Holographic R-symmetric flows and the τ_U-conjecture

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Credits

Based on:

M. Bertolini, L. Di Pietro and FP

- arXiv:1304.1481

Intro & Motivations

- **Buican's conjecture**: in a 4d R-symmetric QFT one can define a quantity, τ_U, which *decreases along the RG-flow*. This puts a bound on the amount of accidental symmetries. [Buican '11]

- Via holography monotonic quantities are expected to correspond to monotonic functions of the extra coordinate in 'domain wall' geometries.

- Our aim is to explore the existence of a *monotonically decreasing function* in the context of 5d SUGRA, both to test the conjecture and to refine the holographic dictionary outside the conformal regime.

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$\mathcal{N} = 1$ 4d QFT preserving $U(1)_R$

In such theories one can always define an *R-multiplet* and often a *Ferrara-Zumino multiplet*

R-multiplet

$$\bar{D}^{\dot{\alpha}} \mathcal{R}_{\alpha\dot{\alpha}} = \chi_\alpha$$

$$\bar{D}_{\dot{\alpha}} \chi_\alpha = D^\alpha \chi_\alpha - \bar{D}_{\dot{\alpha}} \bar{\chi}^{\dot{\alpha}} = 0$$

Ferrara-Zumino

$$\bar{D}^{\dot{\alpha}} \mathcal{J}_{\alpha\dot{\alpha}} = D_\alpha X$$

$$\bar{D}_{\dot{\alpha}} X = 0$$

R-multiplet (II)

$$\bar{D}^{\dot{\alpha}} \mathcal{R}_{\alpha\dot{\alpha}} = \bar{D}^2 D_\alpha U$$

$$U^\dagger = U$$

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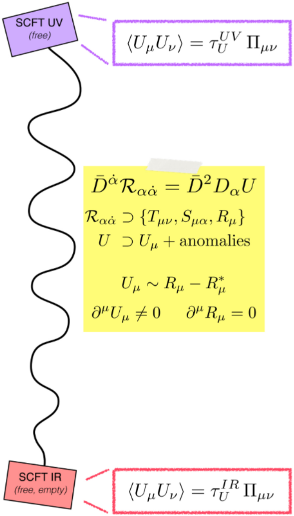
Superconformal limit

When the theory is superconformal

- There is a special conserved R-current R^*_μ that can be found by a-maximization.
- U becomes linear $D^2 U = \bar{D}^2 U = 0$: contains a conserved flavor current U_μ.
- $U_\mu = R_\mu - R^*_\mu$
- 2-point fns of conserved currents are fixed by CI up to a positive definite hermitian matrix

$$\left\langle J^I_\mu J^J_\nu \right\rangle = \tau^{IJ} \Pi_{\mu\nu}$$

The QFT conjecture



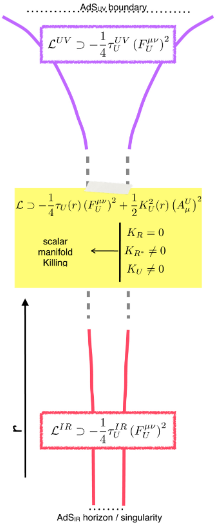
- **SCFT UV**: $U = R - R^*_{UV}$ is conserved.
- **UV + deformation**: R^*_{UV} and U are broken. One picks a particular R performing a-maximization within the subset of *preserved* R-symmetries.
- **SCFT IR**: $U = R - R^*_{IR}$ conserved. There can be accidental symmetries, if there are none $U = R - R^*_{IR} = 0$.

Dictionary

Boundary: $\mathscr{N}=1$ 4d QFT	Bulk: $\mathscr{N}=2$ 5d SUGRA
$\mathscr{R}^{*}_{\alpha\dot{\alpha}}$	$\{g, \Psi, A^{*}\}$ gravity multiplet
U	$\{q, \zeta\}+\{A, \lambda, \rho\}$ hyper+vector
currents J_{μ}	gauge fields A_{μ}
τ_{IJ}	gauge kinetic terms @ AdS cp's

Holographic picture

- **near boundary**: A^*, A^U massless gauge fields.
- **bulk**: A^U gets an r-dependent mass. Gauge kinetics terms also acquire a dependence on the extra coordinate.
- **near horizon**: A^U becomes again massless.



