Gauged SDFT and stable de Sitter in $d = 7$

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Based on 1505.01301: W. Cho, J.J. FM, I. Jeon, J.-H. Park (JHEP 2015)

1506.01294: G. Dibitetto, J.J. FM, D. Marqués (sub. JHEP 2015)

Duality symmetries in String and M-Theories
August 10, 2015

Our goals

- Goal 1: DFT from relaxed (SC) gauge principle. Uniqueness of the action upon what symmetries?

  Cho,FM,Jeon,Park'15

  - Generalised diffeomorphisms
  - Double Lorentz transformations
  - O(D,D)
  - ... SUSY?

- Goal 2: Half-maximal $d = 7$: natural continuation of previous results

  Dibitetto,FM,Marqués'15

  - Classification of deformations
  - Vacua
  - Mass spectrum

Outline

1. Twisted supersymmetric DFT (SDFT) [Cho,Jeon,FM,Park]
   - Relaxation approaches
   - Untwisted SDFT
   - Twisting
2. Stable de Sitter in half-maximal $d = 7$ [Dibitetto,FM,Marqués]
3. Conclusions

Outline

1. Twisted supersymmetric DFT (SDFT) [Cho,Jeon,FM,Park]
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2. Stable de Sitter in half-maximal $d = 7$ [Dibitetto,FM,Marqués]

3. Conclusions

Geometric formulation

Jeon...'11, Hohm...'11, Hohm...'12

- $\mathcal{S}_{\mathrm{DFT}}(\mathcal{H}_{AB}, d)$ as a curvature: S_{ABCD}
- Non-vanishing scalar curvatures

$$S_{ABCD}\left\{ \quad \mathcal{H}^{AC}\mathcal{H}^{BD} \quad , \qquad \mathcal{J}^{AC}\mathcal{J}^{BD}\right\}$$

- Upon SC:

$$S_{ABCD}\mathcal{J}^{AC}\mathcal{J}^{BD} = -S_{ABCD}\mathcal{H}^{AC}\mathcal{H}^{BD}$$

- [DFT + SC] lacks some $O(d,d)$ gaugings

Aldazabal. . . '11,Geissbühler'11

- Relaxation of the SC?

Relaxation of the SC

Aldazabal. . . '11, Geissbühler'11, Graña. . . '12, Geissbühler. . . '13, Berman. . . '13

- Lower-dim SC stronger than quadratic constraints in half-maximal SUGRA
- $\mathcal{S}_{\text{DFT}}$+SC-terms
- $\mathcal{G}_{ABCD} = [S + \Delta]_{ABCD}$
- Geometric approaches $\qquad \Delta = \Delta({E_A}^M)$
  - Weitzenböck connection
  - Generalised flux formulation
  - $\mathcal{G}_{ABCD}(\alpha \mathcal{H}^{AC}\mathcal{H}^{BD} + \beta \mathcal{J}^{AC}\mathcal{J}^{BD})$ such that half-max SUGRA
- DFT action fixed by first principles?

Supersymmetric theories

- $N = 1$ SDFT — Siegel'93, Hohm...'12, Jeon...'12, Berman...'13

$$\{ \quad d\,, \quad V_{Ap}\,, \quad \bar{V}_{A\bar{p}}\,, \quad \rho^{\alpha}\,, \quad \psi^{\alpha}_{\bar{p}} \quad \}$$

- $N = 2$ SDFT — Jeon...'12

$$\{ \quad d\,, \quad V_{Ap}\,, \quad \bar{V}_{A\bar{p}}\,, \quad \mathcal{C}^{\alpha}{}_{\bar{\alpha}}\,, \quad \rho^{\alpha}\,, \quad \rho'^{\bar{\alpha}}\,, \quad \psi^{\alpha}_{\bar{p}}\,, \quad \psi'^{\bar{\alpha}}_{p} \quad \}$$

- Symmetries:
  - O(10,10)
  - Generalised diffeo's
  - Spin(1,9)×Spin(9,1)
  - SUSY

SDFT - $\{V, \bar{V}\}$

- Double vielbein formalism — Siegel, Hohm. . . , Jeon. . .

