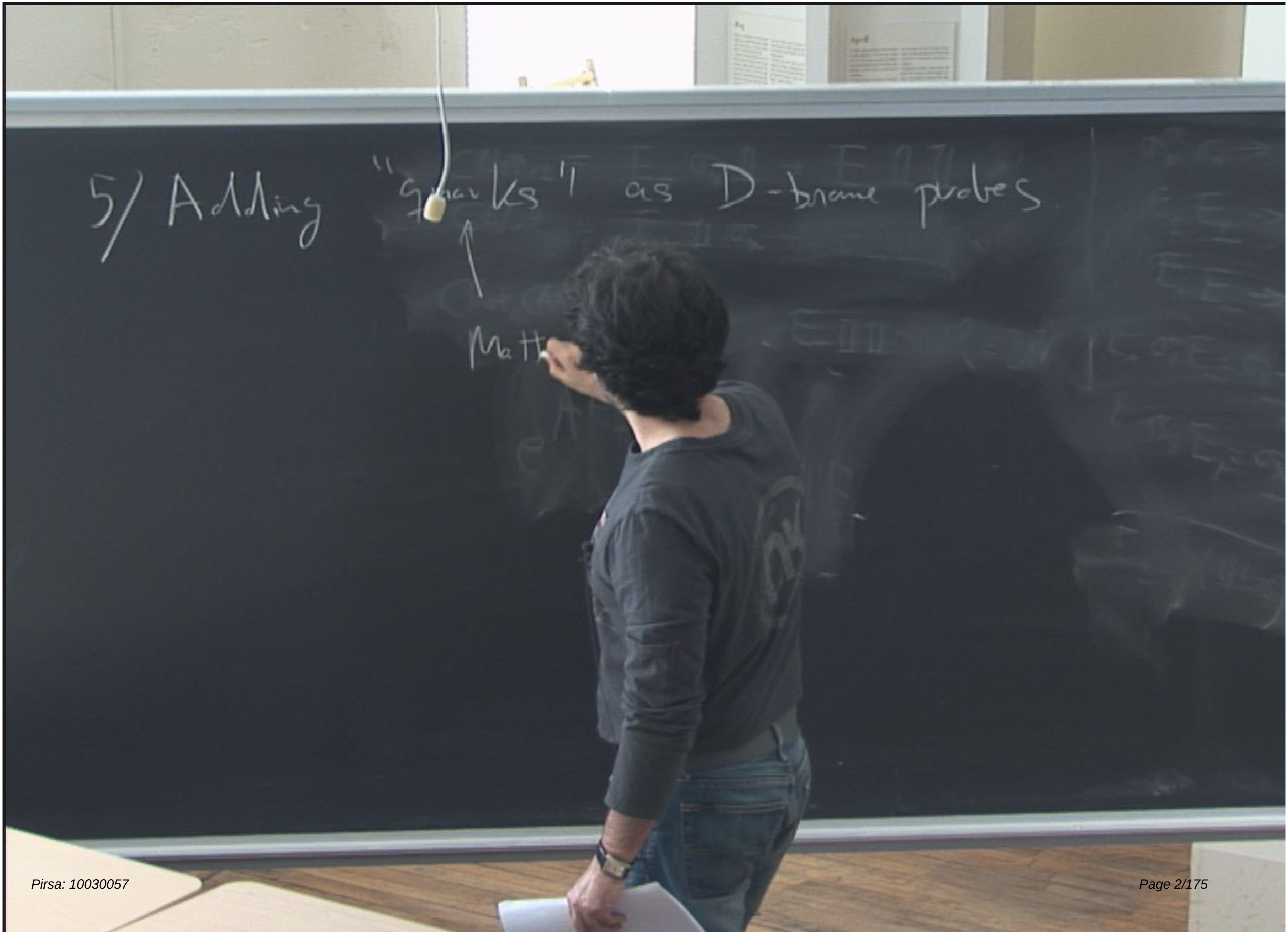
Title: Explorations in String Theory (PHYS 647) - Lecture 16

Date: Mar 05, 2010 10:10 AM

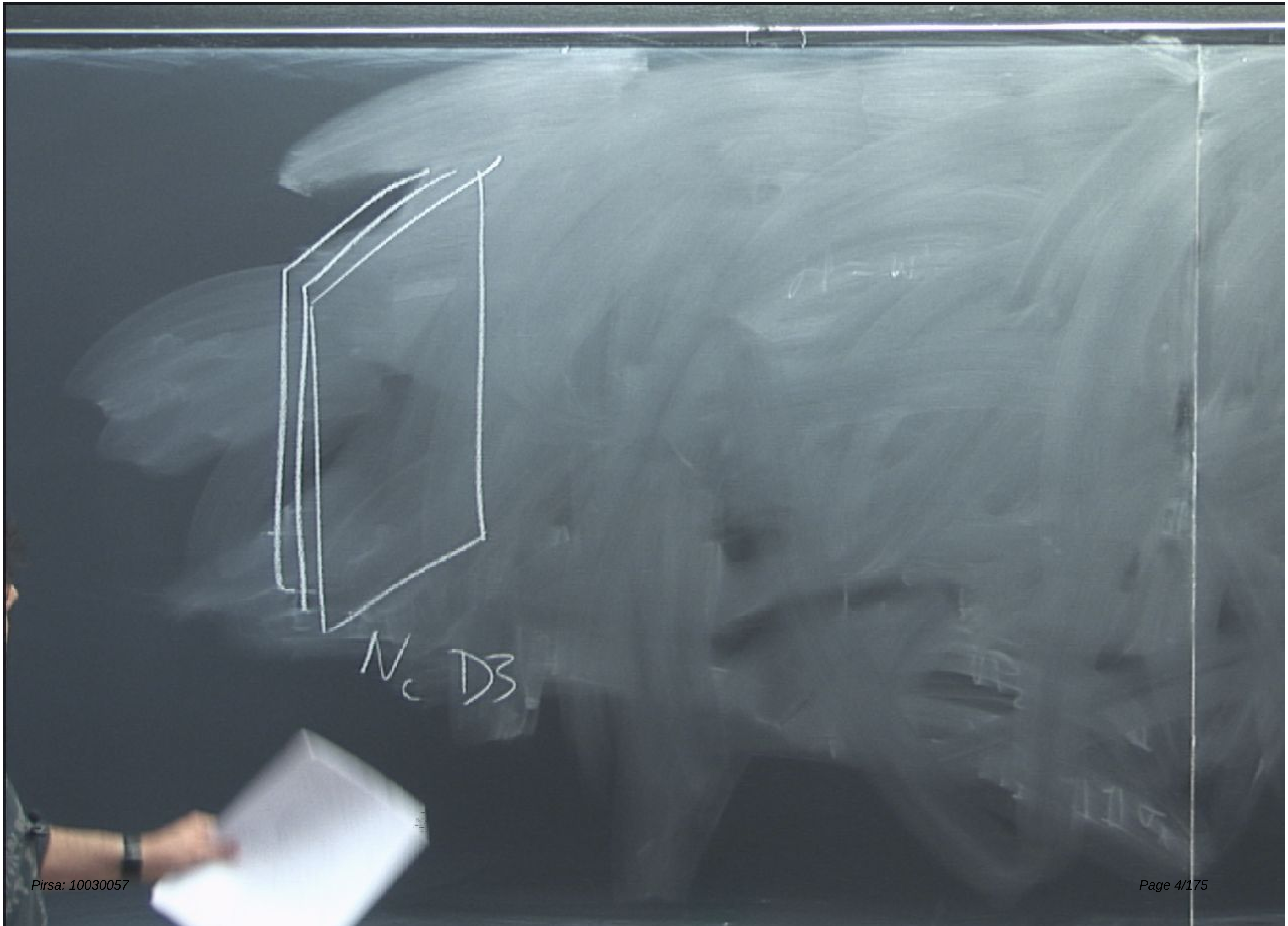
URL: http://pirsa.org/10030057

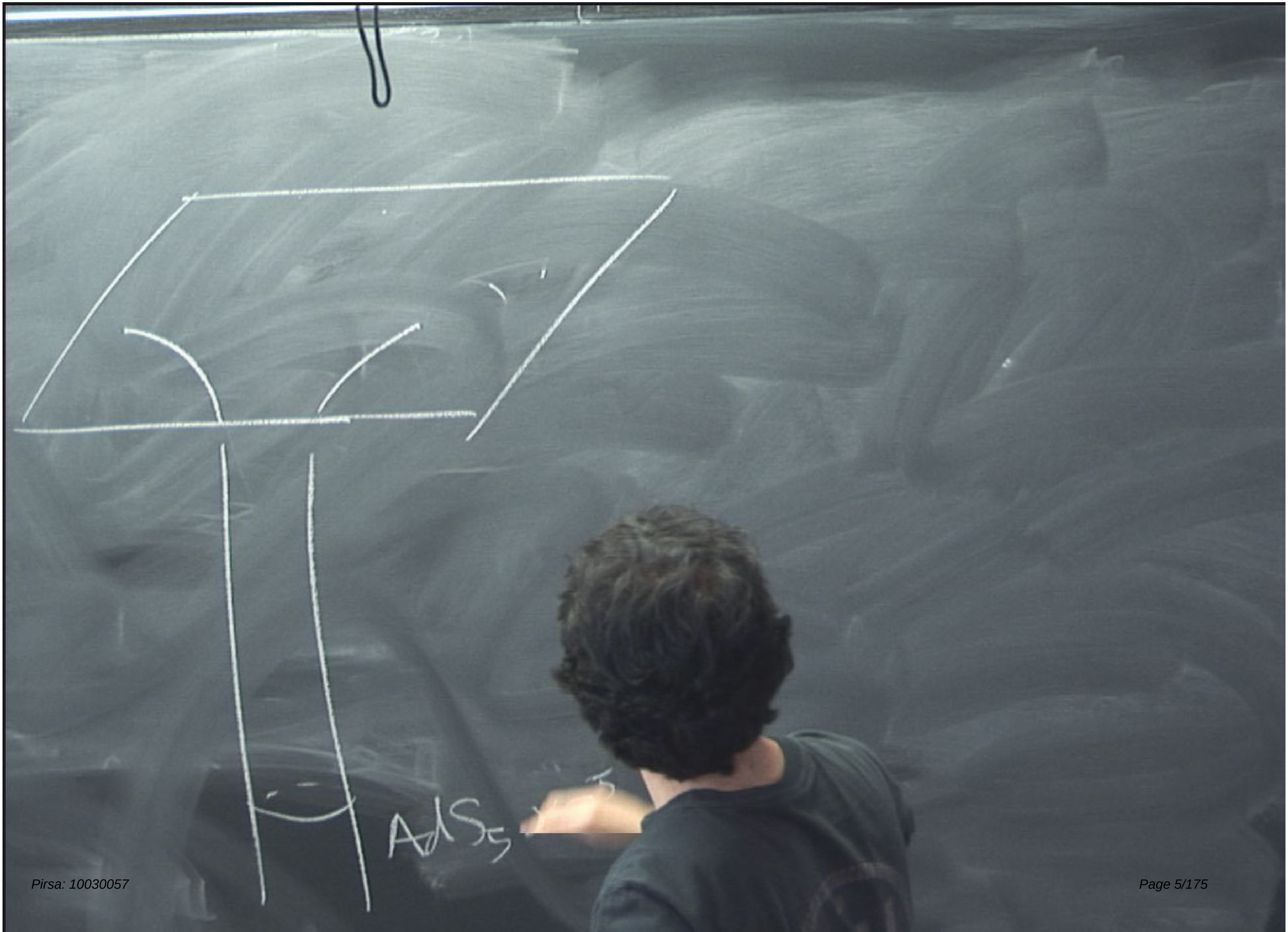
Abstract:

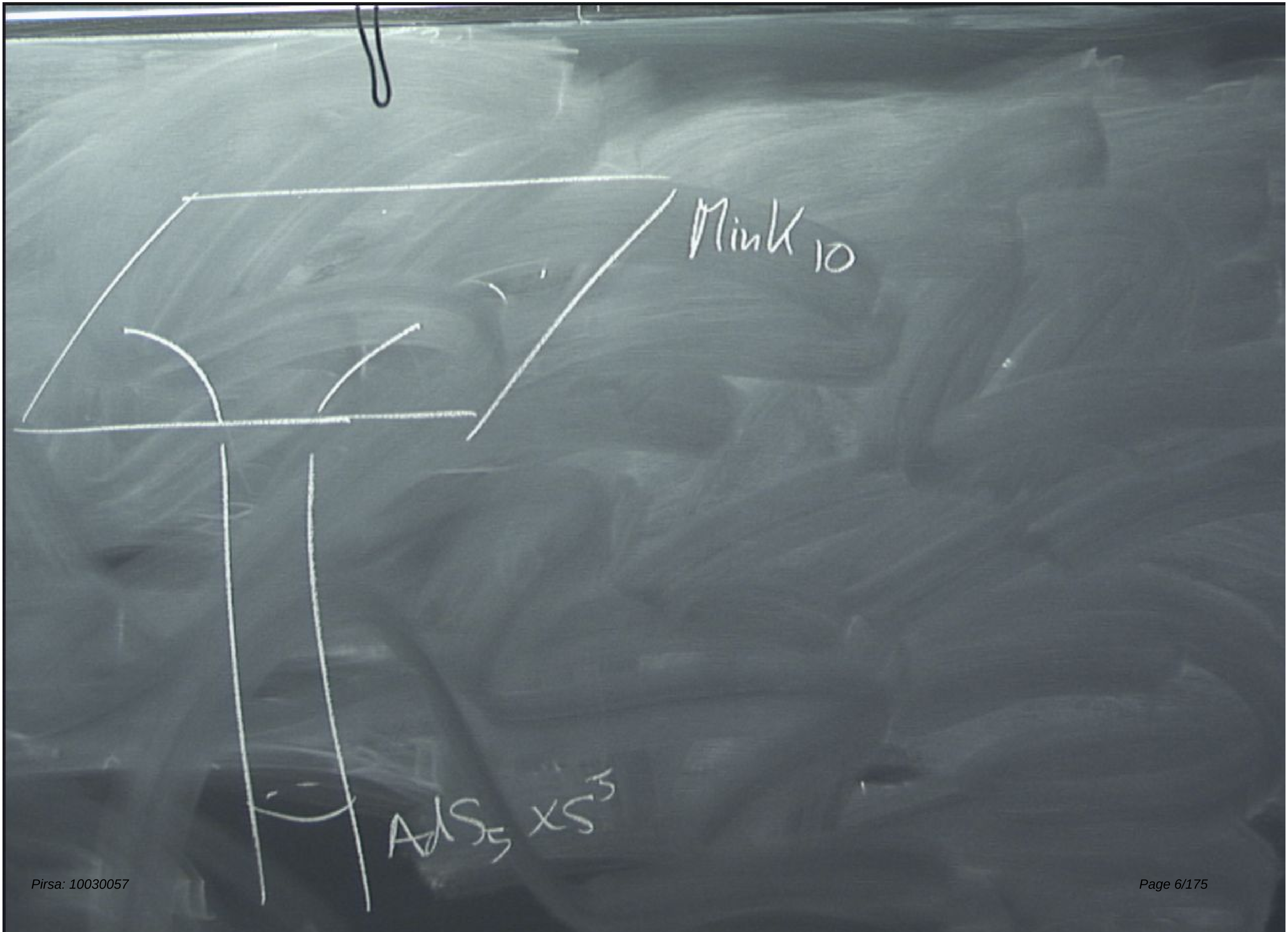

5/ Adding "quarks" as D-brane probes
Matt

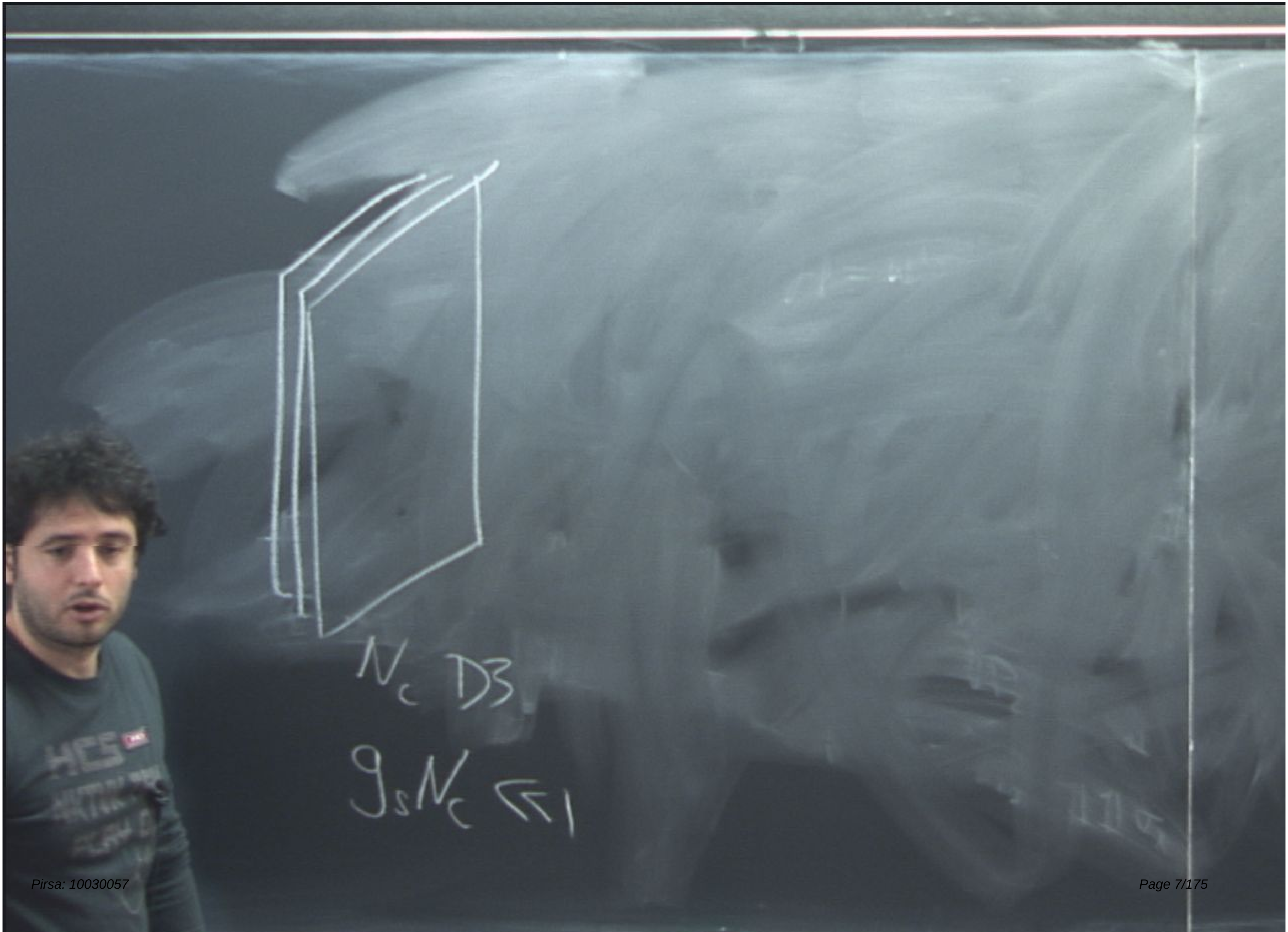
5/ Adding "quarks" as D-brane probes

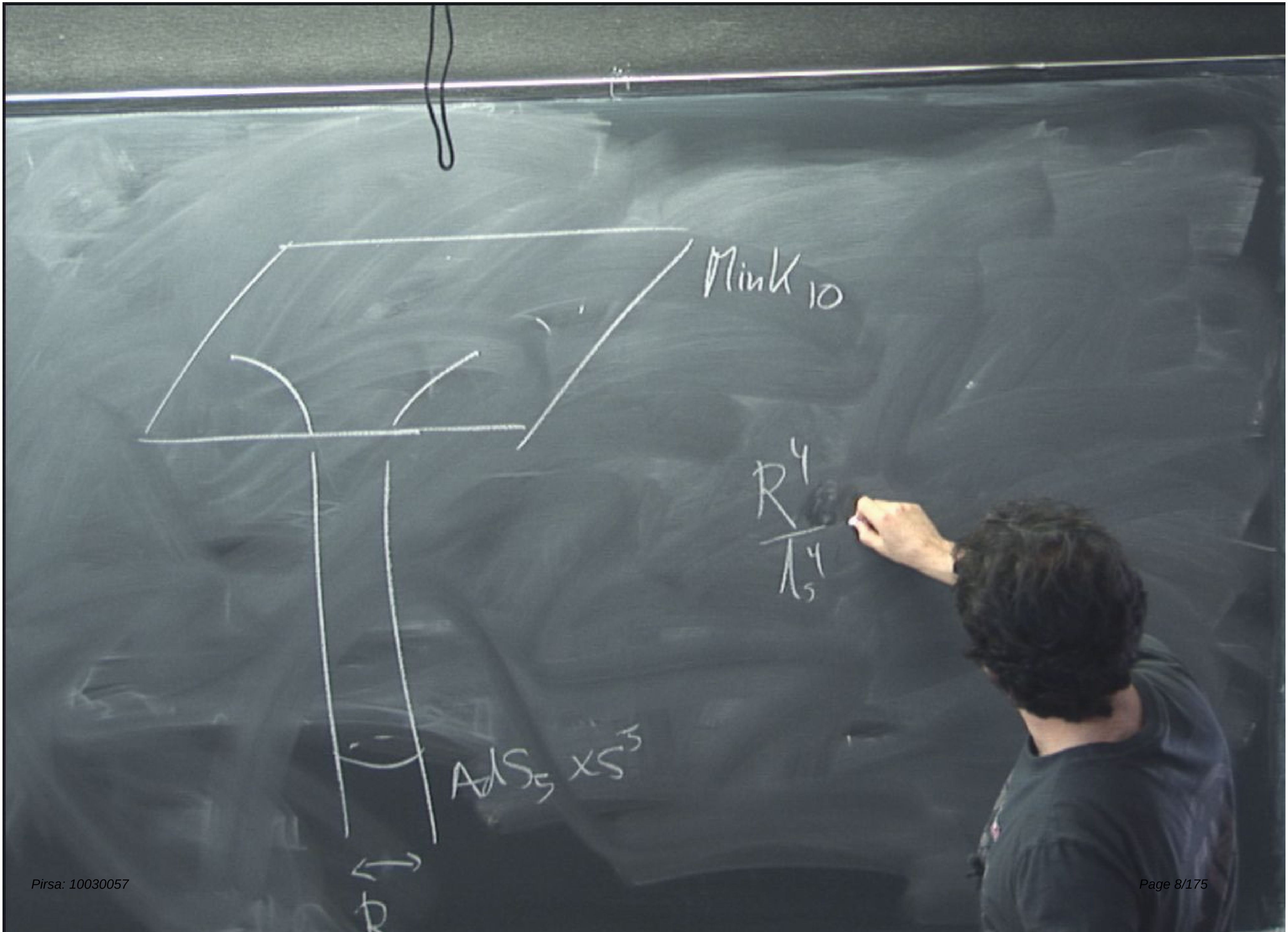
Matter in the fund. of $SU(N_c)$.

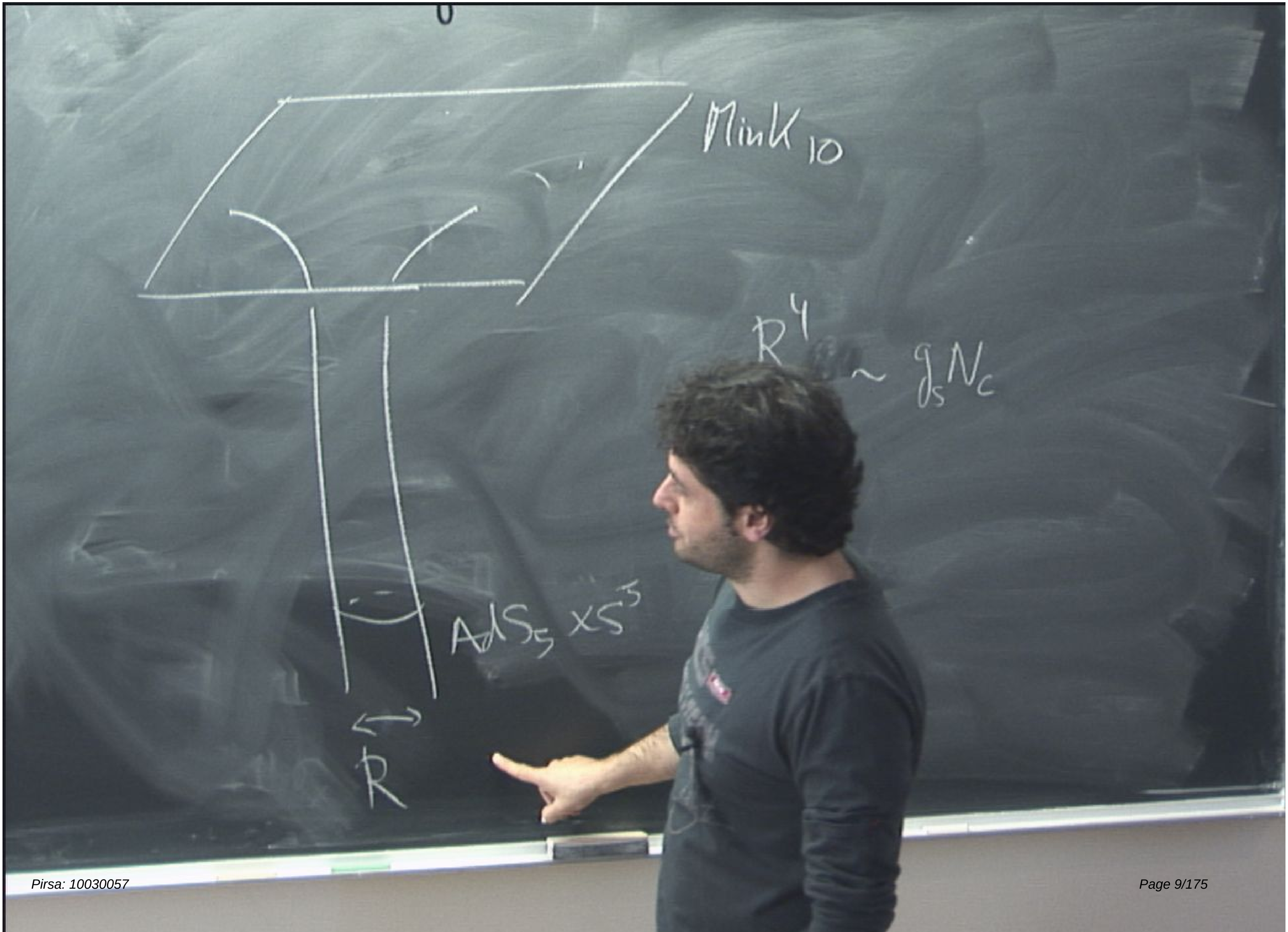

N_c D3

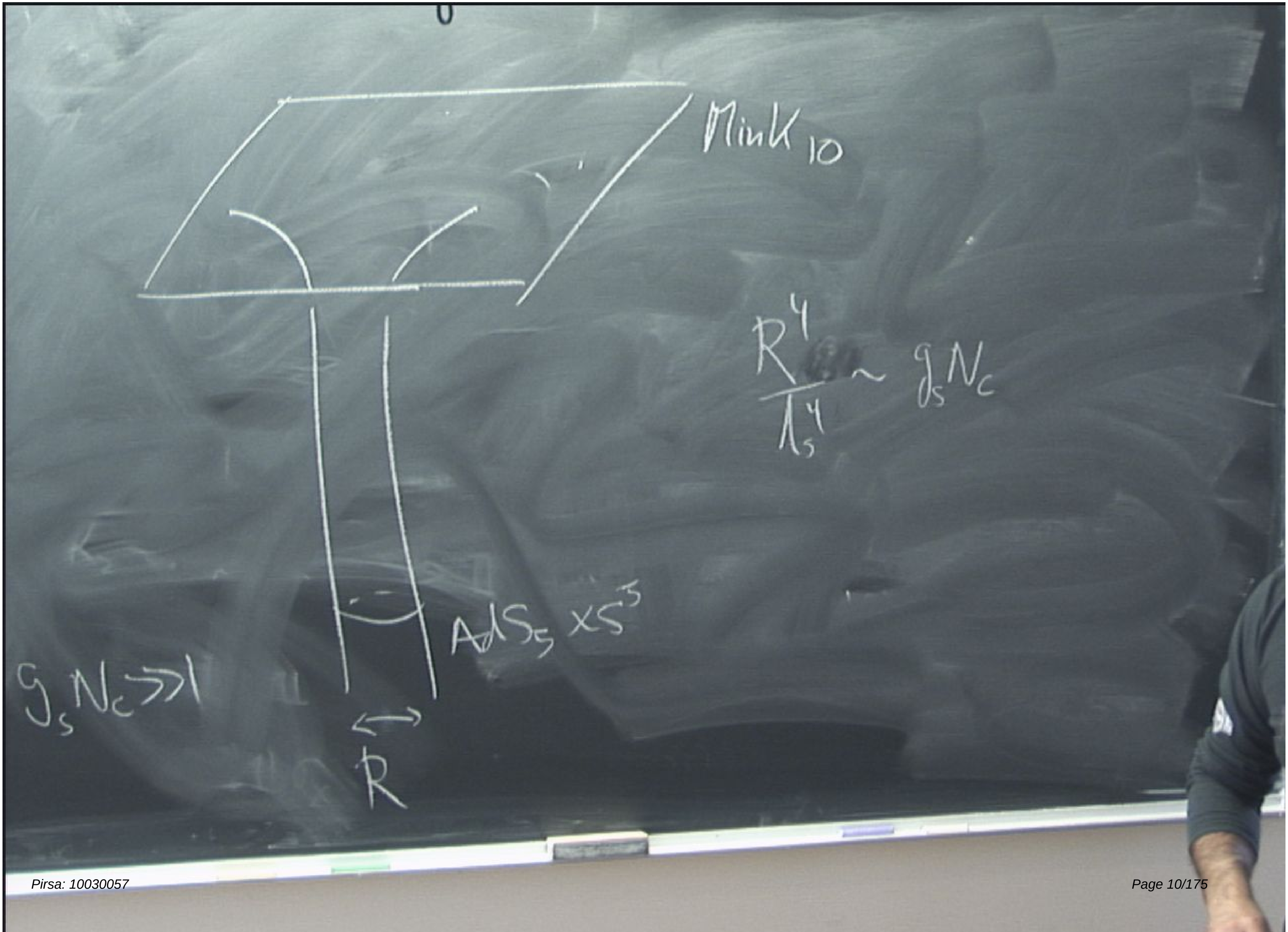

AdS5

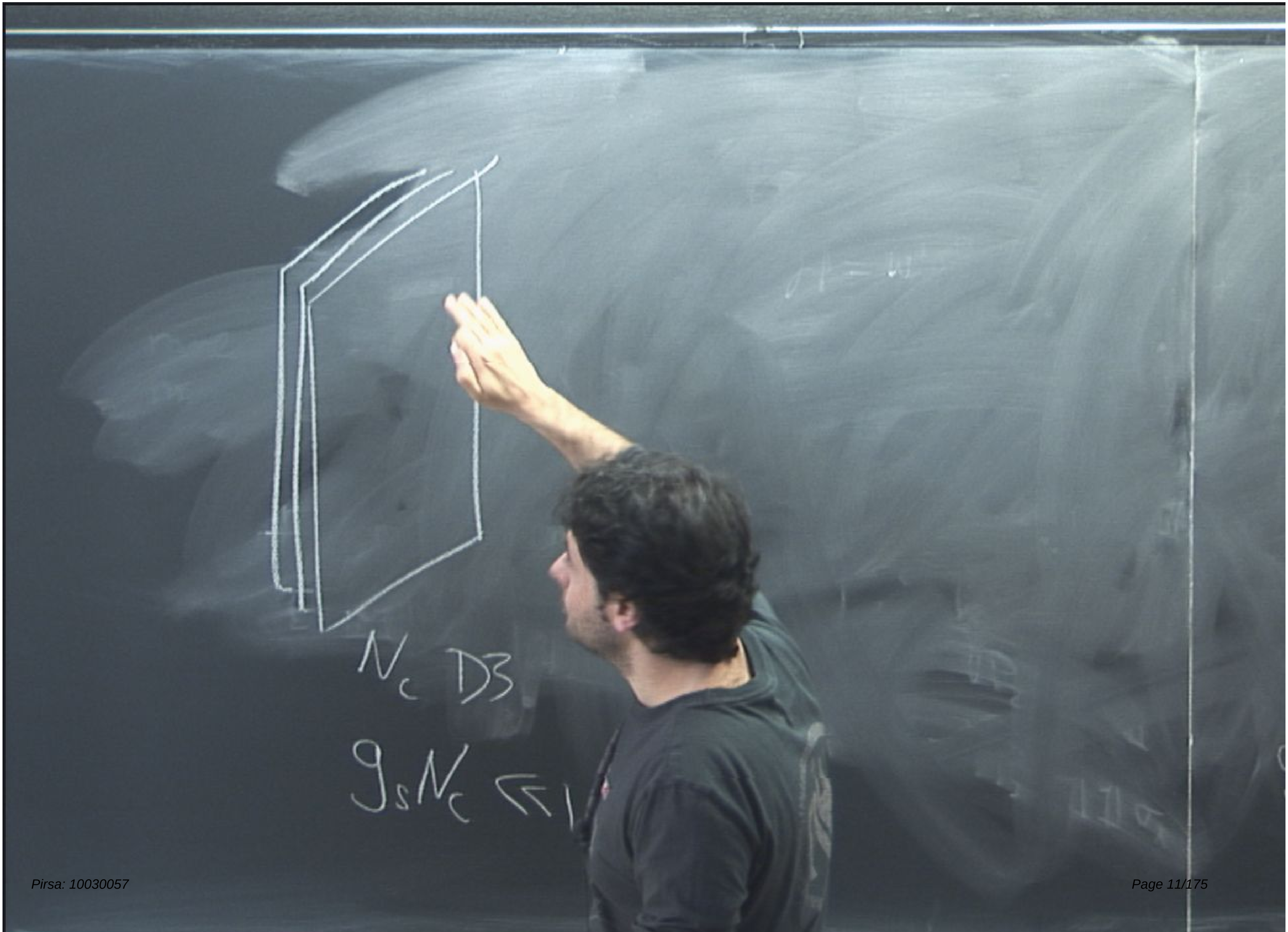

$Mink_{10}$
$AdS_5 \times S^5$

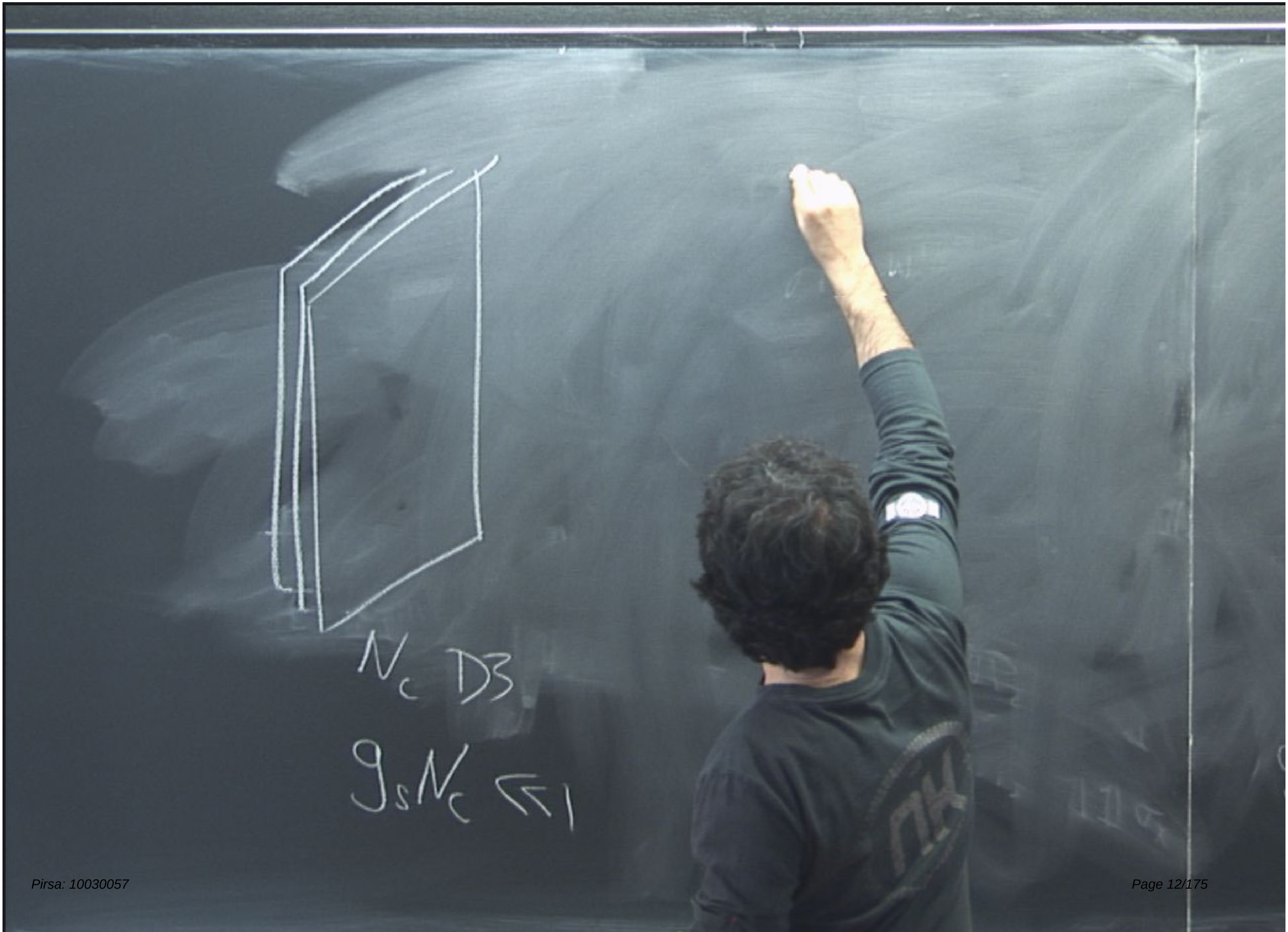

N_c D3
$g_s N_c \ll 1$

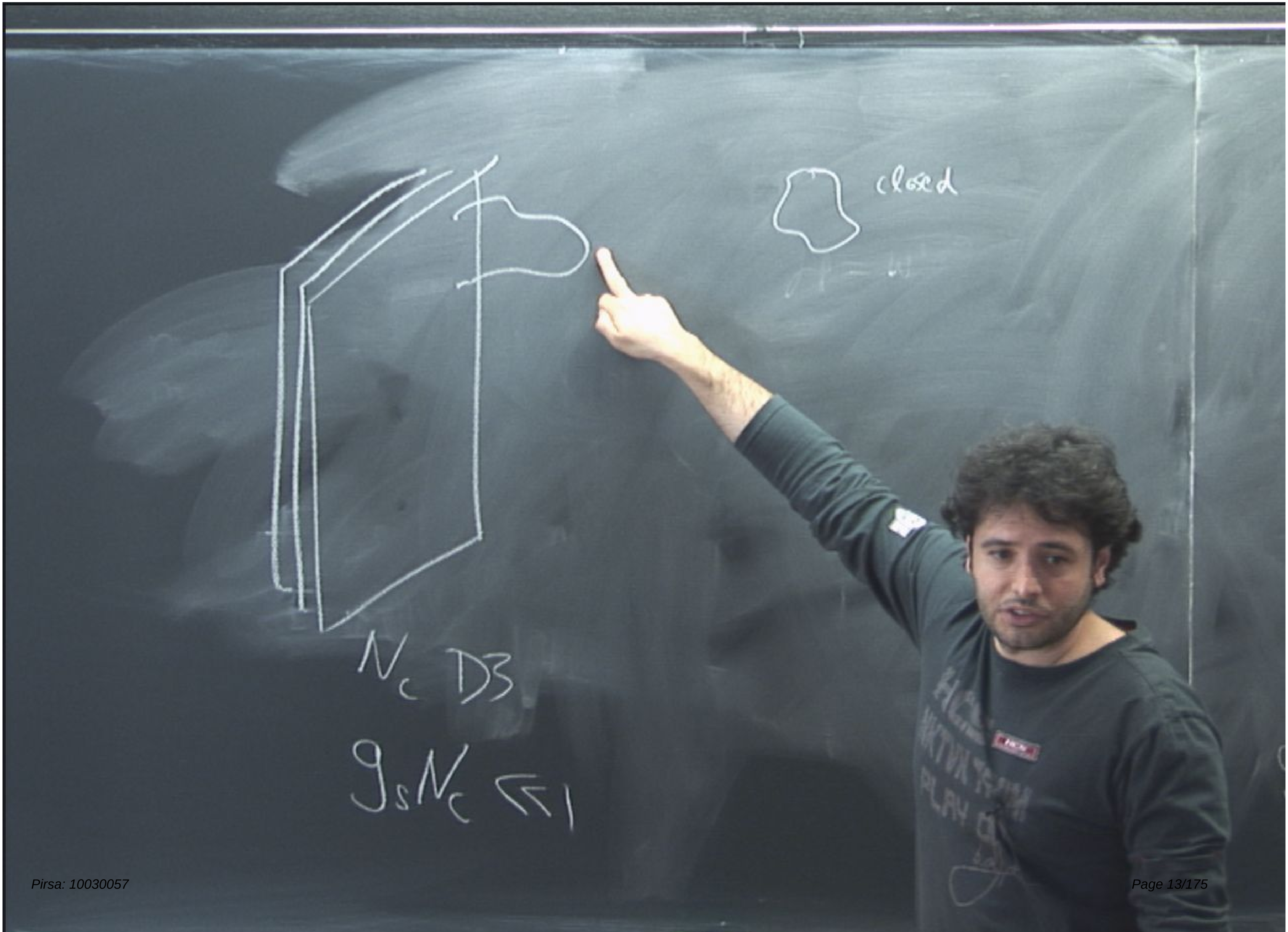

Mink_{10}
$AdS_5 \times S^5$
$\frac{R^4}{\ell_s^4}$


Mink 10
R4 ~ gs Nc
AdS5 x S5
R


Mink$_{10}$
$\frac{R^4}{l_s^4} \sim g_s N_c$
$AdS_5 \times S^5$
$g_s N_c \gg 1$
R

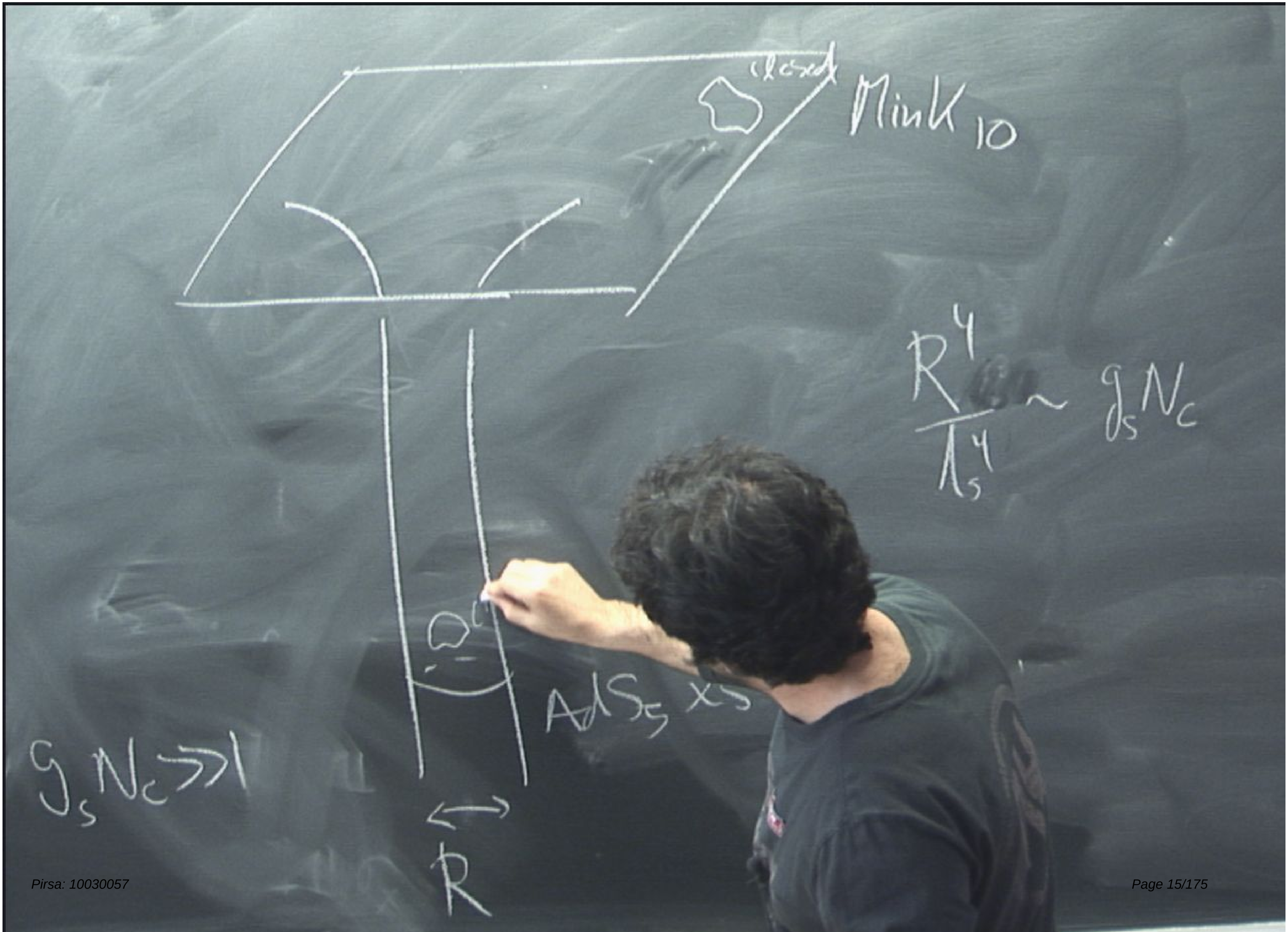

N_c D3
$g_s N_c \ll 1$

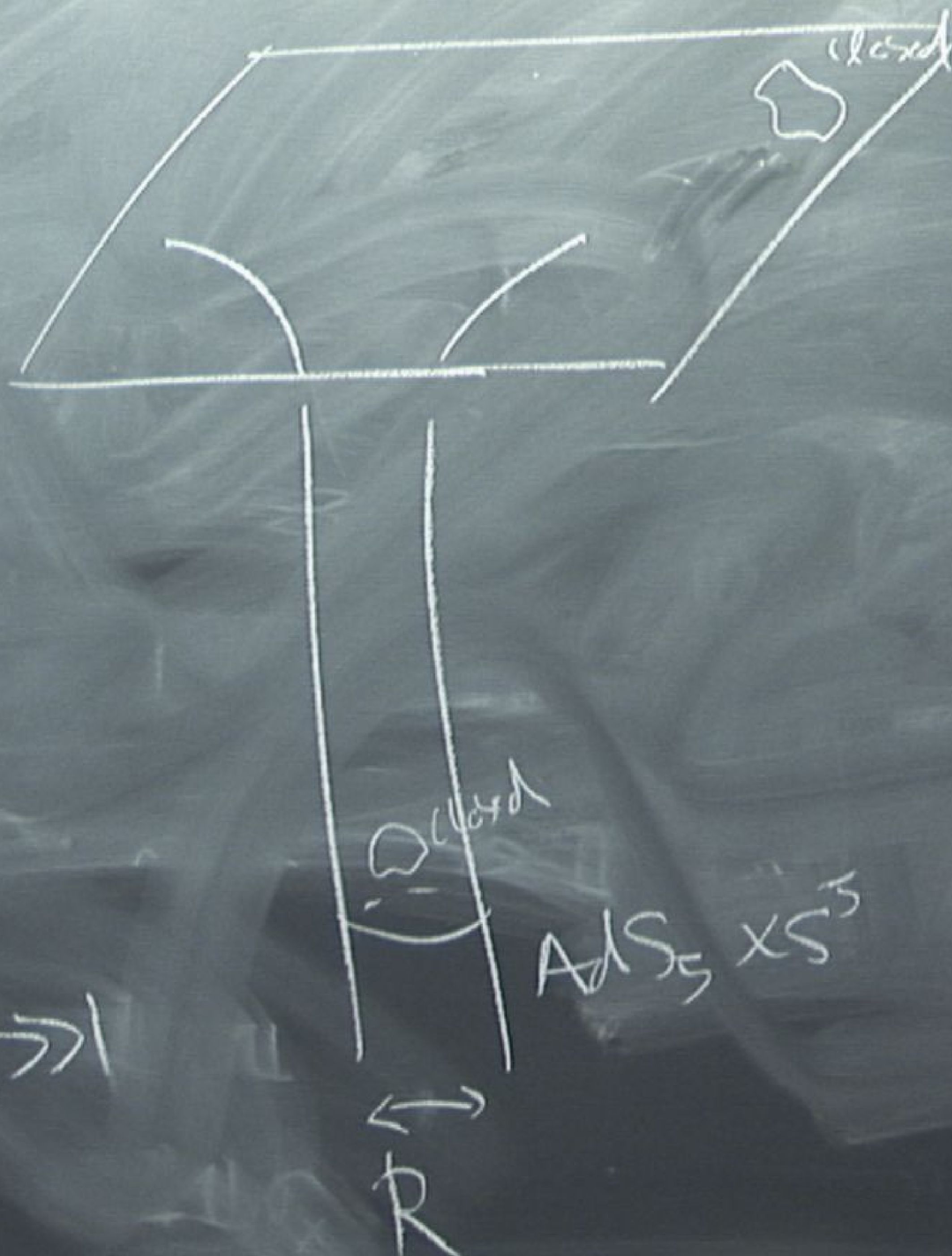

N_c D3
$g_s N_c \ll 1$


closed
N_c D3
$g_s N_c \ll 1$

N_c D3

$g_s N_c \ll 1$


closed
Mink 10
$\frac{R^4}{l_s^4} \sim g_s N_c$
$AdS_5 \times S^5$
$g_s N_c \gg 1$
R



