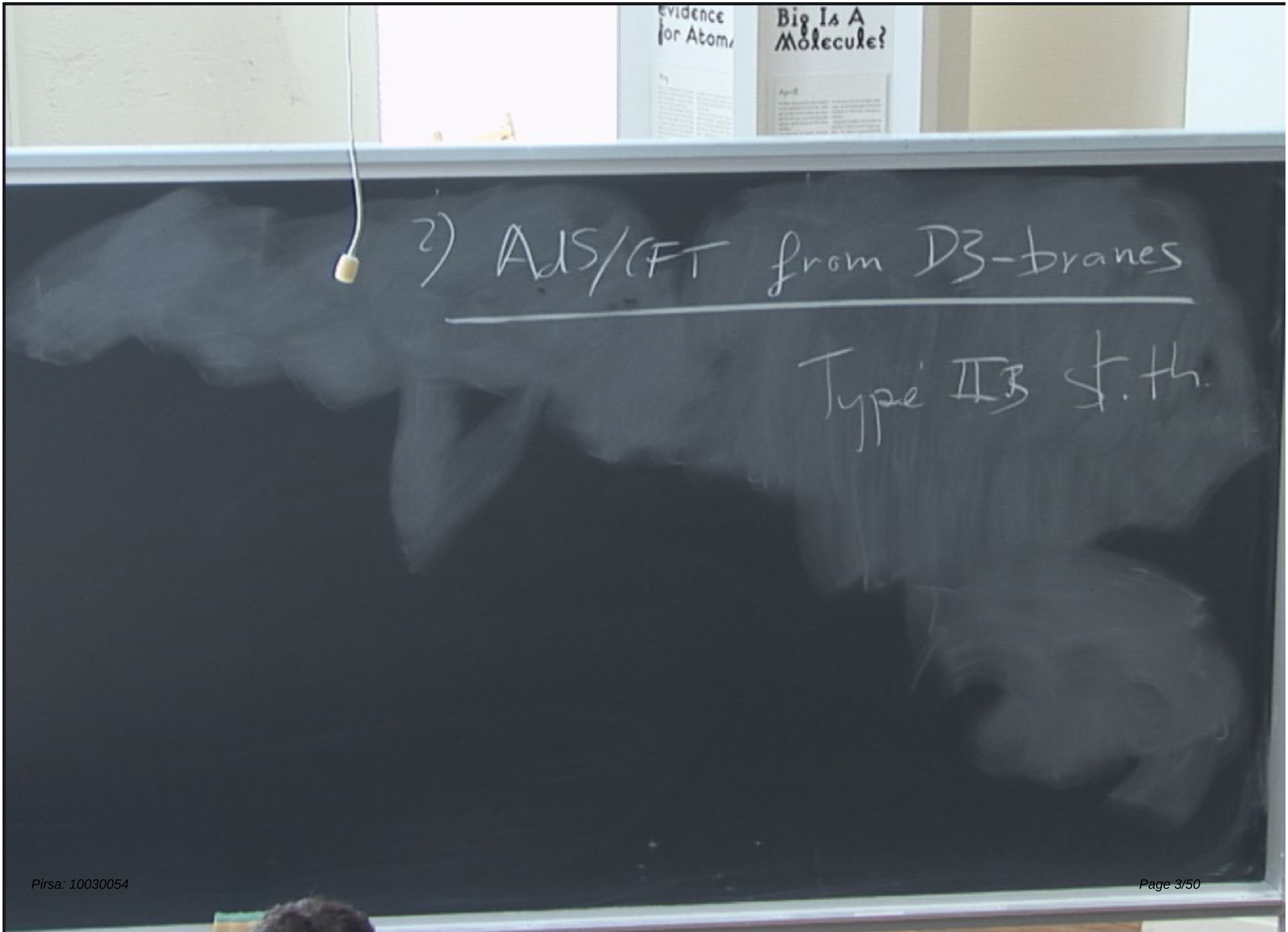
Title: Explorations in String Theory (PHYS 647) - Lecture 12

Date: Mar 02, 2010 11:20 AM

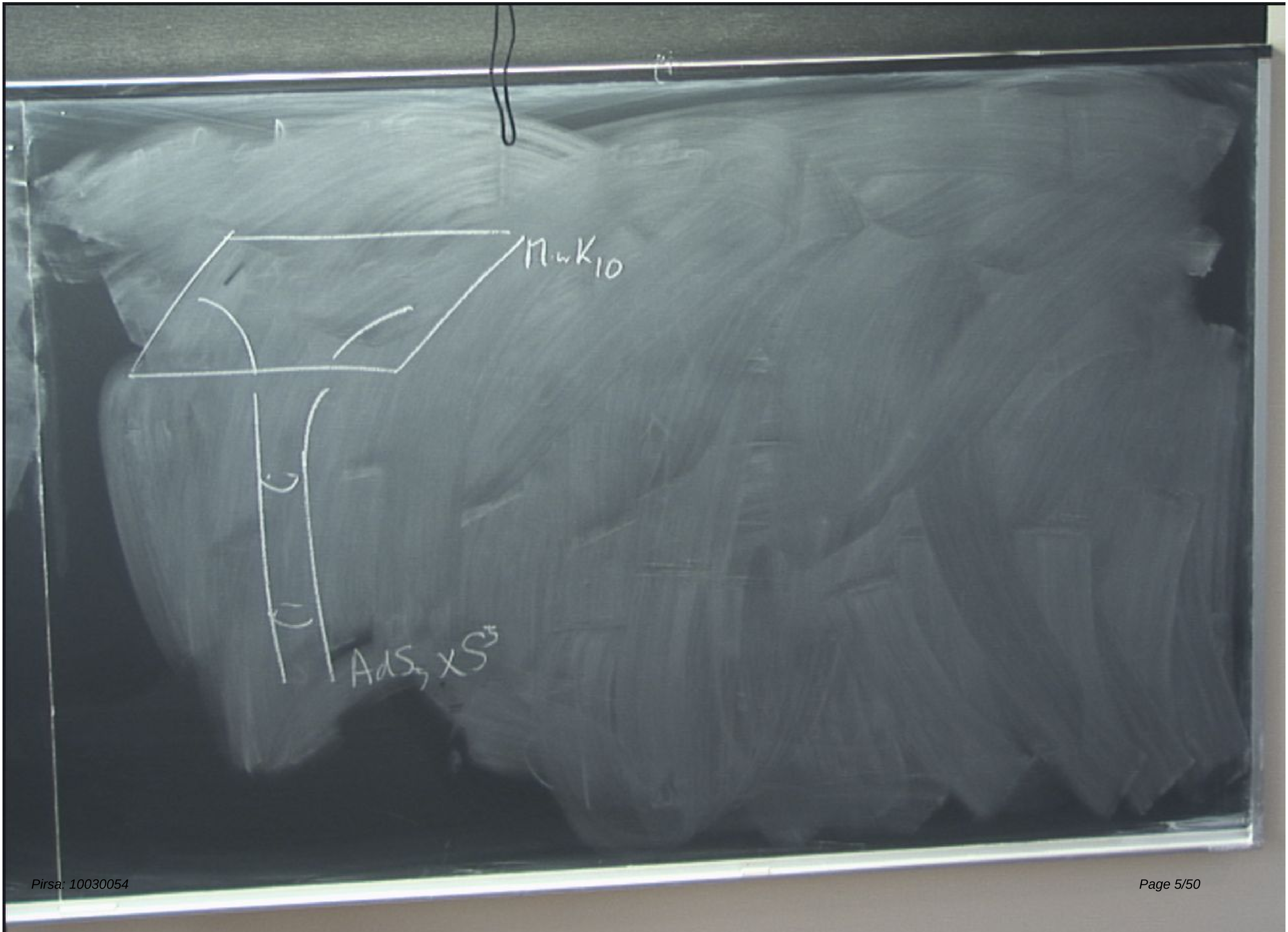
URL: http://pirsa.org/10030054

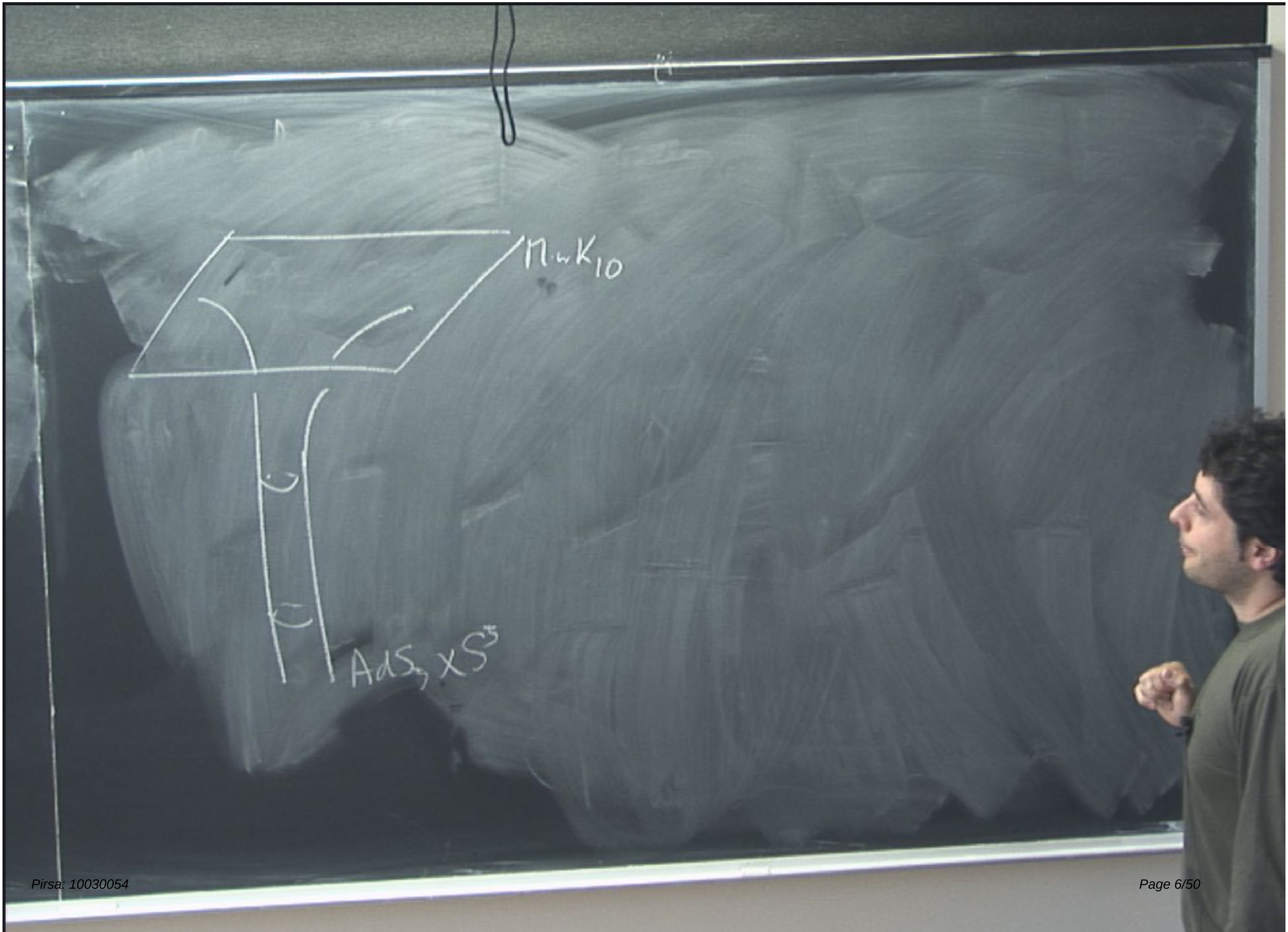
Abstract:

2) AdS/CFT from D3-branes

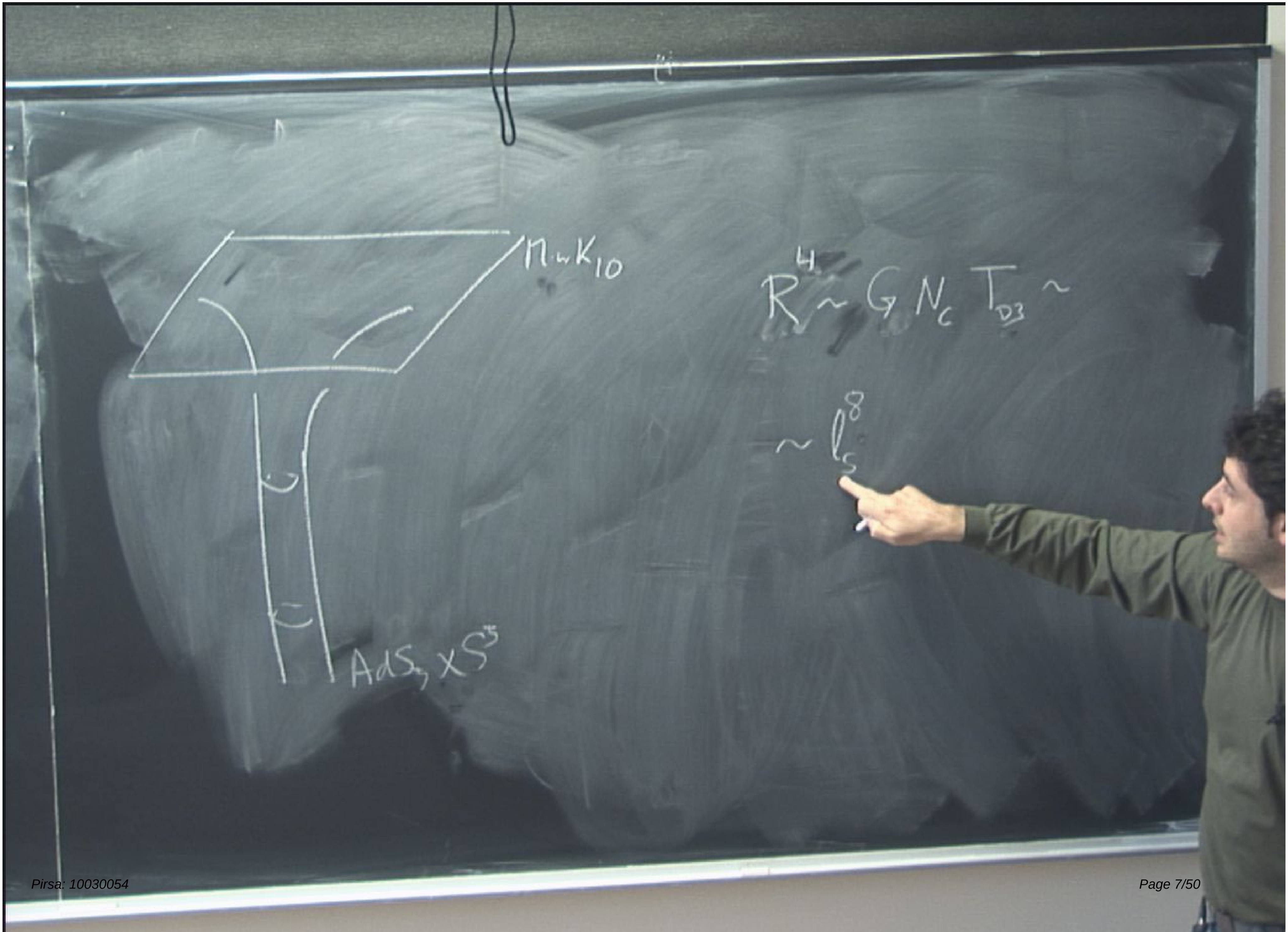

vidence
for Atom
Big Is A
Molecule?
2) AdS/CFT from D3-branes
Type IIB st. th.