$$V_{Ap}V^{A}{}_{q} = \eta_{pq}\,, \qquad \bar{V}_{A\bar{p}}\bar{V}^{A}{}_{\bar{q}} = \bar{\eta}_{\bar{p}\bar{q}}\,,$$
$$V_{Ap}\bar{V}^{A}{}_{\bar{q}} = 0\,, \qquad V_{Ap}V_{B}{}^{p} + \bar{V}_{A\bar{p}}\bar{V}_{B}{}^{\bar{p}} = \mathcal{J}_{AB}\,.$$

- Projectors $\qquad P_{AB} = V_{A}{}^{p}V_{Bp} \qquad \bar{P}_{AB} = \bar{V}_{A}{}^{\bar{p}}\bar{V}_{B\bar{p}}$

- $\mathcal{D} = \partial + \Gamma + \Phi + \bar{\Phi} \qquad \mathcal{D}\left\{V_{Ap}\,, \quad \bar{V}_{A\bar{p}}\,, \quad d\,, \quad \mathcal{J}_{AB}\right\} = 0$

- Connections

$\Gamma_{CAB}(V, \bar{V}, d)$	Christoffel
$\Phi_{Apq}(V, \bar{V}, d)$	Spin(1,9)
$\bar{\Phi}_{A\bar{p}\bar{q}}(V, \bar{V}, d)$	Spin(9,1)

SDFT - $\{V, \bar{V}\}$

- Field strengths

$$S_{ABCD} = \tfrac{1}{2}\left(R_{ABCD} + R_{CDAB} - \Gamma^{E}{}_{AB}\Gamma_{ECD}\right)$$

$$\mathcal{F}_{ABCD} = 2\nabla_{[A}\Phi_{B]CD} - 2\Phi_{[A|C}{}^{E}\Phi_{|B]ED}$$

$$\bar{\mathcal{F}}_{ABCD} = 2\nabla_{[A}\bar{\Phi}_{B]CD} - 2\bar{\Phi}_{[A|C}{}^{E}\bar{\Phi}_{|B]ED}$$

$$\begin{aligned}\mathcal{G}_{ABCD} &= \tfrac{1}{2}\left[(\mathcal{F}+\bar{\mathcal{F}})_{ABCD} + (\mathcal{F}+\bar{\mathcal{F}})_{CDAB} + (\Phi+\bar{\Phi})^{E}{}_{AB}(\Phi+\bar{\Phi})_{ECD}\right] \\ &= S_{ABCD} + \tfrac{1}{2}(V_{A}{}^{p}\partial_{E}V_{Bp} + \bar{V}_{A}{}^{\bar{p}}\partial_{E}\bar{V}_{B\bar{p}})(V_{C}{}^{q}\partial^{E}V_{Dq} + \bar{V}_{C}{}^{\bar{q}}\partial^{E}\bar{V}_{D\bar{q}})\end{aligned}$$

- $(\delta_X - \mathcal{L}_X)\mathcal{G}_{ABCD} \sim (\delta_X - \mathcal{L}_X)S_{ABCD} \sim 0$
- Non-vanishing Ricci $\quad \mathcal{G}_{pr\bar{q}}{}^{r} \quad \mathcal{G}_{p\bar{r}\bar{q}}{}^{\bar{r}}$
- Non-vanishing scalar curvatures

$$\mathcal{G}_{pq}{}^{pq} \qquad \mathcal{G}_{\bar{p}\bar{q}}{}^{\bar{p}\bar{q}}$$

SDFT - RR sector

- O(10,10) scalar bispinor

$$\mathcal{C}^{\alpha}{}_{\bar{\beta}} \qquad \longrightarrow \qquad \mathcal{F} := \mathcal{D}_{+}\mathcal{C} \qquad\qquad \bar{\mathcal{F}} := \bar{C}_{+}^{-1}(\mathcal{F})^{T} C_{+}$$

where

$$\mathcal{D}_{\pm}\mathcal{T} := \gamma^{p}\mathcal{D}_{p}\mathcal{T} \pm \gamma^{(11)}\mathcal{D}_{\bar{p}}\mathcal{T}\bar{\gamma}^{\bar{p}}$$

- Gauge invariance upon nilpotency of $\mathcal{D}_{+}$

$$\delta\mathcal{C} = \mathcal{D}_{+}\Lambda \quad \longrightarrow \qquad\qquad \delta\mathcal{F} = (\mathcal{D}_{+})^{2}\Lambda \sim 0$$