$$\frac{R^4}{l_s^4} \sim g_s N_c$$

$$g_s N_c \gg 1$$

N_c D3

$\boxed{E \ll 1/l_s}$

$g_s N_c \ll 1$

$g_s N_c \gg 1$

Free closed M_{10}

$$\boxed{E \ll 1/l_s}$$

N_c D3

$g_s N_c \ll 1$

$g_s N_c \gg 1$

$\boxed{E \ll 1/l_s}$

Free closed M_{10}

$+$

$D=4$ $\mathcal{N}=4$ $SU(N_c)$ SYM

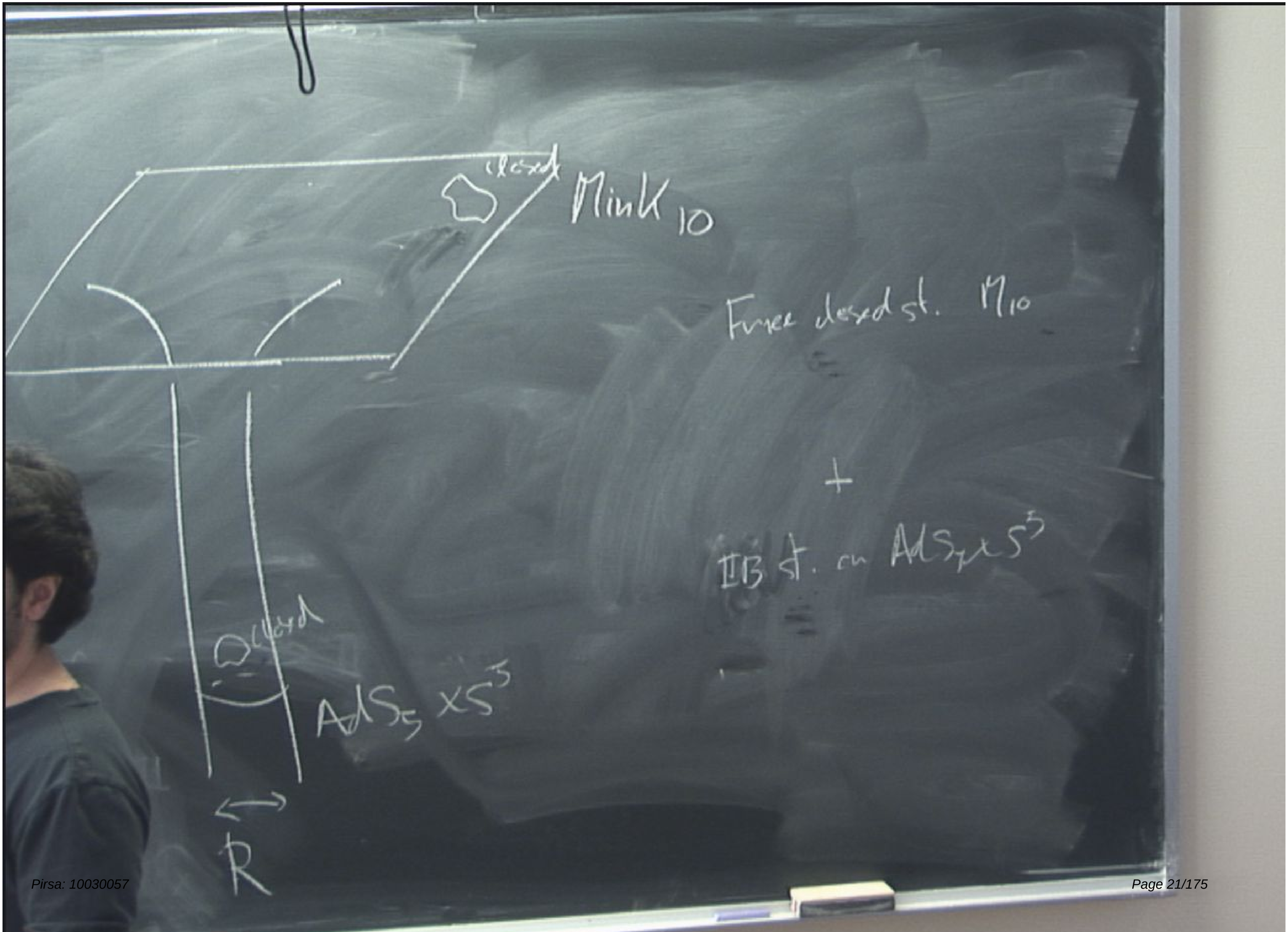
$g^2_{YM} \sim g_s$

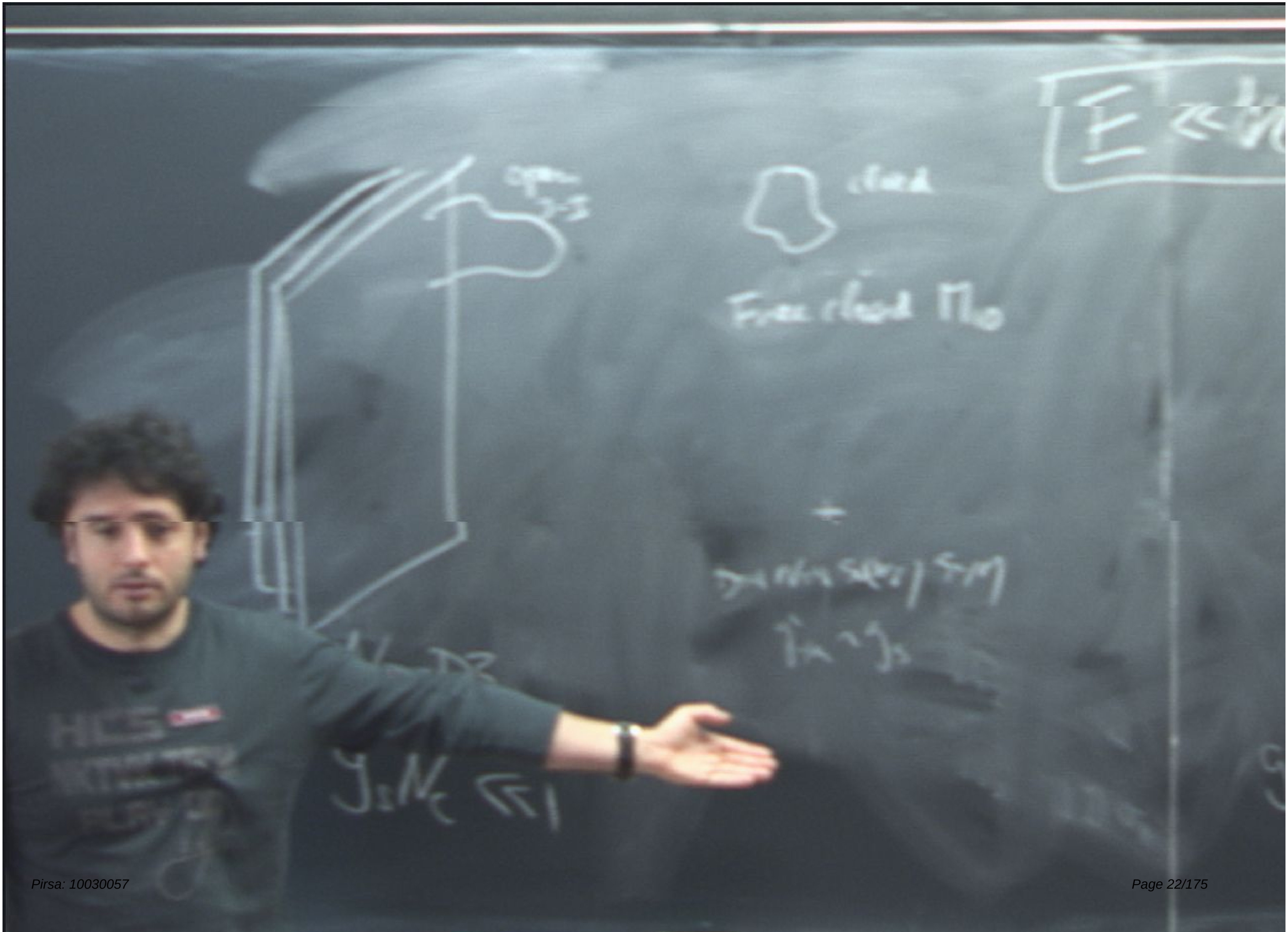
N_c D3

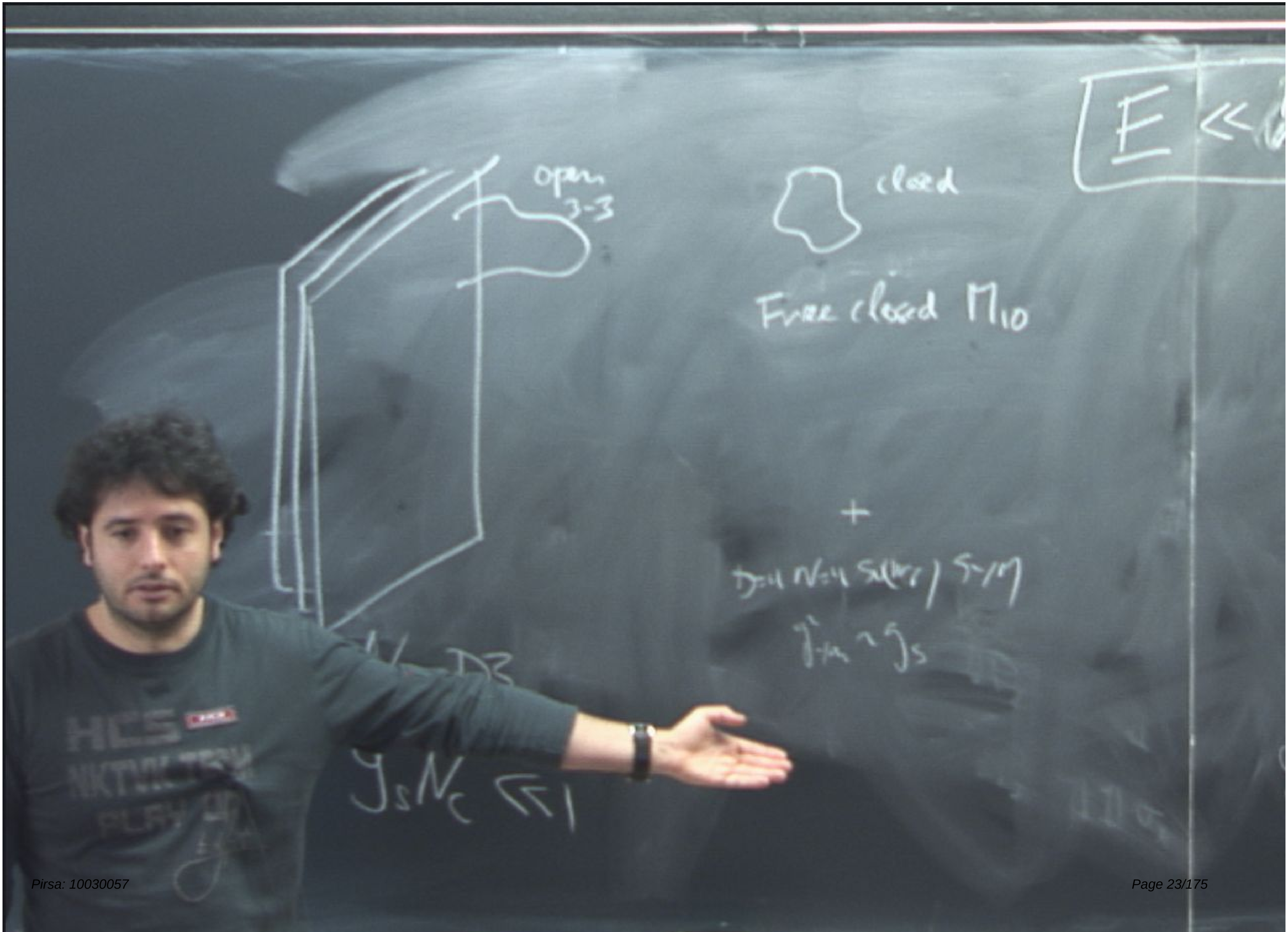
$g_s N_c \ll 1$

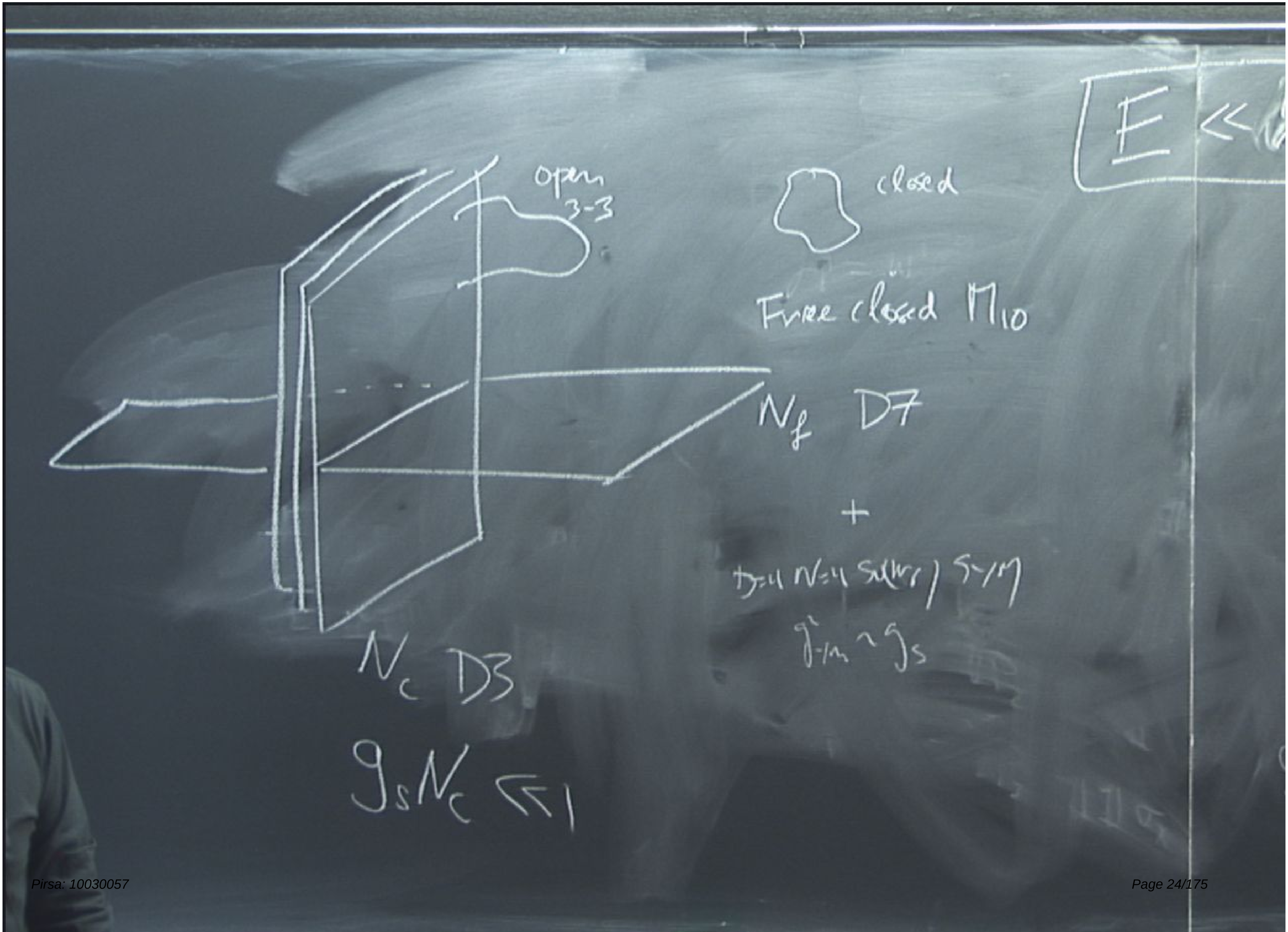
$g_s N_c \gg 1$

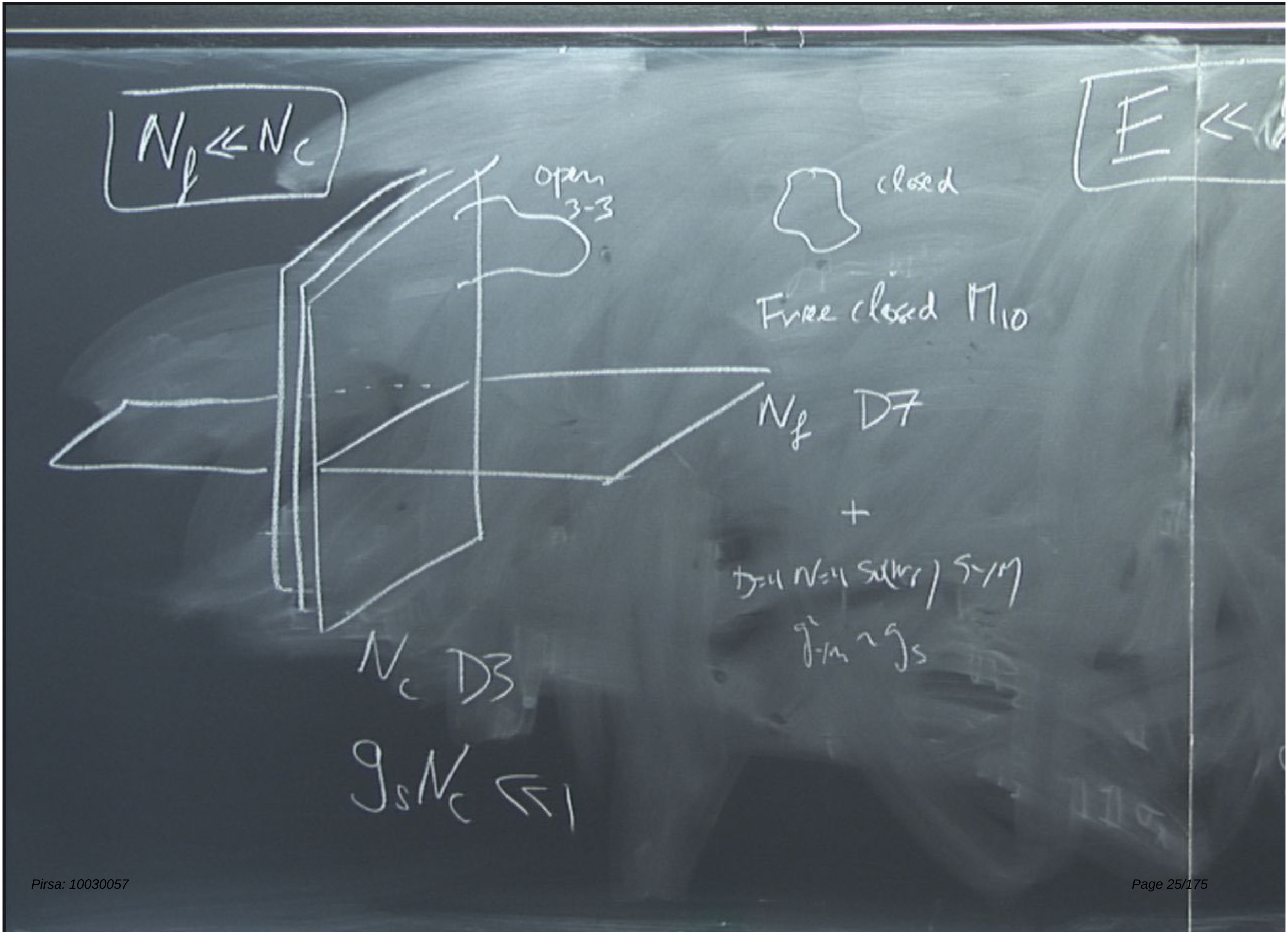

closed
Mink 10
closed
AdS5 x S5
Nc >> 1

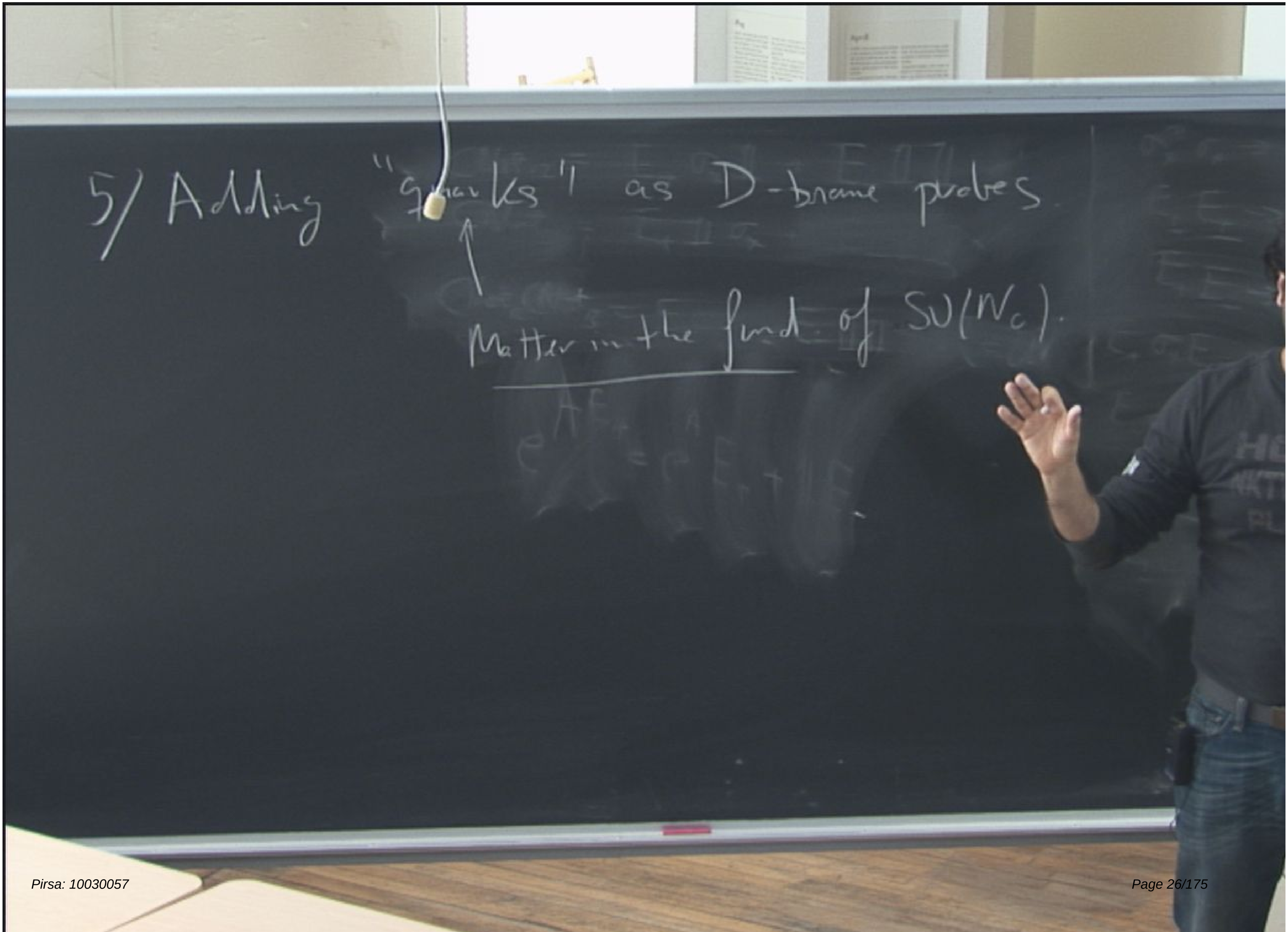

closed
Mink 10
Free closed st. M10
+
IIB st. on AdS5 x S5
closed
AdS5 x S5
R

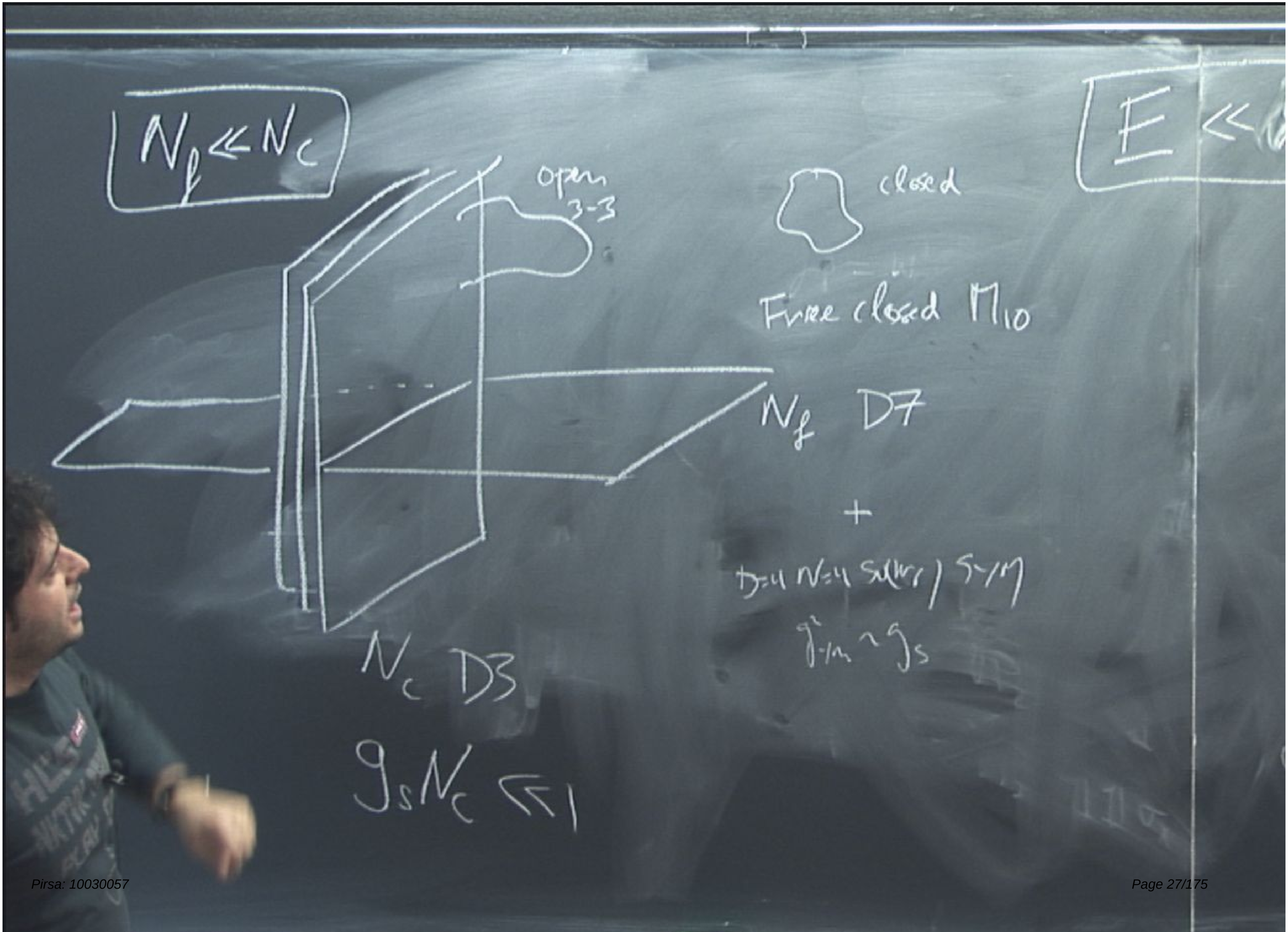


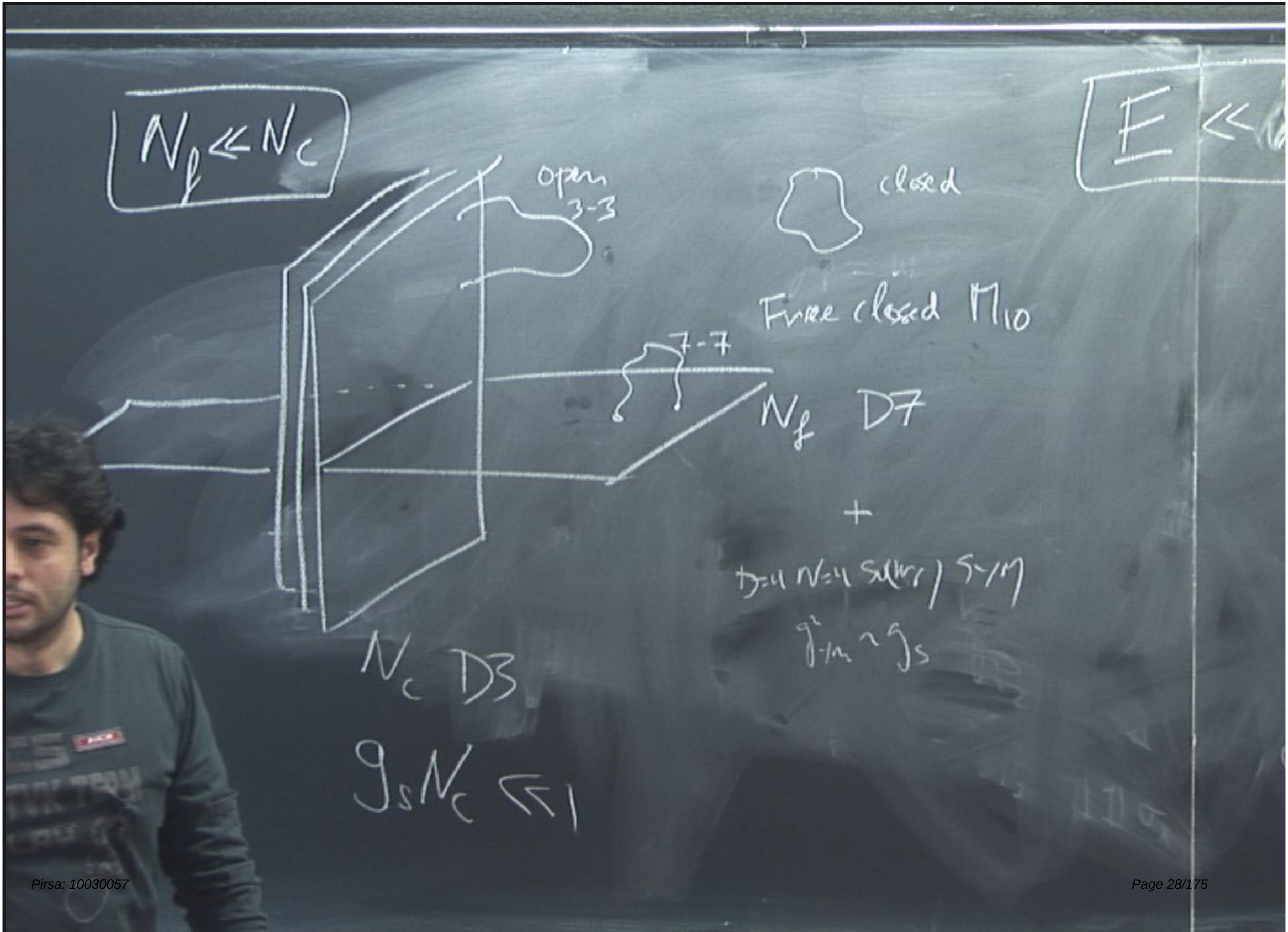

open
3-3
closed
Free closed M10
+
gsNc ≪ 1
E ≪


E <<
open
3-3
closed
Free closed M10
Nf D7
+
D=4 N=4 SU(Nc) S-YM
g²YM ~ gs
Nc D3
gs Nc <<1

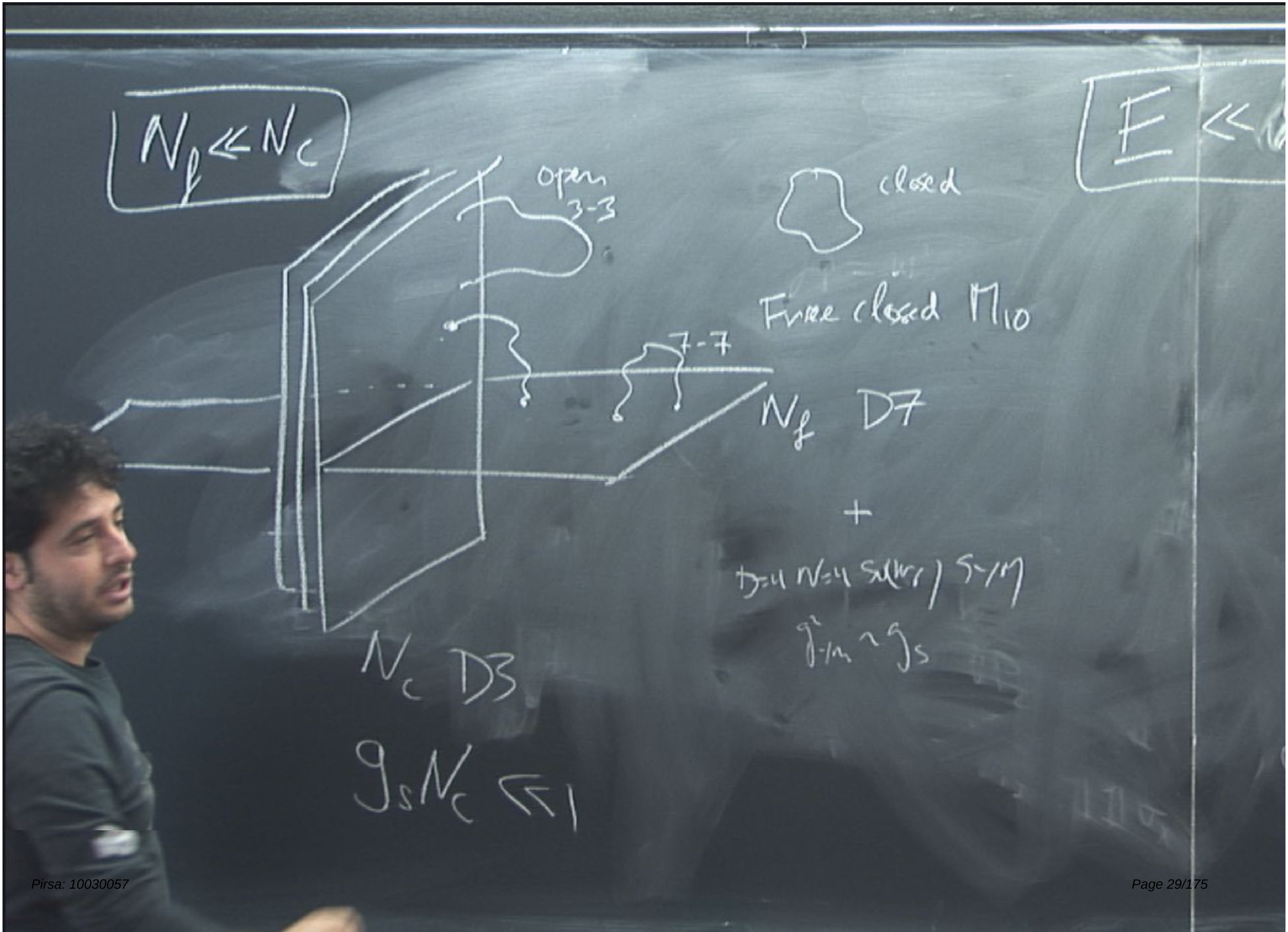

Nf ≪ Nc
open
3-3
closed
Free closed M10
Nf D7
+
D=4 N=4 SU(Nc) S-YM
g²YM ~ gs
Nc D3
gsNc ≪ 1
E ≪


5/ Adding "quarks" as D-brane probes
Matter in the fund. of SU(N_c).

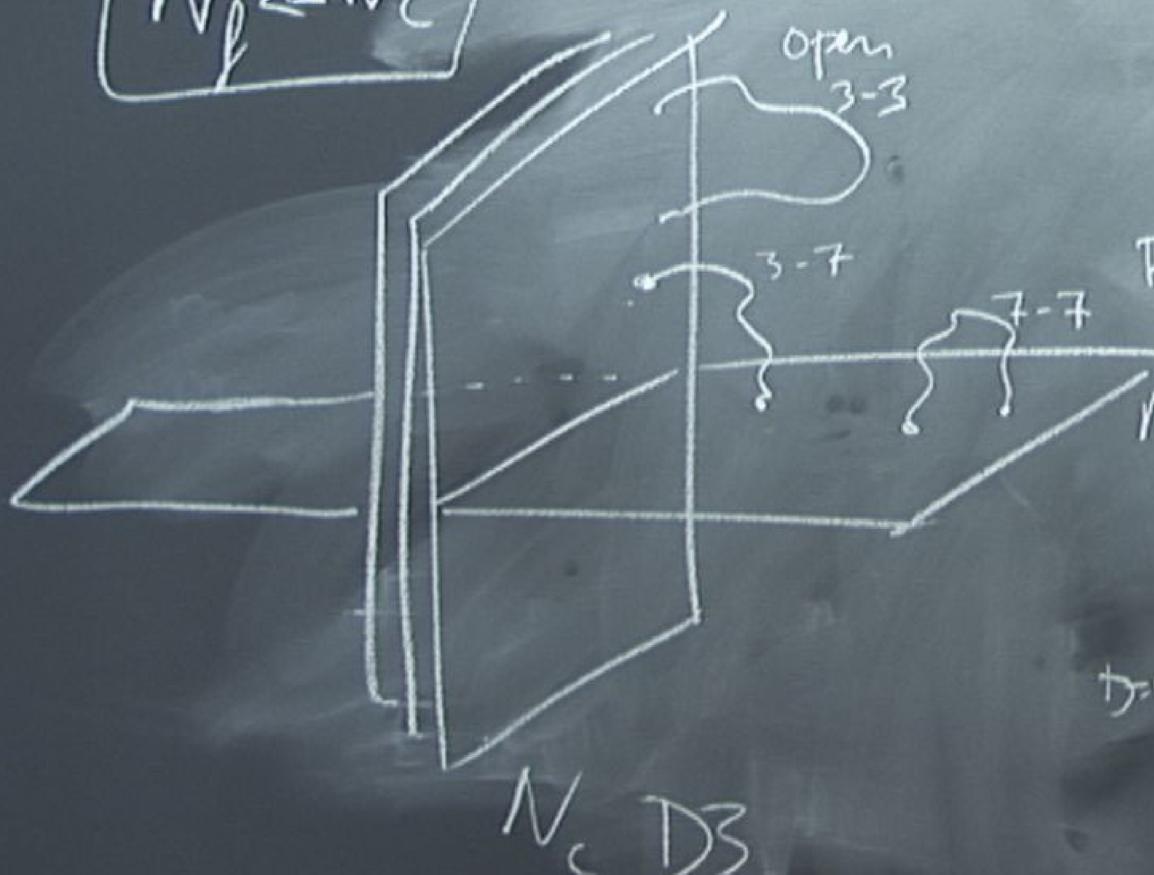

Nf << Nc
open
3-3
closed
Free closed M10
Nf D7
+
D=4 N=4 SU(Nc) SYM
g²YM ~ gs
Nc D3
gsNc << 1
E <<



$N_f \ll N_c$
open
3-3
closed
Free closed M_{10}
7-7
N_f D7
+
D=4 N=4 SU(N_c) SYM
$g^2_{YM} \sim g_s$
N_c D3
$g_s N_c \ll 1$
E ≪


Nf << Nc
open
3-3
closed
Free closed M10
7-7
Nf D7
+
Nc D3
gs Nc << 1
E <<

$\boxed{N_f \ll N_c}$



closed

$G E^8 \to 0$

Free closed M_{10}

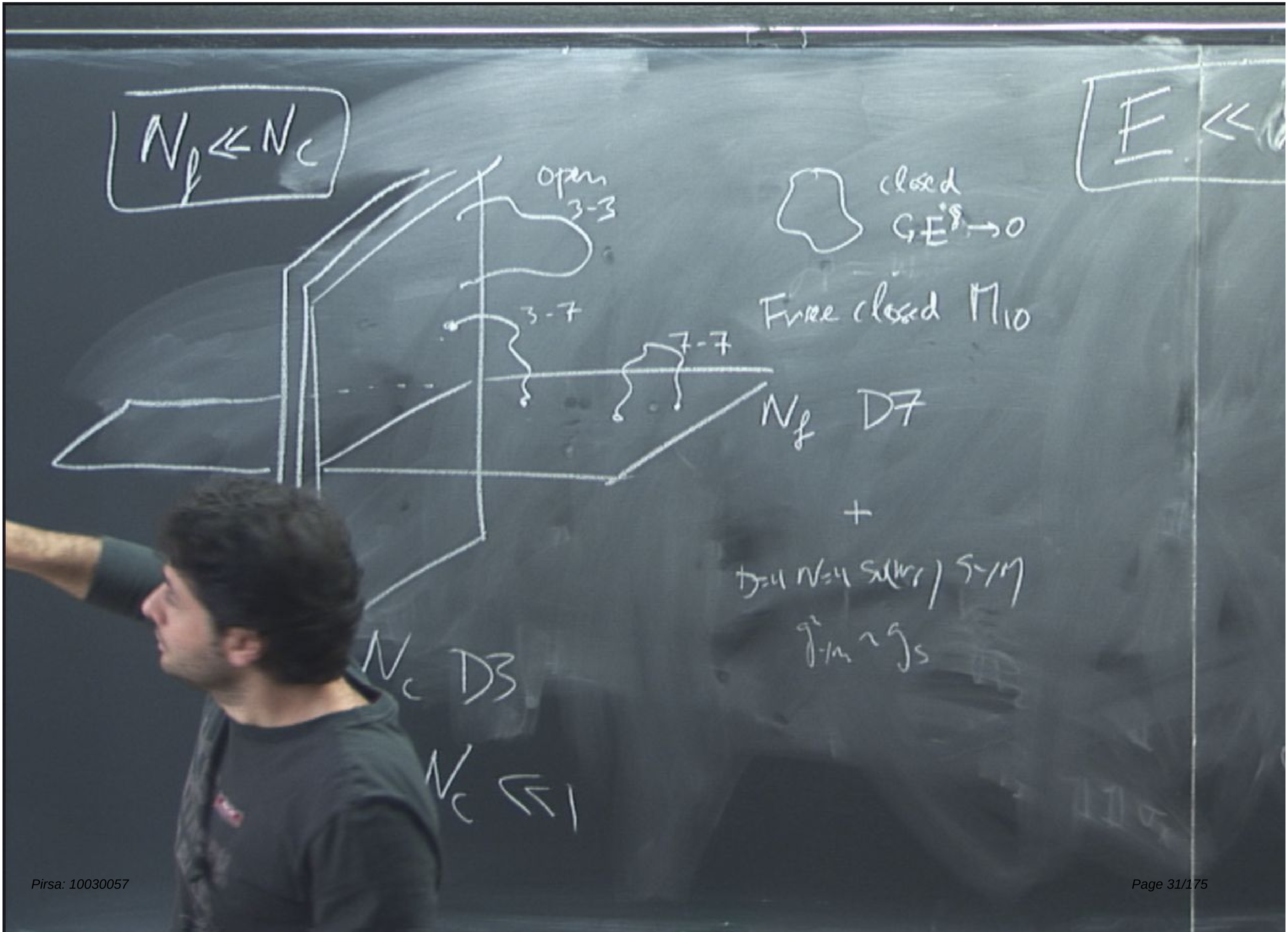
+

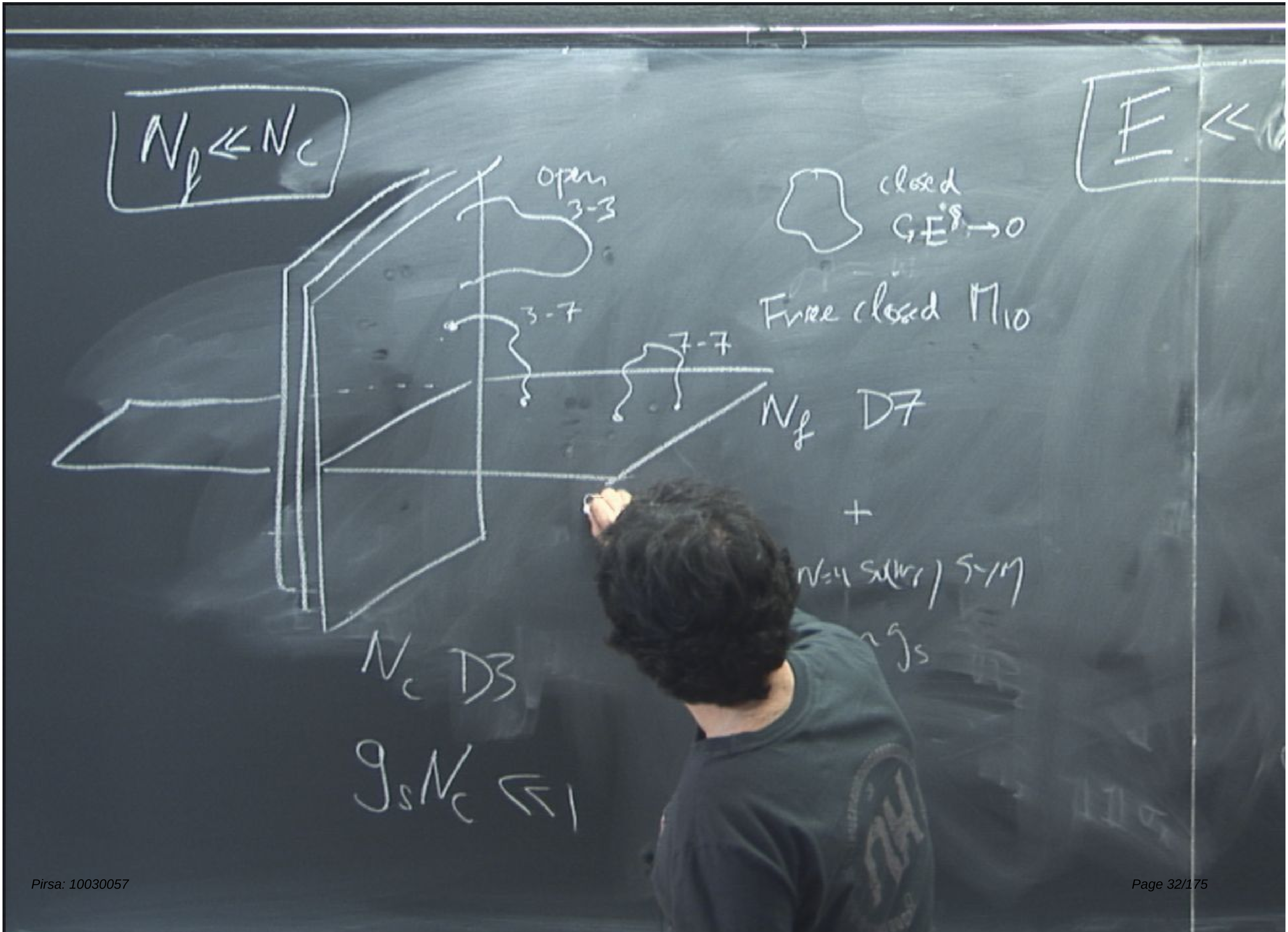
$D=4$ $\mathcal{N}=4$ $SU(N_c)$ SYM

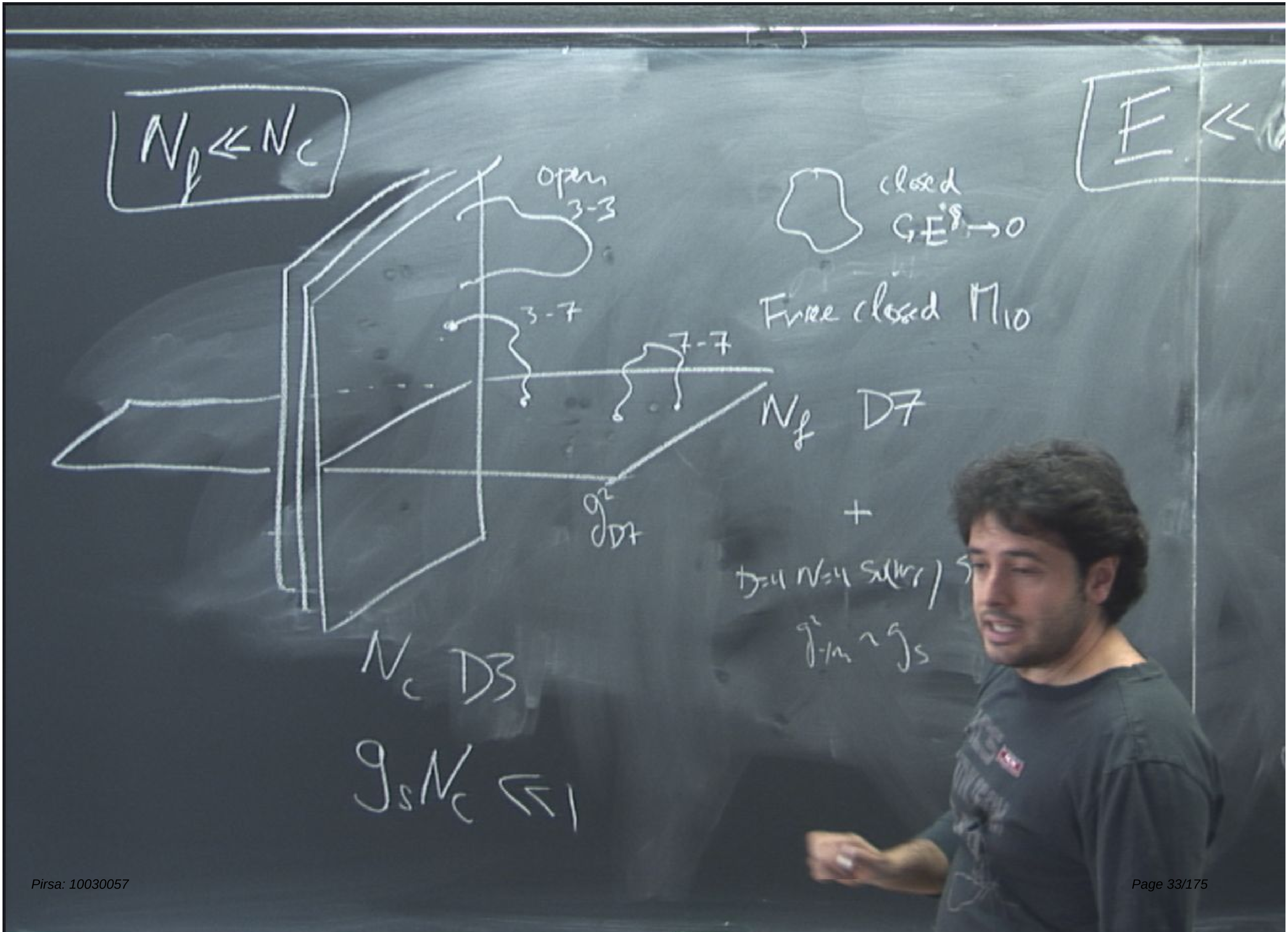
$g^2_{YM} \sim g_s$

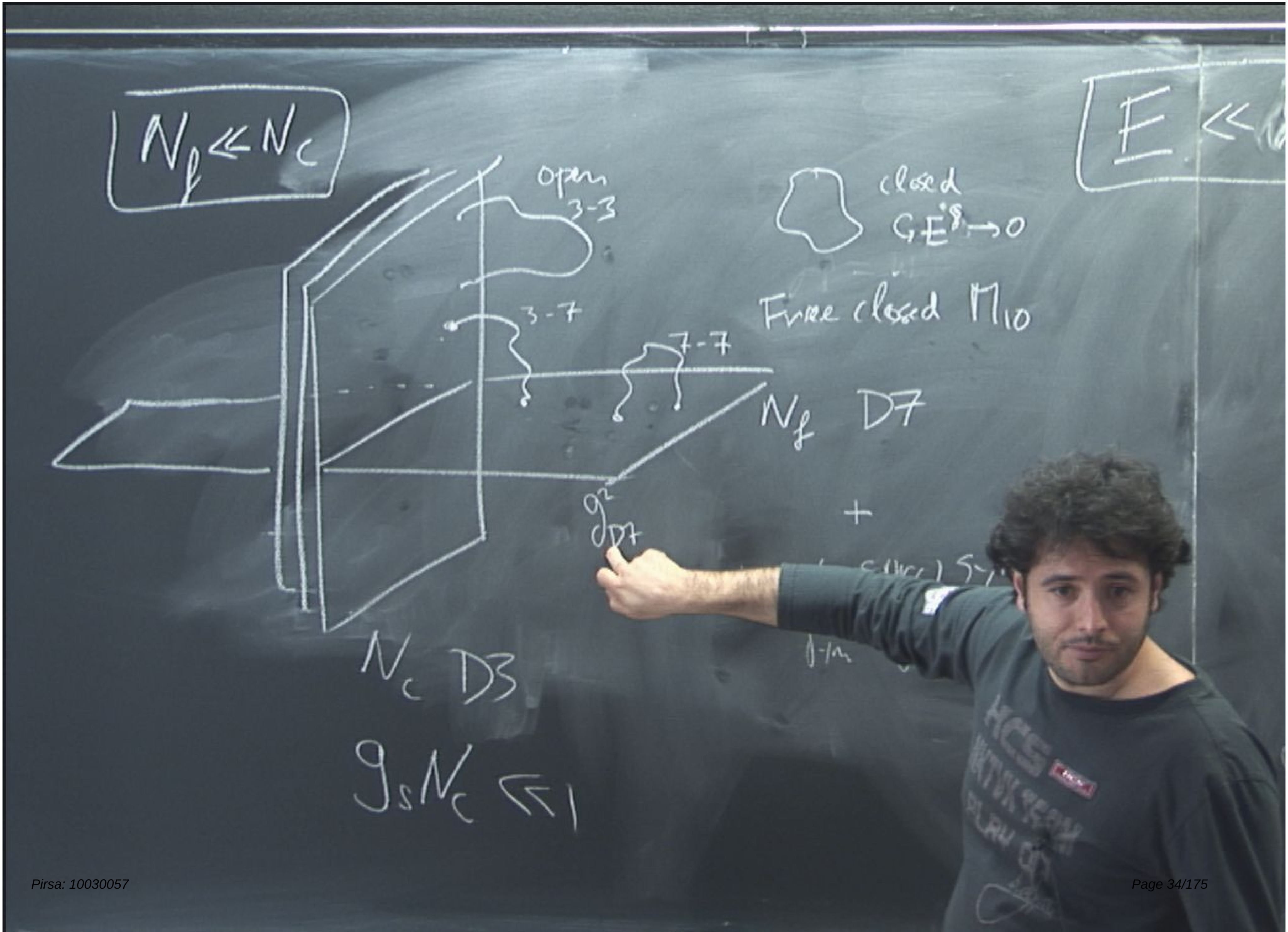
$g_s N_c \ll 1$

$\boxed{E \ll}$


Nf ≪ Nc
open
3-3
3-7
7-7
closed
Free closed
Nf D7
+
Nc D3
E ≪


Nf << Nc
E <<
open
3-3
closed
Free closed M10
3-7
7-7
Nf D7
+
Nc D3
gs Nc << 1

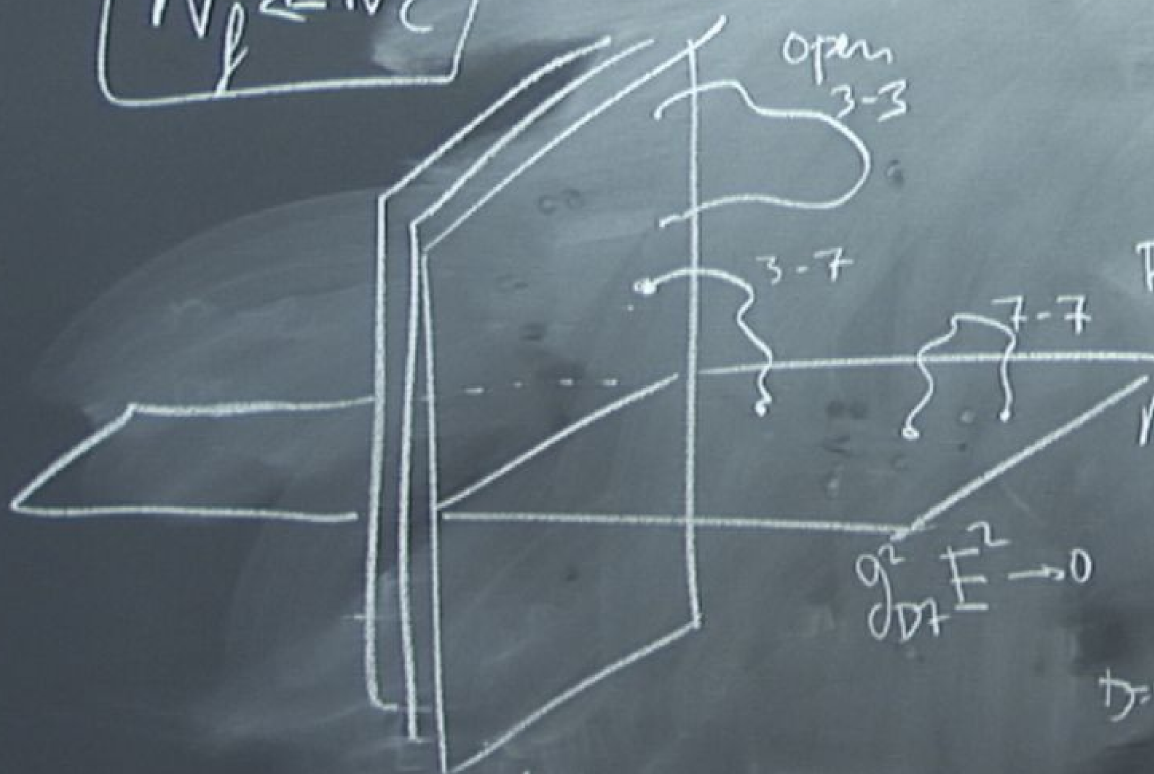

Nf << Nc
open
3-3
closed
3-7
7-7
Free closed M10
Nf D7
Nc D3
gs Nc << 1
E <<
+



$N_f \ll N_c$
open
3-3
closed
$G E^8 \to 0$
Free closed M_{10}
3-7
7-7
N_f D7
g^2_{D7}
+
N_c D3
$g_s N_c \ll 1$
$E \ll$

