A NON-PERTURBATIVE TEST OF THE DGKT VACUUM

Work in progress with I. Valenzuela

+

Work in progress with F. Apers, I. Valenzuela

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IFT Madrid

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CSIC
Consejo Superior de Investigaciones Científicas

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Plan of the talk

Review of Scale-sep & DGKT

Brane probes of DGKT

3d N=1 & moduli spaces

Implications for DGKT

General case +comments

Scale-separated vacua:

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2) Why should I care?

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$$m_{KK} \sim \Lambda^{1/2}$$

The solution is not **scale-separated**

[See also Lust, Palti, Vafa '19]

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$AdS_5 \times \mathrm{SE}$

(4d N=2 SCFT)

$AdS_4 \times \mathrm{SE}_7$

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And there are a few proposals for **total** scale separation (DGKT & friends, KKLT, Polchinski-Silverstein, LVS)

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Constructed scale-separated AdS vacua use the same techniques that one uses for low-SUSY or dS constructions.

Scale-sep subtlety	⟷	dS, Minkowski subtlety

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3) The 10d eoms are very complicated. Instead, **solve only the eoms** for the zero modes (moduli)

4) There is one **unconstrained flux**

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$$\Lambda \sim N^{9/2}, \quad L_{KK}^2 = N^{7/2}$$

$$\left(\frac{\ell_{AdS}}{L_{KK}}\right)^2 \sim N$$

So this solution is **scale-separated** in the large N limit.

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No conclusive answer, but **everything cool** so far.

In this talk, I will **assume** everything is OK, and study branes on the DGKT vacuum.

[Aharony,Antebi,Berkooz '08, Marchesano-Prieto-Quirant ’21,Apers ’22, Shiu-Tonioni-Van Hemelryck- Van Riet ‘22]

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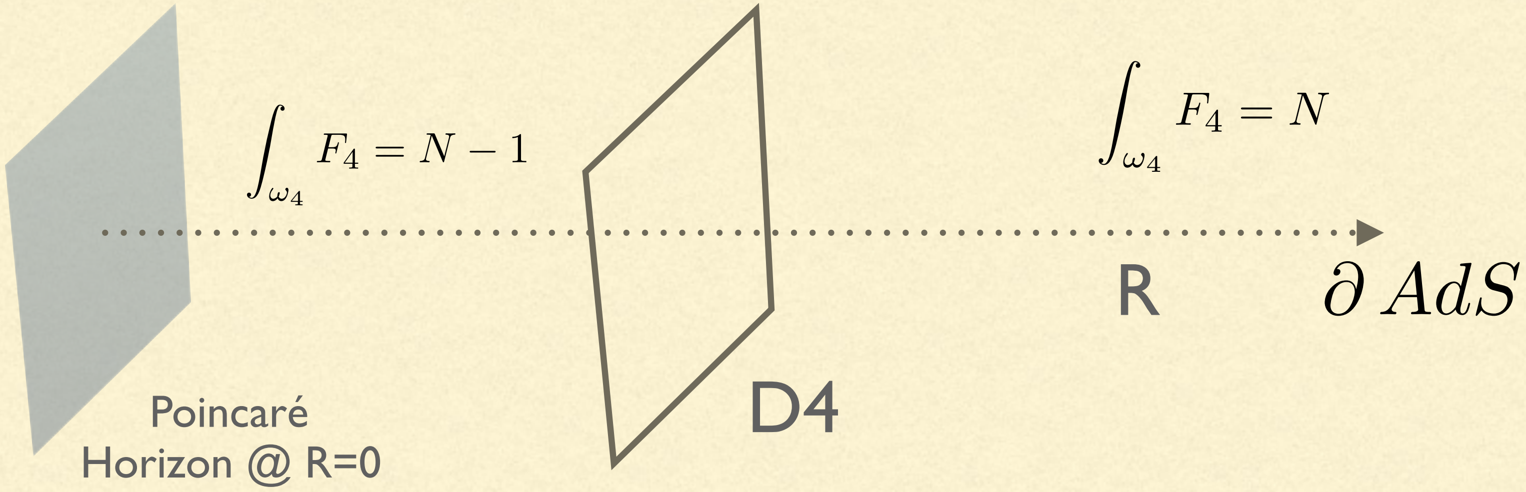

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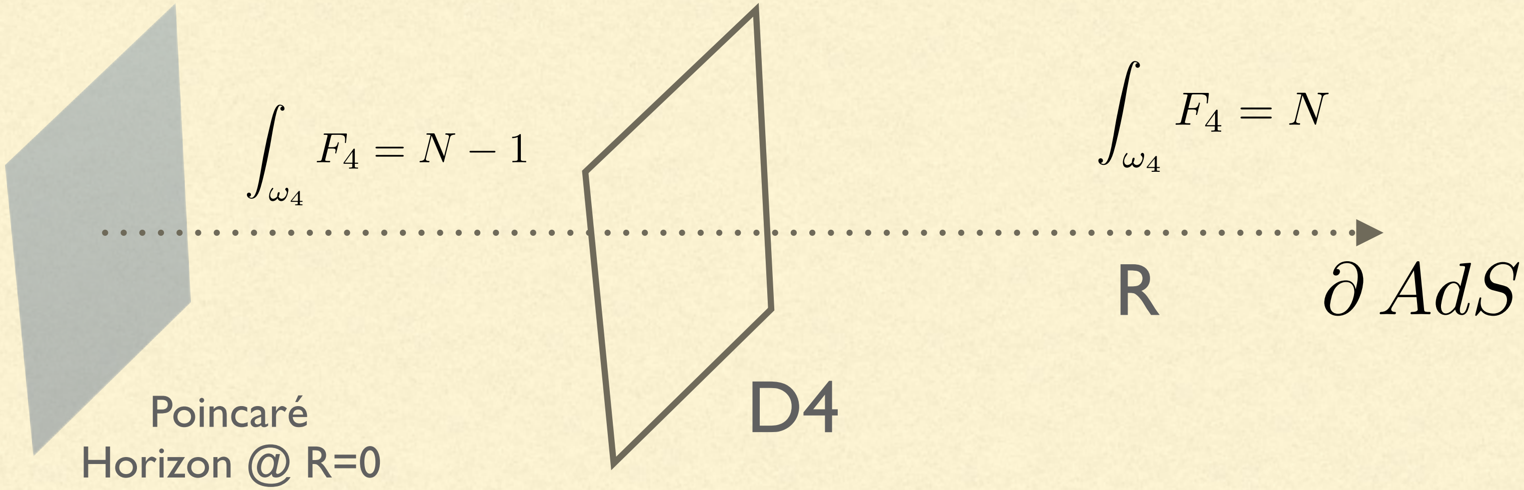

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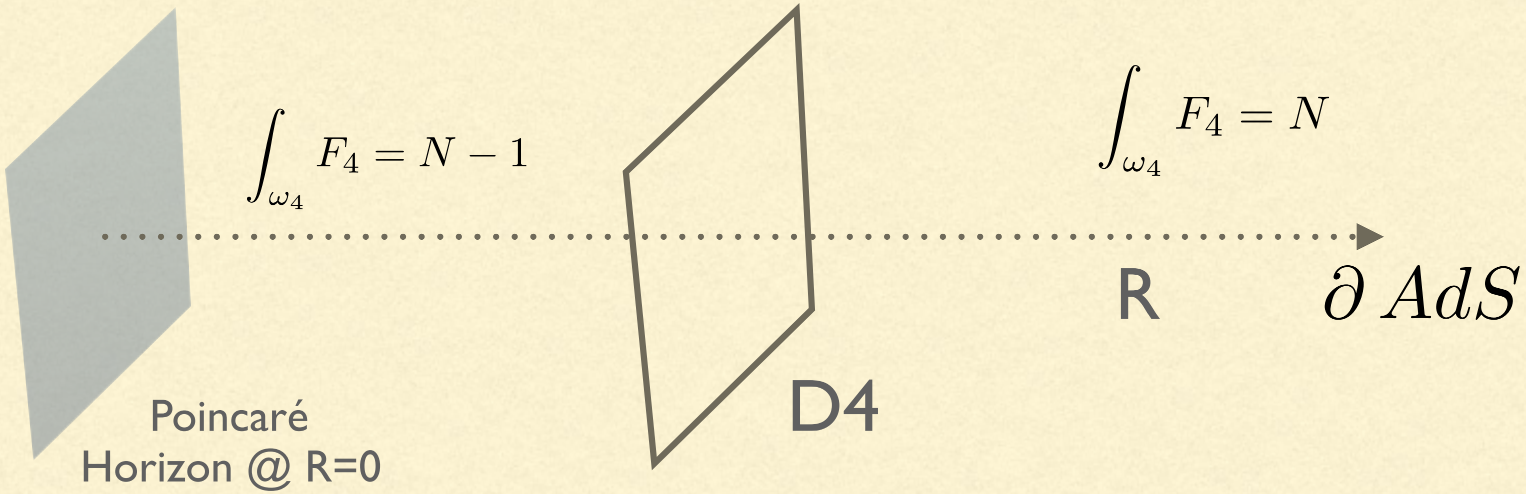

