A Kaluza-Klein spectrometer from Exceptional Field Theory

Emanuel Malek

Max-Planck-Institut für Gravitationsphysik
(Albert-Einstein-Institut)

Exceptional Geometry Seminars,
24th April 2020

Based on:
EM, Samtleben: 1911.12640, PRL 124 (2020) 10, 101601
EM, Samtleben: 20xx.xxxx
EM, Nicolai, Samtleben: 20xx.xxxx

The importance of Kaluza-Klein spectra

- Compactification $\Rightarrow$ massive Kaluza-Klein modes arise
- Kaluza-Klein spectrum important
  - AdS/CFT: conformal dimensions
  - Stability of non-SUSY vacua?

Computing Kaluza-Klein spectra is hard

- Free scalar on S^1:

$$0 = \partial_x^2 \phi(x,y) + \partial_y^2 \phi(x,y)\,,$$

$$\phi(x,y) = \phi^{(k)}(x)\, e^{i\,k\,y/R}\,, \qquad m^2 = \frac{k^2}{R^2}\,.$$

- SUGRA: (linearised) EoMs mix metric & fluxes $\Rightarrow$ eigenmodes?

$$\nabla_Q f^{QMNP} + \frac{1}{2} F^{QMNP} \nabla_Q h_R{}^R - \nabla_Q \left(h^{QR} F_R{}^{MNP} \right) - 3 \nabla^Q \left(h^{S[M} F_{QS}{}^{NP]} \right) = -\frac{1}{288} \epsilon^{MNPQ_1 \ldots Q_8} F_{Q_1 \ldots Q_4} f_{Q_5 \ldots Q_8}\,.$$

- Spin-2 fields [Bachas, Estes '11] ✓
- $M_{int} = \frac{G}{H}$ ✓

... even on G/H

- 11-d on $AdS_4 \times S^7$ [Englert, Nicolai '83] [Sezgin '84] [Biran, Casher, Englert, Rooman, Spindel]
- KK split:

$$g \longrightarrow (g_{ij},\, g_{\mu\, i},\, g_{\mu\nu})\,, \qquad C_{(3)} \longrightarrow (C_{ijk},\, C_{\mu\, ij},\, \ldots)\,,$$
$$C_{(6)} \longrightarrow (C_{ijklmn},\, C_{\mu\, ijklm},\, \ldots)\,.$$

- Expand in S^7 harmonics

$$g_{ij}(x,y) = \sum_k g^{(k)}(x)\, \mathcal{Y}^{(k)}_{ij}\,, \qquad C_{ijk}(x,y) = \sum_k C^{(k)}(x)\, \mathcal{Y}^{(k)}_{ijk}\,,$$
$$g_{\mu i}(x,y) = \sum_k g^{(k)}_{\mu}\, \mathcal{Y}^{(k)}_{i}\,, \qquad C_{\mu\, ij}(x,y) = \sum_k C^{(k)(x)}_{\mu}\, \mathcal{Y}^{(k)}_{ijk}\,,$$
$$g_{\mu\nu}(x,y) = \sum_k g^{(k)}_{\mu\nu}\, \mathcal{Y}^{(k)}\,, \qquad \ldots$$

- EoMs mix metric & fluxes $\Rightarrow$ diagonalisation problem

BPS multiplets

- BPS multiplets mix different KK levels

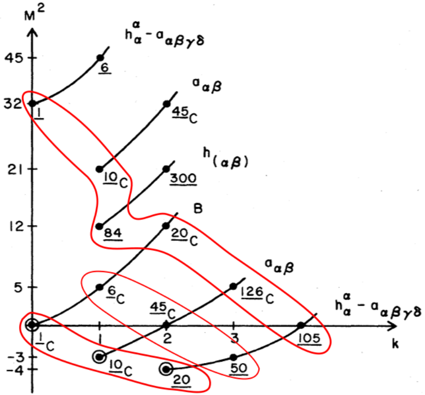


FIG. 2. Mass spectrum of scalars.

[Kim, Romans, Van Nieuwenhuizen '85]

A new method for computing Kaluza-Klein spectra

Our method: [Malek, Samtleben 1911.12640] (for max SUSY AdS_D)

- Only requires scalar harmonics
- Leads to immediate mass diagonalisation
- Organises into supermultiplets
- Can follow deformations by D-dim SUGRA multiplet

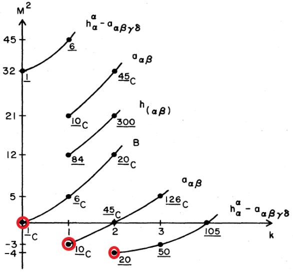
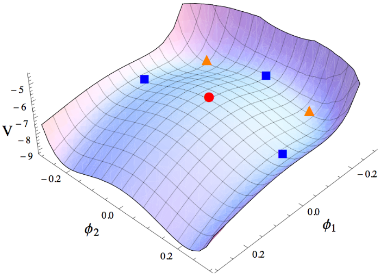