$\boxed{N_f \ll N_c}$

$E \ll$



closed

$G E^8 \to 0$

Free closed M_{10}

N_f D7

$g_{D7}^2 E^2 \to 0$

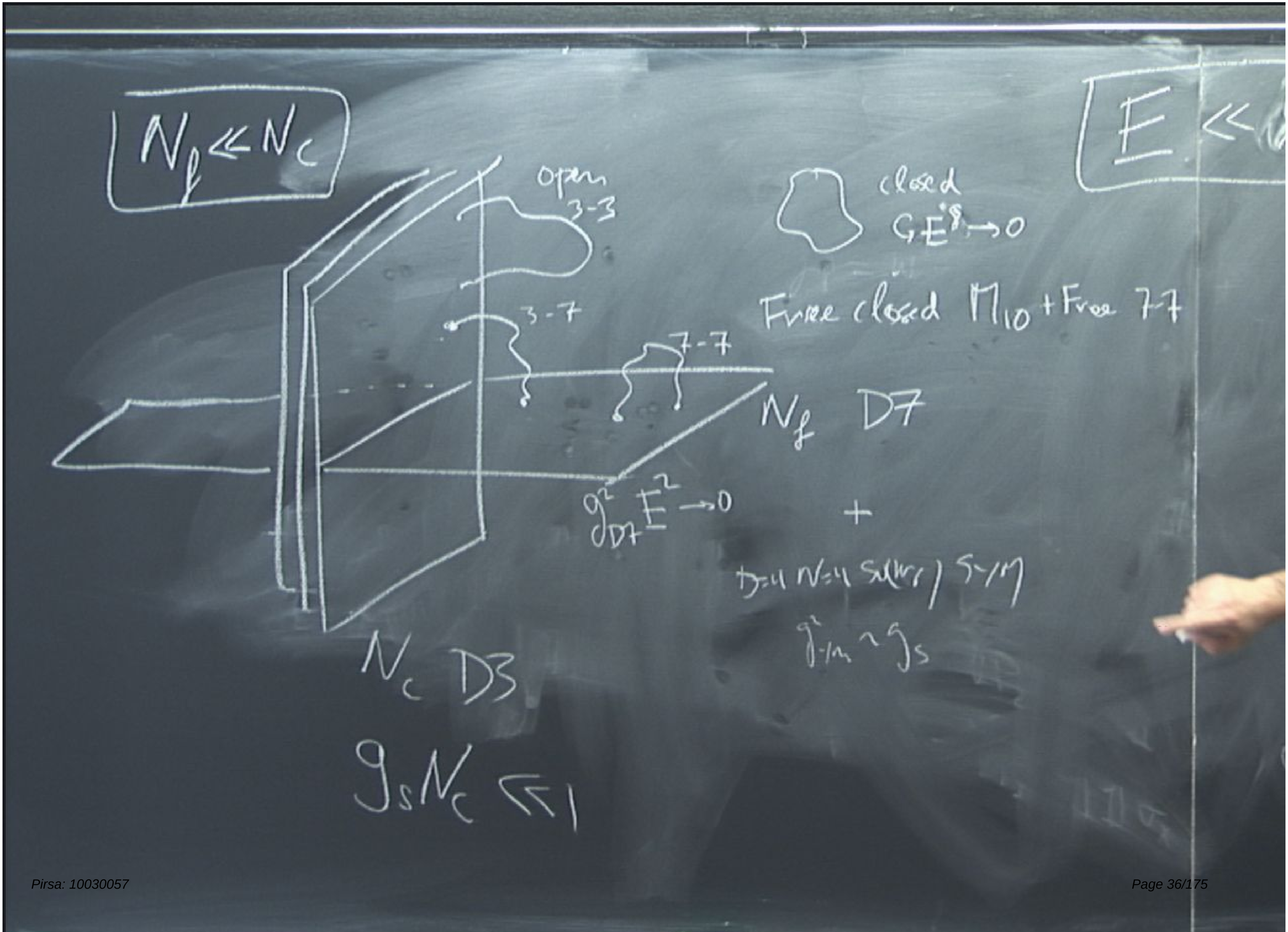
+

D=4 N=4 SU(N_c) SYM

$g_{YM}^2 \sim g_s$

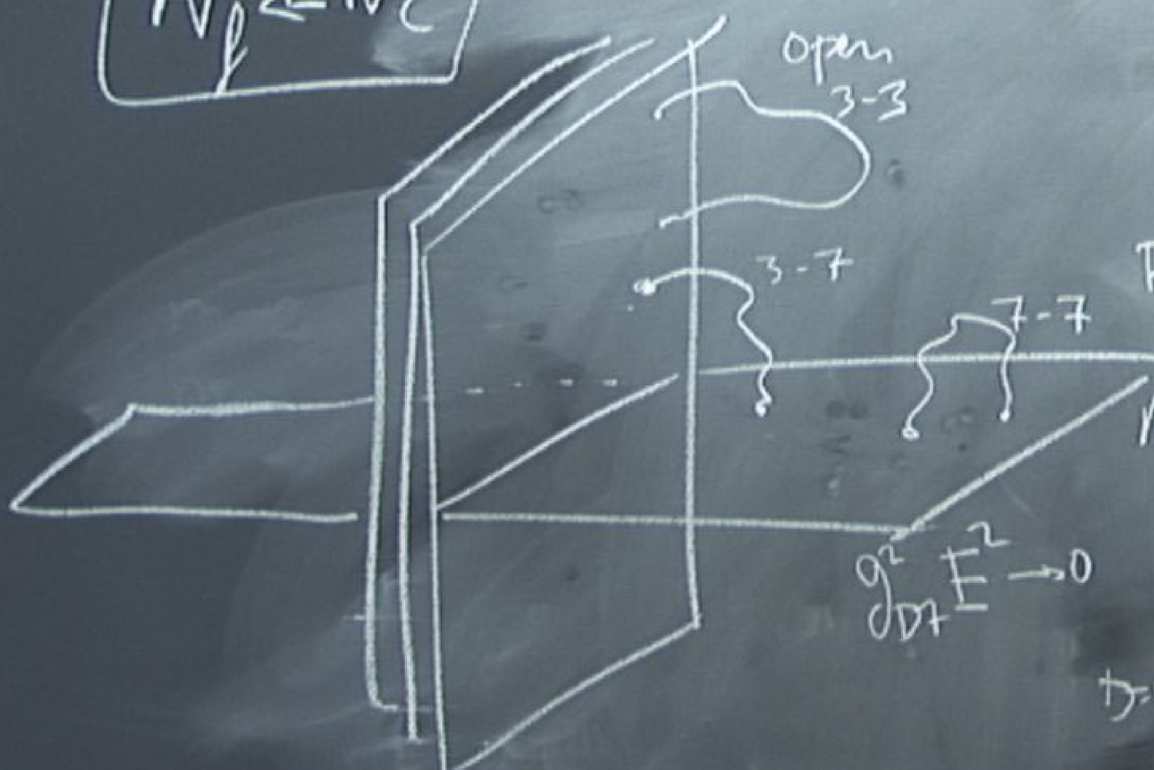
N_c D3

$g_s N_c \ll 1$


N_f ≪ N_c
open
3-3
3-7
7-7
closed
GE^8 → 0
Free closed M_10 + Free 7-7
N_f D7
g^2_D7 E^2 → 0
+
D=4 N=4 SU(N_c) S-YM
g^2_YM ~ g_s
N_c D3
g_s N_c ≪ 1
E ≪

$\boxed{N_f \ll N_c}$

$\boxed{E \ll}$



closed

$G E^8 \to 0$

Free closed M_{10} + Free 7-7 M_8

$g^2_{D7} E^2 \to 0$

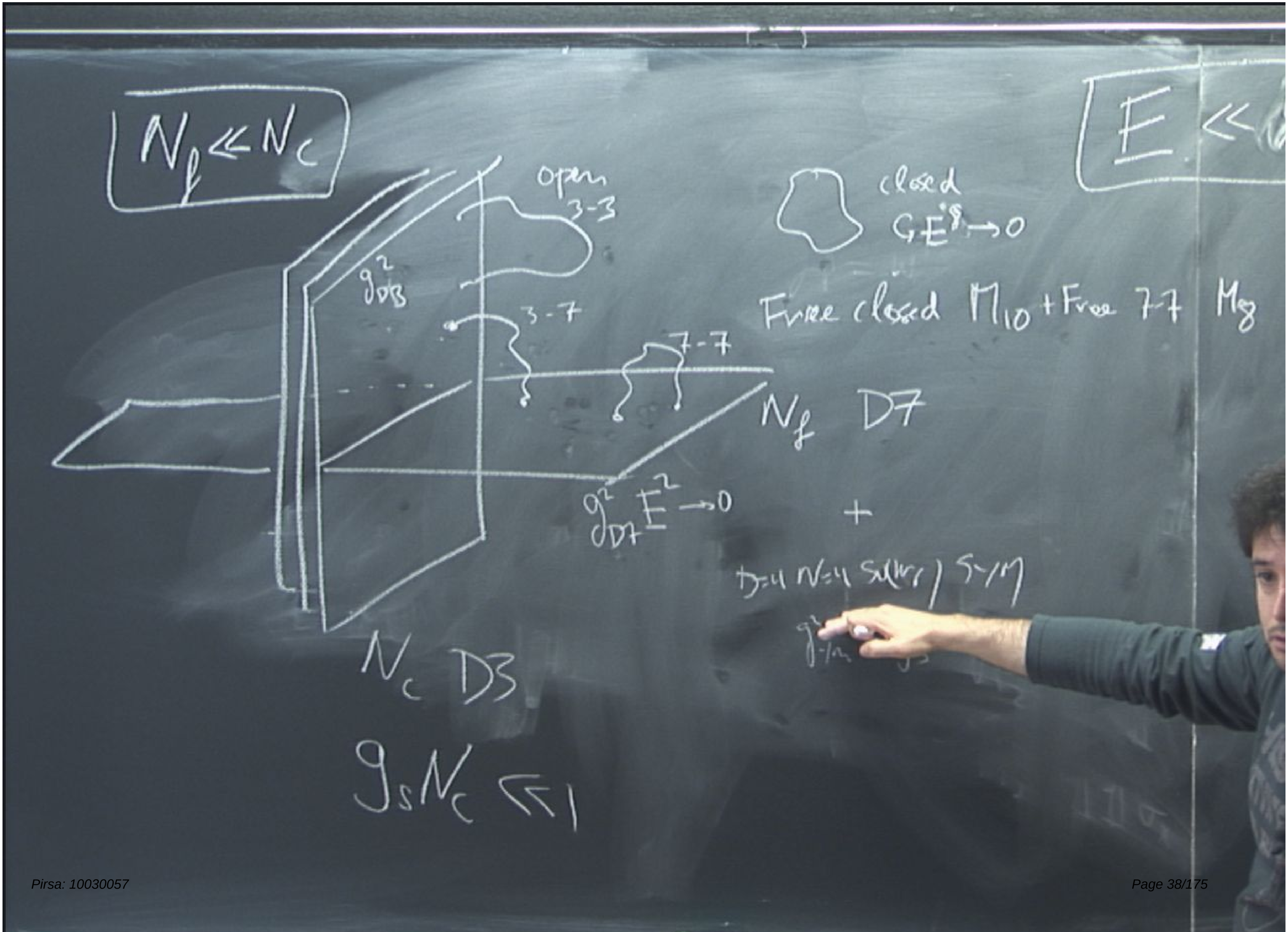
+

$D=4$ $\mathcal{N}=4$ $SU(N_c)$ SYM

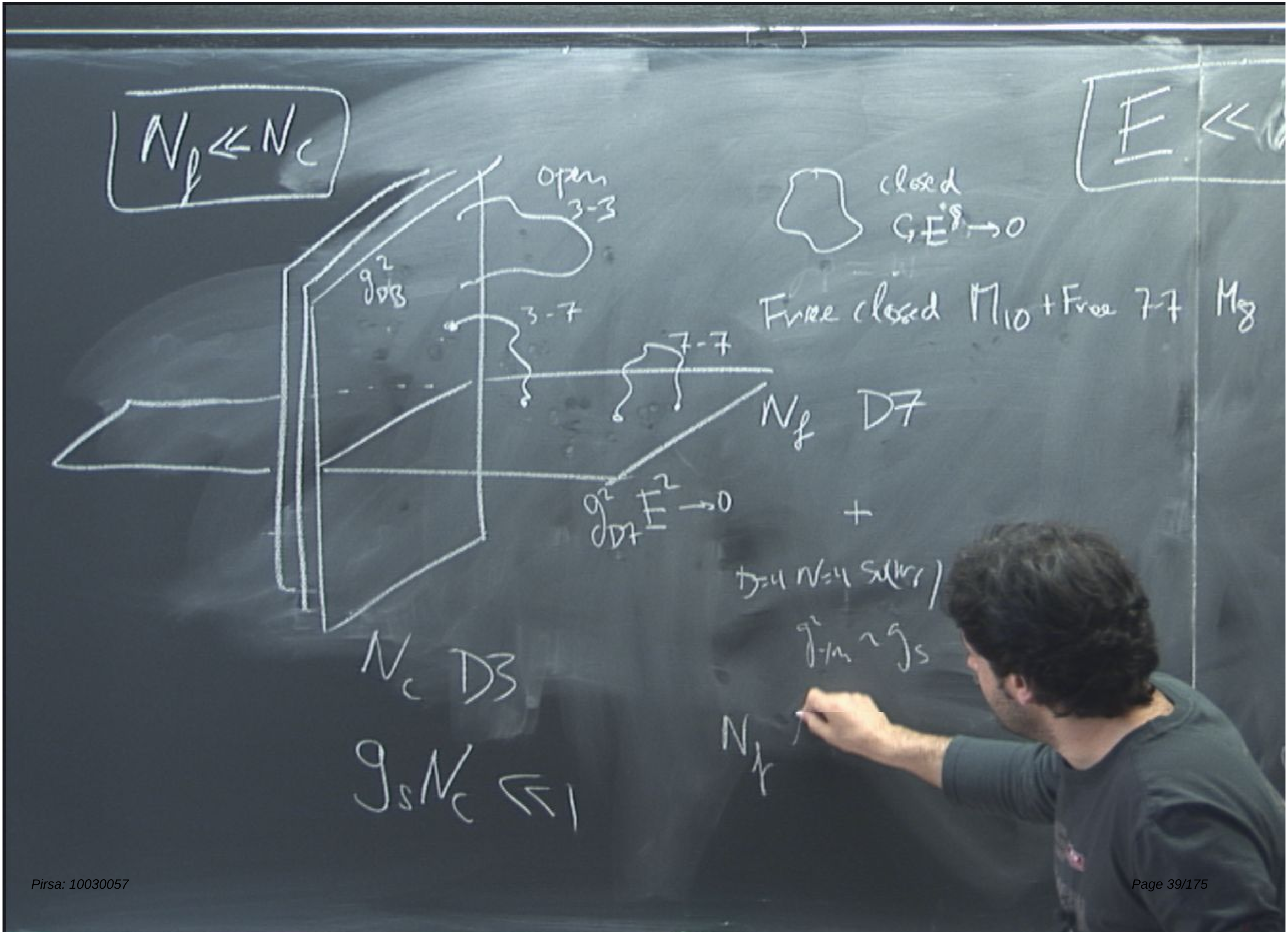
$g^2_{YM} \sim g_s$

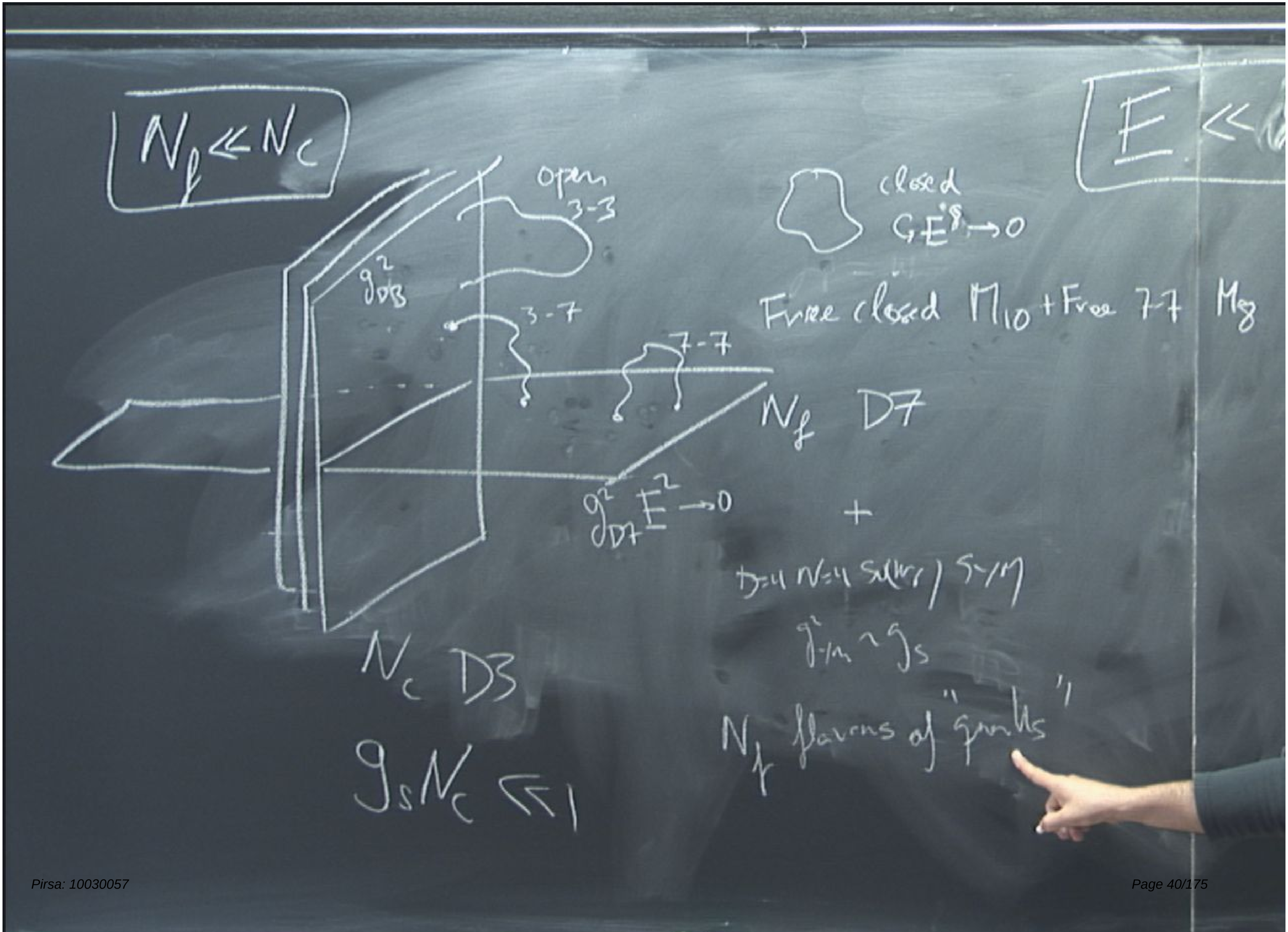
N_c D3

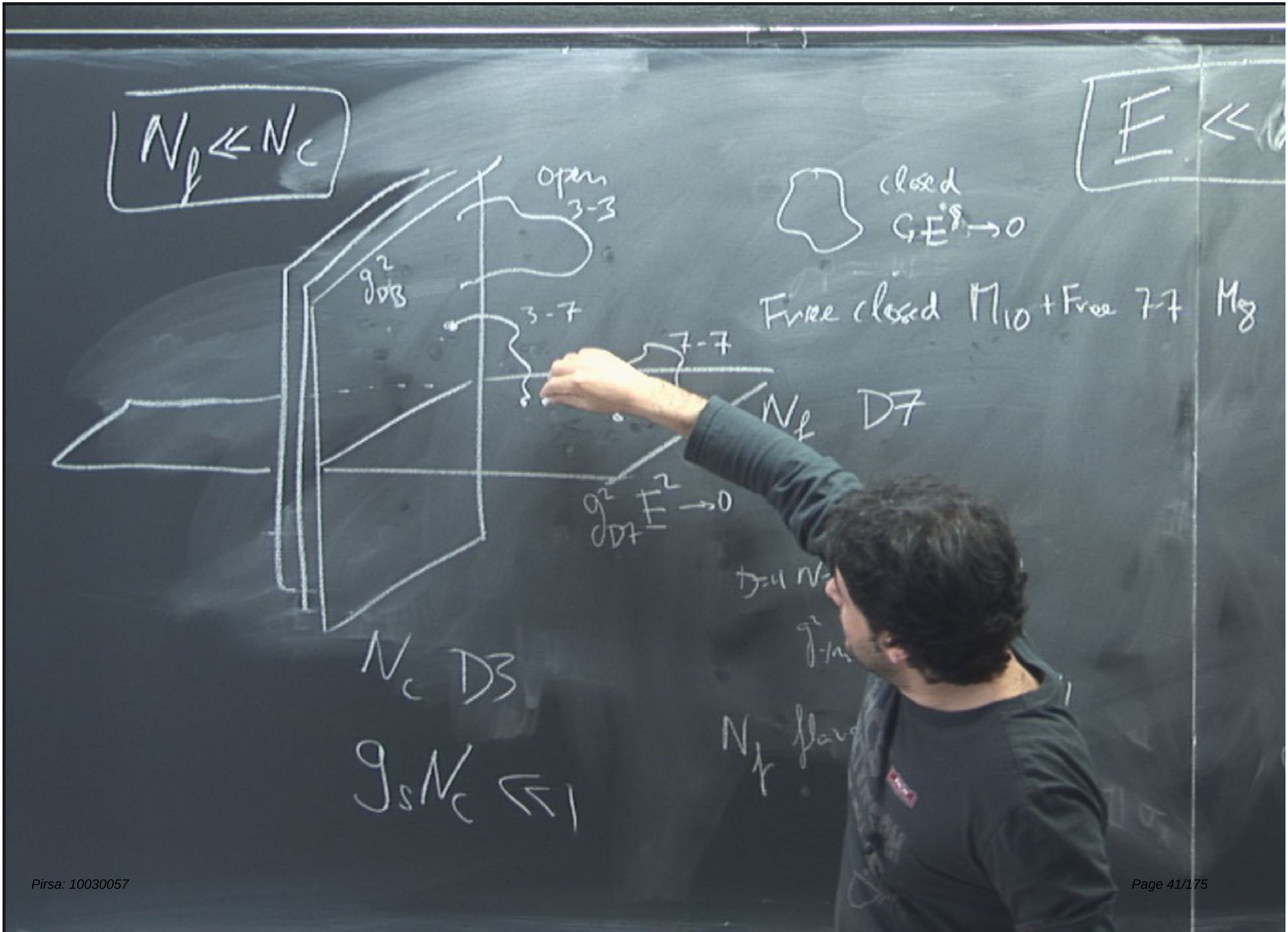
$g_s N_c \ll 1$



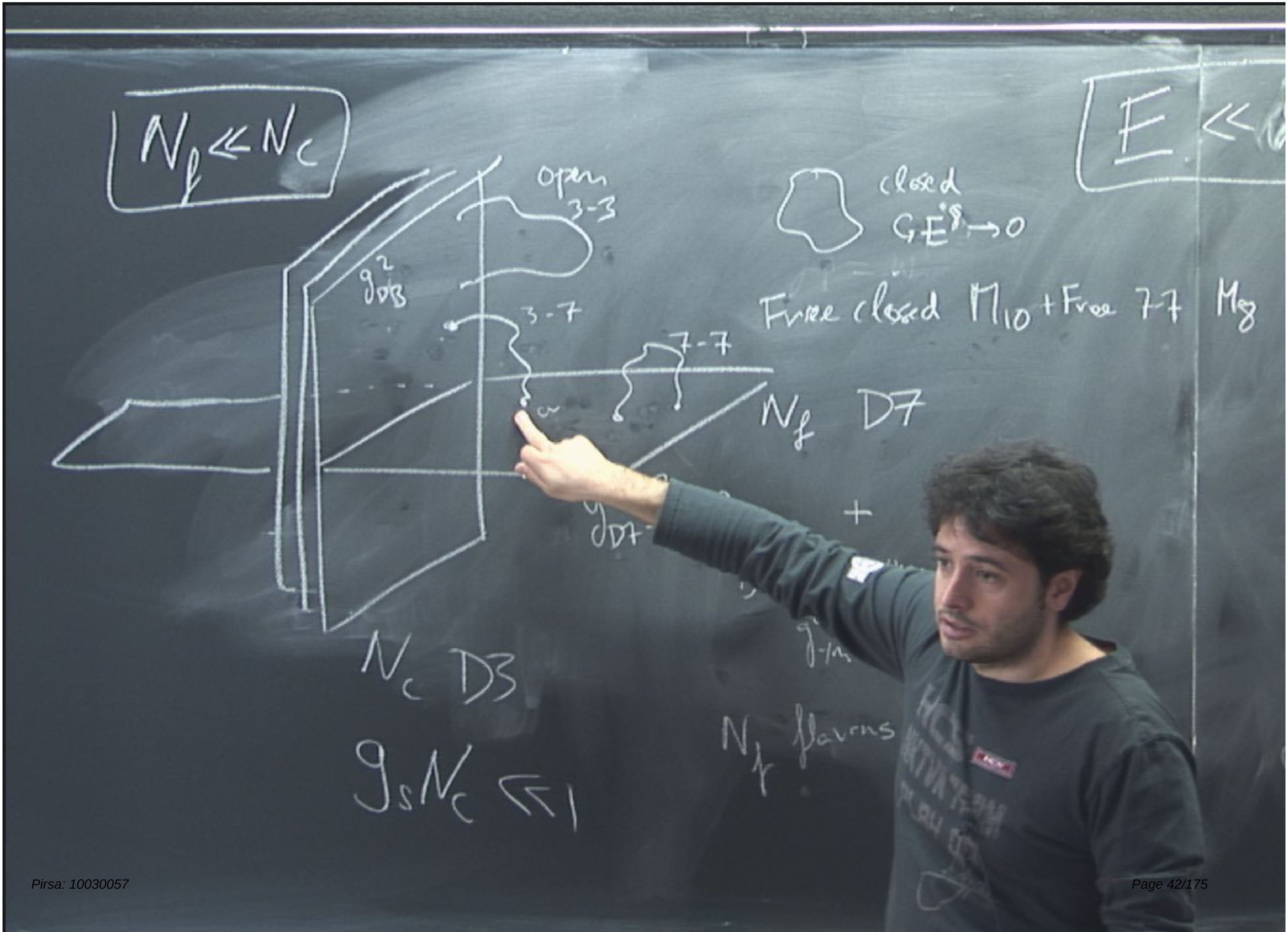
Nf ≪ Nc
E ≪
open
3-3
closed
GE^8 → 0
g²D3
3-7
Free closed M10 + Free 7-7 M8
7-7
Nf D7
g²D7 E² → 0
+
D=4 N=4 SU(Nc) SYM
Nc D3
gs Nc ≪ 1


$N_f \ll N_c$
open
3-3
g^2_{D3}
3-7
7-7
closed
$G E^8 \to 0$
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
+
$D=4$ $N=4$ $SU(N_c)$
$g^2_{YM} \sim g_s$
N_c D3
$g_s N_c \ll 1$
N_f
$E \ll$

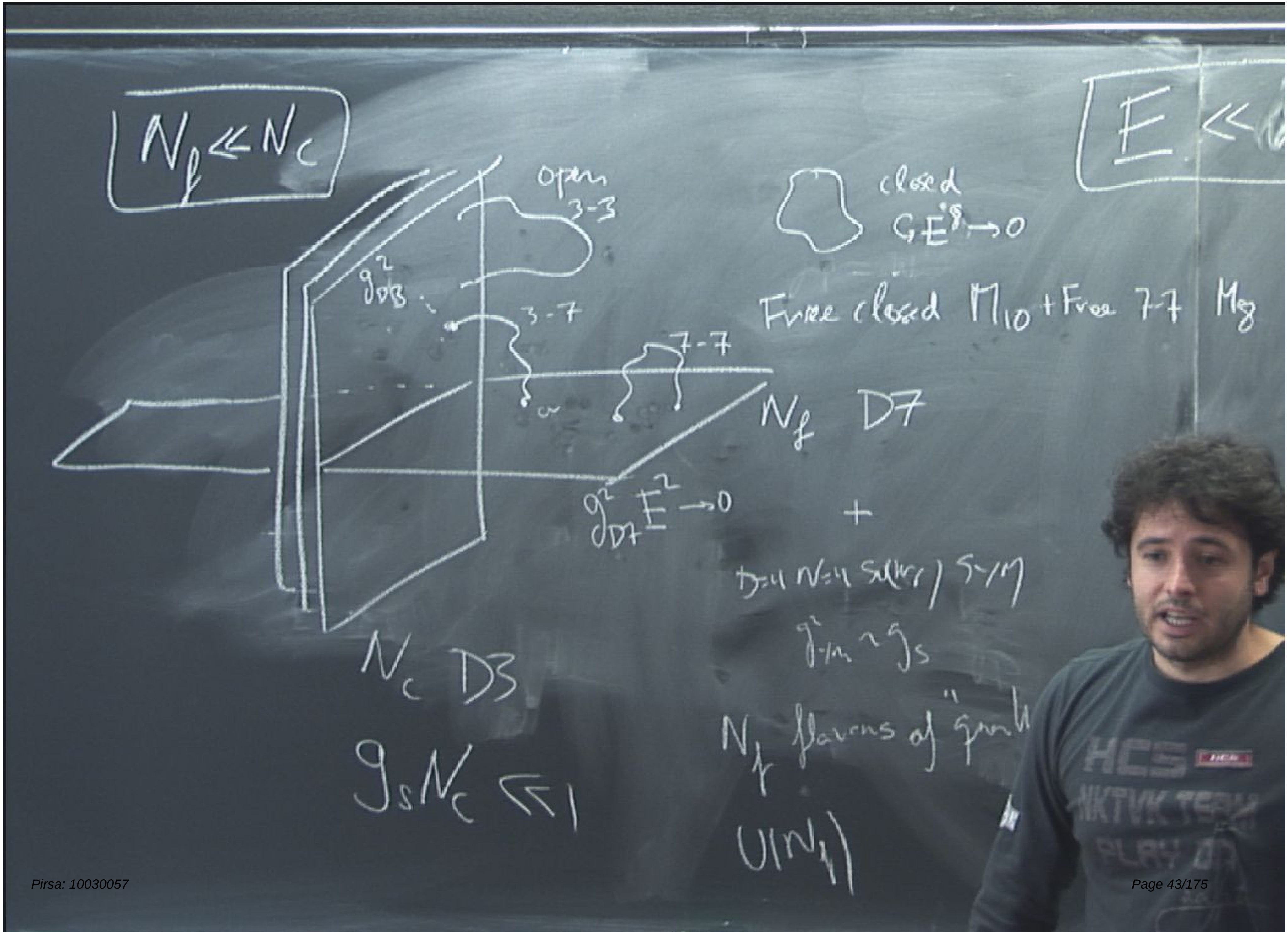

$N_f \ll N_c$
open
3-3
closed
$G E^8 \to 0$
g^2_{D3}
3-7
7-7
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
+
D=4 N=4 SU(N_c) SYM
$g^2_{YM} \sim g_s$
N_f flavors of "quarks"
N_c D3
$g_s N_c \ll 1$
$E \ll$

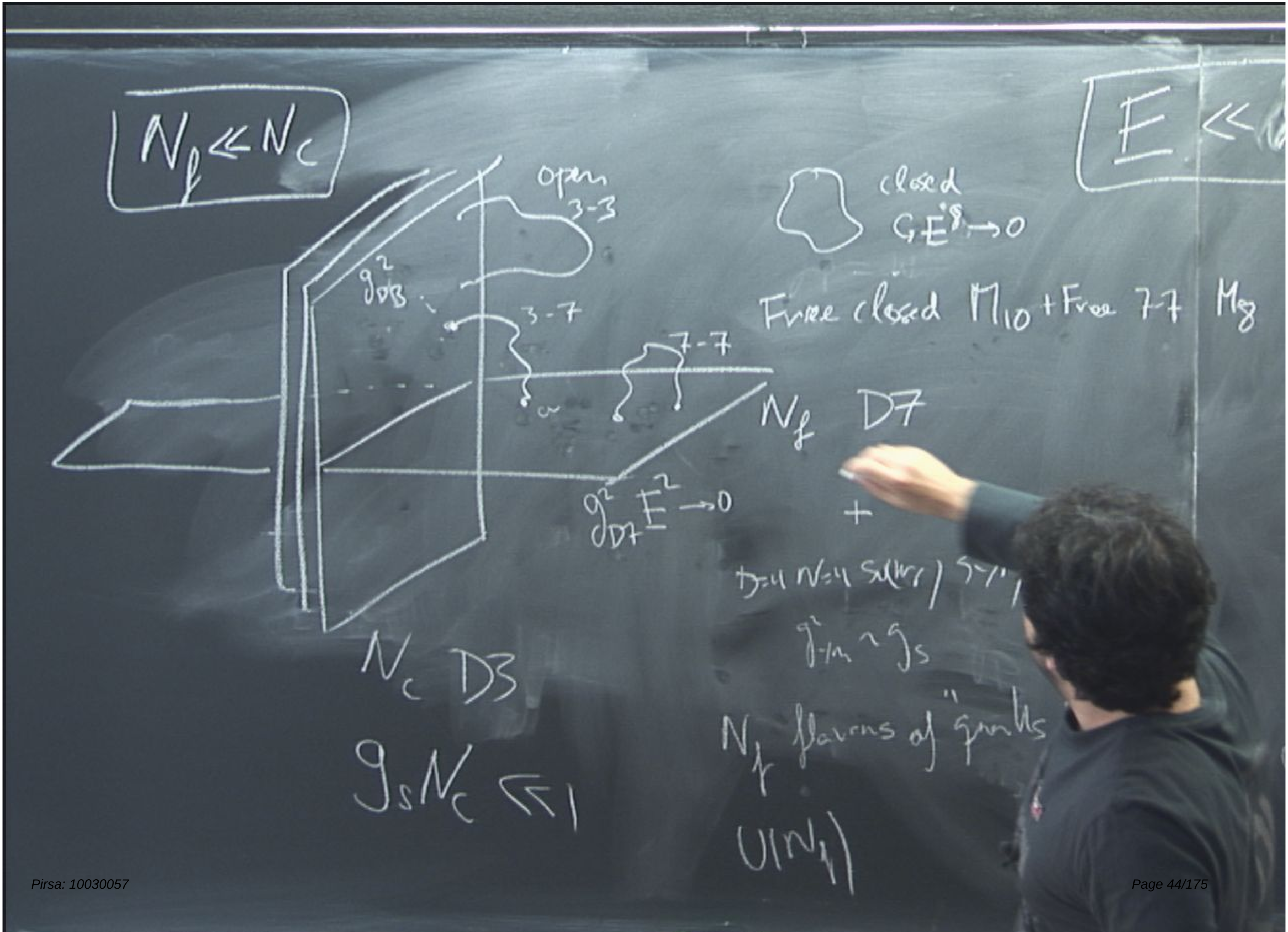


$N_f \ll N_c$
open
3-3
g^2_{D3}
3-7
7-7
closed
$G E^8 \to 0$
$E \ll$
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
N_c D3
$g_s N_c \ll 1$

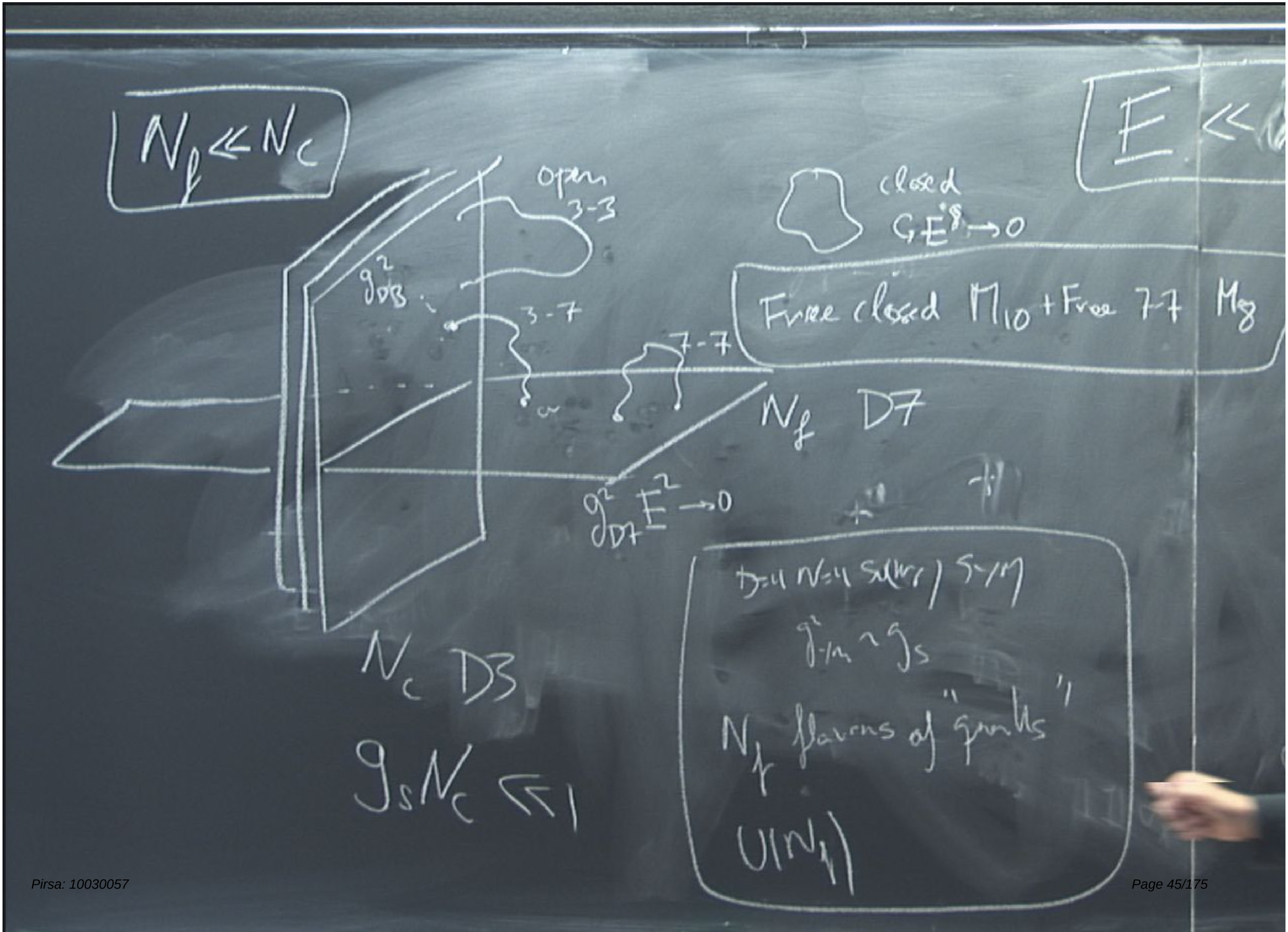


N_f << N_c
open
3-3
closed
GE^8 → 0
g_D3^2
3-7
7-7
Free closed M_10 + Free 7-7 M_8
N_f D7
E <<
+
g_D7
N_c D3
g_s N_c << 1
N_f flavors

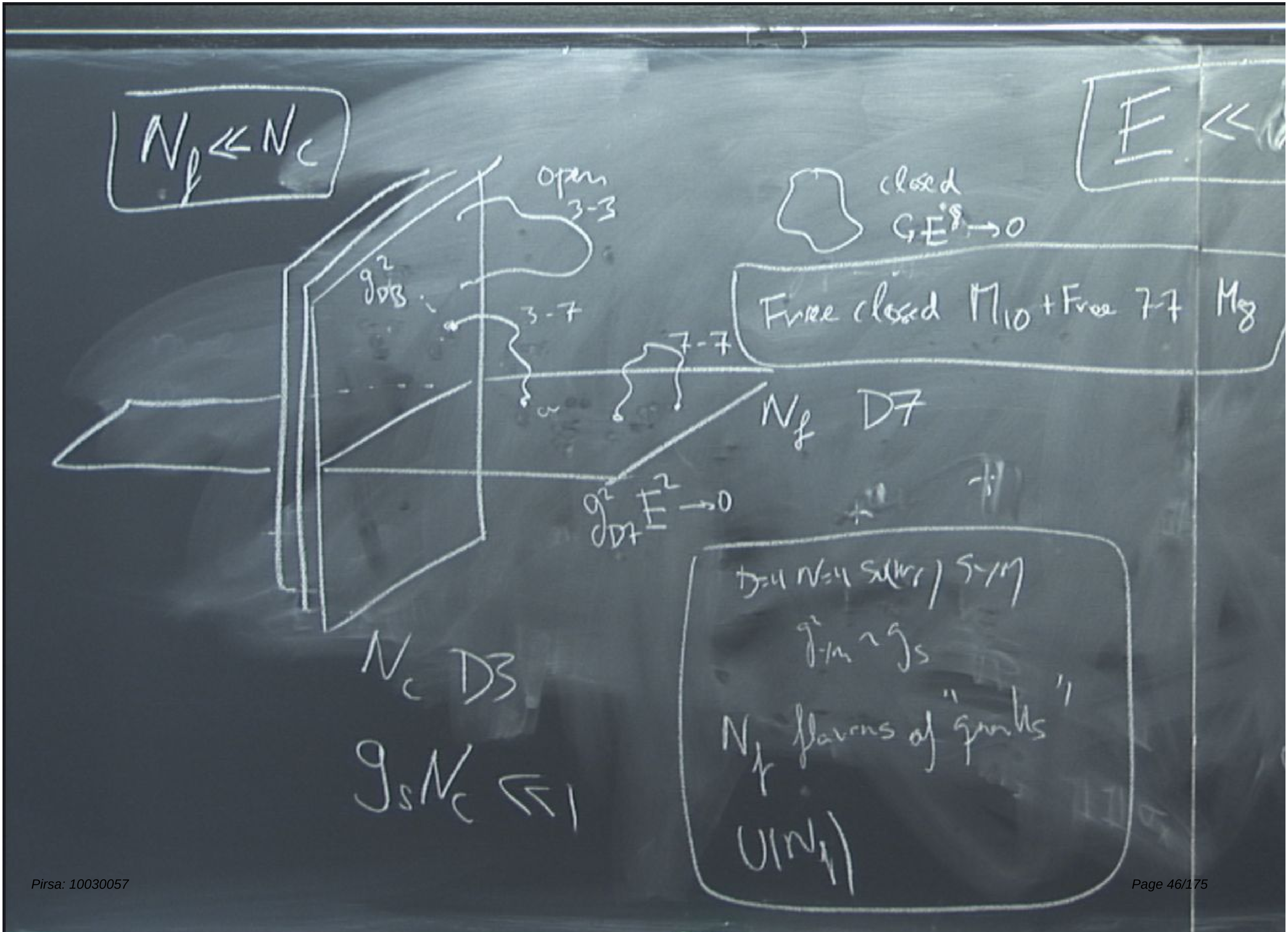

$N_f \ll N_c$
open
3-3
closed
$G E^8 \to 0$
g^2_{D3}
3-7
7-7
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
+
D=4 N=4 SU(N_c) SYM
$g^2_{YM} \sim g_s$
N_c D3
N_f flavors of "quark"
$g_s N_c \ll 1$
$U(N_f)$
$E \ll$



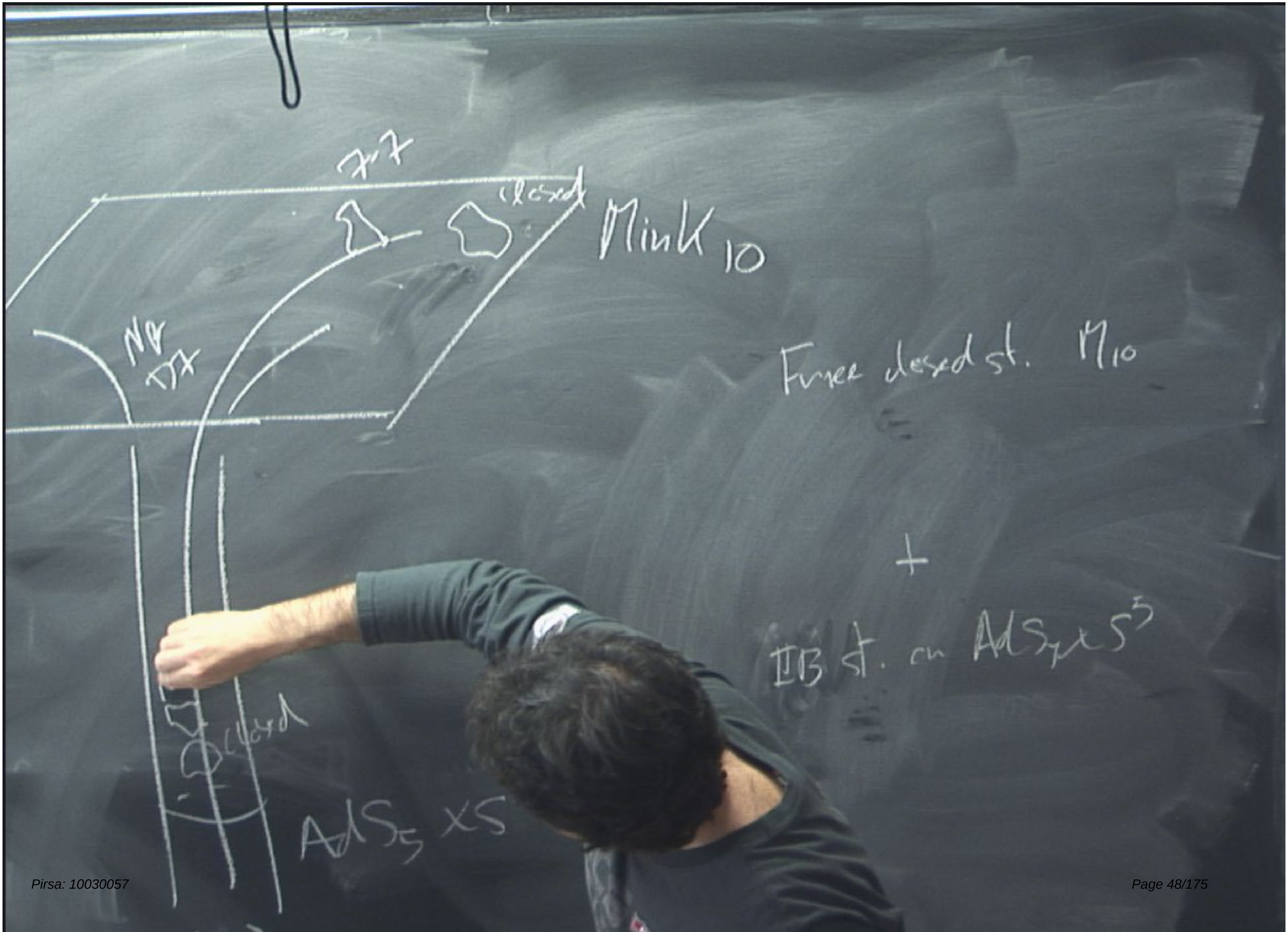
$N_f \ll N_c$
open
3-3
g_{D3}^2
3-7
7-7
closed
$G E^8 \to 0$
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g_{D7}^2 E^2 \to 0$
+
$g_{YM}^2 \sim g_s$
N_f flavors of "quarks"
$U(N_f)$
N_c D3
$g_s N_c \lll 1$
$E \ll$



