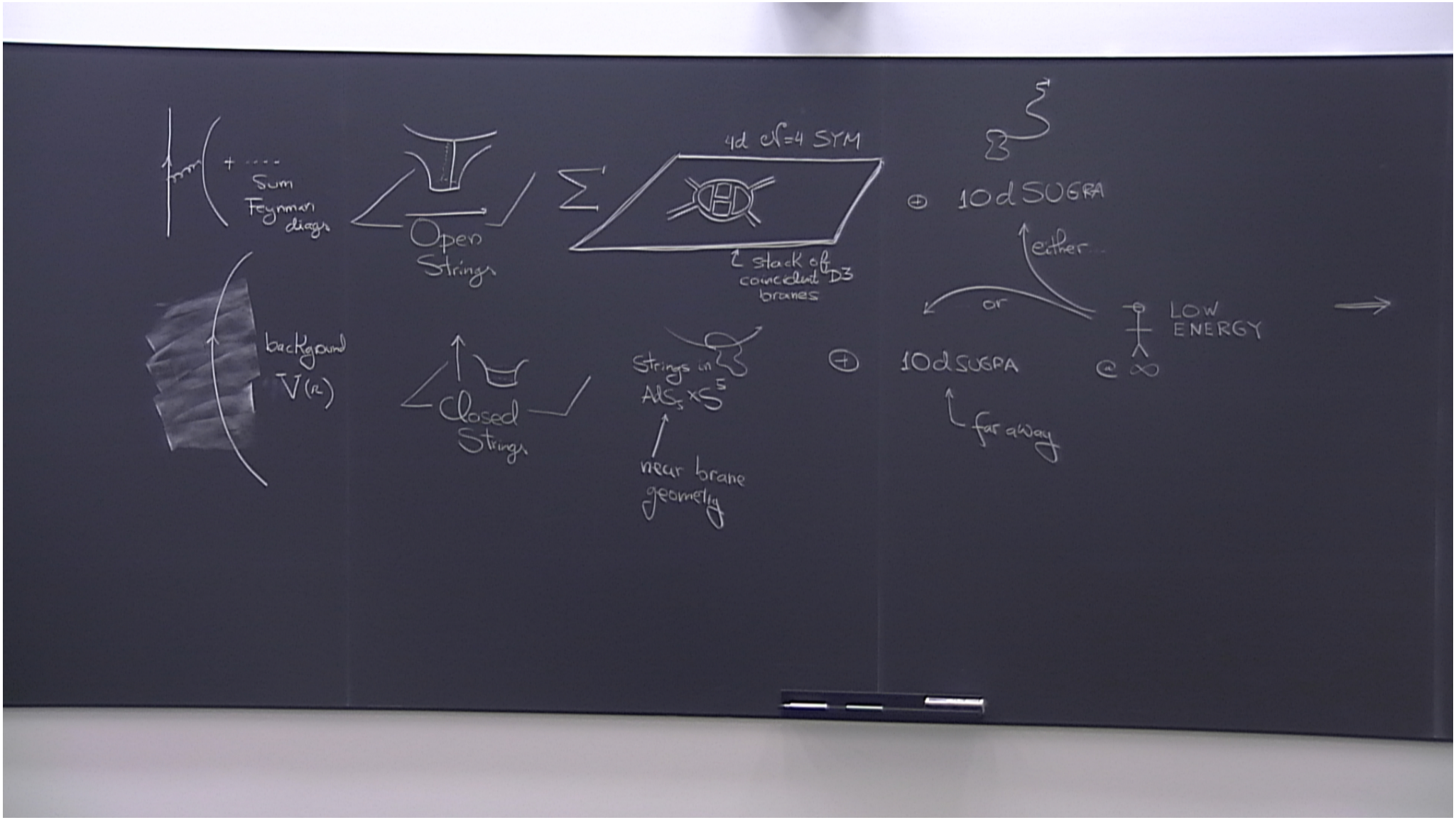
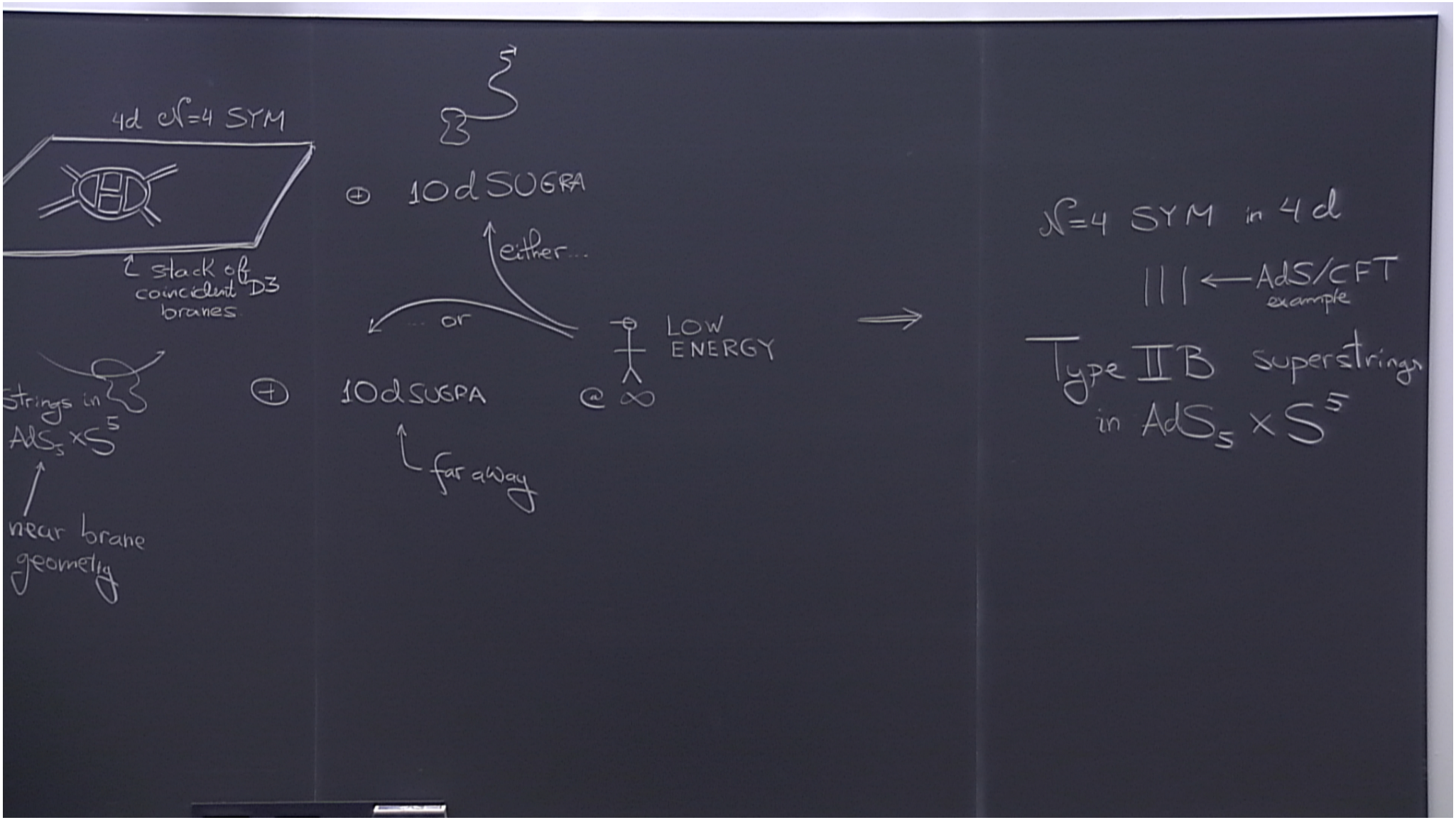
Title: Explorations in String Theory -12

