M-THEORY ORIGIN OF N=8 GAUGED SUPERGRAVITIES

Walter H. Baron

Università Degli Studi di Padova

String Phenomenology 2015 - Madrid
June 11^{th}, 2015

talk based on JHEP **1502***, 003 (2015), W. B., G. Dall'Agata*

Phys. Rev. D **91** *(2015) 2, W. B.*

Plan of the Talk

1. Exceptional Generalised Geometry and Exceptional Field Theories

2. Embedding of gauged supergravities in EGG and EFT

3. Uplifting the $SO(3) \times SO(3)$ critical point of SO(4,4)

4. Conclusions and perspectives

Plan of the Talk

1. Exceptional Generalised Geometry and Exceptional Field Theories
2. Embedding of gauged supergravities in EGG and EFT
3. Uplifting the $SO(3) \times SO(3)$ critical point of SO(4,4)
4. Conclusions and perspectives

Plan of the Talk

1. Exceptional Generalised Geometry and Exceptional Field Theories
2. Embedding of gauged supergravities in EGG and EFT
3. Uplifting the $SO(3) \times SO(3)$ critical point of SO(4,4)
4. Conclusions and perspectives

Plan of the Talk

1. Exceptional Generalised Geometry and Exceptional Field Theories
2. Embedding of gauged supergravities in EGG and EFT
3. Uplifting the $SO(3) \times SO(3)$ critical point of SO(4,4)
4. Conclusions and perspectives

$E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry (EGG)

- $E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry = Reformulation of 11D SUGRA where ...
  - Geometric Interpretation of the Bosonic Sector
    $g_{MN}, A_{MNP}, \tilde{A}_{N_1 \dots N_6}$ encoded in the "Generalised metric"
  - Generalised Tangent Bundle ($E_{d(d)} \times \mathbb{R}^+$ structure)
    $E = v + w + \sigma + \tau \quad \in TM \oplus \Lambda^2 T^*M \oplus \Lambda^5 T^*M \oplus (T^*M \otimes \Lambda^7 T^*M)$
  - Generalised Lie Derivative
    $$L_E E' = \mathcal{L}_v v' + (\mathcal{L}_v w' - i_{v'} dw) + (\mathcal{L}_v \sigma' - i_{v'} d\sigma - w' \wedge dw)$$
    $$+ (\mathcal{L}_v \tau' - j\sigma' \wedge dw - jw' \wedge d\sigma)$$

Nice (unified) mathematical structure

$E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry (EGG)

- $E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry = Reformulation of 11D SUGRA where ...
  - Geometric Interpretation of the Bosonic Sector
    $g_{MN}, A_{MNP}, \tilde{A}_{N_1 \ldots N_6}$ encoded in the "Generalised metric"
  - Generalised Tangent Bundle ($E_{d(d)} \times \mathbb{R}^+$ structure)
    $E = v + w + \sigma + \tau \quad \in TM \oplus \Lambda^2 T^*M \oplus \Lambda^5 T^*M \oplus (T^*M \otimes \Lambda^7 T^*M)$
  - Generalised Lie Derivative
    $$L_E E' = \mathcal{L}_v v' + (\mathcal{L}_v w' - i_{v'} dw) + (\mathcal{L}_v \sigma' - i_{v'} d\sigma - w' \wedge dw)$$
    $$+ (\mathcal{L}_v \tau' - j\sigma' \wedge dw - jw' \wedge d\sigma)$$

Nice (unified) mathematical structure

$E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry (EGG)

- $E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry = Reformulation of 11D SUGRA where ...
  - Geometric Interpretation of the Bosonic Sector
    $g_{MN}, A_{MNP}, \tilde{A}_{N_1\dots N_6}$ encoded in the "Generalised metric"
  - Generalised Tangent Bundle ($E_{d(d)} \times \mathbb{R}^+$ structure)
    $E = v + w + \sigma + \tau \quad \in TM \oplus \Lambda^2 T^*M \oplus \Lambda^5 T^*M \oplus (T^*M \otimes \Lambda^7 T^*M)$
  - Generalised Lie Derivative
    $$L_E E' = \mathcal{L}_v v' + (\mathcal{L}_v w' - i_{v'} dw) + (\mathcal{L}_v \sigma' - i_{v'} d\sigma - w' \wedge dw) + (\mathcal{L}_v \tau' - j\sigma' \wedge dw - jw' \wedge d\sigma)$$

Nice (unified) mathematical structure

$E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry (EGG)

- $E_{d(d)} \times \mathbb{R}^+$ Generalised Geometry = Reformulation of 11D SUGRA where ...
  - Geometric Interpretation of the Bosonic Sector
    $g_{MN}, A_{MNP}, \tilde{A}_{N_1 \dots N_6}$ encoded in the "Generalised metric"
  - Generalised Tangent Bundle ($E_{d(d)} \times \mathbb{R}^+$ structure)
    $E = v + w + \sigma + \tau \quad \in TM \oplus \Lambda^2 T^*M \oplus \Lambda^5 T^*M \oplus (T^*M \otimes \Lambda^7 T^*M)$
  - Generalised Lie Derivative
    $$L_E E' = \mathcal{L}_v v' + (\mathcal{L}_v w' - i_{v'} dw) + (\mathcal{L}_v \sigma' - i_{v'} d\sigma - w' \wedge dw)$$
    $$+ (\mathcal{L}_v \tau' - j\sigma' \wedge dw - jw' \wedge d\sigma)$$