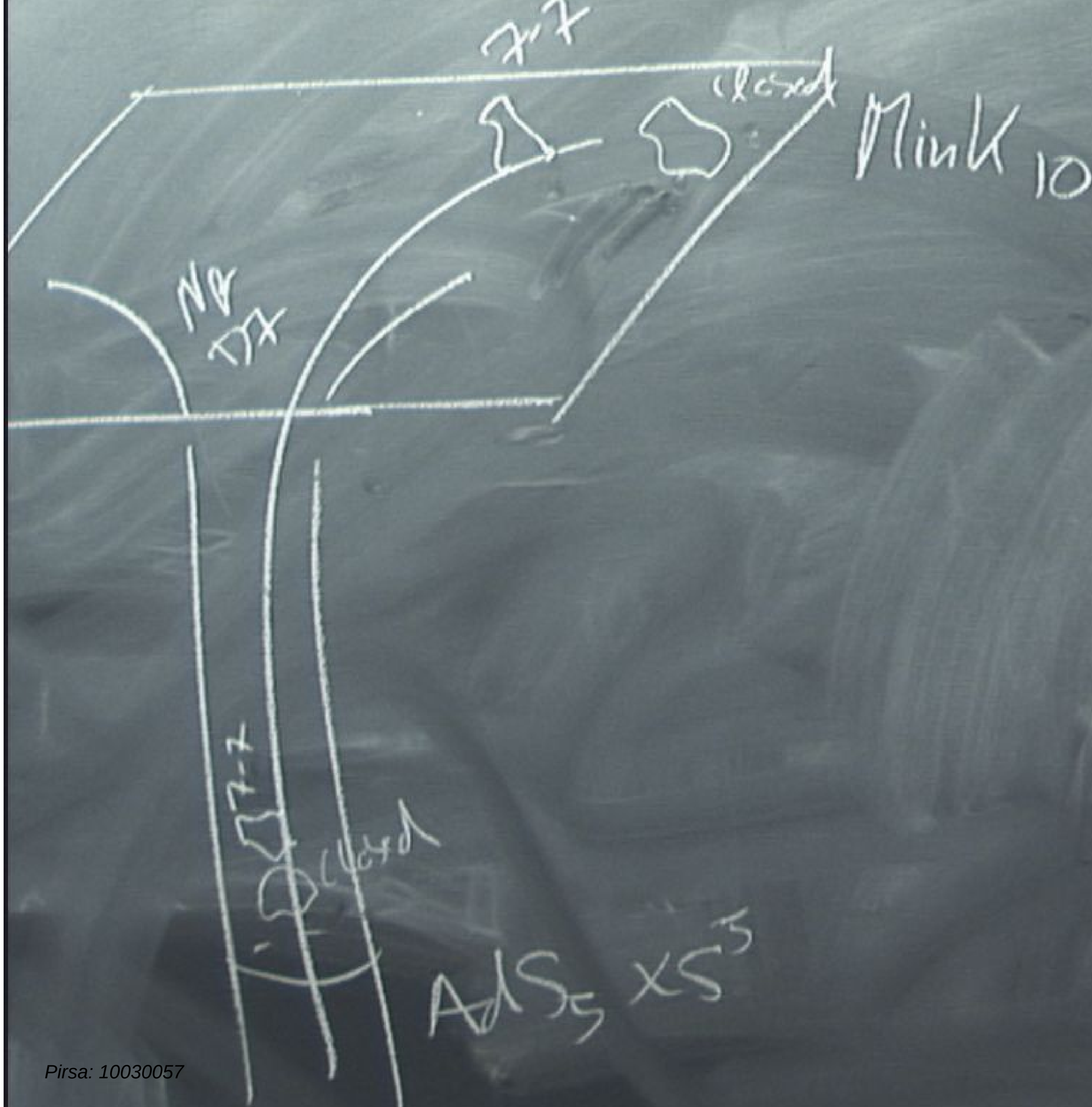
$N_f \ll N_c$
open
3-3
g^2_{D3}
3-7
7-7
closed
$G E^8 \to 0$
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
N_c D3
$g_s N_c \lll 1$
$g^2_{YM} \sim g_s$
N_f flavors of "quarks"
$U(N_f)$


$N_f \ll N_c$
open
3-3
g^2_{D3}
3-7
7-7
closed
$G E^8 \to 0$
$E \ll$
Free closed M_{10} + Free 7-7 M_8
N_f D7
$g^2_{D7} E^2 \to 0$
D=4 N=4 SU(N_c) S-YM
$g^2_{YM} \sim g_s$
N_f flavors of "quarks"
U(N_f)
N_c D3
$g_s N_c \ll 1$


closed
Mink 10
closed
AdS5 x S5


closed
Mink 10
Free closed st. M10
+
IIB st. on AdS5 x S5
closed
AdS5 x S

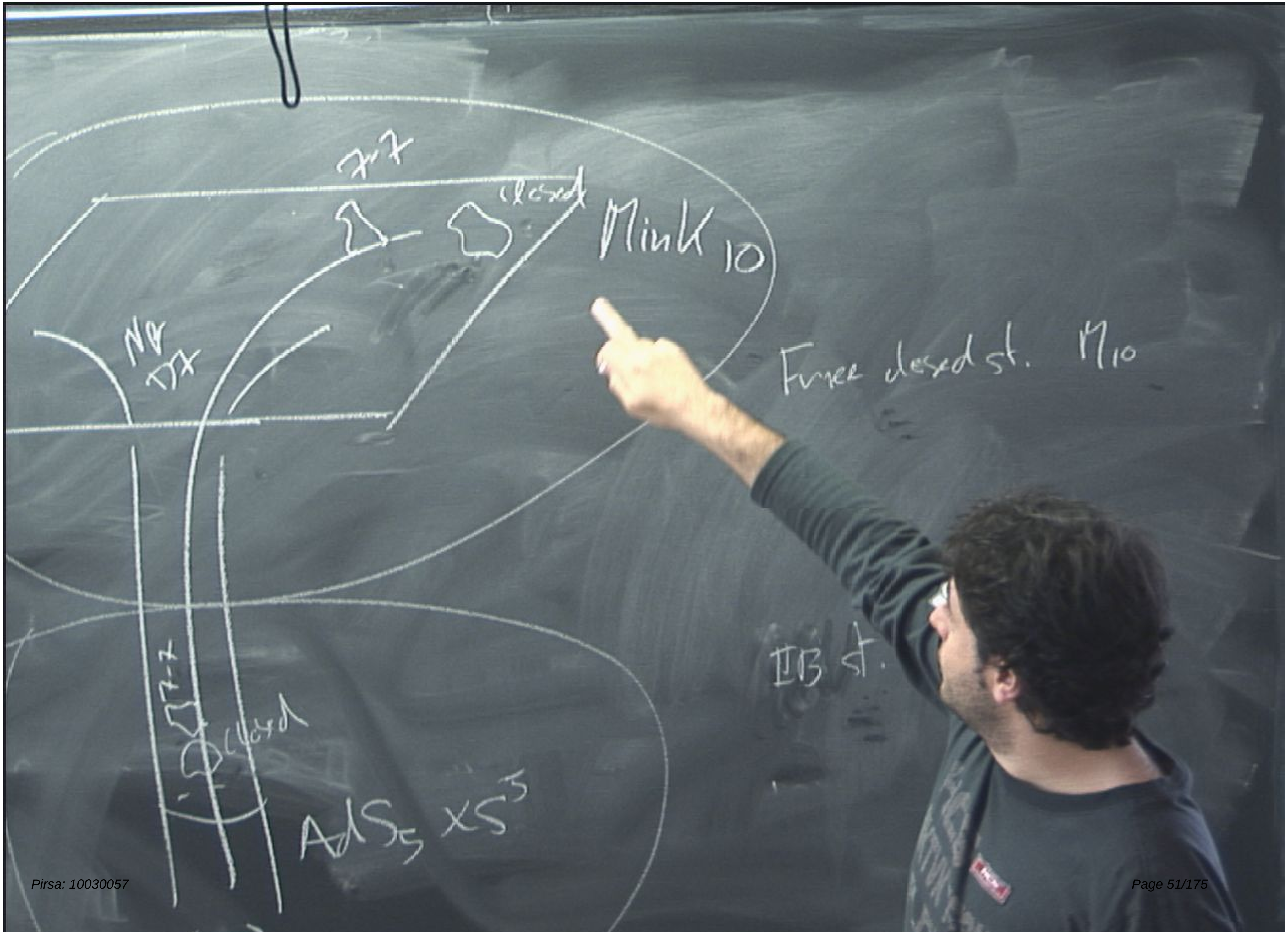

closed
Mink 10
AdS5 x S5

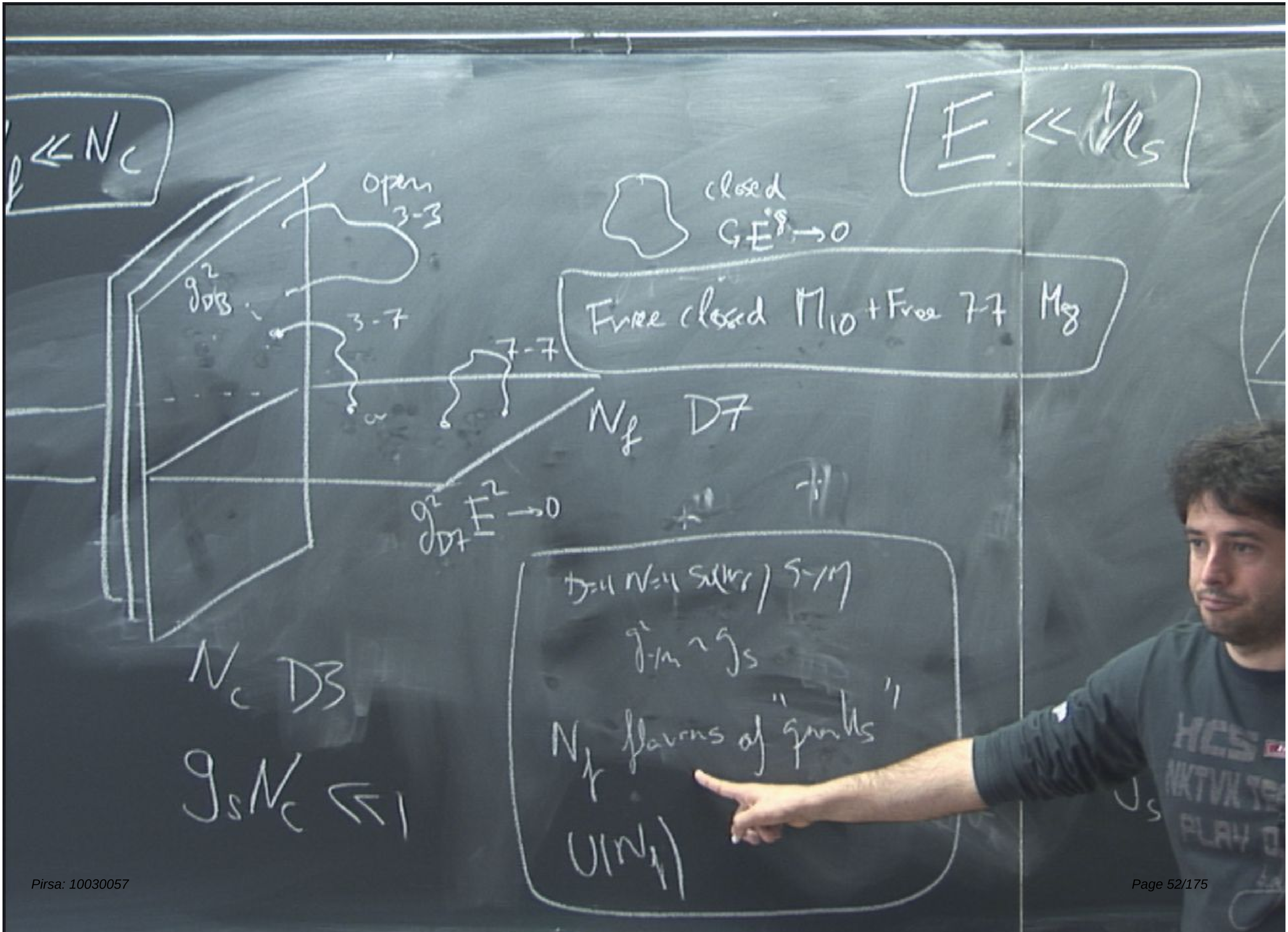


Free closed st. M_{10}

+

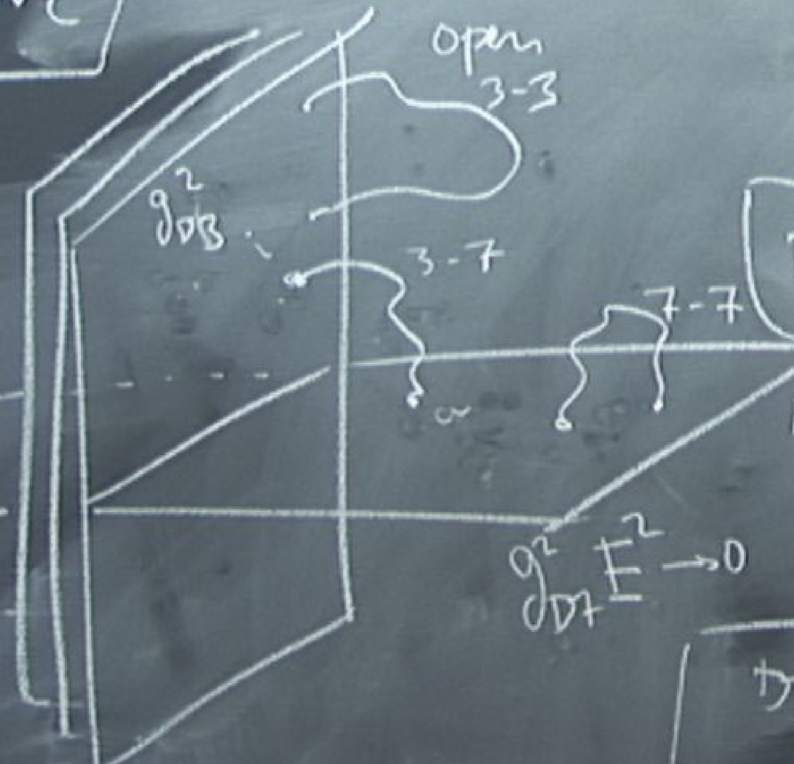
IIB st. on $AdS_5 \times S^5$


closed
$Mink_{10}$
IIB st.
closed
$AdS_5 \times S^5$


≪ Nc
open
3-3
closed
GE^8 → 0
E ≪ 1/ls
g²D3
3-7
7-7
Free closed M10 + Free 7-7 M8
Nf D7
g²D7 E² → 0
Nc D3
gs Nc ≪ 1
g²YM ~ gs
Nf flavors of "quarks"
U(Nf)

$\boxed{N_f \ll N_c}$

$\boxed{E \ll 1/l_s}$



$\boxed{\text{Free closed } M_{10} + \text{Free 7-7 } M_8}$

$g_s N_c \ll 1$

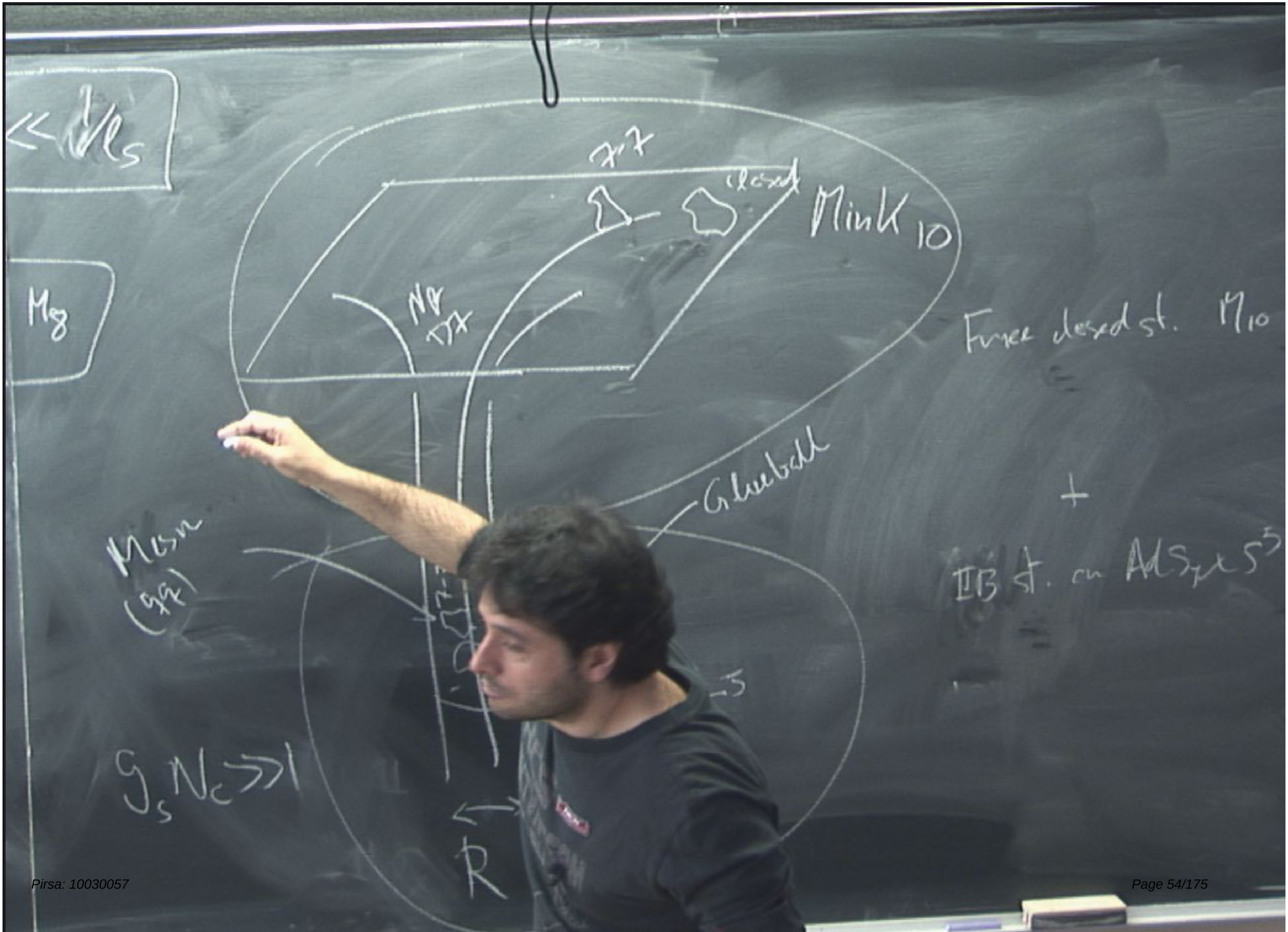
D=4 N=4 SU(N_c) SYM

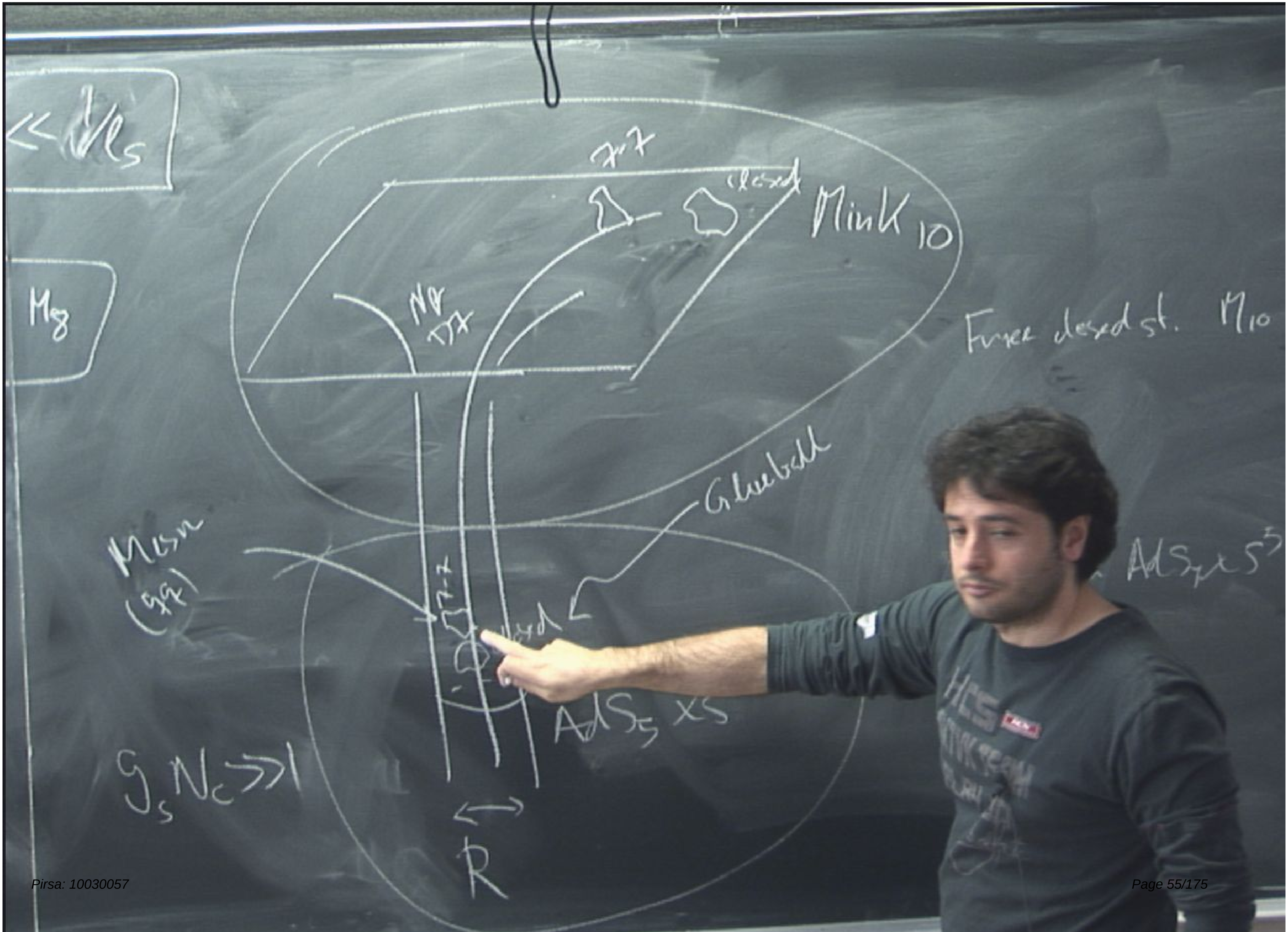
$g^2_{YM} \sim g_s$

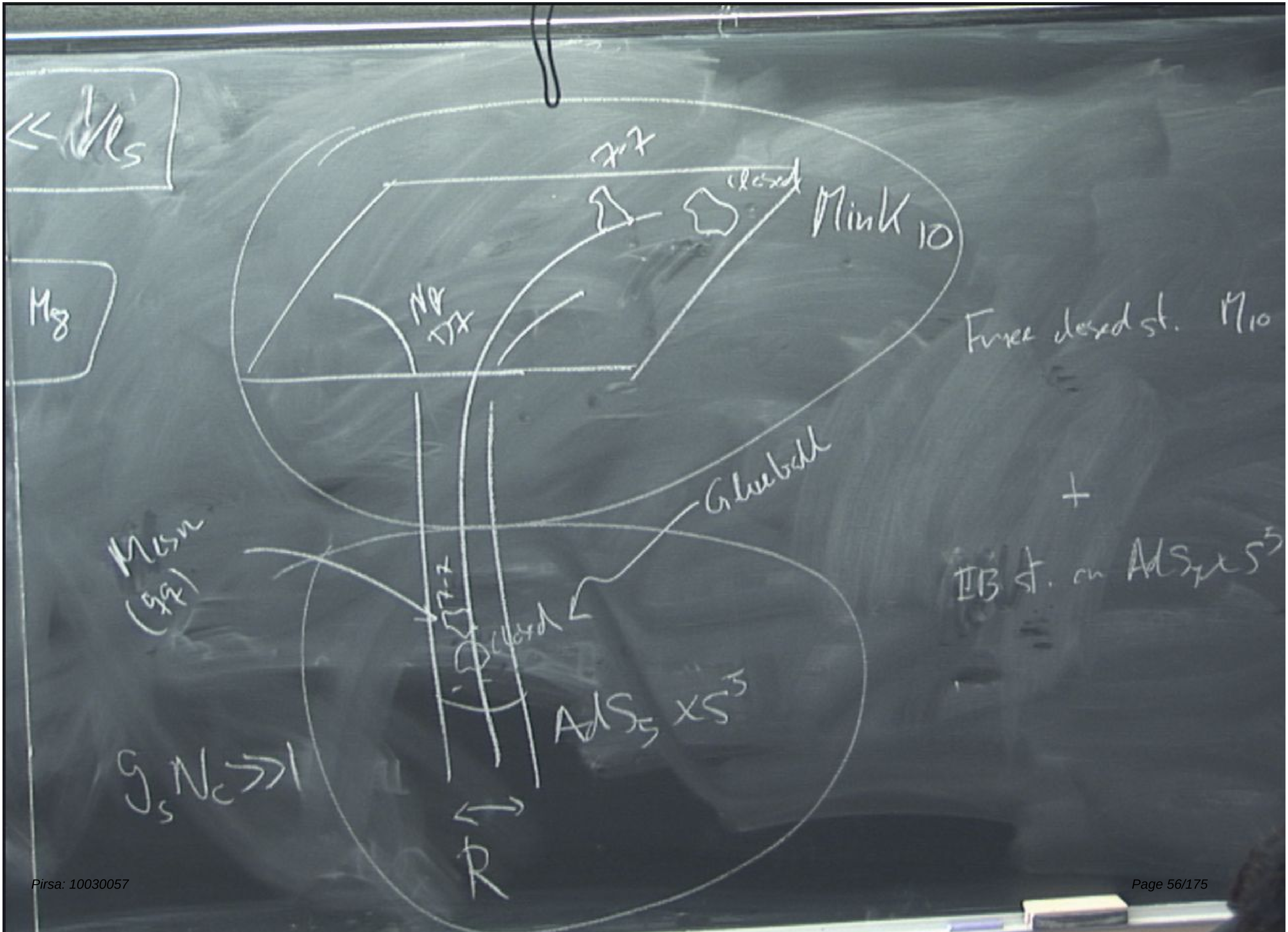
N_f flavors of "quarks"

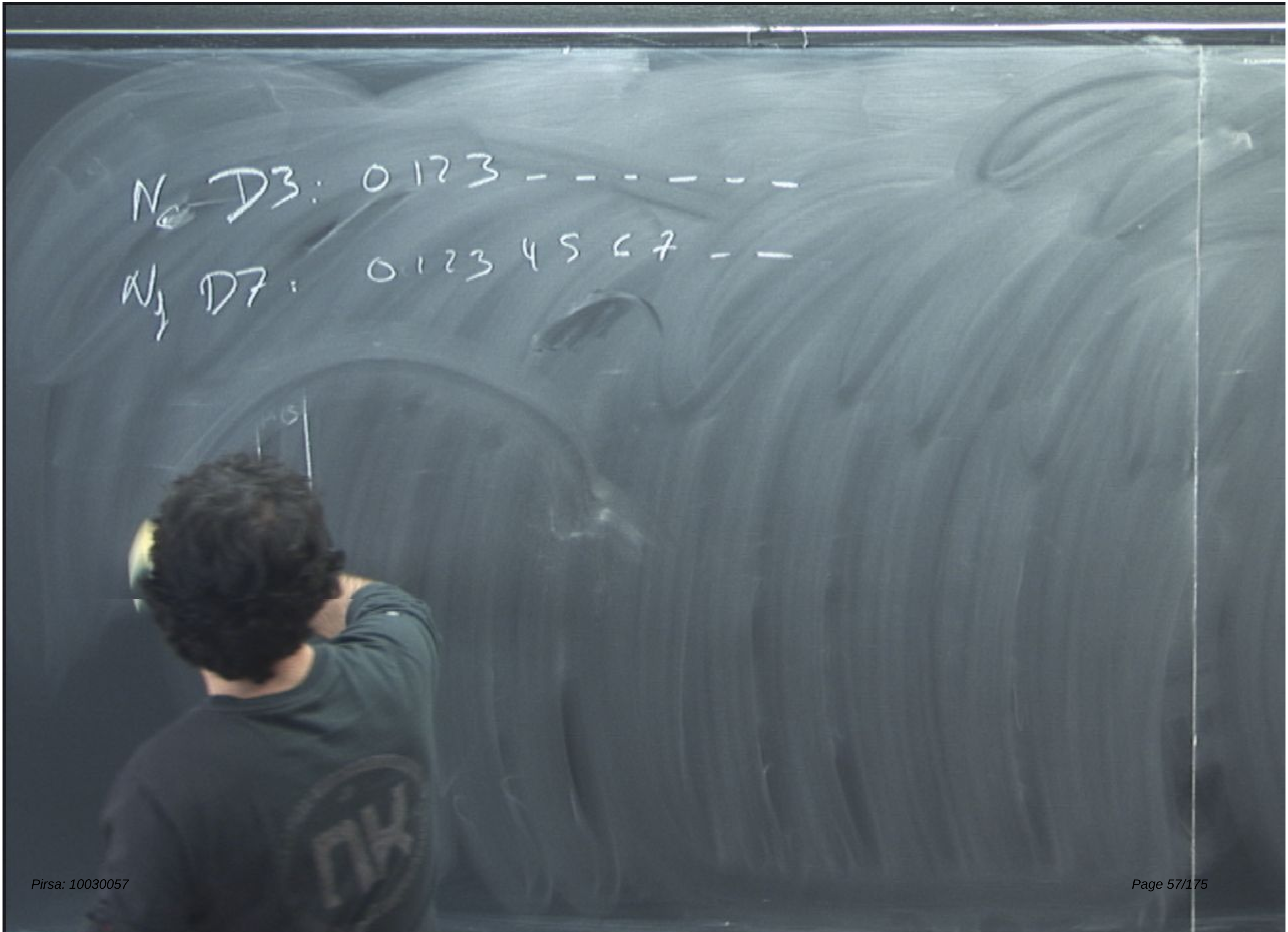
U(N_f)

$g_s N_c \gg 1$


Mink 10
closed
Free closed st. M10
+
IIB st. on AdS5 x S5
Glueball
Meson
gsNc >> 1
R

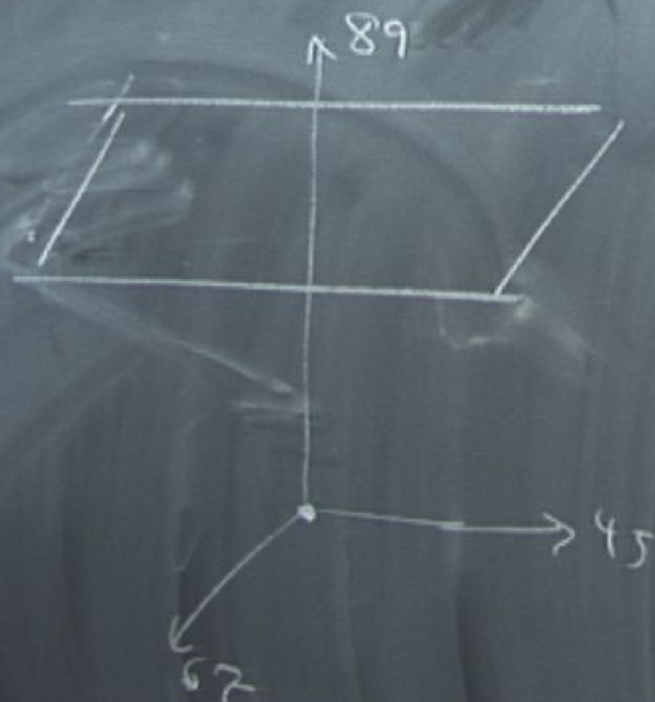

Mink10
closed
Glueball
Meson
$AdS_5 \times S_5$
$g_s N_c >> 1$
M_8
R

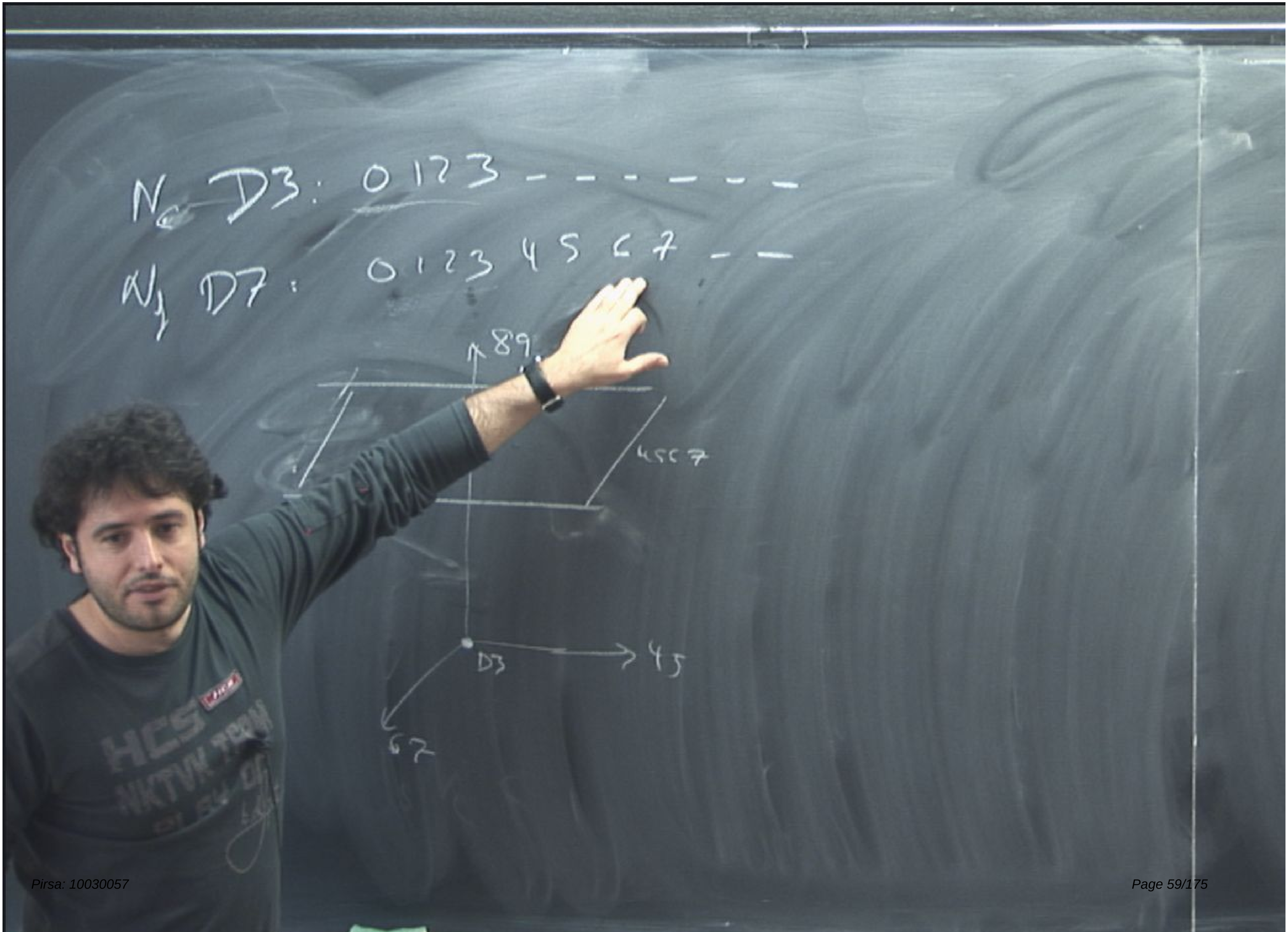

closed
Mink 10
Glueball
Meson
AdS5 x S5
gs Nc >> 1
R
+
IIB st. on AdS5 x S5


N_c D3: 0 1 2 3 - - - - - -
N_f D7: 0 1 2 3 4 5 6 7 - -

N_c D3: 0 1 2 3 - - - - - -

N_f D7: 0 1 2 3 4 5 6 7 - -

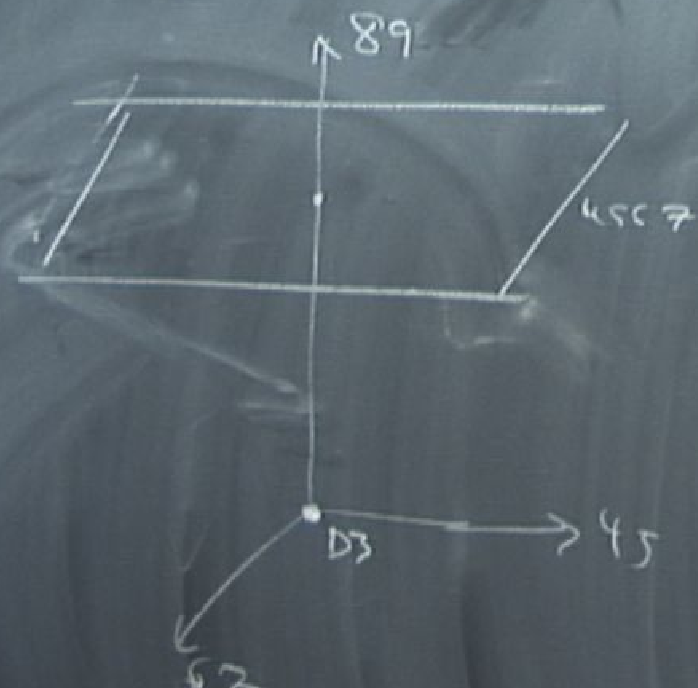




N_c D3: 0 1 2 3 - - - - - -
N_f D7: 0 1 2 3 4 5 6 7 - -
89
4567
D3
45
67

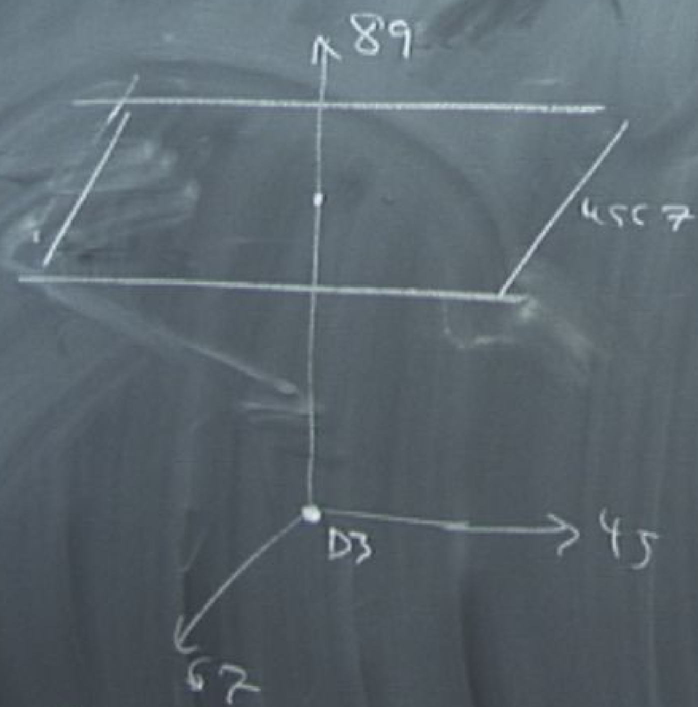
N_c D3: 0 1 2 3 - - - - - -

N_f D7: 0 1 2 3 4 5 6 7 - -



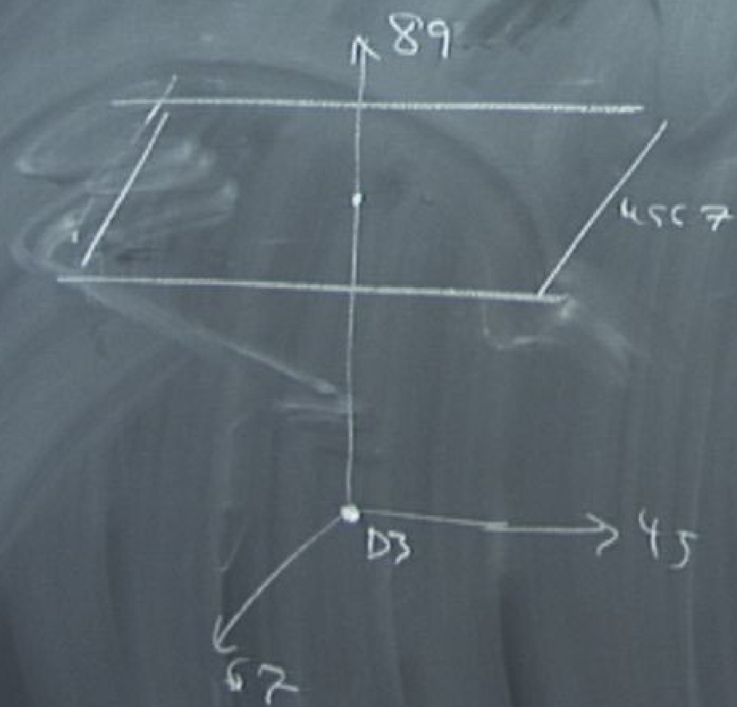
N_c D3: 0 1 2 3 - - - - - -

N_f D7: 0 1 2 3 4 5 6 7 - -

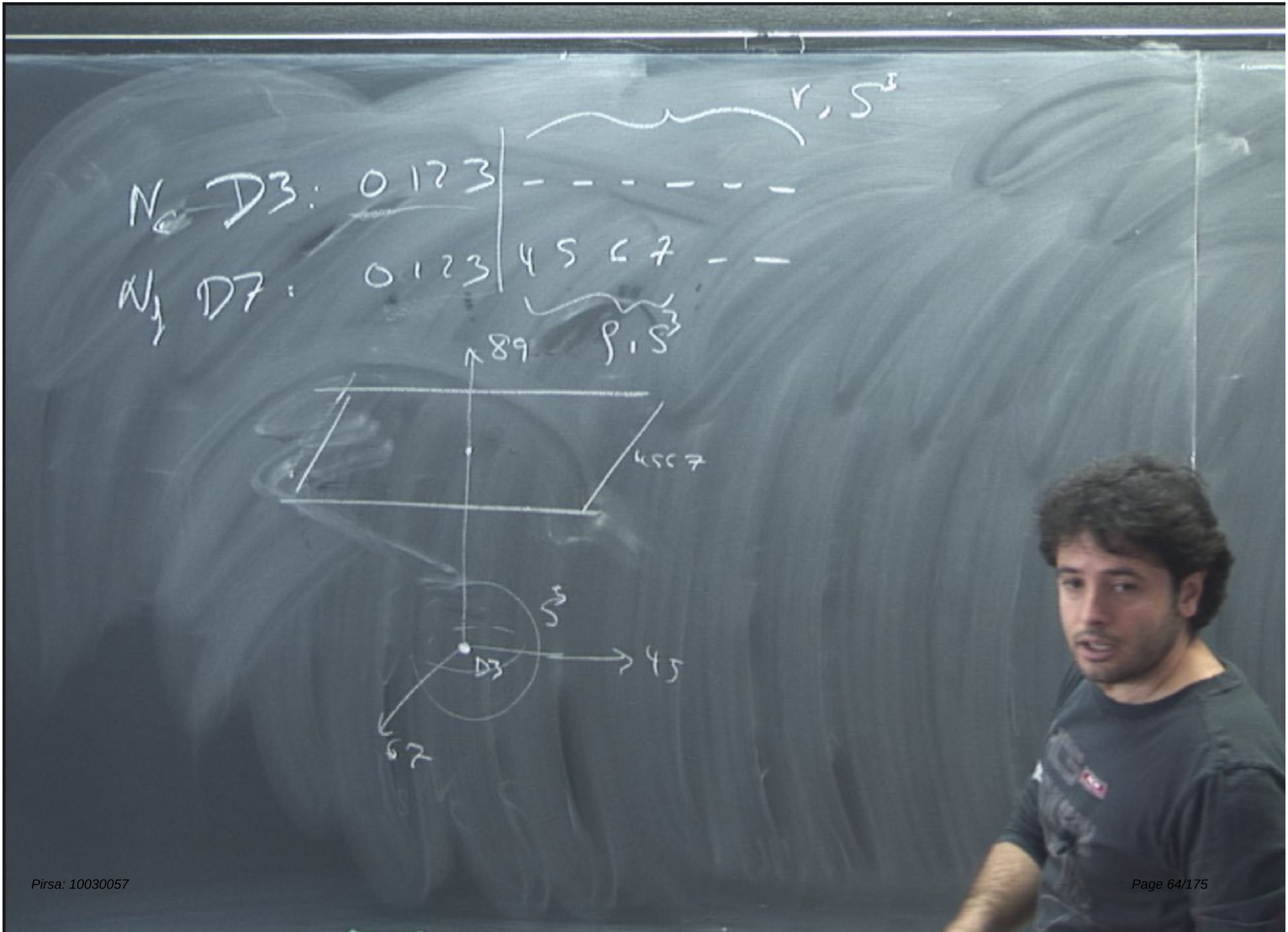


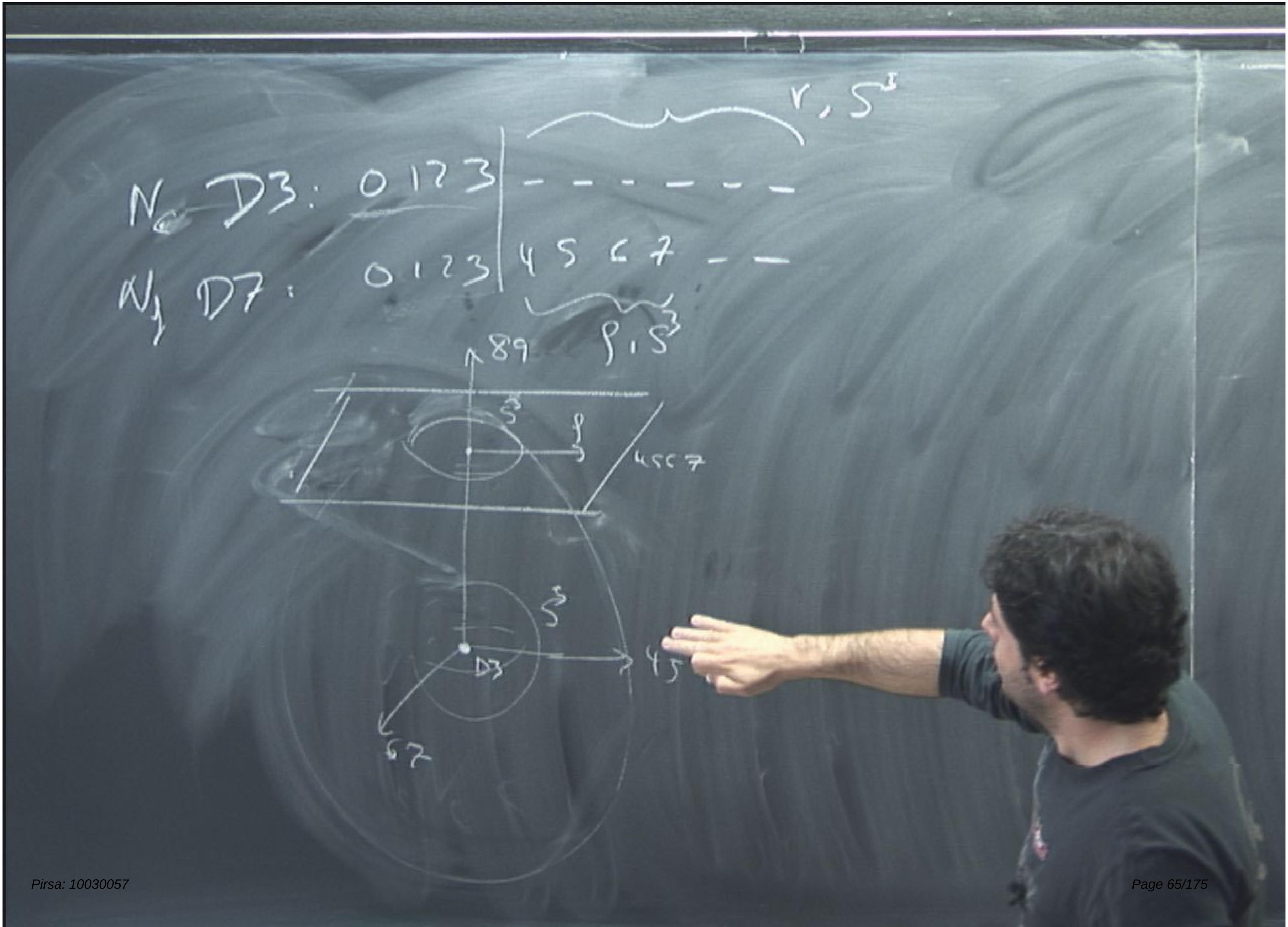
$$N_c \ D3: \ 0123 \ | \ \underbrace{-\ -\ -\ -\ -\ -}^{r,\,S^5}$$