- Nilpotency upon strong constraint

$$(\mathcal{D}_{\pm})^{2}\mathcal{T} \sim 0$$

Twisting

- Twisted fields

$$T_{A_1\cdots A_n}(X,Y) = e^{-2\omega\lambda(Y)} U_{A_1}{}^{\dot{A}_1}(Y)\cdots U_{A_n}{}^{\dot{A}_n}(Y)\dot{T}_{\dot{A}_1\cdots\dot{A}_n}(X)$$

- Twisting derivatives

$$\partial_C T_{A_1\cdots A_n} = e^{-2\omega\lambda} U_C{}^{\dot{C}} U_{A_1}{}^{\dot{A}_1}\cdots U_{A_n}{}^{\dot{A}_n}\dot{D}_{\dot{C}}\dot{T}_{\dot{A}_1\cdots\dot{A}_n}$$

where

$$\dot{D}_{\dot{C}}\dot{T}_{\dot{A}_1\cdots\dot{A}_n} := \dot{\partial}_{\dot{C}}\dot{T}_{\dot{A}_1\cdots\dot{A}_n} - 2\omega\dot{\partial}_{\dot{C}}\lambda\,\dot{T}_{\dot{A}_1\cdots\dot{A}_n} + \sum_{i=1}^{n}\Omega_{\dot{C}\dot{A}_i}{}^{\dot{B}}\dot{T}_{\dot{A}_1\cdots\dot{B}\cdots\dot{A}_n}$$

$$\dot{\partial}_{\dot{C}} := (U^{-1})_{\dot{C}}{}^{C}\partial_C \qquad \Omega_{\dot{C}\dot{A}}{}^{\dot{B}} := \left(U^{-1}\dot{\partial}_{\dot{C}}U\right)_{\dot{A}}{}^{\dot{B}}$$

- We define

$$f_{\dot{A}\dot{B}\dot{C}} := 3\Omega_{[\dot{A}\dot{B}\dot{C}]} \qquad f_{\dot{A}} := \Omega^{\dot{B}}{}_{\dot{B}\dot{A}} - 2\dot{\partial}_{\dot{A}}\lambda$$

Consistency/twistability conditions

- Twisted $\dot{\mathcal{L}}_{\dot{X}}$

$$\dot{\mathcal{L}}_{\dot{X}}\,\dot{T}_{\dot{A}_1\cdots\dot{A}_n} = e^{2\omega\lambda}(U^{-1})_{\dot{A}_1}{}^{A_1}\cdots(U^{-1})_{\dot{A}_n}{}^{A_n}\,\mathcal{L}_X\,T_{A_1\cdots A_n}$$

$$= \dot{X}^{\dot{B}}\dot{D}_{\dot{B}}\,\dot{T}_{\dot{A}_1\cdots\dot{A}_n} + \omega\dot{D}_{\dot{B}}\dot{X}^{\dot{B}}\,\dot{T}_{\dot{A}_1\cdots\dot{A}_n} + \sum_{i=1}^{n}(\dot{D}_{\dot{A}_i}\dot{X}_{\dot{B}} - \dot{D}_{\dot{B}}\dot{X}_{\dot{A}_i})\,\dot{T}_{\dot{A}_1\cdots\dot{A}_{i-1}}{}^{\dot{B}}{}_{\dot{A}_{i+1}\cdots\dot{A}_n}$$

- Twisted C-bracket

$$[\dot{X},\dot{Y}]^{\dot{A}}_{\dot{\mathrm{C}}} = (U^{-1})_{\dot{A}}{}^{A}[X,Y]^{A}_{\mathrm{C}}$$

$$= \dot{X}^{\dot{B}}\dot{D}_{\dot{B}}\dot{Y}^{\dot{A}} - \dot{Y}^{\dot{B}}\dot{D}_{\dot{B}}\dot{X}^{\dot{A}} + \tfrac{1}{2}\dot{Y}^{\dot{B}}\dot{D}^{\dot{A}}\dot{X}_{\dot{B}} - \tfrac{1}{2}\dot{X}^{\dot{B}}\dot{D}^{\dot{A}}\dot{Y}_{\dot{B}}$$