Date: Apr 21, 2015 11:30 AM

URL: http://pirsa.org/15040151

Abstract:


+ .... Sum Feynman diags
Open Strings
Σ
4d N=4 SYM
N stack of coincident D3 branes
10d SUGRA
either
or
LOW ENERGY
background V(r)
Closed Strings
Strings in AdS5 x S5
near brane geometry
10d SUGRA
far away


4d $\mathcal{N}=4$ SYM
stack of coincident D3 branes
$\oplus$ 10d SUGRA
either...
... or
LOW ENERGY
@ ∞
far away
$\oplus$ 10d SUGRA
strings in $AdS_5 \times S^5$
near brane geometry
$\mathcal{N}=4$ SYM in 4d
$\Leftarrow$ AdS/CFT example
Type IIB superstrings in $AdS_5 \times S^5$

$$S = \frac{1}{2\pi\alpha'} \int G_{\mu\nu}\, \partial X^\mu \partial X^\nu$$

$G_{\mu\nu}$: $L^2 \hat{G}_{\mu\nu}$; $\hat{G}_{\mu\nu}$ dimensionless

$$= \frac{\sqrt{\lambda}}{2\pi} \int \hat{G}_{\mu\nu}\, \partial X^\mu \partial X^\nu$$

$\hat{G}_{\mu\nu}$: unit $S^5 \times AdS^5$ with $L=1$

$$S = \frac{1}{2\pi\alpha'} \int G_{\mu\nu}\, \partial X^\mu \partial X^\nu$$

$G_{\mu\nu}$: $L^2 \hat{G}$

$\hat{G}_{\mu\nu}$: dimensionless

$$= \frac{\sqrt{\lambda}}{2\pi} \int \hat{G}_{\mu\nu}\, \partial X^\mu \partial X^\nu$$

eff string tension

$\hat{G}_{\mu\nu}$: unit $S^5 \times AdS^5$ with $L = 1$

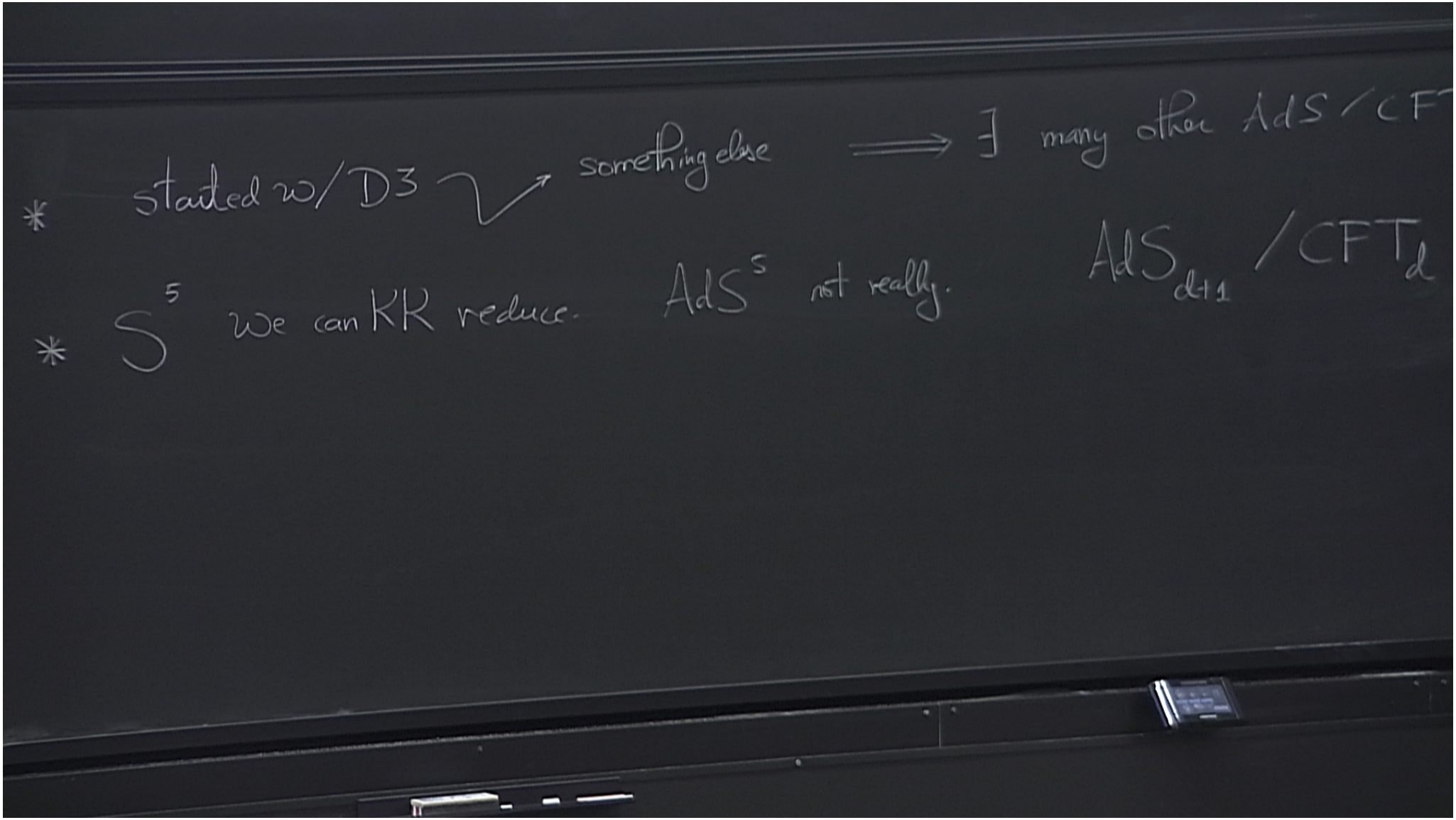
$\lambda \ll 1$ ← $\mathcal{N}=4$ easy perturbation theory