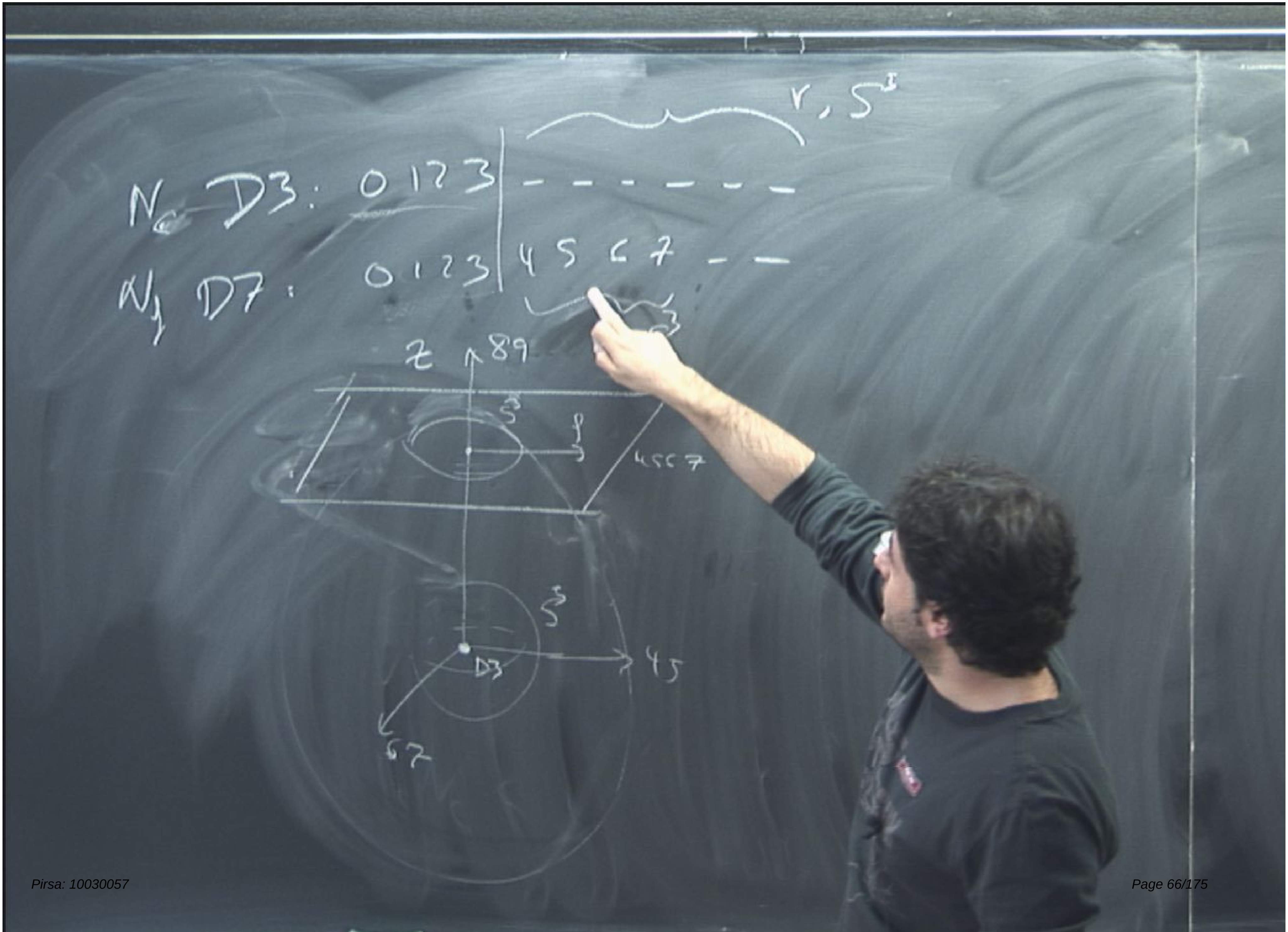
$$N_f \ D7: \ 0123 \ | \ 4567 \ -\ -$$

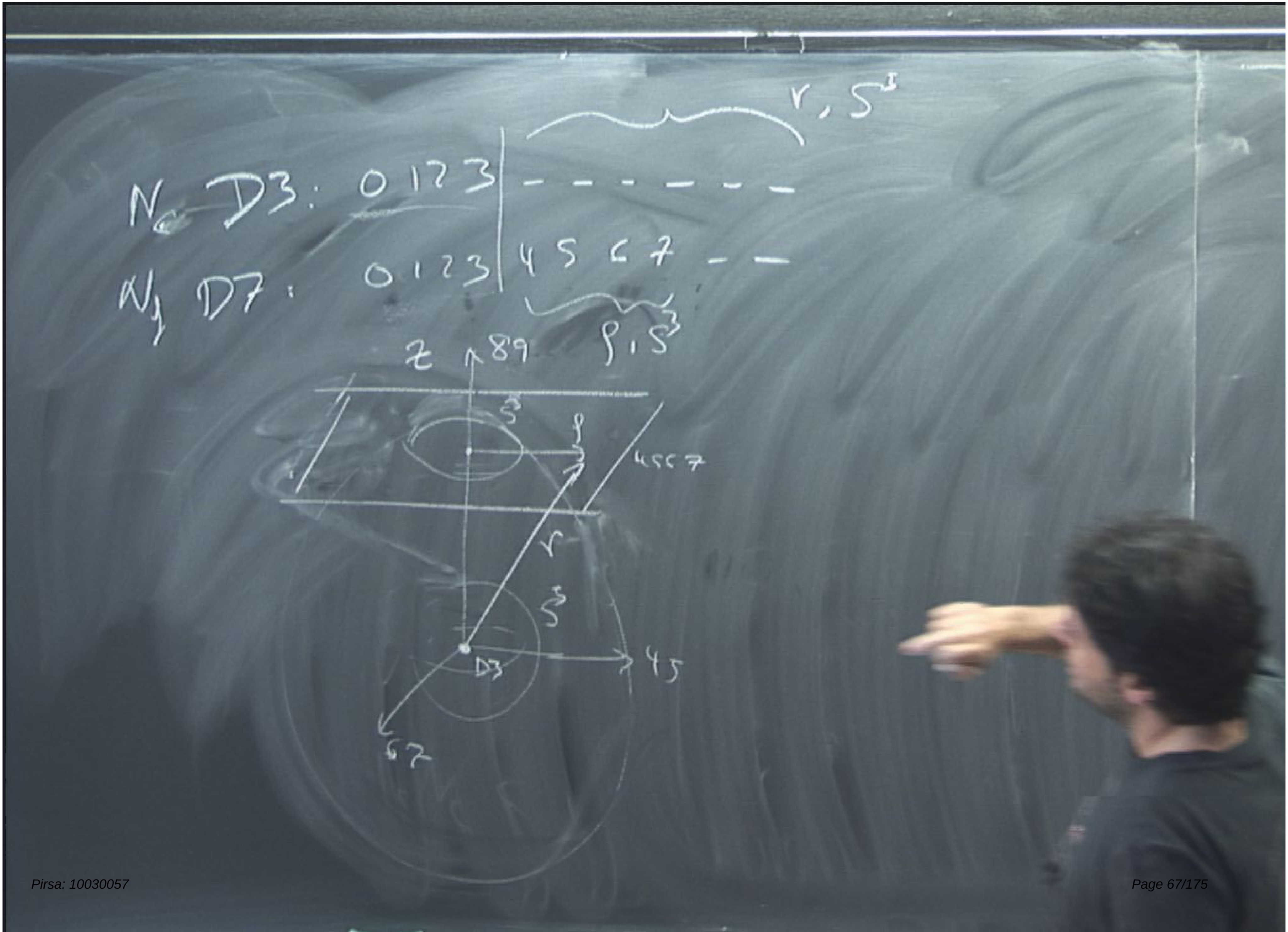


$$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2\, d\Omega_5^2$$

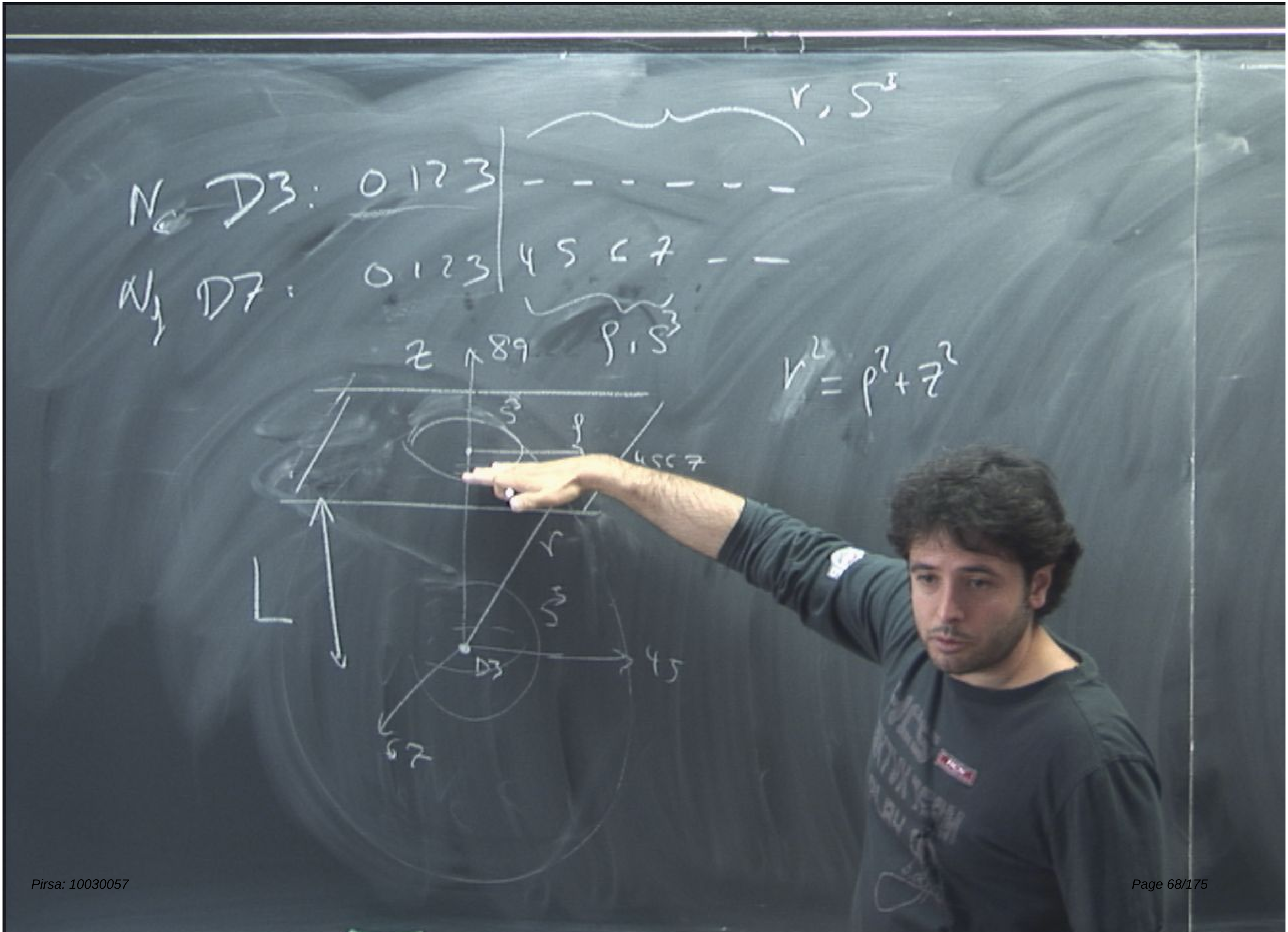

r, S
N D3: 0 1 2 3
N D7: 0 1 2 3 4 5 6 7
ρ, S
89
4567
D3
45
67


r, S^5
N_c D3: 0 1 2 3
N_f D7: 0 1 2 3 | 4 5 6 7
ρ, S^3
89
S^3
ρ
4567
S^5
D3
45
67

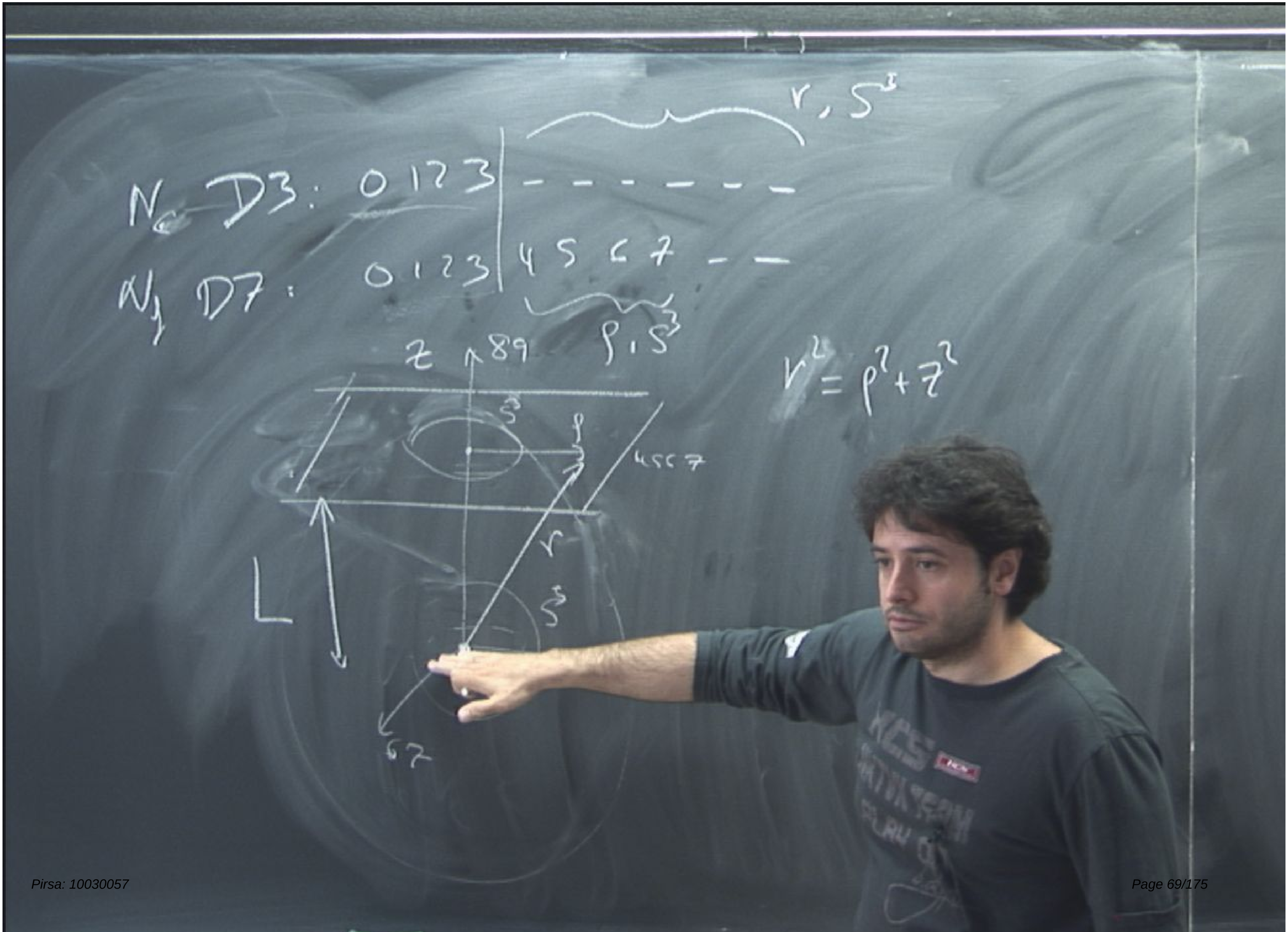

r, S5
Nc D3: 0 1 2 3 - - - - - -
Nf D7: 0 1 2 3 4 5 6 7 - -
S3
z 89
ρ
4567
S3
D3
45
67



r, S^5
N_c D3: 0123
N_f D7: 0123 | 4567
ρ, S^3
z 89
S^3
ρ
4567
r
S^3
D3
45
67

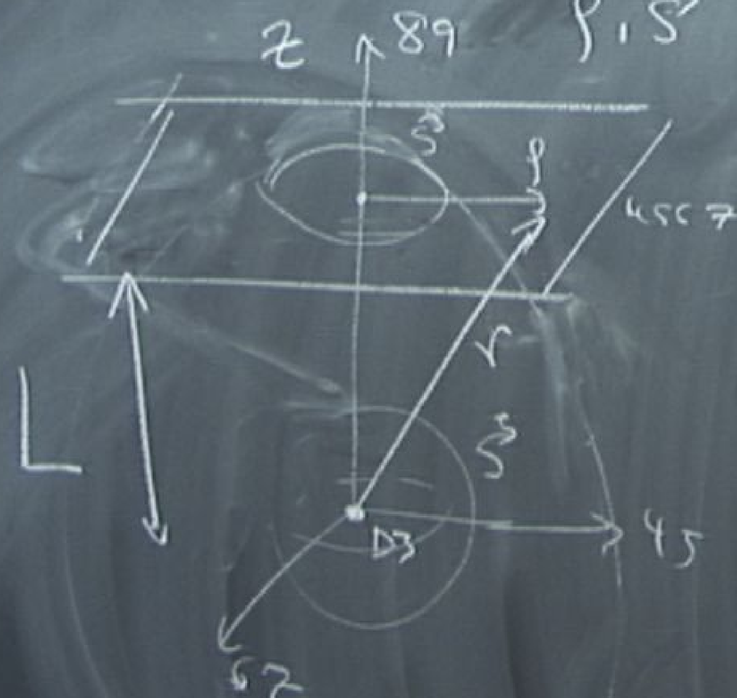


N_c D3: 0123 - - - - - -
N_f D7: 0123 4567 - -
r, S^5
ρ, S^3
z 89
r^2 = ρ^2 + z^2
4567
L
r
D3
45
67


r, S³
N_c D3: 0 1 2 3 | - - - - - -
N_f D7: 0 1 2 3 | 4 5 6 7 - -
ρ, S³
z 89
r² = ρ² + z²
S³
ρ
4567
r
L
S³
67

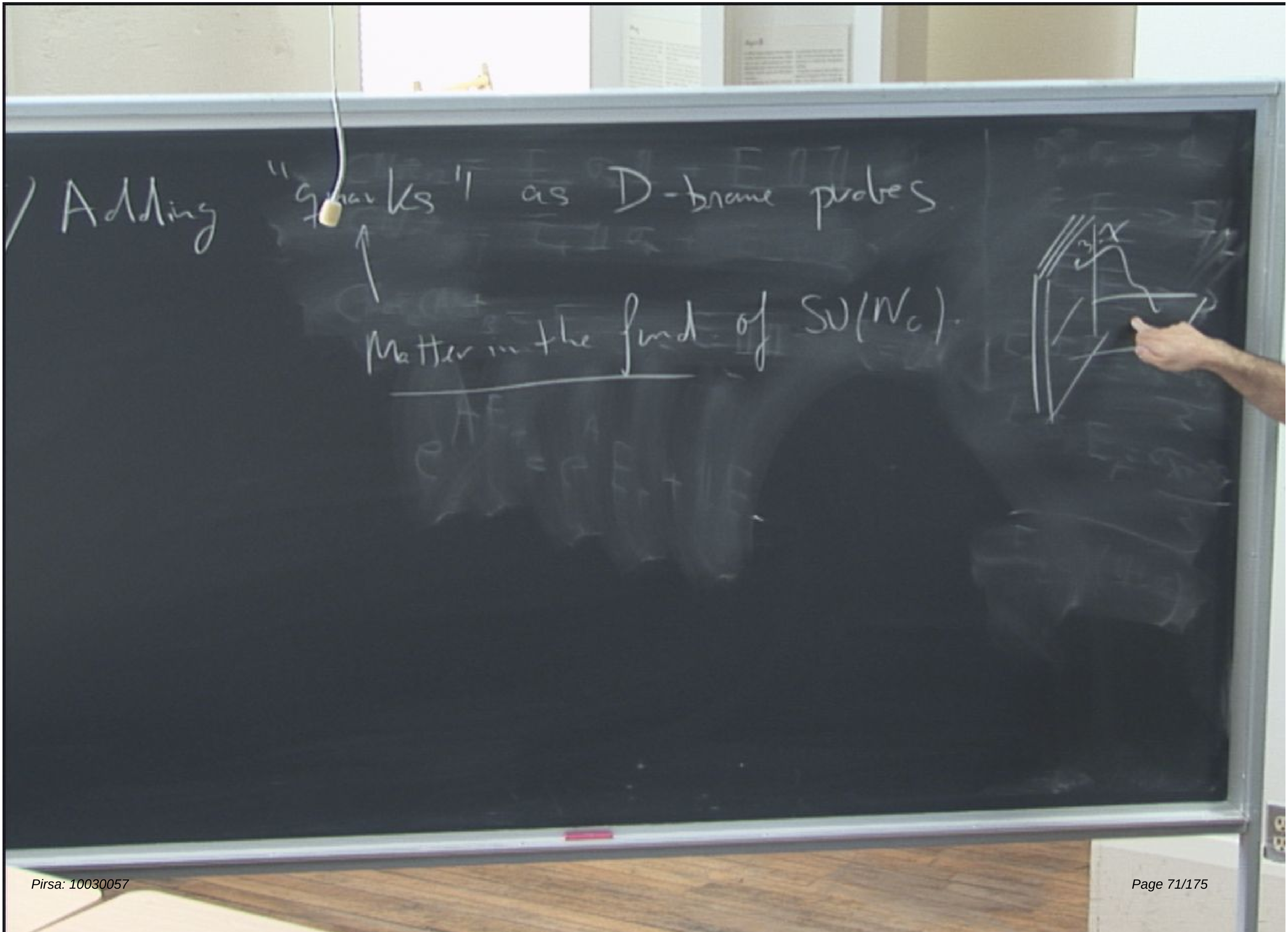
$$N_c \; D3: \; 0123 \,|\, \overbrace{------}^{r,\, S^3}$$

$$N_f \; D7: \; 0123 \,|\, \underbrace{4567}_{\rho,\, S^3}\; --$$



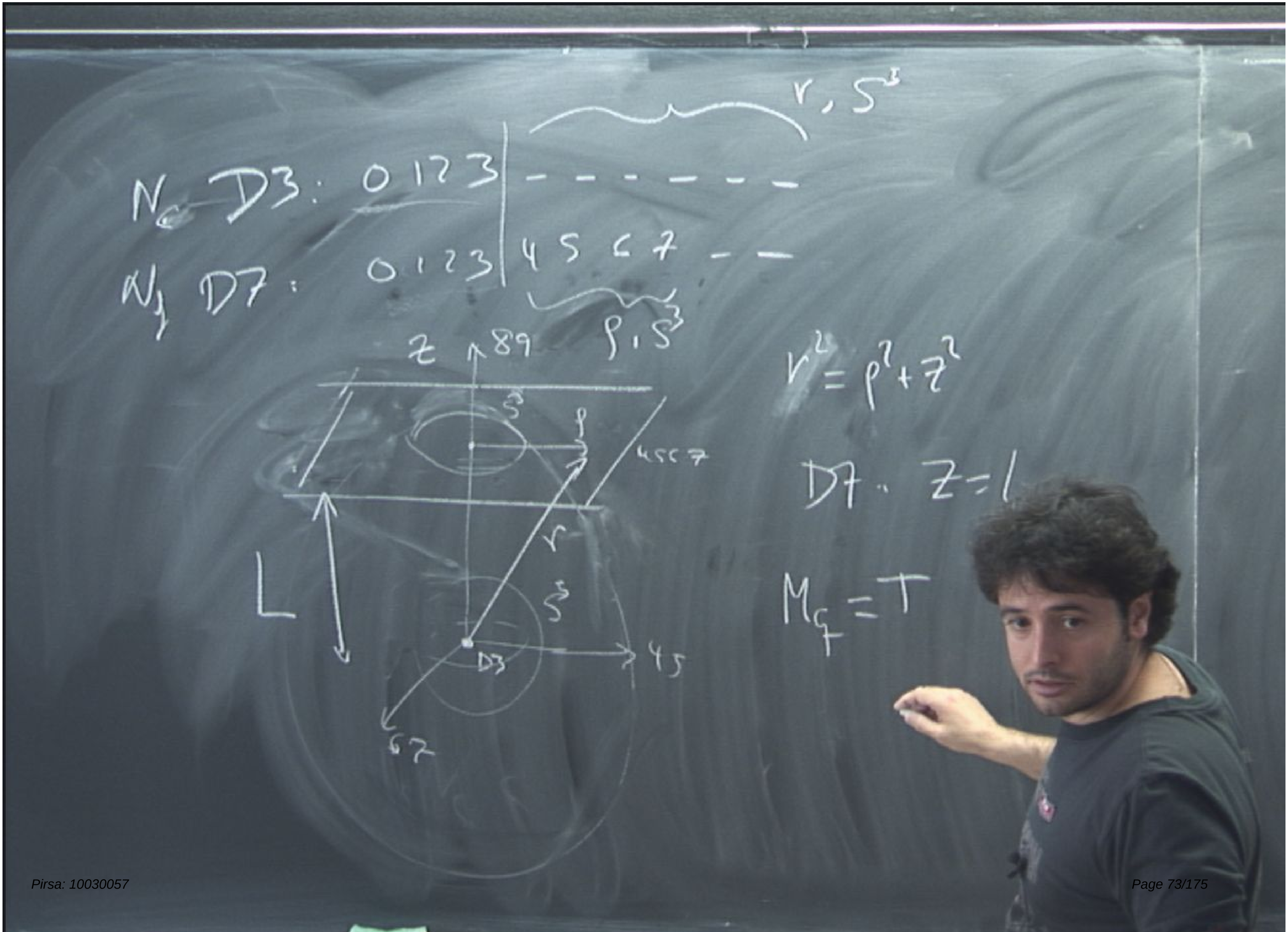
$$r^2 = \rho^2 + z^2$$

$$D7: \; z = L$$


/ Adding "quarks" as D-brane probes
Matter in the fund. of SU(N_c).
x

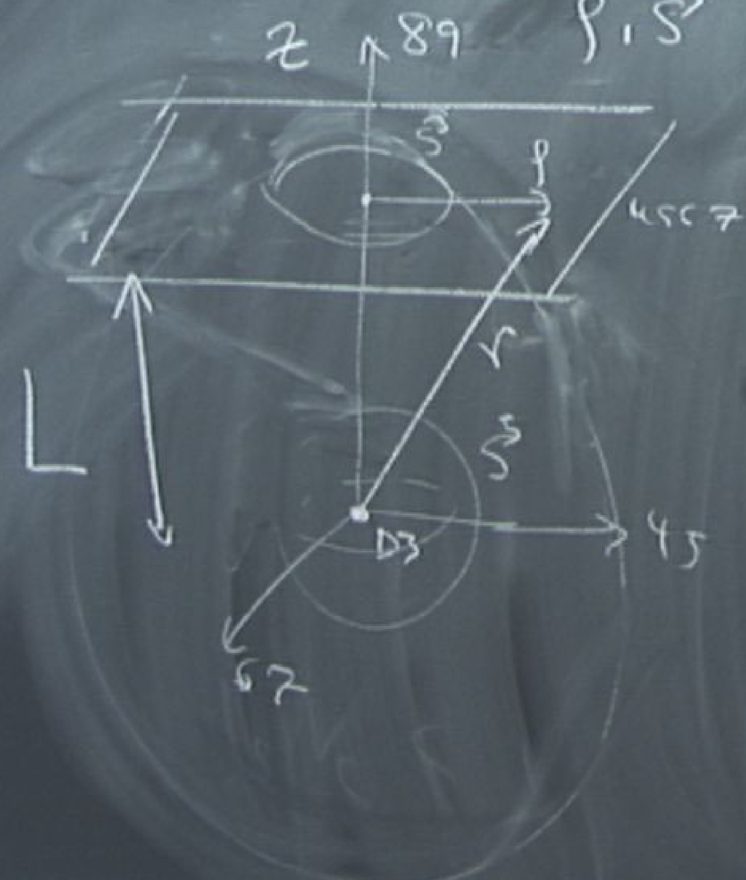
/ Adding "quarks" as D-brane probes

Matter in the fund. of $SU(N_c)$.


r, S^5
N_c D3: 0 1 2 3 - - - - - -
N_f D7: 0 1 2 3 | 4 5 6 7 - -
ρ, S^3
z 89
r^2 = ρ^2 + z^2
D7: Z = l
M_q = T
S^3
ρ
4567
r
L
S^5
D3
45
67

$$N_c\ D3:\ 0\,1\,2\,3 \mid \overbrace{-\ -\ -\ -\ -\ -}^{r,\,S^5}$$

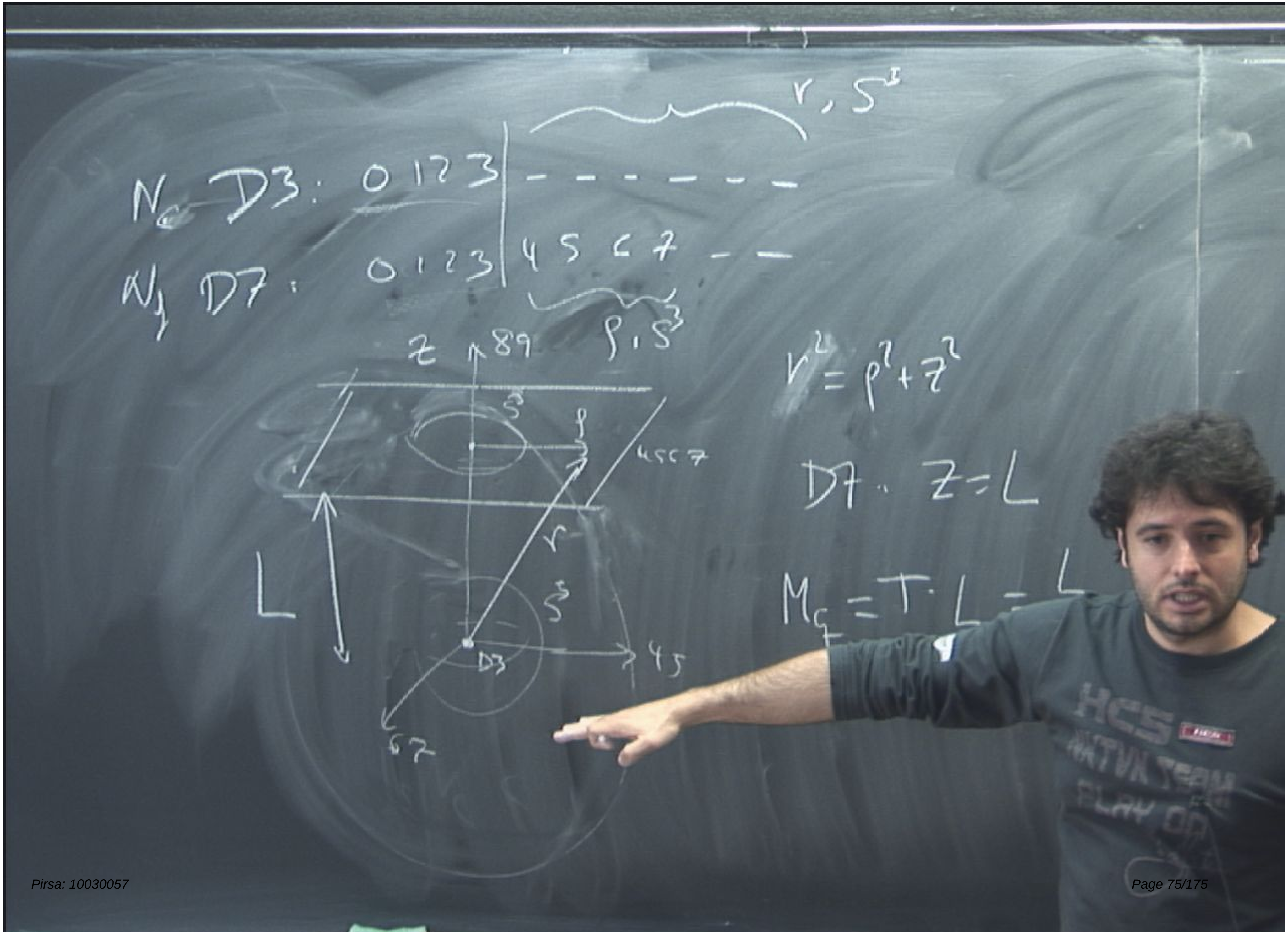
$$N_f\ D7:\ 0\,1\,2\,3 \mid \underbrace{4\,5\,6\,7}_{\rho,\,S^3}\ -\ -$$



$$r^2 = \rho^2 + z^2$$

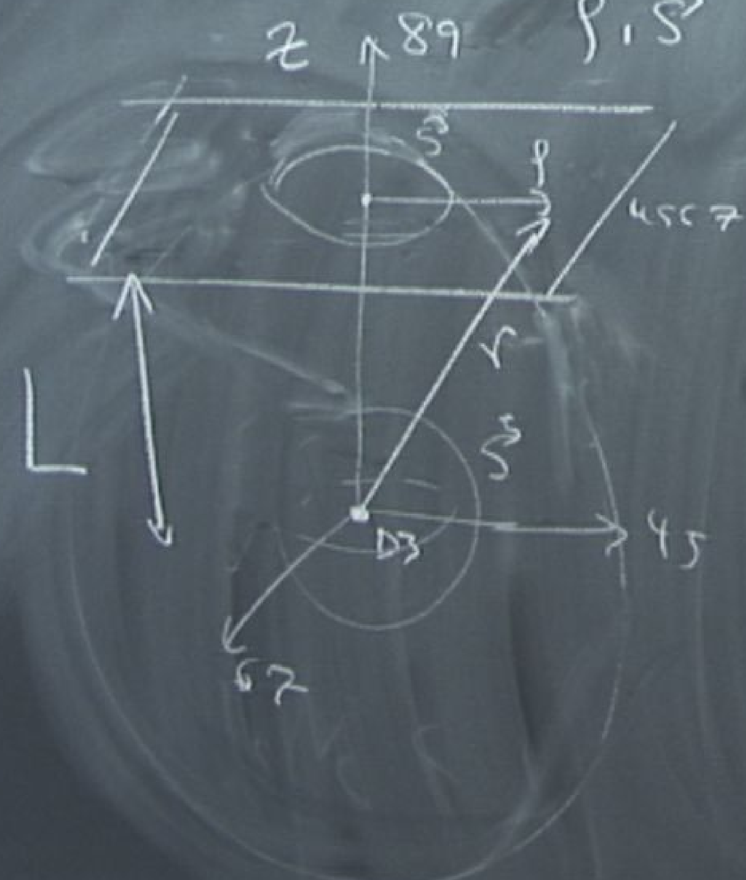
$$D7:\ z = L$$

$$M_q = T \cdot L = \frac{L}{2\pi\alpha'}$$


r, S^5
N_c D3: 0 1 2 3 | - - - - - -
N_f D7: 0 1 2 3 | 4 5 6 7 - -
ρ, S^3
z 89
S^3
ρ
4567
L
r
S^5
D3
45
67
r^2 = ρ^2 + z^2
D7: Z = L
M_q = T · L = L

N_c D3: $0\,1\,2\,3 \,|\, \underbrace{-\ -\ -\ -\ -\ -}_{}$ r, S^3

N_f D7: $0\,1\,2\,3 \,|\, \underbrace{4\,5\,6\,7}_{\rho,\, S^3}\ -\ -$

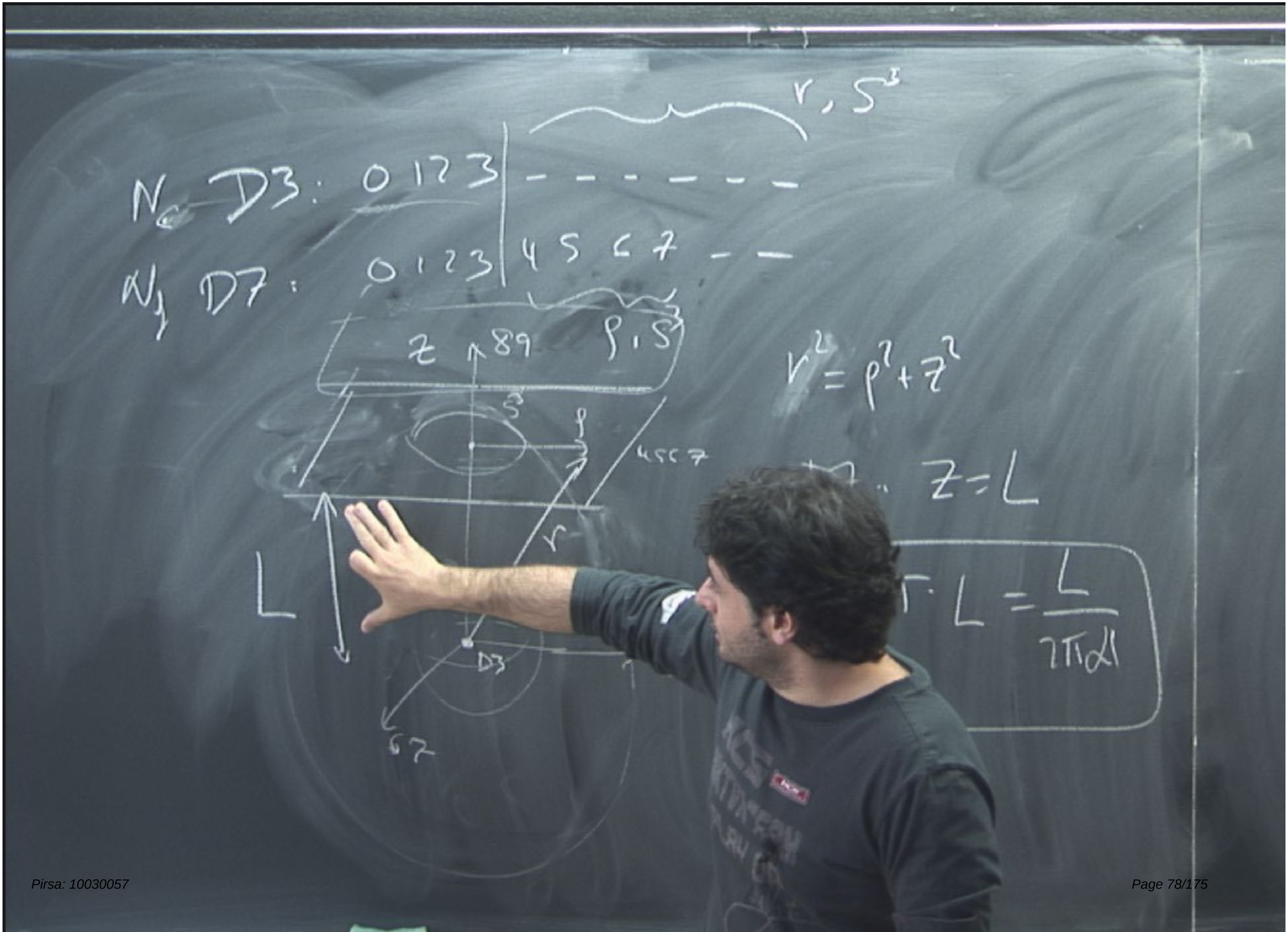


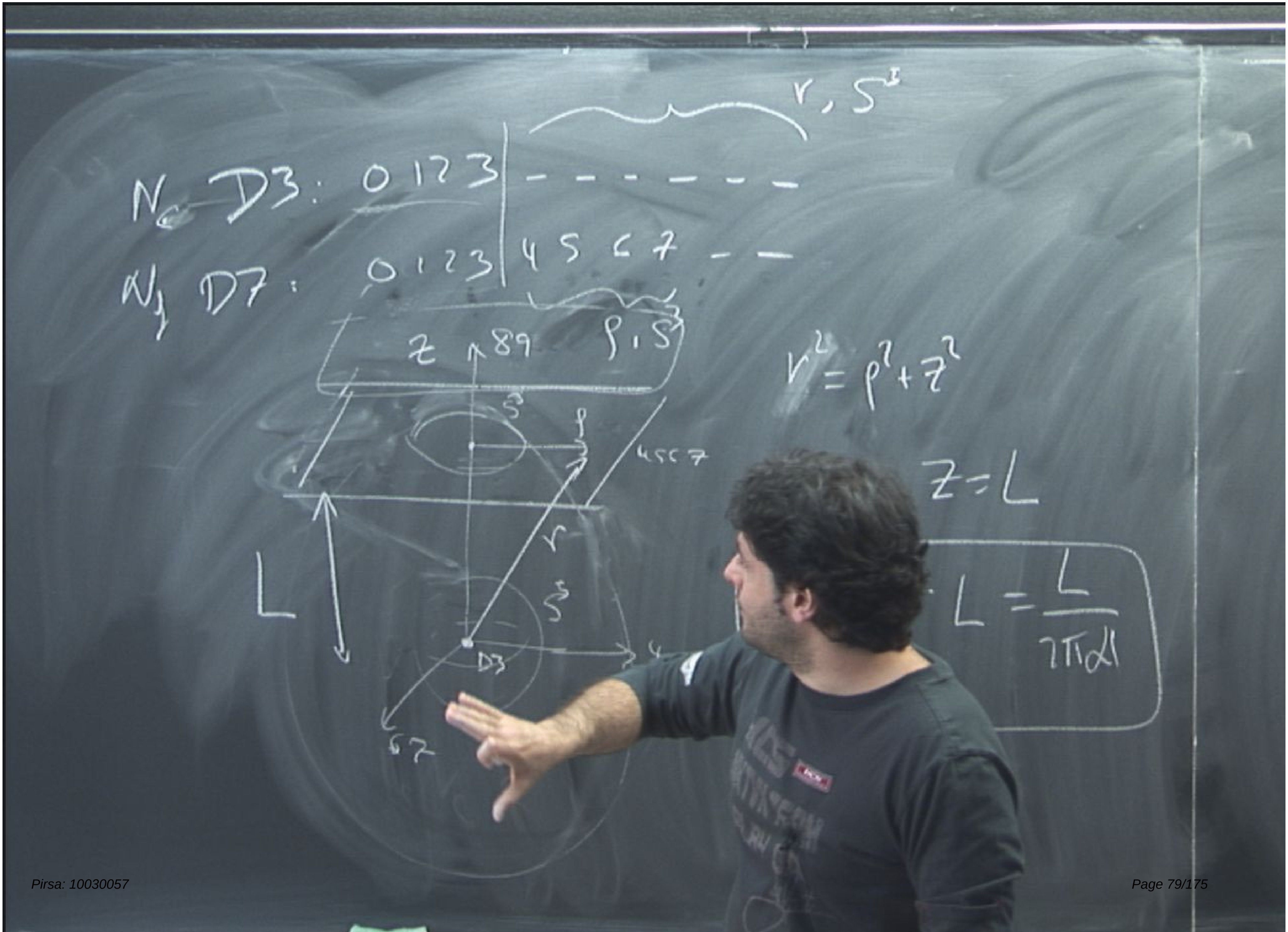
$$r^2 = \rho^2 + z^2$$

$$D7: \ z = L$$

$$\boxed{M_q = T \cdot L = \frac{L}{2\pi\alpha'}}$$


r, S^5
N_c D3: 0123 - - - - - -
N_f D7: 0123 4567 - -
z 89 ρ, S^3
S^3
ρ
4567
L
r
S^5
D3
45
67
$r^2 = \rho^2 + z^2$
D7: Z=
$M_q = T \cdot L$

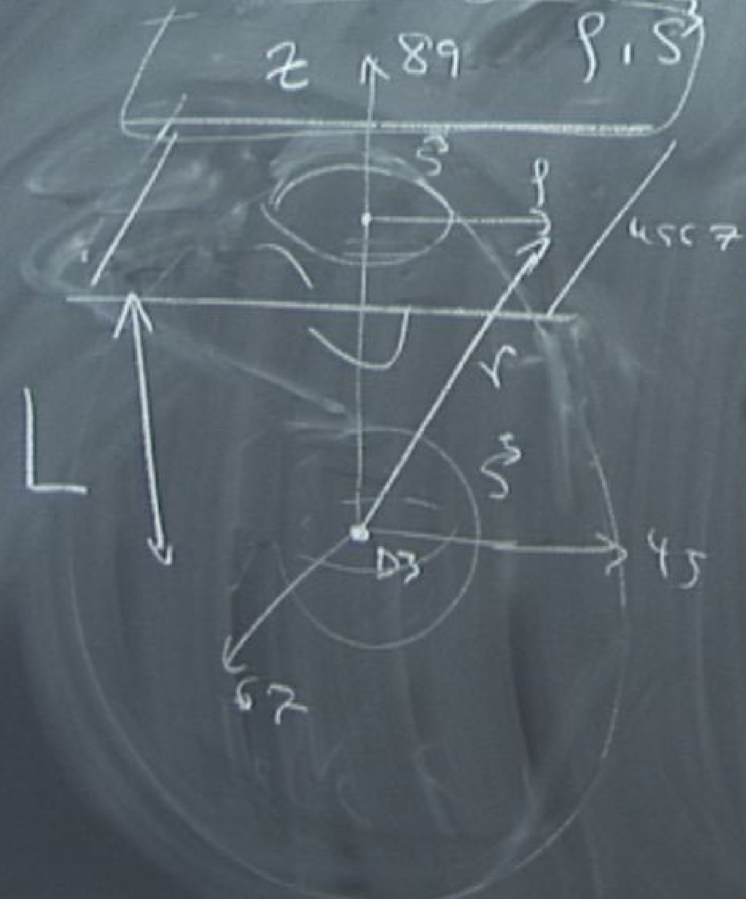

r, S3
Nc D3: 0 1 2 3
Nf D7: 0 1 2 3 4 5 6 7
z 8 9 ρ, S3
r2 = ρ2 + z2
Z = L
L
4 5 6 7
6 7
D3
r
ρ
S3


r, S^5
N_c D3: 0 1 2 3 - - - - - -
N_f D7: 0 1 2 3 4 5 6 7 - -
z 89 ρ, S^3
r^2 = ρ^2 + z^2
z = L
L = L / 2πα'
4567
S^3
ρ
r
L
S^5
D3
67


r, S5
Nc D3: 0 1 2 3 - - - - - -
Nf D7: 0 1 2 3 4 5 6 7 - -
z 8 9 ρ, S3
r2 = ρ2 + z2
D7: z = L
= T · L = L / 2πα'
L
r
S5
D3

$$N_c \; D3: \; 0123 \,|\, \underbrace{- - - - - -}_{}^{r,\, S^5}$$

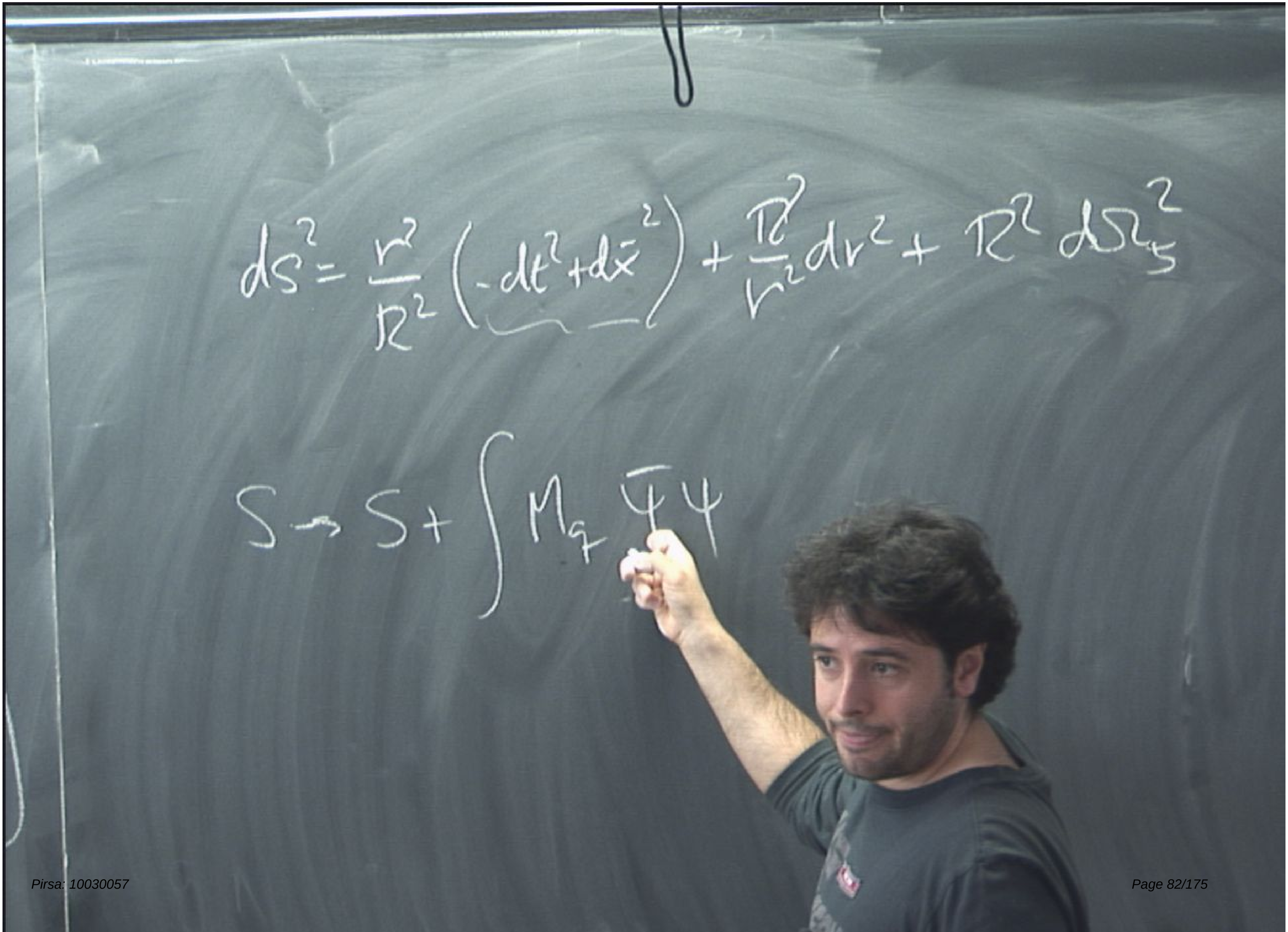
$$N_f \; D7: \; 0123 \,|\, \underbrace{4567}_{\rho,\, S^3} \; - -$$



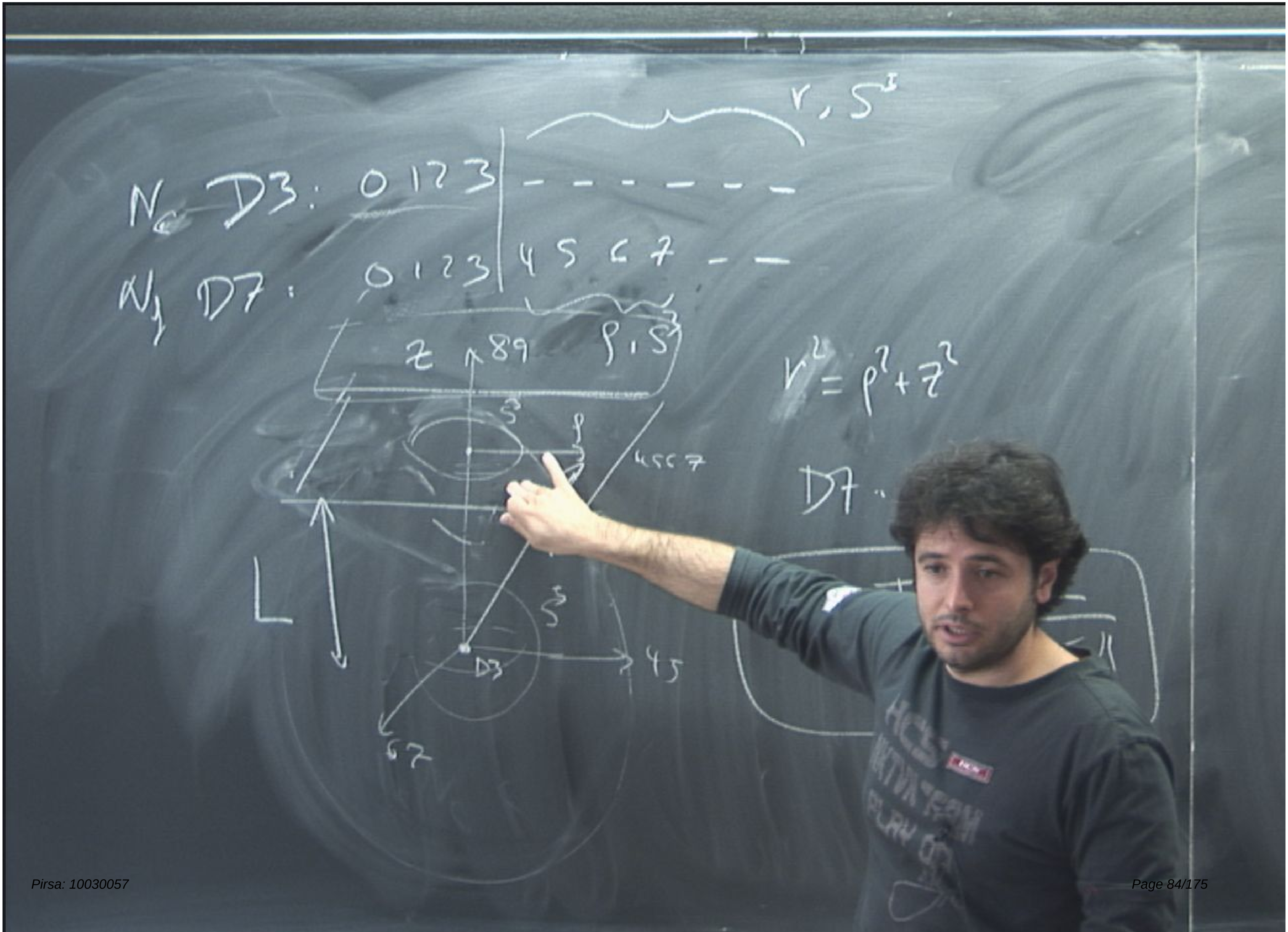
$$r^2 = \rho^2 + z^2$$

$$D7: \; z = L$$

$$\boxed{M_f = T \cdot L = \frac{L}{2\pi\alpha'}}$$

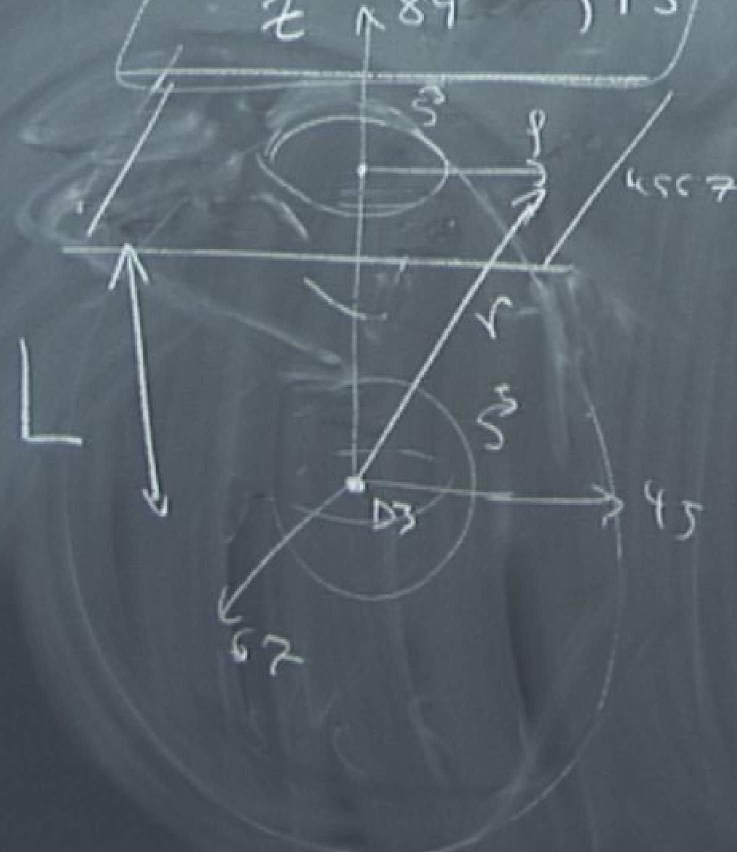

$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2 d\Omega_5^2$
$S \to S + \int M_q \bar{\Psi}\Psi$

$$ds^2 = \frac{r^2}{R^2}\left(\underbrace{-dt^2 + d\vec{x}^2}\right) + \frac{R^2}{r^2}dr^2 + R^2\,d\Omega_5^2$$


r, S^5
N_c D3: 0 1 2 3
N_f D7: 0 1 2 3 4 5 6 7
z 89 ρ, S^3
r^2 = ρ^2 + z^2
4567
D7 ..
L
D3
45
67