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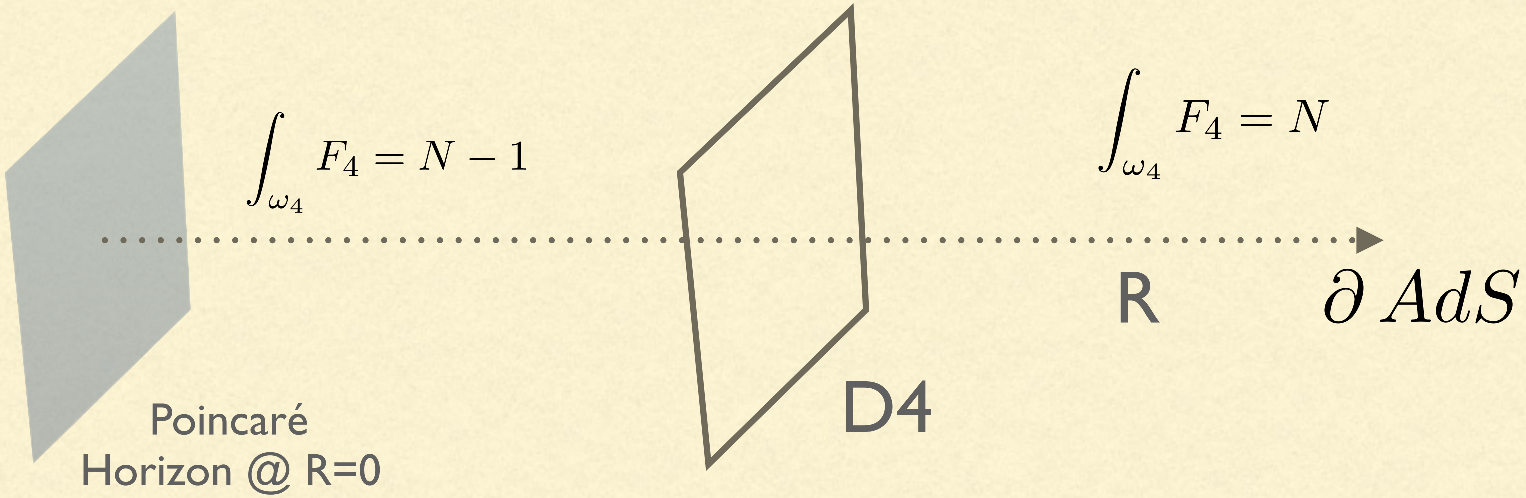

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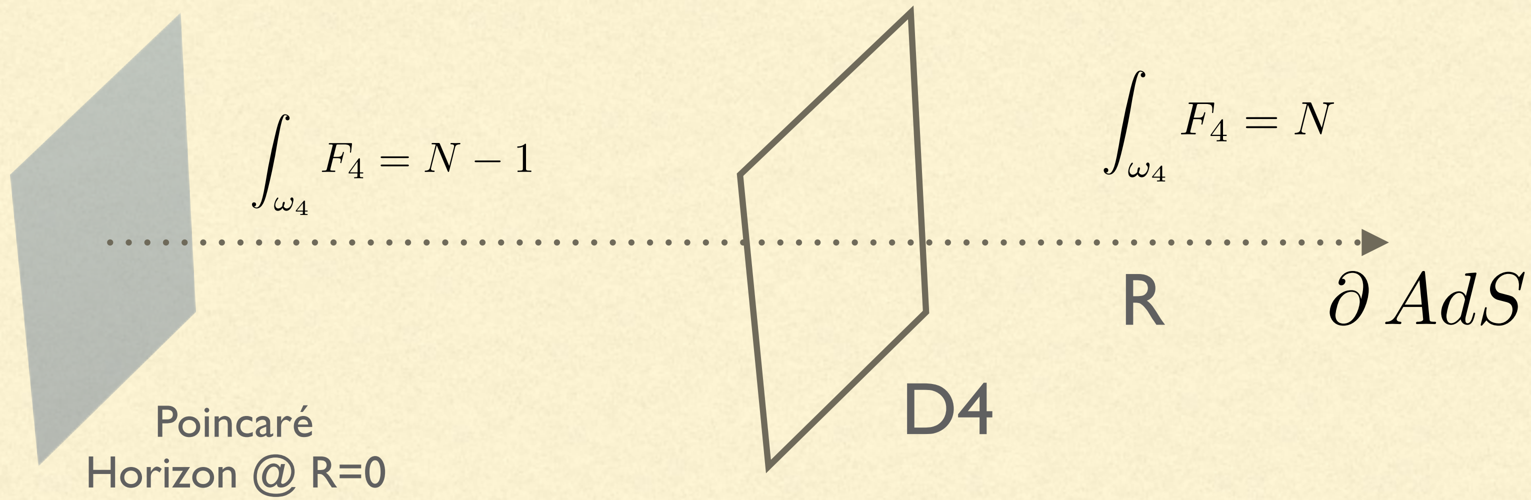

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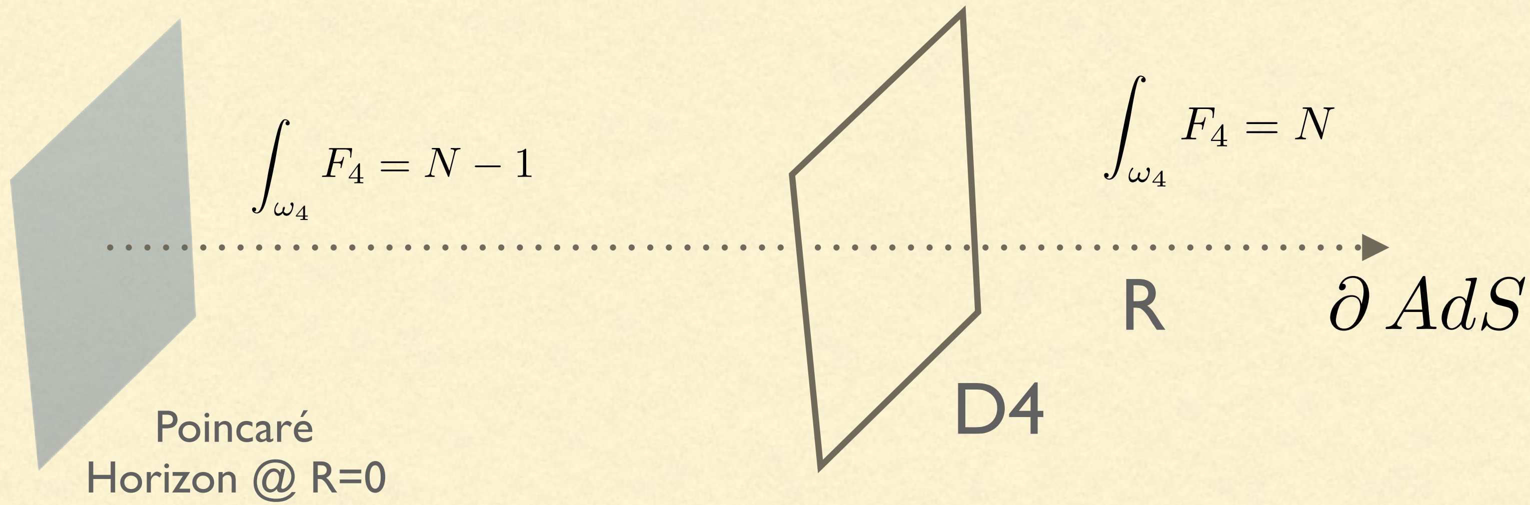

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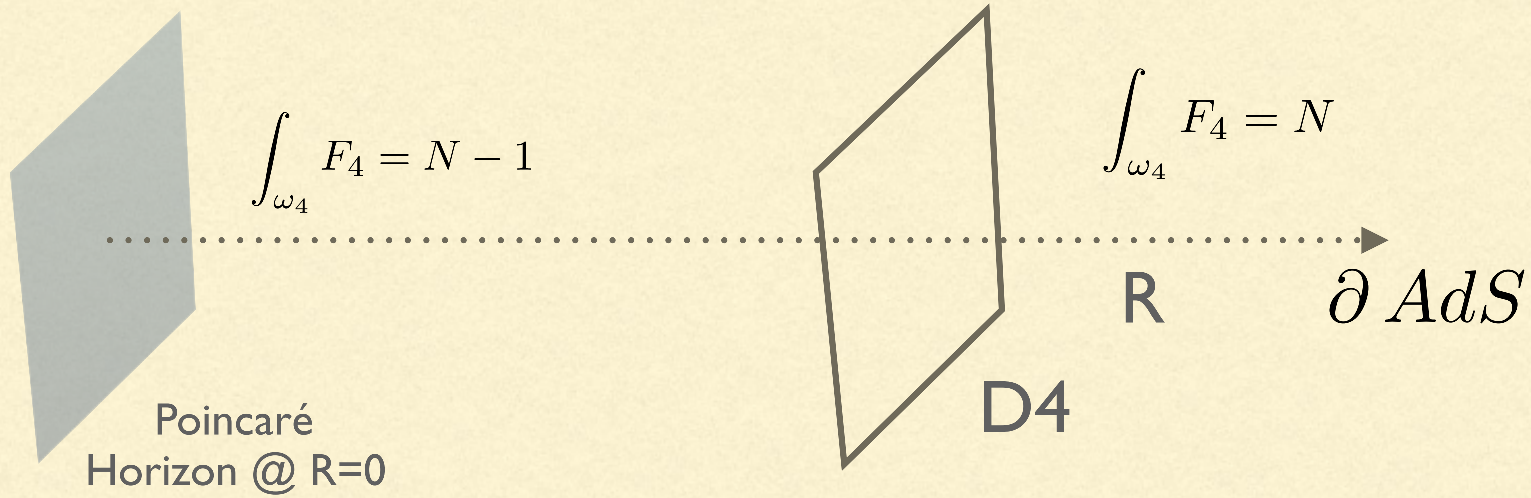

At low energies (long wavelengths), the D4 domain wall is described by a

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SQFT. We can get it from dim. red of D4 worldvolume theory on 2-cycle.