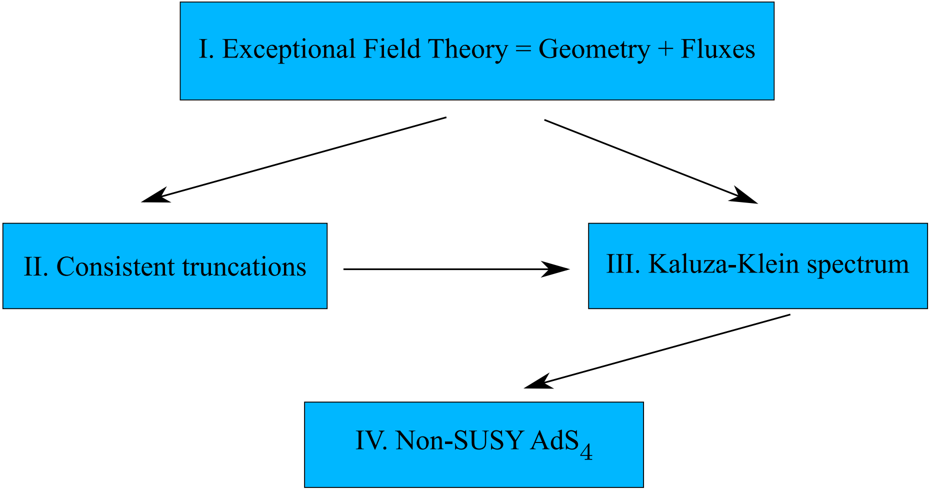
FIG. 2. Mass spectrum of scalars.



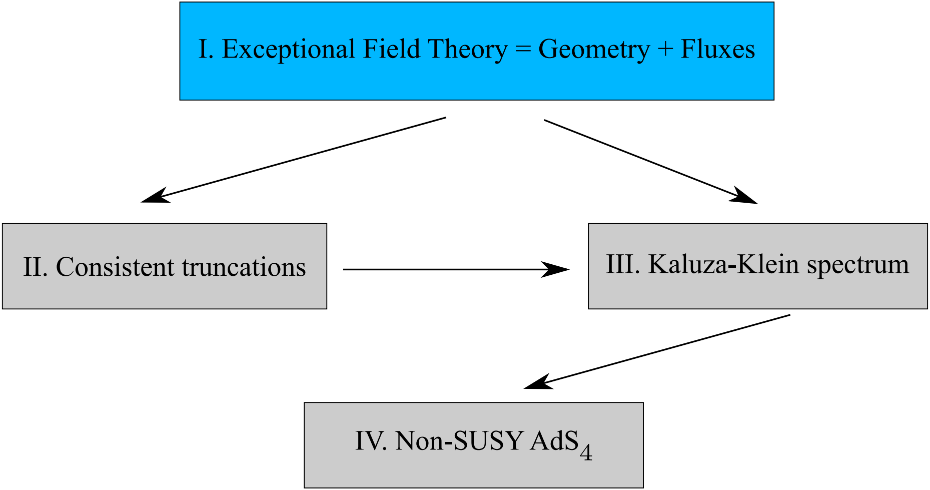
Our methodology

- Mixing of geometry + fluxes $\Rightarrow$ Exceptional Field Theory
- KK Ansatz: $\underbrace{\text{4-D SUGRA multiplet}}_{\text{consistent truncation}} \otimes$ Scalar harmonics
- Cleaner structure
- Non-linear in 4-D $\Rightarrow$ other vacua

Outline


I. Exceptional Field Theory = Geometry + Fluxes
II. Consistent truncations
III. Kaluza-Klein spectrum
IV. Non-SUSY AdS_4

Exceptional Field Theory = Geometry + Fluxes



$E_{7(7)}$ Exceptional field theory

- KK-split of 11-d SUGRA: $\left(g,\ C_{(3)},\ C_{(6)}\right)$

$$M_{11} = M_4 \times M_{int}\,.$$

- Unify metric & fluxes:

$$\left\{g,\ C_{(3)},\ C_{(6)}\right\} = \mathcal{M}_{MN} \in \frac{E_{7(7)}}{\mathrm{SU}(8)}\,.$$

- Unify diffeos + gauge symmetries $\rightarrow$ generalised tangent bundle

$$E \simeq TM \oplus \Lambda^2 T^*M \oplus \Lambda^5 T^*M \oplus \left(T^*M \otimes \Lambda^7 T^*M\right)$$

$$\Rightarrow E \sim \mathbf{56} \text{ of } E_{7(7)}$$

- Generalised Lie derivative

$$\mathcal{L}_V = V^M \partial_M - \left(\partial \times_{adj} V\right) = \text{diffeo} + \text{gauge transf}\,,$$

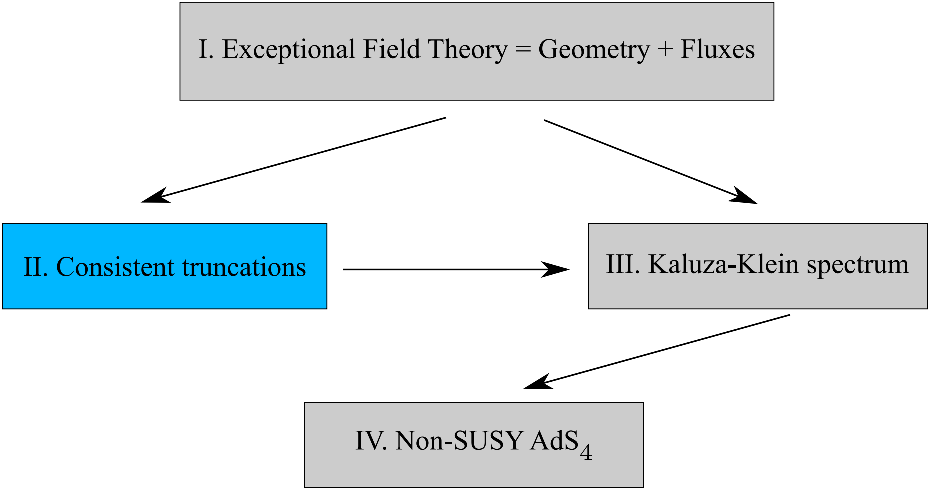
$E_{7(7)}$ ExFT

Full 11-d action: [Hohm, Samtleben '13]

