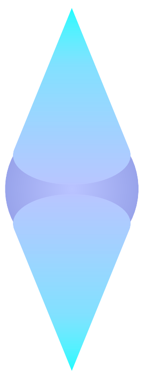
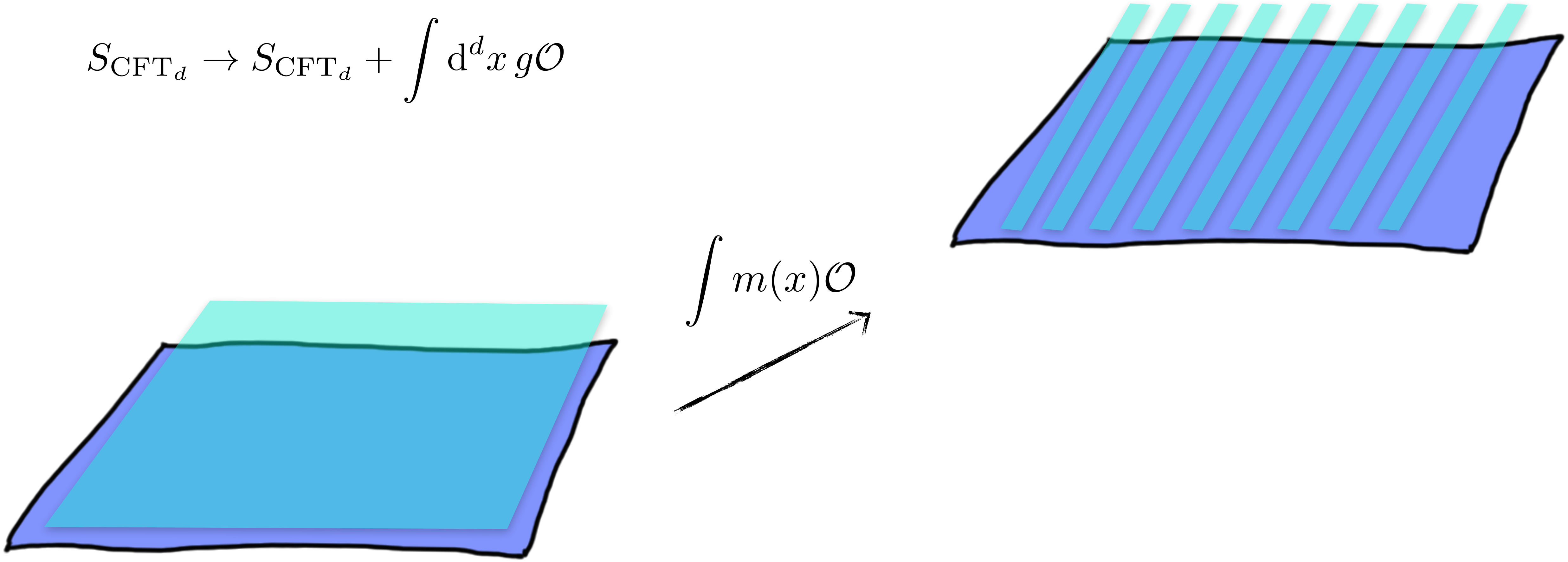