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This scalar is part of the **moduli space** of the DGKT dual.

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So it is extremely weird to have a modulus! Expect quantum corrections to R

$$\mathcal{W} = \mathcal{W}_{kin} + \sum c_n R^n$$

How can there be a modulus?

Answer: **Parity symmetry** $\vec{x} \to -\vec{x}$

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E.g: M-theory on $AdS_4 \times G_2^{weak}$ with $\int_{G_2^{weak}} G_7 = N$

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So 3d N=1 + Parity = Moduli space

Dual to BPS M2 branes in AdS4

So then we check DGKT…

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$$F_4$$

So then we check DGKT…

F_4 m

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All break **parity symmetry!**

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So no reason for D4 brane R to be a modulus.

Let us look more closely!

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$$z_i \;\rightarrow\; z_i \, e^{2\pi i/3}$$

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$$\text{CY3} \quad \frac{T^6}{\mathbb{Z}_3 \times \mathbb{Z}_3 \times \mathbb{Z}_2} \quad \text{Orientifold}$$

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CY3 $$\frac{T^6}{\mathbb{Z}_3 \times \mathbb{Z}_3 \times \mathbb{Z}_2}$$ Orientifold

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Can wrap a D4 on a $T^2 \subset T^6$ **[Aharony,Antebi,Berkooz '08]**

Consider the original DGKT model:

[De Wolfe, Giddings, Kachru, Taylor '05]

$$\frac{T^6}{\mathbb{Z}_3 \times \mathbb{Z}_3 \times \mathbb{Z}_2}$$

CY3 ($\mathbb{Z}_3 \times \mathbb{Z}_3$): $z_i \to z_i \, e^{2\pi i/3}$

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Can wrap a D4 on a $T^2 \subset T^6$ [Aharony,Antebi,Berkooz '08]

…or can wrap on the orbifold fixed locus

$T^2/\mathbb{Z}_3 \sim S^2$ + orientifold image

Worldvolume theory: 5d gauge theory on T3/Z3

5d

SU(2) gauge fields

Hypers
(normal coordinates)

R (gauge coupling)
+ extra scalars

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Resulting theory: 3d N=1 pure SU(2) + modulus for gauge coupling.

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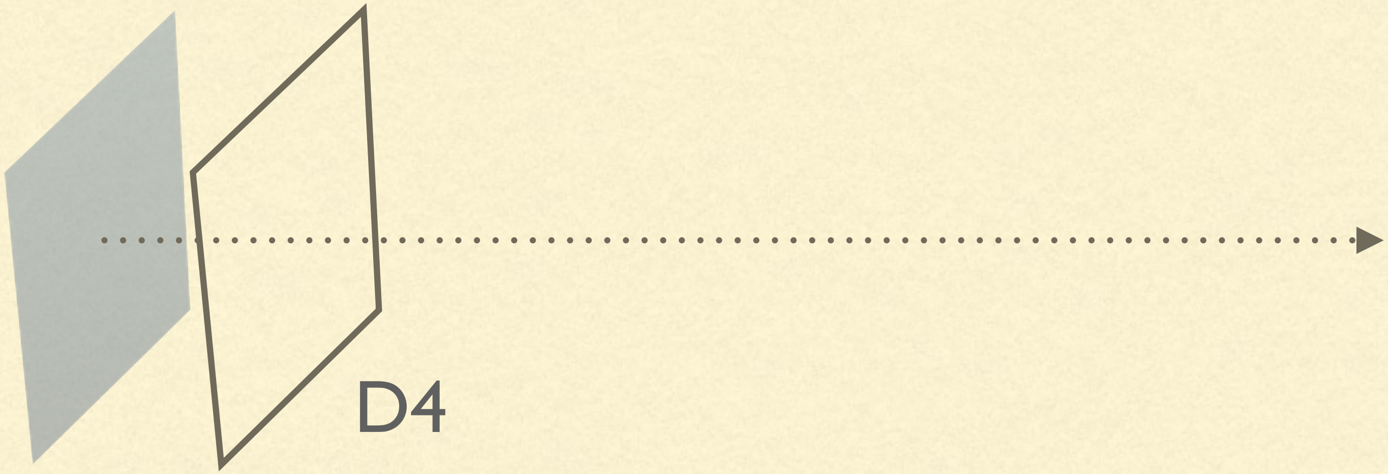
Brane on calibrated cycle $\neq$ BPS

[Lust, Vafa, Wiesner, Xu '22]

It is energetically favorable for the branes to **move to the boundary**, discharging the AdS

$$V \sim \frac{1}{R^3}$$



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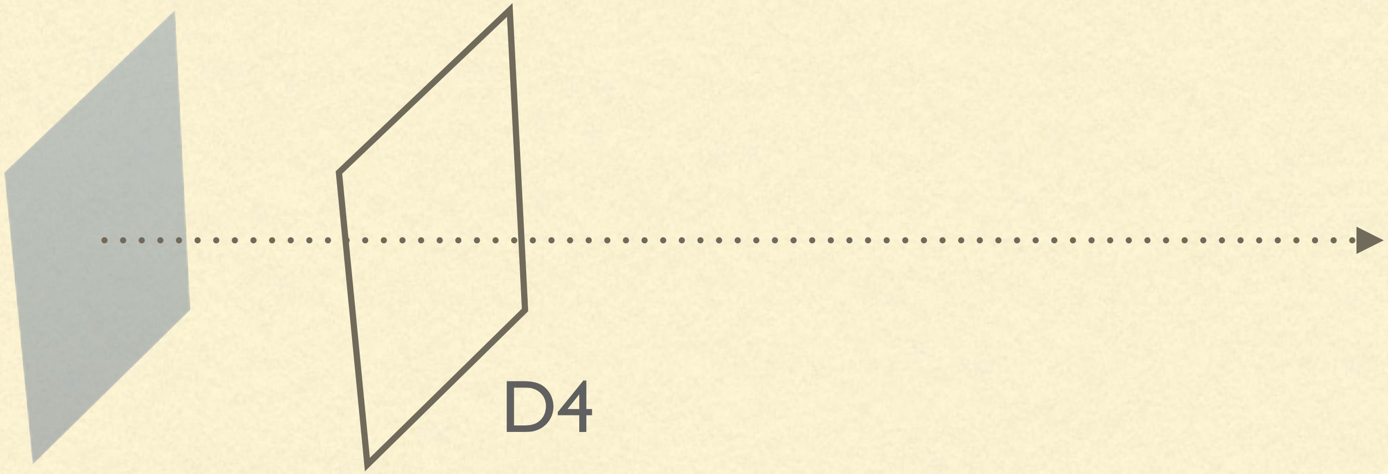

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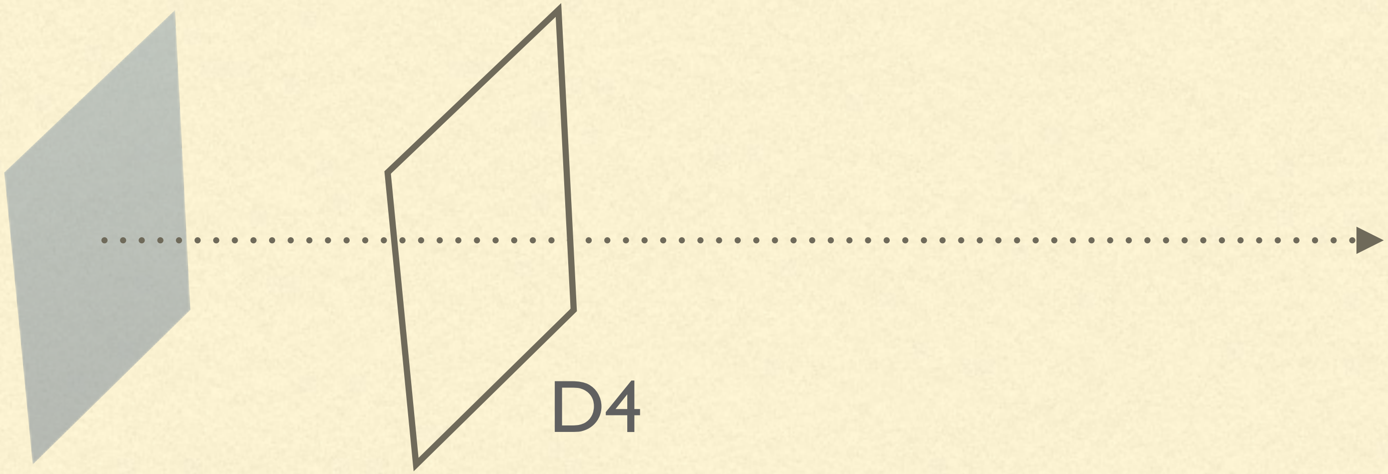