$$L = R_g + \frac{1}{24} g^{\mu\nu} \mathfrak{D}_\mu \mathcal{M}^{MN} \mathfrak{D}_\nu \mathcal{M}_{MN} - \frac{1}{4} \mathcal{F}_{\mu\nu}{}^M \mathcal{F}^{\mu\nu\,N} \mathcal{M}_{MN} + L_{top} - V \,,$$

- "Like 4-D SUGRA"
- $\mathfrak{D}_\mu = \partial_\mu - \mathcal{L}_{\mathcal{A}_\mu}$ "external covariant derivatives"
- $\mathcal{F}_{\mu\nu}{}^M = 2\partial_{[\mu} \mathcal{A}_{\nu]}{}^M - 2\mathcal{L}_{A_{[\mu}} A_{\nu]}{}^M + \ldots$

Consistent truncations from ExFT



Consistent truncations from AdS vacua

- Maximally SUSY AdS vacua admit consistent truncation

10/11-d SUGRA $\xrightarrow{\text{Truncation of } AdS_D \text{x } M_{int} \text{ on } M_{int}}$ D-dim gSUGRA

D-dim gSUGRA $\xrightarrow{\text{Every solution of gSUGRA uplifts to solution of 10/11-d}}$ 10/11-d SUGRA

- $AdS_4 \times S^7 \longrightarrow$ 4-D $\mathcal{N} = 8$ $\mathrm{SO}(8)$ gSUGRA

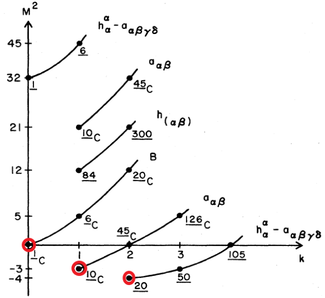


FIG. 2. Mass spectrum of scalars.

Consistent truncations = generalised Scherk-Schwarz

- Generalised Scherk-Schwarz Ansatz: $U_M{}^A(Y) \in E_{7(7)}$

$$\mathcal{M}_{MN}(x, Y) = M_{AB}(x)\, U_M{}^A(Y)\, U_N{}^B(Y)\,,$$
$$\mathcal{A}_\mu{}^M(x, Y) = A_\mu{}^A(x)\, U_A{}^M(Y)$$

- $U_A{}^M$ generalised frame fields
- Consistency condition:

$$\mathcal{L}_{U_A} U_B = X_{AB}{}^C U_C\,.$$

Proof of consistency

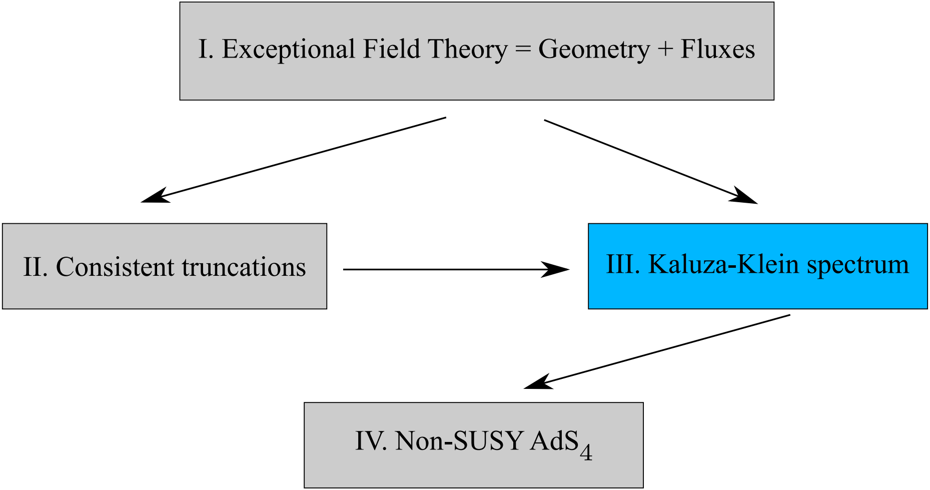
- All Y-dependence in action & EoMs appears via $\mathcal{L}$

$$\mathcal{D}_\mu = \partial_\mu - \mathcal{L}_{A_\mu}$$
$$\mathcal{F}_{\mu\nu}{}^M = 2\partial_{[\mu}\mathcal{A}_{\nu]}{}^M - 2\mathcal{L}_{\mathcal{A}_{[\mu}}\mathcal{A}_{\nu]}{}^M + \ldots$$

$$\boxed{\begin{aligned}\mathcal{M}_{MN}(x,Y) &= \mathcal{M}_{AB}(x)\, U_M{}^A(Y)\, U_N{}^B(Y)\,,\\ \mathcal{A}_\mu{}^M(x,Y) &= A_\mu{}^A(x)\, U_A{}^M(Y)\,,\end{aligned}}$$

$$D_\mu = \partial_\mu - A_\mu{}^A X_A\cdot$$
$$F_{\mu\nu}{}^A = 2\partial_{[\mu}A_{\nu]}{}^A - 2A_\mu{}^B A_\nu{}^C X_{BC}{}^A + \ldots$$