Nice (unified) mathematical structure

Exceptional Field Theory

- $7 \to 56$ + "section condition"
  $\partial_{m8} \to \partial_m, \ \partial_{mn} \to 0$

$$\delta_\xi V^{\mathbb{M}} = \xi^{\mathbb{P}} \partial_{\mathbb{P}} V^{\mathbb{M}} - 12 P_{(adj)}{}^{\mathbb{M}}{}_{\mathbb{N}}{}^{\mathbb{P}}{}_{\mathbb{Q}} \partial_{\mathbb{P}} \xi^{\mathbb{Q}} V^{\mathbb{N}} + \frac{\omega}{2} \partial_{\mathbb{P}} \xi^{\mathbb{P}} V^{\mathbb{M}} \ ,$$

These transformations define the generalised fluxes, $F_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}}$, via

$$\delta_{E_{\mathbb{A}}} E_{\mathbb{B}} = F_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} E_{\mathbb{C}} \ .$$

$$F_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} + D_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}}, \qquad (\mathbf{912} + \mathbf{56})$$

the structure constants $X_{\mathbb{A}\mathbb{B}\mathbb{C}}$ automatically satisfy the 4D maximal supergravity relations of the embedding tensor

$$P_{(adj)}{}^{\mathbb{C}}{}_{\mathbb{B}}{}^{\mathbb{D}}{}_{\mathbb{E}} \, X_{\mathbb{A}\mathbb{D}}{}^{\mathbb{E}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} \ , \quad X_{\mathbb{A}[\mathbb{B}\mathbb{C}]} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{B}} = X_{(\mathbb{A}\mathbb{B}\mathbb{C})} = X_{\mathbb{B}\mathbb{A}}{}^{\mathbb{B}} = 0,$$

section conditions,

$$\Omega^{\mathbb{M}\mathbb{N}} \partial_{\mathbb{M}} \mathcal{A} \, \partial_{\mathbb{N}} \mathcal{B} = 0, \quad [t_\alpha]^{\mathbb{M}\mathbb{N}} \partial_{\mathbb{M}} \mathcal{A} \, \partial_{\mathbb{N}} \mathcal{B} = 0, \quad [t_\alpha]^{\mathbb{M}\mathbb{N}} \partial_{\mathbb{M}} \partial_{\mathbb{N}} \mathcal{A} = 0 \ ,$$

N=8 Supergravity in 4D

Field content: $e^{a}{}_{\mu}$ $U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8)$ A^{a}_{μ} ψ^{A}_{μ} χ_{ABC}

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'

$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{\mathbb{MN}}{}^{\mathbb{P}} = \Theta_{\mathbb{M}}{}^{\alpha}\ (t_\alpha)_{\mathbb{N}}{}^{\mathbb{P}}$$

$$D_\mu = \partial_\mu - A^{\mathbb{M}}_{\mu}\Theta_{\mathbb{M}}{}^{\alpha} t_\alpha$$

Linear constraints

$$t_{\alpha\mathbb{M}}{}^{\mathbb{N}}\,\Theta_{\mathbb{N}}{}^{\alpha} = 0\,, \qquad (t_\beta t^\alpha)_{\mathbb{M}}{}^{\mathbb{N}}\Theta_{\mathbb{N}}{}^{\beta} = -\frac{1}{2}\Theta_{\mathbb{M}}{}^{\alpha}$$

Quadratic constraint $\Theta_{\mathbb{M}}{}^{\alpha}\,\Theta_{\mathbb{N}}{}^{\beta}\,\Omega^{\mathbb{MN}} = 0$

N=8 Supergravity in 4D

Field content: $e^{a}{}_{\mu}$ $U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8)$ A^a_μ ψ^A_μ χ_{ABC}

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'

$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{\mathrm{MN}}{}^{\mathbb{P}} = \Theta_{\mathrm{M}}{}^{\alpha}\ (t_\alpha)_{\mathrm{N}}{}^{\mathbb{P}}$$

$$D_\mu = \partial_\mu - A^{\mathrm{M}}_\mu \Theta_{\mathrm{M}}{}^{\alpha} t_\alpha$$

Linear constraints

$$t_{\alpha\mathrm{M}}{}^{\mathrm{N}}\,\Theta_{\mathrm{N}}{}^{\alpha} = 0\,, \qquad (t_\beta t^\alpha)_{\mathrm{M}}{}^{\mathrm{N}}\Theta_{\mathrm{N}}{}^{\beta} = -\frac{1}{2}\Theta_{\mathrm{M}}{}^{\alpha}$$

Quadratic constraint $\Theta_{\mathrm{M}}{}^{\alpha}\,\Theta_{\mathrm{N}}{}^{\beta}\,\Omega^{\mathrm{MN}} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu \quad U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8) \quad A^a_\mu \quad \psi^A_\mu \quad \chi_{ABC}$

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'
$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{MN}{}^{P} = \Theta_M{}^\alpha \; (t_\alpha)_N{}^P$$

$$D_\mu = \partial_\mu - A^M_\mu \Theta_M{}^\alpha t_\alpha$$

Linear constraints

$$t_{\alpha M}{}^N \, \Theta_N{}^\alpha = 0 \,, \qquad (t_\beta t^\alpha)_M{}^N \Theta_N{}^\beta = -\frac{1}{2}\Theta_M{}^\alpha$$

Quadratic constraint $\quad \Theta_M{}^\alpha \, \Theta_N{}^\beta \, \Omega^{MN} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu \quad U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8) \quad A^a_\mu \quad \psi^A_\mu \quad \chi_{ABC}$

