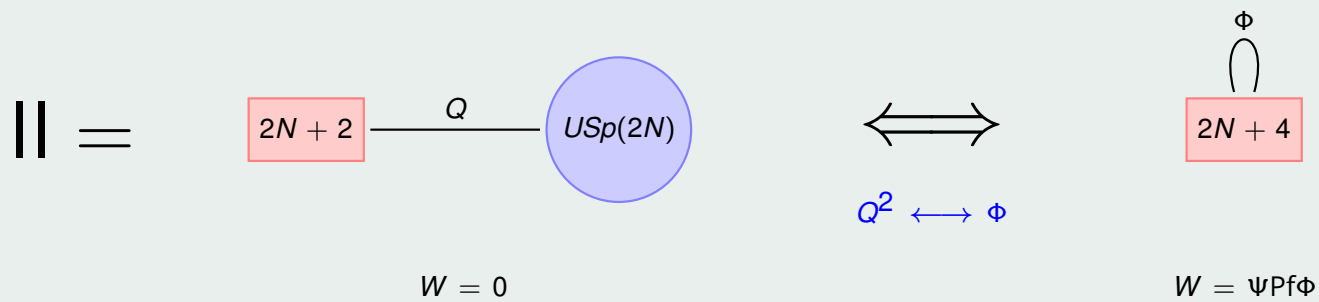
$Q^2 \longleftrightarrow \Phi$

$W = 0$

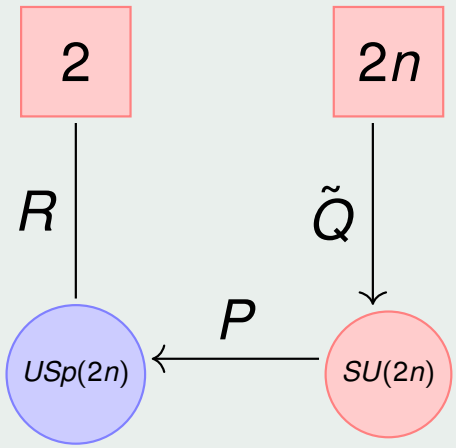
$W = \Psi\mathrm{Pf}\Phi$

$SU(2n)$ with one Antisymmetric, $2n$ $\bar{\square}$ and 2 $\square$ I

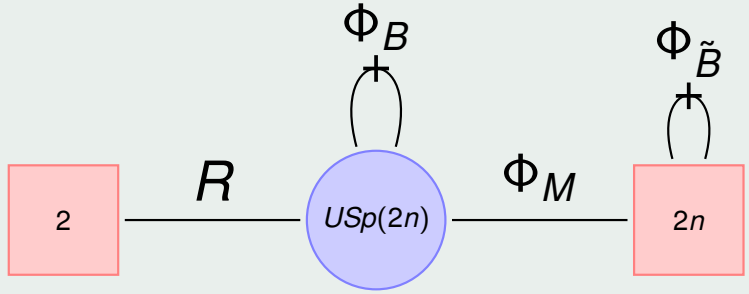




$SU(2n)$ with one Antisymmetric, $2n$ $\bar{\square}$ and 2 $\square$ II



$\Longleftrightarrow$



$\tilde{Q}P \longleftrightarrow \Phi_M$

$P^{2n} \longleftrightarrow \Phi_B$

$\tilde{Q}^{2n} \longleftrightarrow \Phi_{\tilde{B}}$

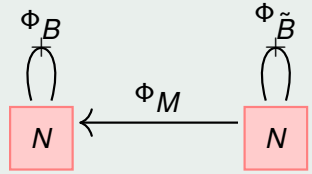
$W = \Psi_R R^2$

$W = \Psi_{SU(2n)(\Phi_B \Phi_{\tilde{B}} + \det \Phi_M)} + \Psi_R R^2$

I =

$W = 0$

$\Longleftrightarrow$



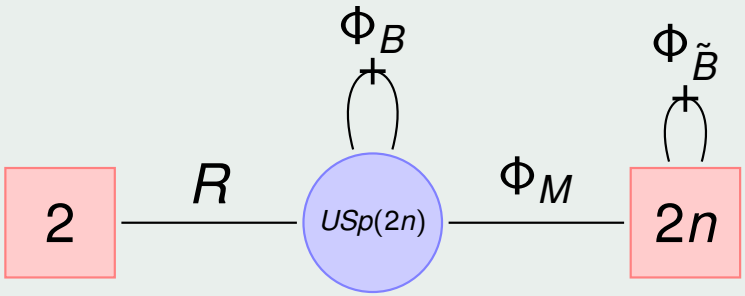
$Q^N \longleftrightarrow \Phi_B$

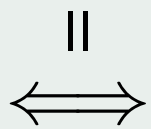
$\tilde{Q}^N \longleftrightarrow \Phi_{\tilde{B}}$

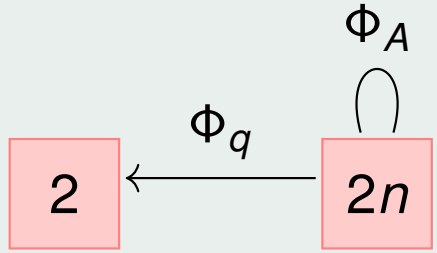
$Q\tilde{Q} \longleftrightarrow \Phi_M$

$W = \Psi(\Phi_B \Phi_{\tilde{B}} + \det \Phi_M)$

$SU(2n)$ with one Antisymmetric, $2n$ $\bar{\square}$ and 2 $\square$ III







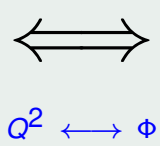
$$W = \Psi_{SU(2n)(\Phi_B \Phi_{\tilde{B}} + \det \Phi_M)} + \Psi_R R^2$$

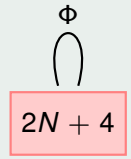
$$W = \Psi_{Su(2n)}(\Phi_A^n + \Phi_{\tilde{B}} \Phi_B) + \Psi_{Usp(2n)} \Phi_A^{n-1} \Phi_q^2$$

$$R\Phi_M \longleftrightarrow \Phi_q$$

$$\Phi_M^2 \longleftrightarrow \Phi_A$$

$$\| = \quad 2N+2 \;\; \overset{Q}{\text{———}} \;\; USp(2N)$$





$W = 0$

$W = \Psi \mathrm{Pf} \Phi$

Validation of the proposed dualities

Consistency checks

- ”Derivation” of the proposed dualities in terms of the 2d building blocks;
- Reproducing the field theory derivation at the level of the elliptic genus;
- Check of the ’t Hooft anomalies for the global symmetries;
- Check of the consistency of the R-charge assignement through the c-extremization;

Conclusions

Results

- We introduced dualities between $SU(N)$ gauge theories with fundamental and antisymmetric chiral matter and LG models in 2d.
- Derivation of some ”pure” 2d dualities, not originating from 4d, by using only 4d descendant dualities.

Future perspectives

- Possible connection with 3d and boundary dualities? [Dimofte et al, 2018]
- Extensions to other gauge groups and matter content in 2d?

Thanks for your attention

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