Kaluza-Klein spectrum from ExFT



Scalar KK Ansatz at symmetric point

- Background (S^7) described by $U^A{}_M \in E_{7(7)}$

$$\left\{g,\ C_{(3)},\ C_{(6)}\right\} \in \mathcal{M}_{MN} = \delta_{AB} U^A{}_M\, U^B{}_N$$

- Kaluza-Klein Ansatz: linear deformation

$$U^A{}_M(Y) \longrightarrow \left(\delta^A{}_B + j^A{}_B{}^\Sigma(x)\,\mathcal{Y}_\Sigma\right) U^B{}_M\,, \qquad j^A{}_B{}^\Sigma \in \mathfrak{e}_{7(7)}\,.$$

- Scalar harmonics: $\mathcal{Y}_\Sigma = \left(1,\, \mathcal{Y}_a,\, \mathcal{Y}_{((a}\mathcal{Y}_{b))},\, \ldots\right)$, where $\mathcal{Y}_a\mathcal{Y}^a = 1$.

KK Ansatz at symmetric point

- Kaluza-Klein Ansatz: consistent truncation $\otimes$ scalar harmonics

$$\mathcal{M}_{MN}(x,Y) = (\delta_{AB} + \underbrace{2\,j_{(AB)}{}^{\Sigma}(x)}_{\in\mathfrak{e}_{7(7)}-\mathfrak{su}(8)}\,\mathcal{Y}_\Sigma)\,U^A{}_M(Y)\,U^B{}_N(Y)\,.$$

$$\mathcal{A}_\mu{}^M(x,Y) = A_\mu{}^{A\,\Sigma}(x)\,U_A{}^M(Y)\,\mathcal{Y}_\Sigma(Y)\,.$$

- Metric as usual:

$$g_{\mu\nu}(x,Y) = g^0_{\mu\nu}(Y) + h_{\mu\nu}{}^{\Sigma}(x)\,\mathcal{Y}_\Sigma\,.$$

Mass matrices at symmetric point

- Mass matrices

$$\Box h_{\mu\nu}{}^{\Sigma} = (M_g)^{\Sigma}{}_{\Omega} h_{\mu\nu}{}^{\Omega} \,, \quad \Box j_{AB}{}^{\Sigma} = (M_s)_{AB}{}^{\Sigma,CD}{}_{\Omega}\, j_{CD}{}^{\Omega} \,,$$
$$\Box A_{\mu}{}^{A\Sigma} = (M_v)^{A\Sigma,}{}_{B\Omega}\, A^{B\Omega} \,, \quad \ldots$$

- All internal dependence through $\mathcal{L}$

$$\mathcal{L}_{U_A} U_B = X_{AB}{}^{C} U_C \,,$$
$$\mathcal{L}_{U_A} \mathcal{Y}_{\Sigma} = L_{\mathcal{K}_A} \mathcal{Y}_{\Sigma} = \mathcal{T}_{A\Sigma}{}^{\Omega} \mathcal{Y}_{\Omega} \,.$$

- $\Rightarrow$ Mass$^2 \sim \mathcal{T}^2$, $\mathcal{T} \cdot X$ and X^2

Mass matrices at symmetric point

- Mass matrices:

$$
\begin{aligned}
& M^{AB\Sigma,CD\Omega}\, j_{AB,\Sigma}\, j_{CD,\Omega} \\
&= \frac{1}{7}\left[-6\, X^{ACD} X^{B}{}_{CD} + 2\, X^{CAD} X_{C}{}^{B}{}_{D}\right] j_{A}{}^{E,\Sigma} j_{BE,\Sigma} \\
&\quad + \frac{2}{7}\left[2\, X^{ACE} X^{BD}{}_{E} - X^{EAC} X_{E}{}^{BD}\right] j_{AB}{}^{\Sigma}\, j_{CD,\Sigma} \\
&\quad - 4\, X^{ACD}\, \mathcal{T}^{B,\Omega\Sigma}\, j_{AB,\Sigma}\, j_{CD,\Omega} - 4\, X^{CAB}\, \mathcal{T}_{C}{}^{\Omega}{}_{\Sigma}\, j_{A}{}^{D,\Sigma}\, j_{BD,\Omega} \\
&\quad + 24\, \mathcal{T}_{A}{}^{\Omega}{}_{\Lambda}\, \mathcal{T}^{B,\Lambda}{}_{\Sigma}\, j^{AC,\Sigma}\, j_{BC,\Omega} - \mathcal{T}^{C,\Omega}{}_{\Lambda}\, \mathcal{T}_{C}{}^{\Lambda}{}_{\Sigma}\, j^{AB,\Sigma}\, j_{AB,\Omega}\,,
\end{aligned}
$$

