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On conformal symmetry in large-N quiver mechanics

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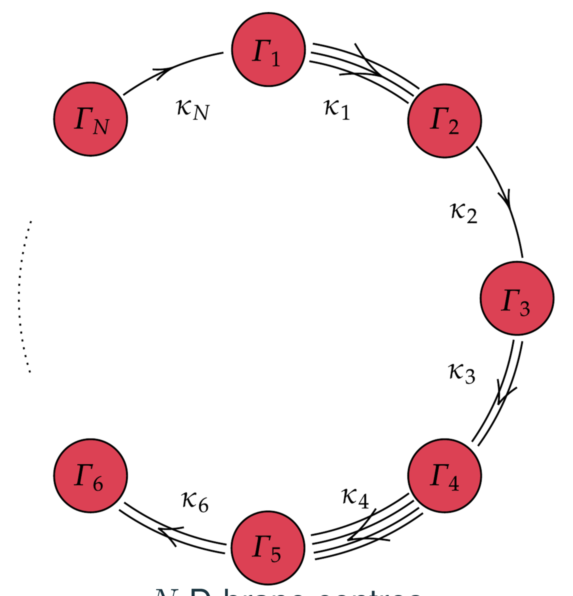
MAIN FINDING

A superconformal index recovers a microscopic BPS scaling contribution.

For cyclic Abelian quivers, selected large-N fixed points lie in a regime where conformal-breaking corrections are expected to be small.

THE PROBLEM

Scaling exposes the limits of the Coulomb description



N D-brane centres
$U(1)$ at each node

Why this matters

Quiver mechanics describes wrapped D-branes. In supergravity, scaling bound states develop an AdS_2 throat, motivating a microscopic description of their BPS spectrum.

What is missing

The ordinary Coulomb fixed-point sum misses scaling contributions. Near the Coulomb–Higgs locus, superpotential corrections break conformal symmetry.

Deep scaling: FI terms and reduced masses drop out; the one-loop Coulomb theory acquires $D(2,1;0)$ superconformal symmetry [2,3].

Coulomb theory: massive chiral multiplets integrated out at one loop.

THE METHOD

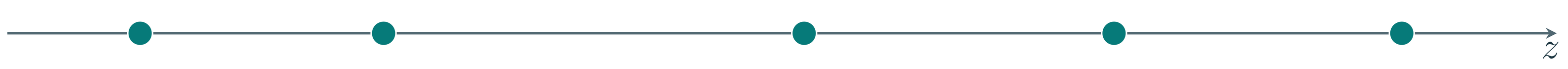
Conformal localization selects collinear centres

Use a weighted count of chiral primaries:

$$\widetilde{H} = H + K + 2J_3 = 2(L_0 + J_3)$$
$$\widetilde{I}[q] = \mathrm{tr}_{\mathcal{H}}(-1)^{2\widetilde{J}_3} e^{-\beta \widetilde{H}} q^{-2(J_3+\widetilde{J}_3)}$$

H has a continuum in the scaling limit; L_0 has a discrete spectrum. Localization gives **deformed Denef equations**:

$$\sum_{b\neq a} \frac{\kappa_{ab}}{2|z^*_{ab}|} - \partial_{3a} K(z_*) = 0$$



The centres lie on one axis; their ordering determines each contribution.

$$\widetilde{I}[q] = \frac{\sum_{z_*} \sigma(z_*)\, q^{-2J_3(z_*)}}{(q-q^{-1})^{N-1}}$$

$\sigma = \mathrm{sgn}\det(\partial_{z^a}\partial_{z^b}\widetilde{\Phi})$, with the centre of mass removed.
Isolated, non-degenerate fixed points.

THE LARGE-N REGIME

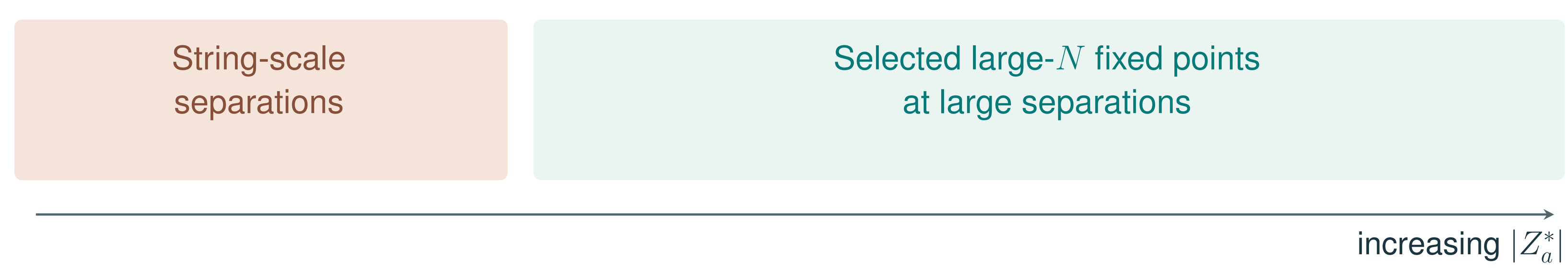
Selected fixed points lie at large separation

For cyclic Abelian quivers, keep the integer charge pairings fixed and select:

$$N \gg 1, \qquad \kappa_a > 0, \qquad \kappa_a = O(1)$$
$$J_3(z_*) = \frac{1}{2}\sum_a s_a \kappa_a = O(1) < 0$$

The conformal description is expected to be reliable for the selected solutions when

$$|Z^*_a| \gg 1 \qquad \textbf{for all } a$$



Control is sector-specific. The comparison does not assume that every fixed point is reliable.

Schematic regime diagram; no numerical data.
String units, $w = O(1)$, $\omega = 1$.

THE RESULT

A microscopic scaling contribution is recovered

$$\Omega_{\mathrm{scaling}}[q] = \Omega_{\mathrm{same}}[q] + \Omega_{\mathrm{uneq}}[q]$$

$$\widetilde{I}[q]\Big|_{N\gg 1,\ J_3=O(1)} = \Omega_{\mathrm{uneq}}[-q^{-1}]\Big|_{N\gg 1,\ J_3=O(1)}$$

The selected contribution matches the unequal-sign part of the microscopic scaling index of Beaujard, Mondal and Pioline [5].

This supports a role for conformal symmetry in the BPS scaling sector; the interpretation of the contributing states remains open.

$Z_a = z_a - z_{a+1}$, $Z_N = z_N - z_1$; $s_a = \mathrm{sgn}\, Z_a$; $\kappa_a = \kappa_{a,a+1}$ (cyclic); J_3: angular momentum; $\widetilde{J}_3$: fermionic-rotational symmetry; K: special conformal generator; q: fugacity.

WHAT REMAINS OPEN

Do these contributions include pure-Higgs states? Their identification remains unresolved. The Ω_{same} sector and more general quivers are further open directions.

SELECTED REFERENCES

[1] Denef, hep-th/0206072.
[2] Anninos et al., 1310.7929.
[3] Mirfendereski et al., 2009.07107.
[4] Manschot–Pioline–Sen, 1207.2230.
[5] Beaujard–Mondal–Pioline, 2103.03205.