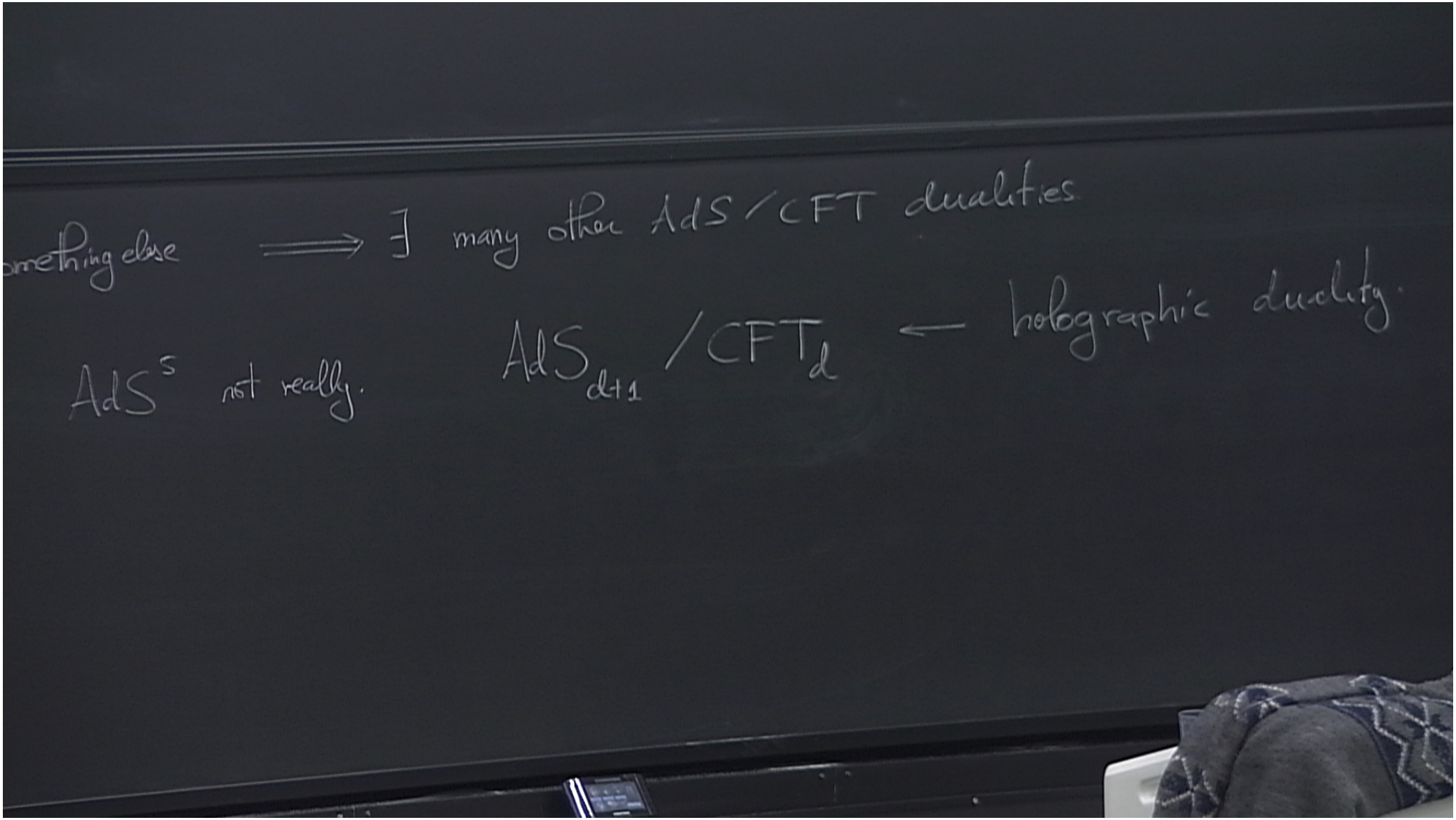
- string th very hard highly quantum vibrating strings

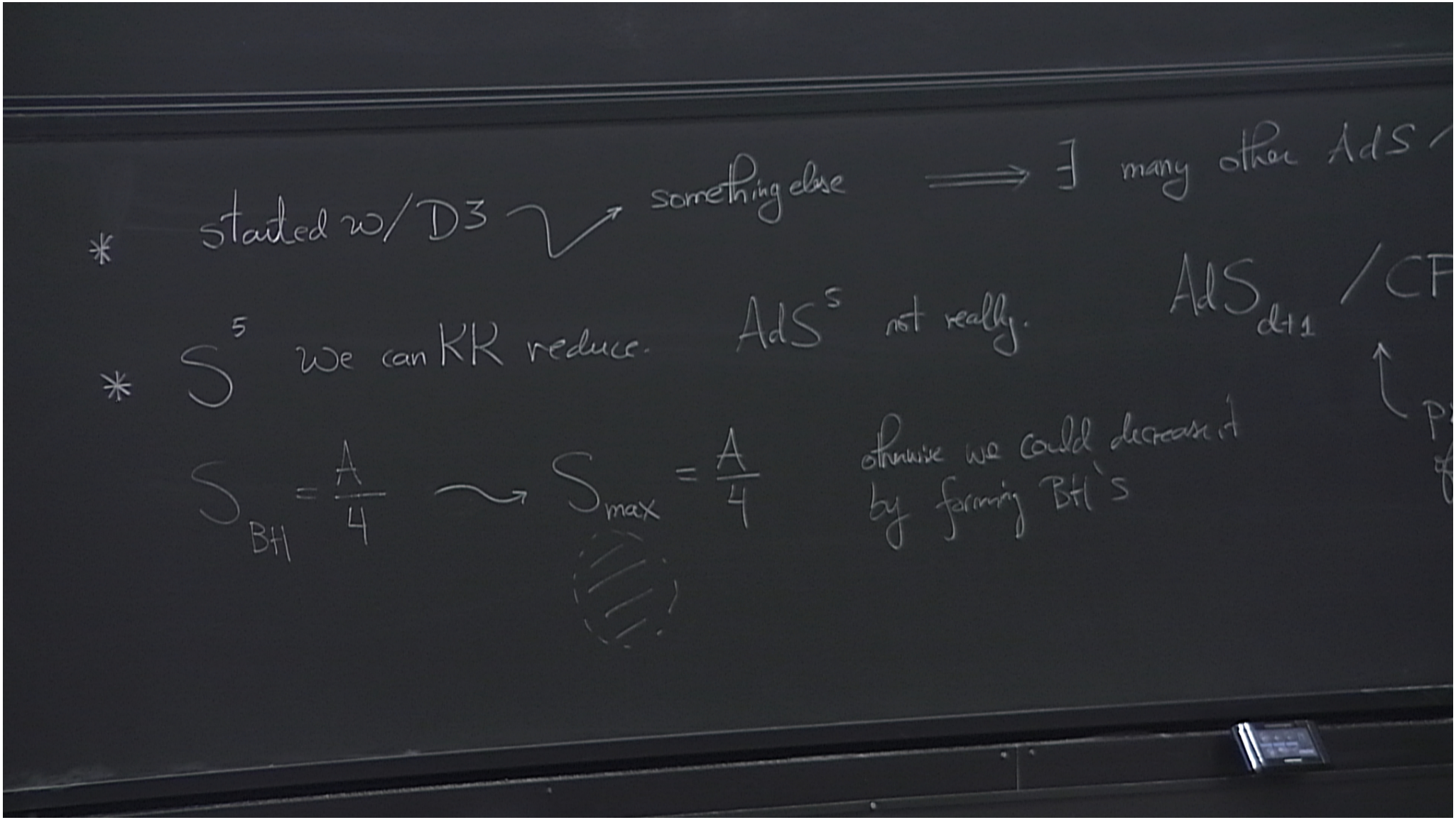
$\lambda \gg 1$ ← - string th easy classical strings