N_c D3: $0\,1\,2\,3 \mid \underbrace{-\;-\;-\;-\;-\;-}_{}$ $\quad r, S^3$

N_f D7: $0\,1\,2\,3 \mid \underbrace{4\,5\,6\,7}\;-\;-$ $\quad \rho, S^3$



$$r^2 = \rho^2 + z^2$$

D7: $z = L$

$$\boxed{M_q = T \cdot L = \frac{L}{2\pi\alpha'}}$$

$$ds^2 = \frac{r^2}{R^2}\left(\underbrace{-dt^2 + d\vec{x}^2}\right) + \frac{R^2}{r^2}dr^2 + R^2 d\Omega_5^2$$

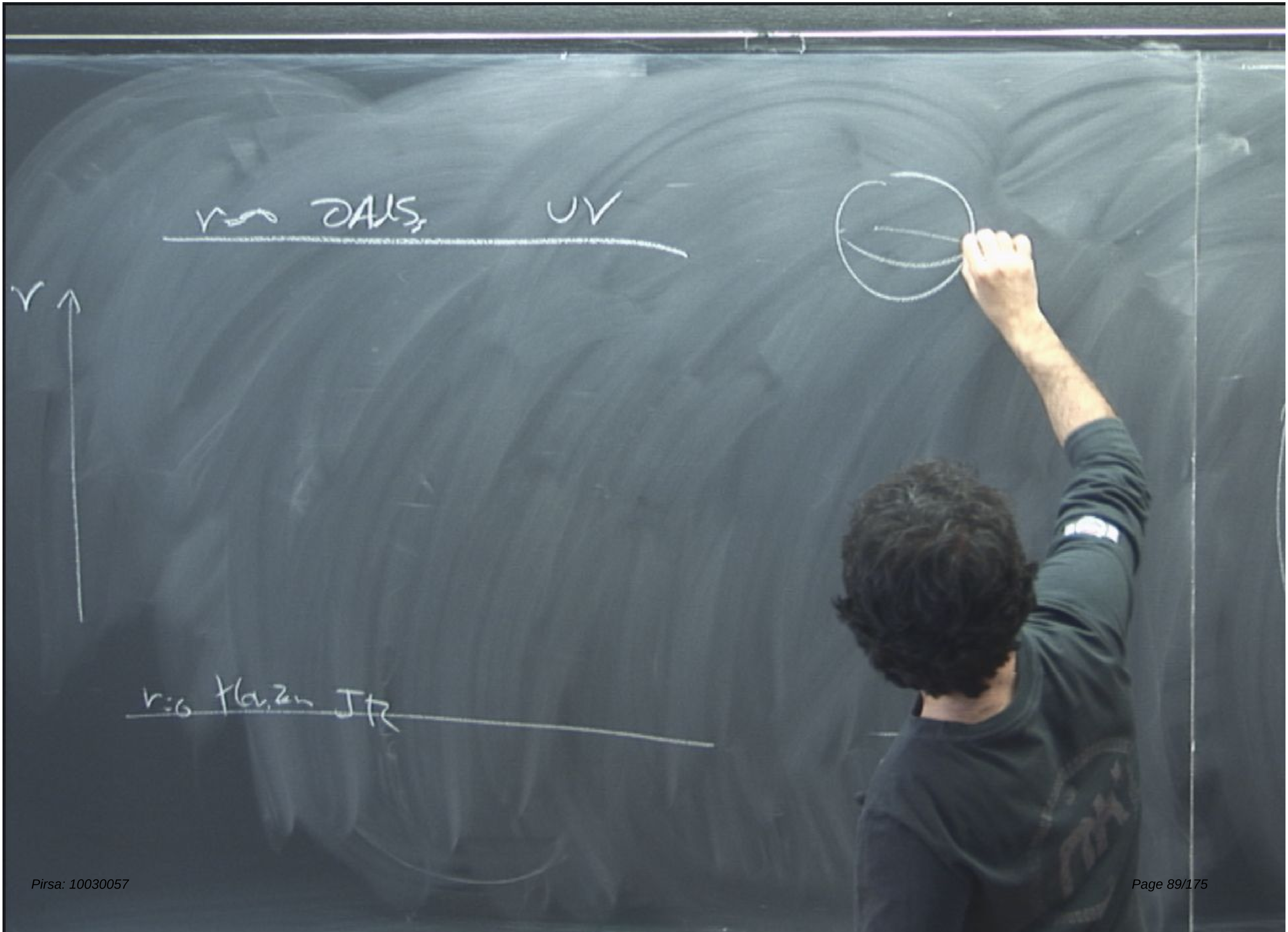
$$ds^2_{D7} = \frac{\rho^2 + L^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{\rho^2 + L^2}d\rho^2 + \frac{R^2\rho^2}{\rho^2 + L^2}\, d\Omega_3^2$$

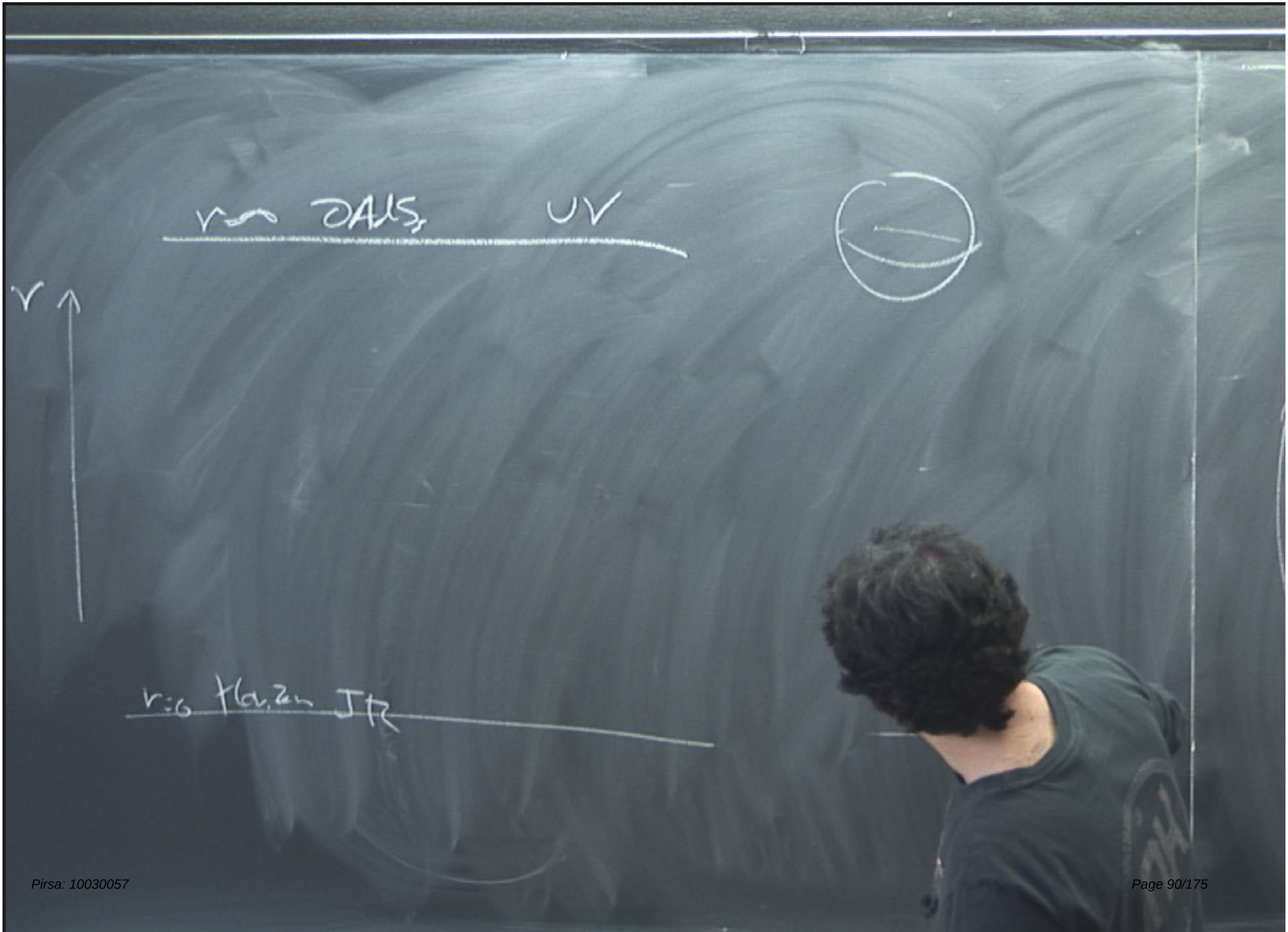
$$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2 d\Omega_5^2$$

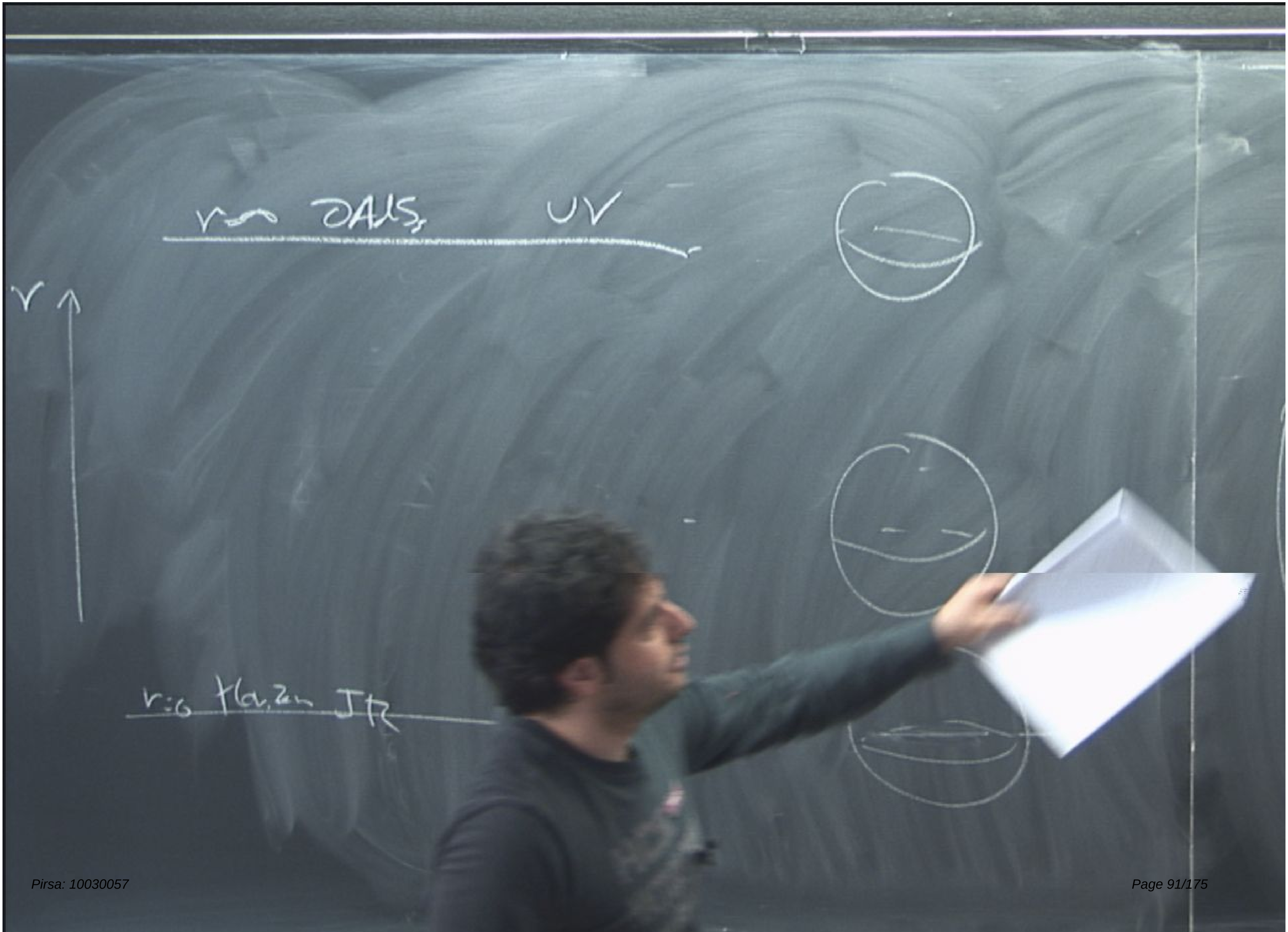
$$\boxed{ds^2_{D7} = \frac{\rho^2+L^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{\rho^2+L^2}d\rho^2 + \frac{R^2\rho^2}{\rho^2+L^2}d\Omega_3^2}$$

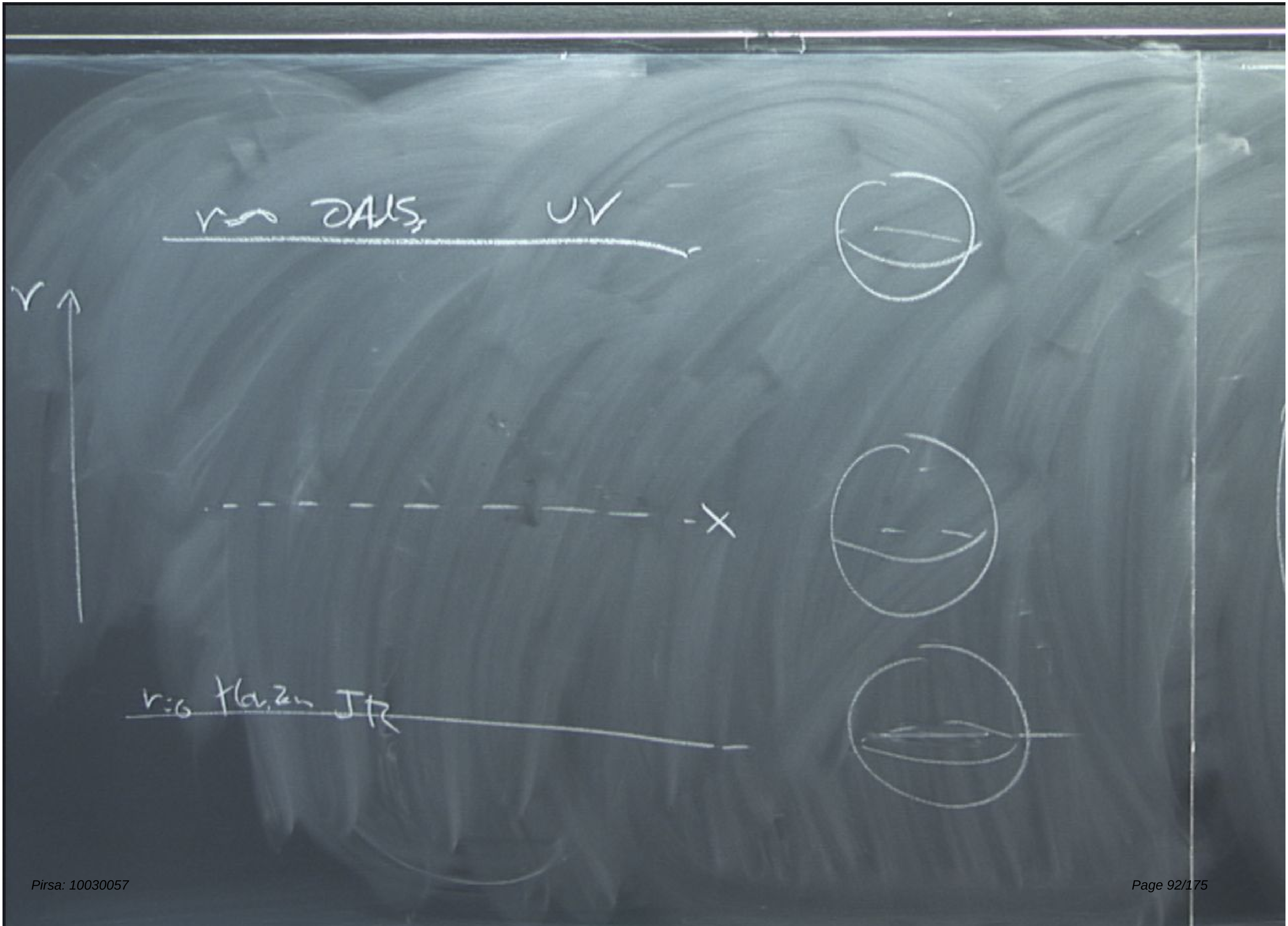
$$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2 d\Omega_5^2$$

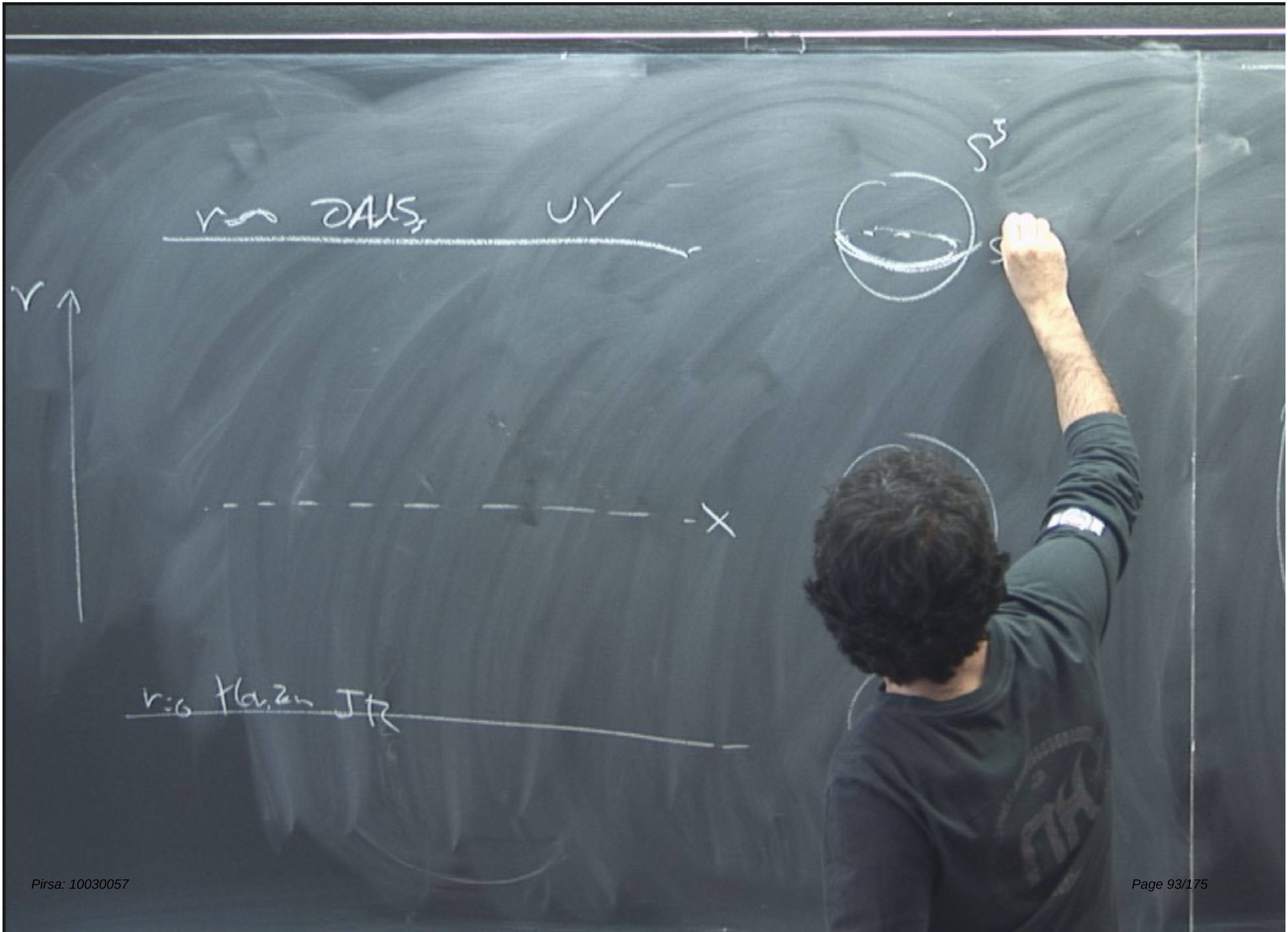
$$\boxed{ds^2_{D7} = \frac{\rho^2 + L^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{\rho^2 + L^2}d\rho^2 + \frac{R^2\rho^2}{\rho^2 + L^2}d\Omega_3^2}$$

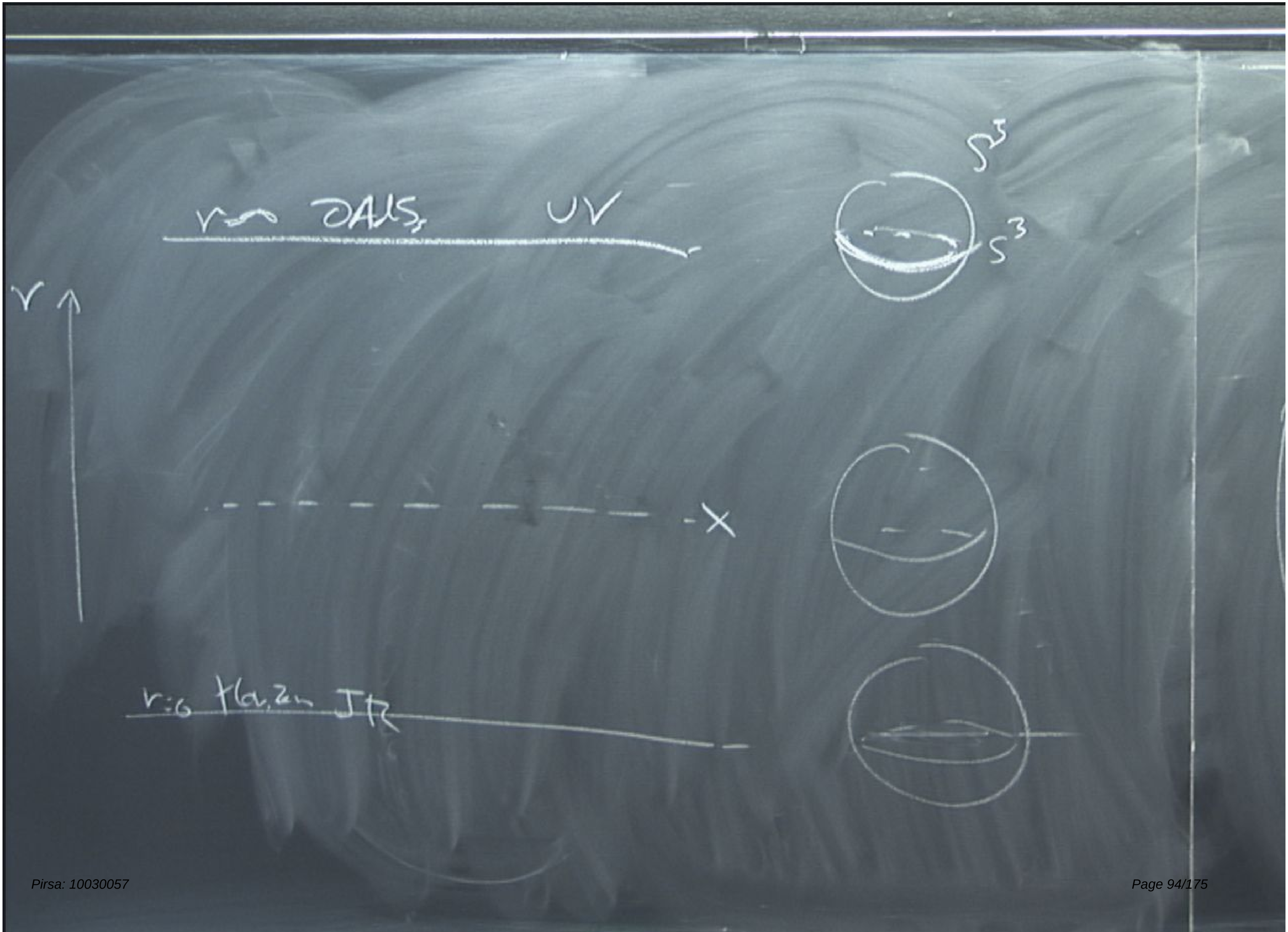

r → ∂AdS5
UV
r
r=0 horizon IR


AdS5
UV
r
r=0 Horizon IR


r→∞ ∂AdS5
UV
r
r=0 Horizon IR


$r \to \infty$ ∂AdS_5 UV
r
$r=0$ Horizon IR

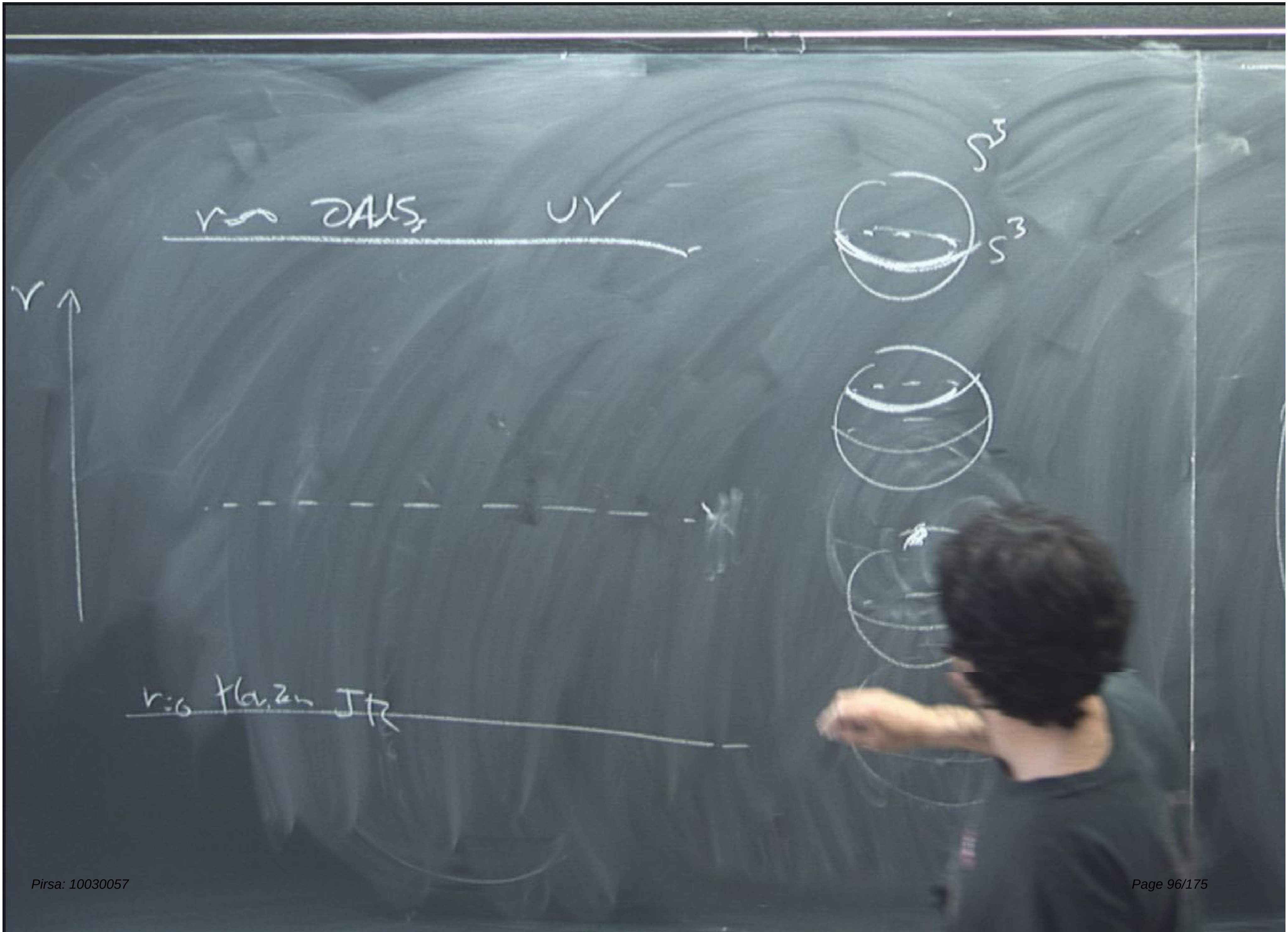

r → ∞ ∂AdS5
UV
S5
r

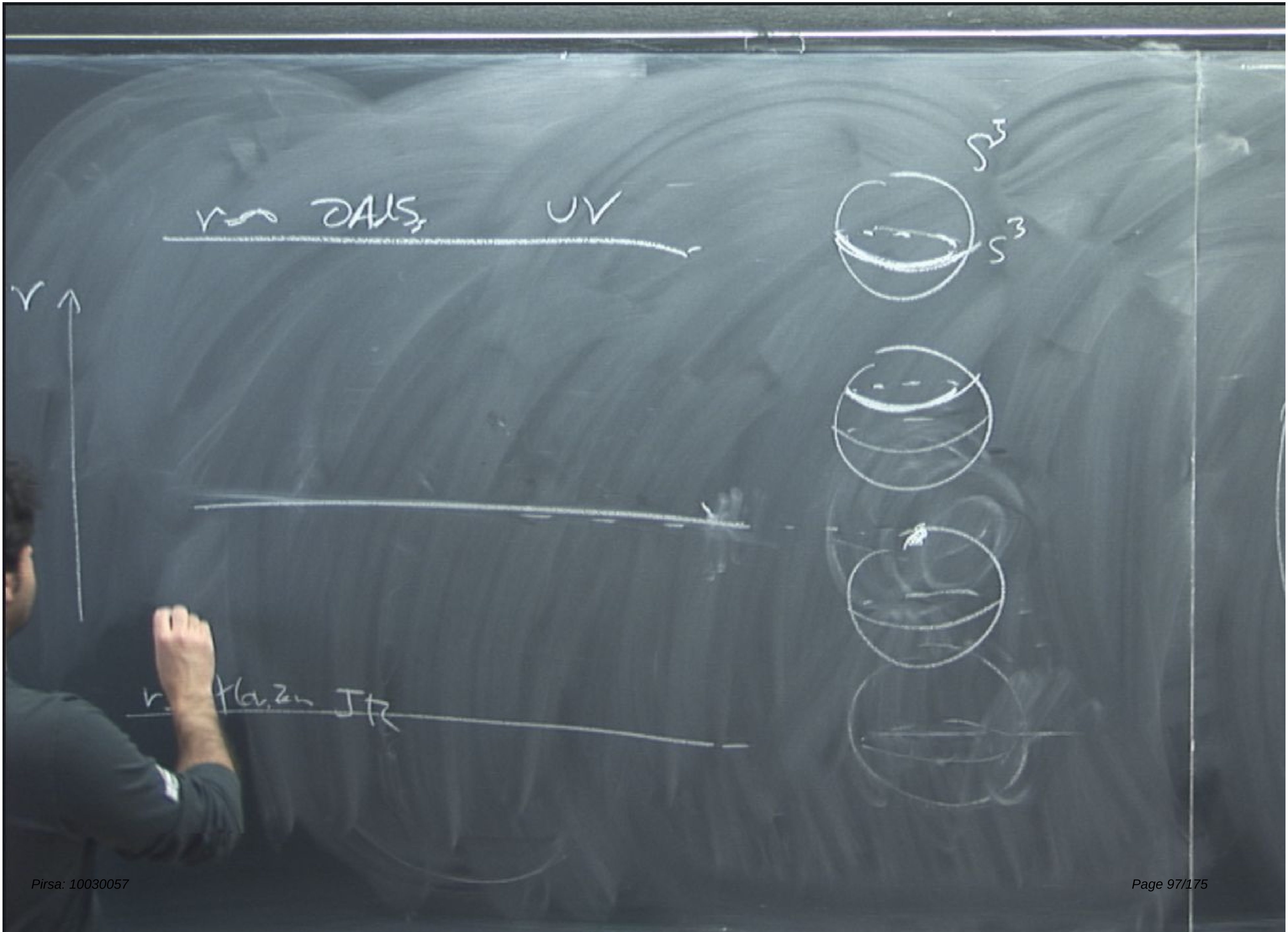

AdS5
UV
S5
S3
r
X

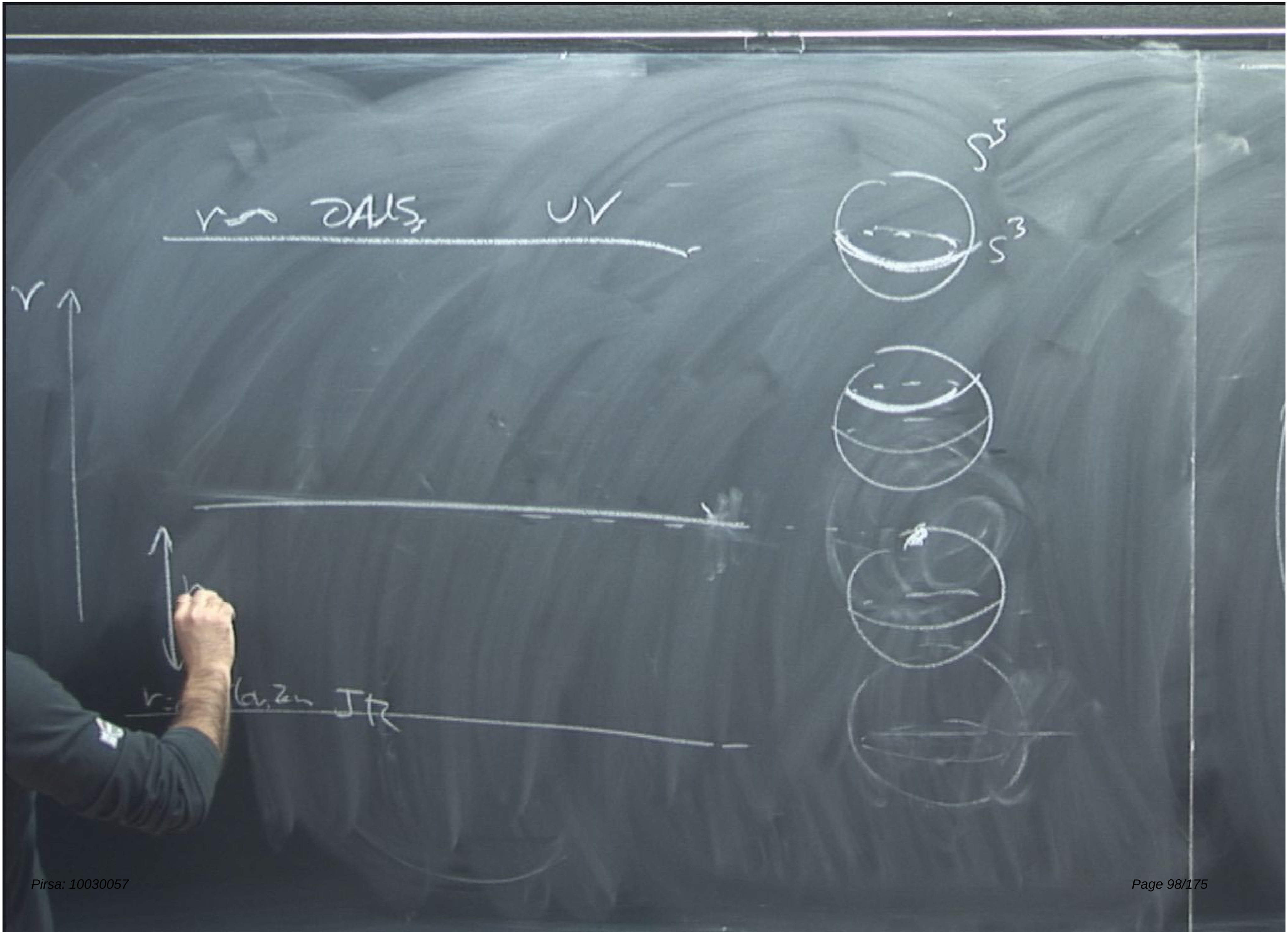
$$r^2 = \rho^2 + z^2$$

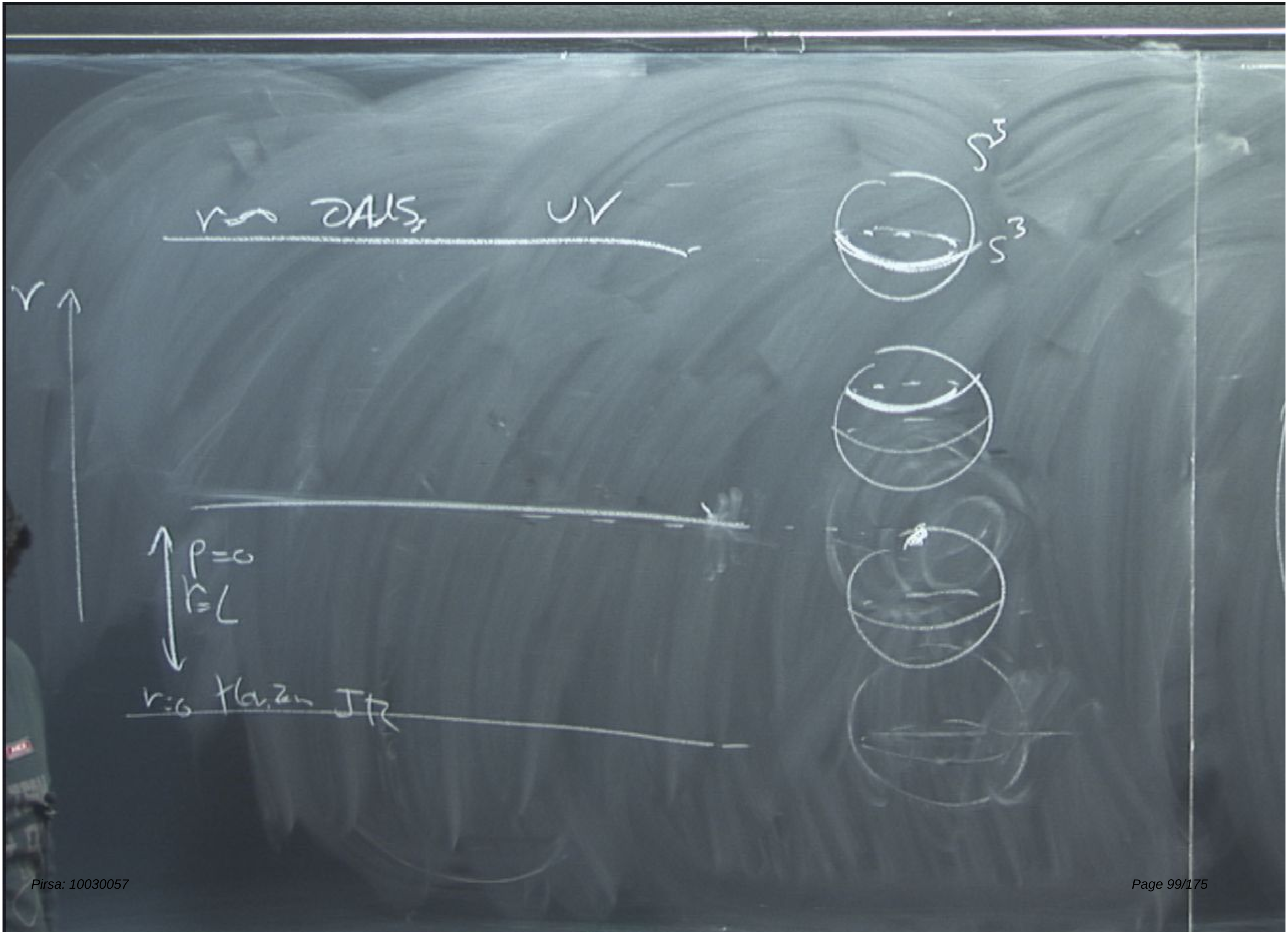
$$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2\, d\Omega_5^2$$

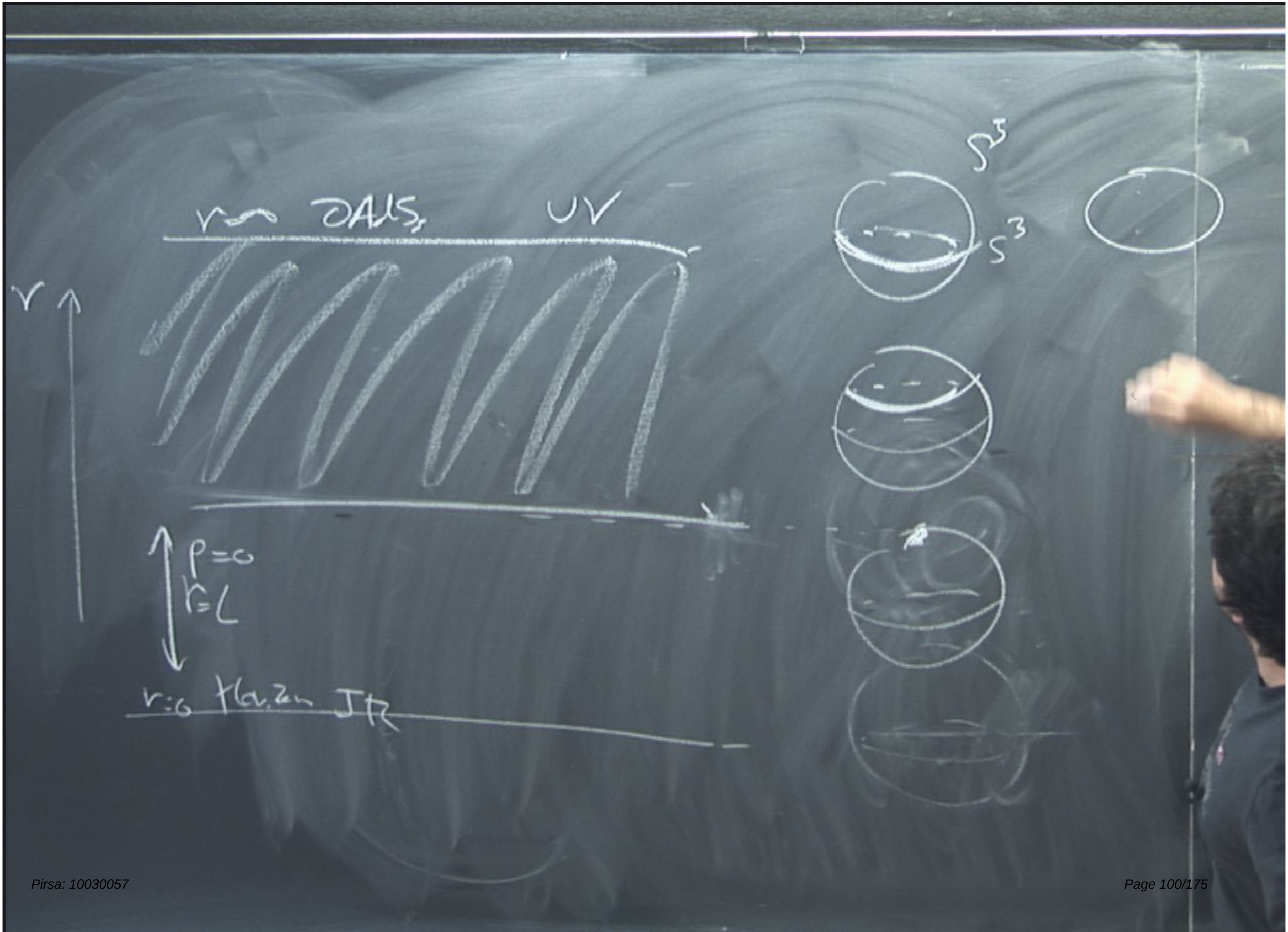
$$\boxed{ds^2_{D7} = \frac{\rho^2 + L^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{\rho^2 + L^2}d\rho^2 + \frac{R^2\rho^2}{\rho^2 + L^2}\, d\Omega_3^2}$$

