

# Defect RG flows in 3d Chern-Simons-matter theory

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April, 2024

Based on [\[2211.16501\]](#), [\[2305.01647\]](#), [\[2312.13283\]](#)  
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# Overview

Motivation

ABJM theory

Circular WLs

Latitude WLs

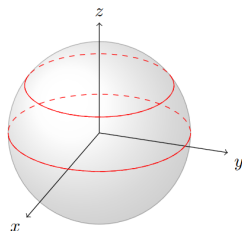
Outlook

# Motivation

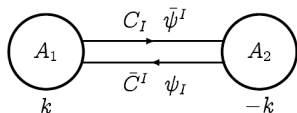
- Gauge symmetry + supersymmetry

$$W = \text{Tr} \mathcal{P} \exp \left[ i \oint_{\gamma} (A_{\mu} + \text{matter}) dx^{\mu} \right]$$

- 1d superconformal defects
  - superconformal bootstrap
- Localization  $\rightarrow$  computable exactly
- AdS/CFT  $\rightarrow$  mapped to fundamental strings
  - probe duality at weak and strong coupling
- Generalized symmetries



# ABJM theory



$$W = \text{Tr} \mathcal{P} \exp \left[ i \oint_{\gamma} (A_{\mu} + \text{matter}) dx^{\mu} \right]$$

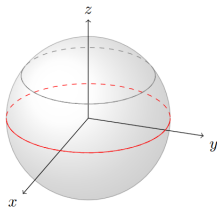
- Bosonic loops

$$W = \text{Tr} \mathcal{P} \exp \left[ i \oint (A_1 + \circ C \bar{C}) dt \right]$$

- Fermionic loops

$$W = \text{sTr} \mathcal{P} \exp \left[ i \oint \begin{pmatrix} A_1 + \circ C \bar{C} & \star \bar{\psi} \\ \Delta \psi & A_2 + \circ \bar{C} C \end{pmatrix} dt \right]$$

# Circular Wilson loops



- $\Delta, \circ, \dots$  such that susy is preserved
- new parametric representatives in ABJM and  $\mathcal{N} = 4$  CSM theories

[MT, N. Drukker, Z. Kong, G. Nagaoka, M. Probst, D. Trancanelli, M. Trepazier]

$$\begin{array}{ccc}
 & \mathcal{W}_{1/24}(\alpha_i, \bar{\alpha}^i, \beta^j, \bar{\beta}_j) & \\
 & \swarrow \quad \searrow & \\
 \mathcal{W}_{1/24}(\alpha_i, \bar{\alpha}^i, 0, 0) = \mathcal{W}_{1/6}^I(\alpha_i, \bar{\alpha}^i) & & \mathcal{W}_{1/24}(0, 0, \beta^j, \bar{\beta}_j) = \mathcal{W}_{1/6}^{II}(\beta^j, \bar{\beta}_j) \\
 \downarrow \bar{\alpha}^i \alpha_i = 1 & & \downarrow \beta^j \bar{\beta}_j = -1 \\
 \mathcal{W}_{1/2}^I & & \mathcal{W}_{1/2}^{II} \\
 & \swarrow \quad \searrow & \\
 & \mathcal{W}_{1/24}(0, 0, 0, 0) = \mathcal{W}_{1/6}^{\text{bos}} & 
 \end{array}$$

# Enriched flows

- $\Delta, \circ, \dots$  constrained & susy is preserved  $\Rightarrow$  Enriched flows

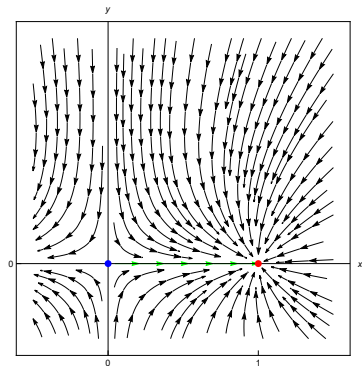
- $\langle W \rangle = f(\Delta, \circ, \dots)$

- non-trivial  $\beta$ -functions

$$\beta_x = \frac{N_1 + N_2}{k} (x^2 + y^2 - 1)x$$

- Susy RG flows connecting susy WLs

- g-theorem [G. Cuomo, Z. Komargodski, A. Raviv-Moshe]



$$g_{UV} > g_{IR}$$

# Defect flows

- $\Delta, \circ, \dots$  generic & susy is not necessarily preserved  $\Rightarrow$  Defect flows

- $\langle W \rangle = f(\Delta, \circ, \dots)$

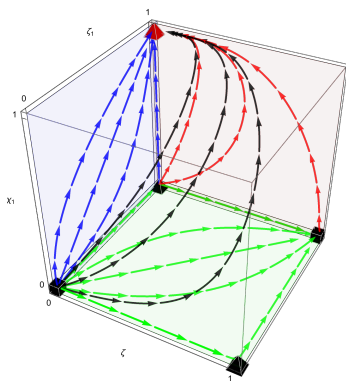
- non-trivial  $\beta$ -functions

$$\beta_{\chi_1} = \frac{N}{k}(\chi_1^2 - 1)\chi_1$$

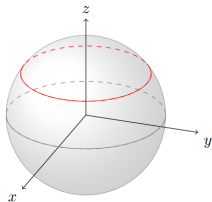
$$\beta_{\zeta_1} = \frac{N}{k}(\zeta_1 - 1 + \chi_1^2)\zeta_1$$

$$\beta_{\zeta} = \frac{N}{k}(\zeta(\zeta - 1 + \chi_1^2) - \chi_1^2)$$

- RG flows connecting WLs



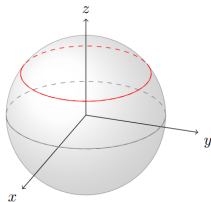
# Latitude Wilson loops



- Less parameters  $\Delta, \circ, \dots$  allowed
- Less supersymmetry preserved
- Non-trivial  $\beta$ -functions
- $\langle W_{\text{lat}} \rangle = f(\Delta, \circ, \dots)$  finite only once parameters are renormalized
- Universal information: energy radiated by an accelerated charged particle, Bremsstrahlung function  $B$



# Bremsstrahlung function



$$B \sim \frac{\partial}{\partial \theta} \log \langle W_{\text{lat}} \rangle \Big|_{\theta=0}$$



$$\langle W_{\text{cusp}} \rangle \sim \exp \left( -\Gamma_{\text{cusp}} \log \frac{\lambda}{\mu} \right)$$

$$B \sim \frac{\partial^2}{\partial \phi^2} \Gamma_{\text{cusp}} \Big|_{\phi=0}$$

- 1/12 and 1/6 BPS fixed points: "bosonic and fermionic latitude"
- Along the flow, prescriptions agree up to terms that are  $\propto \beta$ -function  
 $\Rightarrow$  Interpolating  $B$

# Outlook

- Cohomological equivalence
  - VEVs depend on  $\Delta, \circ, \dots$  while localization results do not
  - Framing  $\rightarrow$  perturbative results at generic framing [\[ongoing with M. Bianchi\]](#)
- Defect CFTs
  - Study multiplets and symmetries at the quantum level
  - Investigate the origin of the conformal anomaly driving the flow
- Gravity dual
  - Strong coupling description not completely known
  - Interpolating boundary conditions on  $\mathbb{CP}^3$ ? [\[D. Correa, G. Silva, A. Faraggi, et al.\]](#)

Thank you!