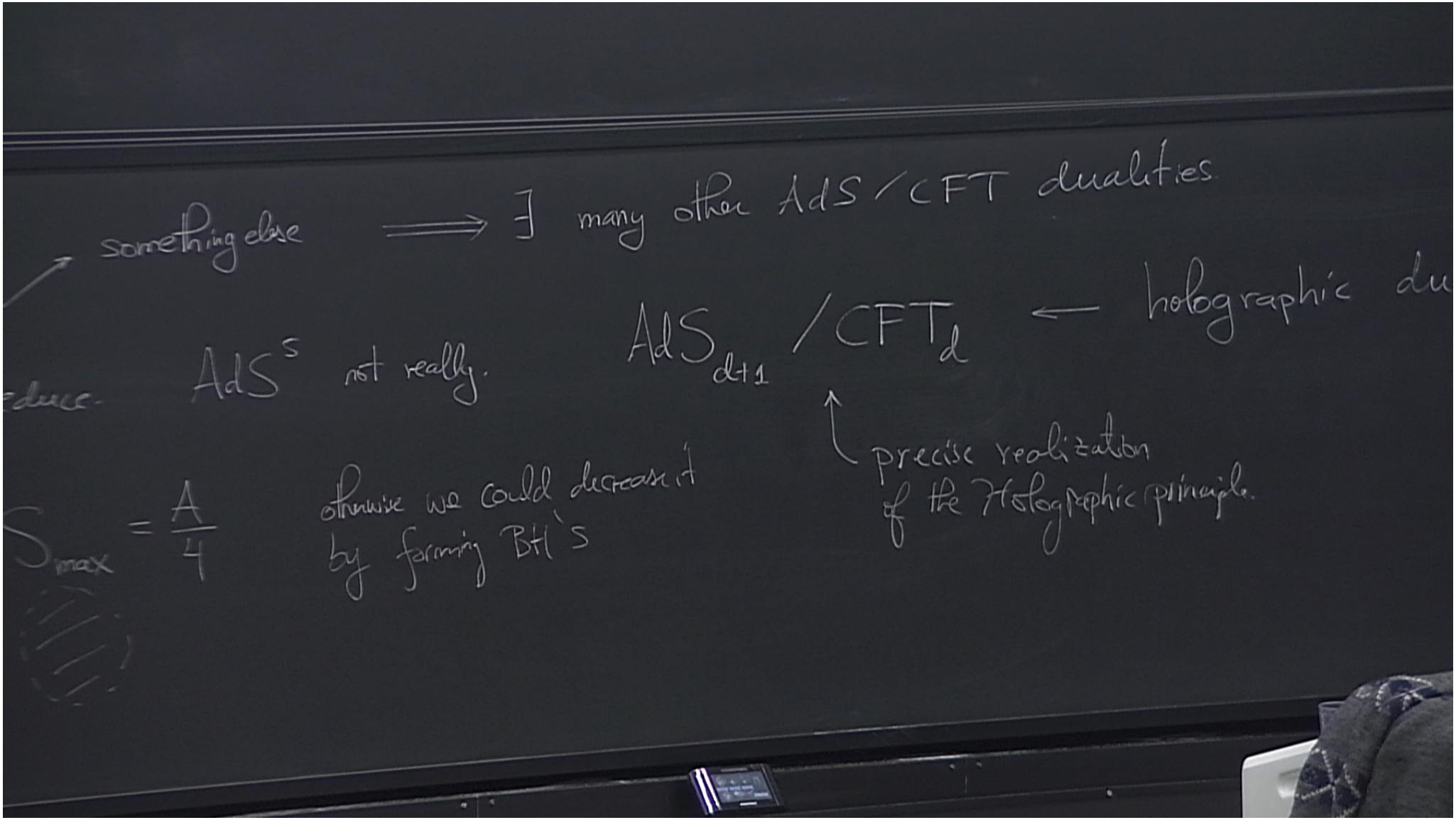
- $\mathcal{N}=4$ is very hard strongly coupled QFT

$L=1$


* started w/ D3 → something else ⟹ ∃ many other AdS/CF
* S^5 we can KK reduce. AdS^5 not really. AdS_{d+1}/CFT_d


something else ⟹ ∃ many other AdS/CFT dualities
AdS^5 not really.
AdS_{d+1}/CFT_d ← holographic duality.