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'
$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case
Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{MN}{}^{P} = \Theta_M{}^{\alpha}\,(t_\alpha)_N{}^{P}$$

$$D_\mu = \partial_\mu - A^M_\mu \Theta_M{}^{\alpha} t_\alpha$$

Linear constraints

$$t_{\alpha M}{}^{N}\,\Theta_N{}^{\alpha} = 0\,, \qquad (t_\beta t^\alpha)_M{}^N \Theta_N{}^\beta = -\frac{1}{2}\Theta_M{}^\alpha$$

Quadratic constraint $\Theta_M{}^\alpha\,\Theta_N{}^\beta\,\Omega^{MN} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu$ $U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8)$ A^a_μ ψ^A_μ χ_{ABC}

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'
$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case
Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{MN}{}^{\mathbb{P}} = \Theta_M{}^\alpha\ (t_\alpha)_N{}^{\mathbb{P}}$$

$$D_\mu = \partial_\mu - A^M_\mu \Theta_M{}^\alpha t_\alpha$$

Linear constraints

$$t_{\alpha M}{}^N\, \Theta_N{}^\alpha = 0\,, \qquad (t_\beta t^\alpha)_M{}^N \Theta_N{}^\beta = -\frac{1}{2}\Theta_M{}^\alpha$$

Quadratic constraint $\Theta_M{}^\alpha\, \Theta_N{}^\beta\, \Omega^{MN} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu$ $U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8)$ A^a_μ ψ^A_μ χ_{ABC}

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'

$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)\,global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{MN}{}^{P} = \Theta_M{}^\alpha\,(t_\alpha)_N{}^P$$

$$D_\mu = \partial_\mu - A^M_\mu \Theta_M{}^\alpha t_\alpha$$

Linear constraints

$$t_{\alpha M}{}^N\,\Theta_N{}^\alpha = 0\,, \qquad (t_\beta t^\alpha)_M{}^N \Theta_N{}^\beta = -\frac{1}{2}\Theta_M{}^\alpha$$

Quadratic constraint $\Theta_M{}^\alpha\,\Theta_N{}^\beta\,\Omega^{MN} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu \quad U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8) \quad A^a_\mu \quad \psi^A_\mu \quad \chi_{ABC}$

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'

$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)\,global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{\mathbb{MN}}{}^{\mathbb{P}} = \Theta_{\mathbb{M}}{}^{\alpha}\ (t_\alpha)_{\mathbb{N}}{}^{\mathbb{P}}$$

$$D_\mu = \partial_\mu - A^{\mathbb{M}}_\mu \Theta_{\mathbb{M}}{}^{\alpha} t_\alpha$$

Linear constraints

$$t_{\alpha\mathbb{M}}{}^{\mathbb{N}}\,\Theta_{\mathbb{N}}{}^{\alpha} = 0\,, \qquad (t_\beta t^\alpha)_{\mathbb{M}}{}^{\mathbb{N}}\Theta_{\mathbb{N}}{}^{\beta} = -\frac{1}{2}\Theta_{\mathbb{M}}{}^{\alpha}$$

Quadratic constraint $\quad \Theta_{\mathbb{M}}{}^{\alpha}\,\Theta_{\mathbb{N}}{}^{\beta}\,\Omega^{\mathbb{MN}} = 0$

N=8 Supergravity in 4D

Field content: $e^a{}_\mu$ $U = \begin{pmatrix} u_{ij}{}^{IJ} & v_{ij\,IJ} \\ v^{ij\,IJ} & u^{ij}{}_{IJ} \end{pmatrix} \subset E_7/SU(8)$ A^a_μ ψ^A_μ χ_{ABC}

N=8 (Abelian) Sugra (up to second order in K) de Wit, Freedman 77'

Full (Abelian) N=8 torus compactification Cremmer,Julia 78'

$GL(7,R)_{global} \times SO(7)_{local} \longrightarrow E_{7(7)global} \times SU(8)_{local}$

Non Abelian case

Flat groups twisted tori Scherk, Schwarz 79'

SO(8) gauged Maximal supergravity de Wit, Nicolai 81'

SO(p,q) and CSO(p,q,r) gauged Maximal supergravity Hull 84'

New Gauged supergravities Dall'Agata, Inverso, Trigiante 12'

Embedding Tensor

$$X_{\mathbb{MN}}{}^{\mathbb{P}} = \Theta_{\mathbb{M}}{}^{\alpha}\ (t_\alpha)_{\mathbb{N}}{}^{\mathbb{P}}$$

$$D_\mu = \partial_\mu - A^{\mathbb{M}}_\mu \Theta_{\mathbb{M}}{}^{\alpha} t_\alpha$$

Linear constraints

$$t_{\alpha\mathbb{M}}{}^{\mathbb{N}}\ \Theta_{\mathbb{N}}{}^{\alpha} = 0\ , \qquad (t_\beta t^\alpha)_{\mathbb{M}}{}^{\mathbb{N}} \Theta_{\mathbb{N}}{}^{\beta} = -\frac{1}{2}\Theta_{\mathbb{M}}{}^{\alpha}$$

Quadratic constraint $\Theta_{\mathbb{M}}{}^{\alpha}\ \Theta_{\mathbb{N}}{}^{\beta}\ \Omega^{\mathbb{MN}} = 0$

