Holographic Goldstino

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based on 1412.6499
w/ Argurio, Musso, Porri & Redigolo

[plus work in progress w/ Musso, Papadimitriou & Raj]

see also: 1205.4709, 1208.3615, 1304.1481, 1310.6897
w/ Argurio, Di Pietro, Porri & Redigolo

Motivations

- Spontaneously broken global symmetries leave universal fingerprints in the IR behavior of QFTs. In particular, Goldstone theorem ensures that massless modes should appear in IR spectrum.

- In supersymmetric QFTs with spontaneously broken supersymmetry, a massless Goldstino is expected.

- Goldstino appears as massless pole in supercurrent 2-point correlator. Pole residue is related to vacuum energy by specific supersymmetry Ward identities.

Motivations

- If QFT dynamics **strongly coupled** (e.g. DSB) things get hard → ***AdS/CFT*** provides a powerful tool, allowing a dual weakly coupled supergravity description.
- Need a complete control of the holographic map in the supercurrent sector, i.e. the **gravitino**. Not much so far for non-AdS bg (necessary condition for broken SUSY).
- ***Primary goal***: fill above gap + provide a holographic derivation of SUSY **Ward identities** and show, in turn, the appearance of **Goldstino** in theories which are inherently strongly coupled.

Supersymmetric RG-flows

- Let us consider 4d SQFTs described by RG-flows triggered by some relevant operator perturbing a strongly coupled UV fixed point. Most generally one can write

[Green et al. '10 + others]

$$\mathcal{L} = \mathcal{L}_{\mathbf{SCFT}} + \lambda \int \mathbf{d}^2\theta\, \mathcal{O} = \mathcal{L}_{\mathbf{SCFT}} + \lambda\, \mathcal{O}_{\mathbf{F}}$$

where $\mathcal{O} = \mathcal{O}_{\mathbf{S}} + \sqrt{\mathbf{2}}\theta\, \mathcal{O}_{\psi} + \theta^{\mathbf{2}}\mathcal{O}_{\mathbf{F}}$.

- The theory can flow to a SUSY or SUSY breaking vacuum, depending whether the operator $\mathcal{O}_{\mathbf{F}}$ acquires a VEV.

→ 1 & 2-point functions of supercurrent multiplet can tell!

- *Note*: we do not consider QFTs without an interacting UV-fixed point, e.g. cascading gauge theories as KS/KT or quiver embeddings of ISS-like models. [work in progress...]

Supercurrent multiplet

- The supercurrent multiplet, which contains the EM tensor and the SUSY current, can be described as (FZ multiplet)

Chiral superfield

$$(\mathcal{J}_\mu, \mathbf{X}) \qquad\qquad \sigma^\mu_{\alpha\dot\alpha}\,\overline{\mathbf{D}}^{\dot\alpha}\mathcal{J}_\mu = -\frac{\mathbf{1}}{\mathbf{2}}\mathbf{D}_\alpha\mathbf{X}$$

Real superfield

$$\mathcal{J}_\mu = \mathbf{j}_\mu + \theta\,\mathbf{S}_\mu + \bar\theta\,\bar{\mathbf{S}}_\mu + \theta\sigma^\nu\bar\theta\,\mathbf{2T}_{\mu\nu} + \dots$$

$$\mathbf{X} = \mathbf{x} + \frac{\mathbf{2}}{\mathbf{3}}\theta\,\mathbf{S} + \theta^{\mathbf{2}}\left(\frac{\mathbf{2}}{\mathbf{3}}\mathbf{T} + \mathbf{i}\,\partial^\mu\mathbf{j}_\mu\right) + \dots$$

- For a SCFT $\mathbf{X} = \mathbf{0}$. In our case, choosing without loss of generality $\mathbf{\Delta}_\mathcal{O} = \mathbf{2}$, we have $\mathbf{X} = \mathbf{4/3}\,\lambda\,\mathcal{O}$.