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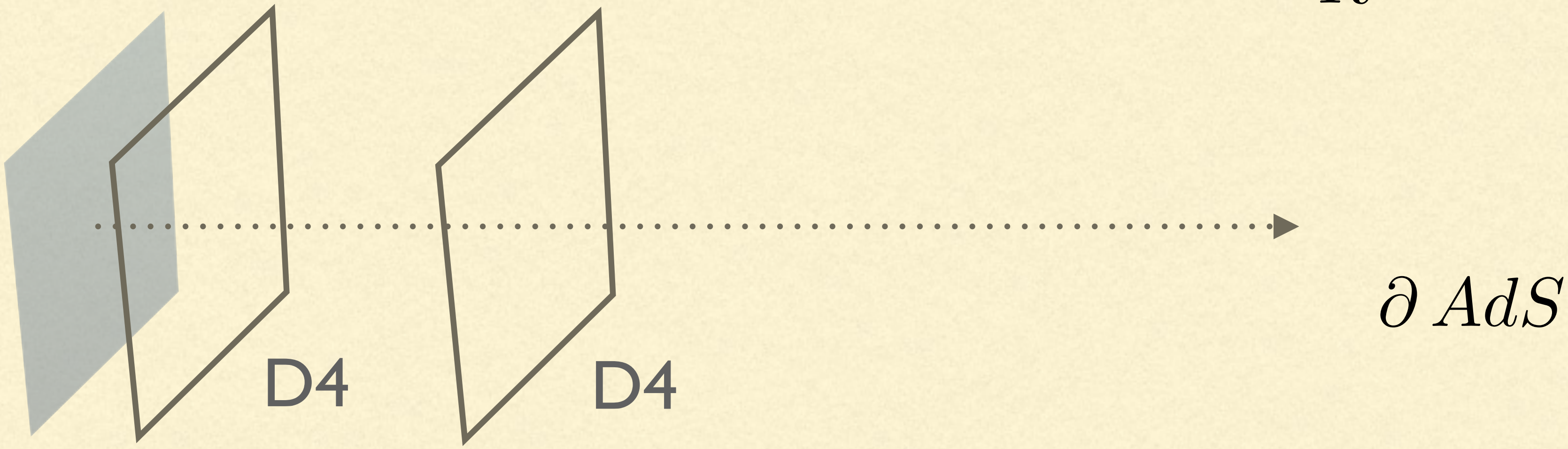

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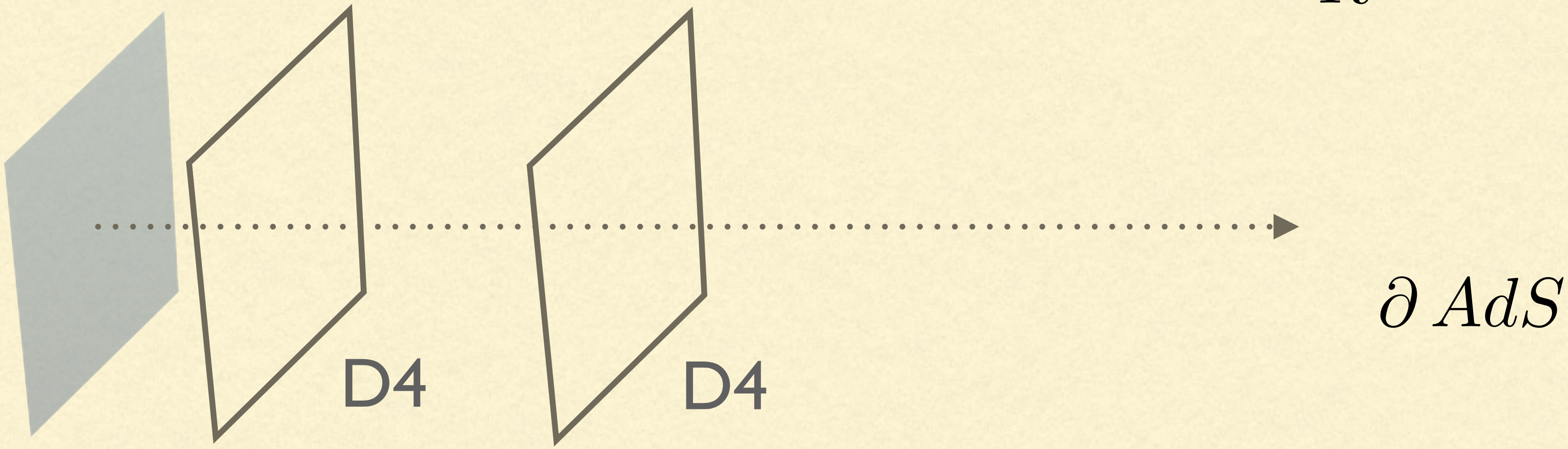

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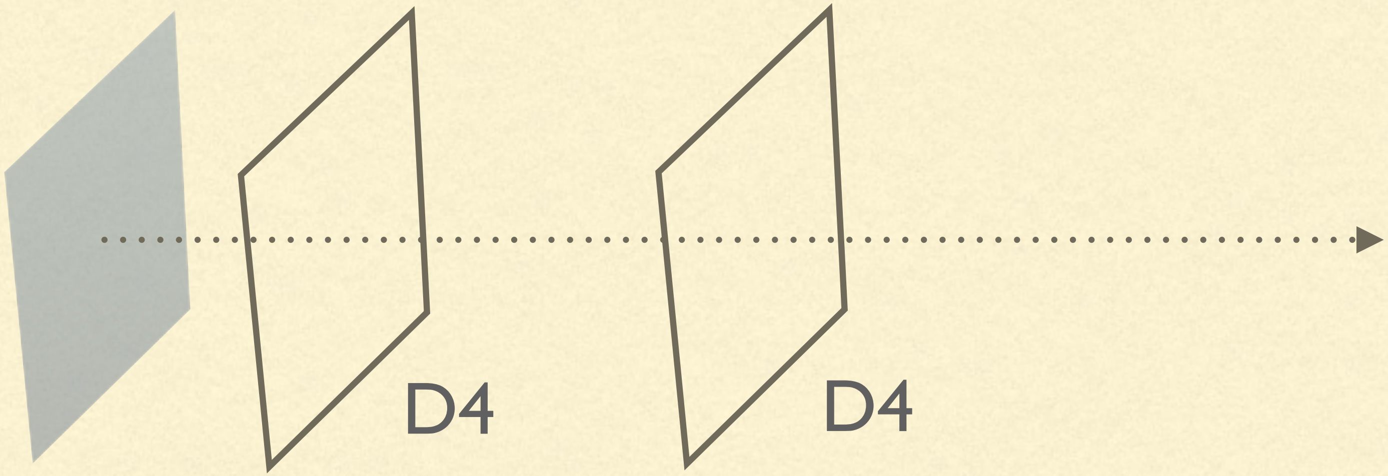

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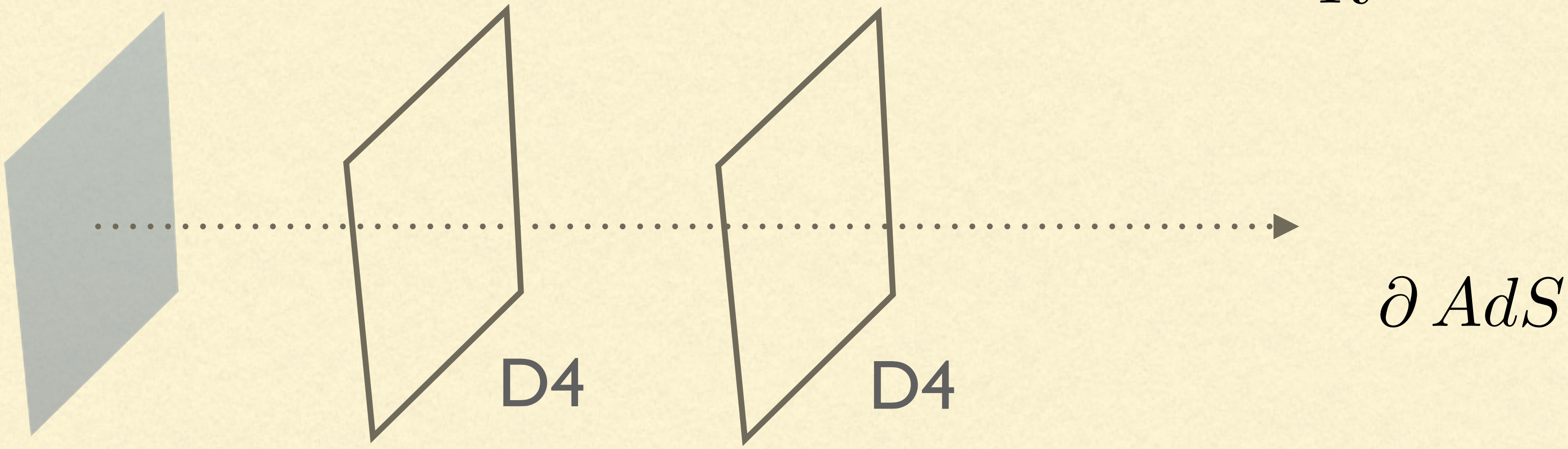