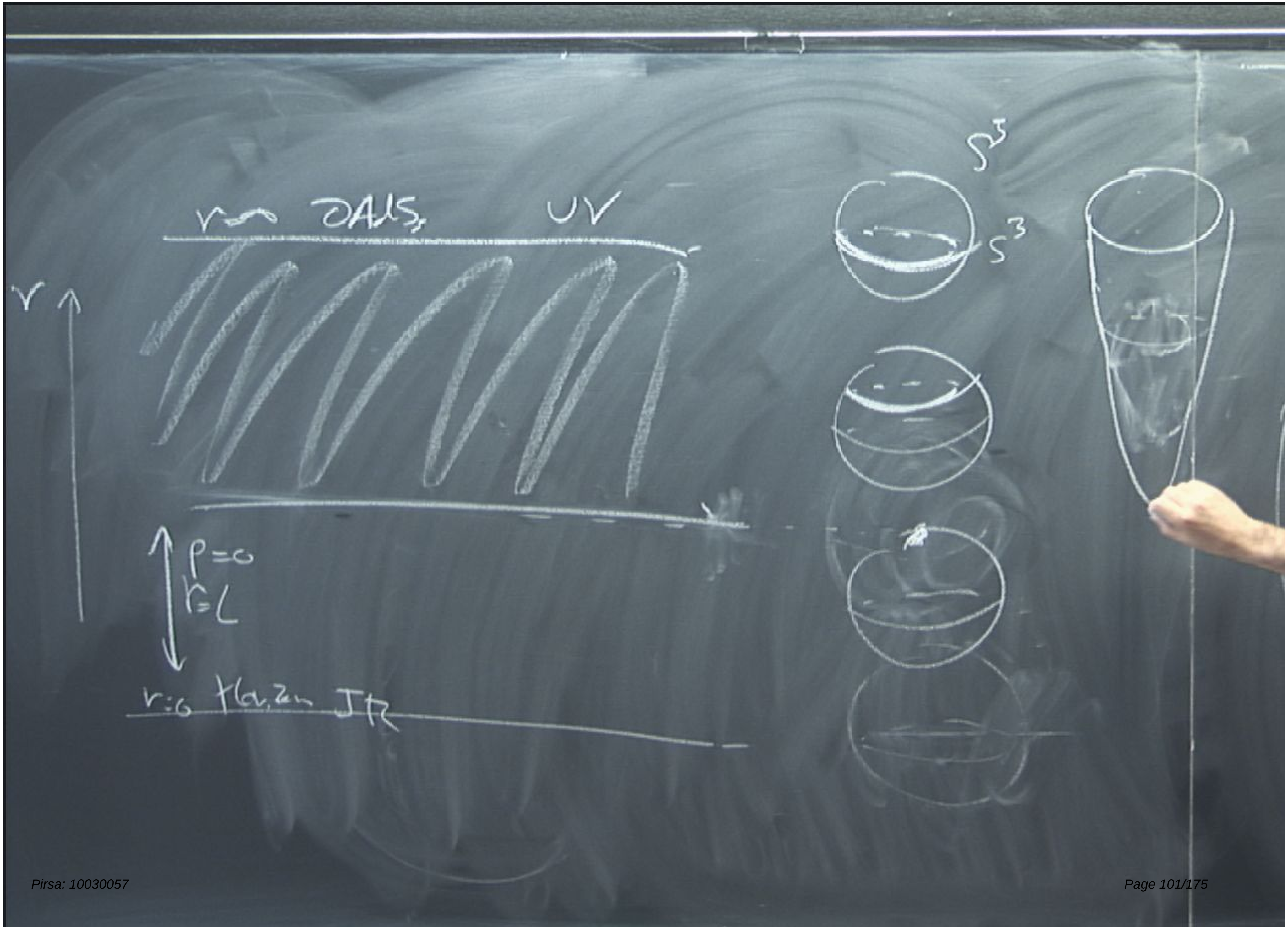

r → ∂AdS5
UV
S5
S3
r
r=0 horizon IR

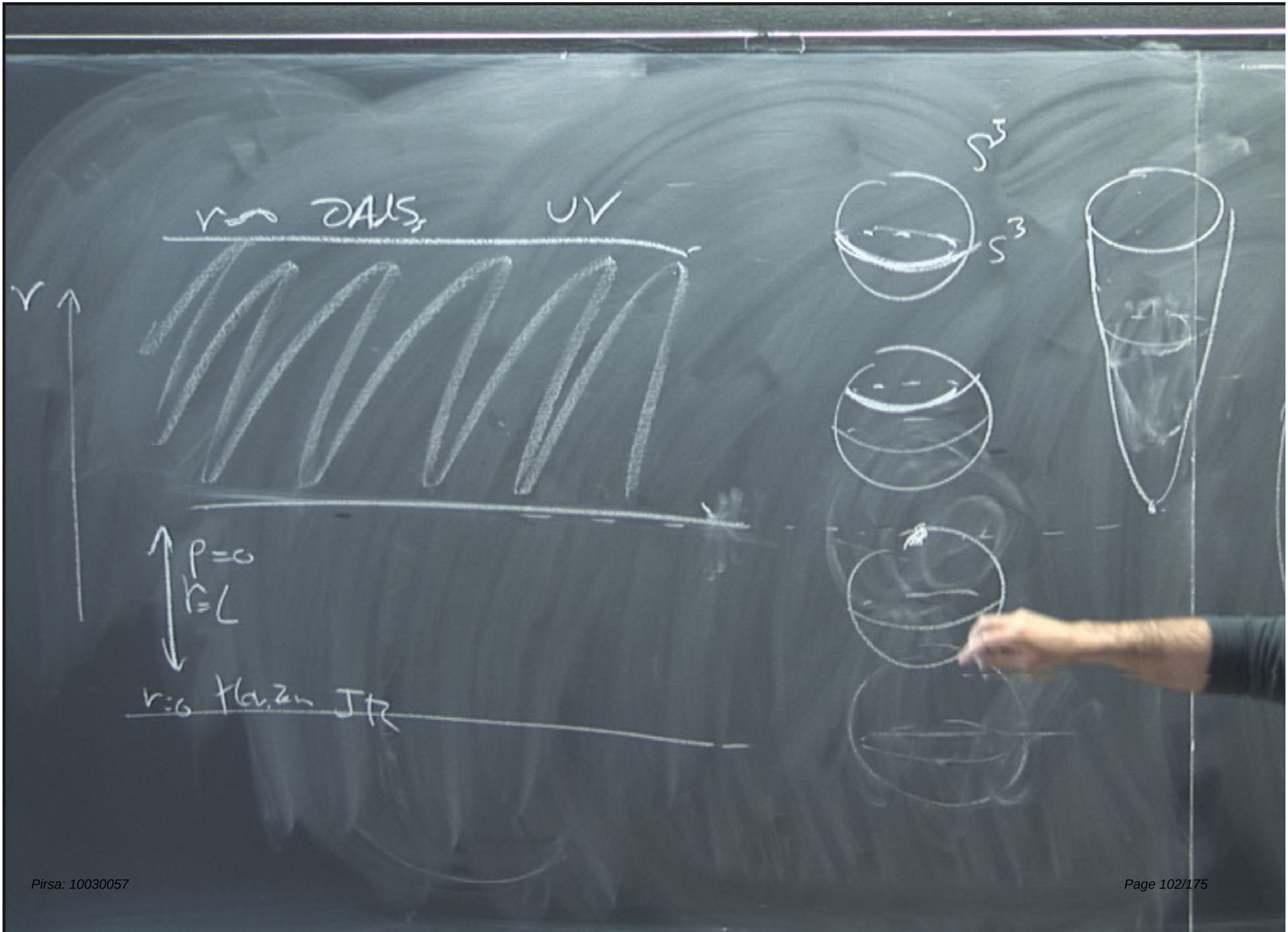

UV
S^5
S^3
r


UV
S5
S3
r

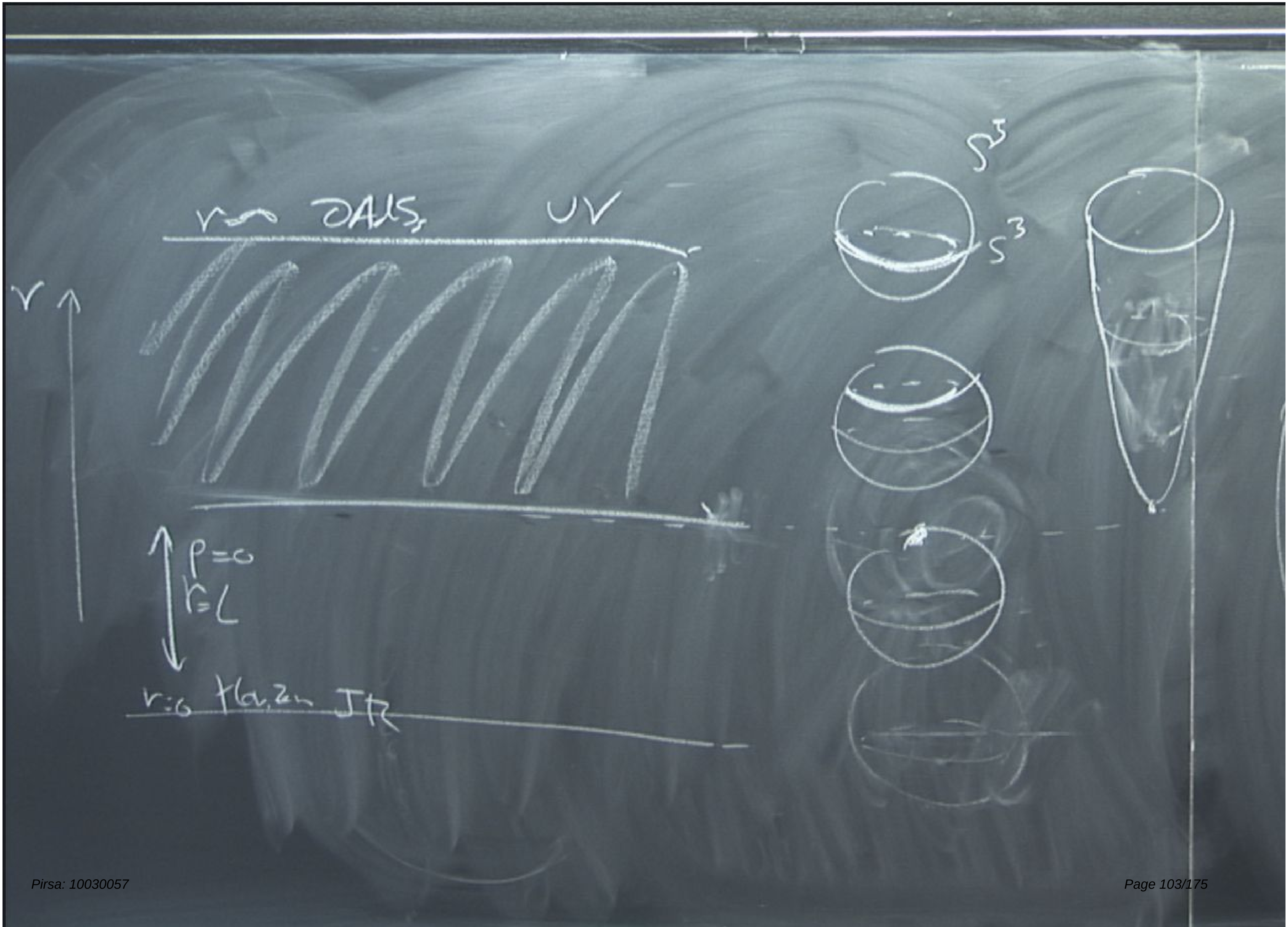

r→∞ ∂AdS5
UV
S5
S3
r
ρ=0
r=L
r=0 Horizon IR

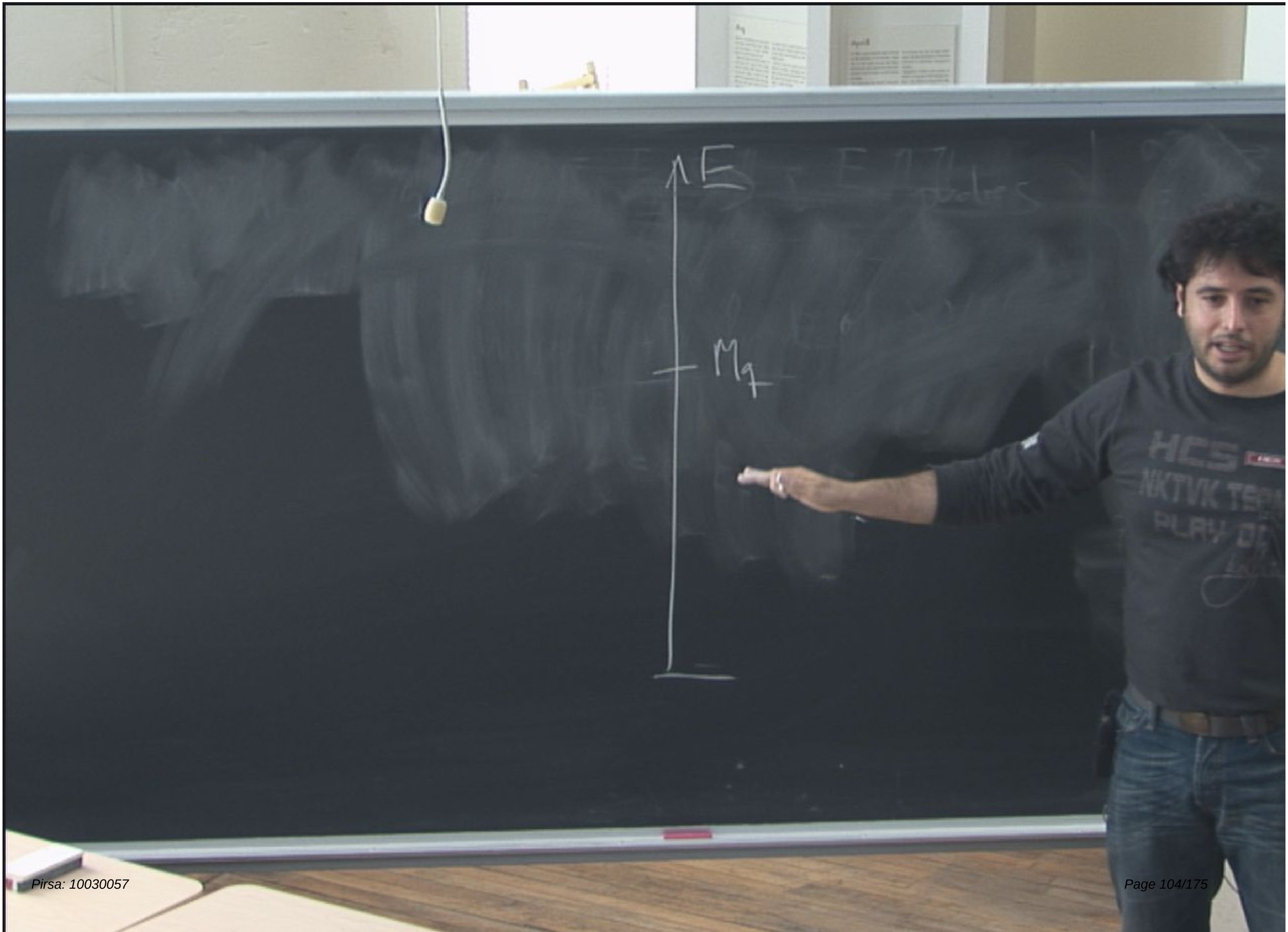

UV
S5
S3
ρ=0
r=L

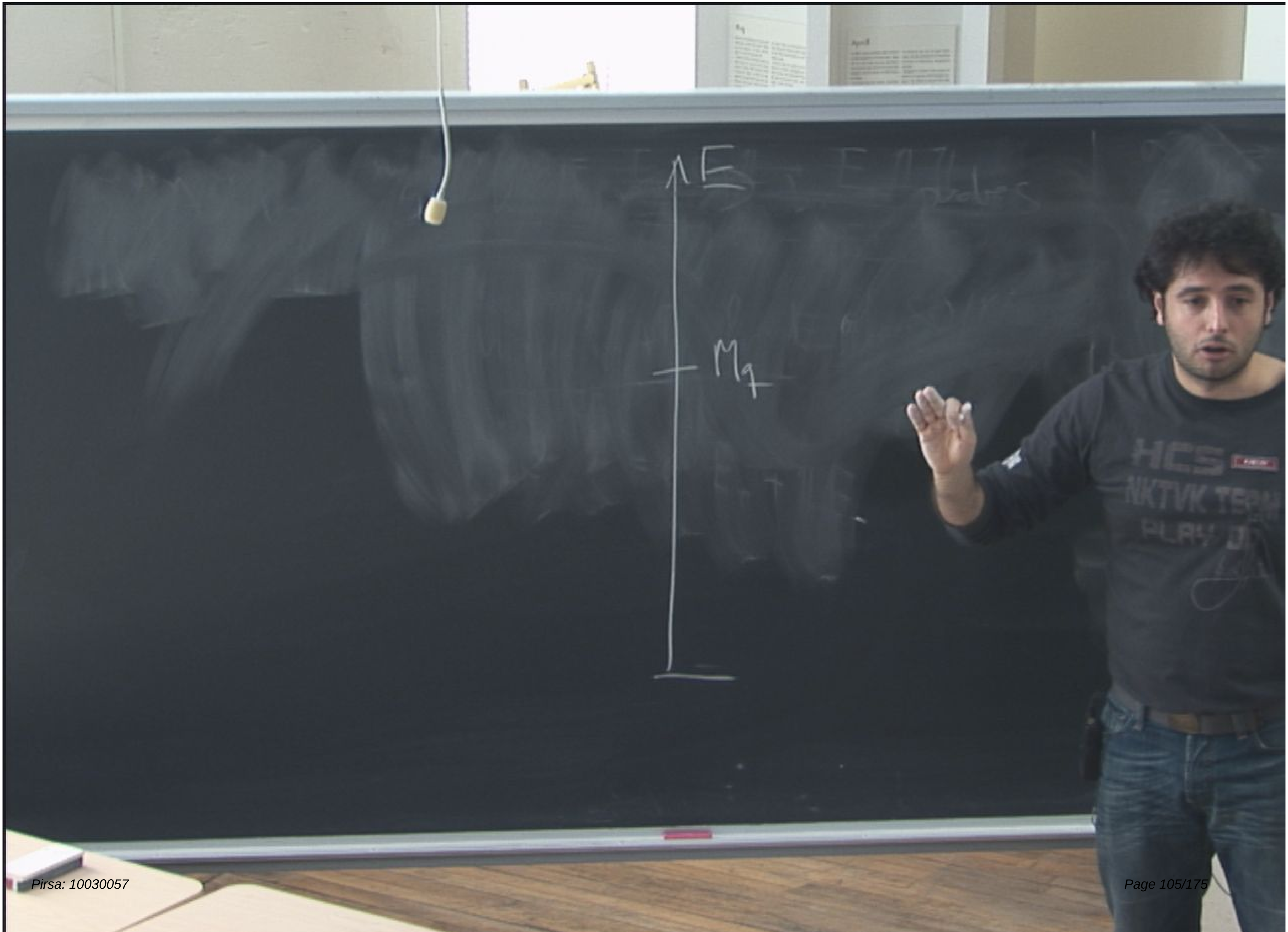

∂AdS5
UV
S5
S3
ρ=0
r=L

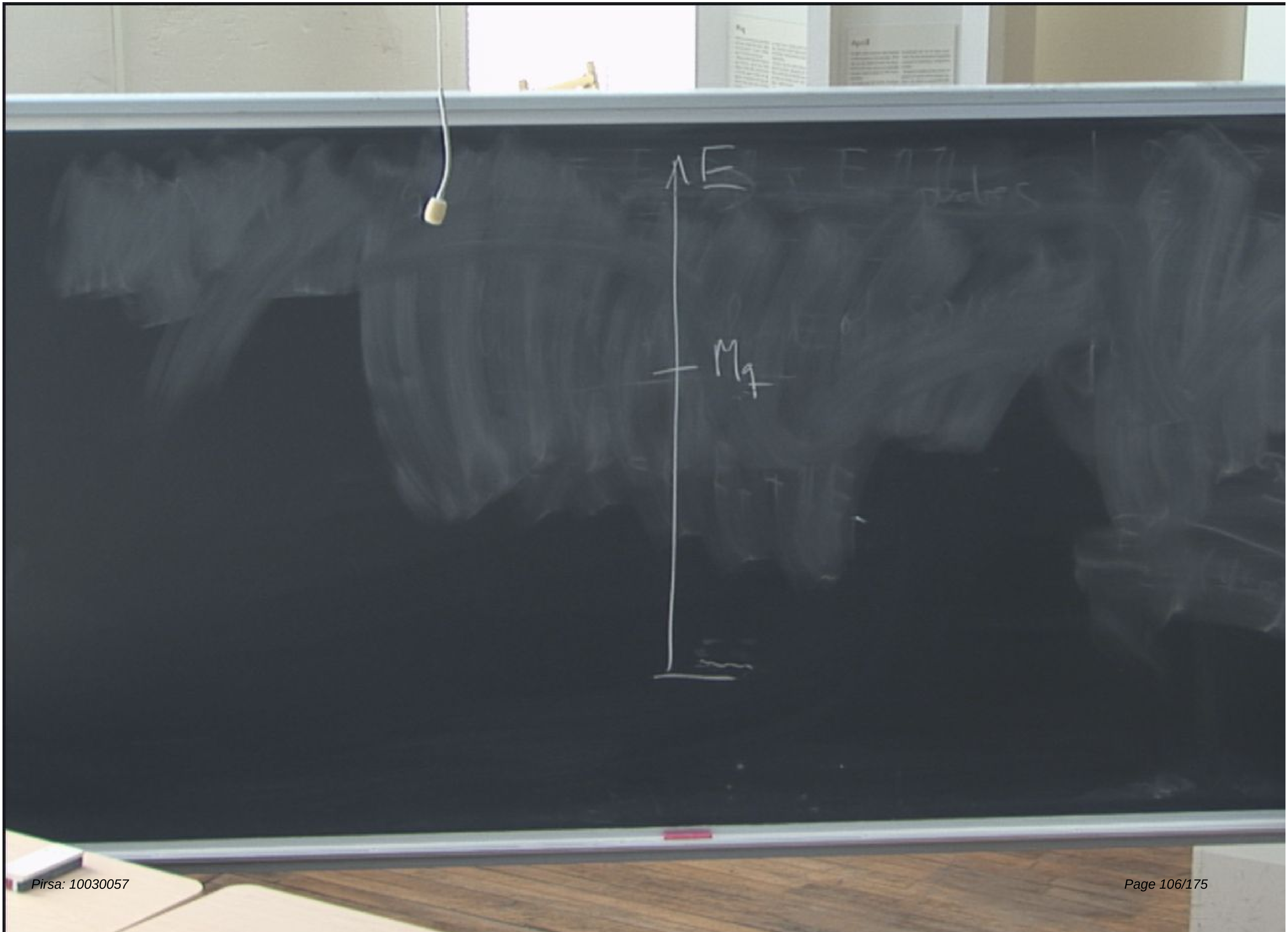


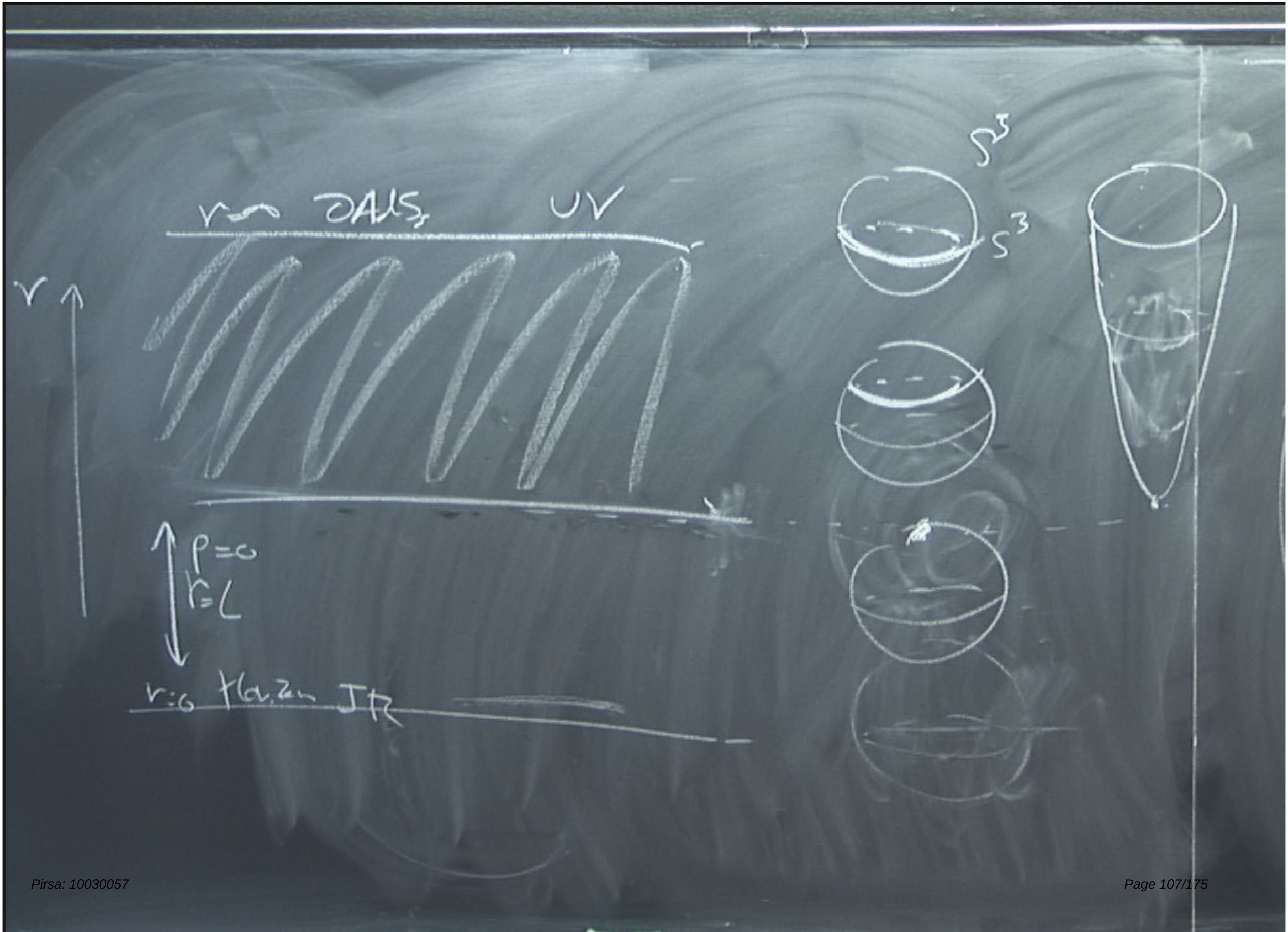
r→∞ ∂AdS₅
UV
r
S⁵
S³
ρ=0
r=L
r=0

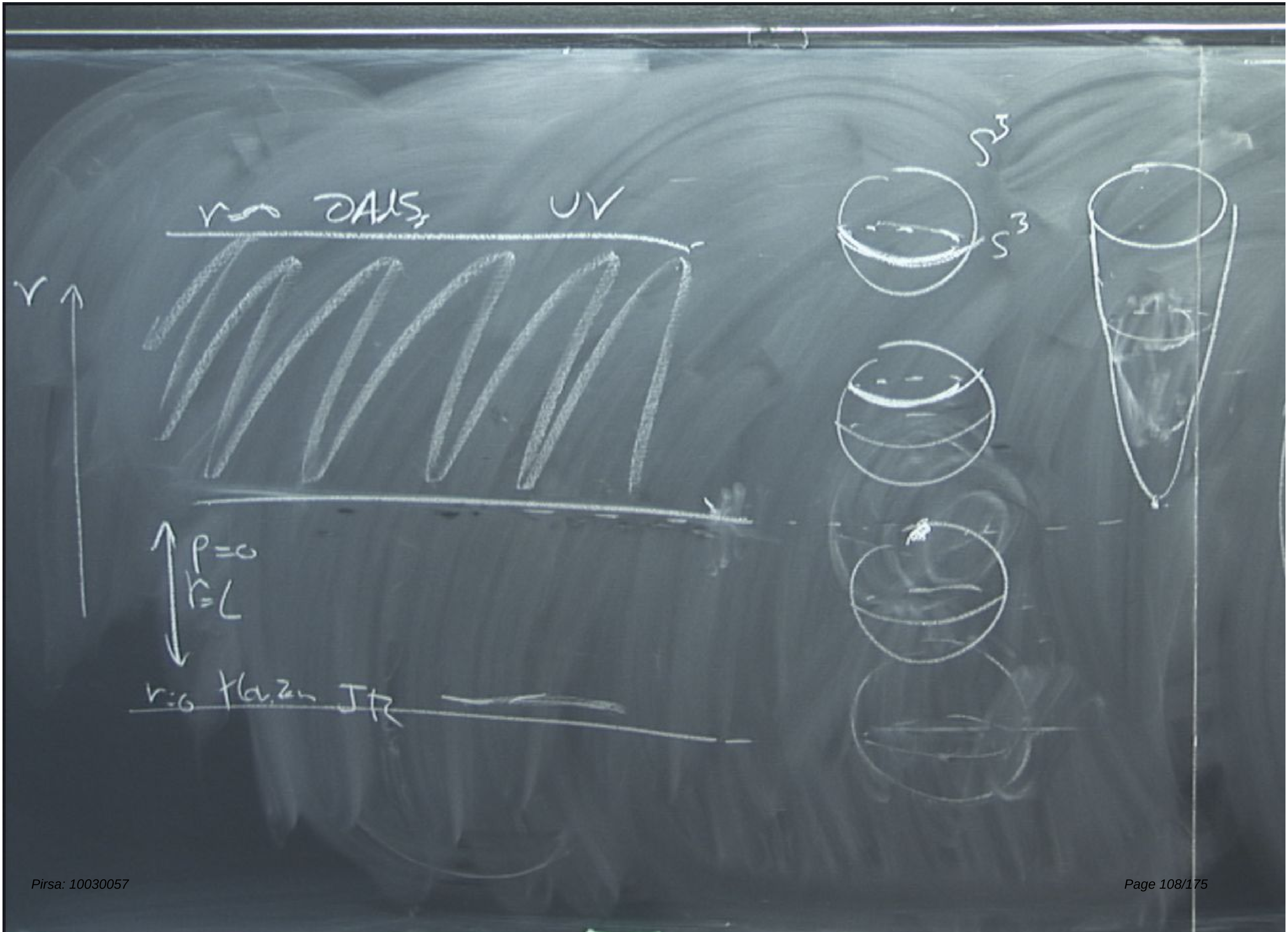

$r \to \partial AdS_5$
UV
S^5
S^3
r
$\rho = 0$
$r = L$
r=0 Horizon $\mathbb{R}$

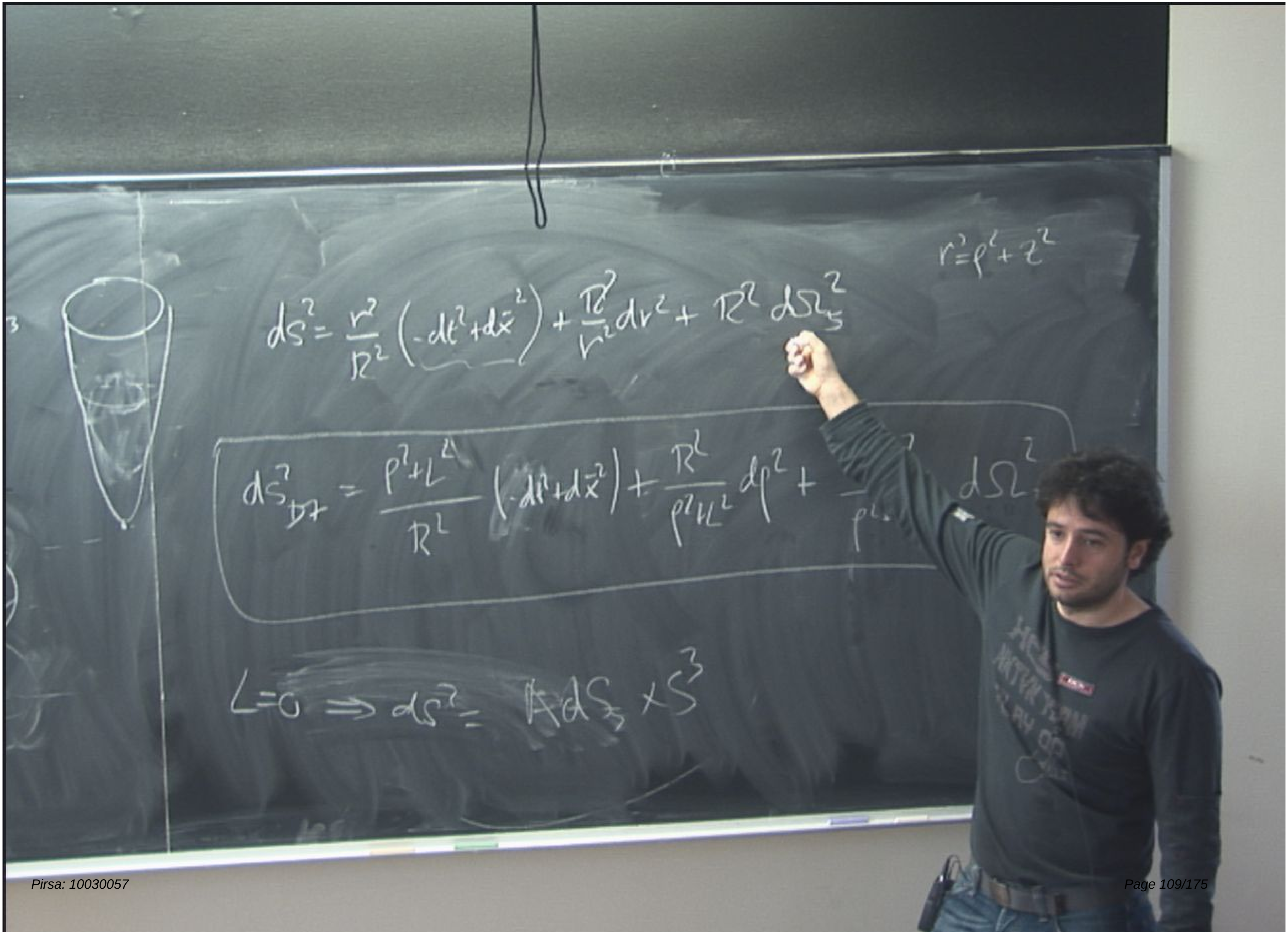

E
Mq


E
M_q

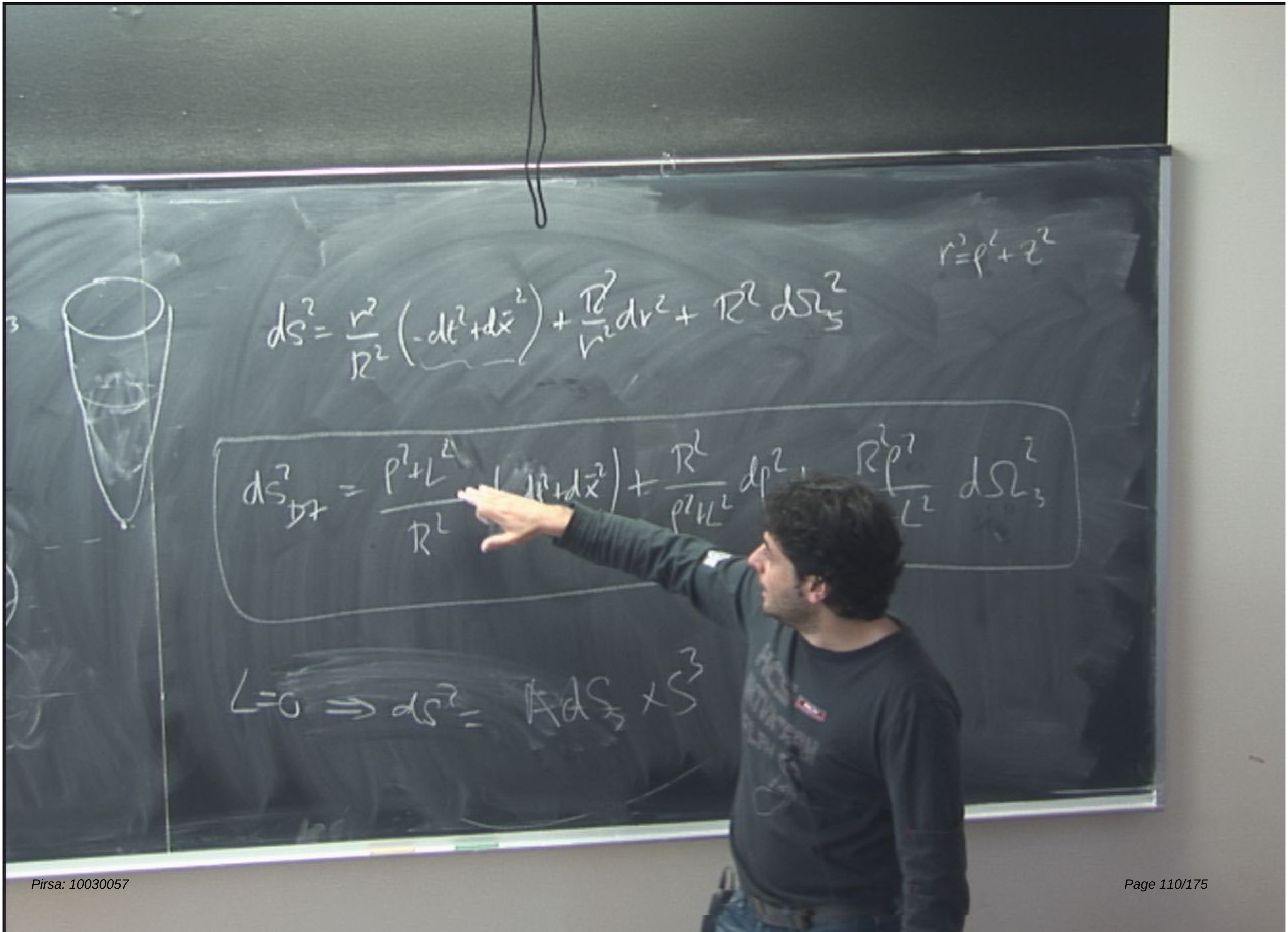

E
Mq

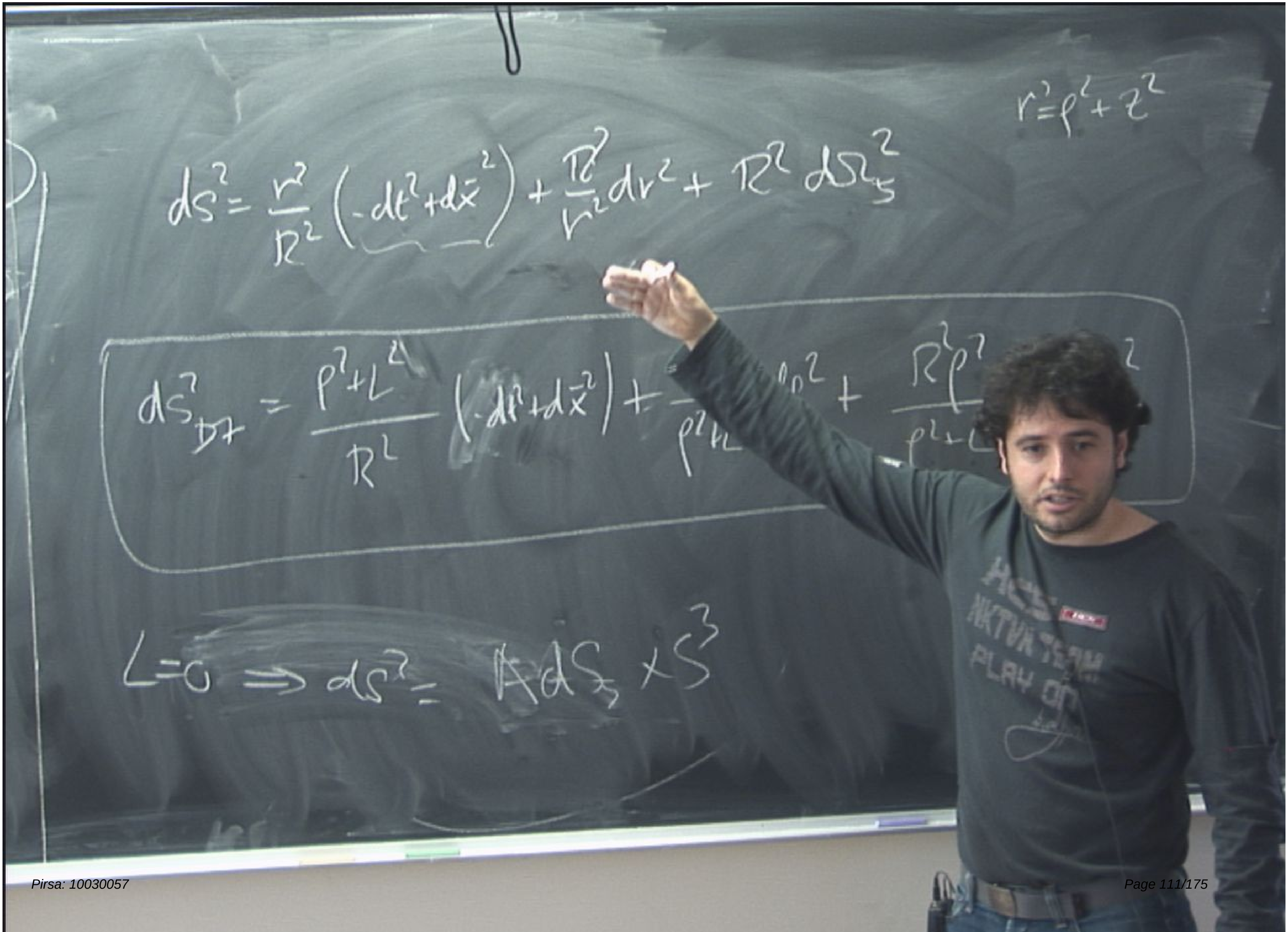

UV
r
S^3
ρ=0
r=L


UV
S^3
ρ=0
r=L



$r^2=\rho^2+z^2$
$ds^2=\frac{r^2}{R^2}\left(-dt^2+d\vec{x}^2\right)+\frac{R^2}{r^2}dr^2+R^2\,d\Omega_5^2$
$ds^2_{D7}=\frac{\rho^2+L^2}{R^2}\left(-dt^2+d\vec{x}^2\right)+\frac{R^2}{\rho^2+L^2}d\rho^2+$
$d\Omega^2$
$L=0\Rightarrow ds^2=AdS_5\times S^3$


r^2 = ρ^2 + z^2
ds^2 = r^2/R^2 (-dt^2 + dx^2) + R^2/r^2 dr^2 + R^2 dΩ_5^2
L=0 ⇒ ds^2 = AdS_5 × S^3



r² = ρ² + z²
ds² = r²/R² (−dt² + dx⃗²) + R²/r² dr² + R² dΩ₅²
ds²_D7 = (ρ² + L²)/R² (−dt² + dx⃗²) +
L = 0 ⇒ ds² = AdS₅ × S³

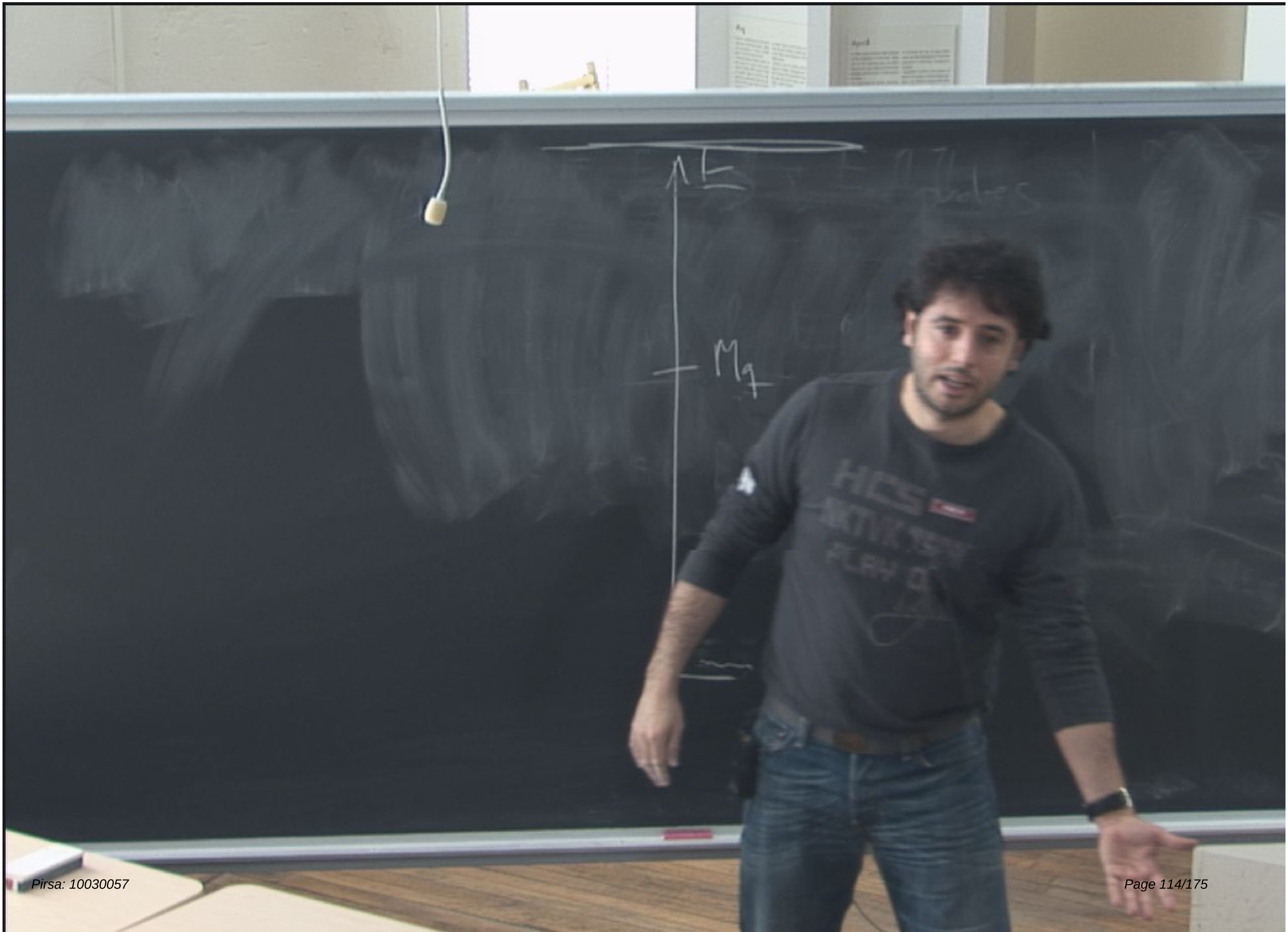
$$r^2 = \rho^2 + z^2$$

$$ds^2 = \frac{r^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{r^2}dr^2 + R^2 d\Omega_5^2$$

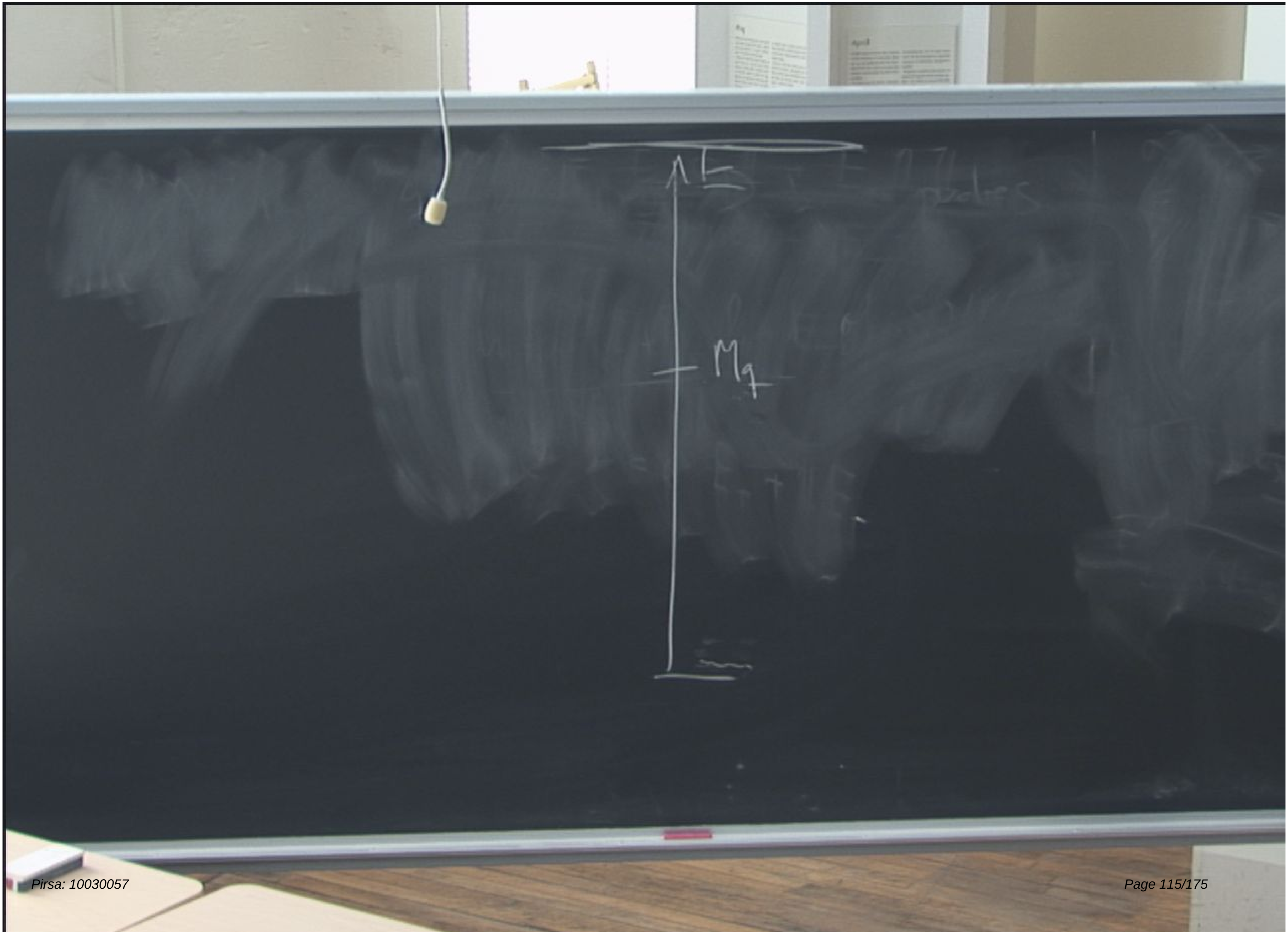
$$\boxed{ds^2_{D7} = \frac{\rho^2 + L^2}{R^2}\left(-dt^2 + d\vec{x}^2\right) + \frac{R^2}{\rho^2 + L^2}d\rho^2 + \frac{R^2\rho^2}{\rho^2 + L^2}d\Omega_3^2}$$

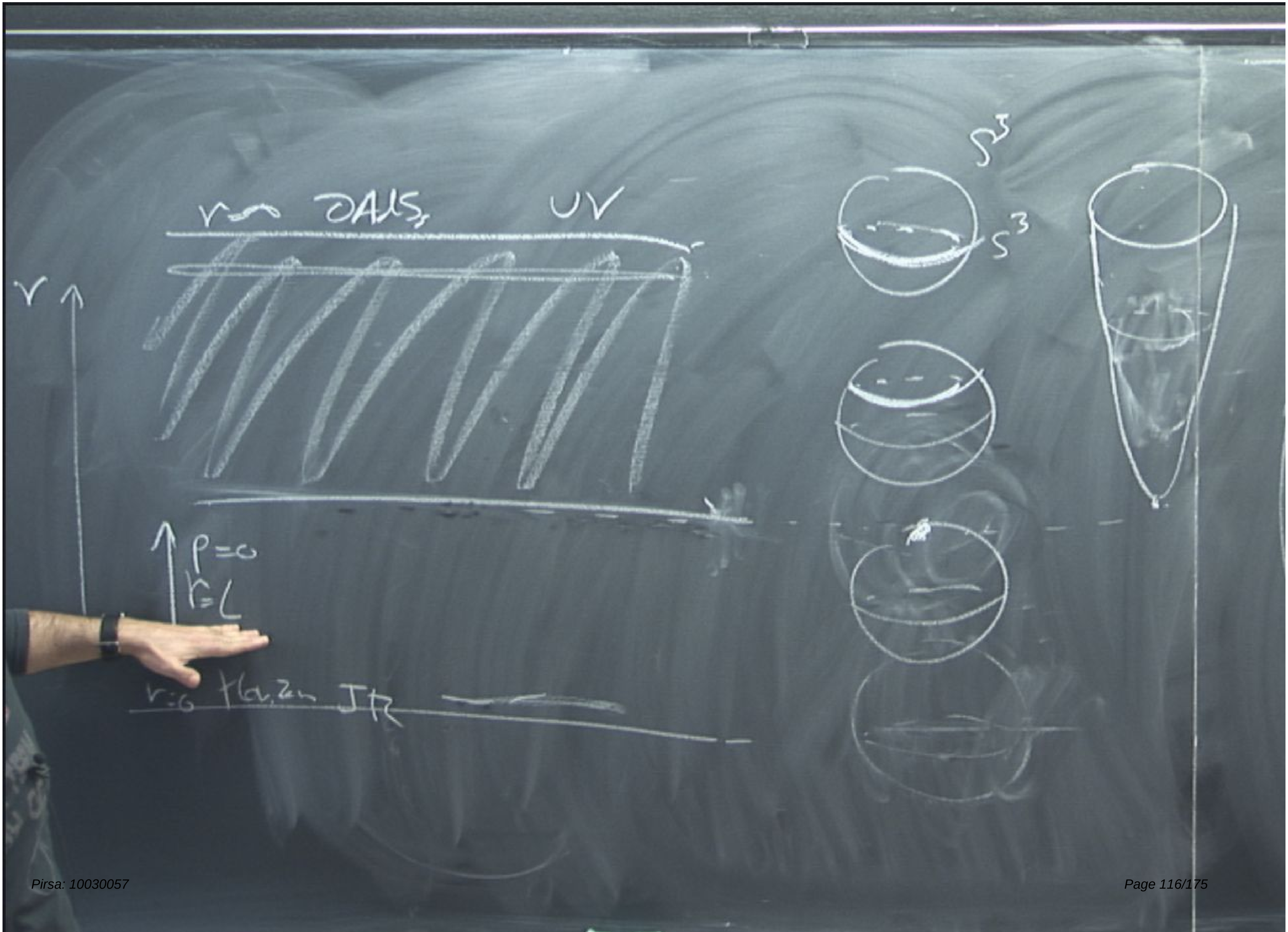
$$L = 0 \Rightarrow ds^2 = AdS_5 \times S^3$$