Supersymmetry Ward identities

- Regardless the vacuum, the SUSY algebra implies that the following Ward identities should hold

$$\langle \partial^\mu \mathbf{S}_{\mu\alpha}(\mathbf{x})\, \bar{\mathbf{S}}_{\nu\dot\beta}(\mathbf{0})\rangle = -\mathbf{2}\,\delta^4(\mathbf{x})\langle \delta_\alpha \bar{\mathbf{S}}_{\nu\dot\beta}\rangle = -\mathbf{2}\,\sigma^\mu_{\alpha\dot\beta}\langle \mathbf{T}_{\mu\nu}\rangle \delta^4(\mathbf{x})$$

$$\langle \partial^\mu \mathbf{S}_{\mu\alpha}(\mathbf{x})\, \mathcal{O}_{\psi_\beta}(\mathbf{0})\rangle = -\mathbf{2}\,\delta^4(\mathbf{x})\langle \delta_\alpha \mathcal{O}_{\psi_\beta}\rangle = \sqrt{\mathbf{2}}\,\langle \mathcal{O}_\mathbf{F}\rangle \delta^4(\mathbf{x})$$

- The Ward identities imply

$$\langle \mathbf{S}_{\mu\alpha}(\mathbf{x})\, \bar{\mathbf{S}}_{\nu\dot\beta}(\mathbf{0})\rangle = \ldots - \frac{\mathbf{i}}{\mathbf{4}\pi^\mathbf{2}}\langle \mathbf{T}\rangle (\sigma_\mu \bar\sigma^\rho \sigma_\nu)_{\alpha\dot\beta}\frac{\mathbf{x}_\rho}{\mathbf{x}^\mathbf{4}}$$

$$\langle \mathbf{S}_{\mu\alpha}(\mathbf{x})\, \mathcal{O}_{\psi_\beta}(\mathbf{0})\rangle = \ldots - \frac{\mathbf{i}}{\mathbf{2}\pi^\mathbf{2}}\sqrt{\mathbf{2}}\langle \mathcal{O}_\mathbf{F}\rangle \epsilon_{\alpha\beta}\frac{\mathbf{x}_\mu}{\mathbf{x}^\mathbf{4}}$$

[ARGURIO ET AL. '13]

Upon Fourier transform it displays the massless pole associated to Goldstino, which is the lowest energy excitation in $\mathbf{S}_\mu$: in IR $\mathbf{S}_\mu = \sigma_\mu \bar{\mathbf{G}}$.

Field/operator map

- The SQFT

$$\mathcal{L} = \mathcal{L}_{\mathbf{SCFT}} + \lambda \int \mathbf{d^2}\theta\, \mathcal{O}$$

can be described holographycally by 5d N=2 SUGRA coupled to one hypermultiplet (made of one hyperino ζ + two complex scalars ρ and ϕ)

- Since $\mathbf{\Delta}(\mathcal{O}) = \mathbf{2}$ dual bg is AAdS and $\mathbf{m}^{\mathbf{2}}_{(\rho,\phi)} = \mathbf{-4, -3}$.

$$\mathbf{ds^2} = \frac{\mathbf{1}}{\mathbf{z^2}}\left(\mathbf{F(z)dx^2 + dz^2}\right) \quad , \quad \mathbf{F(0) = 1}$$

$$\rho \sim \mathbf{z^2}(\mathbf{c}\log \mathbf{z} + \mathbf{d}) + \mathbf{O}(\mathbf{z^4}) \quad , \quad \phi \sim \mathbf{z}(\mathbf{a} + \mathbf{b}\mathbf{z^2}) + \mathbf{O}(\mathbf{z^5})$$

$\rho \longleftrightarrow \mathcal{O}_{\mathbf{S}}$ $\qquad$ $\phi \longleftrightarrow \mathcal{O}_{\mathbf{F}}$

$\mathbf{c} \longleftrightarrow$ source $\mathcal{O}_{\mathbf{S}}$ ~~(SUSY)~~ $\qquad$ $\mathbf{a} \longleftrightarrow$ source $\mathcal{O}_{\mathbf{F}}$ (SUSY)

$\mathbf{d} \longleftrightarrow$ VEV $\mathcal{O}_{\mathbf{S}}$ (SUSY) $\qquad$ $\mathbf{b} \longleftrightarrow$ VEV $\mathcal{O}_{\mathbf{F}}$ ~~(SUSY)~~

Supergravity model

- The model we consider is N=2 SUGRA coupled to one hypermultiplet with σ-model metric $\frac{\mathbf{SU(2,1)}}{\mathbf{U(1)\times SU(2)}}$ of which graviphoton gauges a $\mathbf{U(1)}$ isometry.