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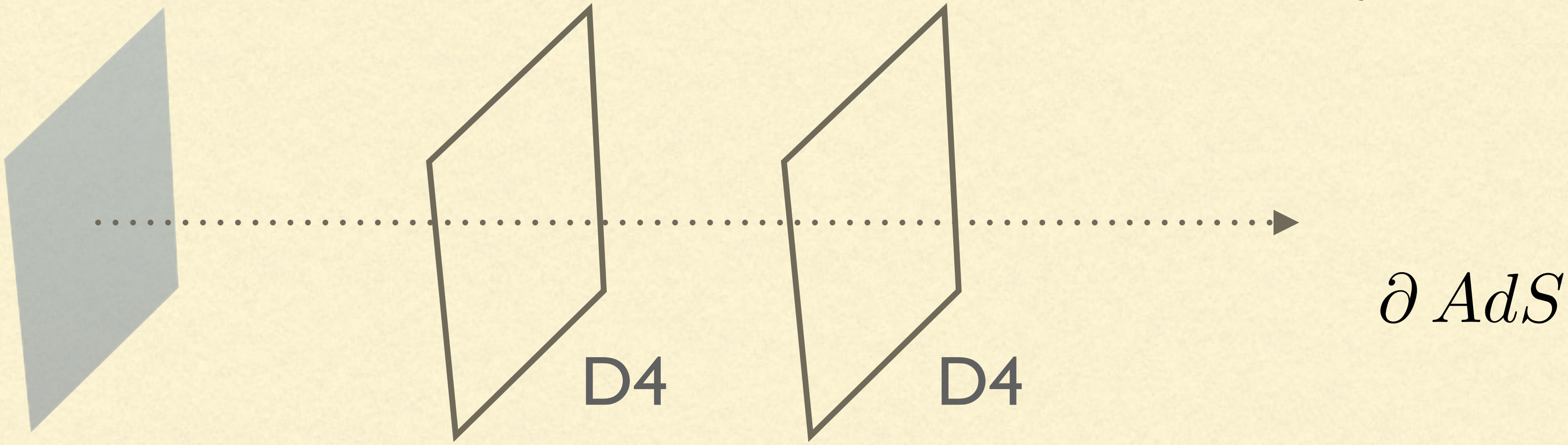

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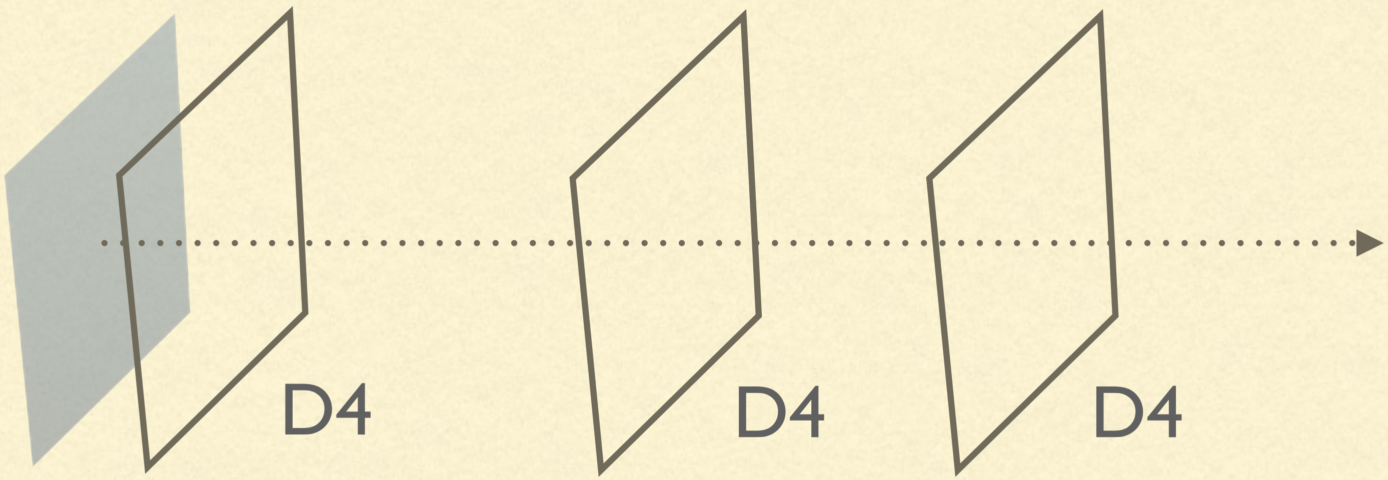

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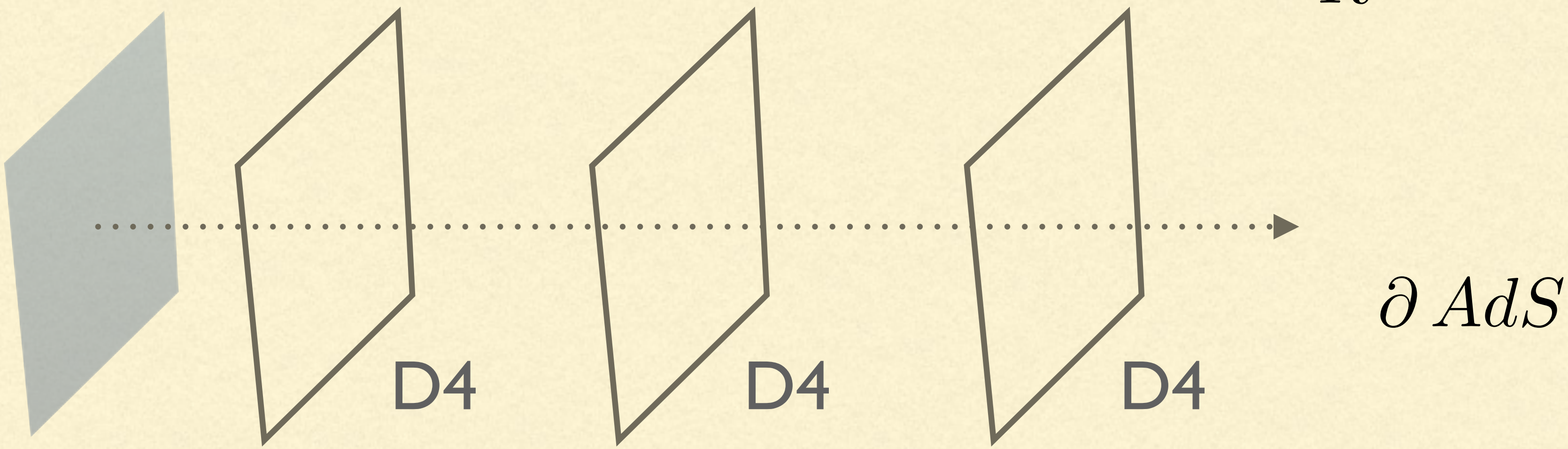

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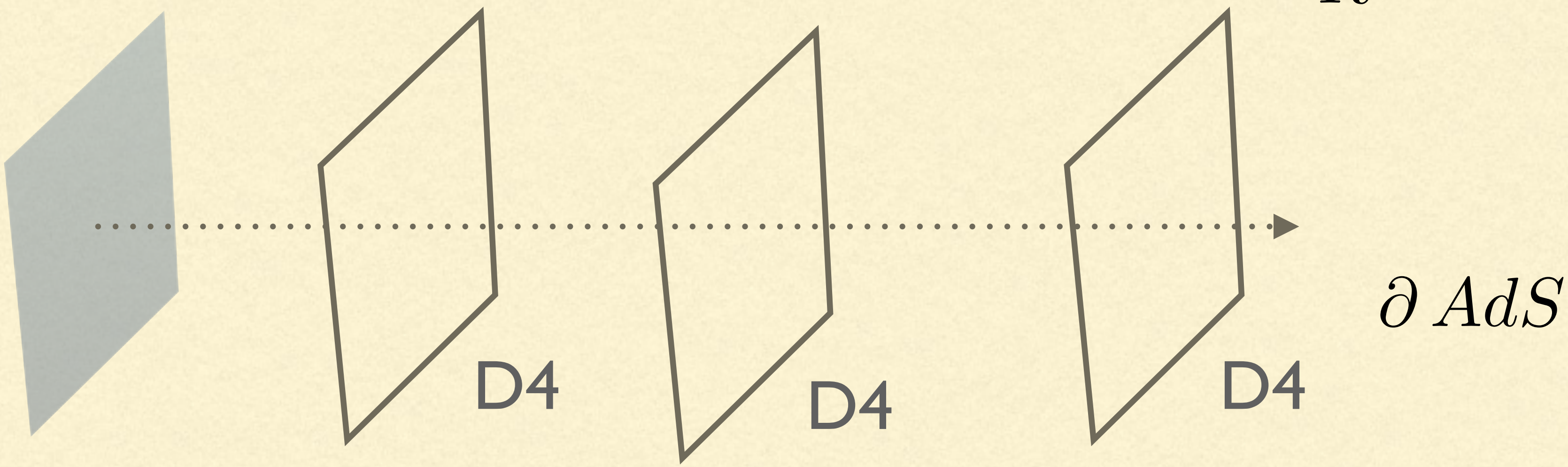