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1}\left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC}\right),$$

$$L_{E_{AB}} E^{CD} = R^{-1}\left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE}\delta^D_B\, E^{CE} - \eta_{BE}\delta^D_A\, E^{CE}\right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad L_{E^{AB}} E^{CD} = 0\,.$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{AB}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad X_{\mathbb{AB}}{}^{\mathbb{C}} = SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1} \left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC} \right),$$

$$L_{E_{AB}} E^{CD} = R^{-1} \left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE} \delta^D_B\, E^{CE} - \eta_{BE} \delta^D_A\, E^{CE} \right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad L_{E^{AB}} E^{CD} = 0 .$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} \equiv SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1} \left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC}\right),$$

$$L_{E_{AB}} E^{CD} = R^{-1} \left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE} \delta^D_B\, E^{CE} - \eta_{BE} \delta^D_A\, E^{CE}\right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad\qquad L_{E^{AB}} E^{CD} = 0\,.$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} \equiv SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1} \left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC} \right),$$

$$L_{E_{AB}} E^{CD} = R^{-1} \left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE} \delta^D_B\, E^{CE} - \eta_{BE} \delta^D_A\, E^{CE} \right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad\qquad L_{E^{AB}} E^{CD} = 0\,.$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{AB}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad\qquad X_{\mathbb{AB}}{}^{\mathbb{C}} \equiv SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1} \left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC}\right),$$

$$L_{E_{AB}} E^{CD} = R^{-1} \left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE} \delta^D_B\, E^{CE} - \eta_{BE} \delta^D_A\, E^{CE}\right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad\qquad L_{E^{AB}} E^{CD} = 0\,.$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad\qquad X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} \equiv SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalised Scherk-Schwarz reductions

$$\begin{pmatrix} \tilde{\mathcal{V}}_{AB}{}^{MN}(x,y) & \tilde{\mathcal{V}}_{AB\,MN}(x,y) \\ \tilde{\mathcal{V}}^{AB\,MN}(x,y) & \tilde{\mathcal{V}}^{AB}{}_{MN}(x,y) \end{pmatrix} = \begin{pmatrix} u_{ab}{}^{CD}(x) & v_{ab\,CD}(x) \\ v^{ab\,CD}(x) & u^{ab}{}_{CD}(x) \end{pmatrix} \begin{pmatrix} E_{CD}{}^{MN}(y) & E_{CD\,MN}(y) \\ E^{CD\,MN}(y) & E^{CD}{}_{MN}(y) \end{pmatrix}$$

Embedding tensor of $SO(p,q)$ Gauged Maximal Supergravity

$$L_{E_{AB}} E_{CD} = R^{-1} \left(\eta_{CB}\, E_{AD} - \eta_{DB}\, E_{AC} - \eta_{CA}\, E_{BD} + \eta_{DA}\, E_{BC}\right),$$

$$L_{E_{AB}} E^{CD} = R^{-1} \left(\eta_{AE}\, \delta^C_B\, E^{ED} - \eta_{BE}\, \delta^C_A\, E^{ED} + \eta_{AE} \delta^D_B\, E^{CE} - \eta_{BE} \delta^D_A\, E^{CE}\right),$$

$$L_{E^{AB}} E_{CD} = 0 \quad , \qquad\qquad L_{E^{AB}} E^{CD} = 0\,.$$

$$L_{E_{\mathbb{A}}} E_{\mathbb{B}} = X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} E_{\mathbb{C}} \qquad\qquad X_{\mathbb{A}\mathbb{B}}{}^{\mathbb{C}} \equiv SO(p,q) \text{ Embedding tensor}$$

- S^n are generalised parallelisable Waldram, Lee, Strickland-Constable 14'
- Are Hyperboloids Generalised parallelisable?

Generalized Vielbein for compact gaugings

- solved in EGG by Waldram, Lee, Strickland-Constable 14'
- solved in EFT by WB 14'

Generalized Vielbein for noncompact gaugings

- solved in EGG by WB, Dall'Agata 14'
- solved in EFT by Hohm, Samtleben 14'

$$E_{\mathbb{A}} = \begin{cases} E_{AB} = K_{AB} + S_{AB} + i_{K_{AB}}\zeta \\ E^{AB} = P^{AB} + T^{AB} - j\zeta \wedge P^{AB}, \end{cases}$$

with

$$\begin{aligned} P^{AB} &= dX^A \wedge dX^B, \\ S_{AB} &= *P_{AB} = \frac{R^{-1}}{(d-2)!}\epsilon_{ABC_1\ldots C_{d-1}} X^{C_1} dX^{C_2} \wedge \cdots \wedge dX^{C_{d-1}} \\ T^{AB} &= R^{-1}\left(X^A dX^B - X^B dX^A\right) \otimes Vol_H, \end{aligned}$$

$$Vol_H = \frac{R^{-1}}{d!}\,\epsilon_{C_1\ldots C_{d+1}} X^{C_1} dX^{C_2} \wedge \cdots \wedge dX^{C_{d+1}},$$

$$d\zeta = \frac{d-1}{R} Vol_H$$

Hyperboloids Generalised parallelizable !

$$\begin{aligned} T^{AB} &= 0 \Longleftrightarrow X^A = X^B = 0, \\ P^{AB} &= 0 \Longleftrightarrow (X^A)^2 + (X^B)^2 = R^2 \quad A, B = 1, \ldots, 4, \\ P^{AB} &= 0 \Longleftrightarrow (X^A)^2 - (X^B)^2 = R^2 \quad A = 1, \ldots, 4; \quad B = 5, \ldots, 8, \\ P^{AB} &\neq 0 \ \ for \ \ A, B = 5, \ldots, 8. \end{aligned}$$

Non linear uplift ansatze (WB, Dall'Agata 14')

Nonlinear metric ansatz

$$\Delta^{-1} g^{mn} = \frac{1}{2} K^m{}_{AB} K^n{}_{CD} \left(u_{ab}{}^{AB} - i v^{ab\,AB}\right)\left(u_{ab}{}^{CD} + i v^{ab\,CD}\right)$$