[CERESOLE ET AL. '01]

- One can choose a gauging for which the two complex hyperscalars (ρ, ϕ) have $\mathbf{m^2 = -4, -3}$. We further truncate the action to $\rho = \mathbf{0}$ and take ϕ real. Bosonic action becomes

$$\mathbf{S}^{\mathrm{B}}_{5\mathrm{D}} = \int \mathbf{d^5x}\,\sqrt{-\mathbf{G}}\left\{\frac{\mathbf{1}}{\mathbf{2}}\mathbf{R} - \partial_{\mathbf{M}}\phi\,\partial^{\mathbf{M}}\phi - \mathbf{U}(\phi)\right\}$$

$$\mathbf{U}(\phi) = \frac{\mathbf{1}}{\mathbf{12}}(\mathbf{10} - \cosh(\mathbf{2}\phi))^{\mathbf{2}} - \frac{\mathbf{51}}{\mathbf{4}}$$

- We look for AAdS solutions preserving 4d Poincare' invariance, hence we require $\phi = \phi(\mathbf{z})$.

Supergravity model

- SUSY solutions

$$\phi(\mathbf{z}) = \frac{\mathbf{1}}{\mathbf{2}} \log\left(\frac{\mathbf{1}+\mathbf{az}}{\mathbf{1}-\mathbf{az}}\right) \;, \quad \mathbf{F}(\mathbf{z}) = \left(\mathbf{1}-\mathbf{a}^2\mathbf{z}^2\right)^{\mathbf{1/3}}$$

- SUSY breaking solutions

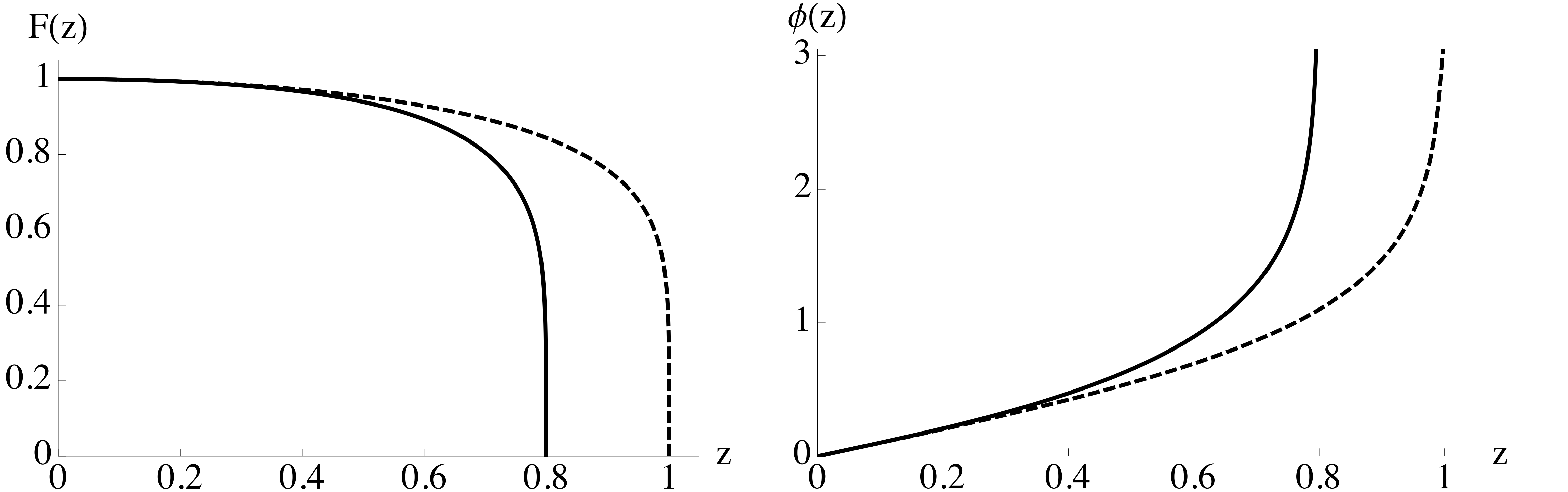
$$\phi(\mathbf{z}) = \mathbf{a}\,\mathbf{z} + \mathbf{b}\,\mathbf{z}^3 + \mathbf{O}(\mathbf{z}^5)$$

$$\mathbf{F}(\mathbf{z}) = \mathbf{1} - \frac{\mathbf{a}^2}{\mathbf{3}}\mathbf{z}^2 + \frac{\mathbf{a}^4 - \mathbf{9ab}}{\mathbf{18}}\mathbf{z}^4 + \mathbf{O}(\mathbf{z}^6)$$

- *Note*: $\mathbf{b} = \mathbf{a}^3/\mathbf{3}$ is the SUSY solution → $\beta = \mathbf{a}^3/\mathbf{3} - \mathbf{b}$ is SUSY breaking parameter (related to VEV of $\mathcal{O}_\mathbf{F}$).
- *Comment*: all solutions are singular. But remarkably, this won't affect final results!