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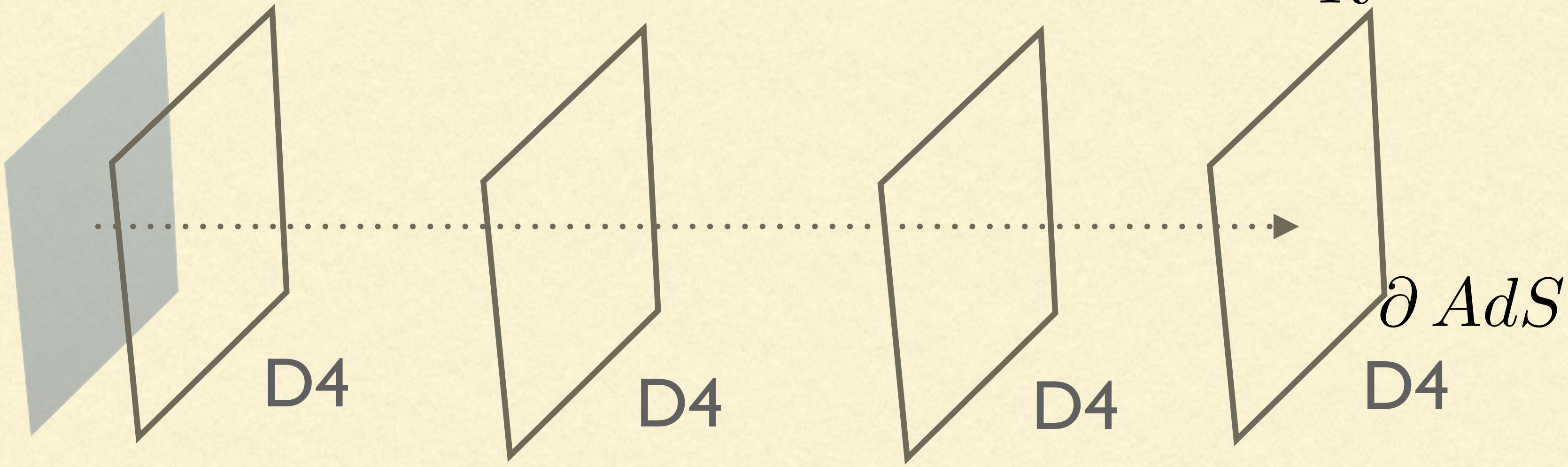

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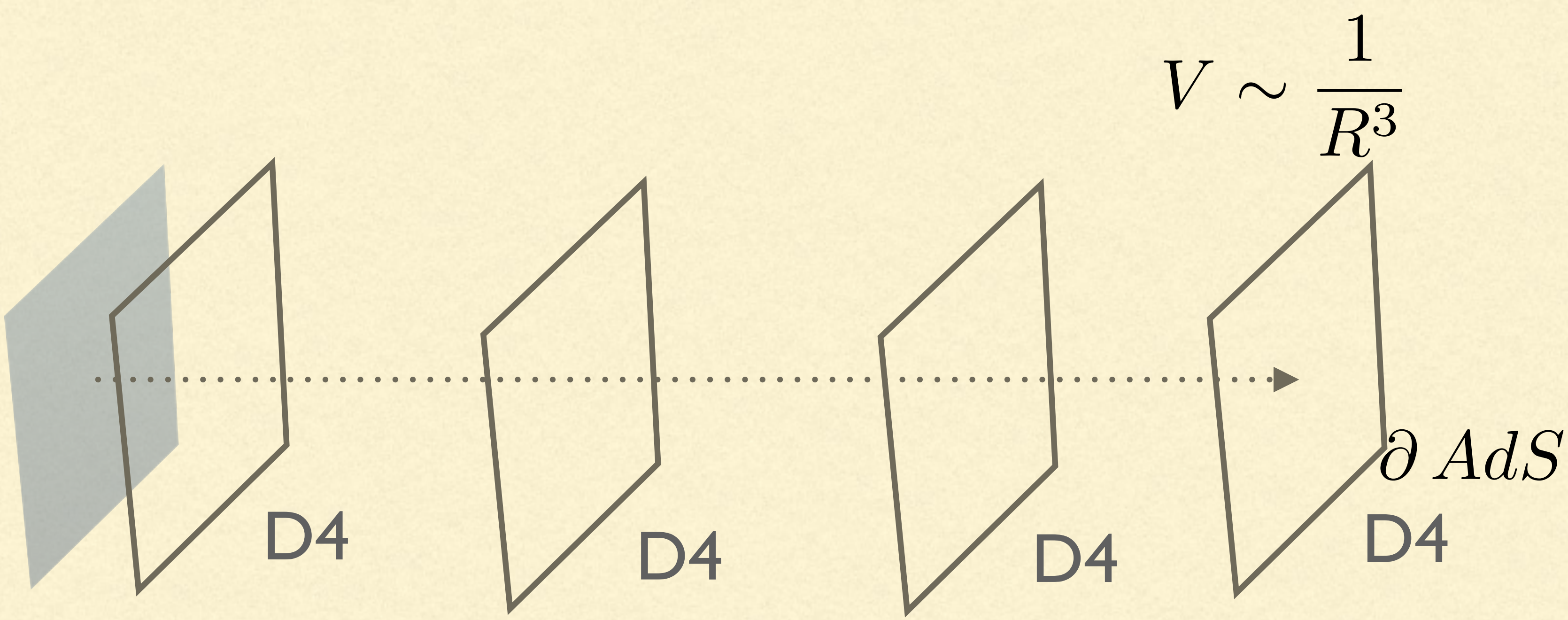

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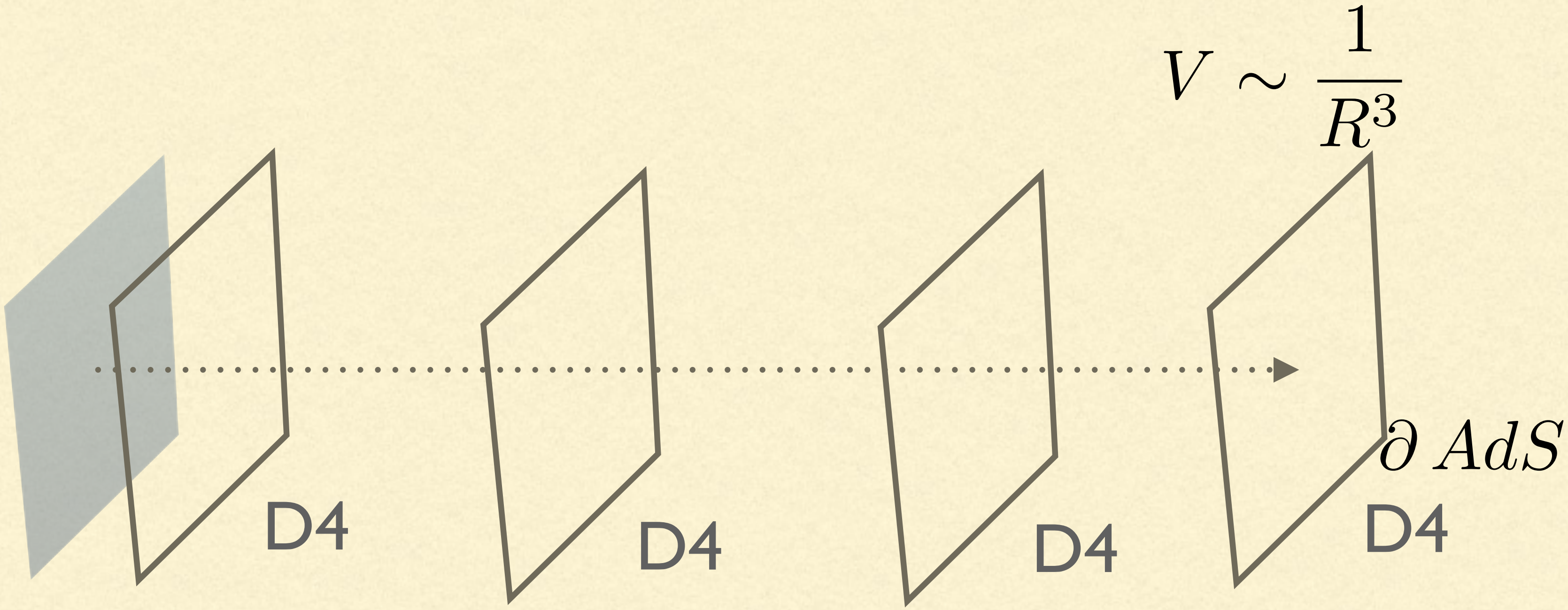

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If so this **DGKT** model is not really a stable SUSY AdS.