Leigh and Strassler Spindled

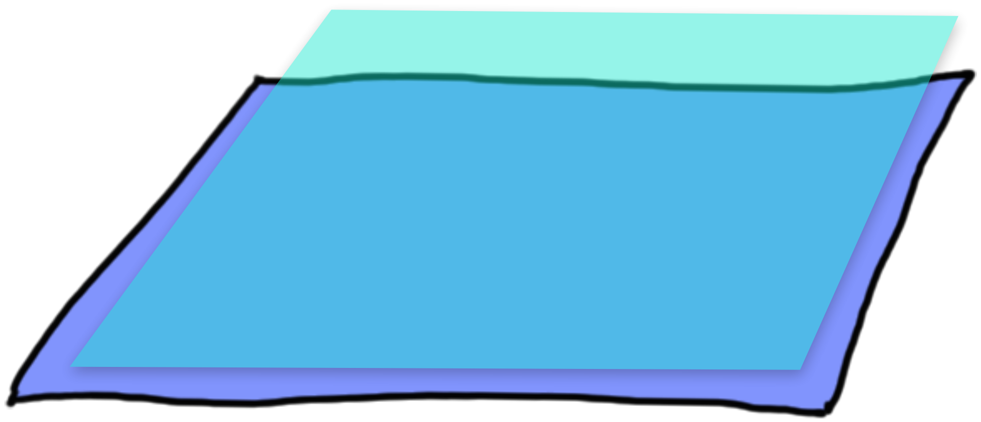
Chris Rosen
UoC

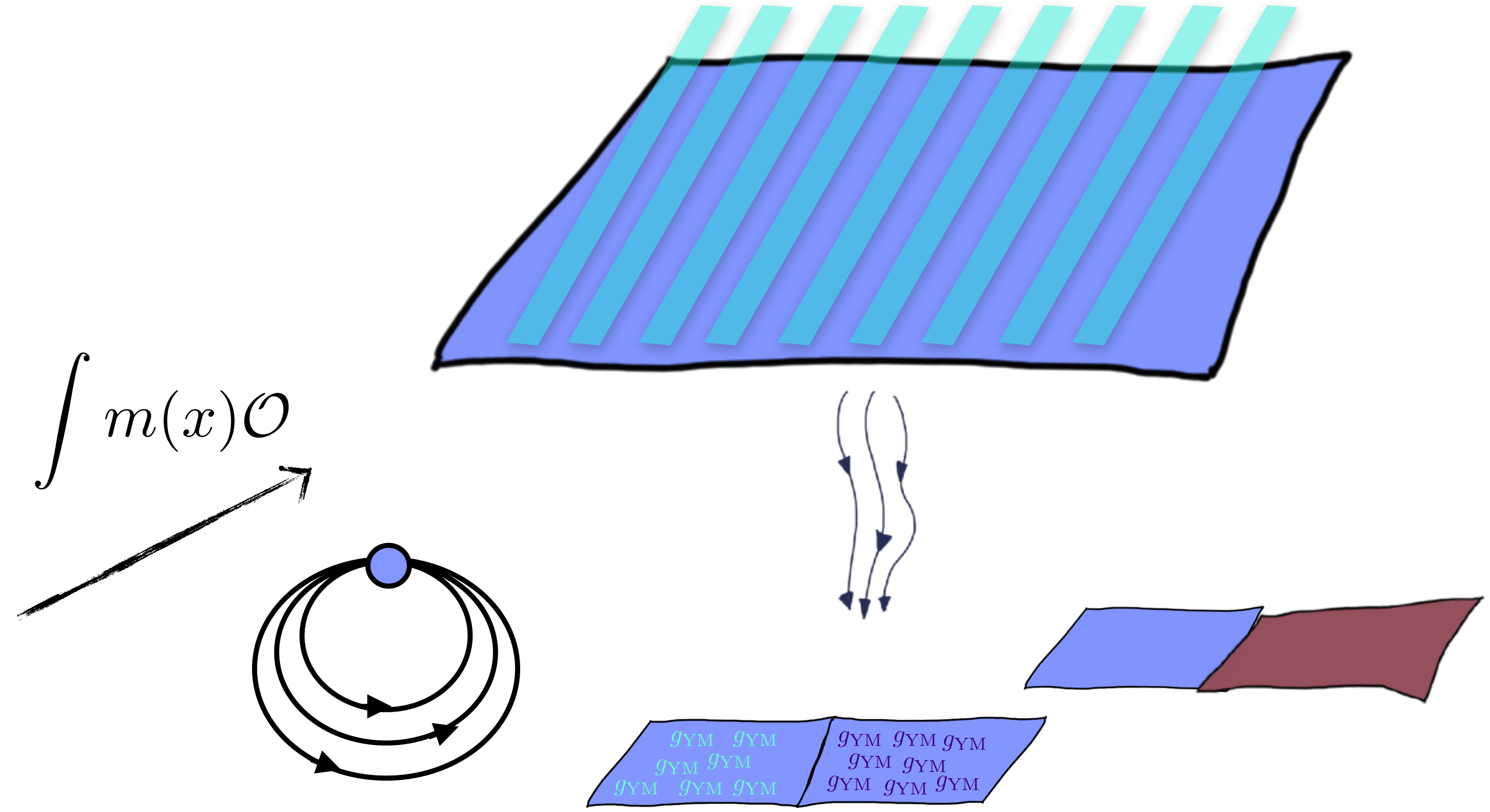
and
Arav, Gauntlett, & Roberts

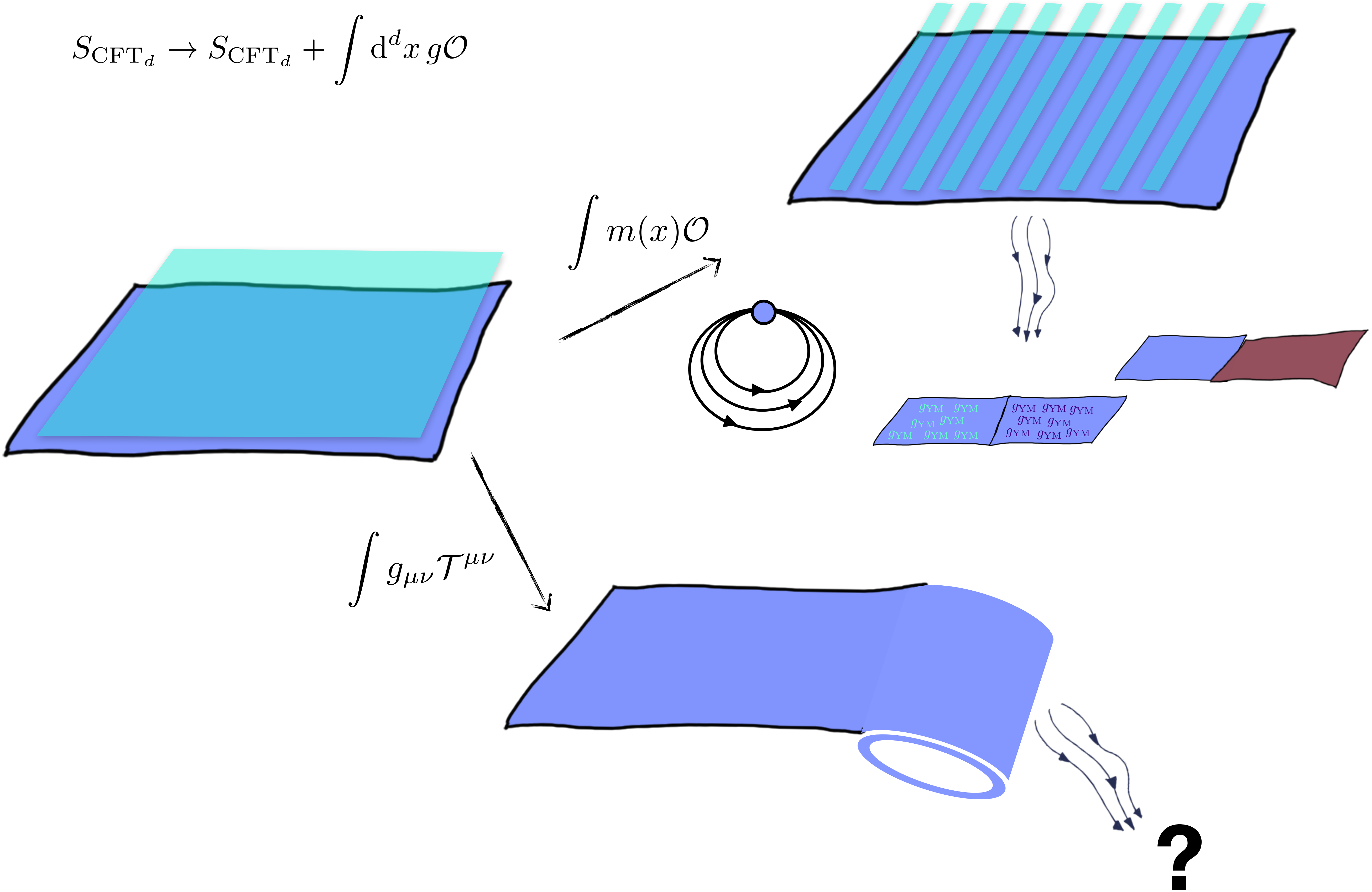
$$S_{\mathrm{CFT}_d} \to S_{\mathrm{CFT}_d} + \int \mathrm{d}^d x \, g\mathcal{O}$$



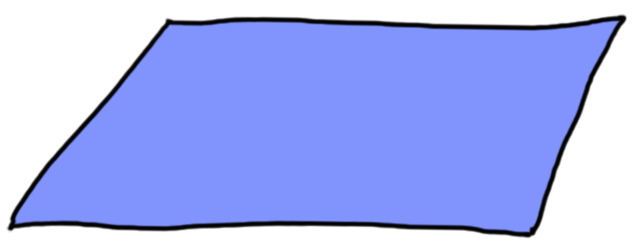
$$S_{\mathrm{CFT}_d} \to S_{\mathrm{CFT}_d} + \int \mathrm{d}^d x \, g\mathcal{O}$$

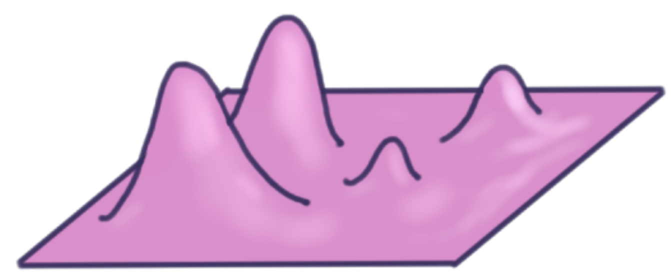


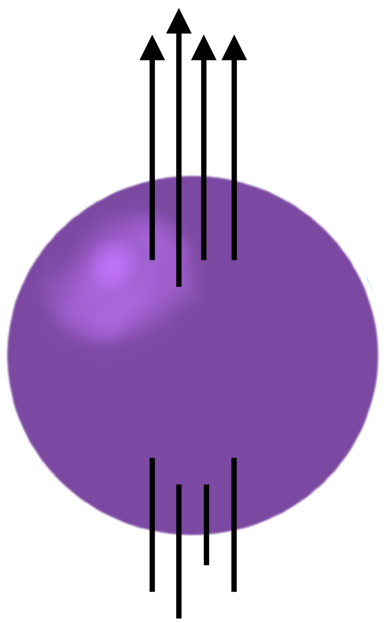



$S_{\mathrm{CFT}_d} \to S_{\mathrm{CFT}_d} + \int \mathrm{d}^d x \, g\mathcal{O}$
$\int m(x)\mathcal{O}$
$\int g_{\mu\nu}\mathcal{T}^{\mu\nu}$
?