Supergravity model

- The BPS and ~~SUSY~~ solutions for the warp factor $\mathbf{F}$ and the scalar ϕ look



where dashed line is the BPS solutions and solid line the ~~SUSY~~ ones (parameters are $\mathbf{a} = \mathbf{1}$ and $\beta = \mathbf{0}, -\mathbf{2/3}$).

AdS/CFT & Hol. Renormalization

- QFT correlators are computed in AdS/CFT as

$$\langle \mathcal{O}(\mathbf{x_1}) \dots \mathcal{O}(\mathbf{x_n}) \rangle = \frac{\delta^{\mathbf{n}} \mathbf{S}_{\text{on-shell}}}{\delta \phi_{\mathbf{0}}(\mathbf{x_1}) \dots \delta \phi_{\mathbf{0}}(\mathbf{x_n})} |_{\phi_{\mathbf{0}}=\mathbf{0}}$$

- $\mathbf{S}_{\text{on-shell}}$ diverges at $\mathbf{z} = \mathbf{0}$ (because of the infinite volume of (A)AdS space) and should then be holographycally renormalized. [Bianchi-Freedman-Skenderis '01a]

- → Regularize the action at $\mathbf{z} = \epsilon$, add a 4d covariant counter-term action $\mathbf{S}_{\text{c.t.}}$ and define a renormalized action

$$\mathbf{S}_{\text{ren}} = \lim_{\epsilon \to \mathbf{0}} \left(\mathbf{S}_{\text{on-shell}}[\epsilon] + \mathbf{S}_{\text{c.t.}}[\epsilon] \right)$$

- ***Note***: in general $\mathbf{S}_{\text{c.t.}}$ provides extra finite terms, which corresponds to arbitrariness in renormalization scheme.

Hol Ren: Bosonic sector

- Have to evaluate 1-pt functions only → focus on on-shell action at linear order in the fluctuations of metric and scalar

$$\phi = \phi(\mathbf{z}) + \varphi(\mathbf{z},\mathbf{x})$$

$$\mathbf{ds^2} = \frac{\mathbf{1}}{\mathbf{z^2}}\left[\mathbf{dz^2} + \mathbf{F}(\mathbf{z})\left(\eta_{\mu\nu} + \mathbf{h}_{\mu\nu}(\mathbf{z},\mathbf{x})\right)\mathbf{dx}^\mu\mathbf{dx}^\nu\right]$$

where we fixed the gauge $\mathbf{h_{zz}} = \mathbf{h}_{\mu\mathbf{z}} = \mathbf{0}$ and we decompose the metric as

$$\mathbf{h}_{\mu\nu} = \mathbf{h}^{\mathbf{tt}}_{\mu\nu} + \eta_{\mu\nu}\mathbf{h} + \partial_{(\mu}\mathbf{H}_{\nu)}$$

- Evaluating the on-shell SUGRA action

$$\mathbf{S} = \mathbf{S}^{\mathrm{B}}_{5\mathrm{D}} + \mathbf{S}_{\mathrm{GH}} \quad , \quad \mathbf{S}_{\mathrm{GH}} = \int \mathbf{d^4x}\sqrt{-\mathbf{g}}\,\mathcal{K}$$

one gets a boundary term, only.