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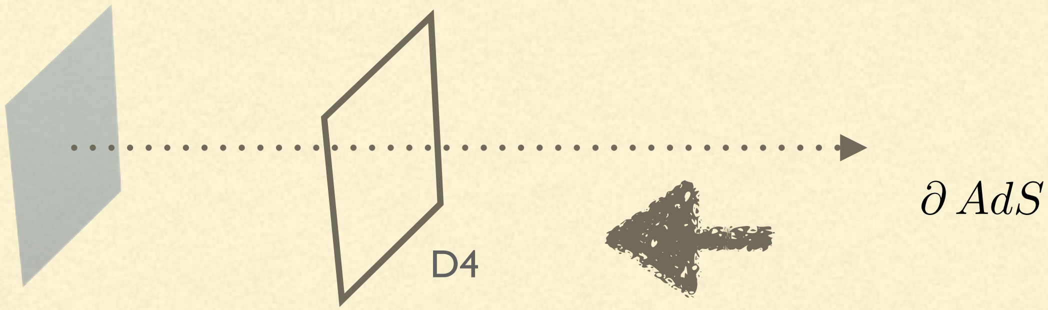

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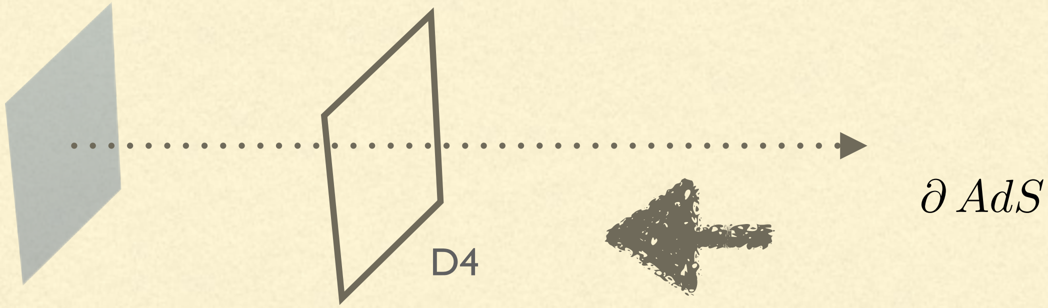

This would go against a strong **WGC for membranes**

[Ooguri-Vafa '16]

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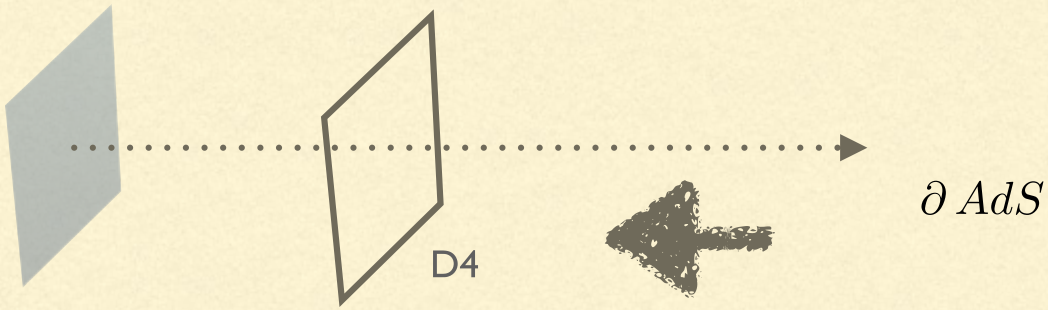

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WGC forces exact moduli space in SUSY theories!

Can’t have scale-sep without minimal SUSY!

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[Polchinski, Silverstein '09; Perlmutter, Alday '19; Cribiori, Dall'Agata '22; MM, Rocek, Vafa '22…]

Dimension	# of Q's	R-symmetry
$d=4$	$2\,(\mathcal{N}=1)$	$--$
	$4\,(\mathcal{N}=2)$	$\mathfrak{so}(2)$
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	$8\,(\mathcal{N}=4)$	$\mathfrak{so}(4)$
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$$\ell = 0, 1, 2, \ldots$$