Nonlinear Flux ansatz

$$A_{mnp} = \frac{\sqrt{2}}{4} \Delta\, g_{pq}\, K_{mn}{}^{AB} K^q{}_{CD}\, \left(u^{ab}{}_{AB} + i\, v_{ab\,AB}\right)\left(u_{ab}{}^{CD} + i\, v_{ab\,AB}\right)$$

$K^m{}_{AB}$: Killing vectors

$$K_{mn}{}^{AB} = R^{-1} \eta^{AC} \eta^{BD}\, \mathring{g}_{mp} \mathring{\nabla}_n\, K^p_{CD}$$

Tests:

- In $SO(8)$ $\Rightarrow$ $SO(8)$, $SO(7)$, $G2$, $SU(4)$, $SO(3)\times SO(3)$
- In $SO(5,3)$ $\Rightarrow$ $SO(5)\times SO(3)$
- In $SO(4,4)$ $\Rightarrow$ $SO(4)\times SO(4)$, $SO(3)\times SO(3)$

Non linear uplift ansatze (WB, Dall'Agata 14')

Nonlinear metric ansatz

$$\Delta^{-1} g^{mn} = \frac{1}{2} K^m{}_{AB} K^n{}_{CD} \left(u_{ab}{}^{AB} - i v^{ab\,AB} \right) \left(u_{ab}{}^{CD} + i v^{ab\,CD} \right)$$

Nonlinear Flux ansatz

$$A_{mnp} = \frac{\sqrt{2}}{4} \Delta \; g_{pq} \; K_{mn}{}^{AB} K^q{}_{CD} \; \left(u^{ab}{}_{AB} + i\, v_{ab\,AB} \right) \left(u_{ab}{}^{CD} + i\, v_{ab\,AB} \right)$$

$K^m{}_{AB}$: Killing vectors

$K_{mn}{}^{AB} = R^{-1} \eta^{AC} \eta^{BD} \, \mathring{g}_{mp} \mathring{\nabla}_n \, K^p_{CD}$

Tests:

- In $SO(8) \quad \Rightarrow \qquad SO(8),\, SO(7),\, G2,\, SU(4),\, SO(3) \times SO(3)$
- In $SO(5,3) \Rightarrow \qquad SO(5) \times SO(3)$
- In $SO(4,4) \Rightarrow \qquad SO(4) \times SO(4), SO(3) \times SO(3)$

Non linear uplift ansatze (WB, Dall'Agata 14')

Nonlinear metric ansatz

$$\Delta^{-1} g^{mn} = \frac{1}{2} K^m{}_{AB} K^n{}_{CD} \left(u_{ab}{}^{AB} - i v^{ab\,AB} \right) \left(u_{ab}{}^{CD} + i v^{ab\,CD} \right)$$

Nonlinear Flux ansatz

$$A_{mnp} = \frac{\sqrt{2}}{4} \Delta \; g_{pq} \; K_{mn}{}^{AB} K^q{}_{CD} \; \left(u^{ab}{}_{AB} + i \, v_{ab\,AB} \right) \left(u_{ab}{}^{CD} + i \, v_{ab\,AB} \right)$$

$K^m{}_{AB}$: Killing vectors

$K_{mn}{}^{AB} = R^{-1} \eta^{AC} \eta^{BD} \; \mathring{g}_{mp} \mathring{\nabla}_n \; K^p_{CD}$

Tests:

- In $SO(8) \quad \Rightarrow \qquad SO(8), \, SO(7), \, G2, \, SU(4), \, SO(3) \times SO(3)$
- In $SO(5,3) \Rightarrow \qquad SO(5) \times SO(3)$
- In $SO(4,4) \Rightarrow \qquad SO(4) \times SO(4), SO(3) \times SO(3)$

Non linear uplift ansatze (WB, Dall'Agata 14')

Nonlinear metric ansatz

$$\Delta^{-1} g^{mn} = \frac{1}{2} K^m{}_{AB} K^n{}_{CD} \left(u_{ab}{}^{AB} - i v^{ab\,AB}\right)\left(u_{ab}{}^{CD} + i v^{ab\,CD}\right)$$

Nonlinear Flux ansatz

$$A_{mnp} = \frac{\sqrt{2}}{4}\,\Delta\; g_{pq}\; K_{mn}{}^{AB} K^q{}_{CD}\;\left(u^{ab}{}_{AB} + i\, v_{ab\,AB}\right)\left(u_{ab}{}^{CD} + i\, v_{ab\,AB}\right)$$

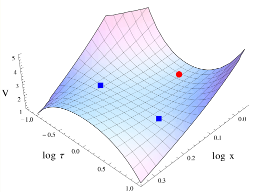
$K^m{}_{AB}$: Killing vectors

$K_{mn}{}^{AB} = R^{-1} \eta^{AC} \eta^{BD}\; \mathring{g}_{mp} \mathring{\nabla}_n\; K^p_{CD}$

Tests:

- In $SO(8)$ $\Rightarrow$ $SO(8)$, $SO(7)$, $G2$, $SU(4)$, $SO(3) \times SO(3)$
- In $SO(5,3) \Rightarrow$ $SO(5) \times SO(3)$
- In $SO(4,4) \Rightarrow$ $SO(4) \times SO(4), SO(3) \times SO(3)$

The $SO(3)\times SO(3)$ invariant critical points of $SO(4,4)$ gauged supergravity (Dall'Agata, Inverso 12') can be obtained by truncating the scalar manifold to a 2d sector.