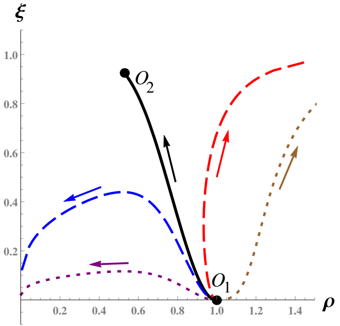
$\mathcal{N}=2$ 5d SUGRA with $U(1)\times U(1)_R$ gauging

The model

[Ceresole et al. '01]

- $\mathcal{N}=2$ SUGRA coupled to 1 hyper + 1 vector multiplets.
- Admits a two-parameter family of smooth AdS-to-AdS solns in addition to a large class of singular solns.

- All solutions have the same near boundary geometry, two scalars running, one massive vector in the bulk.
- singular solns of 2 kinds:
  - dual to confining gauge theories with mass gap
  - run into bad singularity [Gubser '00]



$\mathcal{N} = 2$ 5d SUGRA with $U(1) \times U(1)_R$ gauging

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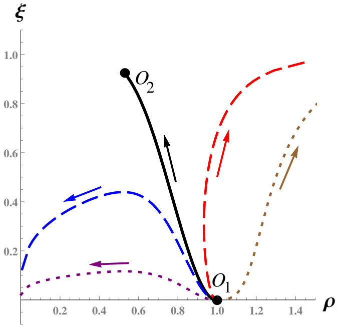

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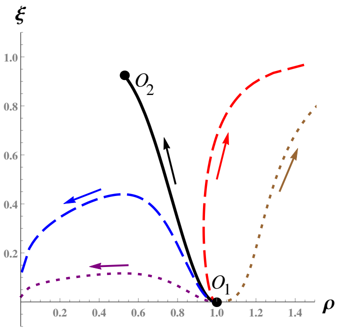

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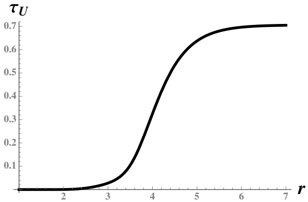

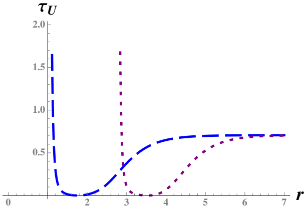

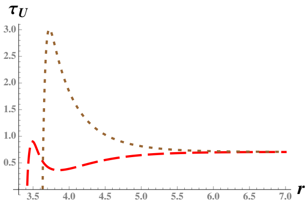

Ads-to-Ads

τ_U decreases monotonically to zero. As expected for the dual of RG-flow without emergent symmetries.

admissible sing.

τ_U is monotonic until it reaches zero. Below such point SUGRA approx. is no more reliable. Dual to confining theory with mass gap.

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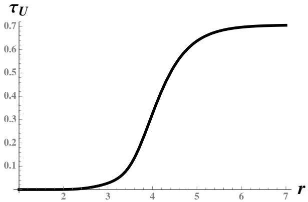

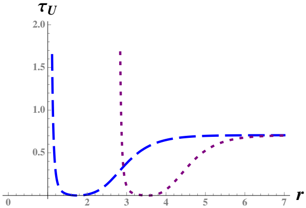

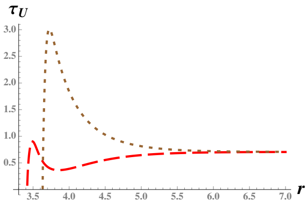

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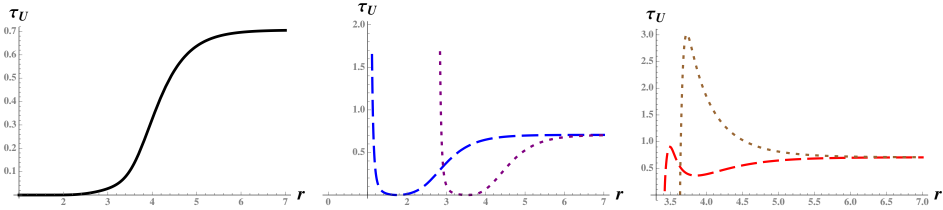

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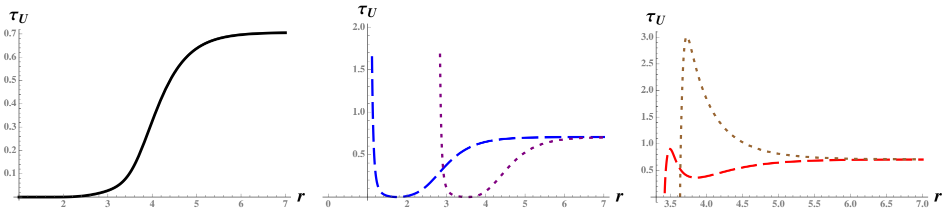

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- Tested our proposed τ_U-function in a simple set up: it works!

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Thank you!