KK spectrum on S^7

- Break $E_{7(7)} \to \mathrm{SO}(8)$, $\mathbf{56} \longrightarrow \mathbf{28} \oplus \mathbf{28}$
- $X_{AB}{}^{C} \to \mathrm{SO}(8)$
- Harmonics $\mathcal{Y}_\Sigma = (1,\, \mathcal{Y}_a,\, \mathcal{Y}_{ab},\, \ldots) \in [n,0,0,0]$

$$\mathcal{T}_A{}^\Sigma{}_\Omega = \big(\underbrace{\mathcal{T}_{ab}{}^{e_1\ldots e_n}{}_{f_1\ldots f_n}}_{\mathrm{SO}(8)\text{generators}},\, \underbrace{\mathcal{T}^{ab,e_1\ldots e_n}{}_{f_1\ldots f_n}}_{=0}\big)\,.$$

$$j^A{}_{B\,\Sigma} = \big(\phi_{ab},\, \phi_{abcd}\big)_{,e_1\ldots e_n}\,.$$

S^7 mass diagonalisation and BPS multiplets

$$\phi_{ab,e_1\dots e_n} \ni [n+2,0,0,0] \oplus [n-2,2,0,0] \oplus \dots$$

- Each irrep $\to$ 1 mass eigenstate
- $[n,0,0,0] \to$ 1 BPS multiplet
- Mixing from ${U_A}^M \mathcal{Y}_\Sigma$ and ExFT $\leftrightarrow$ 11-d dictionary

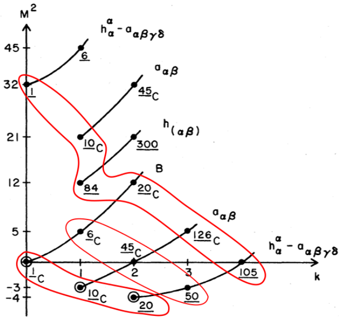
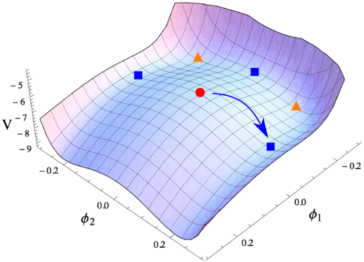


FIG. 2. Mass spectrum of scalars.

Moving to a less symmetric vacuum

- Vacuum $M_{AB}(x) = \mathcal{V}^{\bar{A}}{}_A(x)\, \mathcal{V}^{\bar{B}}{}_B(x)\, \delta_{\bar{A}\bar{B}}$
- $U^A{}_M \longrightarrow U^{\bar{A}}{}_M = \mathcal{V}^{\bar{A}}{}_B U^B{}_M$.

$$\mathcal{L}_{U_{\bar{A}}} U_{\bar{B}} = X_{\bar{A}\bar{B}}{}^{\bar{C}} U_{\bar{C}} \,, \qquad X_{\bar{A}\bar{B}}{}^{\bar{C}} = \mathcal{V}_{\bar{A}}{}^A \mathcal{V}_{\bar{B}}{}^B \mathcal{V}^{\bar{C}}{}_C X_{AB}{}^C \,.$$



Harmonics at less symmetric vacuum

- Use same harmonics $\mathcal{Y}_\Sigma$ as max. symmetric vacuum.
- Linear action on harmonics:

$$\mathcal{L}_{U_{\bar{A}}}\mathcal{Y}_\Sigma = L_{\mathcal{K}_{\bar{A}}}\mathcal{Y}_\Sigma = \mathcal{T}_{\bar{A}\,\Sigma}{}^{\Omega}\mathcal{Y}_\Omega\,,$$

$$\mathcal{T}_{\bar{A}\,\Sigma}{}^{\Omega} = \mathcal{V}_{\bar{A}}{}^{A}\,\mathcal{T}_{A\,\Sigma}{}^{\Omega}\,,$$

Kaluza-Klein masses at less symmetric vacuum

- Harmonic analysis *at max. symmetric point*:
  - Scalar harmonics
  - $\mathcal{T}_{A,\Omega}{}^{\Sigma}$
- All deformation info from "dressing":

$$X_{AB}{}^{C} \longrightarrow X_{\bar{A}\bar{B}}{}^{\bar{C}}\,, \qquad \mathcal{T}_{A\,\Omega}{}^{\Sigma} \longrightarrow \mathcal{T}_{\bar{A},\Omega}{}^{\Sigma}\,,$$

$$X_{\bar{A}\bar{B}}{}^{\bar{C}} = \mathcal{V}_{\bar{A}}{}^{A}\,\mathcal{V}_{\bar{B}}{}^{B}\,\mathcal{V}^{\bar{C}}{}_{C}\,X_{AB}{}^{C}\,, \qquad \mathcal{T}_{\bar{A},\Omega}{}^{\Sigma} = \mathcal{V}_{\bar{A}}{}^{A}\,\mathcal{T}_{A\,\Omega}{}^{\Sigma}\,.$$