* started w/ D3 → something else ⟹ ∃ many other AdS
* S^5 we can KK reduce. AdS^5 not really. AdS_{d+1} /CF
$S_{Bh} = \frac{A}{4}$ → $S_{max} = \frac{A}{4}$
otherwise we could decrease it by forming Bh's


something else ⟹ ∃ many other AdS/CFT dualities
AdS^5 not really.
AdS_{d+1}/CFT_d ← holographic du
precise realization of the Holographic principle.
S_max = A/4
otherwise we could decrease it by forming BH's

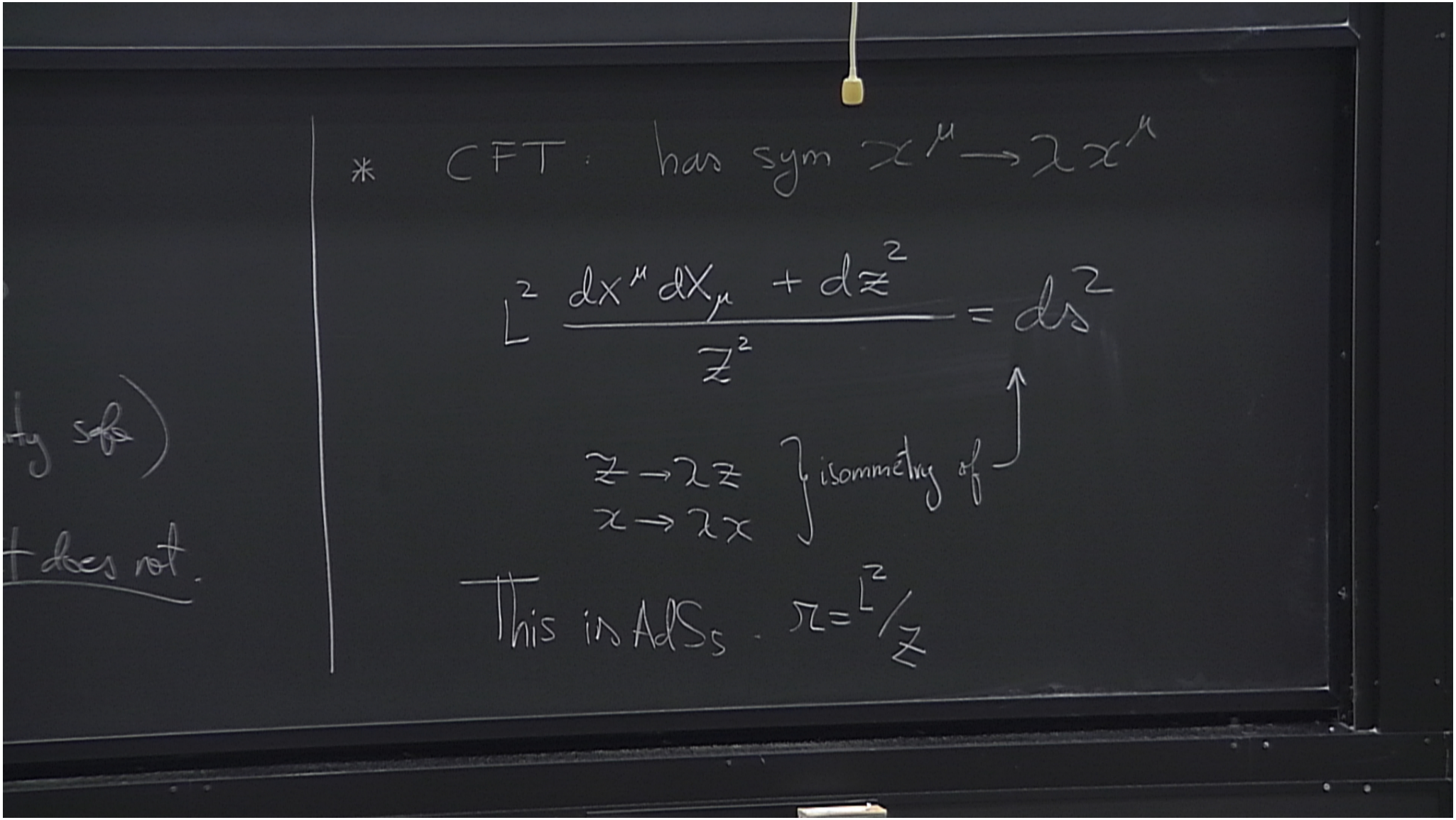
* ∃ theorem by Weinberg/Witten

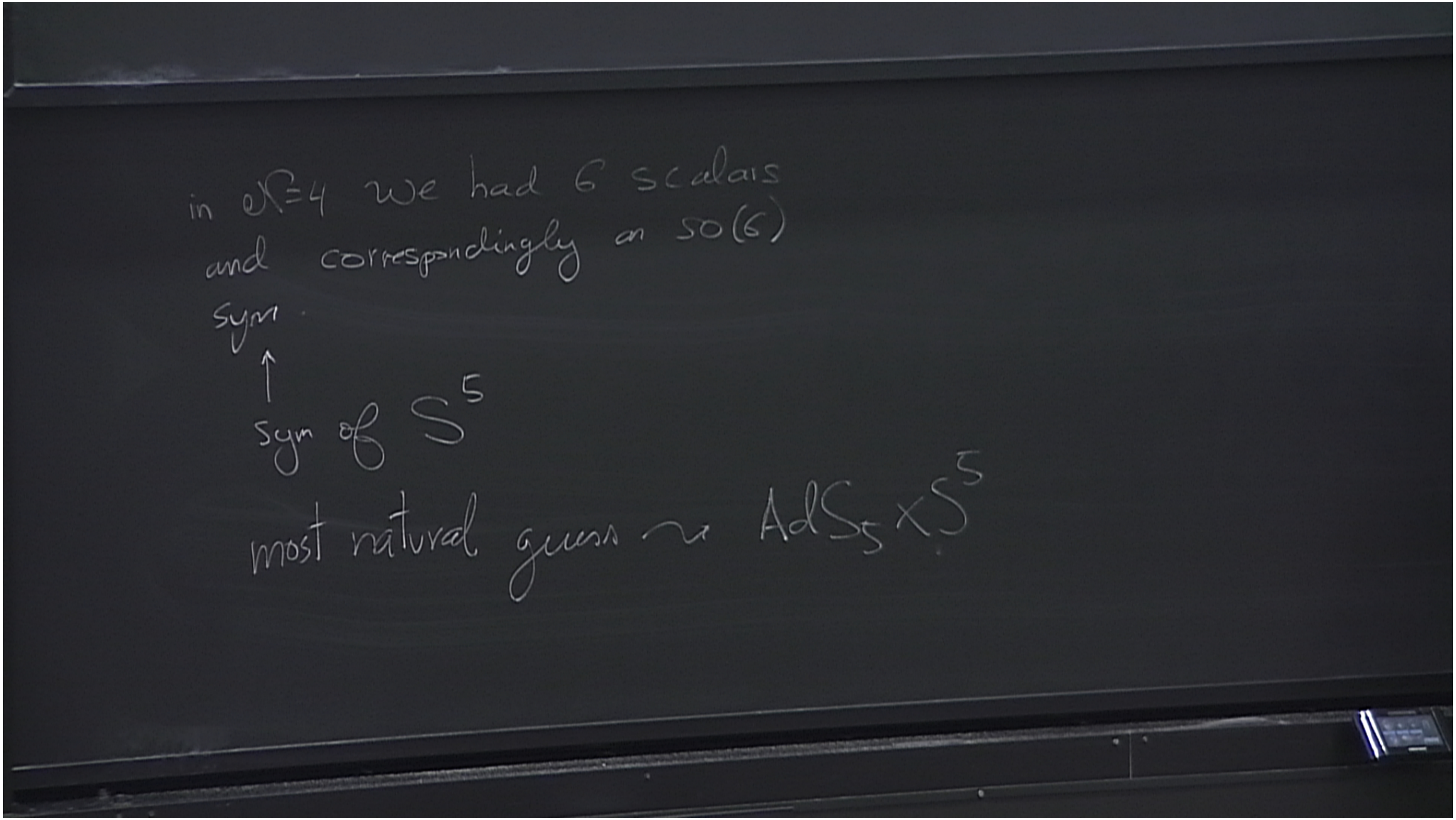
QFT w/ poincaré inv stress tensor ⇒ $P_\mu = \int T_{\mu 0} \neq 0$