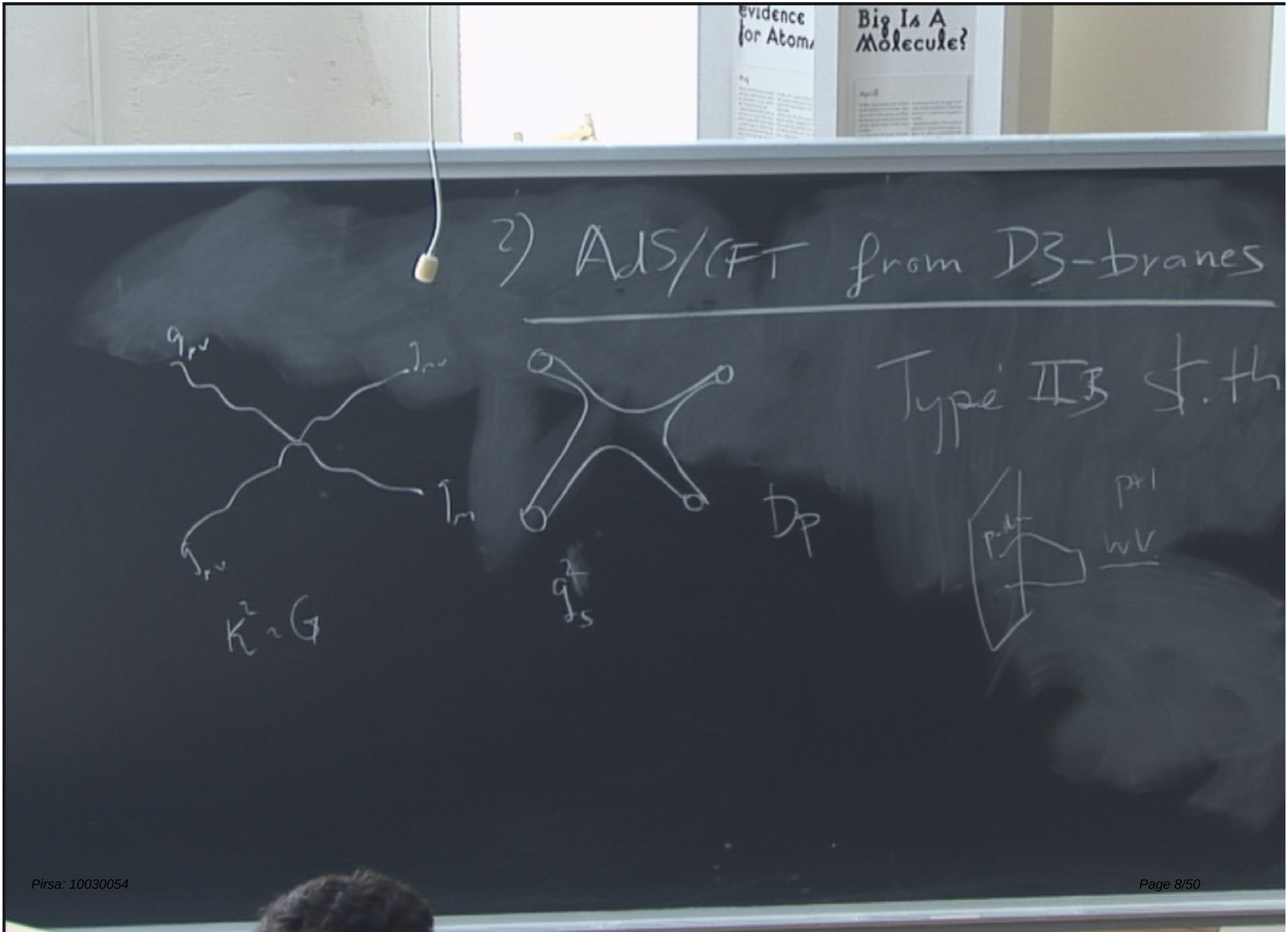
N_c D3-branes

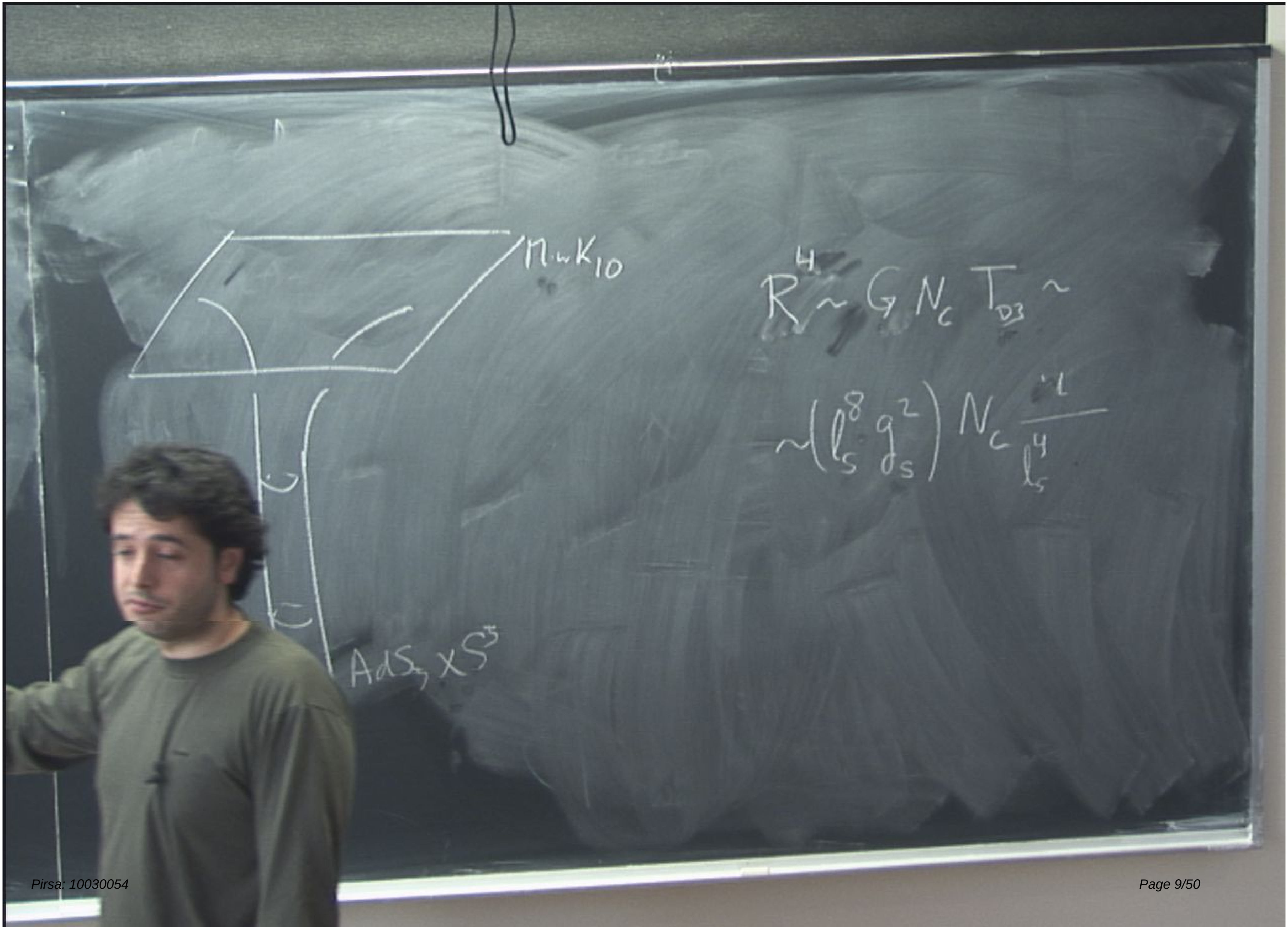

Mink$_{10}$
$AdS_5 \times S^5$



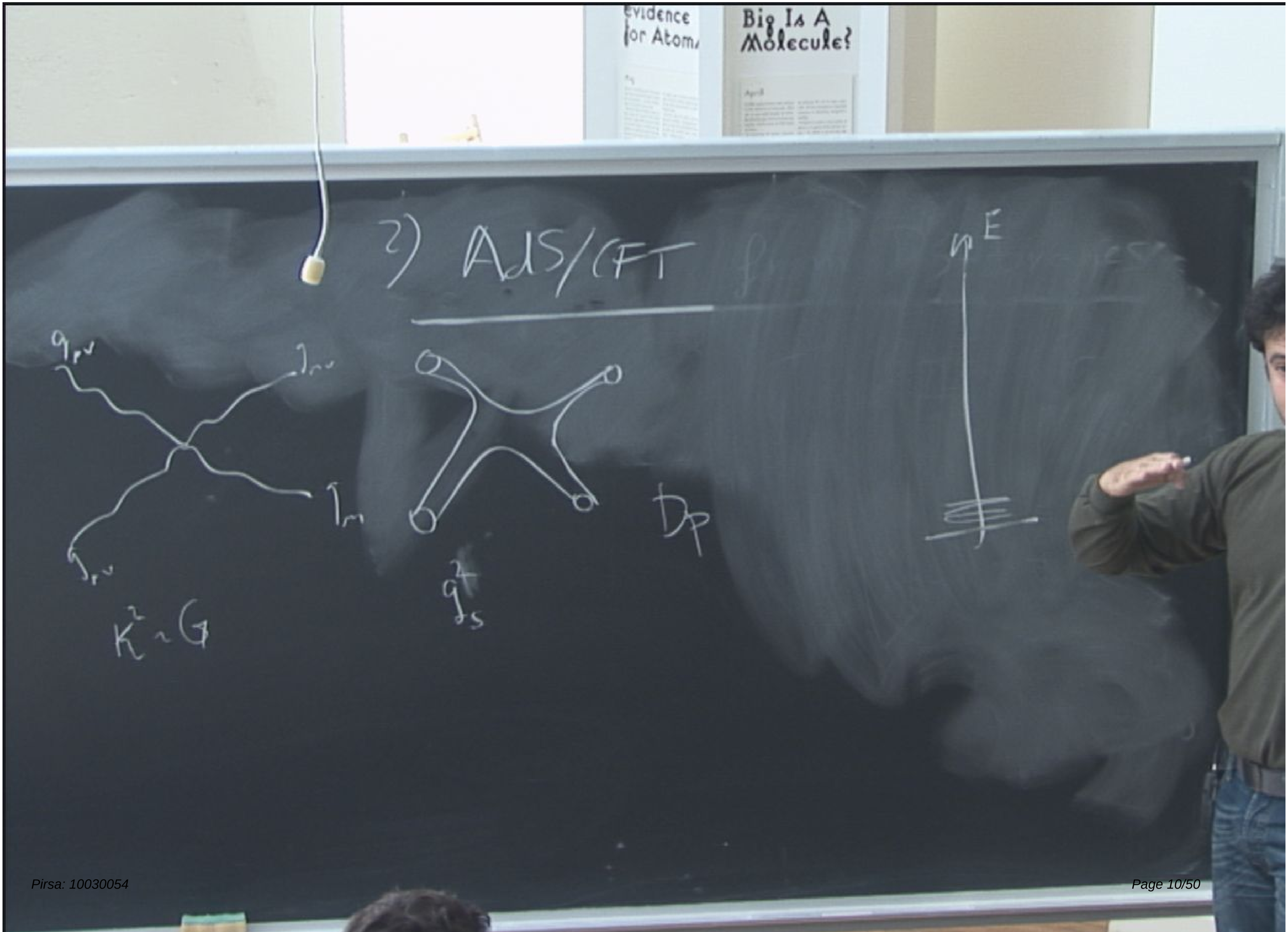
Mink10
AdS5 x S5

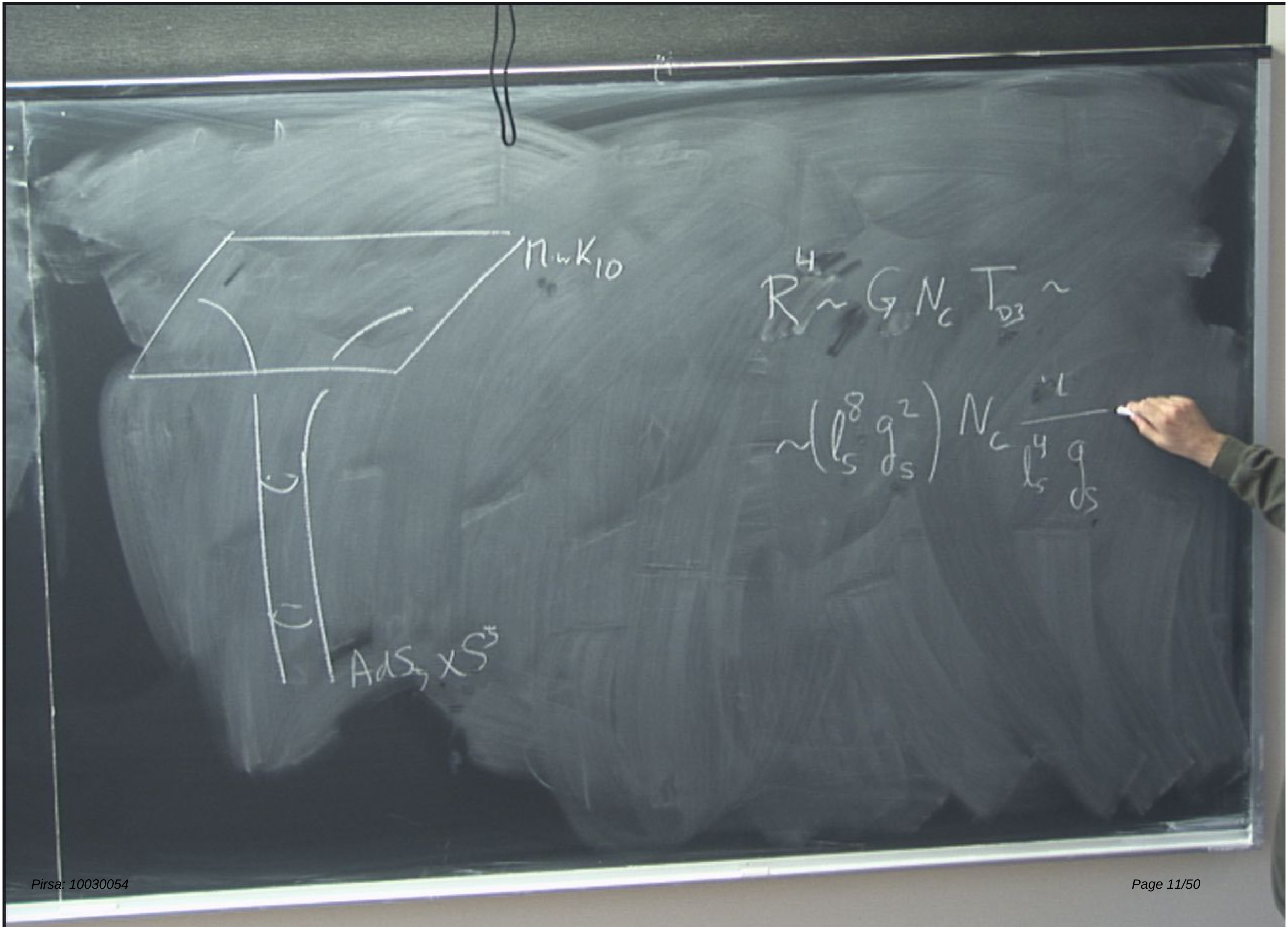

Mink10
R4 ~ G Nc TD3 ~
~ ls8
AdS5 x S5

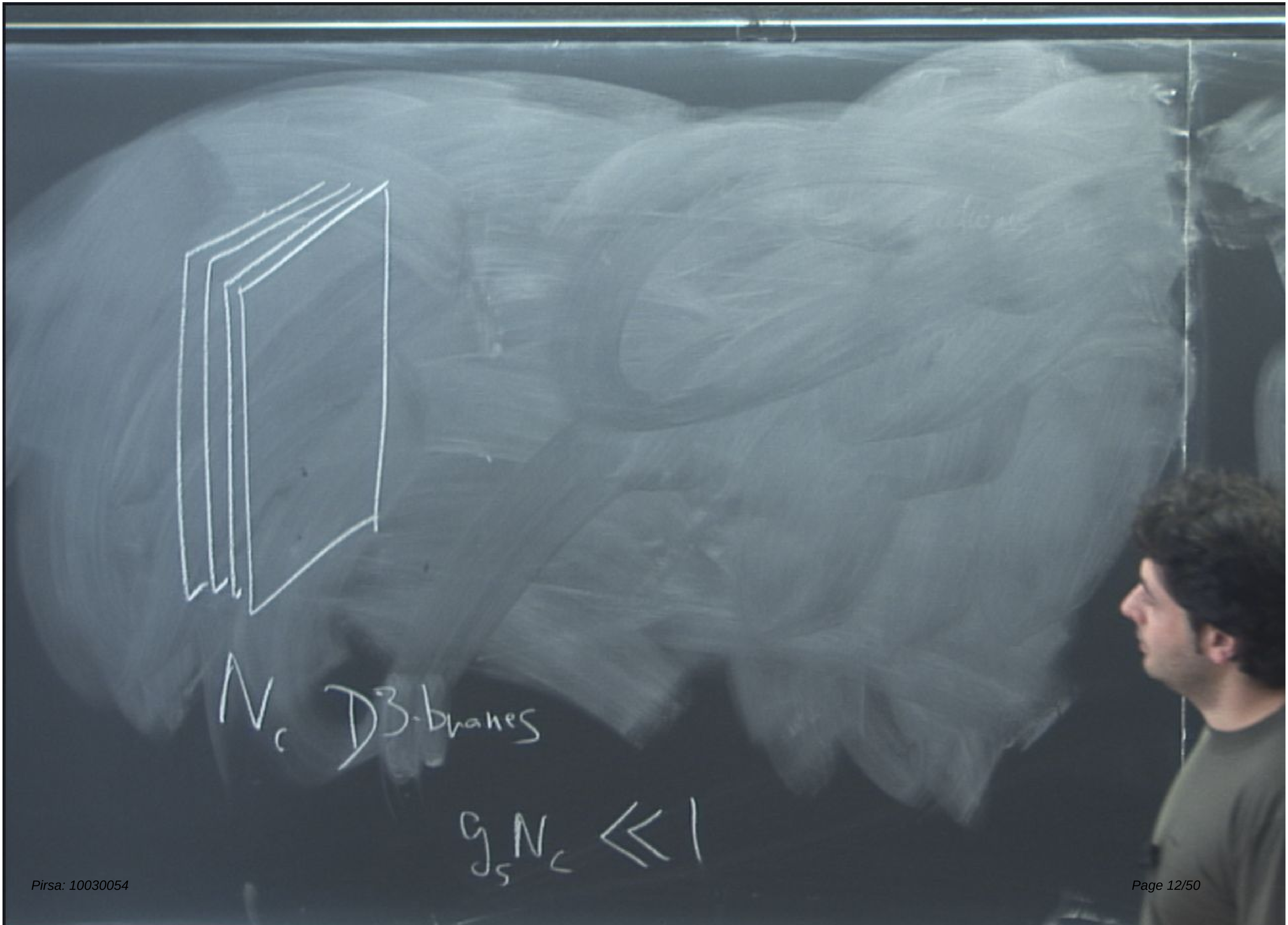

Evidence for Atoms
Big Is A Molecule?
2) AdS/CFT from D3-branes
Type IIB st. th
$g_{\mu\nu}$
$g_{\mu\nu}$
$g_{\mu\nu}$
$g_{\mu\nu}$
$\kappa^2 \sim G$
g_s^2
Dp
p+1
w.v.