- Closure of the algebra

$$\left([\dot{\mathcal{L}}_{\dot{X}},\dot{\mathcal{L}}_{\dot{Y}}] - \dot{\mathcal{L}}_{[\dot{X},\dot{Y}]_{\dot{\mathrm{C}}}}\right)\dot{T}_{\dot{A}_1\cdots\dot{A}_n} \neq 0$$

Closure conditions

Graña-Marqués'12

- SC for all the dotted twisted fields,

$$\dot{\partial}_{\dot{M}}\dot{\partial}^{\dot{M}} \equiv 0$$

- Orthogonality between connection and derivatives

$$\Omega^{\dot{M}}{}_{\dot{F}\dot{G}}\dot{\partial}_{\dot{M}} \equiv 0$$

- Constancy of $f_{\dot{A}\dot{B}\dot{C}}$

$$\dot{\partial}_{\dot{E}} f_{\dot{A}\dot{B}\dot{C}} \equiv 0$$

- Jacobi identities

$$f_{[\dot{A}\dot{B}}{}^{\dot{E}} f_{\dot{C}]\dot{D}\dot{E}} \equiv 0$$

- Triviality of $f_{\dot{A}}$

$$f_{\dot{A}} = \Omega^{\dot{C}}{}_{\dot{C}\dot{A}} - 2\dot{\partial}_{\dot{A}}\lambda = \partial_C U^C{}_{\dot{A}} - 2\dot{\partial}_{\dot{A}}\lambda \equiv 0$$

Twisted connections and field strengths

- Connections ($\partial \to D$)

$$\left\{\Gamma, \Phi, \bar{\Phi}\right\} \qquad \to \qquad \left\{\dot{\Gamma}, \dot{\Phi}, \dot{\bar{\Phi}}\right\}$$

- (Semi-)covariant generalised curvature

$$(\delta_{\dot{X}} - \hat{\mathcal{L}}_{\dot{X}})\dot{\mathcal{G}}_{\dot{A}\dot{B}\dot{C}\dot{D}} \equiv \dot{\mathcal{D}}_{[\dot{A}}(\dot{\mathcal{P}} + \dot{\bar{\mathcal{P}}})_{\dot{B}]\dot{C}\dot{D}} + \dot{\mathcal{D}}_{[\dot{C}}(\dot{\mathcal{P}} + \dot{\bar{\mathcal{P}}})_{\dot{D}]\dot{A}\dot{B}}$$

- Natural curvature $\mathcal{G}_{ABCD}$

$$\tfrac{1}{2}[\dot{\mathcal{D}}_p, \dot{\mathcal{D}}_{\bar{q}}]\, T^p \equiv \dot{\mathcal{G}}_{pr\bar{q}}{}^{r}\, T^p$$
$$\tfrac{1}{2}[\dot{\mathcal{D}}_p, \dot{\mathcal{D}}_{\bar{q}}]\, T^{\bar{q}} \equiv -\dot{\mathcal{G}}_{p\bar{r}\bar{q}}{}^{\bar{r}}\, T^{\bar{q}}$$

$N = 1$ twisted SDFT

- $N = 1$

$$\dot{\mathcal{L}}^{\rm Half-maximal}_{\rm Twisted\ \ SDFT} = e^{-2\dot{d}}\Big[\tfrac{1}{4}\dot{\mathcal{G}}_{pq}{}^{pq} + i\tfrac{1}{2}\bar{\rho}\gamma^{p}\dot{\mathcal{D}}_{p}\rho - i\bar{\psi}^{\bar{p}}\dot{\mathcal{D}}_{\bar{p}}\rho - i\tfrac{1}{2}\bar{\psi}^{\bar{p}}\gamma^{q}\dot{\mathcal{D}}_{q}\psi_{\bar{p}}\Big]$$

- Twisted transformations for fermions

$$\delta_{\varepsilon}\rho = -\gamma^{p}\dot{\mathcal{D}}_{p}\varepsilon\,, \qquad \delta_{\varepsilon}\psi_{\bar{p}} = \dot{\mathcal{D}}_{\bar{p}}\varepsilon\,.$$