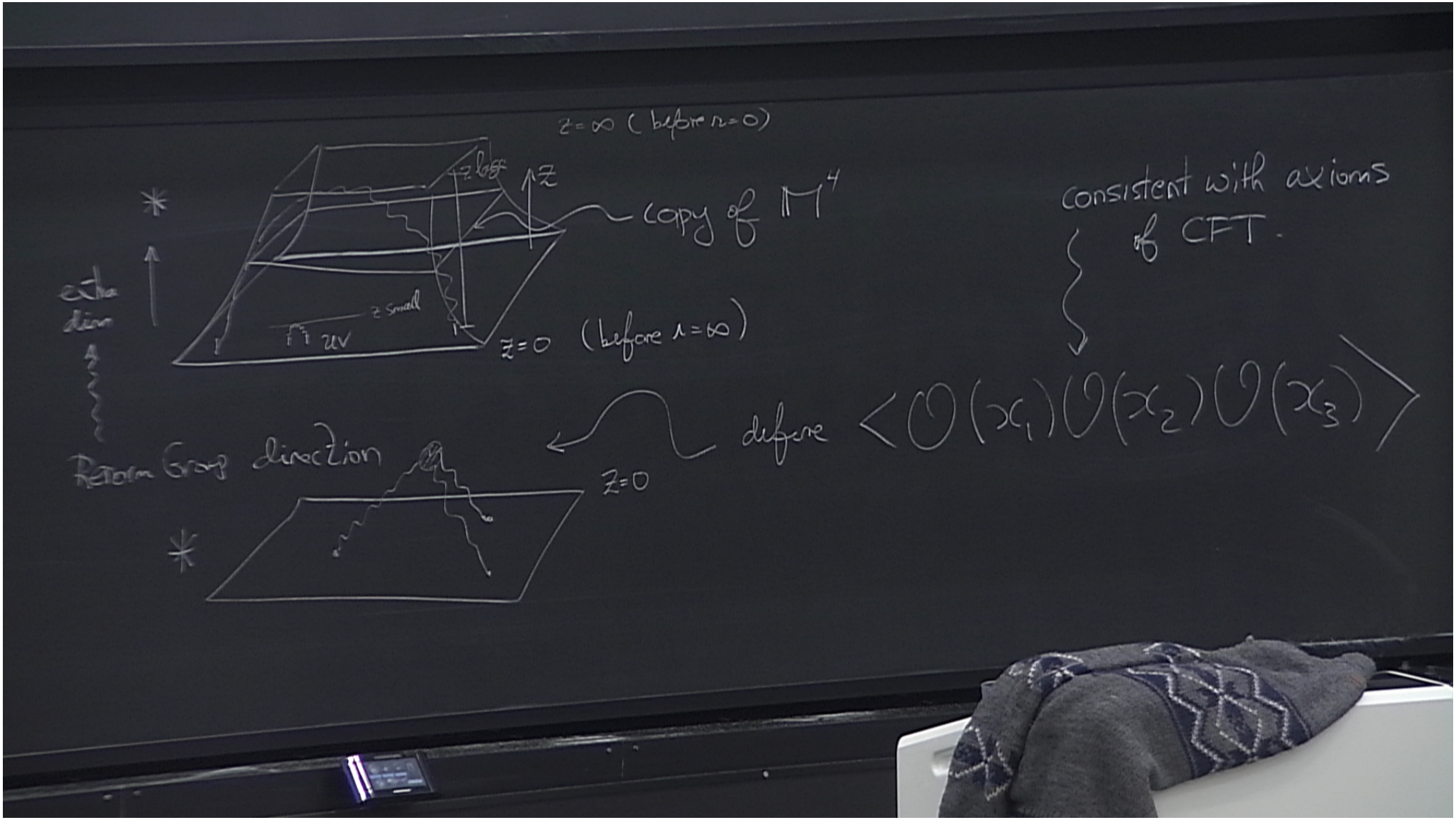
forbids fields of spin $j > 1$

$\left(\frac{\delta S}{\delta g_{\mu\nu}} = 0 \leftarrow \text{gravity sofa} \right)$

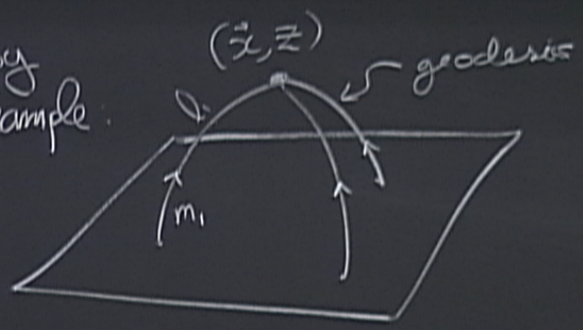
Assumption: Graviton lives in the same space-time as the gluons. It does not.