Sometimes one can compactify supersymmetrically…



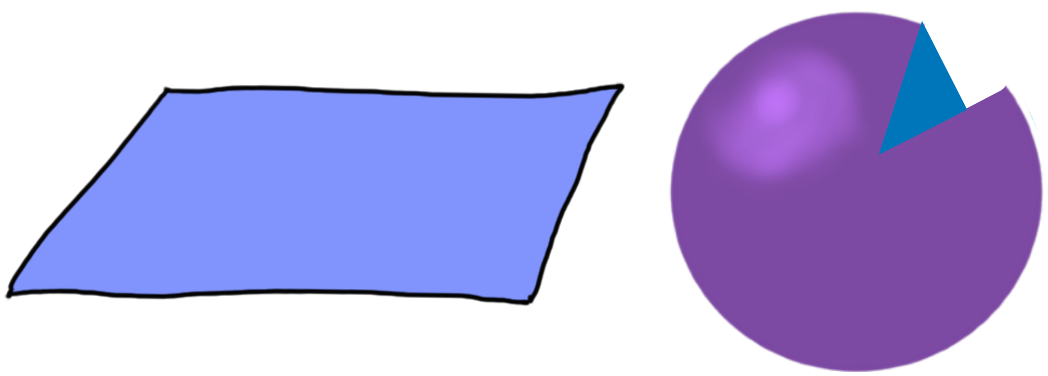


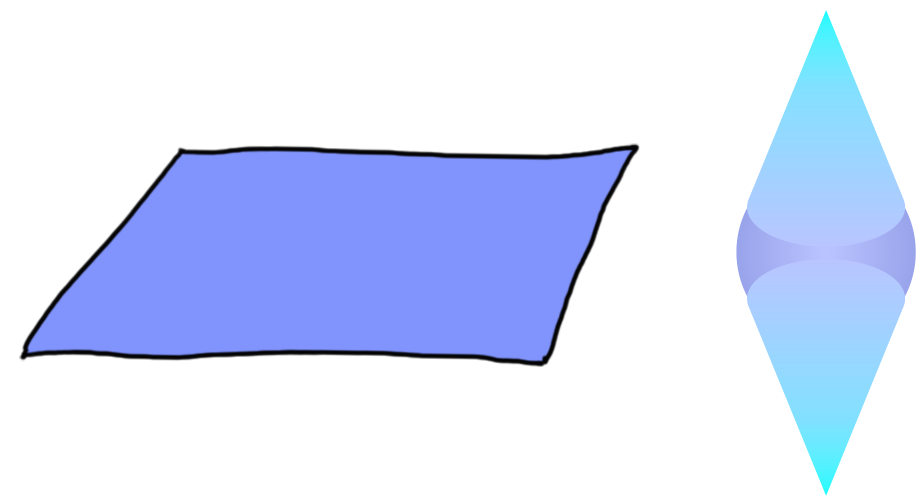


$$0 = \partial\epsilon = \nabla\epsilon = D\epsilon$$
$$= (\mathrm{d} + \omega - A)\,\epsilon$$

The (partial) topological twist is a powerful manoeuvre in our sQFT playbook
(e.g. Maldacena/Nunez, Festuccia/Seiberg,…)

Sometimes one can compactify supersymmetrically…



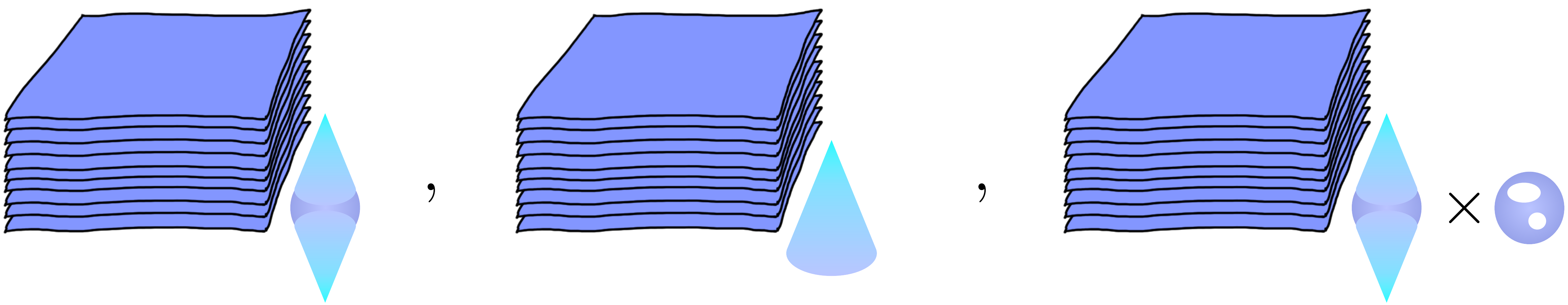


$$2\pi\left(1-\frac{1}{n_{N,S}}\right)$$

It has recently been appreciated (Ferrero/Gauntlett/Perez-Ipina/Martelli/Sparks,…) that there exist other possibilities.

Such spaces are singular, so it is important to understand when/why it makes sense to study them.

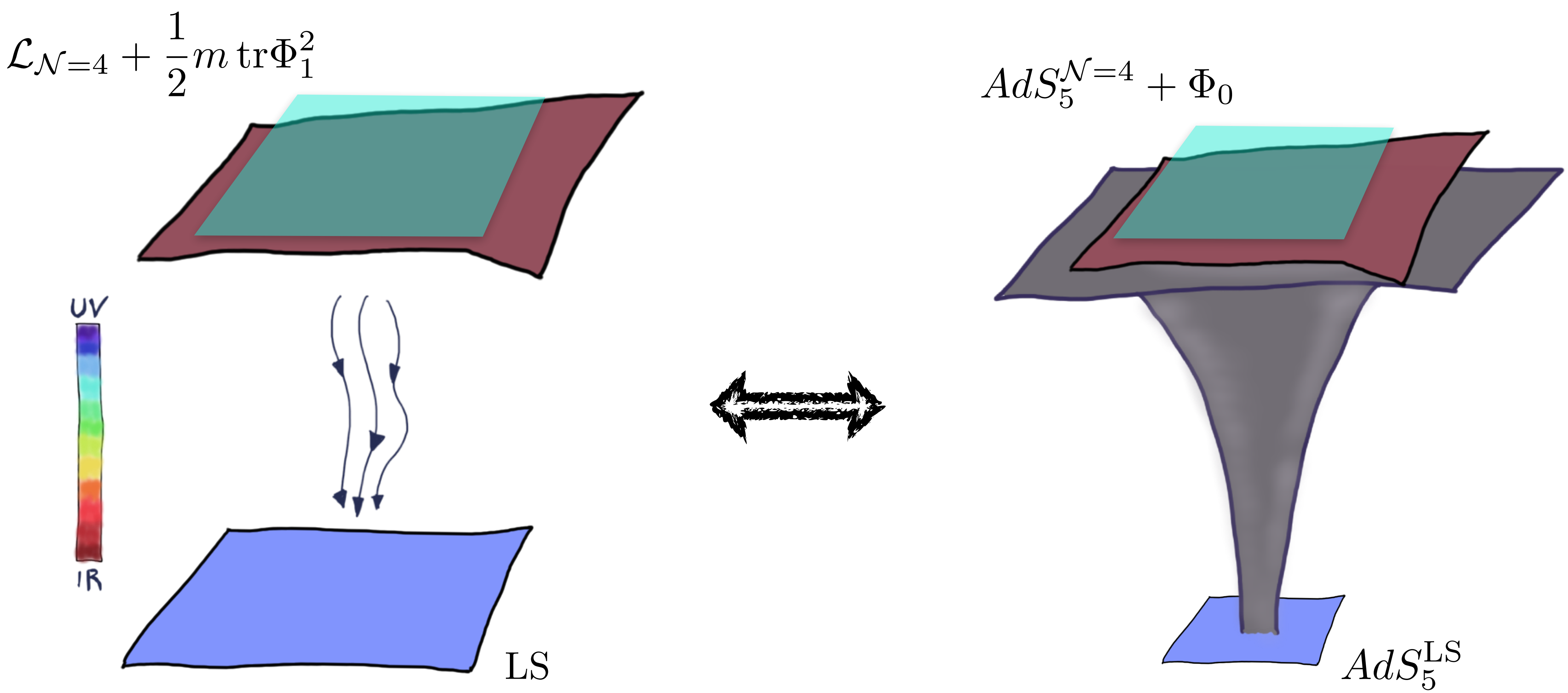
Sometimes one can compactify supersymmetrically…