- $f_{\dot{A}\dot{B}\dot{C}}f^{\dot{A}\dot{B}\dot{C}}$ breaks $\mathbb{Z}_2$ symmetry

$$\dot{\mathcal{G}}_{pq}{}^{pq} + \dot{\mathcal{G}}_{\bar{p}\bar{q}}{}^{\bar{p}\bar{q}} = \tfrac{1}{6}f_{\dot{A}\dot{B}\dot{C}}f^{\dot{A}\dot{B}\dot{C}}$$

where Aldazabal...'11, Dibitetto...'12

$$f_{\dot{A}\dot{B}\dot{C}}f^{\dot{A}\dot{B}\dot{C}} = -3\partial_{D}U_{A}{}^{\dot{A}}\partial^{D}\left(U^{-1}\right)_{\dot{A}}{}^{A} - 24\,\partial_{D}\lambda\,\partial^{D}\lambda$$

$N=2$ twisted SDFT

- $N=2$

$$\dot{\mathcal{L}}^{\text{Maximal}}_{\text{Twisted SDFT}} = e^{-2\dot{d}}\Big[\tfrac{1}{8}(\dot{\mathcal{G}}_{pq}{}^{pq} - \dot{\mathcal{G}}_{\bar{p}\bar{q}}{}^{\bar{p}\bar{q}}) + \tfrac{1}{2}\mathrm{Tr}(\dot{\mathcal{F}}\bar{\dot{\mathcal{F}}})$$
$$+ i\tfrac{1}{2}\bar{\rho}\gamma^{p}\dot{\mathcal{D}}_{p}\rho - i\tfrac{1}{2}\bar{\rho}'\bar{\gamma}^{\bar{p}}\dot{\mathcal{D}}_{\bar{p}}\rho'$$
$$- i\tfrac{1}{2}\bar{\psi}^{\bar{p}}\gamma^{q}\dot{\mathcal{D}}_{q}\psi_{\bar{p}} + i\tfrac{1}{2}\bar{\psi}'^{p}\bar{\gamma}^{\bar{q}}\dot{\mathcal{D}}_{\bar{q}}\psi'_{p}$$
$$-i\bar{\rho}\dot{\mathcal{F}}\rho' + i\bar{\psi}_{\bar{p}}\gamma_{q}\dot{\mathcal{F}}\bar{\gamma}^{\bar{p}}\psi'^{q} - i\bar{\psi}^{\bar{p}}\dot{\mathcal{D}}_{\bar{p}}\rho + i\bar{\psi}'^{p}\dot{\mathcal{D}}_{p}\rho'\Big]$$

- Twisted SUSY transformations for fermions

$$\delta_{\varepsilon}\rho = -\gamma^{p}\dot{\mathcal{D}}_{p}\varepsilon \qquad \delta_{\varepsilon}\rho' = -\bar{\gamma}^{\bar{p}}\dot{\mathcal{D}}_{\bar{p}}\varepsilon'$$
$$\delta_{\varepsilon}\psi_{\bar{p}} = \dot{\mathcal{D}}_{\bar{p}}\varepsilon + \dot{\mathcal{F}}\bar{\gamma}_{\bar{p}}\varepsilon' \qquad \delta_{\varepsilon}\psi'_{p} = \dot{\mathcal{D}}_{p}\varepsilon' + \bar{\dot{\mathcal{F}}}\gamma_{p}\varepsilon$$

- R-R sector

$$\delta\mathcal{C} = \dot{\mathcal{D}}_{+}\Lambda \quad \longrightarrow \quad \delta\dot{\mathcal{F}} = (\dot{\mathcal{D}}_{+})^{2}\Lambda \equiv -\tfrac{1}{24}f_{\dot{A}\dot{B}\dot{C}}f^{\dot{A}\dot{B}\dot{C}}\Lambda \stackrel{!}{=} 0$$

- $\dot{\mathcal{G}}_{pq}{}^{pq} + \dot{\mathcal{G}}_{\bar{p}\bar{q}}{}^{\bar{p}\bar{q}} = 0$