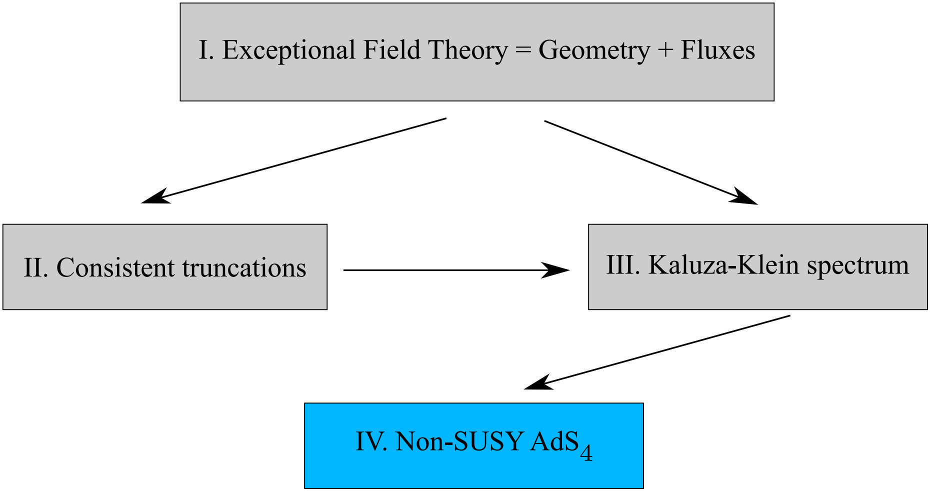
Kaluza-Klein masses at less symmetric vacuum

- Harmonic analysis *at max. symmetric point*:
  - Scalar harmonics
  - $\mathcal{T}_{A,\Omega}{}^{\Sigma}$
- All deformation info from "dressing":

$$X_{AB}{}^{C} \longrightarrow X_{\bar{A}\bar{B}}{}^{\bar{C}}\,, \qquad \mathcal{T}_{A\,\Omega}{}^{\Sigma} \longrightarrow \mathcal{T}_{\bar{A},\Omega}{}^{\Sigma}\,,$$
$$X_{\bar{A}\bar{B}}{}^{\bar{C}} = \mathcal{V}_{\bar{A}}{}^{A}\,\mathcal{V}_{\bar{B}}{}^{B}\,\mathcal{V}^{\bar{C}}{}_{C}\,X_{AB}{}^{C}\,, \qquad \mathcal{T}_{\bar{A},\Omega}{}^{\Sigma} = \mathcal{V}_{\bar{A}}{}^{A}\,\mathcal{T}_{A\,\Omega}{}^{\Sigma}\,.$$

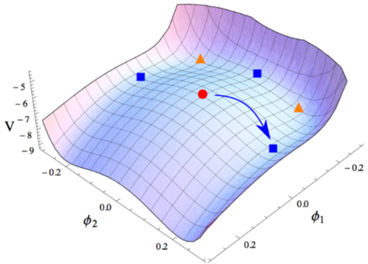
$$\begin{aligned}
M^{\bar{A}\bar{B}\Sigma,\bar{C}\bar{D}\Omega}\, j_{\bar{A}\bar{B},\Sigma}\, j_{\bar{C}\bar{D},\Omega} = {}& \frac{1}{7}\left[-6\,X^{\bar{A}\bar{C}\bar{D}}X^{\bar{B}}{}_{\bar{C}\bar{D}} + 2\,X^{\bar{C}\bar{A}\bar{D}}X_{\bar{C}}{}^{\bar{B}}{}_{\bar{D}}\right] j_{\bar{A}}{}^{\bar{E},\Sigma} j_{\bar{B}\bar{E},\Sigma} \\
&+ \frac{2}{7}\left[2\,X^{\bar{A}\bar{C}\bar{E}}X^{\bar{B}\bar{D}}{}_{\bar{E}} - X^{\bar{E}\bar{A}\bar{C}}X_{\bar{E}}{}^{\bar{B}\bar{D}}\right] j_{\bar{A}\bar{B}}{}^{\Sigma} j_{\bar{C}\bar{D},\Sigma} \\
&- 4X^{\bar{A}\bar{C}\bar{D}}\mathcal{T}^{\bar{B},\Omega\Sigma} j_{\bar{A}\bar{B},\Sigma}\, j_{\bar{C}\bar{D},\Omega} - 4X^{\bar{C}\bar{A}\bar{B}}\mathcal{T}_{\bar{C}}{}^{\Omega}{}_{\Sigma}\, j_{\bar{A}}{}^{\bar{D},\Sigma} j_{\bar{B}\bar{D},\Omega} \\
&+ 24\mathcal{T}_{\bar{A}}{}^{\Omega}{}_{\Lambda}\mathcal{T}^{\bar{B},\Lambda}{}_{\Sigma}\, j^{\bar{A}\bar{C},\Sigma} j_{\bar{B}\bar{C},\Omega} - \mathcal{T}^{\bar{C},\Omega}{}_{\Lambda}\mathcal{T}_{\bar{C}}{}^{\Lambda}{}_{\Sigma}\, j^{\bar{A}\bar{B},\Sigma} j_{\bar{A}\bar{B},\Omega}\,,
\end{aligned}$$

Non-SUSY AdS_4



Non-supersymmetric AdS_4

- 4-D $\mathrm{SO}(8)$ gSUGRA $\supset \mathrm{SO}(3) \times \mathrm{SO}(3)$-invariant $\mathcal{N} = 0$ AdS_4 vacuum [Warner '83]



- Uplift to 11-d [Godazgar, Godazgar, Kruger, Nicolai, Pilch]
- Fully stable in 4-D! [Fishbacher, Pilch, Warner '10]
  Only known example in 4-D.