It has recently been appreciated (Ferrero/Gauntlett/Perez-Ipina//Martelli/Sparks,…) that there exist other possibilities.

N=4 SYM, ABJM on spindles, punctured spheres, 6d N=(0,2) theory on products,…

Today, something different

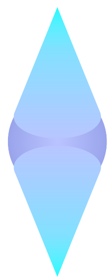


A "tried and true" testing ground for moving beyond the most symmetric examples is the Leigh-Strassler (LS) N=1 SCFT.

Can it also be used to generate new 2d SCFTs? "Yes" (Bobev/Pilch/Vasilakis) and "Likely" (Us).

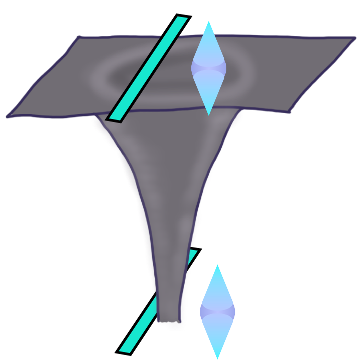
The outline of this talk

Part 1



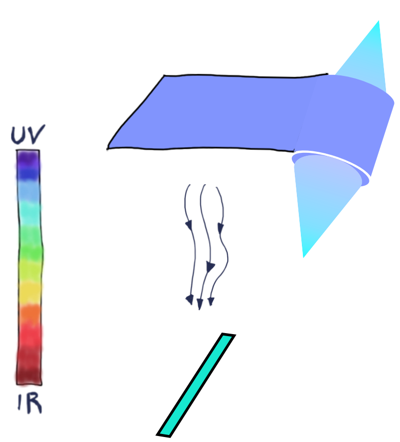
Spindle basics

Part 2



Spindles holographically

Part 3



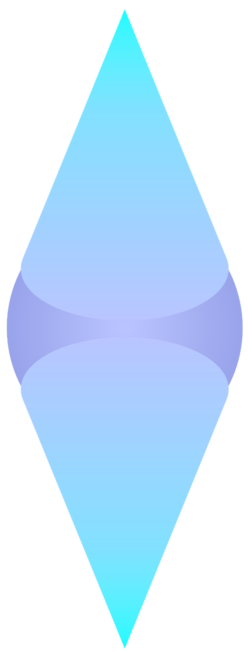
RG flows and Spindle compactifications

Some comments about Spindles

An enchanted object promising death to those who can't keep their hands off…

…You've been warned.

Some comments about Spindles



$$\mathrm{d}s^2_\Sigma = \mathrm{d}y^2 + h(y)^2\mathrm{d}z^2$$

Killing, with $\Delta z = 2\pi$

$$h(y_N) = h(y_S) = 0$$

$$|h'(y_{N,S})| = \frac{1}{n_{N,S}}$$

Spindles are two-dimensional orbifolds with conical deficits at the poles specified by two co-prime integers. They are spaces of non-constant curvature which can be equipped with a metric.