Fixing the actions

- $N = 1 \quad \longrightarrow \quad \mathbb{Z}_2$ transformation
  - $\mathcal{J} \to -\mathcal{J} \quad \Leftrightarrow \quad B^{(2)} \to -B^{(2)}$
  - $\overline{\dot{\mathcal{L}}^{\mathrm{Half-maximal}}_{\mathrm{Twisted\ SDFT}}}(d,\, V_{Ap},\, \bar{V}_{A\bar{p}},\, \rho'^{\bar{\alpha}},\, \psi'_p{}^{\bar{\alpha}})$
- $N = 2 \quad \longrightarrow \quad \mathbb{Z}_2$ unbroken
  - $\mathcal{G}_{pq}{}^{pq} = -\mathcal{G}_{\bar{p}\bar{q}}{}^{\bar{p}\bar{q}}$
- SC relaxation
  - genuinely non-geometric configurations (deformations)
  - stringy origin? Level-matching conditions

Outline

1. Twisted supersymmetric DFT (SDFT) [Cho,Jeon,FM,Park]
   - Relaxation approaches
   - Untwisted SDFT
   - Twisting

2. Stable de Sitter in half-maximal $d = 7$ [Dibitetto,FM,Marqués]

3. Conclusions

Half-maximal $d = 7$ SUGRA

- $\mathbb{R}^+ \times SL(4)$
- Field content $\left\{ e_\mu{}^a, A_\mu{}^{[mn]}, B_{\mu\nu}, \Sigma, \mathcal{V}_m{}^{\alpha\hat{\alpha}}, \psi_{\mu\alpha}, \chi_\alpha, \lambda^{\alpha\hat{\alpha}\hat{\beta}} \right\}$
- Embedding tensor

$$\Theta \in \underbrace{\mathbf{1}_{(-4)}}_{\theta} \oplus \underbrace{\mathbf{10}'_{(+1)}}_{Q_{(mn)}} \oplus \underbrace{\mathbf{10}_{(+1)}}_{\tilde{Q}^{(mn)}} \oplus \underbrace{\mathbf{6}_{(+1)}}_{\xi_{[mn]}}$$

- Previous work: $\mathbf{10} \oplus \mathbf{10}'$ Dibitetto,FM,Marqués,Roest'12
- Scalar potential

$$V = \frac{1}{4} Q_{mn} Q_{pq} \Sigma^{-2} \left(2M^{mp} M^{nq} - M^{mn} M^{pq}\right) + \frac{1}{4} \tilde{Q}^{mn} \tilde{Q}^{pq} \Sigma^{-2} \left(2M_{mp} M_{nq} - M_{mn} M_{pq}\right) + Q_{mn} \tilde{Q}^{mn} \Sigma^{-2} + \theta^2 \Sigma^8 - \theta \left(Q_{mn} M^{mn} - \tilde{Q}^{mn} M_{mn}\right) \Sigma^3 + \frac{3}{2} \xi_{mn} \xi_{pq} \Sigma^{-2} M^{mp} M^{nq}$$

Orbit classification of deformations ($\theta\,\xi_{mn} = 0$)

- branch 1 ($\theta = 0$): $\mathbf{6} \oplus \mathbf{10} \oplus \mathbf{10}'$ Dibitetto,FM,Marqués'15