Hol Ren: Bosonic sector

- The boundary action (to linear order) reads

$$\mathbf{S}^{\mathrm{B}}_{\mathrm{bdy}} = \int \mathbf{d^4x}\sqrt{-\mathbf{g}}\left[\left(\mathbf{3} - \frac{\mathbf{3zF'}}{\mathbf{2F}}\right)(\mathbf{1} + \mathbf{2h} + \dots) + \mathbf{2z}\phi'\varphi\right]$$

$\mathbf{F^2/z^4}$

- $\mathbf{S}^{\mathrm{B}}_{\mathrm{bdy}}$ diverges at $\mathbf{z} = \mathbf{0}$. The (SUSY preserving scheme) c.t. action is [Bianchi-Freedman-Skenderis '01b + others]

$$\mathbf{S}^{\mathrm{B}}_{\mathrm{c.t.}} = -\int_{\mathbf{z}=\epsilon} \mathbf{d^4x}\sqrt{-\mathbf{g}}\,\mathbf{3}\,\mathbf{W}(\phi + \varphi)$$

with $\mathbf{W}$ the SUGRA superpotential evaluated at the bdy.

- The end result is

$$\mathbf{S}^{\mathrm{B}}_{\mathrm{ren}} = -\int \mathbf{d^4x}\ [\mathbf{a}\beta\,(\mathbf{1} + \mathbf{2h_0} + \dots) + \mathbf{4}\beta\varphi_\mathbf{0}]$$

Consistently, the renormalized action vanishes for $\beta = \mathbf{0}$.

Hol Ren: Fermionic sector

- As for the fermions, we need to work at quadratic order

$$\mathbf{S^F_{5D}} = \int \mathbf{d^5x\sqrt{-G}} \Big\{ -\mathbf{\bar\Psi_M \Gamma^{MNP} D_N \Psi_P} - \mathbf{2}\,\bar\zeta \mathbf{\Gamma^M D_M}\zeta$$
$$+\mathbf{i}\partial_\mathbf{N}\phi\,(\bar\zeta\mathbf{\Gamma^M\Gamma^N\Psi_M} - \mathbf{\bar\Psi_M\Gamma^N\Gamma^M}\zeta) - \mathbf{2}\,\mathcal{M}(\phi)\,\bar\zeta\zeta$$
$$+\mathbf{2}\,\mathcal{N}(\phi)\,(\mathbf{\bar\Psi_M\Gamma^M}\zeta + \bar\zeta\mathbf{\Gamma^M\Psi_M}) + \mathbf{m}(\phi)\,\mathbf{\bar\Psi_M\Gamma^{MN}\Psi_N}\Big\}$$

- In AAdS space has to be supplemented by a bdy term, to make it stationary on the EOM.We get

$$\mathbf{S^F_{bdy}} = \int \mathbf{d^4x\sqrt{-g}} \left\{ -\frac{\mathbf{1}}{\mathbf{2}}\mathbf{\bar\Psi_m\Gamma^{mn}\Psi_n} - \bar\zeta\zeta \right\}$$

- We work in axial gauge $\mathbf{\Psi_z = 0}$ and split the gravitino as

$$\mathbf{\Psi_m} = \psi^\mathbf{tt}_\mathbf{m} + \partial_\mathbf{m}\vartheta + \mathbf{\Gamma_m}\chi$$

→ EOM for $\psi^\mathbf{tt}_\mathbf{m}$ decouple, those for ϑ and χ coupled to ζ.

Hol Ren: Fermionic sector

- The bulk action vanishes on-shell, only bdy term matters ... and diverges. The action has ϵ^{-2} and $\log\epsilon$ divergent terms and should be holographycally renormalized. The counter-term action is

$$\mathbf{S}^{\mathrm{F}}_{\mathrm{c.t.}} = \int_{\mathbf{z}=\epsilon} \mathbf{d^4x}\sqrt{-\mathbf{g}}\Big\{ \frac{\mathbf{1}}{\mathbf{2}} \bar{\mathbf{\Psi}}_{\mathbf{m}}\mathbf{\Gamma}^{\mathbf{mrn}}\partial_{\mathbf{r}}\mathbf{\Psi}_{\mathbf{n}} + \log\epsilon\Big[-\mathbf{2}\bar{\zeta}\,\partial\!\!\!/\,\zeta - \frac{\mathbf{1}}{\mathbf{4}}\bar{\mathbf{\Psi}}_{\mathbf{m}}\mathbf{\Gamma}^{\mathbf{mrn}}\Box\,\partial_{\mathbf{r}}\mathbf{\Psi}_{\mathbf{n}} + \frac{\mathbf{1}}{\mathbf{3}}\phi^{\mathbf{2}}\bar{\mathbf{\Psi}}_{\mathbf{m}}\mathbf{\Gamma}^{\mathbf{mnr}}\partial_{\mathbf{r}}\mathbf{\Psi}_{\mathbf{n}} - \frac{\mathbf{1}}{\mathbf{6}}\big(\partial_{\mathbf{n}}\bar{\mathbf{\Psi}}_{\mathbf{m}}\mathbf{\Gamma}^{\mathbf{mn}}\big)\partial\!\!\!/\big(\mathbf{\Gamma}^{\mathbf{rs}}\partial_{\mathbf{r}}\mathbf{\Psi}_{\mathbf{s}}\big) - \frac{\mathbf{2}}{\mathbf{3}}\,\mathbf{i}\,\phi\,[\bar{\zeta}(\mathbf{\Gamma}^{\mathbf{rs}}\partial_{\mathbf{r}}\mathbf{\Psi}_{\mathbf{s}}) - (\partial_{\mathbf{n}}\bar{\mathbf{\Psi}}_{\mathbf{m}}\mathbf{\Gamma}^{\mathbf{mn}})\zeta]\Big]\Big\}$$