Stability in 11-d?

- Uplift to 11-d stable? Higher KK modes?
- AdS swampland conjecture [Ooguri, Vafa '16]]
- Brane-Jet instability [Bena, Pilch, Warner '20]

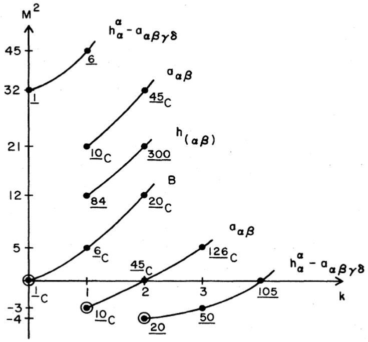
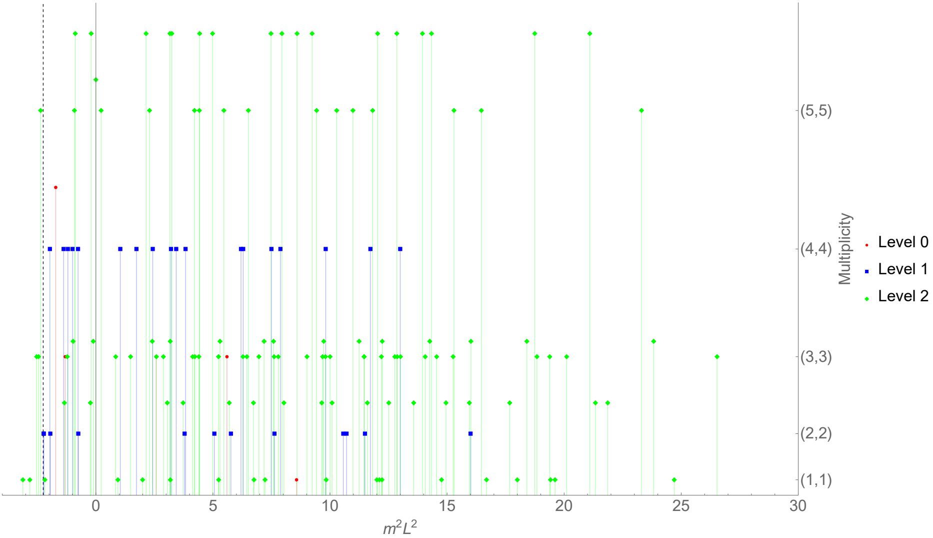


FIG. 2. Mass spectrum of scalars.

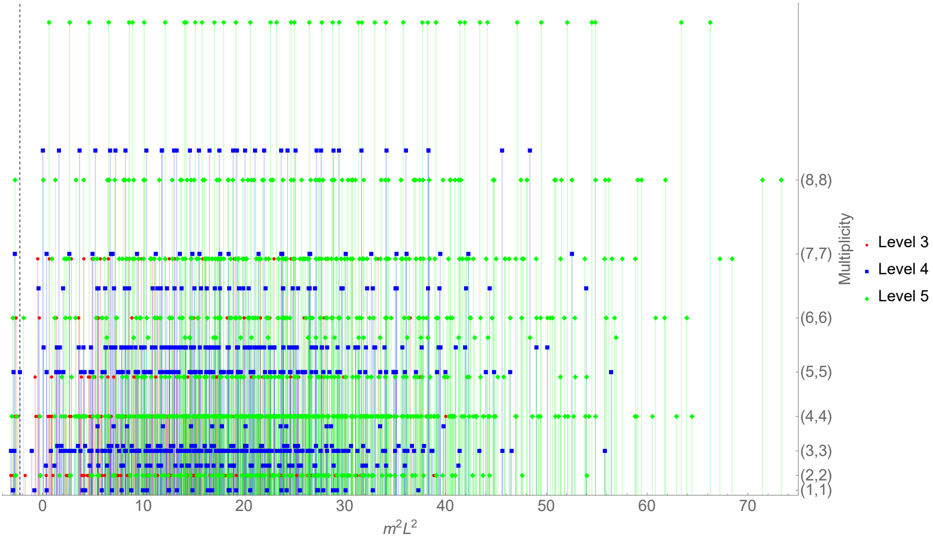
Non-supersymmetric KK spectroscopy

- Harmonic analysis for round S^7 ($\mathrm{SO}(8)$ point)
  - Scalar harmonics $\mathcal{Y}^\Sigma = \left(1,\, \mathcal{Y}^a,\, \mathcal{Y}^{ab},\, \ldots,\, \mathcal{Y}^{a_1\ldots a_n},\, \ldots\right)$
  - ${\mathcal{T}_{A,\Omega}}^\Sigma \to {\mathcal{T}_{A,a_1\ldots a_n}}^{b_1\ldots b_n} \to \mathrm{SO}(8)$ generators
- Lower-dimensional info captures deformation
  - ${\mathcal{V}_{\bar{A}}}^A$ from [Warner '83].
  - $\to$ dressed ${X_{\bar{A}\bar{B}}}^{\bar{C}}$, ${\mathcal{T}_{\bar{A},\Omega}}^\Sigma$.