This critical point has the following uplift solution in 11D SUGRA (WB, Dall'Agata 14'). $y^i=\{\psi,\theta_1,\phi_1\}$

$$ds_7^2=\frac{\alpha^{-1}R^2}{\Delta(y)}\left[\sum_{i,j=1}^{3}h_{ij}(y)dy^i dy^j+R_1^2(y)\left(d\theta_2^2+\sin^2(\theta_2)\,d\theta_3^2\right)+R_2^2(y)\left(d\phi_2^2+\sin^2(\phi_2)\,d\phi_3^2\right)\right],$$

$$A=A^{(1)}\wedge e^4\wedge e^5+A^{(2)}\wedge e^6\wedge e^7,\qquad \begin{array}{rcl} e^4 &=& R_1\,d\theta_2,\qquad e^5=R_1\,\sin\theta_2\,d\theta_3,\\ e^6 &=& R_2\,d\phi_2,\qquad e^7=R_2\,\sin\phi_2\,d\phi_3,\end{array}$$

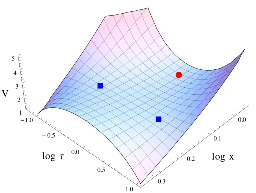
$$\begin{array}{rcl} A^{(1)} &=& -A_0\left[\sinh^2(\psi)+\left(1+\frac{2}{\sqrt{3}}\right)\cosh^2(\psi)\right]\sin(\theta_1)\cos(\phi_1)\,d\psi\\ &-& A_0\sinh(\psi)\cosh(\psi)\cos(\theta_1)\cos(\phi_1)\,d\theta_1\;+\;A_0\left(1+\frac{2}{\sqrt{3}}\right)\sinh(\psi)\cosh(\psi)\sin(\theta_1)\sin(\phi_1)\,d\phi_1\end{array}$$

The 4D metric $\tilde{g}$ describes de Sitter spacetime and therefore $\tilde{R}_{\mu\nu}=3\,R_4^{-2}\,\tilde{g}_{\mu\nu}$, with R_4 the de Sitter radius. The 4-form $F_{\mu\nu\rho\sigma}=f_{FR}\,\epsilon_{\mu\nu\rho\sigma}$, where

$$R_4^2=\frac{3}{2}\frac{g^2}{V_c}R^2\,,\qquad f_{FR}=\pm\frac{1}{g^2\sqrt{2}}V_cR^{-1}\,,$$

where g is the coupling constant of the 4-dimensional gauged supergravity theory and V_c is the value of the potential at the critical point.

The $SO(3) \times SO(3)$ invariant critical points of $SO(4,4)$ gauged supergravity (Dall'Agata, Inverso 12') can be obtained by truncating the scalar manifold to a 2d sector.



This critical point has the following uplift solution in 11D SUGRA (WB, Dall'Agata 14'). $y^i = \{\psi, \theta_1, \phi_1\}$

$$ds_7^2 = \frac{\alpha^{-1} R^2}{\Delta(y)} \left[\sum_{i,j=1}^{3} h_{ij}(y) dy^i dy^j + R_1^2(y) \left(d\theta_2^2 + \sin^2(\theta_2)\, d\theta_3^2 \right) + R_2^2(y) \left(d\phi_2^2 + \sin^2(\phi_2)\, d\phi_3^2 \right) \right],$$

$$A = A^{(1)} \wedge e^4 \wedge e^5 + A^{(2)} \wedge e^6 \wedge e^7, \qquad \begin{aligned} e^4 &= R_1\, d\theta_2, \qquad & e^5 &= R_1 \sin\theta_2\, d\theta_3, \\ e^6 &= R_2\, d\phi_2, \qquad & e^7 &= R_2 \sin\phi_2\, d\phi_3, \end{aligned}$$

$$\begin{aligned} A^{(1)} &= -A_0 \left[\sinh^2(\psi) + \left(1 + \tfrac{2}{\sqrt{3}}\right) \cosh^2(\psi) \right] \sin(\theta_1) \cos(\phi_1)\, d\psi \\ &- A_0 \sinh(\psi) \cosh(\psi) \cos(\theta_1) \cos(\phi_1)\, d\theta_1 + A_0 \left(1 + \tfrac{2}{\sqrt{3}}\right) \sinh(\psi) \cosh(\psi) \sin(\theta_1) \sin(\phi_1)\, d\phi_1 \end{aligned}$$

The 4D metric $\tilde{g}$ describes de Sitter spacetime and therefore $\tilde{R}_{\mu\nu} = 3\, R_4^{-2}\, \tilde{g}_{\mu\nu}$, with R_4 the de Sitter radius. The 4-form $F_{\mu\nu\rho\sigma} = f_{FR}\, \epsilon_{\mu\nu\rho\sigma}$, where

$$R_4^2 = \frac{3}{2} \frac{g^2}{V_c} R^2 \quad , \qquad f_{FR} = \pm \frac{1}{g^2 \sqrt{2}} V_c R^{-1} \, ,$$

where g is the coupling constant of the 4-dimensional gauged supergravity theory and V_c is the value of the potential at the critical point.

$$R_1^2 = \frac{4(2\sqrt{3}-3)\sin^2\theta_1}{3(\sqrt{3}-1)+6\sin^2\theta_1+\tanh^2\psi[3\sqrt{3}(\sqrt{3}-1)-(6-4\sqrt{3})\sin^2\phi_1]},$$

$$R_2^2 = \frac{4(2\sqrt{3}-3)\sin^2\phi_1}{3(\sqrt{3}-1)+6\sin^2(\phi_1)+\coth^2\psi[3\sqrt{3}(\sqrt{3}-1)-(6-4\sqrt{3})\sin^2\theta_1]},$$

and the overall warp factors are

$$\Delta^{-9} = \alpha^7 \det h^{-1}\ \frac{\sin^4\theta_1}{R_1^4}\frac{\sin^4\phi_1}{R_2^4}\cosh^6\psi\ \sinh^6\psi$$