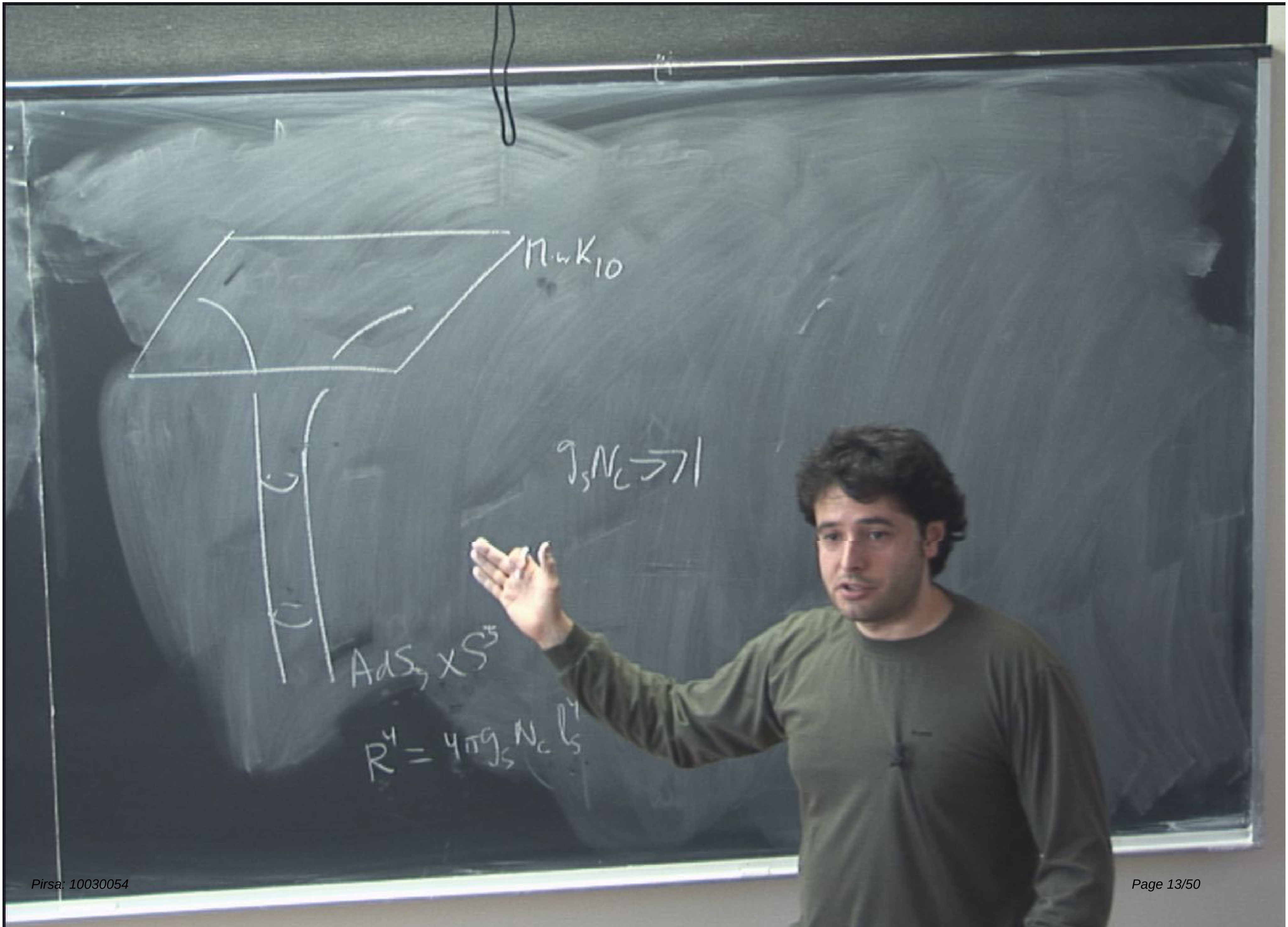


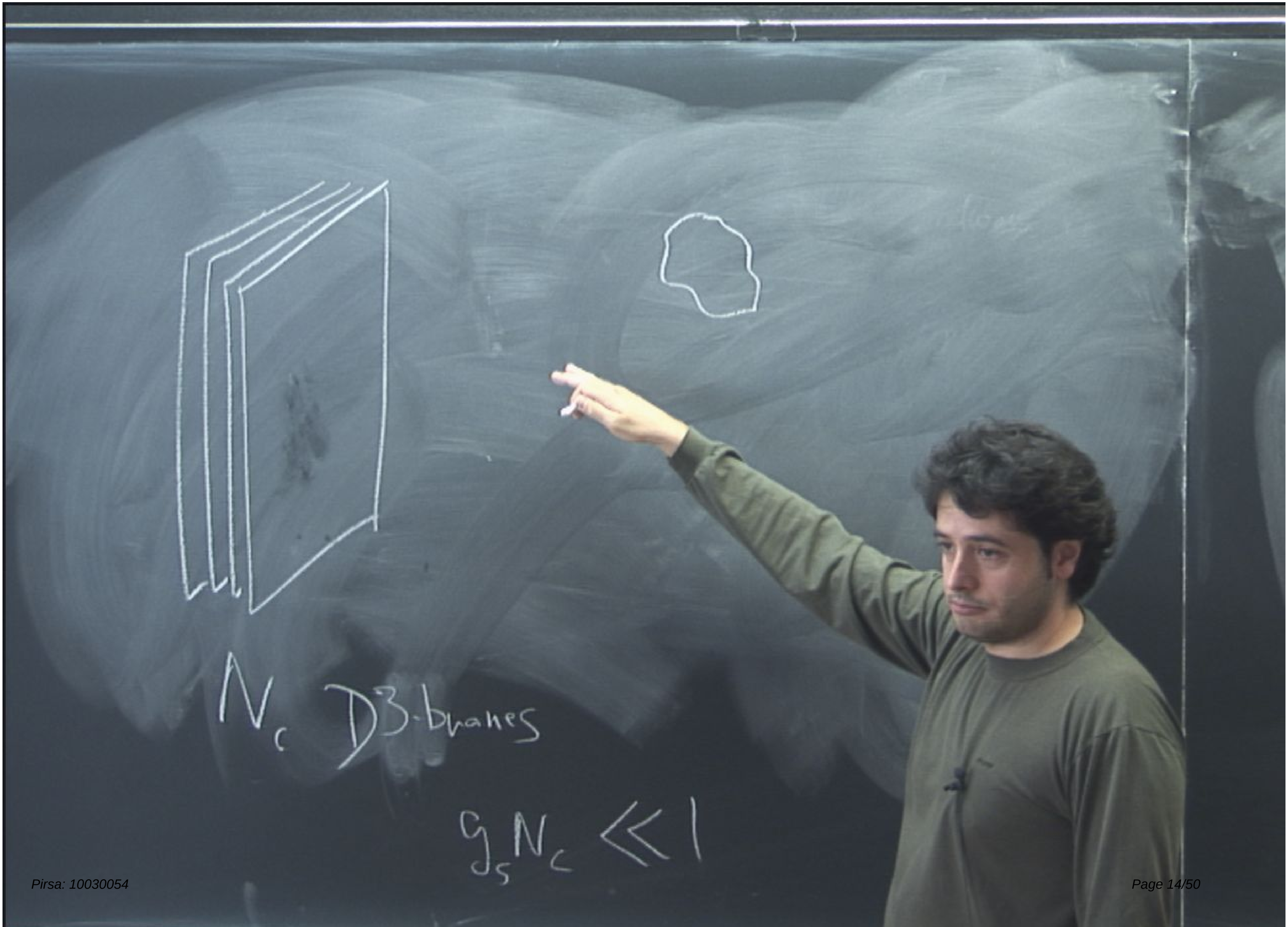
$Mink_{10}$
$R^4 \sim G_N N_c T_{D3} \sim$
$\sim (l_s^8 g_s^2) N_c \frac{1}{l_s^4}$
$AdS_5 \times S^5$

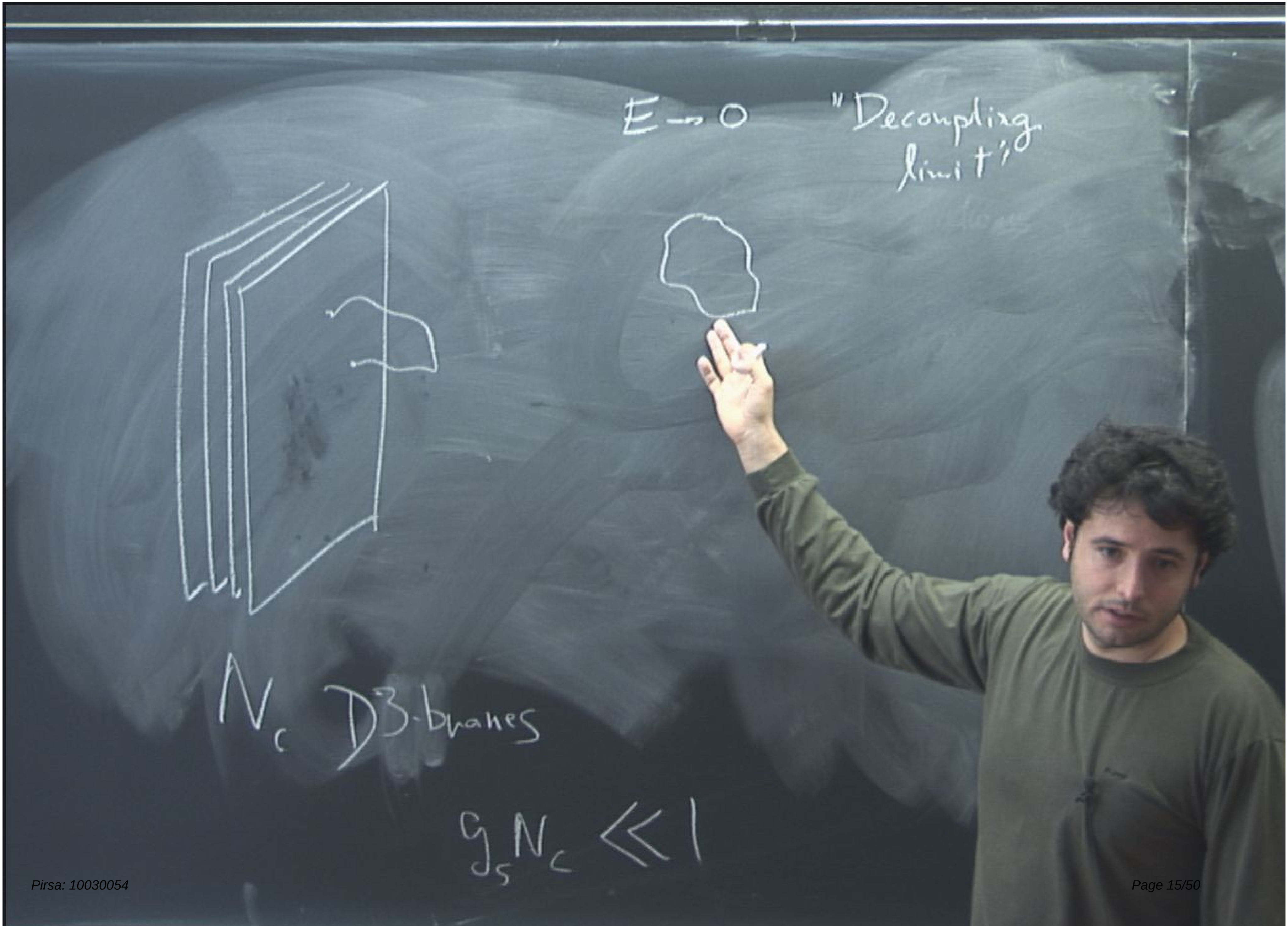

Big Is A
Molecule?
2) AdS/CFT
Dp
K² ~ G


Mink_{10}
$AdS_5 \times S^5$
$R^4 \sim G N_c T_{D3} \sim$
$\sim (l_s^8 g_s^2) N_c \frac{1}{l_s^4 g_s}$


N_c D3-branes
$g_s N_c \lll 1$


Mink10
g_s N_c >> 1
AdS_5 x S^5
R^4 = 4π g_s N_c l_s^4


N_c D3-branes
$g_s N_c \ll 1$


E → 0
"Decoupling limit"
N_c D3-branes
g_s N_c <<< 1

$E \to 0$ "Decoupling limit"