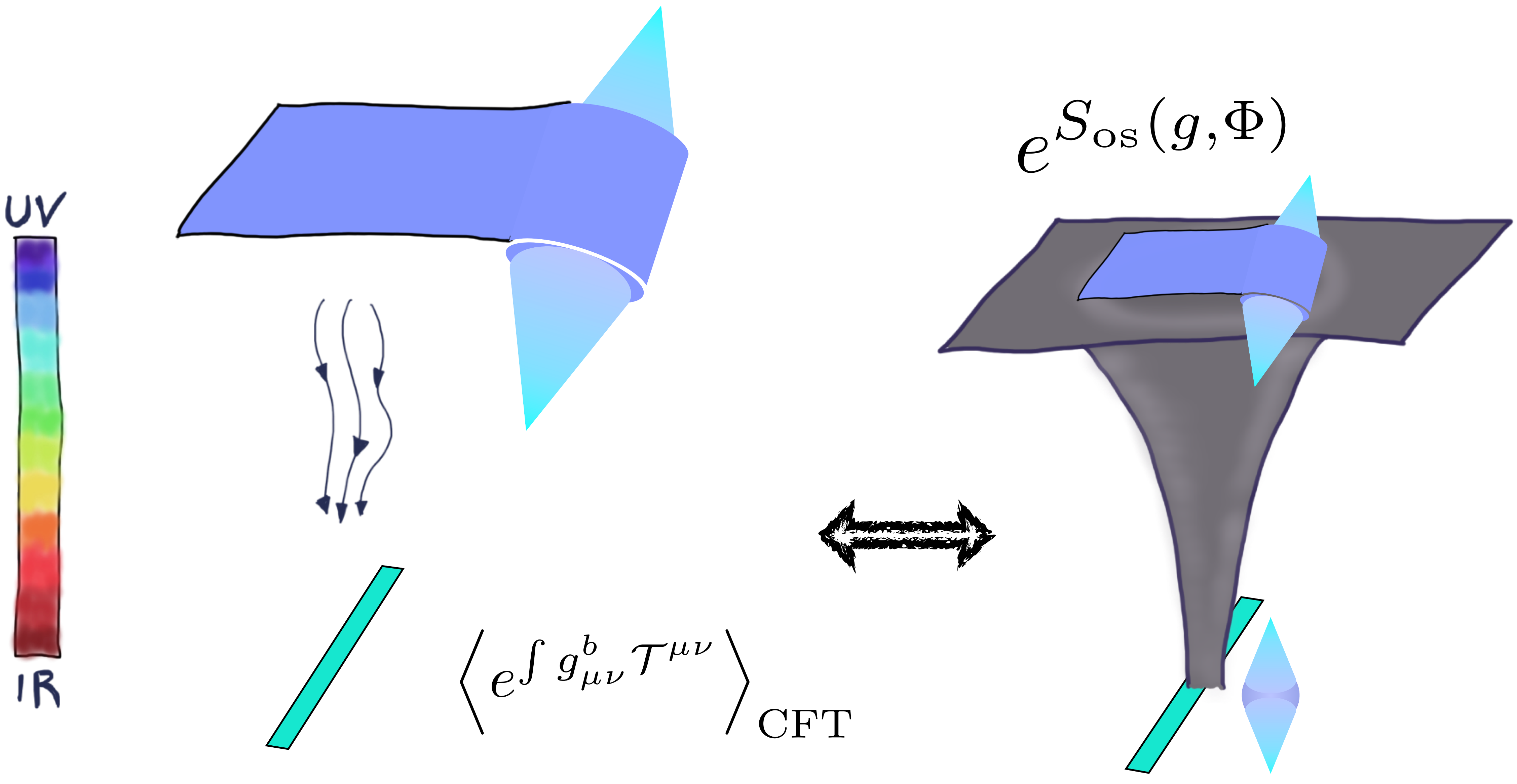
Some comments about Spindles

$$\frac{1}{2\pi}\int_\Sigma F^R = \frac{p}{n_N n_S} \begin{cases} \dfrac{n_N + n_S}{n_N n_S} & \text{“Twist”} \\[2ex] \dfrac{n_N - n_S}{n_N n_S} & \text{“Anti-Twist”} \end{cases}$$

In the context of supersymmetry, it is necessary to understand how to “put” gauge fields, spinors, scalars, etc. on these singular spaces…

Most of these questions can be answered by “geometrizing” the U(1) gauge bundle on the spindle, such that the total space is a smooth manifold (a lens space).

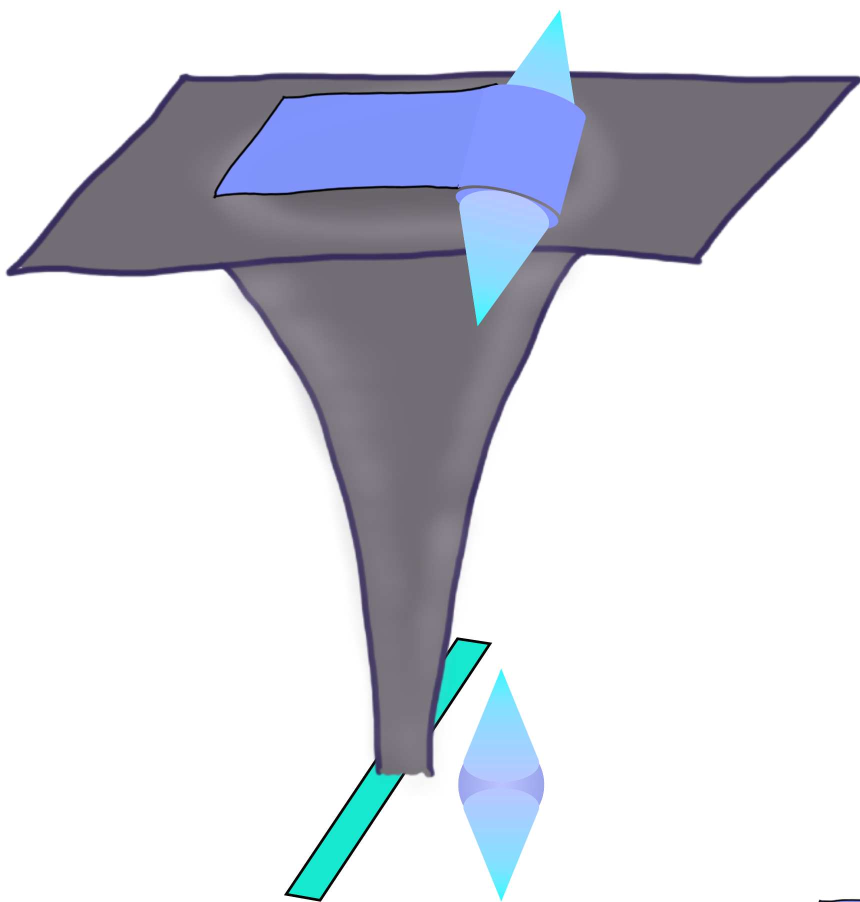
Spindles in holography



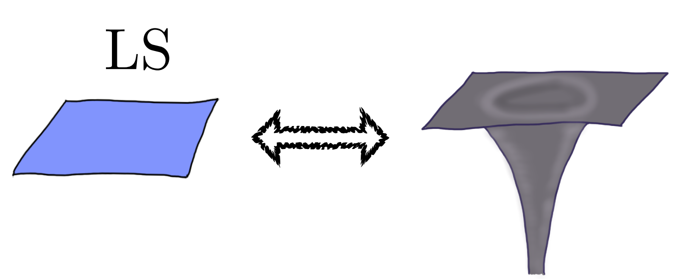
Want: A bonafide RG flow solution

Spindles in holography

D=5 N=8 SO(6) gauged SUGRA:



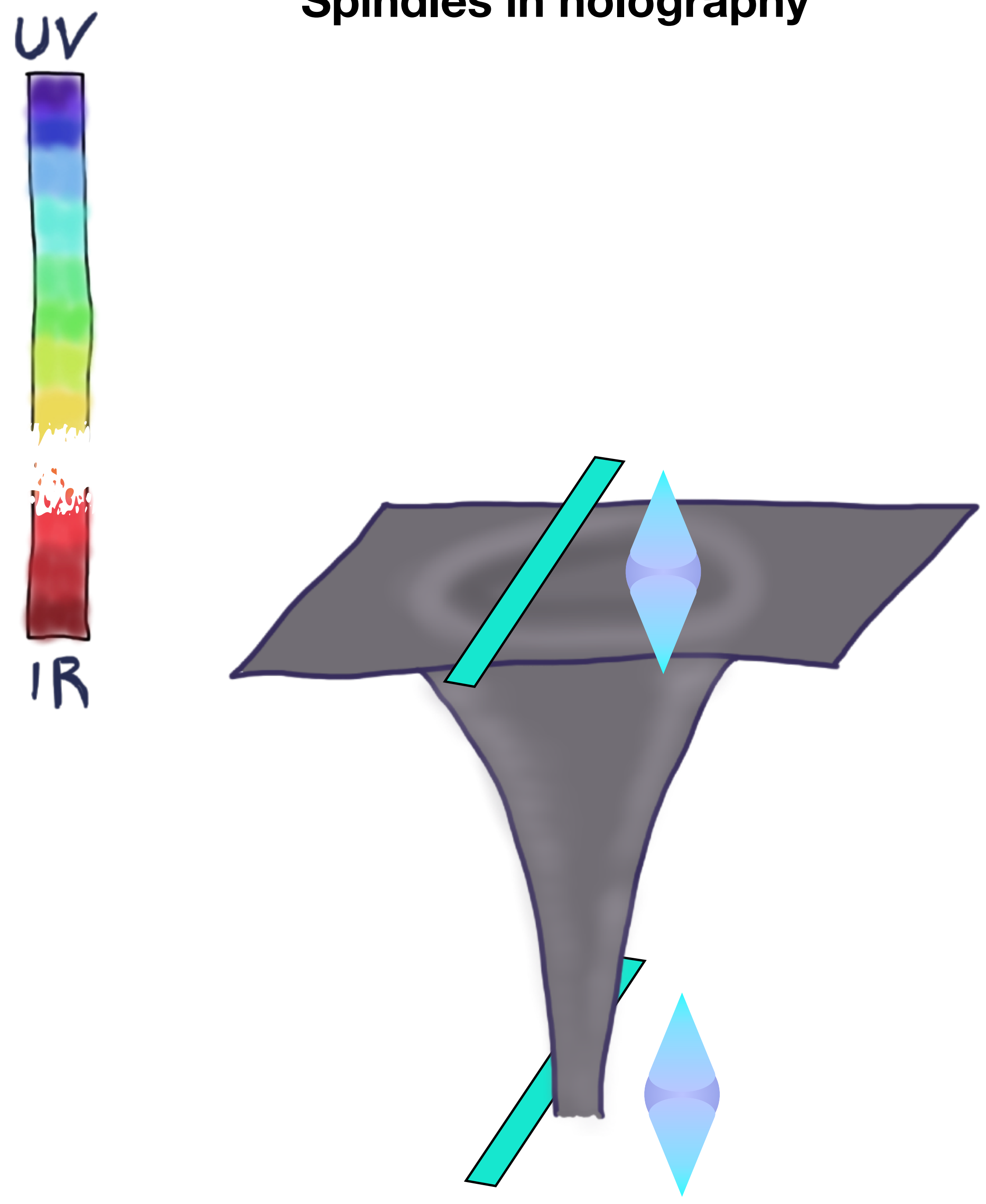
- $\mathrm{d}s_5^2 = g_{\mu\nu}\mathrm{d}x^\mu \mathrm{d}x^\nu$
- $A^{(i)}$: $U(1)^3 \subset SO(6)$
- α , β , $\varphi e^{i\theta}$