where $\mathbf{m},\mathbf{n},\ldots$ 4d curved indices.

Hol Ren: Fermionic sector

- The end result for the renormalized action is

$$\mathbf{S}^{\mathrm{F}}_{\mathrm{ren}} = \int \mathbf{d^4x}\Big\{\mathbf{i}\frac{\beta\mathbf{a}}{\mathbf{2}}\,\bar{\vartheta}_{\mathbf{0}}\,\partial\!\!\!/\,\vartheta_{\mathbf{0}} + \mathbf{2}\beta\vartheta_{\mathbf{0}}(\mathbf{i}\zeta_{\mathbf{0}} + \mathbf{a}\chi_{\mathbf{0}})$$

$$-\mathbf{2}\beta\bar{\vartheta}_{\mathbf{0}}(\mathbf{i}\bar{\zeta}_{\mathbf{0}} - \mathbf{a}\,\bar{\chi}_{\mathbf{0}}) + \text{non-local} + \text{scheme-dep}\Big\}$$

where $\zeta_{\mathbf{0}}$, $\vartheta_{\mathbf{0}}$ and $\chi_{\mathbf{0}}$ are bdy leading modes of hyperino and gravitino, resp.

- ***Note***: local dependence of ***all*** subleading modes on leading ones can be uniquely fixed ***just*** by near boundary analysis + on-shell SUSY invariance of EOM! In particular we find

$$\tilde{\zeta}_{\mathbf{1}} = -\mathbf{i}\beta\vartheta_{\mathbf{0}} + \partial\!\!\!/\,\mathbf{f}(\Box)(\bar{\zeta}_{\mathbf{0}} + \mathbf{ia}\bar{\chi}_{\mathbf{0}}) + \bar{\mathbf{f}}(\Box)\mathbf{a}(\zeta_{\mathbf{0}} - \mathbf{ia}\chi_{\mathbf{0}})^{\mathbf{T}}$$

Holographic Ward identities

- The field/operator map can be read from couplings between FZ and $\mathcal{O}$ multiplets with bulk fields at the boundary. This is

$$\int \mathbf{d^4x} \left[\frac{\mathbf{1}}{\mathbf{2}} \mathbf{h_0^{\mu\nu} T_{\mu\nu}} + \frac{\mathbf{1}}{\mathbf{2}} (\mathbf{i \Psi_0^{\mu} S_{\mu} + c.c.}) + \right.$$

$$\left. + \mathbf{2}\,(\varphi_\mathbf{0} \mathcal{O}_\mathbf{F} + \mathbf{c.c.}) - \sqrt{\mathbf{2}}\,(\mathbf{i}\,\zeta_\mathbf{0} \mathcal{O}_\psi + \mathbf{c.c.}) + \ldots \right]$$

which gives

$$\mathbf{h_0^{\mu\nu}} \longleftrightarrow \frac{\mathbf{1}}{\mathbf{2}} \mathbf{T}_{\mu\nu} \quad , \quad \mathbf{\Psi_0^{\mu\alpha}} \longleftrightarrow \frac{\mathbf{i}}{\mathbf{2}} \mathbf{S}_{\mu\alpha}$$

$$\varphi_\mathbf{0} \longleftrightarrow \mathbf{2}\,\mathcal{O}_\mathbf{F} \quad , \quad \zeta_\mathbf{0}^{\alpha} \longleftrightarrow -\mathbf{i}\sqrt{\mathbf{2}}\,\mathcal{O}_{\psi\,\alpha}$$