$G E^8 \to 0$

$N=4$ $D=4=p+1=3+1$

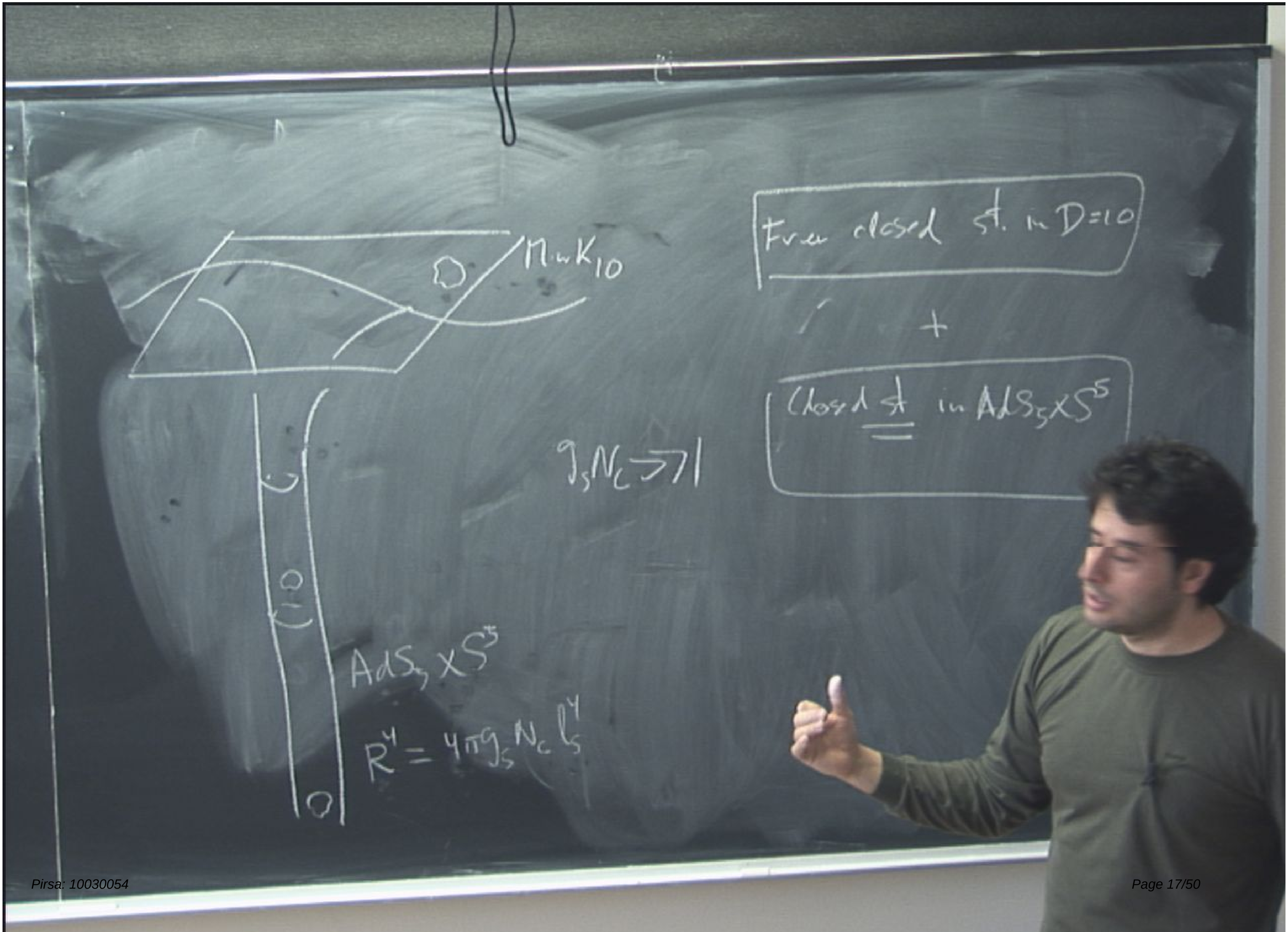
$SU(N_c)$ SYM theory

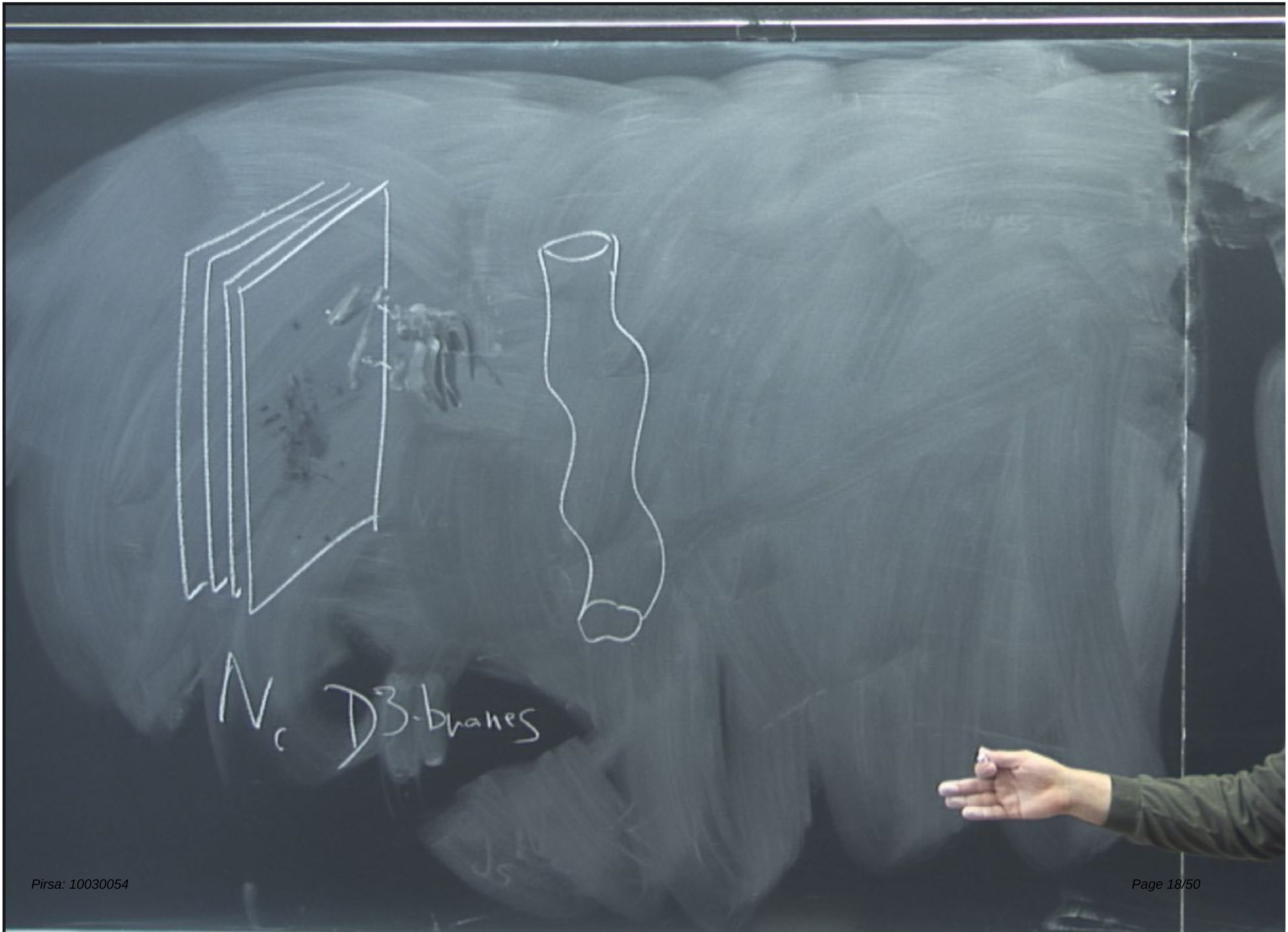
Free closed st.
$D=10$

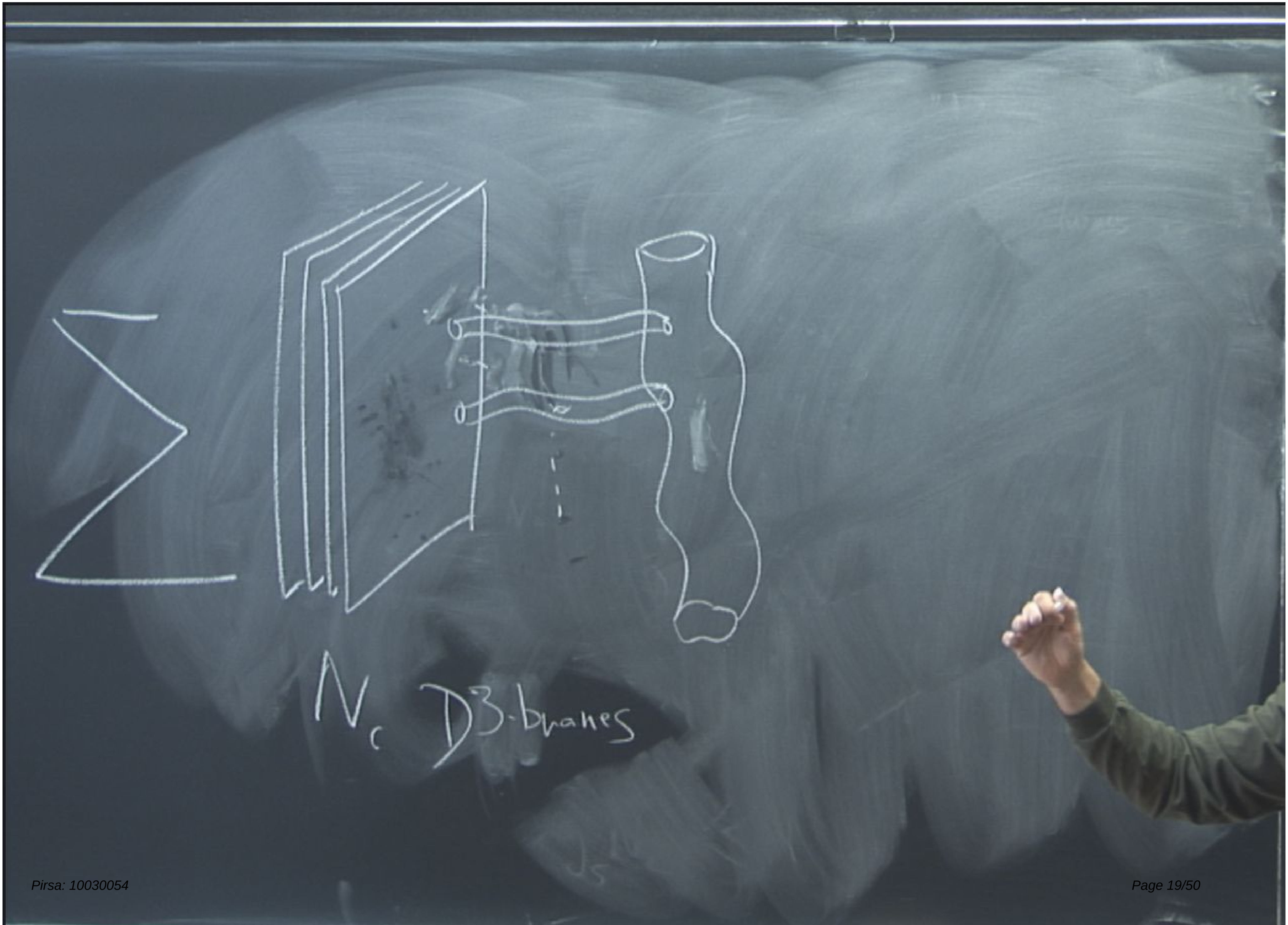
+

N_c D3-branes

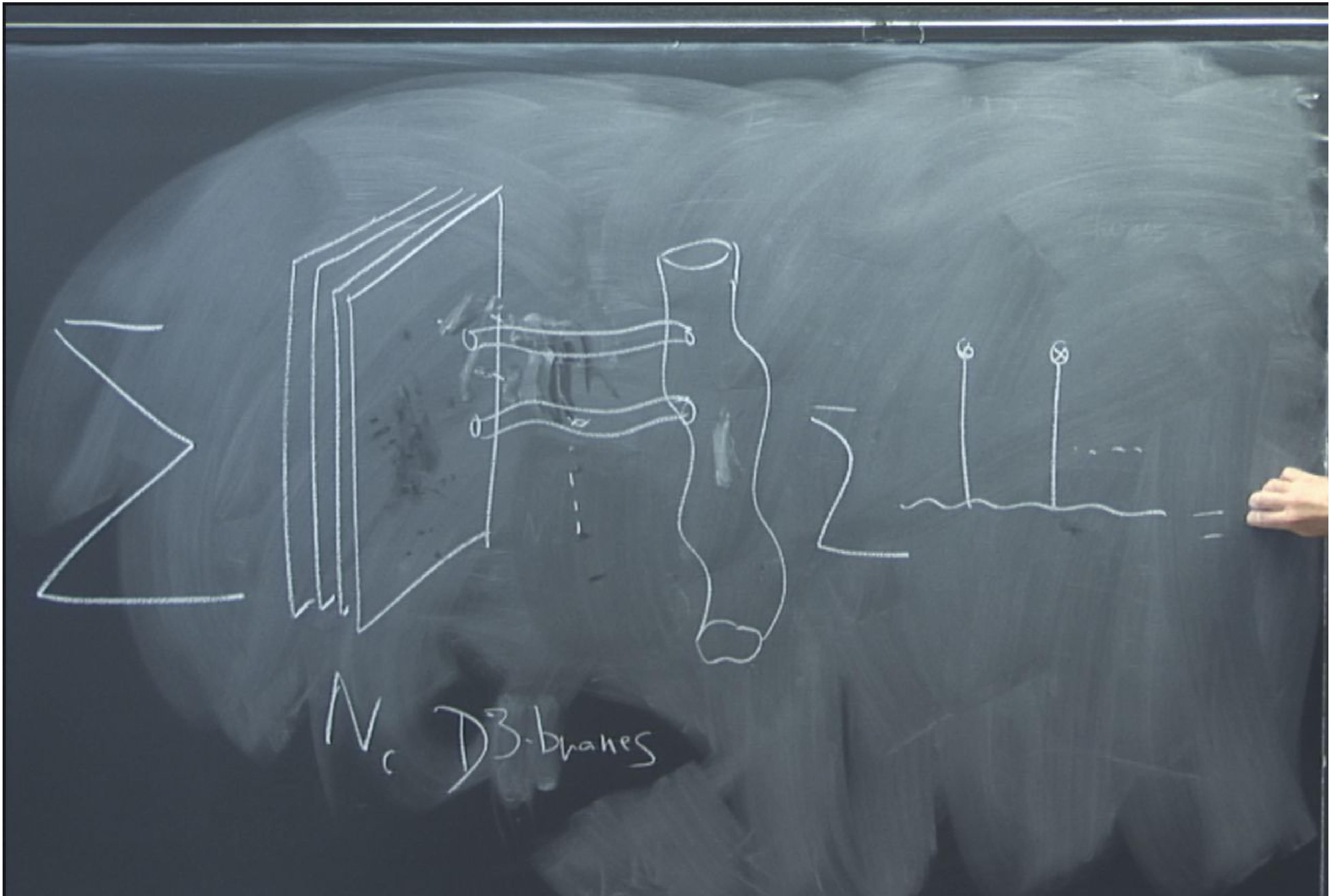
$g_s N_c \ll 1$

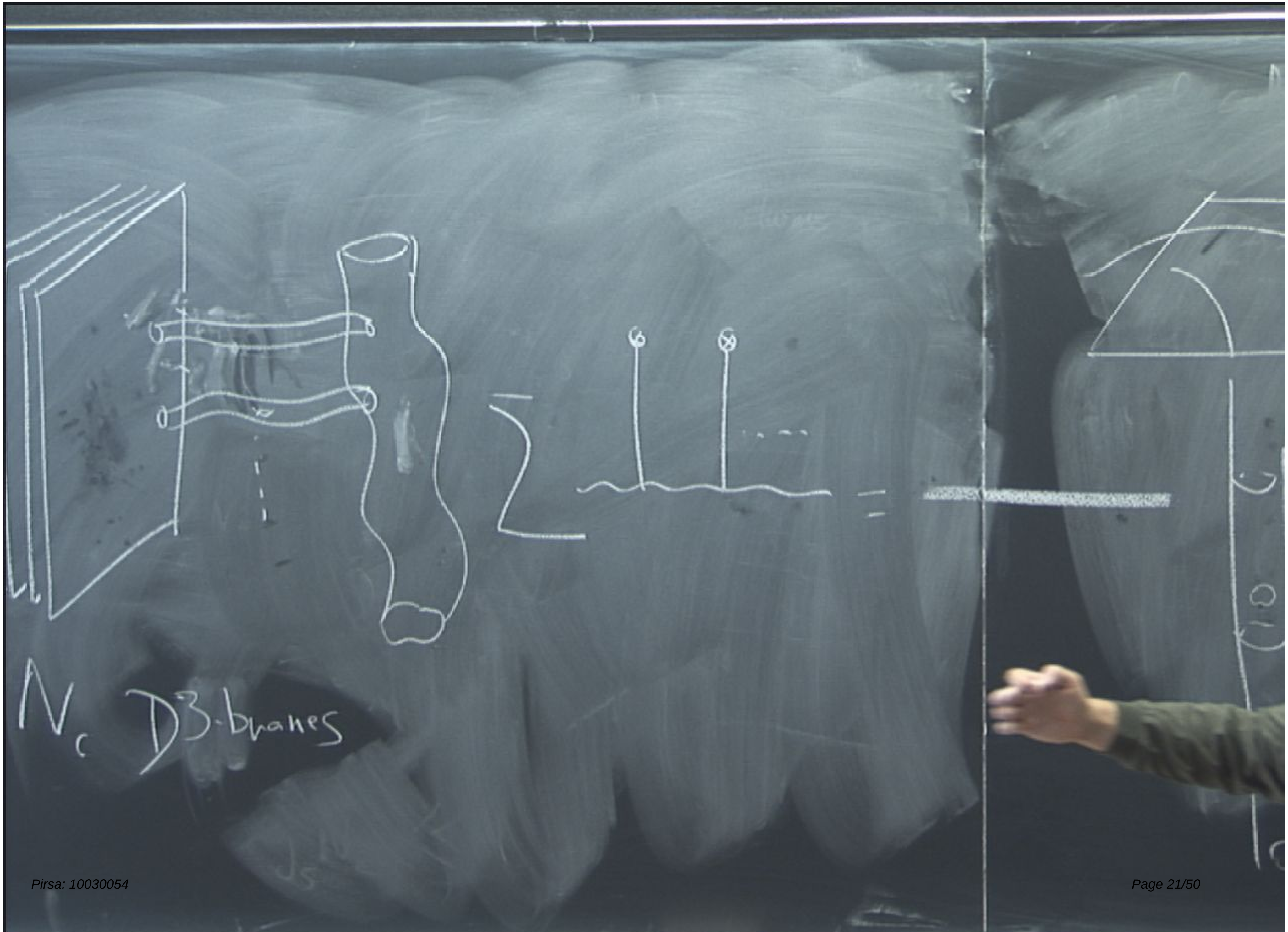

Mink$_{10}$
Free closed st. in D=10
+
Closed st in $AdS_5 \times S^5$
$g_s N_c \gg 1$
$AdS_5 \times S^5$
$R^4 = 4\pi g_s N_c l_s^4$