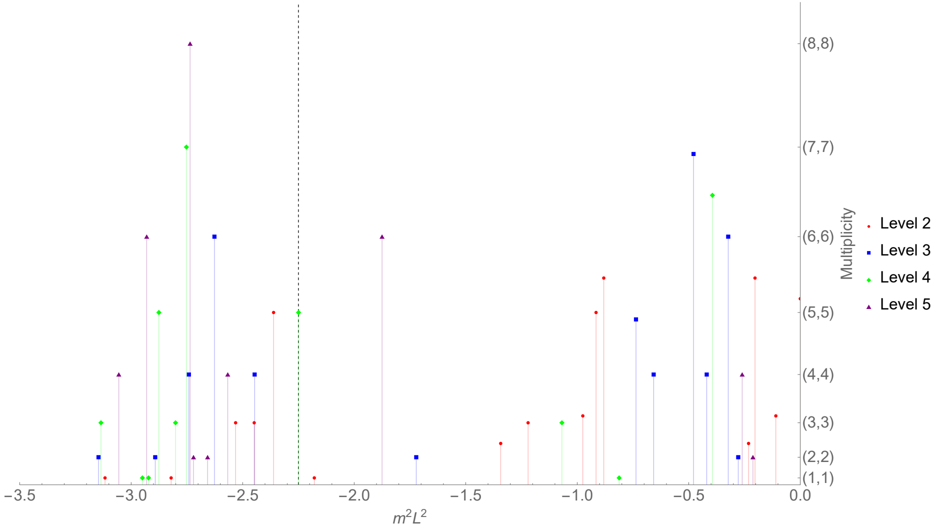
KK spectrum levels 0 – 2



KK spectrum levels 3 – 5



KK Tachyons


(8,8)
(7,7)
(6,6)
(5,5)
(4,4)
(3,3)
(2,2)
(1,1)
Multiplicity
−3.5
−3.0
−2.5
−2.0
−1.5
−1.0
−0.5
0.0
m^2L^2
Level 2
Level 3
Level 4
Level 5

Tachyonic Kaluza-Klein modes

$$
\begin{aligned}
&\text{Level 2:} && 2\cdot(\mathbf{1},\mathbf{1})\oplus 2\cdot(\mathbf{3},\mathbf{3})\oplus(\mathbf{5},\mathbf{5})\,,\\
&\text{Level 3:} && 2\cdot(\mathbf{2},\mathbf{2})\oplus 2\cdot(\mathbf{4},\mathbf{4})\oplus(\mathbf{6},\mathbf{6})\,,\\
&\text{Level 4:} && 2\cdot(\mathbf{1},\mathbf{1})\oplus 2\cdot(\mathbf{3},\mathbf{3})\oplus(\mathbf{5},\mathbf{5})\oplus(\mathbf{7},\mathbf{7})\,,\\
&\text{Level 5:} && 2\cdot(\mathbf{2},\mathbf{2})\oplus 2\cdot(\mathbf{4},\mathbf{4})\oplus(\mathbf{6},\mathbf{6})\oplus(\mathbf{8},\mathbf{8})\,.
\end{aligned}
$$

Moduli

- 27 massless scalar fields at level 2
- $3 \cdot (\mathbf{3}, \mathbf{3}) \Rightarrow$ break $\mathrm{SO}(3) \times \mathrm{SO}(3)$ symmetry!
- Finite deformations?
- Family of non-SUSY AdS$_4$ vacua of 11-d SUGRA?

General procedure

- Given consistent truncation to $\mathcal{N} = 8$ D-dim SUGRA
- Scalar harmonics on $M_{int} = G/H$ at maximally symmetric point
- Can compute KK masses for *any* vacuum of D-dim SUGRA

AdS$_4$ vacua of $\mathrm{ISO}(7)$ SUGRA

- Consistent truncation of massive IIA on $S^6 \Rightarrow \mathcal{N} = 8$ $\mathrm{ISO}(7)$ gSUGRA [Guarino, Jafferis, Varela '15]
  - $\mathcal{N} = 2$ AdS$_4$ [Guarino, Jafferis, Varela '15]
  - $\mathcal{N} = 3$ AdS$_4$ vacua [Gallerati, Samtleben, Trigiante '14]
- No maximally supersymmetric vacuum
- Round S^6 not a solution!
- But use harmonics on S^6 for KK spectrum

Conclusions

- Powerful method for computing KK spectra
- KK spectrum of less symmetric vacua
- Non-SUSY $\mathrm{SO}(3) \times \mathrm{SO}(3)$ AdS_4 vacuum is unstable
  c.f. Brane-Jet instability [Bena, Pilch, Warner '20]
- Existence of consistent truncation has bigger implications!

Outlook

- Non-SUSY AdS$_4$
  - End-point of instability?
  - Finite moduli?
  - Other examples in 3-D [Fischbacher '02] [Fischbacher, Nicolai, Samtleben '02]
- KK spectrum of SUSY AdS vacua
  - Compute indices (c.f. [Ashmore, Petrini, Tasker, Waldram])
  - Understanding of long multiplets
  - Correlation functions
- Extension to consistent truncations with less SUSY
  $\Rightarrow$ KK spectrum of 1/2-max AdS vacua, c.f. spin-2 [Chen, Gutperle, Uhlemann '19], [Gutperle, Uhlemann, Varela '18]