Scale-separated Flux Vacua in 3D

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String Theory

- We want a single theory that explains everything: **gravity** and **quantum** physics — the **very big** and the **very small**.
- **String theory** is the most promising candidate.
- Strings need **10** (or 11) **dimensions** to work!
- We don't see these extra dimensions… so where are they?

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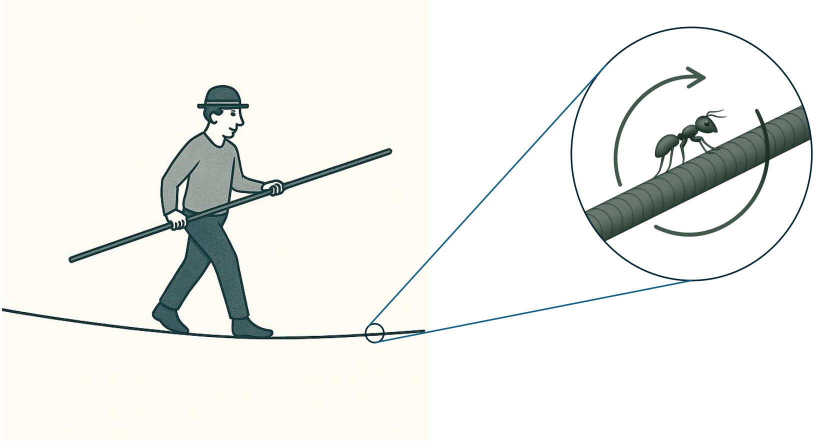
THEY ARE COMPACTIFIED!

Compact dimensions



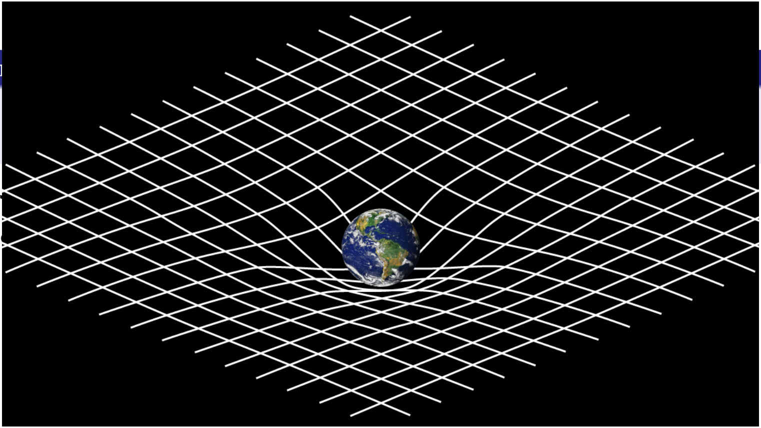
Kaluza-Klein

Pure gravity in 5D

$$S_E = \int d^5x \sqrt{-\hat{g}}\, \hat{R}$$

- **Gravity $\longleftrightarrow$ Spacetime curvature**
- Geometry encoded in the **metric**

Pure gr



- **Gr**
- Ge

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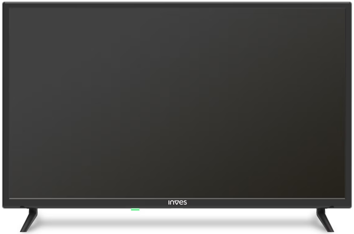

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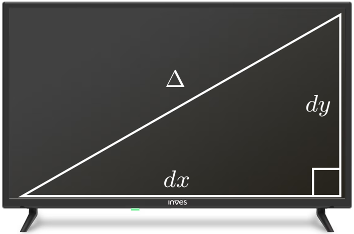

$$\Delta^2 = dx^2 + dy^2 = \begin{pmatrix} dx & dy \end{pmatrix} \underbrace{\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}}_{g} \begin{pmatrix} dx \\ dy \end{pmatrix}$$

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$$\Delta^2 = \begin{pmatrix} d\theta & d\varphi \end{pmatrix} \underbrace{\begin{pmatrix} R^2 & 0 \\ 0 & R^2 \sin^2\theta \end{pmatrix}}_{g} \begin{pmatrix} d\theta \\ d\varphi \end{pmatrix}$$

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$$\Delta^2 = \begin{pmatrix} dx & dy \end{pmatrix} \underbrace{\begin{pmatrix} g_{xx} & g_{xy} \\ g_{xy} & g_{yy} \end{pmatrix}}_{g} \begin{pmatrix} dx \\ dy \end{pmatrix}$$

Pure gravity in 5D

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5D metric:

$$g_5 = \left(\begin{array}{c|c} g_4 & v \\ \hline v & \phi \end{array}\right)$$

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Gravity + Maxwell + Scalar

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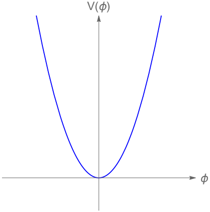
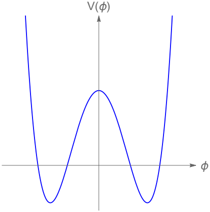
Gravity + Maxwell + Scalar

- ϕ parametrises the size of the extra dimension
- Needs to be small compared with external spacetime $\rightsquigarrow$ **Scale separation.**

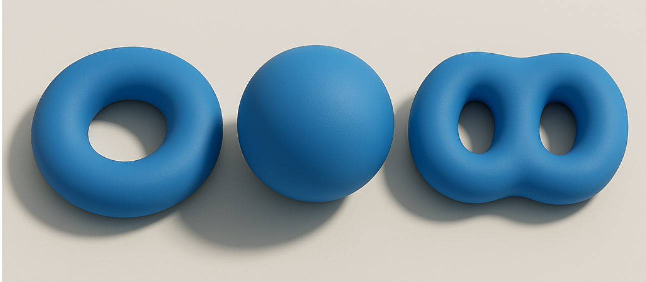
Scalar potential

- We need a **scalar potential** to stabilise the scalar(s)





- Different internal **geometries** and/or **background fluxes**



Set-up

Pure Gravity	$\longrightarrow$	Type II Supergravity
5D $\to$ 4D	$\longrightarrow$	10D $\to$ 3D
Circle	$\longrightarrow$	Group manifolds

- Family of 3D theories coming from type IIB string theory
- Characterised by a **scalar potential** with
  - 13 parameters (Fluxes)
  - 8 scalars (sizes of internal space) appearing at high powers
- Can we find a 3D theory (**flux choice**) allowing for **scale separation**?

Finding minima of scalar potential

We don't have time for the details...

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- We found 15 independent families of vacua
- 2 of them feature parametric **scale separation** !!!

Thanks!