N_c D3-branes

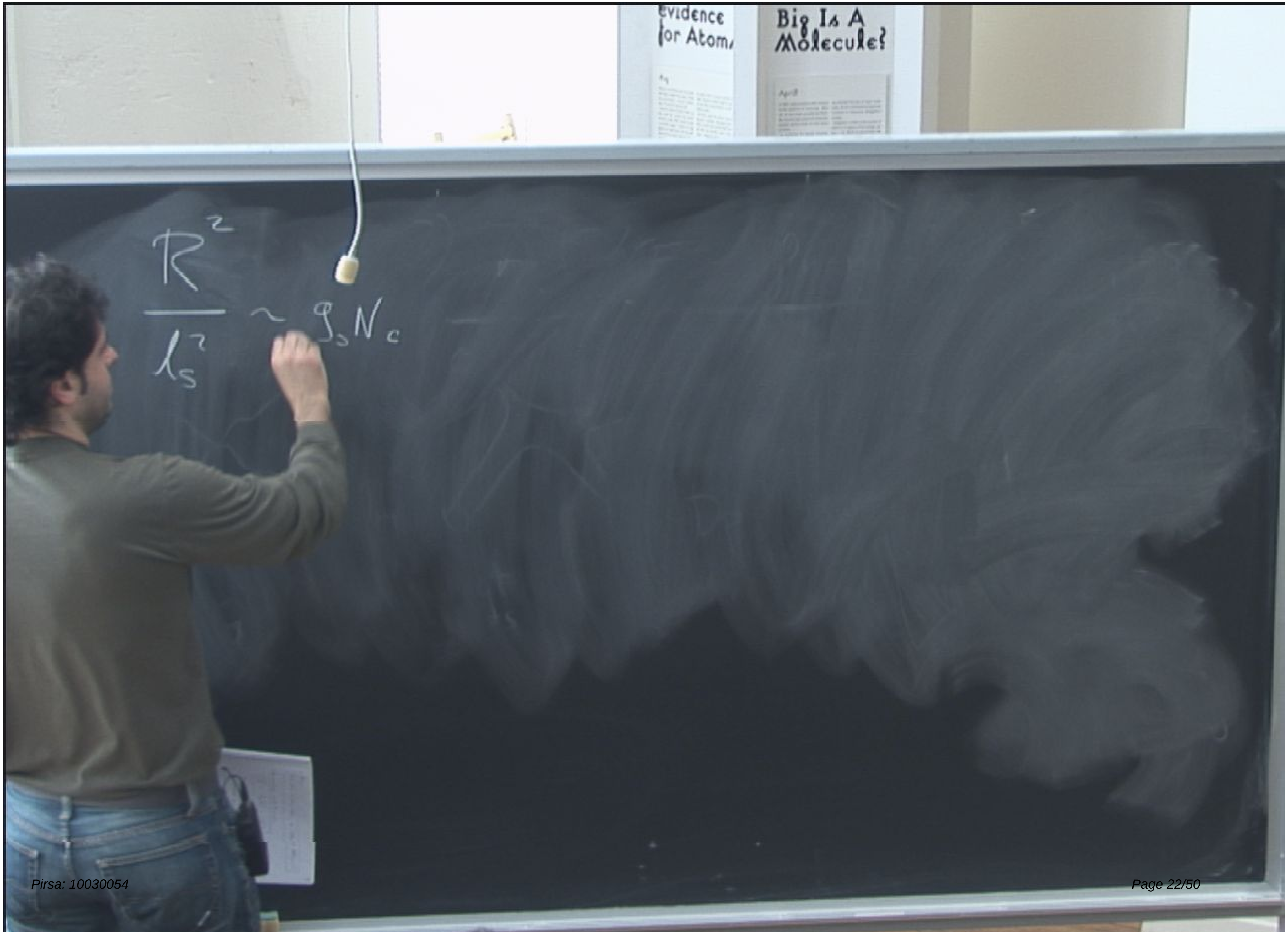


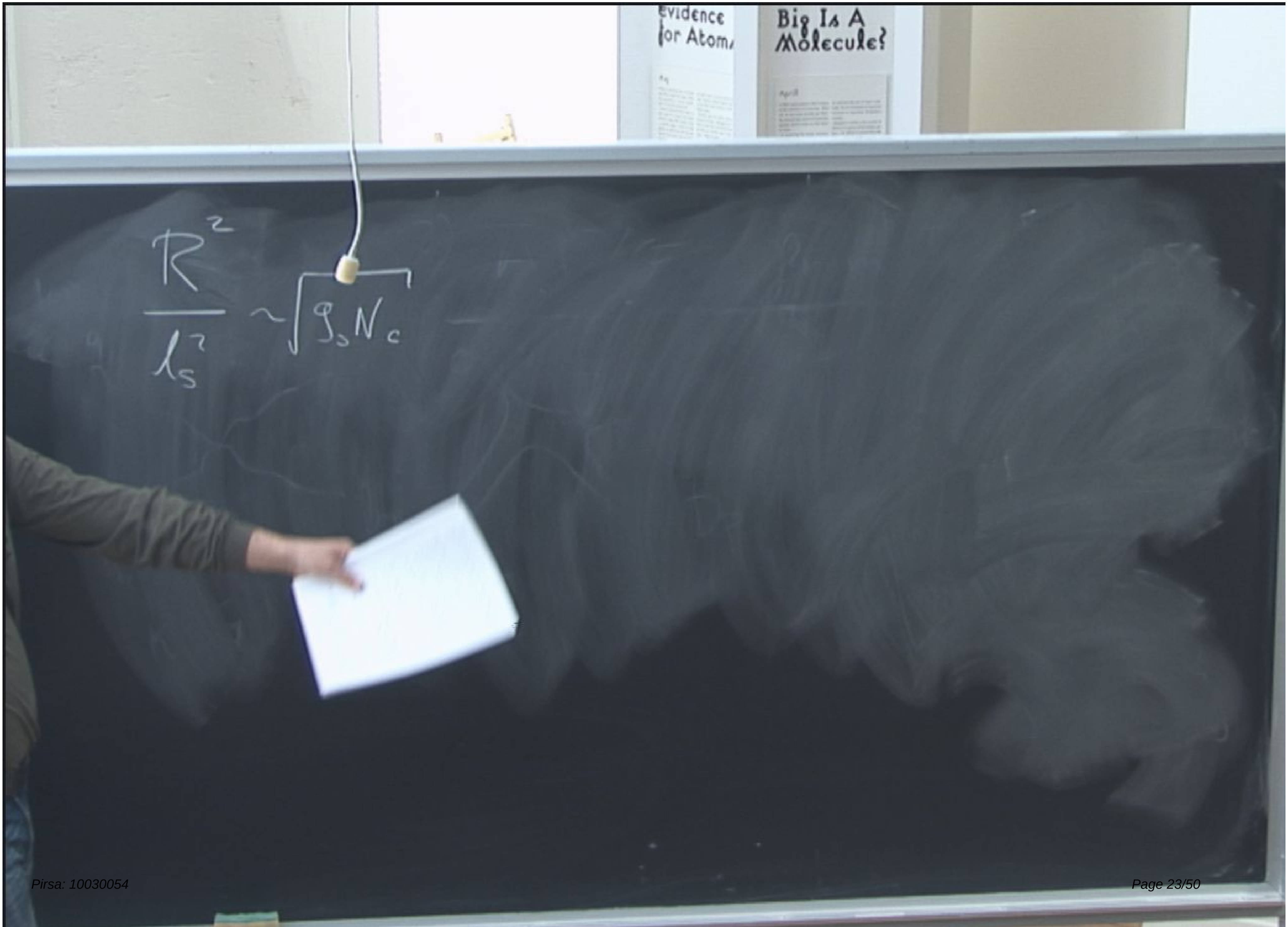
Σ
N_c D3-branes


N_c D3-branes

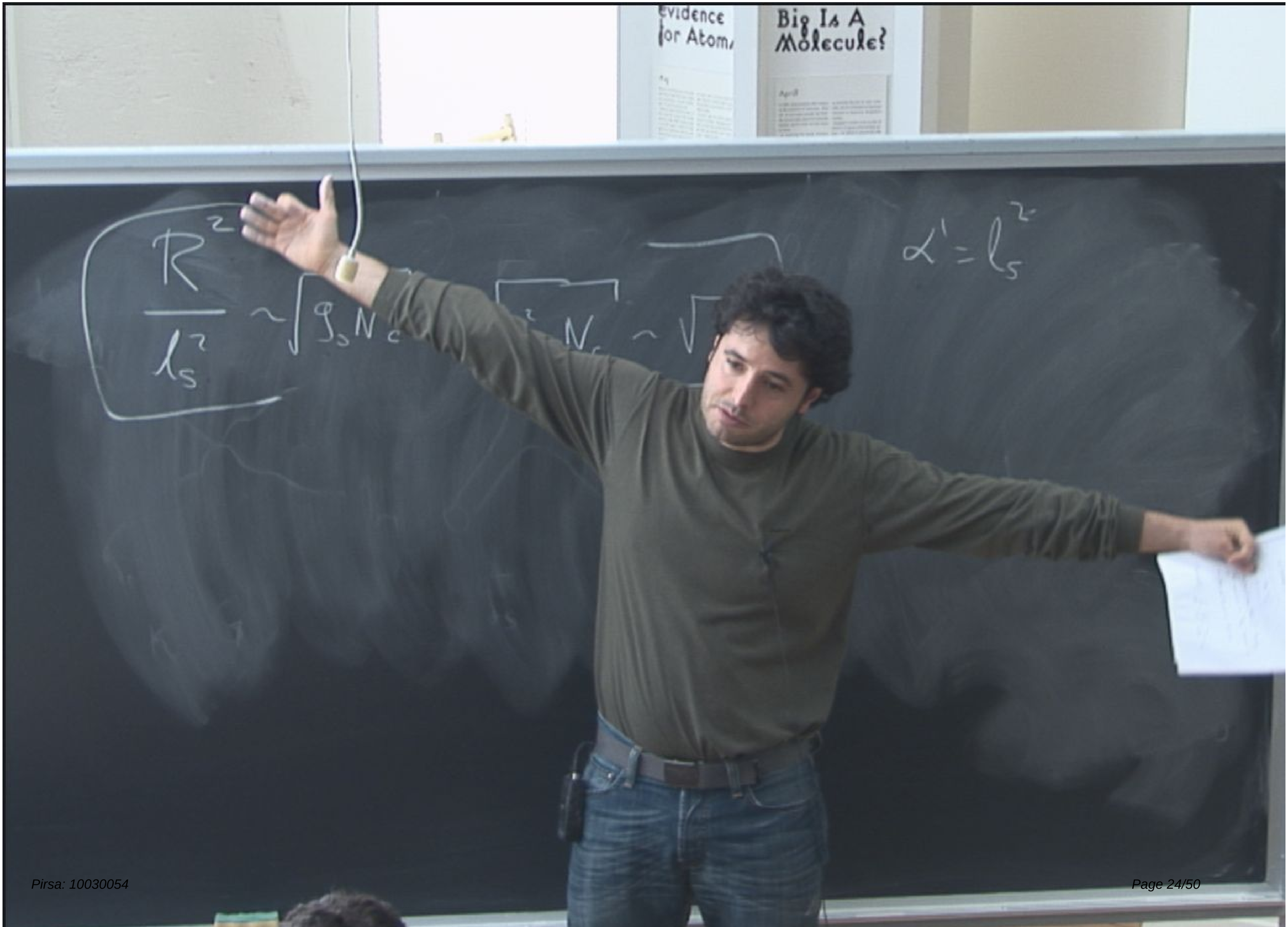


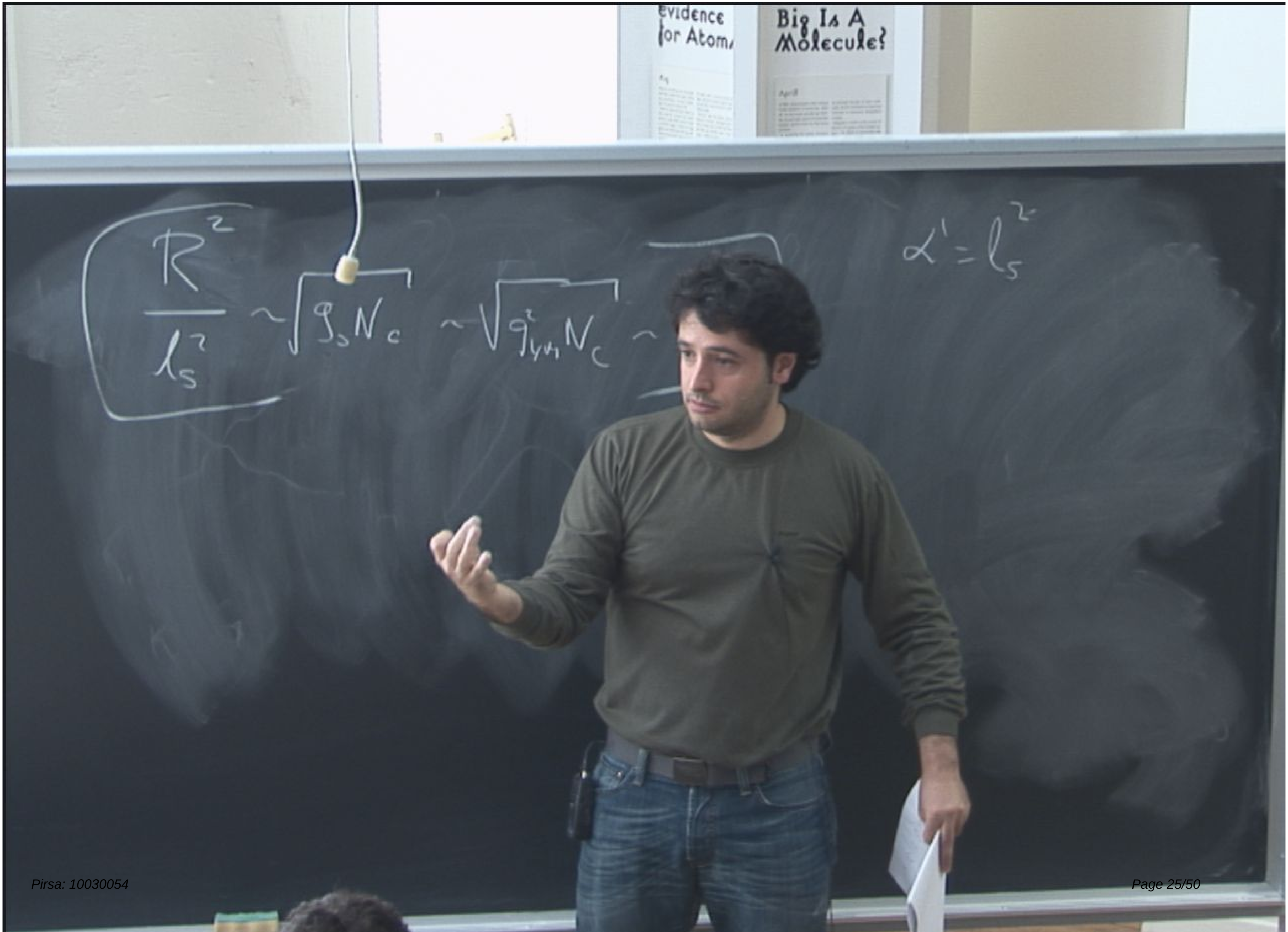
N_c D3-branes


Big Is A
Molecule?
$\frac{R^2}{l_s^2} \sim g_s N_c$



Big Is A
Molecule?
$\frac{R^2}{l_s^2} \sim \sqrt{g_s N_c}$


Big Is A Molecule?
$\alpha' = l_s^2$

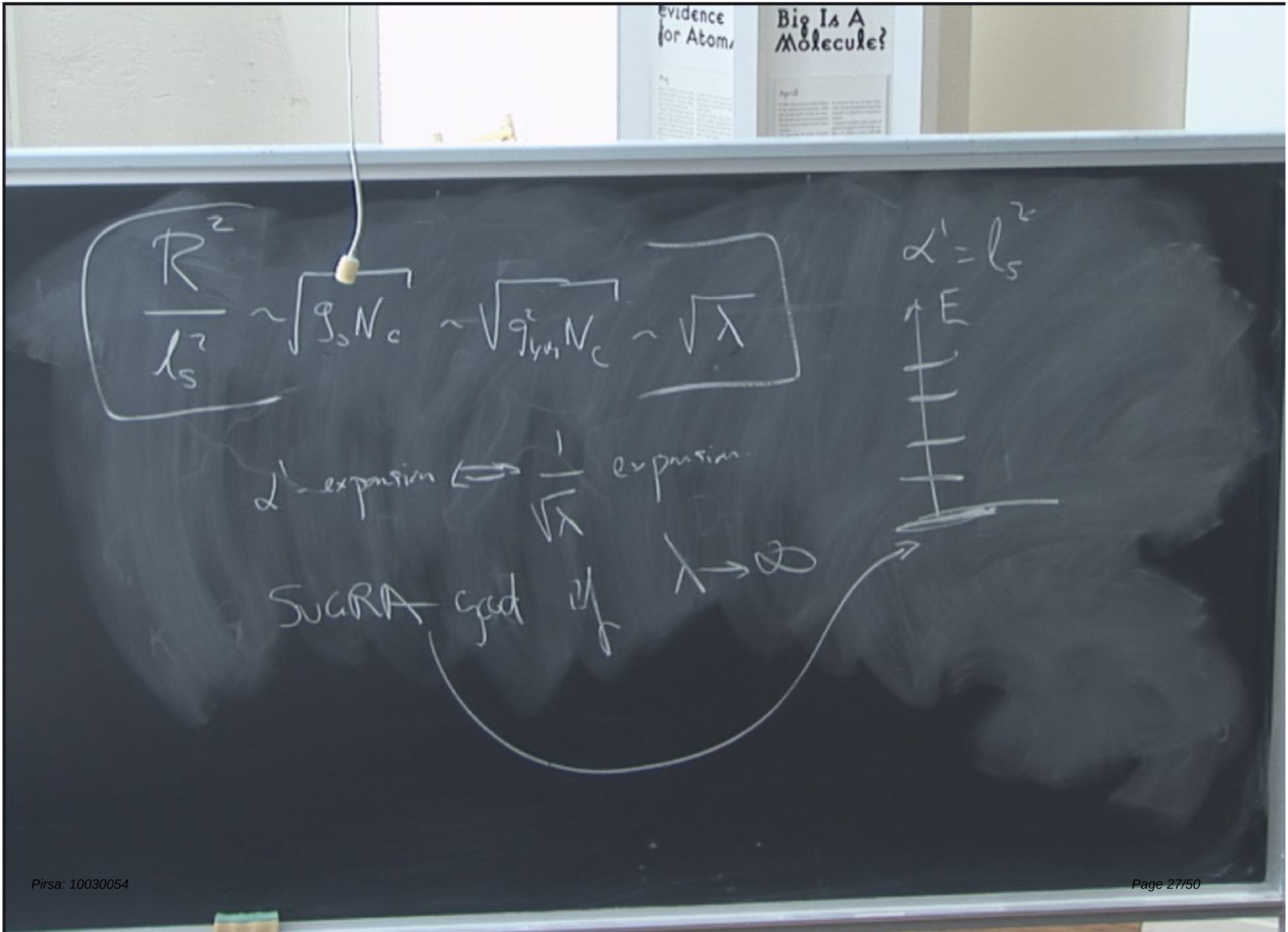


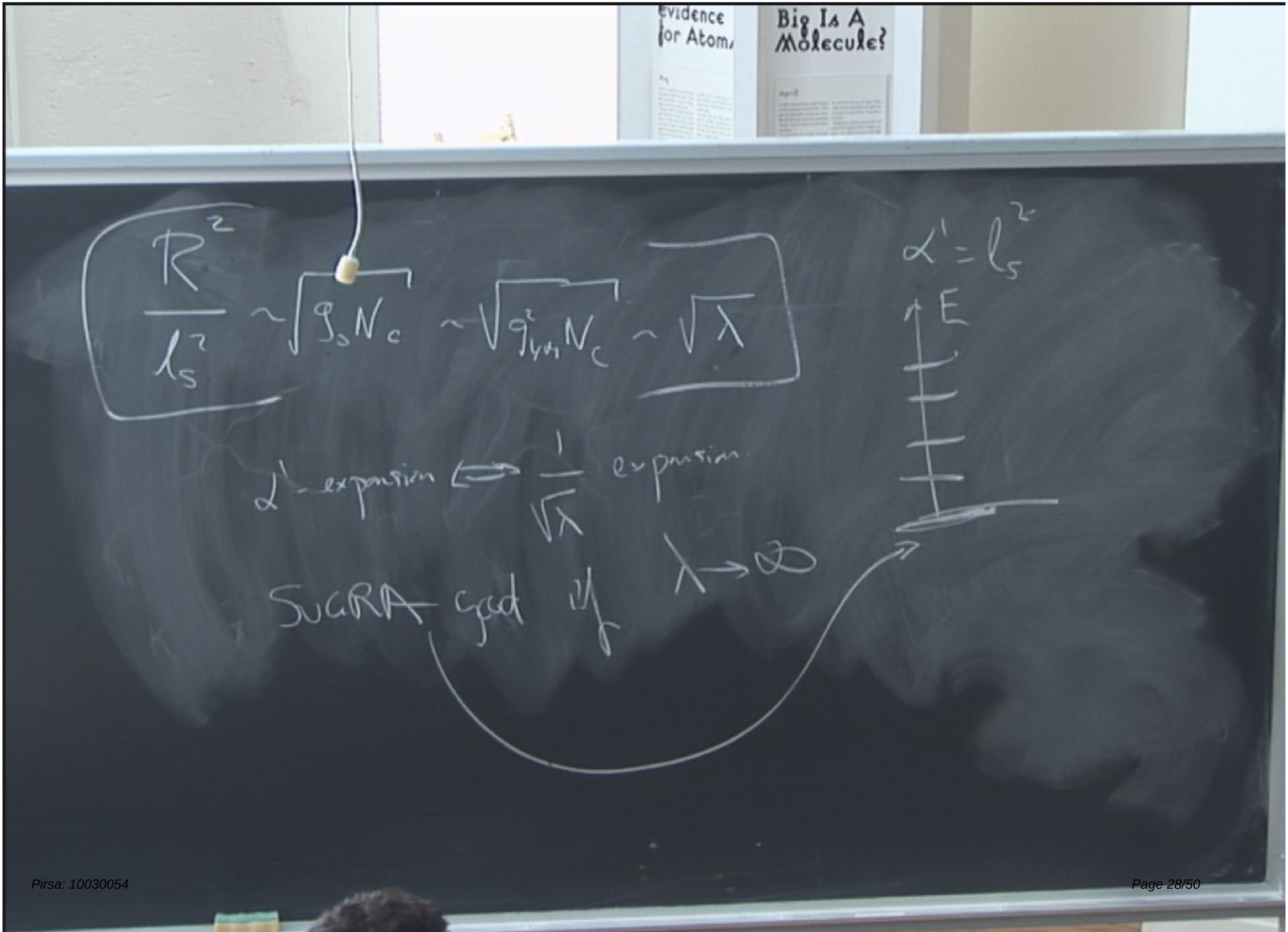
Big Is A
Molecule?
$\frac{R^2}{l_s^2} \sim \sqrt{g_s N_c} \sim \sqrt{g_{YM}^2 N_c} \sim$
$\alpha' = l_s^2$

$$\boxed{\frac{R^2}{l_s^2} \sim \sqrt{g_s N_c} \sim \sqrt{g_{YM}^2 N_c} \sim \sqrt{\lambda}}$$

$$\alpha' = l_s^2$$

α'-expansion $\Longleftrightarrow$ $\frac{1}{\sqrt{\lambda}}$ expansion


Big Is A Molecule?
$\frac{R^2}{l_s^2} \sim \sqrt{g_s N_c} \sim \sqrt{g_{YM}^2 N_c} \sim \sqrt{\lambda}$
$\alpha' = l_s^2$
E
α'-expansion $\Longleftrightarrow$ $\frac{1}{\sqrt{\lambda}}$ expansion
SUGRA good iff $\lambda \to \infty$