$$h = (\det \mathrm{M})^{-\frac{1}{2}}\ \mathrm{M}$$

where

$$M = \begin{pmatrix} A\,B - S_2^2\ S_3^2 & -(\Phi_3\,B + S3^2\ \Phi_2)\ S_2 & -(\Phi_2\,A + S2^2\ \Phi_3)\ S_3 \\ -(\Phi_3\,B + S_3^2\ \Phi_2)S_2 & [\frac{3(2+\sqrt{3})}{4} - \Phi_2\Phi_3]\,B - S_3^2\ \Phi_2^2 & \frac{3(2+\sqrt{3})}{4}\ S_2\ S_3 \\ -(\Phi_2\,A + S_2^2\ \Phi_3)\ S_3 & \frac{3(2+\sqrt{3})}{4}\ S_2\ S_3 & [\frac{3(2+\sqrt{3})}{4} - \Phi_2\Phi_3]\,A - S_2^2\ \Phi_3^2 \end{pmatrix},$$

and

$$S_2 = \tfrac{1}{2}\tanh\psi\ \sin(2\theta_1), \qquad S_3 = \tfrac{1}{2}\coth\psi\ \sin(2\phi_1),$$

$$\Phi_2 = \tfrac{3}{2} - \sin^2\theta_1\,, \qquad \Psi_2 = \tfrac{3}{2} - \cos^2\theta_1\,,$$

$$\Phi_3 = \tfrac{3}{2} - \sin^2\phi_1\,, \qquad \Psi_3 = \tfrac{3}{2} - \cos^2\phi_1\,,$$

$$A = \tfrac{3+\sqrt{3}}{4} + \tanh^2\psi\left[\tfrac{3(2+\sqrt{3})}{4} - \Psi_2\Phi_3\right], \qquad B = \tfrac{3+\sqrt{3}}{4} + \coth^2\psi\left[\tfrac{3(2+\sqrt{3})}{4} - \Psi_3\Phi_2\right].$$

Conclusions and perspectives

- We provided a new ansatz for the full uplift of the vacua of maximal gauged supergravity with non-compact gauge groups $SO(p,q)$ and tested it against the 11- dimensional equations of motion for all the known de Sitter vacua of these models.
- An alternative way of deriving the Uplift ansatze follows from a ground-up approach by using the $SU(8)$ reformulation of 11D SUGRA and SUSY as a organising principle.
- While the construction of the generalised vielbein involves the use of Killing tensors for the space with (p,q) signature, this procedure correctly reproduces euclidean geometries, because the scalar-dependent matrix $\mathcal{M}_{\mathbb{AB}}(x)$ is positive definite.
- The fact that the final metric depends on the contraction of the generalised vielbeins with a positive definite matrix $\mathcal{M}$, implies that at any vacuum the $SO(p,q)$ gauge group is broken to a subgroup of its maximal compact subgroup $SO(p) \times SO(q)$.

Conclusions and perspectives

- We provided a new ansatz for the full uplift of the vacua of maximal gauged supergravity with non-compact gauge groups $SO(p,q)$ and tested it against the 11- dimensional equations of motion for all the known de Sitter vacua of these models.
- An alternative way of deriving the Uplift ansatze follows from a ground-up approach by using the $SU(8)$ reformulation of 11D SUGRA and SUSY as a organising principle.
- While the construction of the generalised vielbein involves the use of Killing tensors for the space with (p,q) signature, this procedure correctly reproduces euclidean geometries, because the scalar-dependent matrix $\mathcal{M}_{\mathbb{A}\mathbb{B}}(x)$ is positive definite.
- The fact that the final metric depends on the contraction of the generalised vielbeins with a positive definite matrix $\mathcal{M}$, implies that at any vacuum the $SO(p,q)$ gauge group is broken to a subgroup of its maximal compact subgroup $SO(p) \times SO(q)$.

Conclusions and perspectives

- We provided a new ansatz for the full uplift of the vacua of maximal gauged supergravity with non-compact gauge groups $SO(p,q)$ and tested it against the 11- dimensional equations of motion for all the known de Sitter vacua of these models.
- An alternative way of deriving the Uplift ansatze follows from a ground-up approach by using the $SU(8)$ reformulation of 11D SUGRA and SUSY as a organising principle.
- While the construction of the generalised vielbein involves the use of Killing tensors for the space with (p,q) signature, this procedure correctly reproduces euclidean geometries, because the scalar-dependent matrix $\mathcal{M}_{\mathbb{AB}}(x)$ is positive definite.
- The fact that the final metric depends on the contraction of the generalised vielbeins with a positive definite matrix $\mathcal{M}$, implies that at any vacuum the $SO(p,q)$ gauge group is broken to a subgroup of its maximal compact subgroup $SO(p) \times SO(q)$.

Conclusions and perspectives

- We provided a new ansatz for the full uplift of the vacua of maximal gauged supergravity with non-compact gauge groups $SO(p,q)$ and tested it against the 11- dimensional equations of motion for all the known de Sitter vacua of these models.
- An alternative way of deriving the Uplift ansatze follows from a ground-up approach by using the $SU(8)$ reformulation of 11D SUGRA and SUSY as a organising principle.
- While the construction of the generalised vielbein involves the use of Killing tensors for the space with (p,q) signature, this procedure correctly reproduces euclidean geometries, because the scalar-dependent matrix $\mathcal{M}_{\mathbb{A}\mathbb{B}}(x)$ is positive definite.
- The fact that the final metric depends on the contraction of the generalised vielbeins with a positive definite matrix $\mathcal{M}$, implies that at any vacuum the $SO(p,q)$ gauge group is broken to a subgroup of its maximal compact subgroup $SO(p) \times SO(q)$.