: $\left(e^{6\alpha} = 2, e^{2\varphi} = 3, \beta = 0\right)$

To construct such a solution, we could look for consistent truncations of the gauged SUGRA with the “right” ingredients…

Spindles in holography

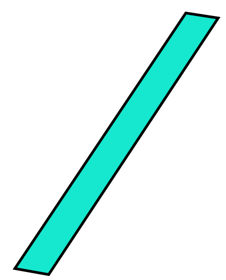


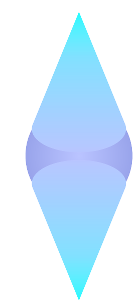
Get: A candidate IR for the RG flow

Spindles in holography

D=5 N=8 SO(6) gauged SUGRA:

$$\mathrm{d}s^2 = e^{2V(y)}\,\mathrm{d}s^2_{\mathrm{AdS}_3} + \mathrm{d}y^2 + h(y)^2\mathrm{d}z^2$$





$$A^{(i)} = a^{(i)}(y)\,\mathrm{d}z$$

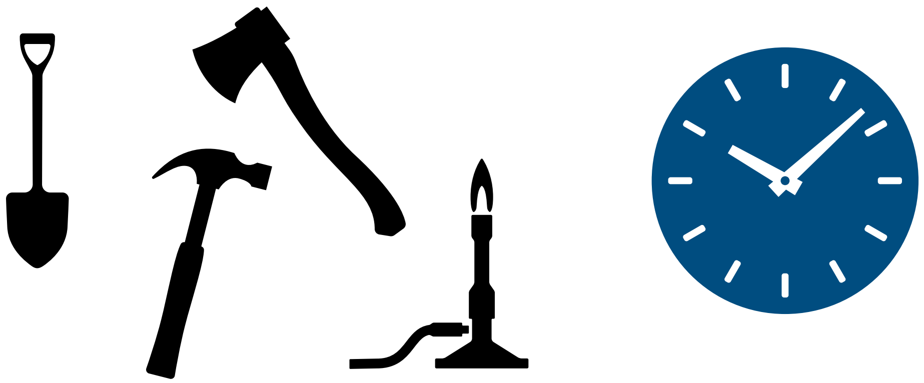
$$\alpha(y)\,,\ \beta(y),\ \varphi(y)$$

The bulk ansatz is chosen to manifest the symmetries of the putative IR SCFT: An SO(2,2) from the AdS factor, a U(1) from the spindle azimuth, …

Spindles in holography

$$\delta\Psi_\mu = 0 = \text{``}(\nabla - A - W - H)\text{''}\epsilon$$

$$\delta\chi = 0 = \text{``}(\partial\Phi + \partial_\Phi W + H)\text{''}\epsilon$$



Solving the bulk BPS equations yields SUGRA backgrounds preserving 4 supercharges, dual to N=(0,2) SCFTs in two dimensions.

Spindles in holography

$$-\frac{1}{2\pi}\int_\Sigma g\left(F^{(1)}+F^{(2)}+F^{(3)}\right) = \frac{n_N(-1)^{t_S+1}+n_S(-1)^{t_N+1}}{n_N n_S}$$

$$\longmapsto F^R \longleftarrow$$

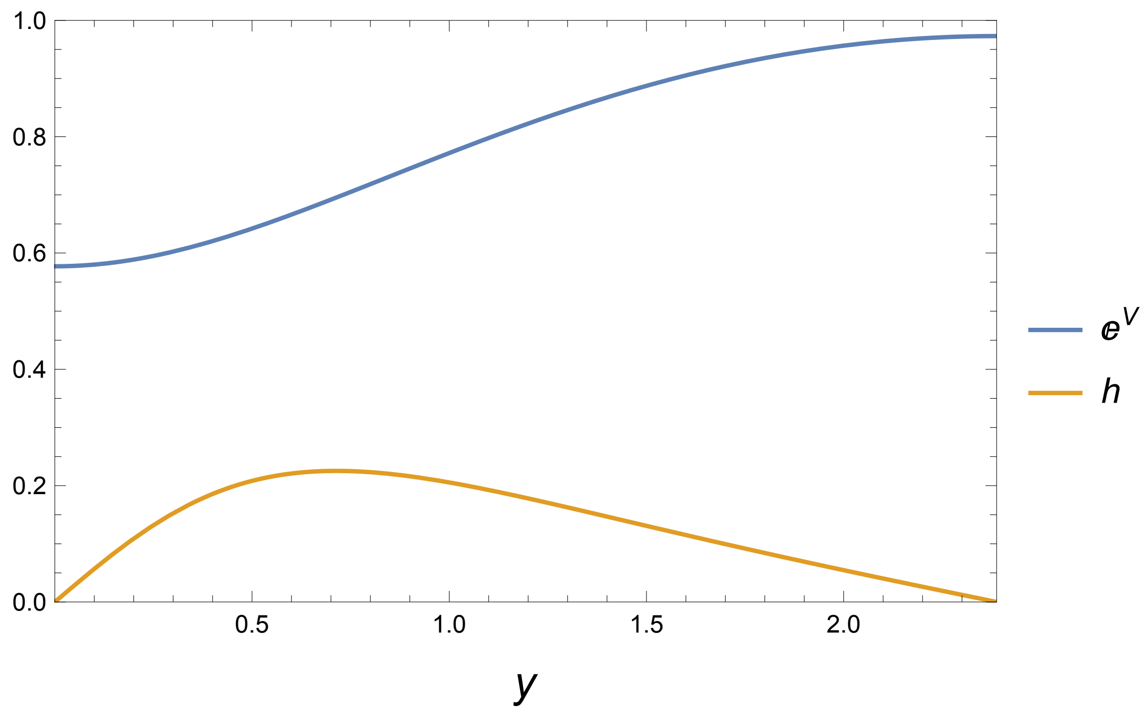
$$\frac{1}{2\pi}\int_\Sigma g\left(F^{(1)}+F^{(2)}-F^{(3)}\right) = 0$$