Big Is A Molecule?
$\boxed{\frac{R^2}{l_s^2} \sim \sqrt{g_s N_c} \sim \sqrt{g_{YM}^2 N_c} \sim \sqrt{\lambda}}$
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α'-expansion $\Longleftrightarrow$ $\frac{1}{\sqrt{\lambda}}$ expansion
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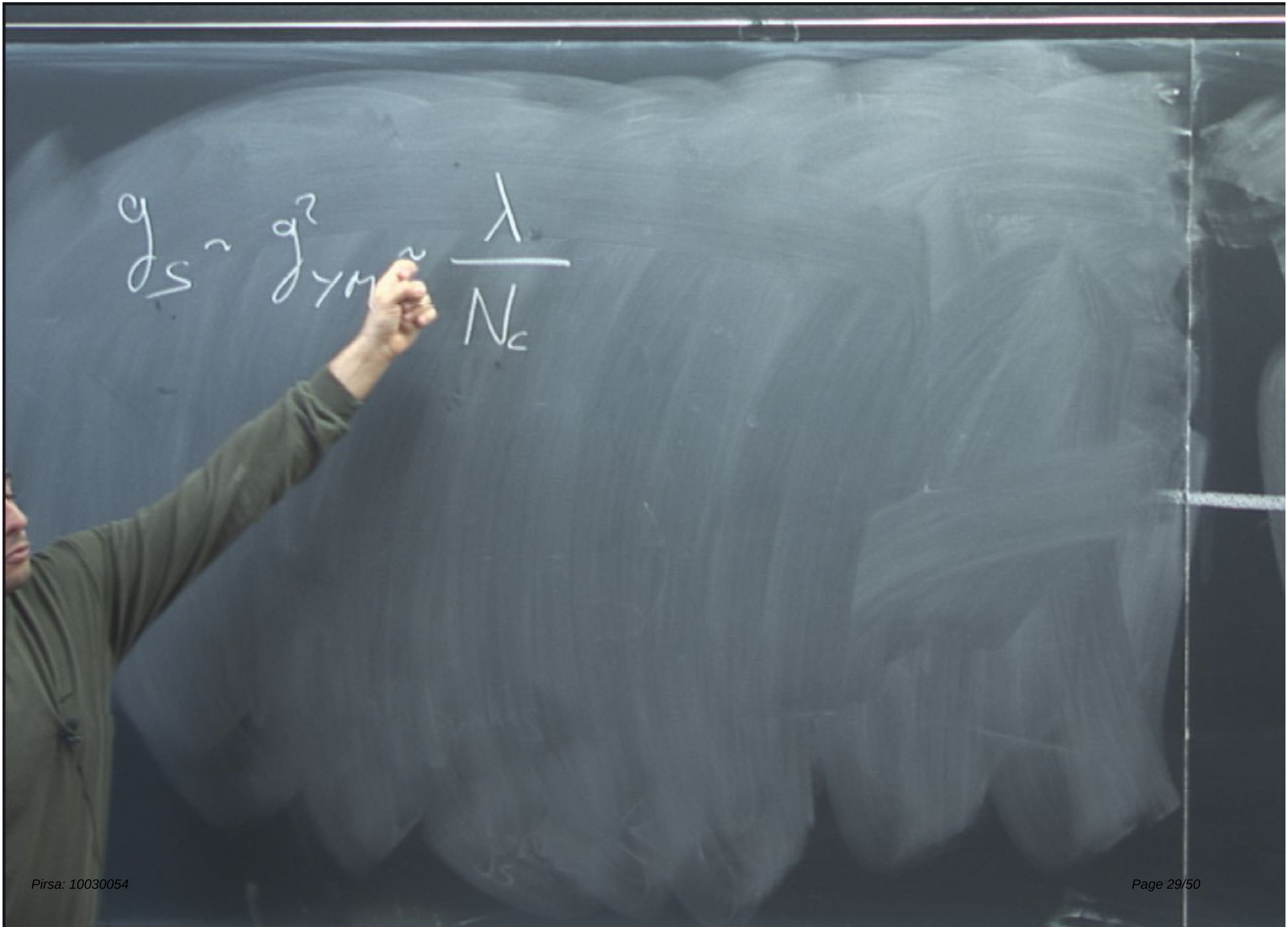
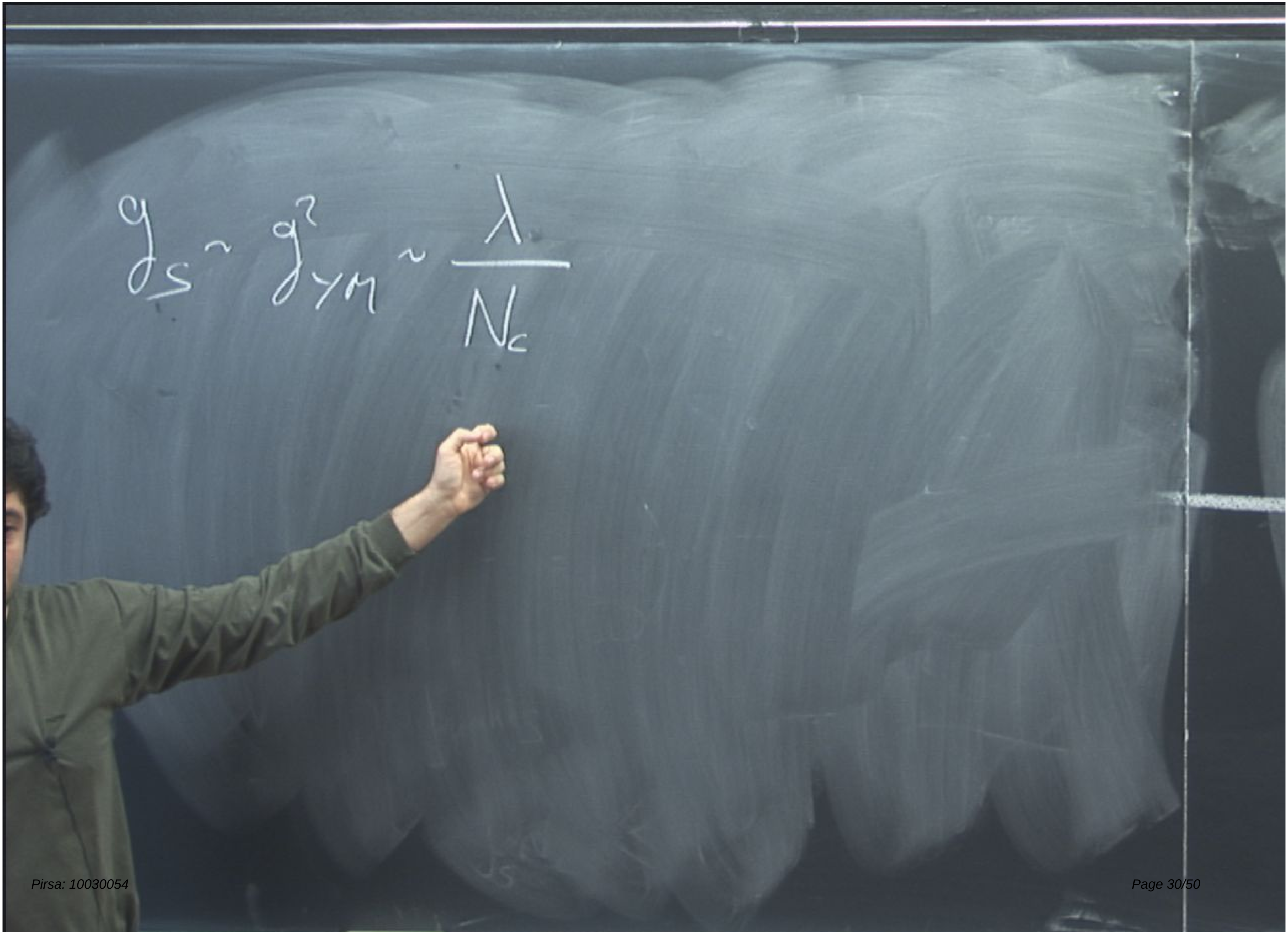

$g_s \sim g^2_{YM} \sim \frac{\lambda}{N_c}$


$g_s \sim g^2_{YM} \sim \frac{\lambda}{N_c}$

$$g_s \sim g^2_{YM} \sim \frac{\lambda}{N_c}$$

$$g_s \to 0 \iff N_c \to \infty$$

St. Loops $\sim \frac{1}{N_c}$

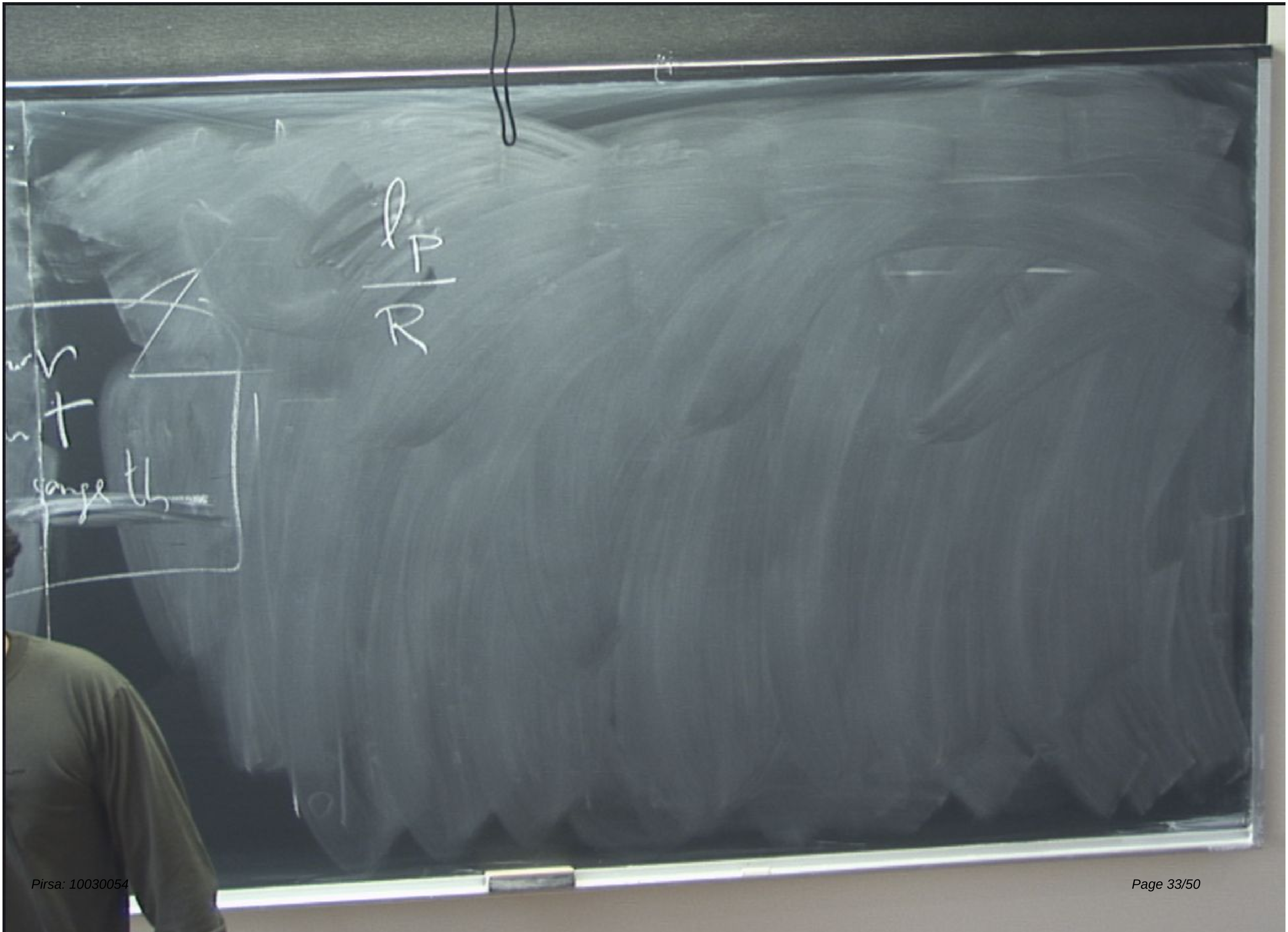
$\boxed{\text{Classical limit st. side } g_s \to 0}$ = $\boxed{\text{Planar limit in gauge}}$

$$g_s \sim g_{YM}^2 \sim \frac{\lambda}{N_c}$$

$$g_s \to 0 \Longleftrightarrow N_c \to \infty$$

St. Loops $\sim \frac{1}{N_c}$

$\boxed{\text{Classical limit st. side } g_s \to 0}$ = $\boxed{\text{Planar limit in gauge th.}}$


l_P
R

$$\frac{l_P^4}{R^4} \sim \frac{\sqrt{G}}{g_s N_c l_s^4} \sim \frac{\sqrt{g_s^2 l_s^8}}{g_s N_c l_s^4} \sim \boxed{\frac{1}{N_c}}$$

gauge th


$\frac{l_P^4}{R^4} \sim \frac{\sqrt{G}}{g_s N_c l_s^4} \sim \frac{\sqrt{g_s^2 l_s^8}}{g_s N_c l_s^4} \sim \frac{1}{N_c}$
gauge th
∂AdS_5
G
QG
AdS_5

Symmetries

$\mathcal{N}=4$

Symmetries

$\mathcal{N}=4$ $\quad Conf(1,3) \times SO(6) \quad \times \; 32$ susy's

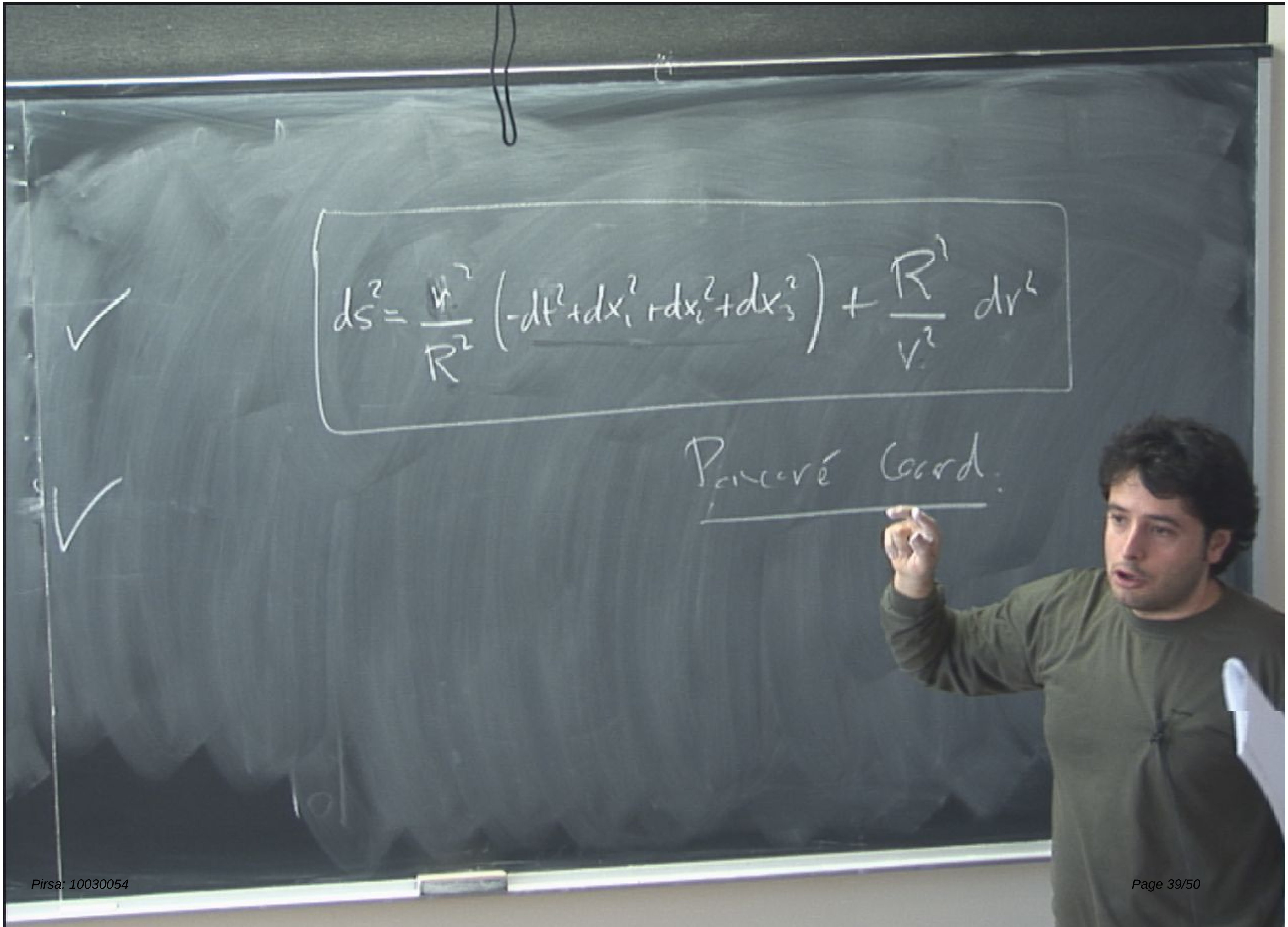
$AdS_5 \times S^5$:

Symmetries

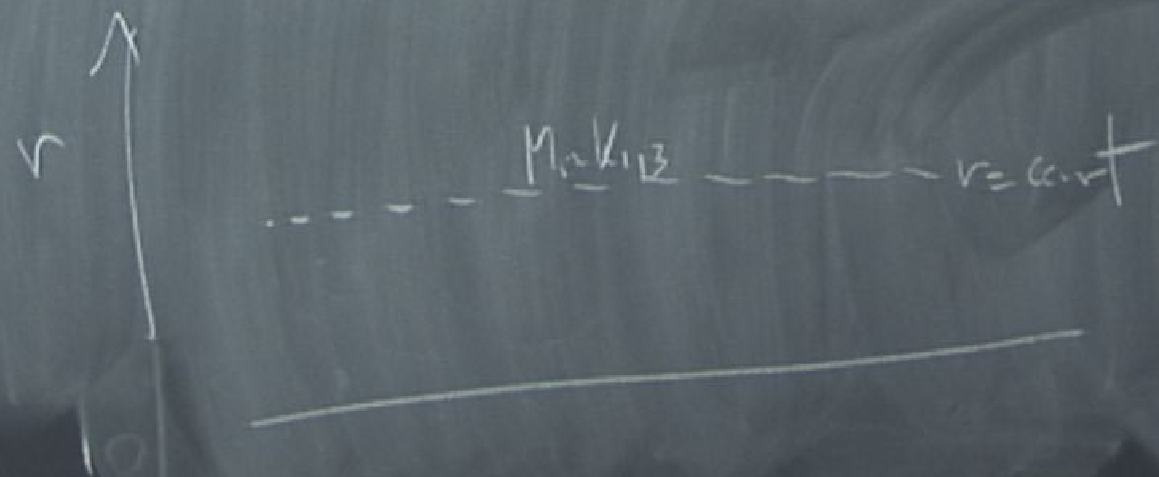
$\mathcal{N}=4$: $\mathrm{Conf}(1,3) \times SO(6) \times 32$ susy's ✓

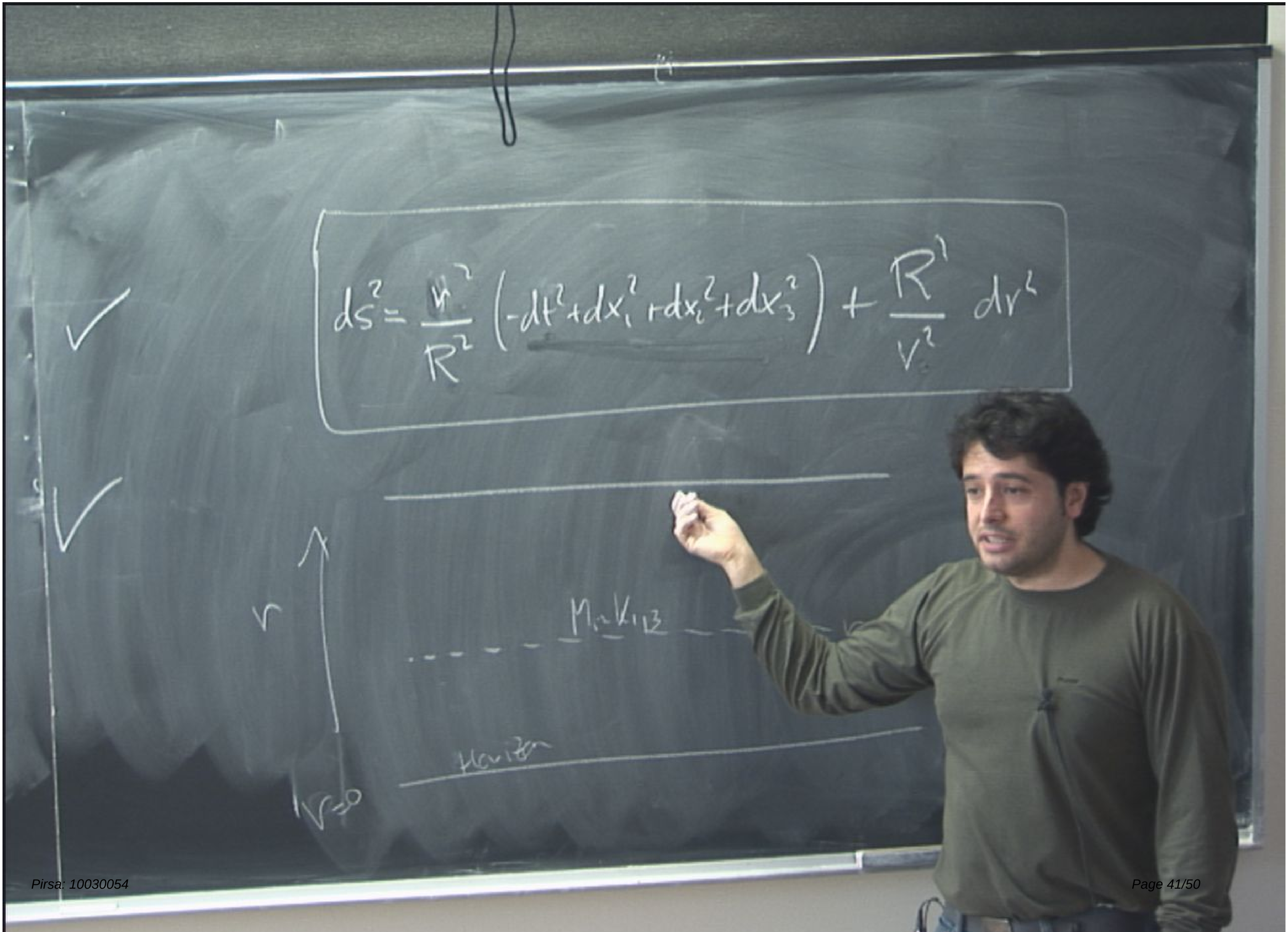
$\cong$

$AdS_5 \times S^5$: $SO(2,4) \times SO(6) \times 32$ susy's ✓


$ds^2 = \frac{r^2}{R^2}\left(-dt^2+dx_1^2+dx_2^2+dx_3^2\right) + \frac{R^2}{r^2}\, dr^2$
Poincaré Coord.

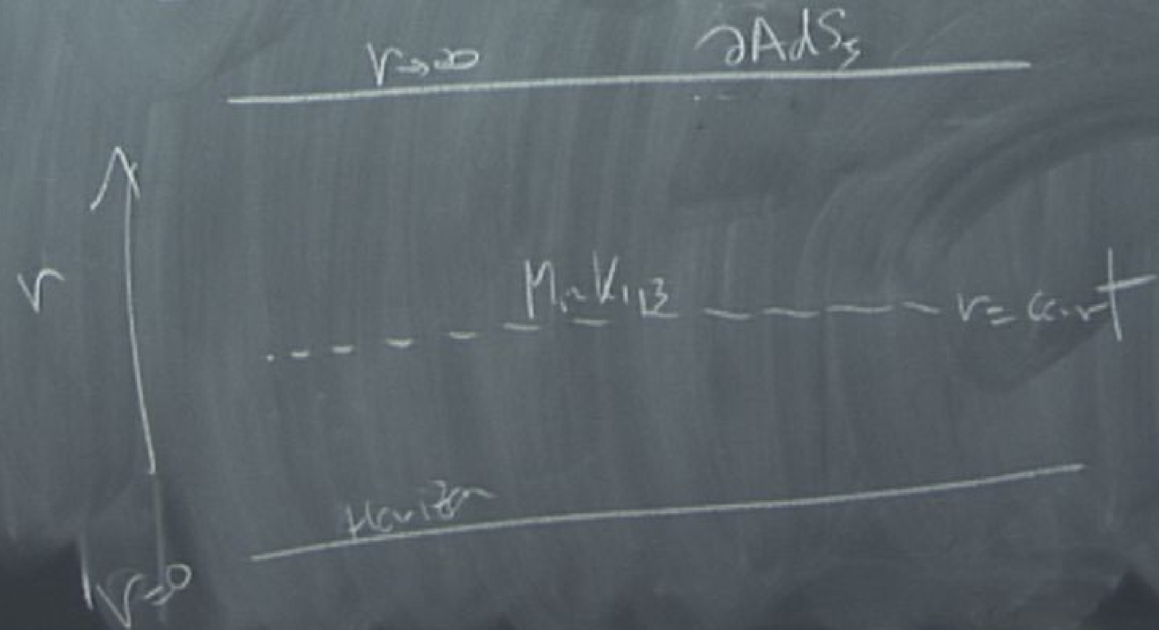
$$\boxed{ds^2 = \frac{r^2}{R^2}\left(-dt^2+dx_1^2+dx_2^2+dx_3^2\right) + \frac{R^2}{r^2}\, dr^2}$$





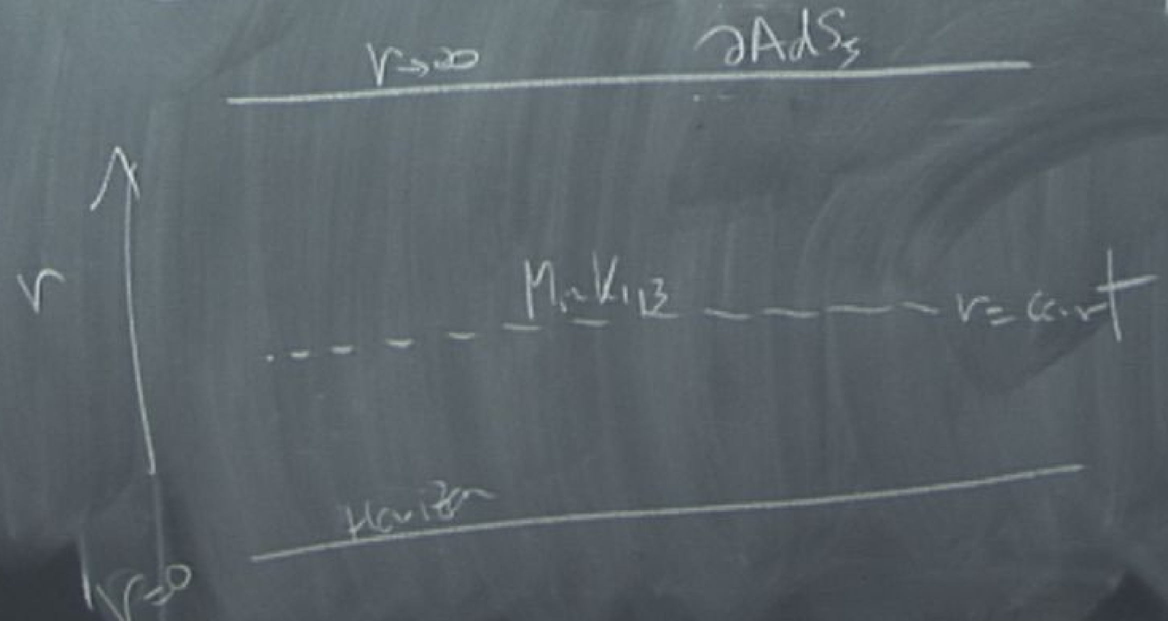
$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + dx_1^2 + dx_2^2 + dx_3^2\right) + \frac{R^2}{r^2}\, dr^2$
r
Horizon
r=0

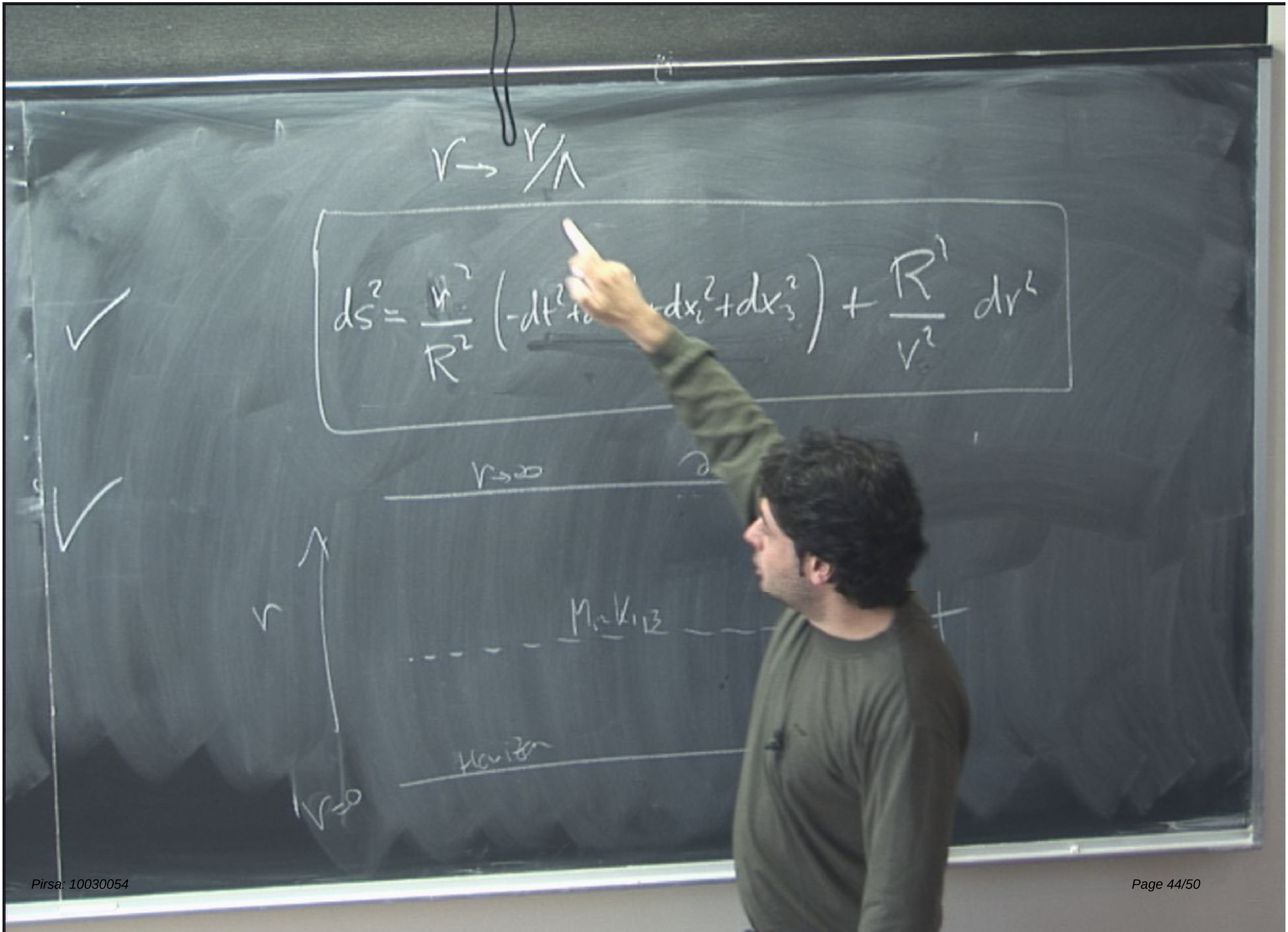
$$\boxed{ds^2 = \frac{r^2}{R^2}\left(-dt^2 + dx_1^2 + dx_2^2 + dx_3^2\right) + \frac{R^2}{r^2}\,dr^2}$$