- As far as gravitational sector, the relevant maps hence is

$$\mathbf{h_0} \longleftrightarrow \frac{\mathbf{1}}{\mathbf{2}} \mathbf{T} \quad , \quad \vartheta_\mathbf{0}^{\alpha} \longleftrightarrow -\frac{\mathbf{i}}{\mathbf{2}} \partial^{\mu} \mathbf{S}_{\mu\alpha} \quad , \quad \bar{\chi}_{\mathbf{0}\dot{\alpha}} \longleftrightarrow \frac{\mathbf{1}}{\mathbf{2}} \bar{\sigma}^{\mu\dot{\alpha}\alpha} \mathbf{S}_{\mu\alpha}$$

Holographic Ward identities

- Using AdS/CFT prescription, from $\mathbf{S}^{\rm B}_{\rm ren}$ we get

$$\langle \mathbf{T}\rangle = \mathbf{2}\frac{\delta \mathbf{S}^{\mathbf{B}}_{\mathbf{ren}}}{\delta \mathbf{h_0}} = -\mathbf{4}\beta\mathbf{a}\,,\ \ \langle \mathcal{O}_{\mathbf{F}}\rangle = \frac{\mathbf{1}}{\mathbf{2}}\,\frac{\delta \mathbf{S}^{\mathbf{B}}_{\mathbf{ren}}}{\delta \varphi_{\mathbf{0}}} = -\mathbf{2}\,\beta$$

and from $\mathbf{S}^{\rm F}_{\rm ren}$

$$\langle \partial^\mu \mathbf{S}_{\mu\alpha}(\sigma^\nu \bar{\mathbf{S}}_\nu)_\beta\rangle = -\mathbf{4}\,\frac{\delta^{\mathbf{2}}\mathbf{S}^{\rm F}_{\rm ren}}{\delta\vartheta^\alpha_{\mathbf{0}}\delta\chi^\beta_{\mathbf{0}}} = -\mathbf{8}\beta\mathbf{a}\,\varepsilon_{\alpha\beta}$$

$$\langle \partial^\mu \mathbf{S}_{\mu\alpha}\ \mathcal{O}_{\psi\beta}\rangle = \sqrt{\mathbf{2}}\mathbf{i}\,\frac{\delta^{\mathbf{2}}\mathbf{S}^{\rm F}_{\rm ren}}{\delta\vartheta^\alpha_{\mathbf{0}}\delta\zeta^\beta_{\mathbf{0}}} = -\mathbf{2}\sqrt{\mathbf{2}}\,\beta\,\varepsilon_{\alpha\beta}$$

which exactly reproduce the QFT Ward identities!

- ***Note***: dependence of $\mathbf{S}^{\rm F}_{\rm ren}$ on combination $\mathbf{i}\zeta_{\mathbf{0}} + \mathbf{a}\chi_{\mathbf{0}}$ provides holographic derivation of QFT identity $\sigma^\mu\bar{\mathbf{S}}_\mu = \mathbf{2}\sqrt{\mathbf{2}}\lambda\mathcal{O}_\psi$. Corresponding bosonic operator identity from $\mathbf{S}^{\rm B}_{\rm ren}$, too.

Summary

- We provided a holographic description of a general class of SQFT where SUSY is broken at strong coupling.
- Performing holographic renormalization in the gravitino sector, we have recovered a set of Ward identities, which encodes the presence of the Goldstino mode. Non-trivial check of AdS/CFT!
- Focus was on a prototype model, but results have wider applicability → *Notice*: relevant contact terms do not depend on deep interior, or on nature of IR singularity. This is consistent with QFT expectations!

Outlook

- Short-term goal:
  - Repeat the analysis for non-AAdS backgrounds, where QFT ~~SUSY~~ vacua arise due to strong coupling dynamics (like in cascading theories, cfr. KS, quiver completions of ISS-like models, ...).

    [work in progress w/ Musso-Papadimitriou&Raj]
- Longer-term goals:
  - Full control on fermionic sector, in particular gravitino's, could allow for holographic derivation of Goldstino effective action.

    [cfr. Komargodski-Seiberg '09, Hoyos et al. '13]
  - Thorough study of stability properties of e.g. proposed SUSY breaking (string theory) vacua.

    [cfr. Argurio-Musso-Redigolo '14]