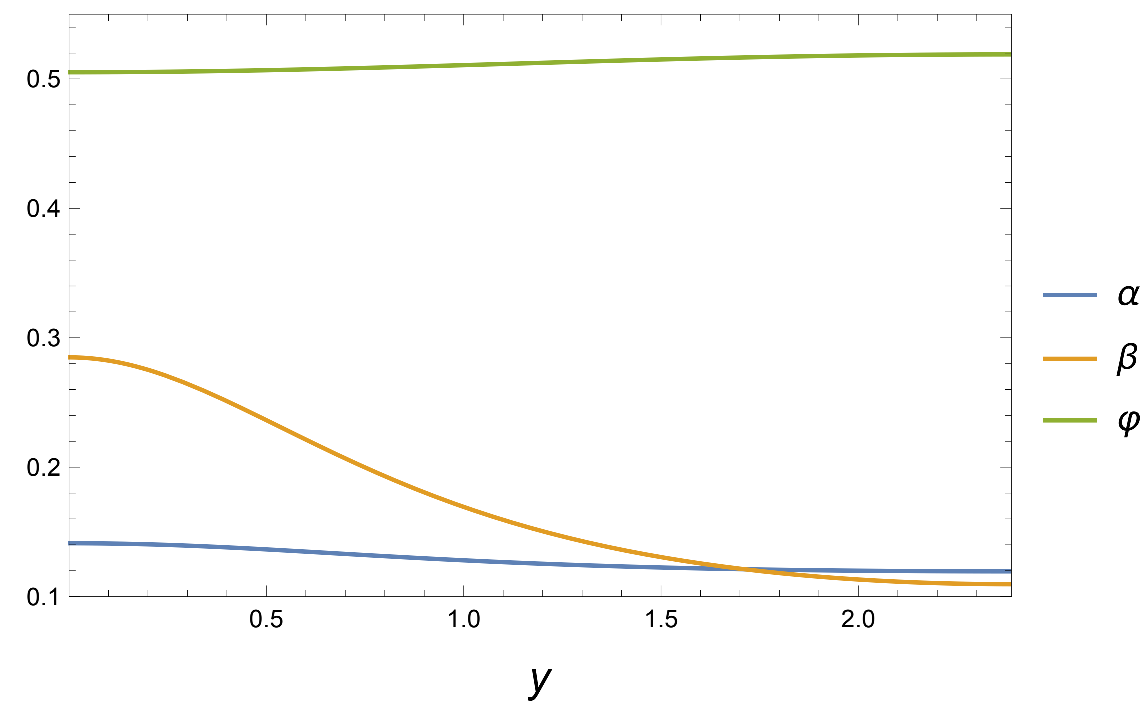
$$\longmapsto F^q \longleftarrow$$

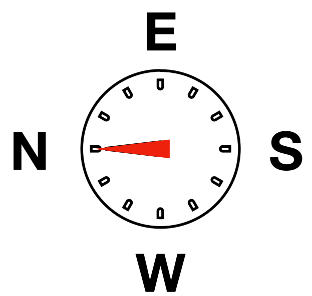
Solving the bulk BPS equations yields SUGRA backgrounds preserving 4 supercharges, dual to N=(0,2) SCFTs in two dimensions.

But also a plethora of fortuitous surprises…

Spindles in holography







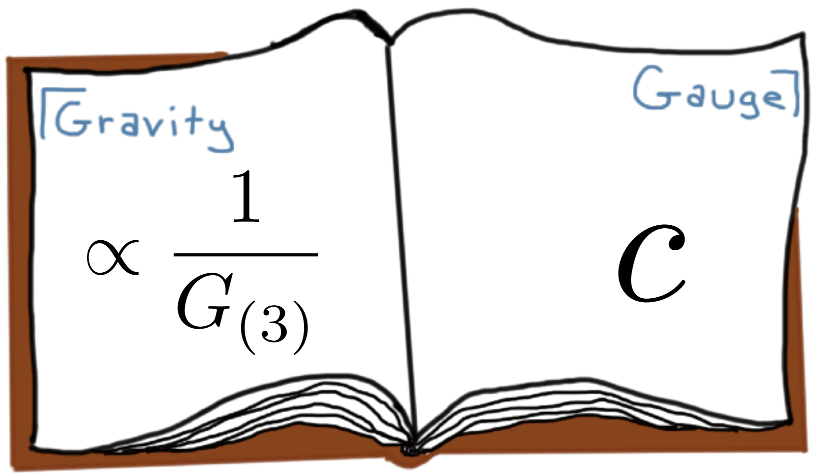
$$n_{N,S} = (1,7)$$

$$t_{N,S} = (1,0)$$

$$p_F = 1$$

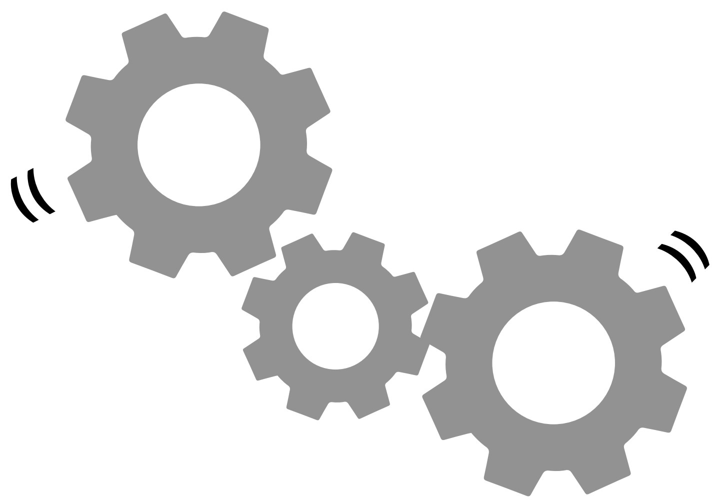
Numerical "proof of existence": Given any spindle data at the poles ($n_{N,S}$ **,** $t_{N,S}$ **,** p_F **) the BPS equations can be 'trivially' integrated to construct the corresponding solution.**

RG flows from Spindle Compactifications



$$\frac{1}{G_{(3)}} = \frac{1}{G_{(5)}} \cdot 2\pi \cdot \int_{y_N}^{y_S} e^{V} h \, \mathrm{d}y$$

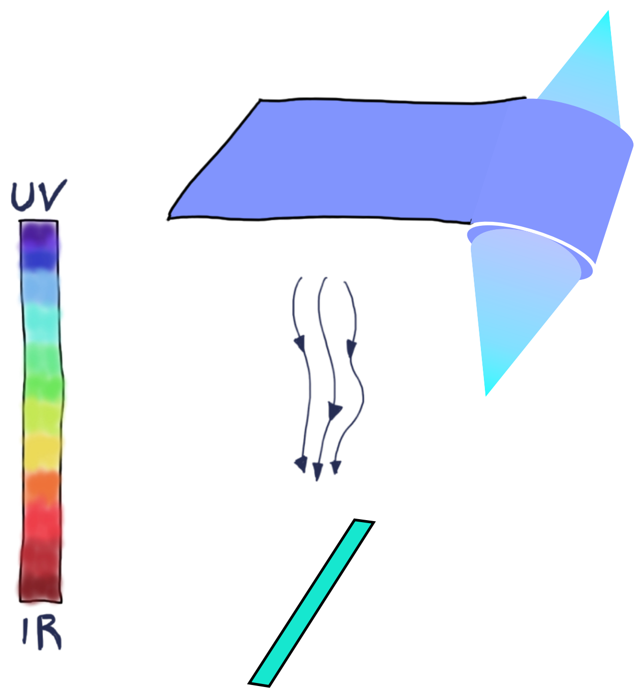
d (**Asstd.**)



$$c = N^2 \mathfrak{c}\,(n, t, p_F)$$

An important quantity characterising a field theory is its central charge. This can be computed geometrically in the theory's holographic limit.