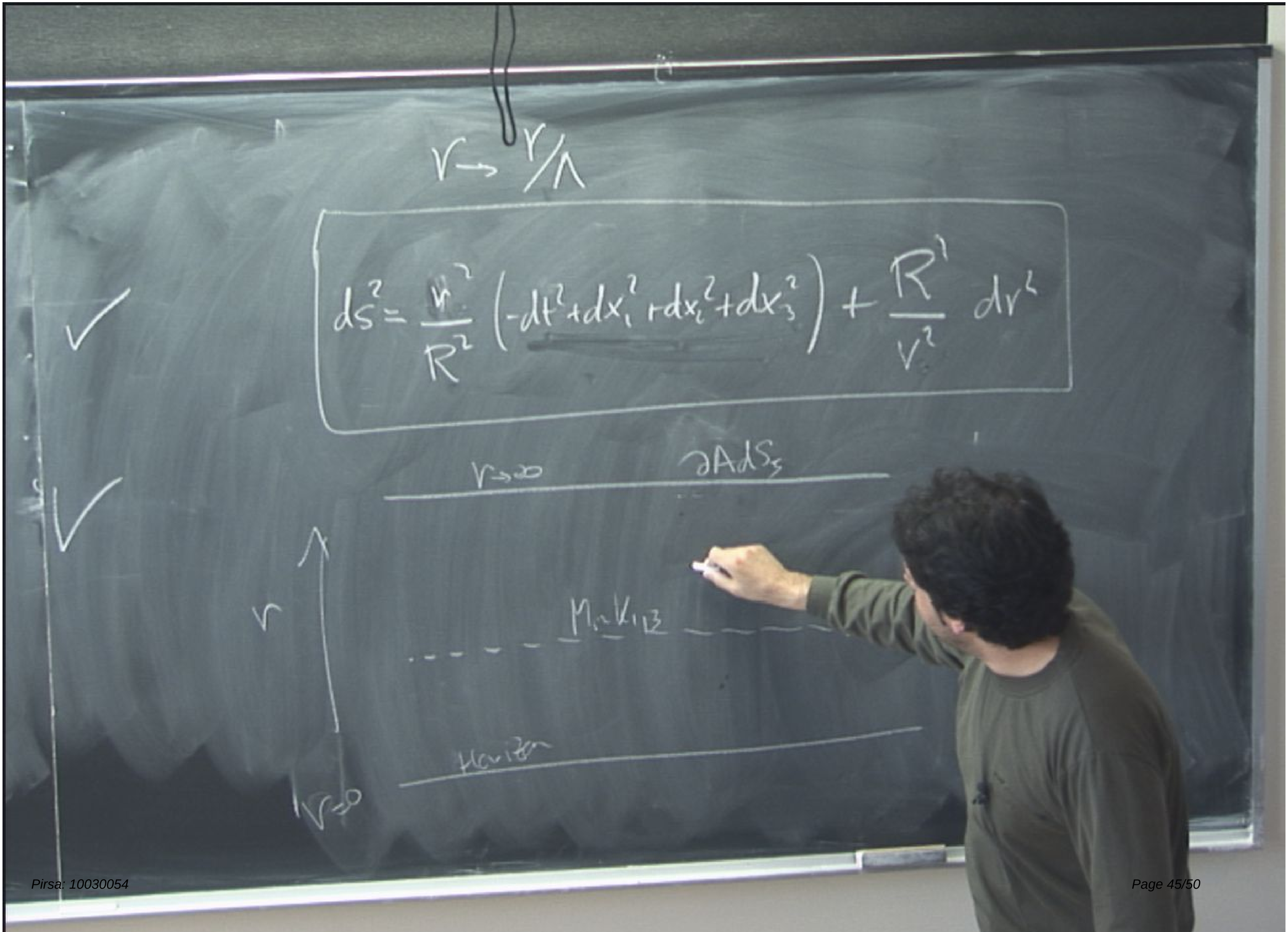


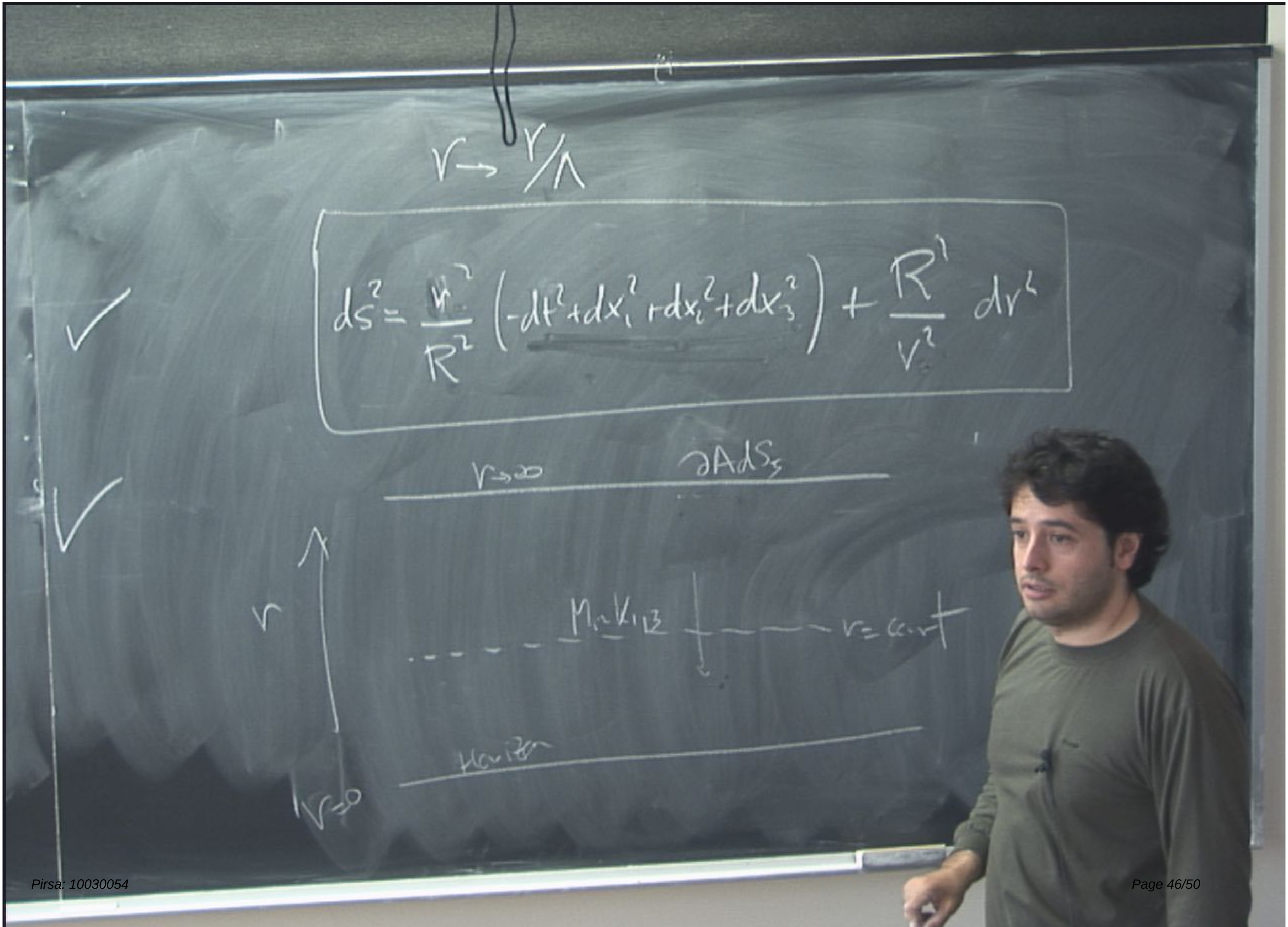
$r \to r/\Lambda$

$$\boxed{ds^2 = \frac{r^2}{R^2}\left(-dt^2+dx_1^2+dx_2^2+dx_3^2\right) + \frac{R^2}{r^2}\,dr^2}$$




r → r/Λ
r→∞
r
Horizon
r=0


r → r/Λ
ds² = r²/R² (−dt² + dx₁² + dx₂² + dx₃²) + R²/r² dr²
r→∞
∂AdS₅
r
Horizon
r=0



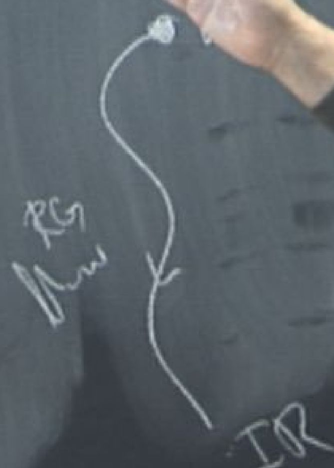
r → r/Λ
ds² = r²/R² (-dt² + dx₁² + dx₂² + dx₃²) + R²/r² dr²
r→∞
∂AdS₅
r
r = const
Horizon
r=0

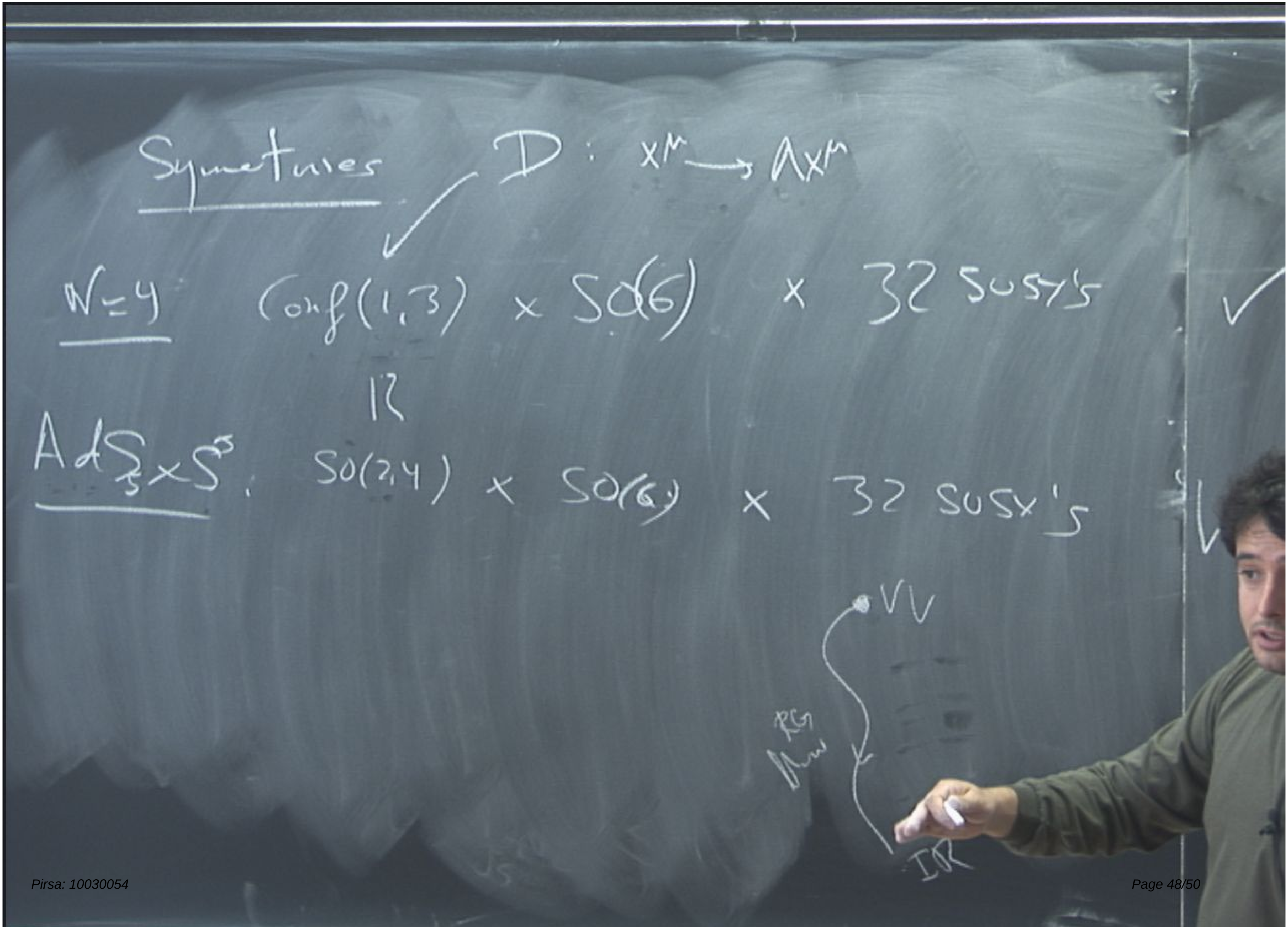
Symmetries $\quad D: x^\mu \to \lambda x^\mu$

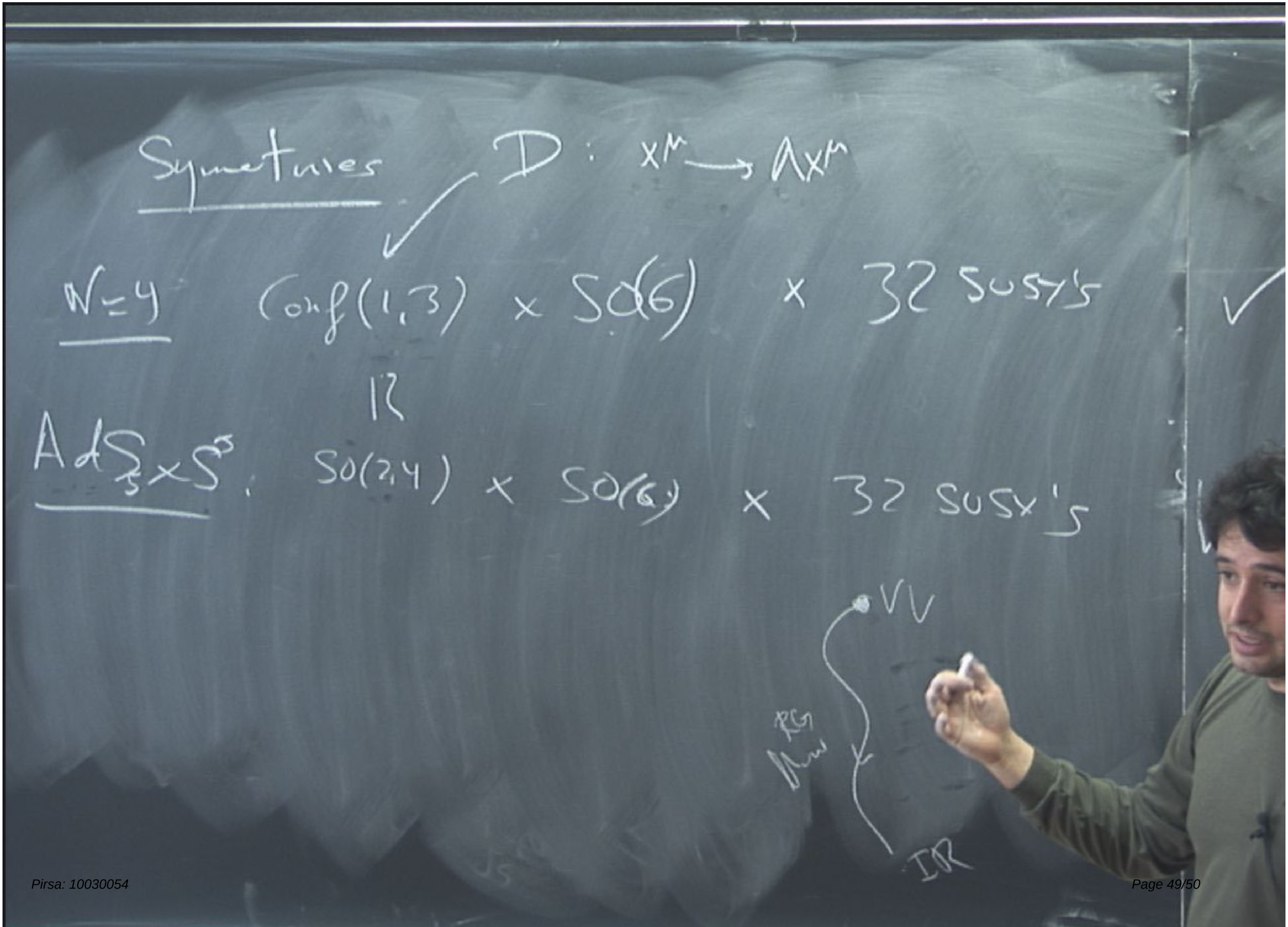
$\mathcal{N}=4$: $\quad \mathrm{Conf}(1,3) \times SO(6) \times 32$ SUSY's

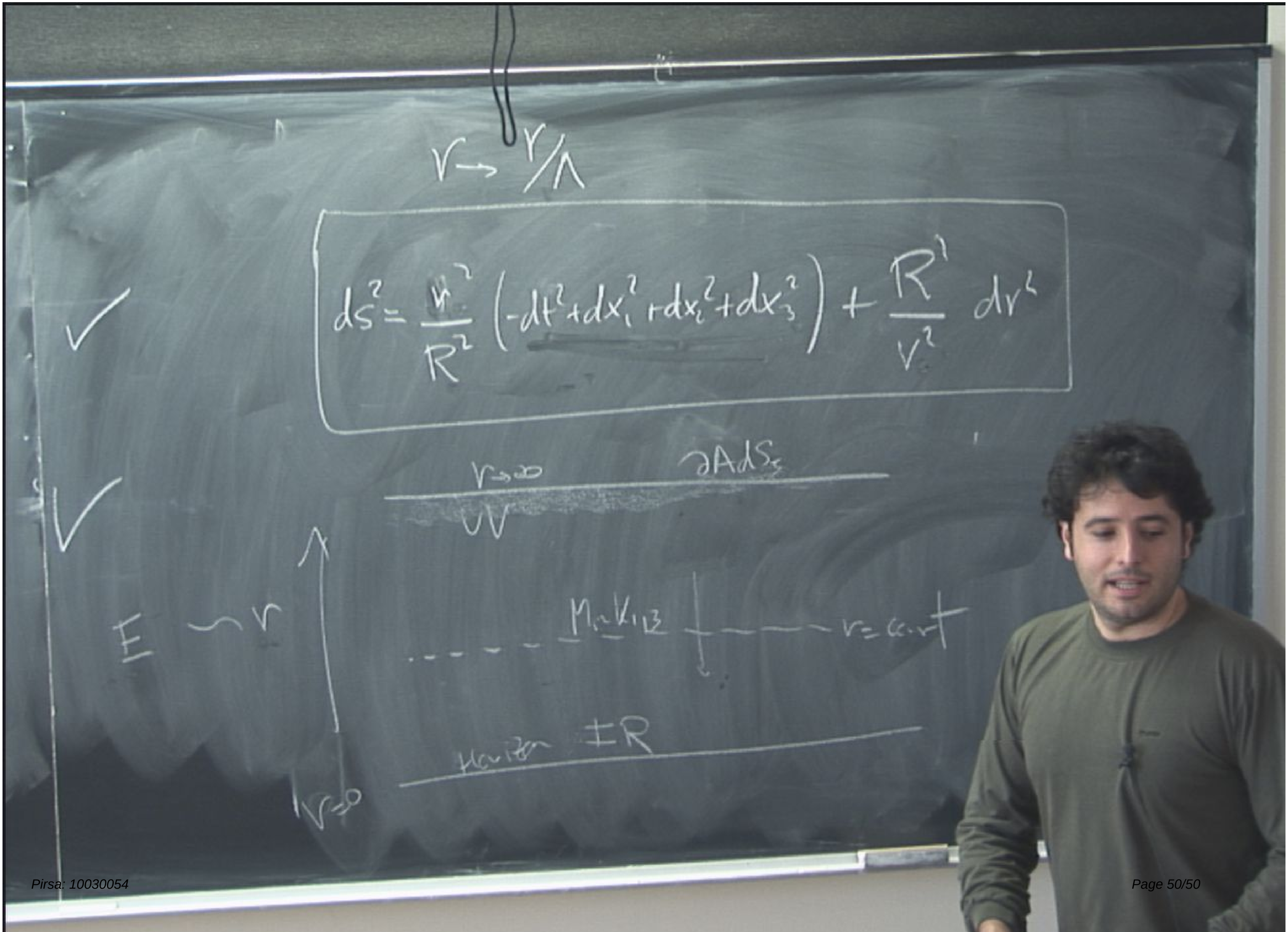
$\wr\wr$

$AdS_5 \times S^5$: $\quad SO(2,4) \times SO(6) \times 32$ SUSY's




Symmetries
D : x^μ → λx^μ
N=4 Conf(1,3) × SO(6) × 32 susy's
AdS5×S5 : SO(2,4) × SO(6) × 32 susy's
UV
RG flow
IR


Symmetries
D : x^μ → λx^μ
N=4 Conf(1,3) × SO(6) × 32 susy's
≅
AdS5×S5: SO(2,4) × SO(6) × 32 susy's
UV
RG flow
IR



$r \to r/\Lambda$
$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + dx_1^2 + dx_2^2 + dx_3^2\right) + \frac{R^2}{r^2}\, dr^2$
$r \to \infty$
∂AdS_5
$E \sim r$
$r = \text{const}$
Horizon IR
$r=0$