* CFT: has sym $x^\mu \to \lambda x^\mu$
$\frac{L^2 \, dx^\mu dx_\mu + dz^2}{z^2} = ds^2$
$z \to \lambda z$
$x \to \lambda x$
} isommetry of
This is AdS_5. $r = L^2/z$

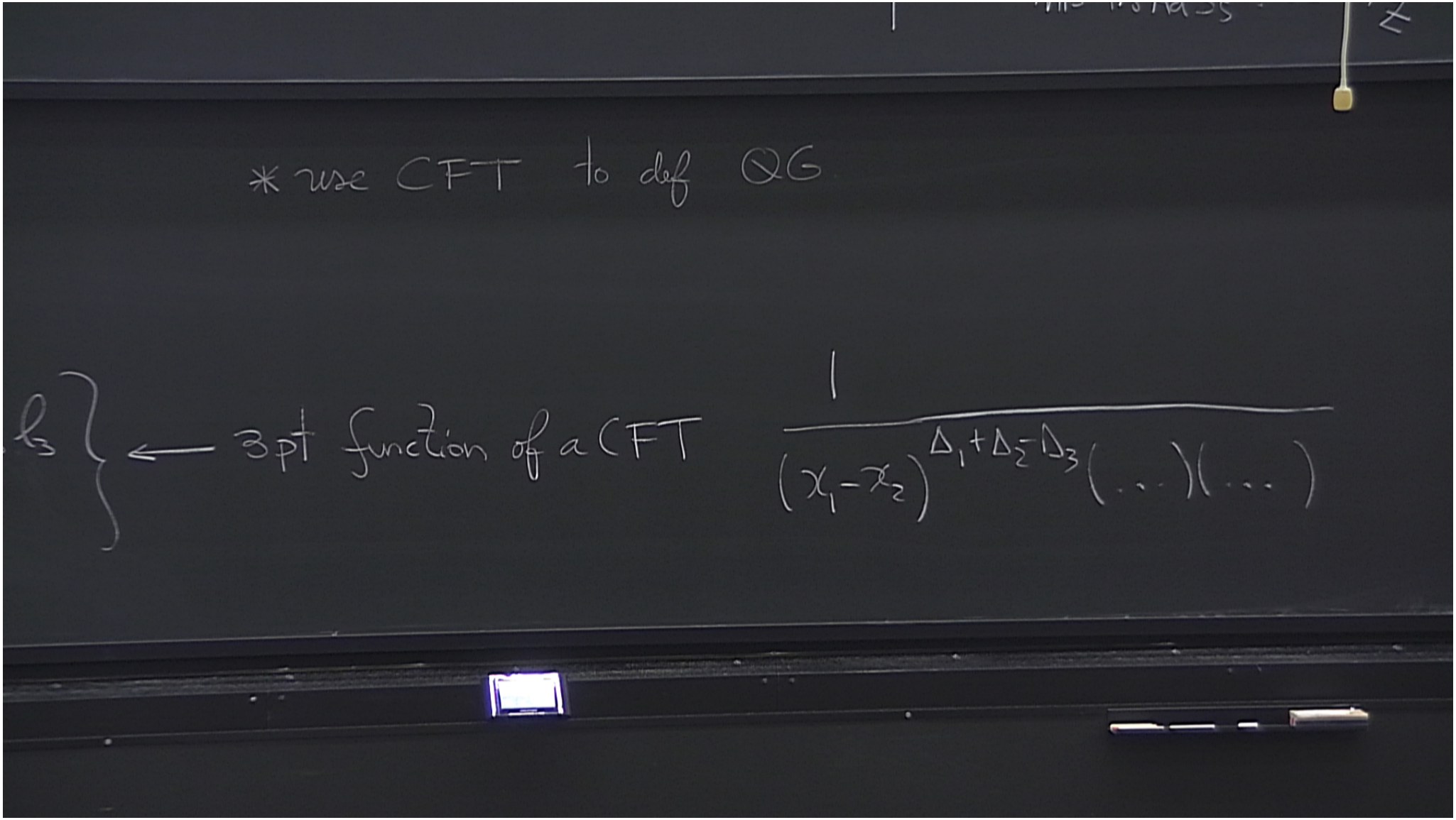

in $\mathcal{N}=4$ we had 6 scalars
and correspondingly an $SO(6)$
sym
↑
sym of S^5
most natural guess $\sim$ $AdS_5 \times S^5$

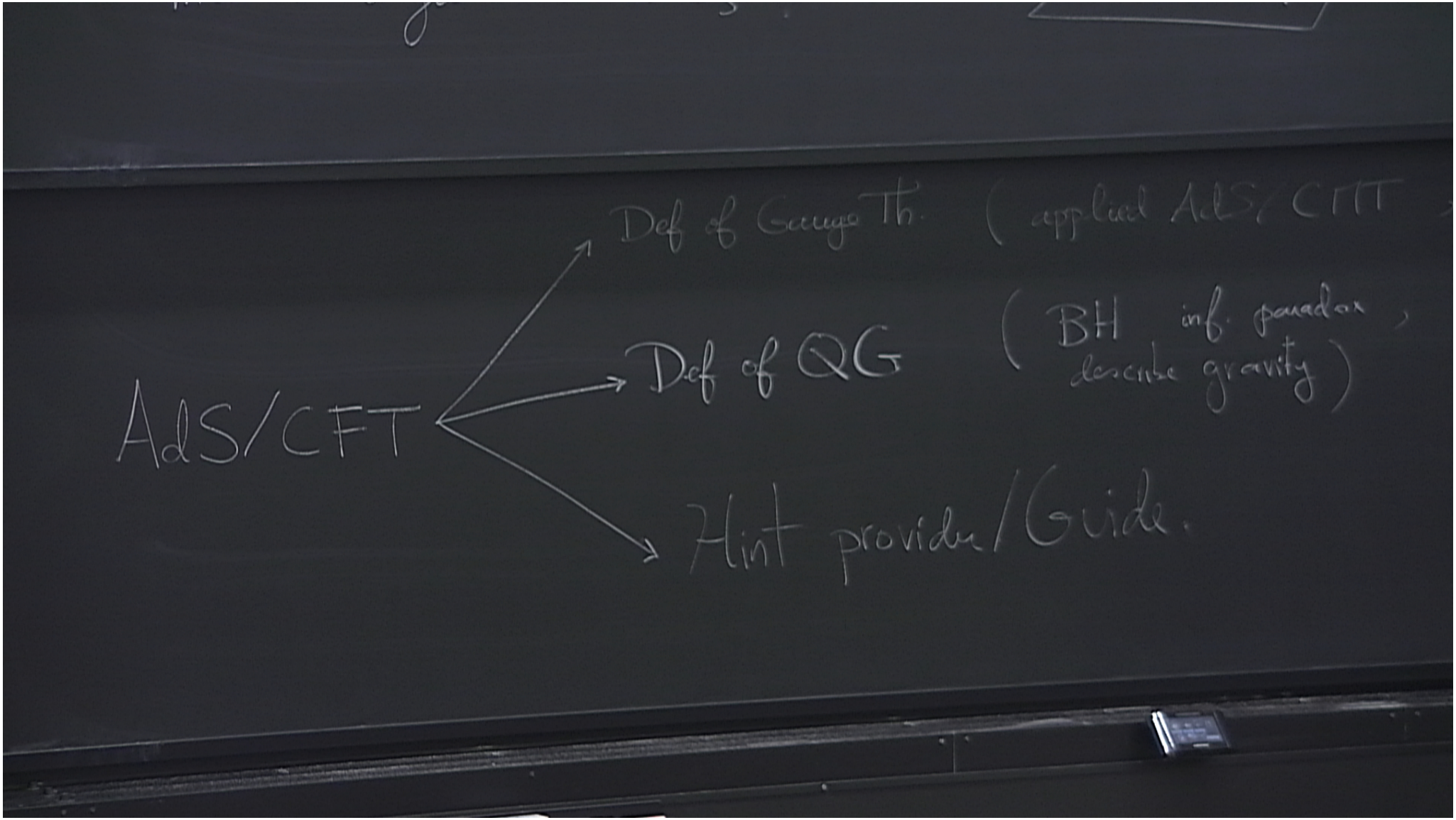

z = ∞ (before λ = 0)
z = log Λ
z
copy of M^4
consistent with axioms of CFT.
extra dim
z small
IR
UV
z = 0 (before Λ = ∞)
define ⟨O(x1)O(x2)O(x3)⟩
Renorm Group direction
z = 0