ID	ξ_{mn}	$Q_{mn}/\cos\alpha$	$\tilde{Q}^{mn}/\sin\alpha$	gauging
1	0_4	$\mathbb{1}_4$	$\mathbb{1}_4$	$\mathrm{SO}(4)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathrm{SO}(3)\,,\quad \alpha = \frac{\pi}{4}$
2		$\mathrm{diag}(1,1,1,-1)$	$\mathrm{diag}(1,1,1,-1)$	$\mathrm{SO}(3,1)$
3		$\mathrm{diag}(1,1,-1,-1)$	$\mathrm{diag}(1,1,-1,-1)$	$\mathrm{SO}(2,2)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathrm{SO}(2,1)\,,\quad \alpha = \frac{\pi}{4}$
4	0_4	$\mathrm{diag}(1,1,1,0)$	$\mathrm{diag}(0,0,0,1)$	$\mathrm{CSO}(3,0,1)$
5		$\mathrm{diag}(1,1,-1,0)$		$\mathrm{CSO}(2,1,1)$
6	$\xi_0 \left(\begin{array}{c\|c} \epsilon_2 & \\ \hline & 0_2 \end{array}\right)$	$\mathrm{diag}(1,1,0,0)$	$\mathrm{diag}(0,0,1,1)$	$\mathrm{CSO}(2,0,2)\,,\quad \|\xi_0\| < 1$ $\mathfrak{f}_1 \quad (\mathrm{Solv}_6)^*\,,\quad \|\xi_0\| = 1$
7			$\mathrm{diag}(0,0,1,-1)$	$\mathrm{CSO}(2,0,2)\,,\quad \|\xi_0\| < \sqrt{\cos(2\alpha)}$ $\mathrm{CSO}(1,1,2)\,,\quad \|\xi_0\| > \sqrt{\cos(2\alpha)}$ $\mathfrak{g}_0 \quad (\mathrm{Solv}_6)^*\,,\quad \|\xi_0\| = \sqrt{\cos(2\alpha)}$
8			$\mathrm{diag}(0,0,0,1)$	$\mathfrak{h}_1 \quad (\mathrm{Solv}_6)^*$
9	$\xi_0 \left(\begin{array}{c\|c} \epsilon_2 & \\ \hline & 0_2 \end{array}\right)$	$\mathrm{diag}(1,-1,0,0)$	$\mathrm{diag}(0,0,1,1)$	$\mathfrak{f}_2 \quad (\mathrm{Solv}_6)^*$
10			$\mathrm{diag}(0,0,1,-1)$	$\mathrm{CSO}(1,1,2)$
11			$\mathrm{diag}(0,0,0,1)$	$\mathfrak{h}_2 \quad (\mathrm{Solv}_6)^*$
12	$\xi_0 \left(\begin{array}{c\|c} \epsilon_2 & \\ \hline & 0_2 \end{array}\right)$	$\mathrm{diag}(1,0,0,0)$	$\mathrm{diag}(0,0,0,1)$	$\mathfrak{l} \quad (\mathrm{Nil}_6(3))^*\,,\quad \xi_0 \neq 0$ $\mathrm{CSO}(1,0,3)\,,\quad \xi_0 = 0$
13	$\xi_0 \left(\begin{array}{c\|c} \epsilon_2 & \\ \hline & 0_2 \end{array}\right)$	0_4	0_4	$\left(\mathbb{R}^+ \ltimes (\mathbb{R}^+)^3\right) \times \mathrm{U}(1)^2$

Orbit classification of deformations ($\theta\,\xi_{mn} = 0$)

- branch 2 ($\xi_{mn} = 0$): $\mathbf{1} \oplus \mathbf{10} \oplus \mathbf{10'}$ — Dibitetto,FM,Marqués'15

ID	θ	$Q_{mn}/\cos\alpha$	$\tilde{Q}^{mn}/\sin\alpha$	gauging
1	κ	$\mathbb{1}_4$	$\mathbb{1}_4$	$\mathrm{SO}(4)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathrm{SO}(3)\,,\quad \alpha = \frac{\pi}{4}$
2		$\mathrm{diag}(1,1,1,-1)$	$\mathrm{diag}(1,1,1,-1)$	$\mathrm{SO}(3,1)$
3		$\mathrm{diag}(1,1,-1,-1)$	$\mathrm{diag}(1,1,-1,-1)$	$\mathrm{SO}(2,2)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathrm{SO}(2,1)\,,\quad \alpha = \frac{\pi}{4}$
4	κ	$\mathrm{diag}(1,1,1,0)$	$\mathrm{diag}(0,0,0,1)$	$\mathrm{CSO}(3,0,1)$
5		$\mathrm{diag}(1,1,-1,0)$		$\mathrm{CSO}(2,1,1)$
6	κ	$\mathrm{diag}(1,1,0,0)$	$\mathrm{diag}(0,0,1,1)$	$\mathrm{CSO}(2,0,2)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathfrak{f}_1\quad(\mathrm{Solv}_6)^*\,,\quad \alpha = \frac{\pi}{4}$
7			$\mathrm{diag}(0,0,1,-1)$	$\mathrm{CSO}(2,0,2)\,,\quad \lvert\alpha\rvert < \frac{\pi}{4}$ $\mathrm{CSO}(1,1,2)\,,\quad \lvert\alpha\rvert > \frac{\pi}{4}$ $\mathfrak{g}_0\quad(\mathrm{Solv}_6)^*\,,\quad \lvert\alpha\rvert = \frac{\pi}{4}$
8			$\mathrm{diag}(0,0,0,1)$	$\mathfrak{h}_1\quad(\mathrm{Solv}_6)^*$
9	κ	$\mathrm{diag}(1,-1,0,0)$	$\mathrm{diag}(0,0,1,-1)$	$\mathrm{CSO}(1,1,2)\,,\quad \alpha \neq \frac{\pi}{4}$ $\mathfrak{f}_2\quad(\mathrm{Solv}_6)^*\,,\quad \alpha = \frac{\pi}{4}$
10			$\mathrm{diag}(0,0,0,1)$	$\mathfrak{h}_2\quad(\mathrm{Solv}_6)^*$
11	κ	$\mathrm{diag}(1,0,0,0)$	$\mathrm{diag}(0,0,0,1)$	$\mathfrak{l}\quad(\mathrm{Nil}_6(3))^*\,,\quad \alpha \neq 0$ $\mathrm{CSO}(1,0,3)\,,\quad \alpha = 0$