RG flows from Spindle Compactifications



1) $$\mathcal{A}_{2d} = \int_{\Sigma} \mathcal{A}_{LS}\left[\mathfrak{a}_R, \mathfrak{a}_f, \mathfrak{a}_\Sigma\right]$$

2) $$U(1)^R_{2d} \sim U(1)^R + \varepsilon U(1)^f + x U(1)^\Sigma$$

$$\rightarrow \quad c_{\text{try}}(\varepsilon, x)$$

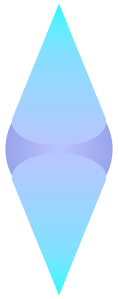
$$c = N^2 \mathfrak{c}\left(n, t, p_F\right)$$

The reduction of the anomaly polynomial together with c-extremisation offer the opportunity to make a detailed comparison between the putative IR of "LS on a spindle" and the gravitational solutions we obtained…

…the 2d central charge is exactly the same in both (!?).

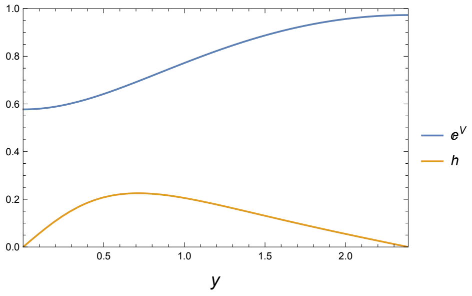
The Takeaway

In **Part 1**



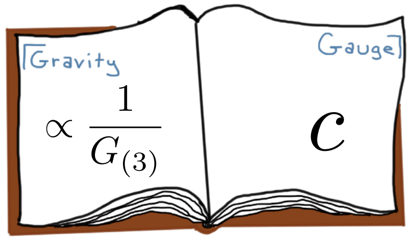
Spindles provide a new way to supersymmetrically compactify SCFTs

In **Part 2**



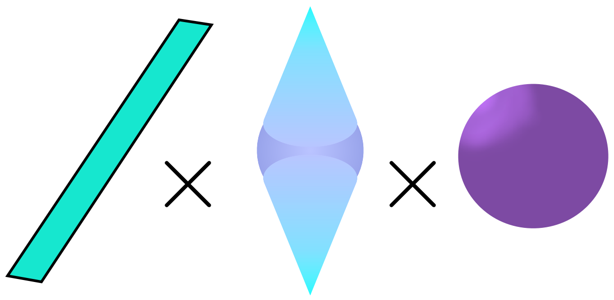
The IR 'daughter' theories of such compactifications are elusive. Holography helps.

In **Part 3**



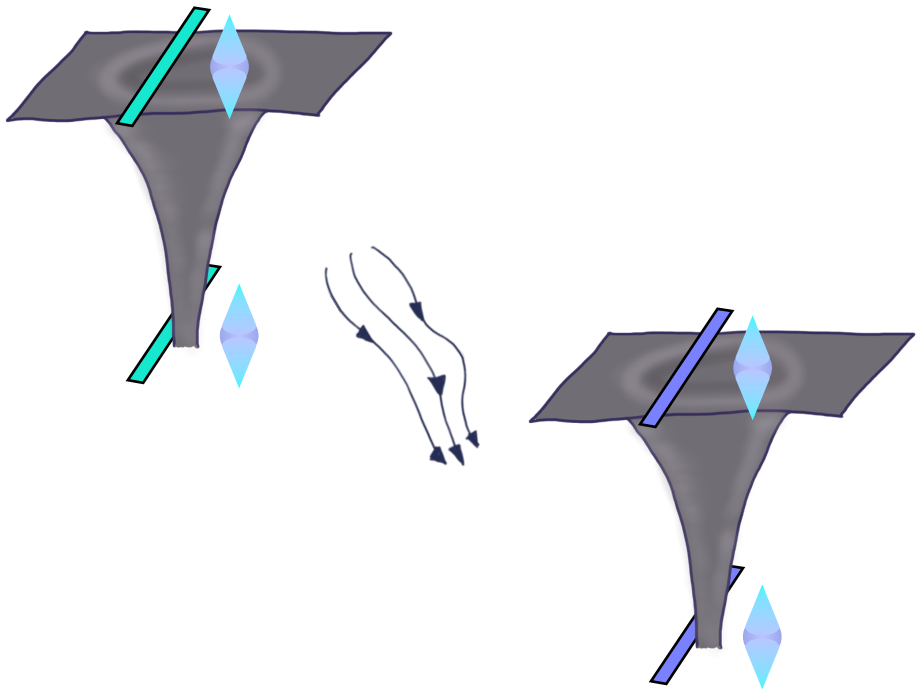
sQFT tools allow interesting and precise matches to gravitational results

Further considerations



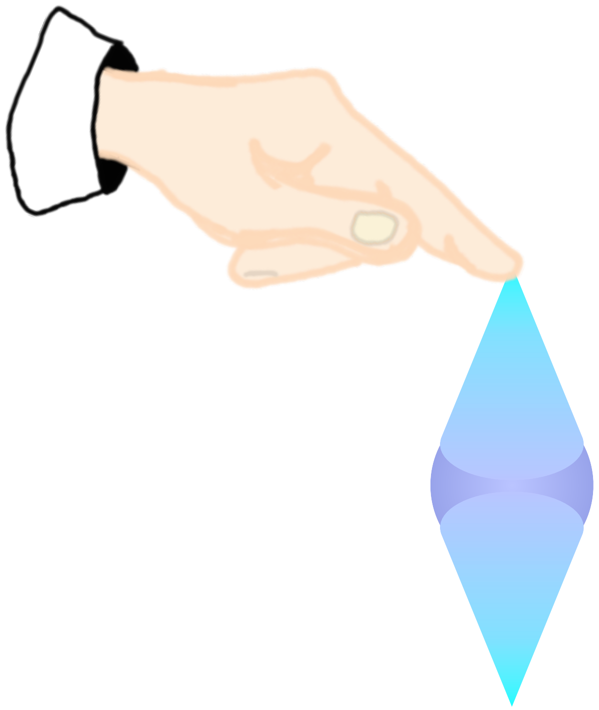
Properly quantized fluxes ensure a regular 10d solution

Although spindles can preserve symmetry via a ‘twist’ or ‘anti-twist’, our SUGRA solutions only realise the latter…?



The fact that the holographically computed central charge depends only on pole data is striking. What gives?

Are there RG flows between these 2d SCFTs? Looks plausible…



Thank you!