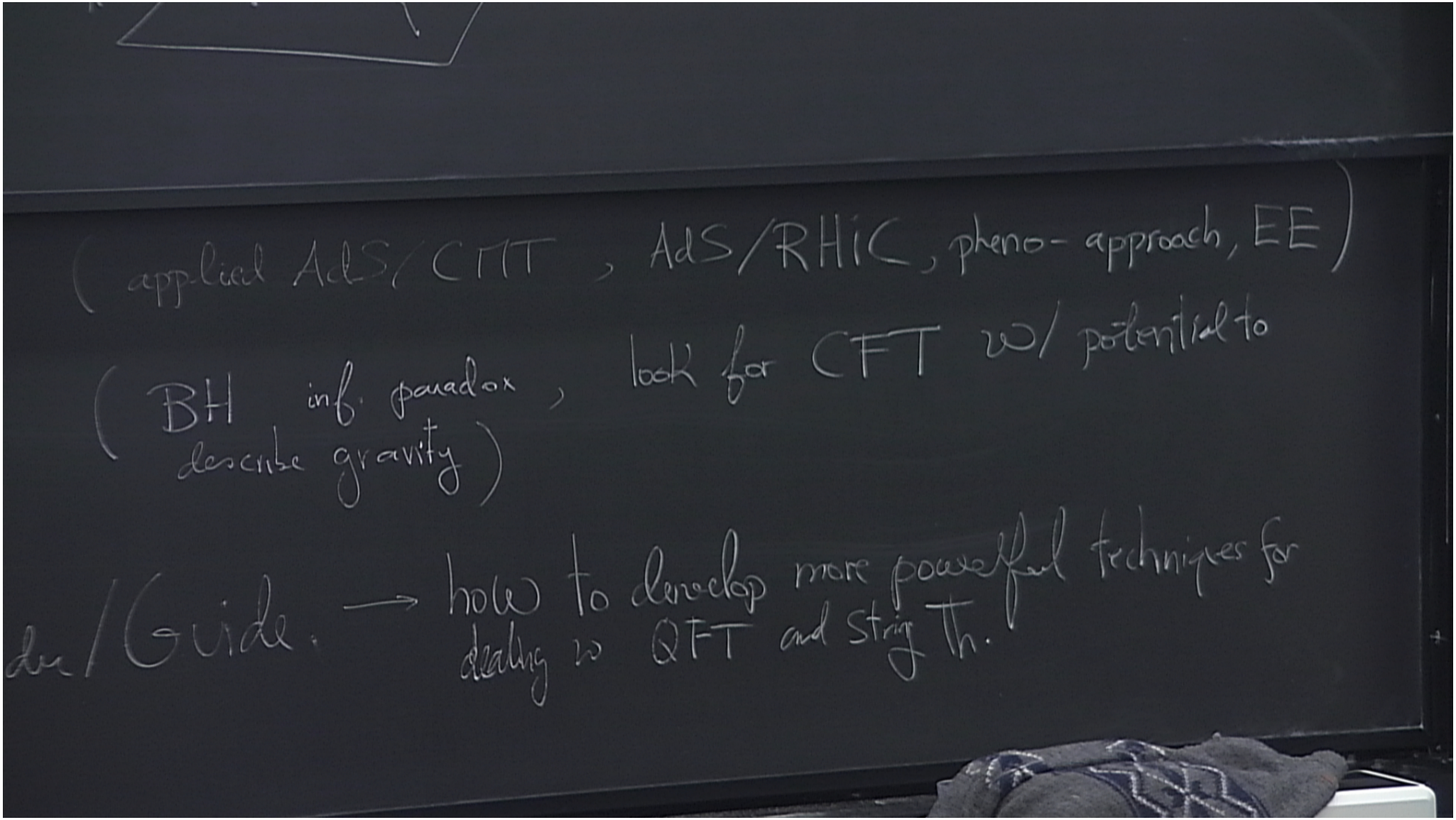
toy example



$$\min\left\{ e^{-S} = e^{-m_1 l_1 - m_2 l_2 - m_3 l_3} \right\} \leftarrow \text{3pt function of a C}$$


* use CFT to def QG
h_3 } ← 3pt function of a CFT
$\frac{1}{(x_1-x_2)^{\Delta_1+\Delta_2-\Delta_3}(\ldots)(\ldots)}$


AdS/CFT
Def of Gauge Th. (applied AdS/CFT
Def of QG (BH inf. paradox, describe gravity)
Hint provider/Guide.


(applied AdS/CFT , AdS/RHIC, pheno-approach, EE)
(BH inf. paradox , look for CFT w/ potential to describe gravity)
→ how to develop more powerful techniques for dealing w QFT and String Th.

Example:

- In $\mathcal{N}=4$ we had a gift - 2 factor
  $\Longrightarrow$ Spin-chains were integrable.

- Take dual of a spin-chain $\equiv$ string.
  $\vec{u}(\sigma,t) \in AdS_5 \times S^5$
  $u_1^2 + \dots + u_6^2 = 1$ ← motion in the sphere

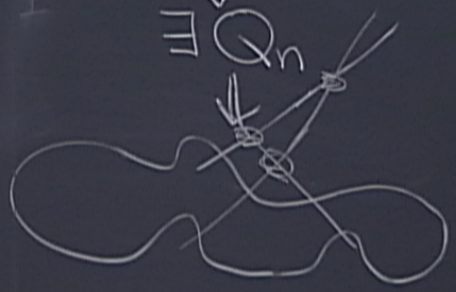


take string e.o.m

$\exists\, A(u \mid \vec{x}(\sigma,t))$ flat (like we had for LL model?)

Spectral

$\exists\, Q_n$



take string eom

$\exists\, A(u \mid \vec{x}(\sigma,t))$ flat (like we had for LL model?)

spectral

$\exists\, Q_n$