= KK tower of extra dim of size ℓ_{AdS}

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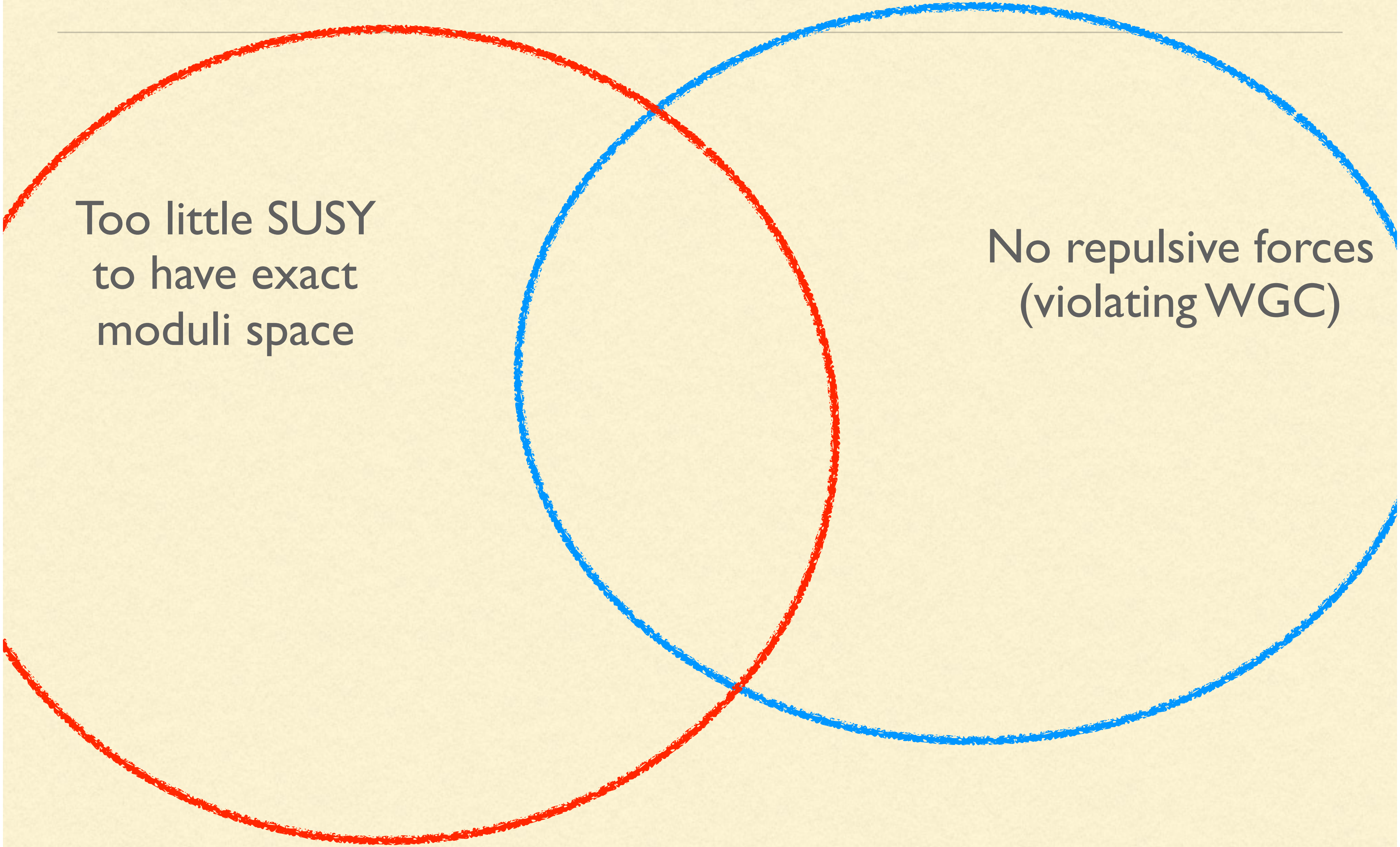
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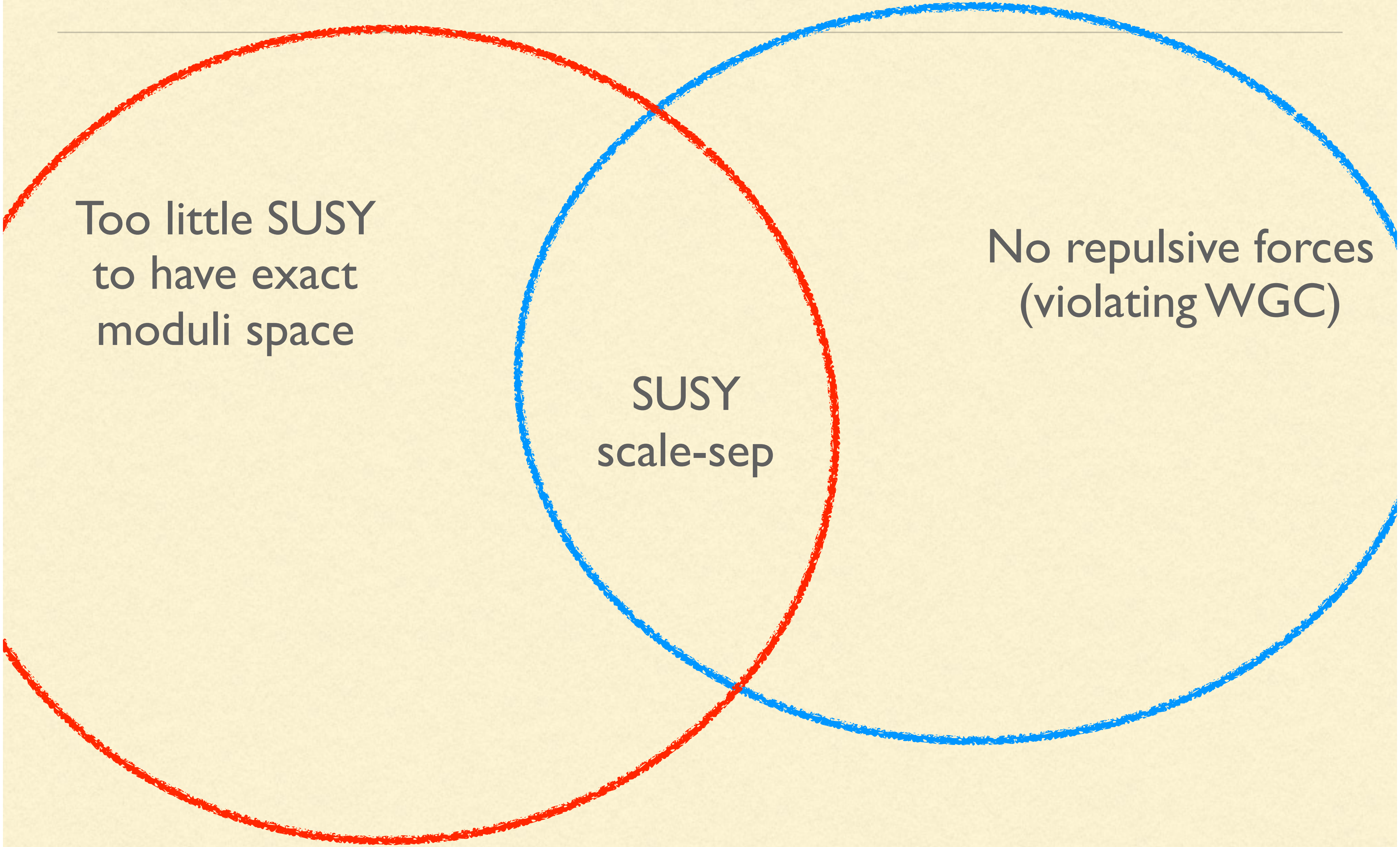
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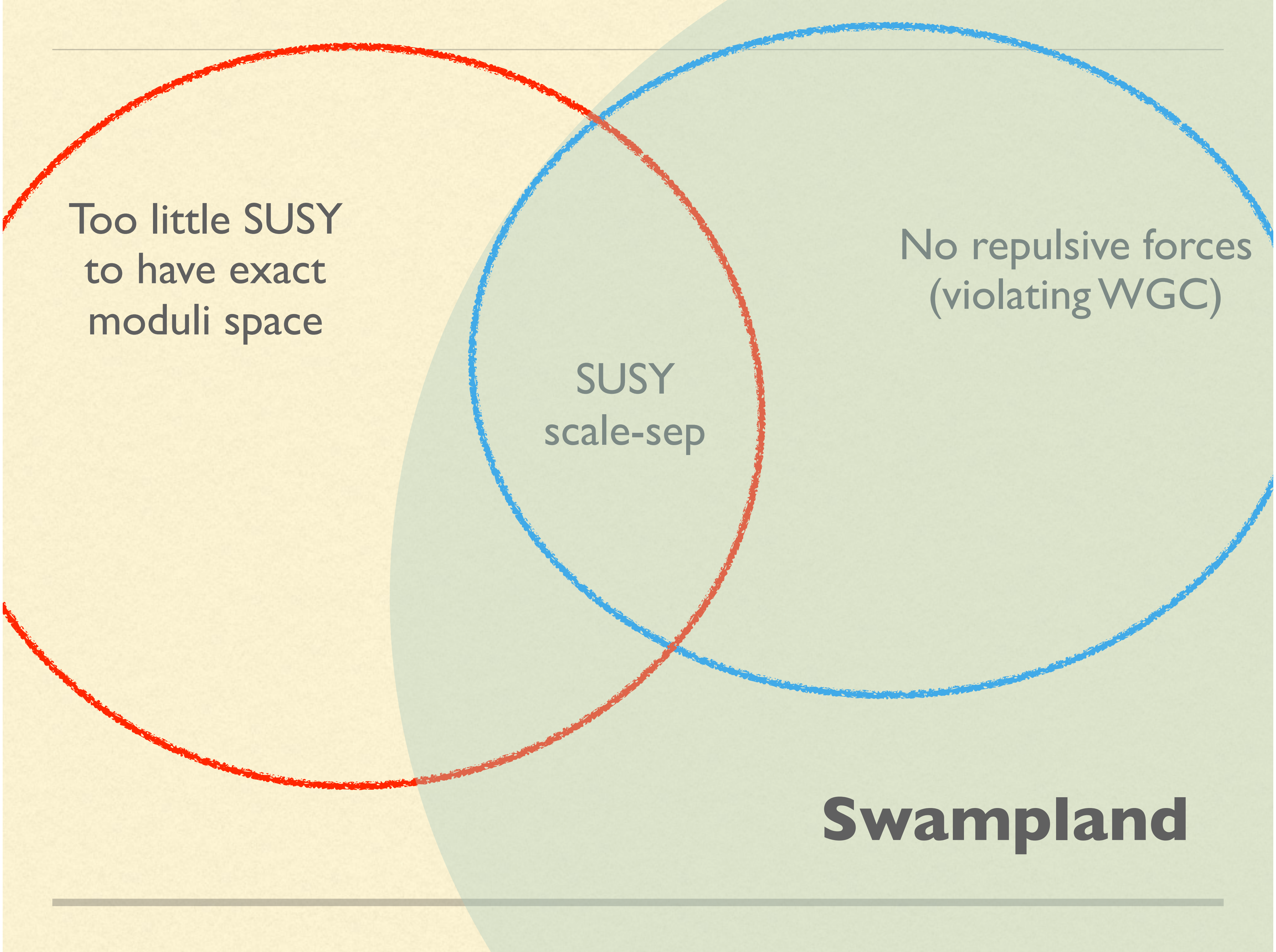
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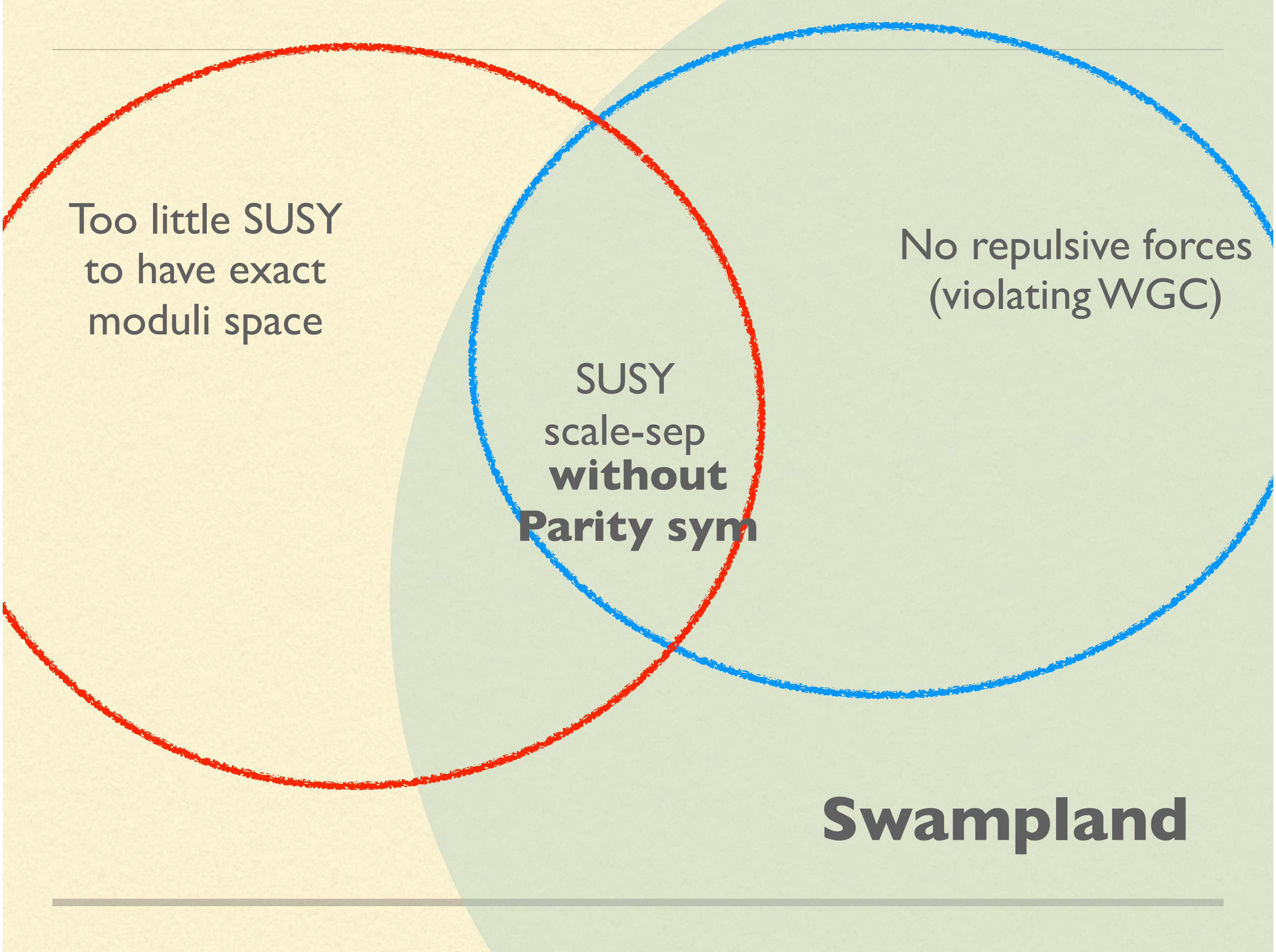
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However: Existing set of
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[Collins, Jafferis, Vafa, Xu, Yau '22]

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[Fien Apers, MM, I. Valenzuela, WIP]

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Triple, four…N re-
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Stay tuned for Irene's talk @ Strings!

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See also Matilda Delgado's talk on anomalies!

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감사합니다!