Conclusions and perspectives

- We provided a new ansatz for the full uplift of the vacua of maximal gauged supergravity with non-compact gauge groups $SO(p,q)$ and tested it against the 11- dimensional equations of motion for all the known de Sitter vacua of these models.
- An alternative way of deriving the Uplift ansatze follows from a ground-up approach by using the $SU(8)$ reformulation of 11D SUGRA and SUSY as a organising principle.
- While the construction of the generalised vielbein involves the use of Killing tensors for the space with (p,q) signature, this procedure correctly reproduces euclidean geometries, because the scalar-dependent matrix $\mathcal{M}_{\mathbb{AB}}(x)$ is positive definite.
- The fact that the final metric depends on the contraction of the generalised vielbeins with a positive definite matrix $\mathcal{M}$, implies that at any vacuum the $SO(p,q)$ gauge group is broken to a subgroup of its maximal compact subgroup $SO(p) \times SO(q)$.

Conclusions and perspectives

- An independent derivation of the CSO(p,q,r) gaugings was proposed by Hohm and Samtleben in the Exceptional Field Theory framework (EFT). Even though the geometrical interpretation of these solutions is not completely clear, these should reduced to ours for $r = 0$ because they imposed the section conditions.
- The same approach was successfully applied by Hohm and Samtleben to get the uplift formulas of IIB supergravity with compact and non compact gauge group.
- After 35 years of work in this longstanding problem we feel confident that today all electric maximal gauged supergravities can be uplifted to 11D Supergravity.
- A very interesting problem is to understand if the dyonic gauged supergravities recently proposed by Dall'Agata, Inverso and Trigiante can be uplifted to 11 D Supergravity or some deformation. By simple analysis of the generalised Lie derivatives of the generalised vielbeins one observes that dyonic gaugings need the inclusion of form fluxes in the background. We expect to explore this situation in the future.

Conclusions and perspectives

- An independent derivation of the CSO(p,q,r) gaugings was proposed by Hohm and Samtleben in the Exceptional Field Theory framework (EFT). Even though the geometrical interpretation of these solutions is not completely clear, these should reduced to ours for $r = 0$ because they imposed the section conditions.
- The same approach was successfully applied by Hohm and Samtleben to get the uplift formulas of IIB supergravity with compact and non compact gauge group.
- After 35 years of work in this longstanding problem we feel confident that today all electric maximal gauged supergravities can be uplifted to 11D Supergravity.
- A very interesting problem is to understand if the dyonic gauged supergravities recently proposed by Dall'Agata, Inverso and Trigiante can be uplifted to 11 D Supergravity or some deformation. By simple analysis of the generalised Lie derivatives of the generalised vielbeins one observes that dyonic gaugings need the inclusion of form fluxes in the background. We expect to explore this situation in the future.

Conclusions and perspectives

- An independent derivation of the CSO(p,q,r) gaugings was proposed by Hohm and Samtleben in the Exceptional Field Theory framework (EFT). Even though the geometrical interpretation of these solutions is not completely clear, these should reduced to ours for $r = 0$ because they imposed the section conditions.
- The same approach was successfully applied by Hohm and Samtleben to get the uplift formulas of IIB supergravity with compact and non compact gauge group.
- After 35 years of work in this longstanding problem we feel confident that today all electric maximal gauged supergravities can be uplifted to 11D Supergravity.
- A very interesting problem is to understand if the dyonic gauged supergravities recently proposed by Dall'Agata, Inverso and Trigiante can be uplifted to 11 D Supergravity or some deformation. By simple analysis of the generalised Lie derivatives of the generalised vielbeins one observes that dyonic gaugings need the inclusion of form fluxes in the background. We expect to explore this situation in the future.

Conclusions and perspectives

- An independent derivation of the CSO(p,q,r) gaugings was proposed by Hohm and Samtleben in the Exceptional Field Theory framework (EFT). Even though the geometrical interpretation of these solutions is not completely clear, these should reduced to ours for $r = 0$ because they imposed the section conditions.
- The same approach was successfully applied by Hohm and Samtleben to get the uplift formulas of IIB supergravity with compact and non compact gauge group.
- After 35 years of work in this longstanding problem we feel confident that today all electric maximal gauged supergravities can be uplifted to 11D Supergravity.
- A very interesting problem is to understand if the dyonic gauged supergravities recently proposed by Dall'Agata, Inverso and Trigiante can be uplifted to 11 D Supergravity or some deformation. By simple analysis of the generalised Lie derivatives of the generalised vielbeins one observes that dyonic gaugings need the inclusion of form fluxes in the background. We expect to explore this situation in the future.

Conclusions and perspectives

- An independent derivation of the CSO(p,q,r) gaugings was proposed by Hohm and Samtleben in the Exceptional Field Theory framework (EFT). Even though the geometrical interpretation of these solutions is not completely clear, these should reduced to ours for $r = 0$ because they imposed the section conditions.
- The same approach was successfully applied by Hohm and Samtleben to get the uplift formulas of IIB supergravity with compact and non compact gauge group.
- After 35 years of work in this longstanding problem we feel confident that today all electric maximal gauged supergravities can be uplifted to 11D Supergravity.
- A very interesting problem is to understand if the dyonic gauged supergravities recently proposed by Dall'Agata, Inverso and Trigiante can be uplifted to 11 D Supergravity or some deformation. By simple analysis of the generalised Lie derivatives of the generalised vielbeins one observes that dyonic gaugings need the inclusion of form fluxes in the background. We expect to explore this situation in the future.

Thank you for your attention!