Critical points

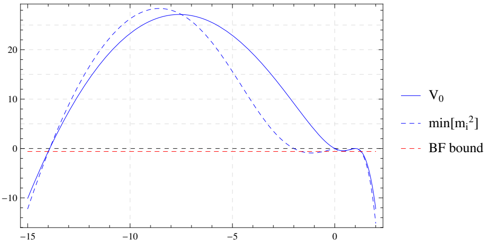
- Equations
  - scalar potential
  - eom's for the scalar fields
  - masses
- Results
  - branch 1 ($\theta = 0$): no-go argument for $\Lambda \neq 0$

$$V = \Sigma^{-2} V_0(M_{mn}) \qquad \rightarrow \qquad \text{eom}(\Sigma) = 0 \quad \text{if} \quad \Lambda = 0$$

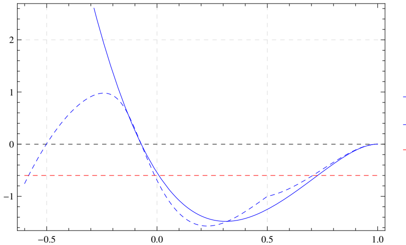
  - branch 2 ($\xi_{mn} = 0$):
    - non-semisimple gaugings: no-scale Mkw and AdS
    - $\tilde{Q}^{mn} = 0$: upliftable to maximal $d = 7$ Samtleben,Weidner'05
    - semisimple in the $\mathbf{10} \oplus \mathbf{10}'$
    - Study of SO(3,1) gauging (genuinely non-geometric)
    - AdS $\leftrightarrow$ Mkw $\leftrightarrow$ dS and stable dS

Stable dS in SO(3,1): two branches ($\pm$)

$$Q_\pm = \mathrm{diag}(1,\lambda,\lambda,\lambda) \qquad \tilde{Q}_\pm = f_\pm(\lambda)\mathrm{diag}(\lambda,1,1,1) \qquad \theta_\pm = g_\pm(\lambda)$$



$-7-4\sqrt{3} < \lambda < \mu_+$



$\mu_- < \lambda < -7+4\sqrt{3}$

- Example in branch (+): $\lambda = -3$
  - Cosmological constant $V_0 = \frac{16}{5}\left(52 - 7\sqrt{46}\right)$
  - Mass spectrum

$$0(\times 3) \quad , \quad \frac{28+\sqrt{46}}{15} \quad (\times 5) \quad , \quad \frac{1}{90}\left(212 - 13\sqrt{46} \pm \sqrt{61310 - 7504\sqrt{46}}\right) \quad (\times 1)$$

Outline

Conclusions

- Gauged SDFT
  - $N = 1$, $N = 2$ twisted SDFT
  - Relaxation of the section condition
    - $N = 1$: Action fixed (still allows for field redefinitions)
    - $N = 2$: Transparent (R-R sector kills the unique $\mathbb{Z}_2$ odd term)
  - Outlook
    - Relaxation from a stringy viewpoint
    - Twisting of R-R sector
- Half-maximal $d = 7$ SUGRA
  - Exhaustive classification of deformations
  - Critical points
    - $\theta = 0$: no-scale Mkw
    - Non-semisimple gaugings: full classification
    - SO(3,1) + θ: two families of stable dS solutions
    - First stable dS solutions in half-maximal SUGRA
  - Outlook
    - Exhaustive vacua classification
    - Stable dS solutions in $N = 4 = D$

Thanks