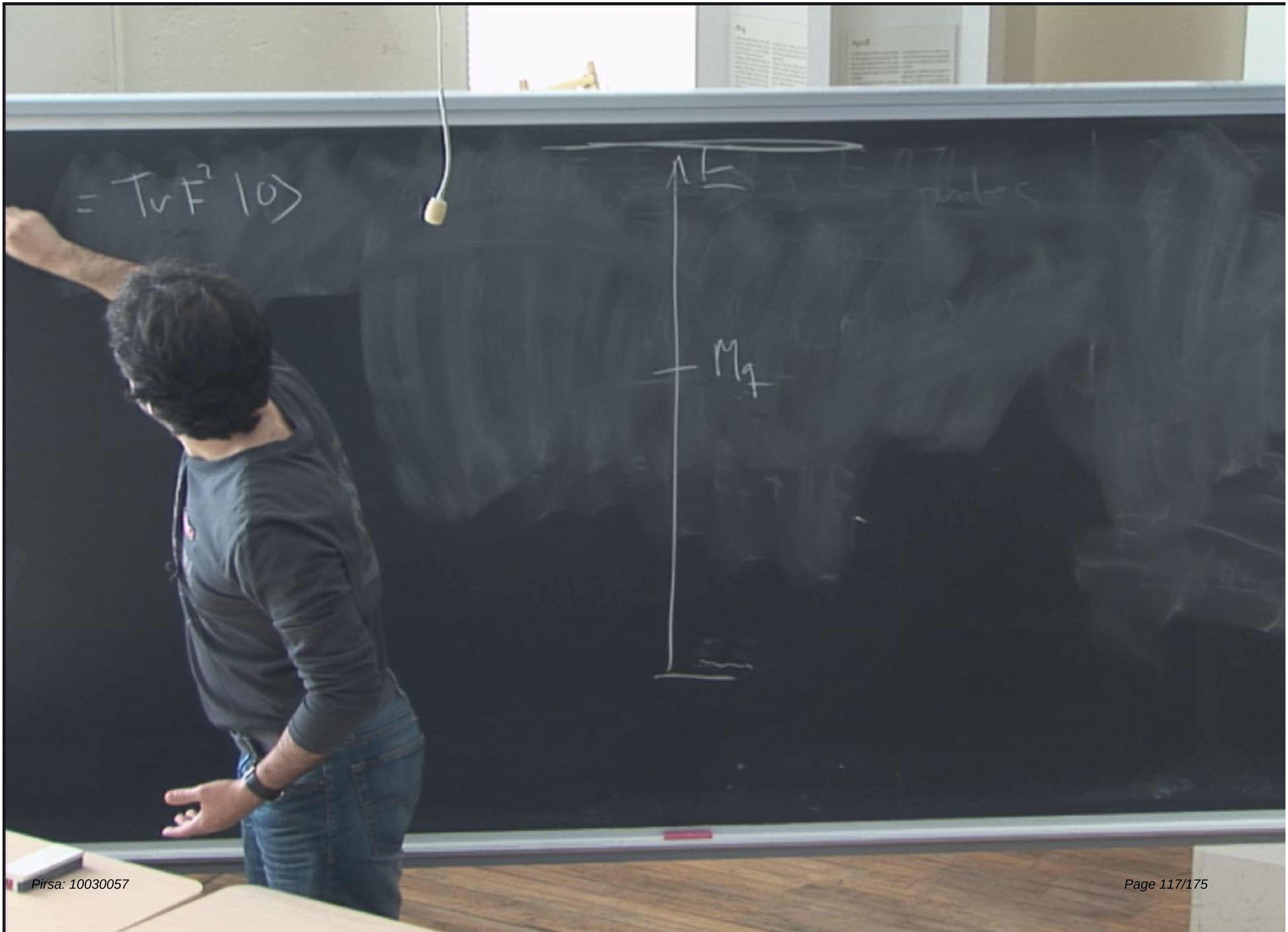
Mq



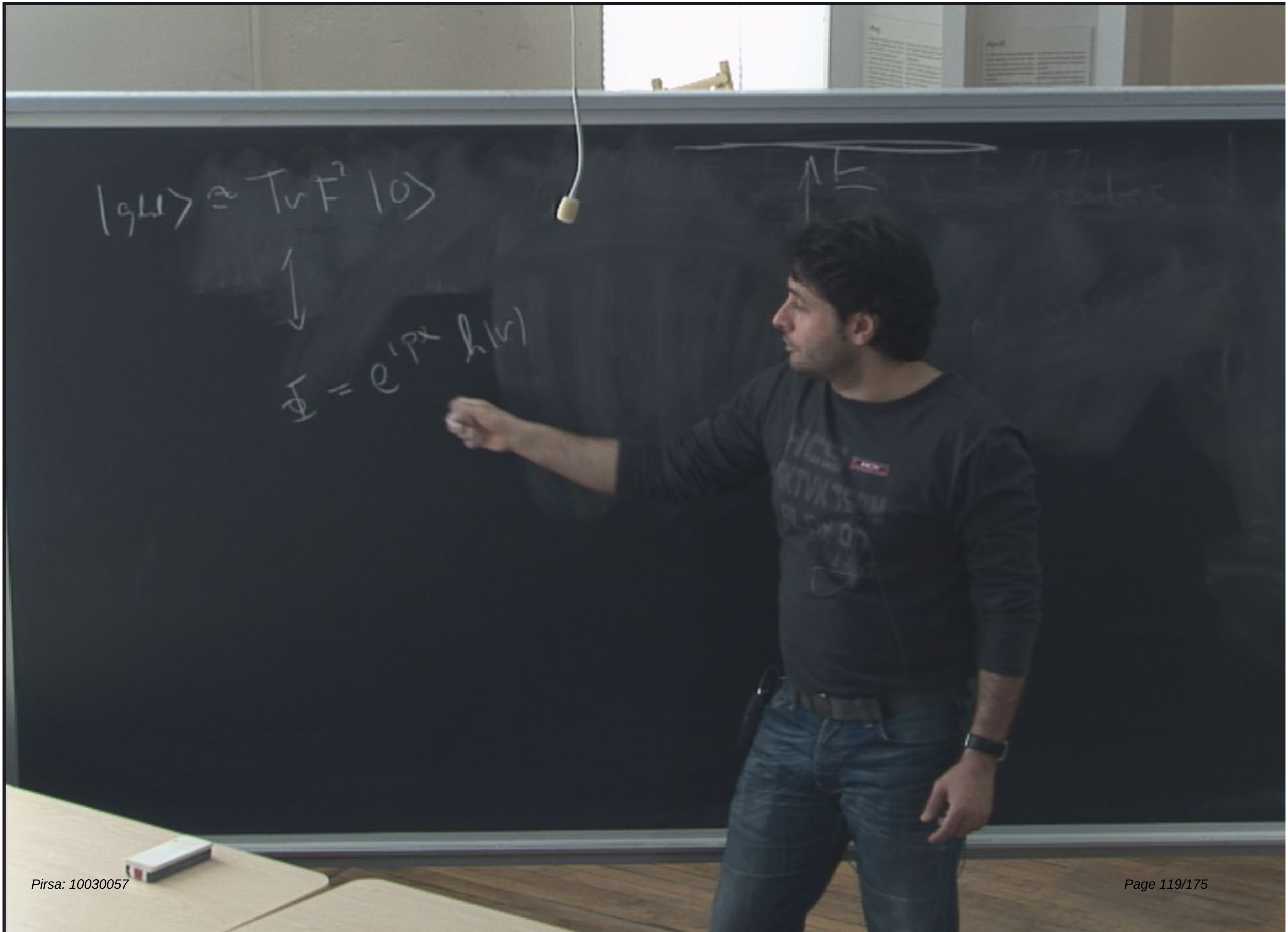
Λ
M_q

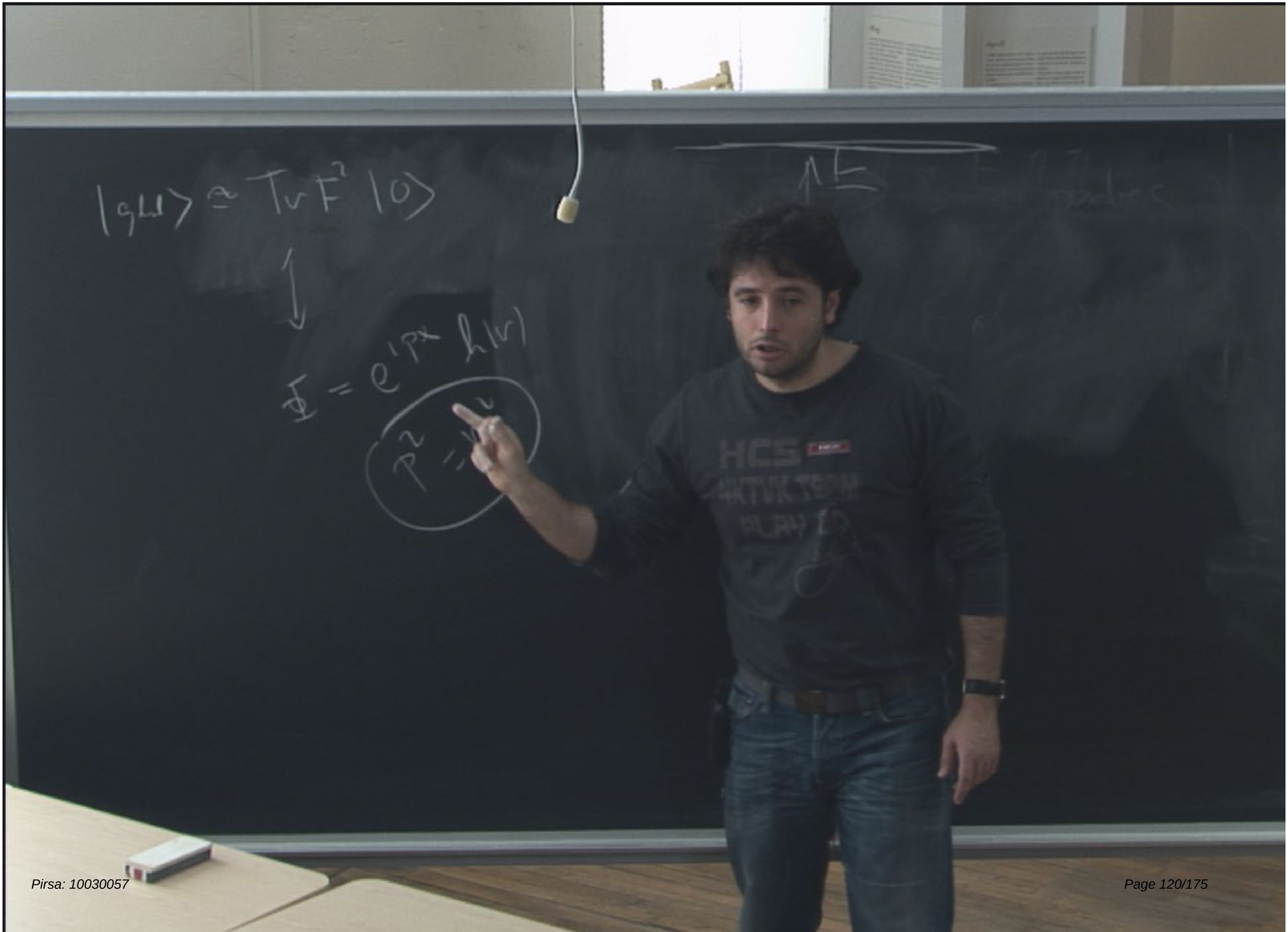

E
Mq

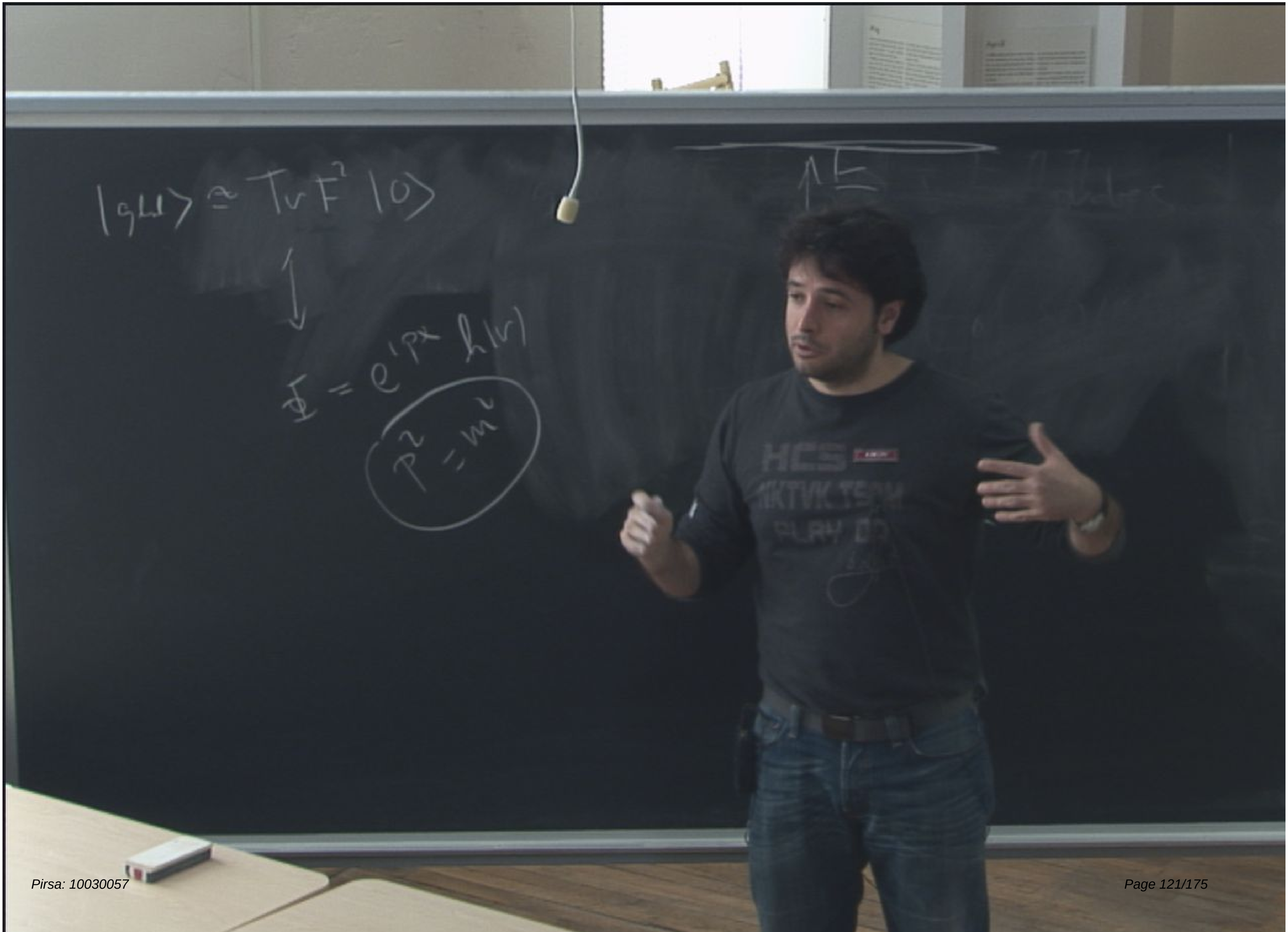

r→∞ ∂AdS5
UV
S5
S3
r
ρ=0
r=L

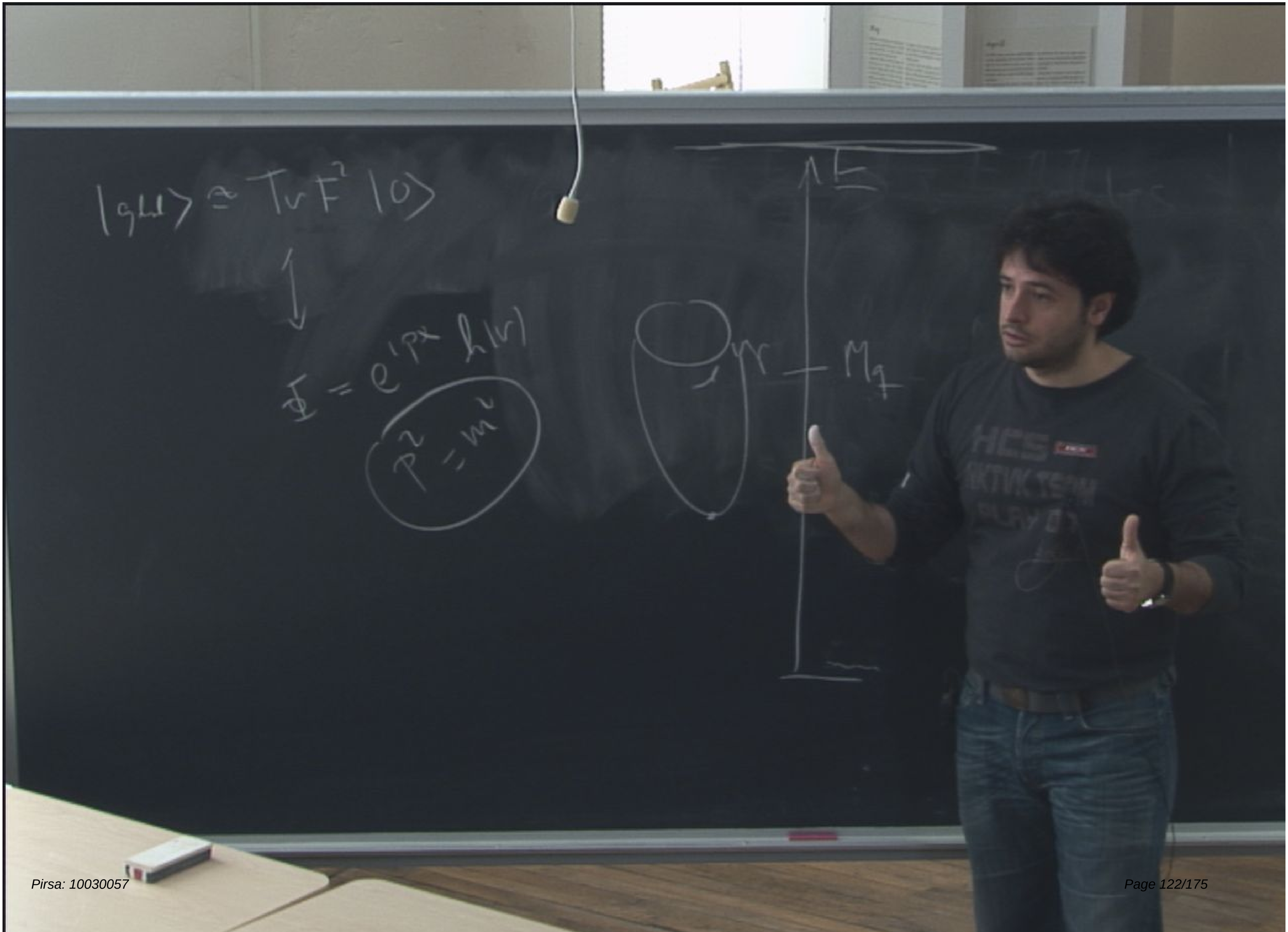

= TrF² |0⟩
E
Mq


Tr F² |0>
Λ
Mq


|glu> ≃ Tr F² |0>
Φ = e^{ipx} h(r)


|glu⟩ ≃ Tr F² |0⟩
Φ = e^{ipx} h(r)


|glu> ≃ TrF² |0>
Φ = e^{ipx} h(r)
p² = m²


|glue⟩ ≃ Tr F² |0⟩
Φ = e^{ipx} h(r)
p² = m²
r
E
M_g

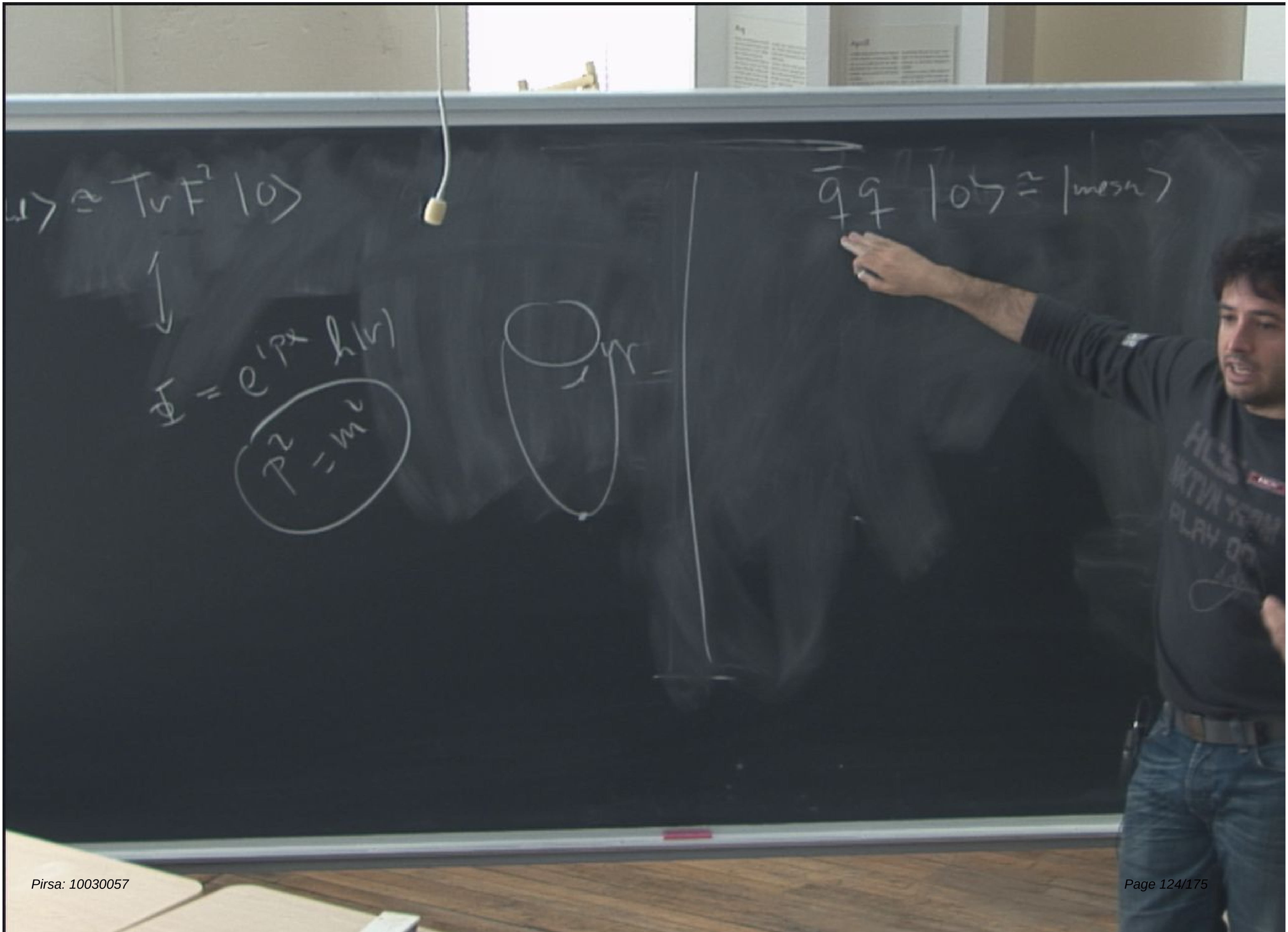
$$|glu\rangle \simeq \mathrm{Tr}\, F^2\, |0\rangle$$

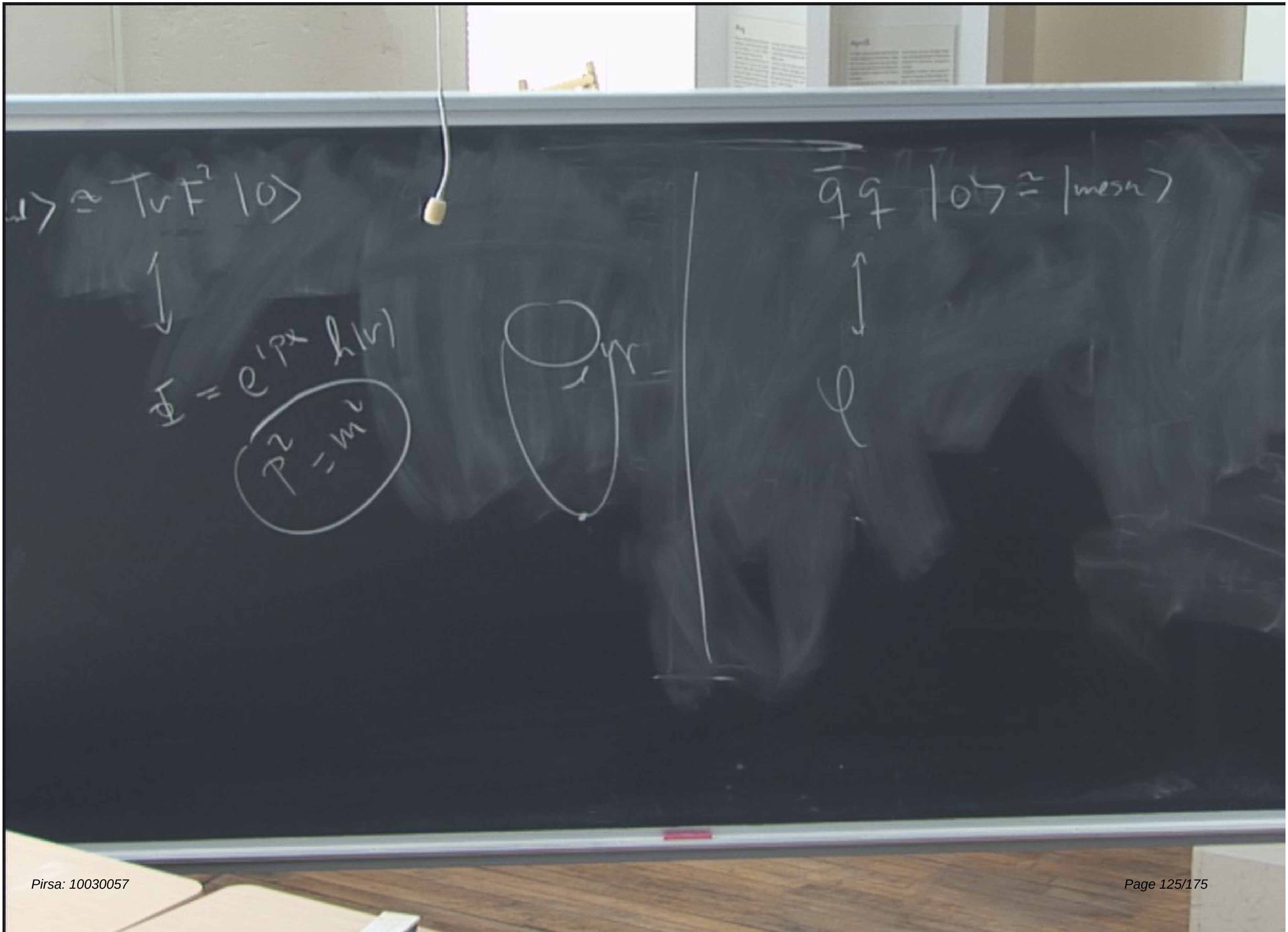
$$\downarrow$$

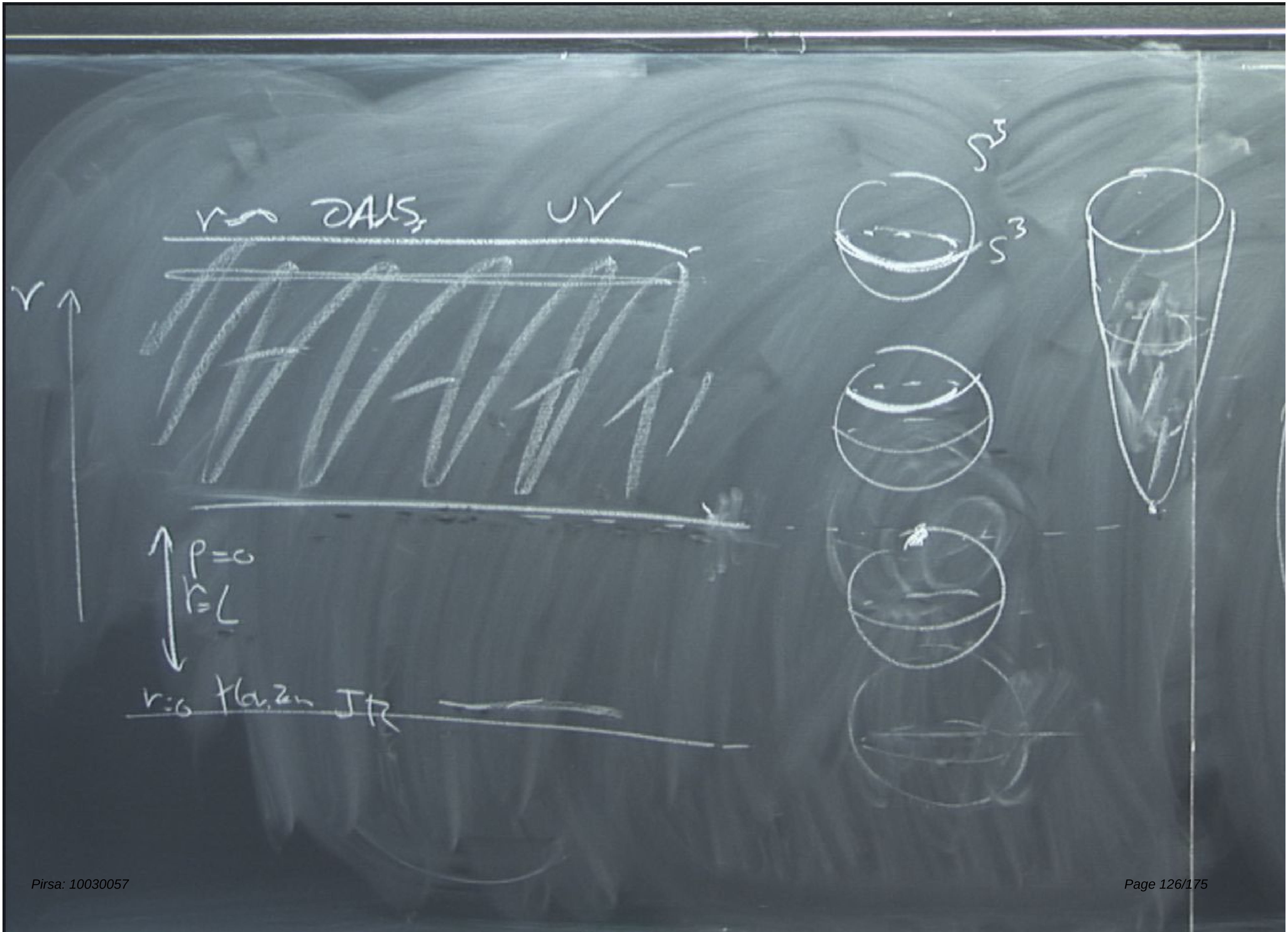
$$\Phi = e^{ipx}\, h(r)$$

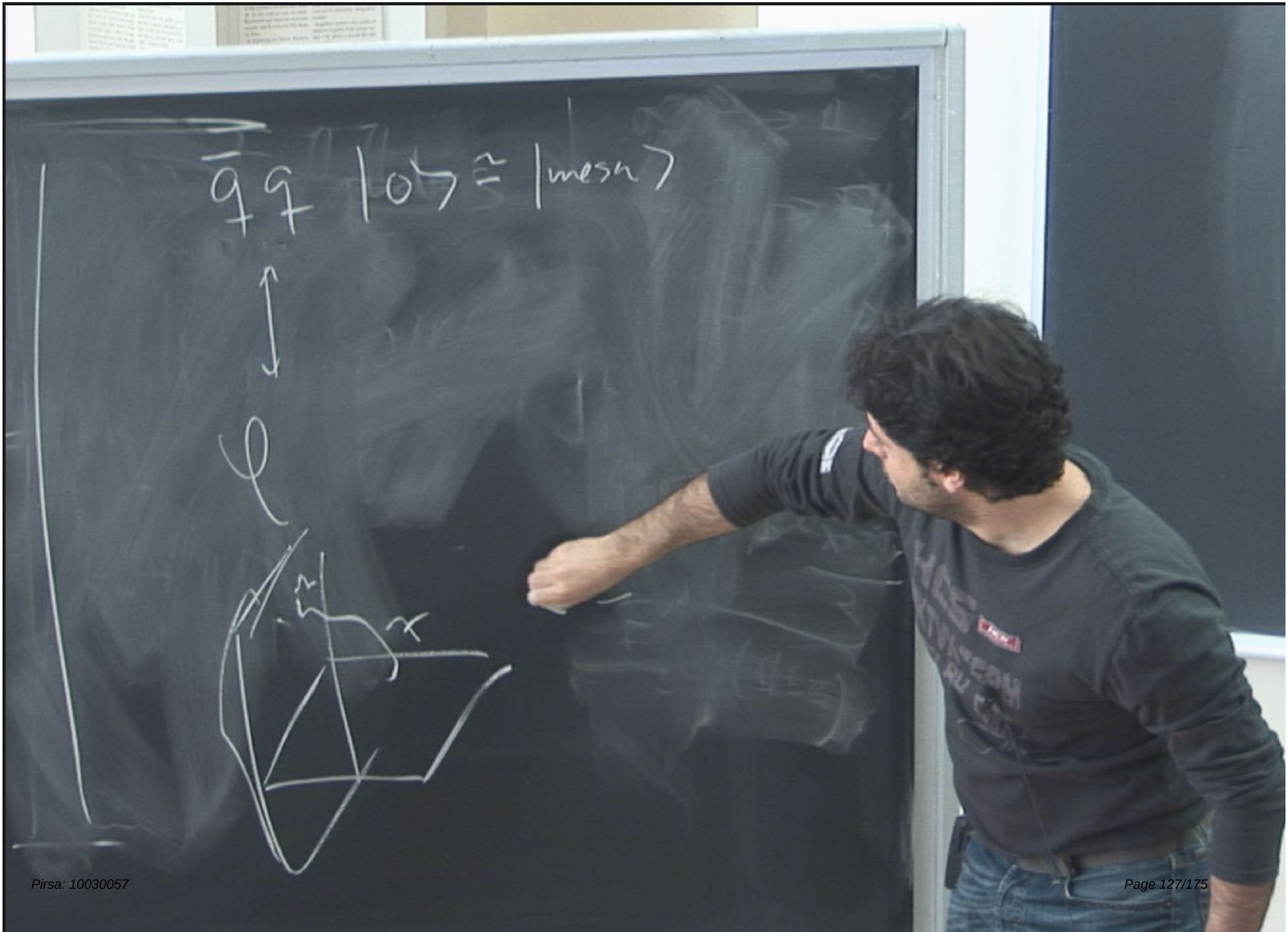
$$p^2 = m^2$$

$$\bar{q}\, q\, |0\rangle \simeq$$

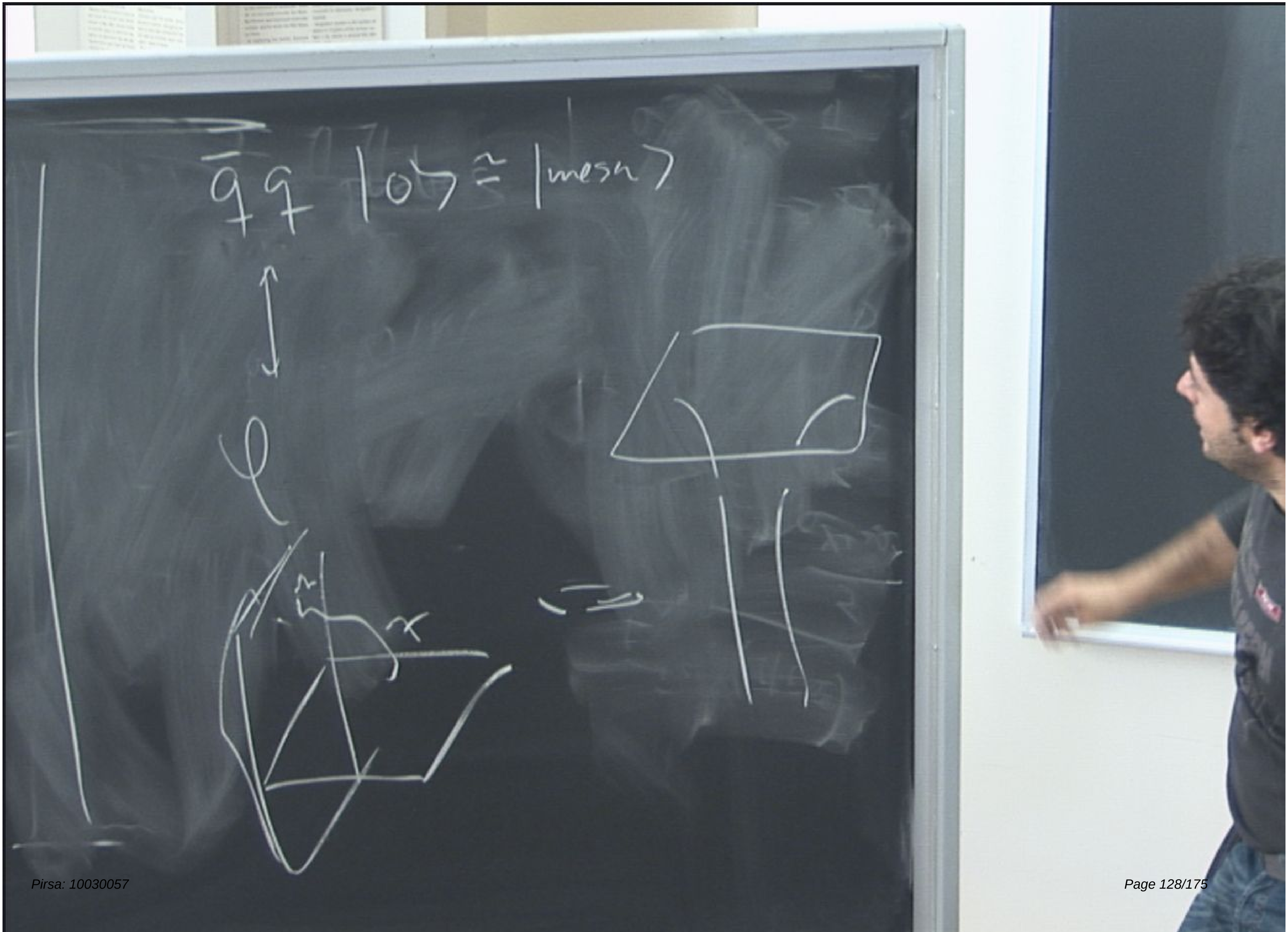

$\rangle \simeq \mathrm{Tr}F^2 |0\rangle$
$\Phi = e^{ipx} h(r)$
$p^2 = m^2$
r
$\bar{q}q |0\rangle \simeq |\text{meson}\rangle$

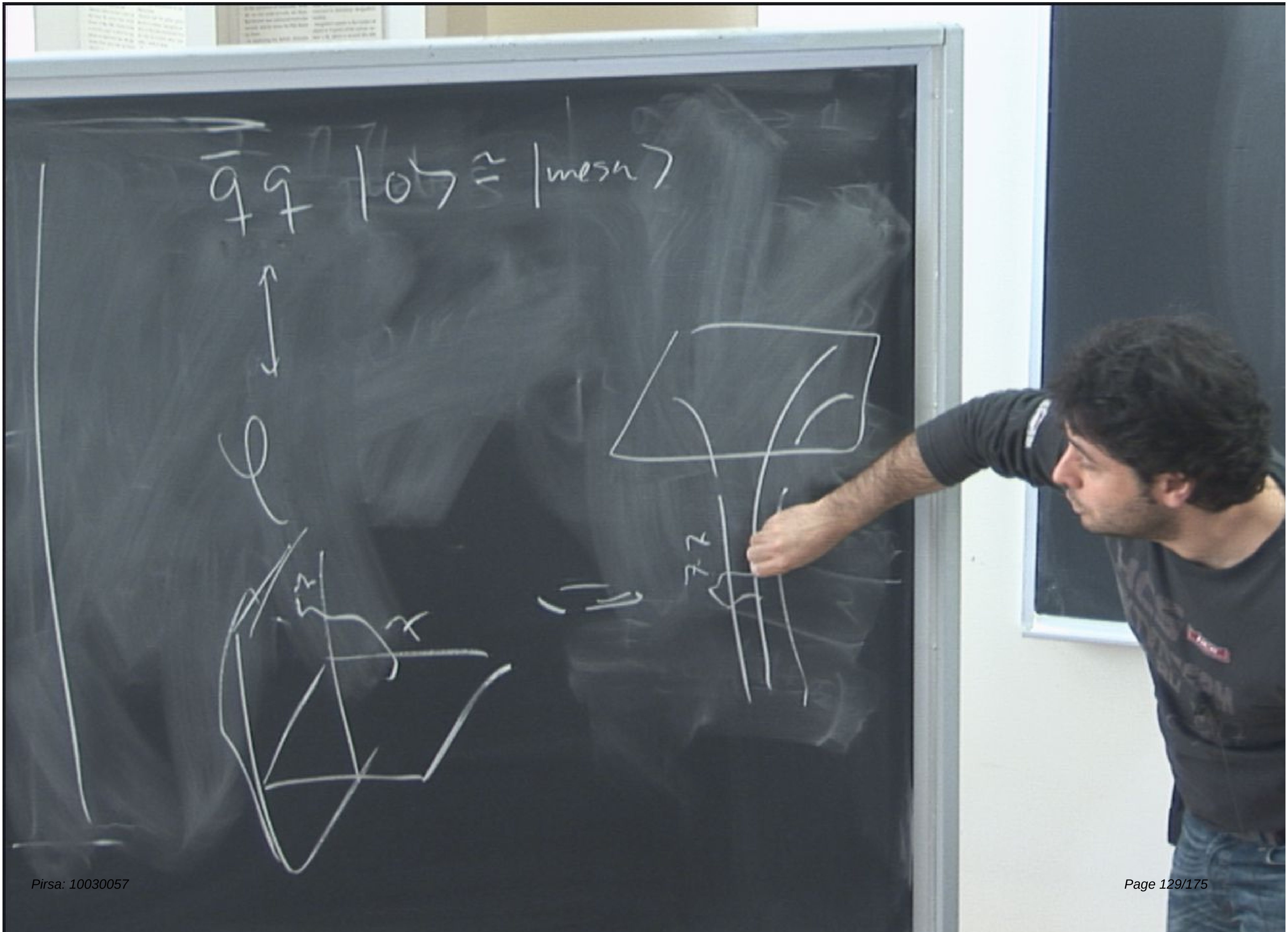

$\rangle \simeq \mathrm{Tr}F^2 |0\rangle$
$\Phi = e^{ipx} h(r)$
$p^2 = m^2$
r
$\bar{q} q |0\rangle \simeq |\text{mesn}\rangle$
φ

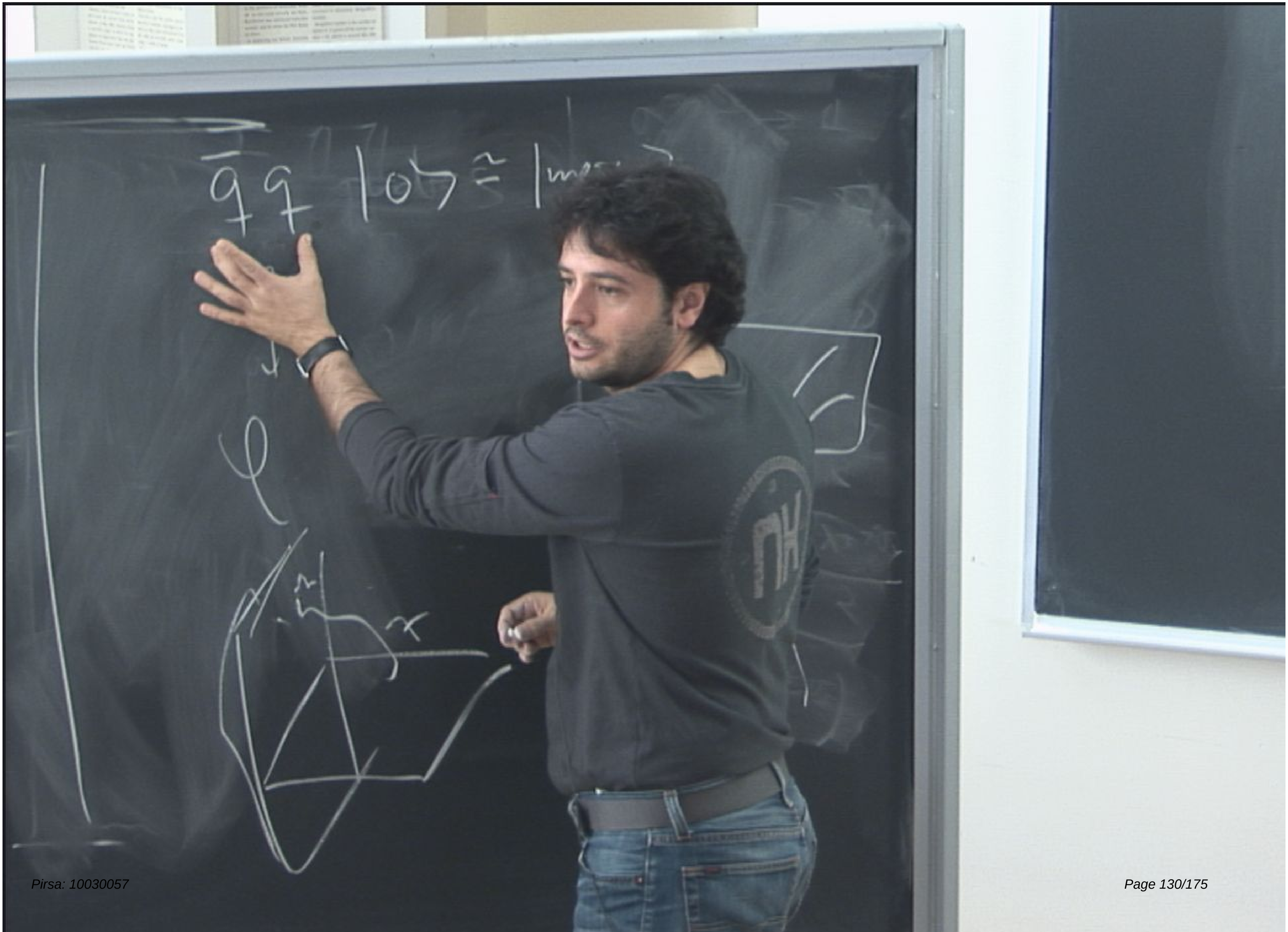

r → ∂AdS5
UV
r
S5
S3
ρ=0
r=L
r=0 Horizon IR

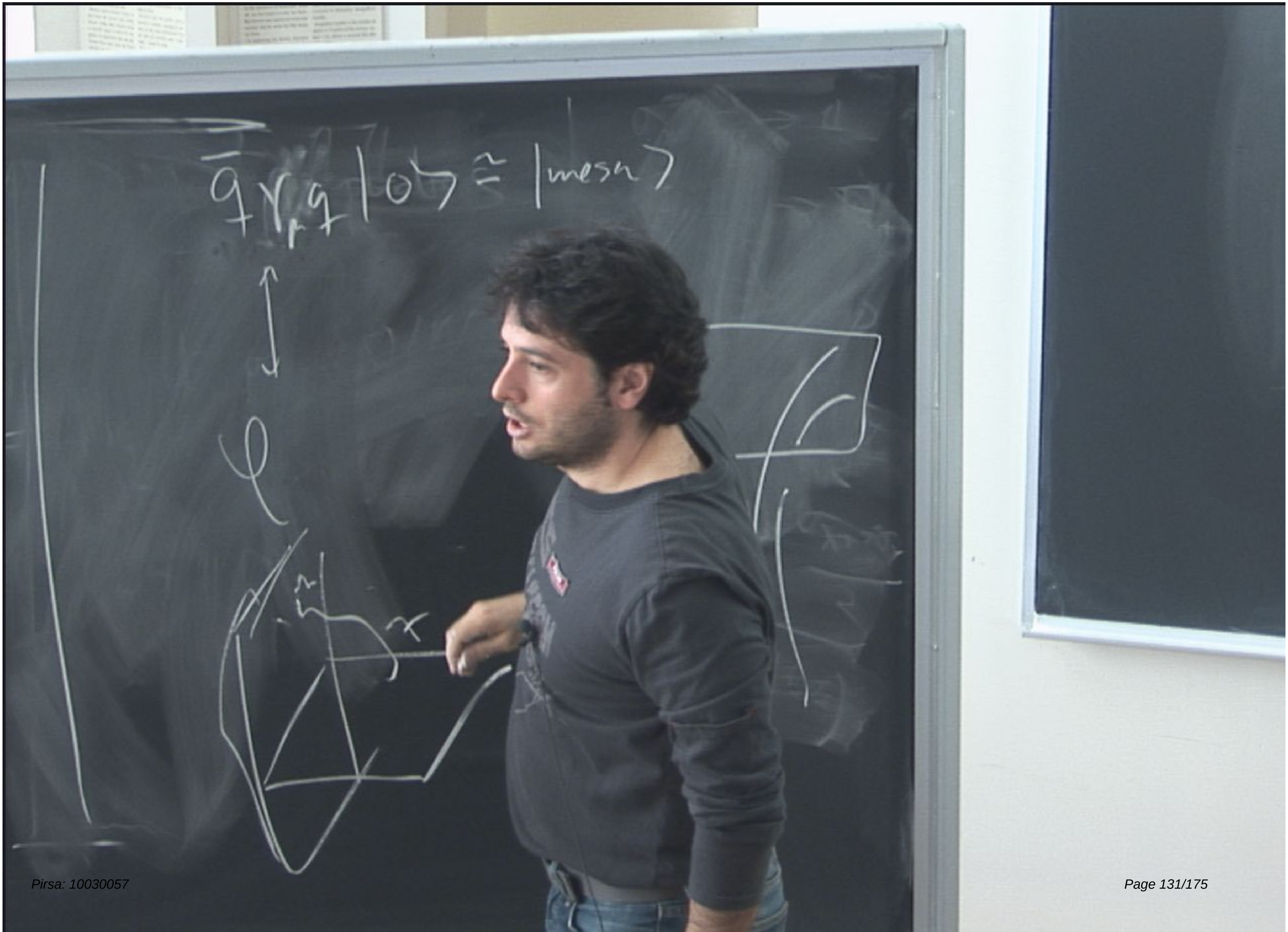


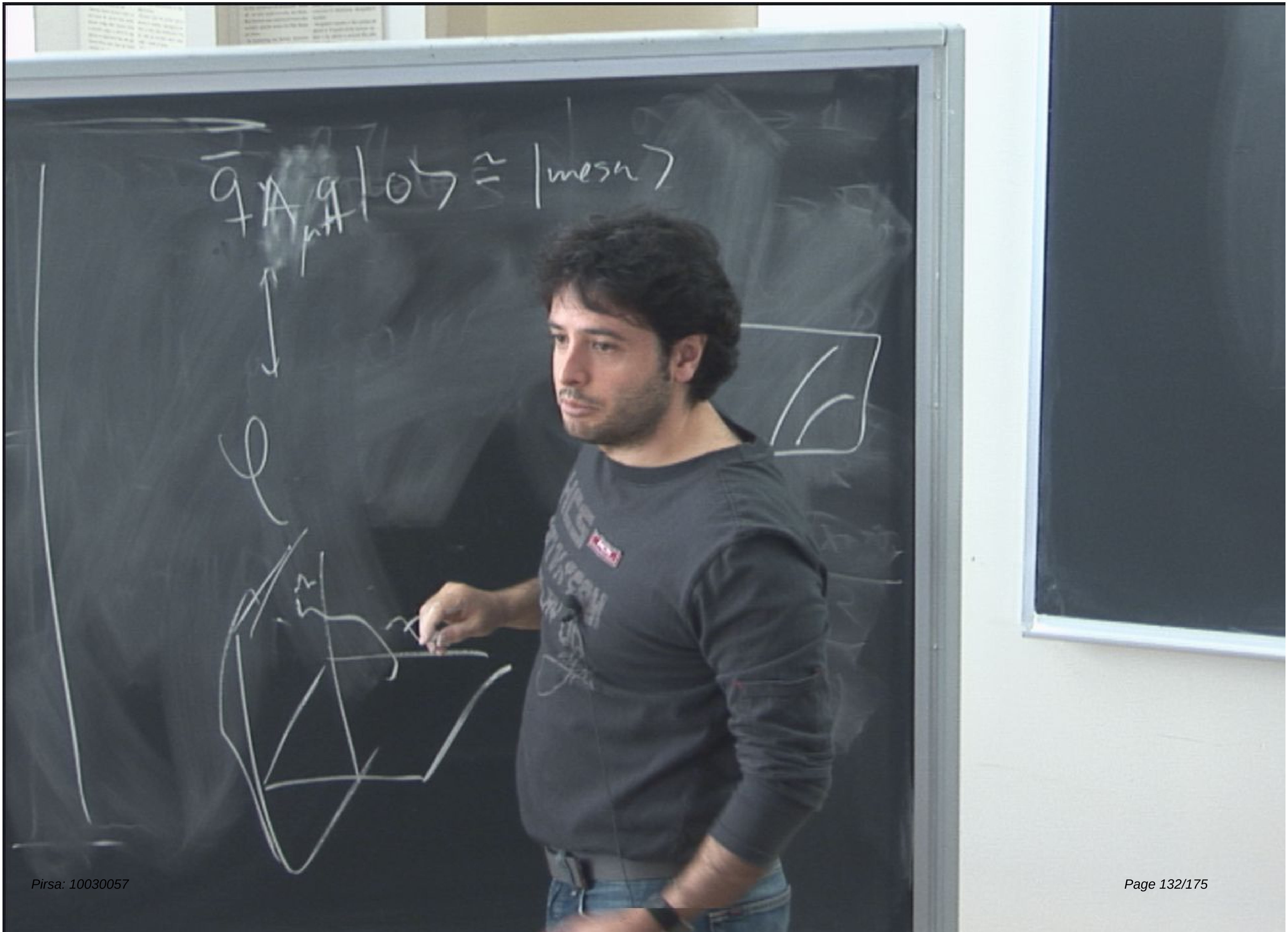
$\bar{q}q\,|0\rangle \cong |\text{meson}\rangle$
φ
x

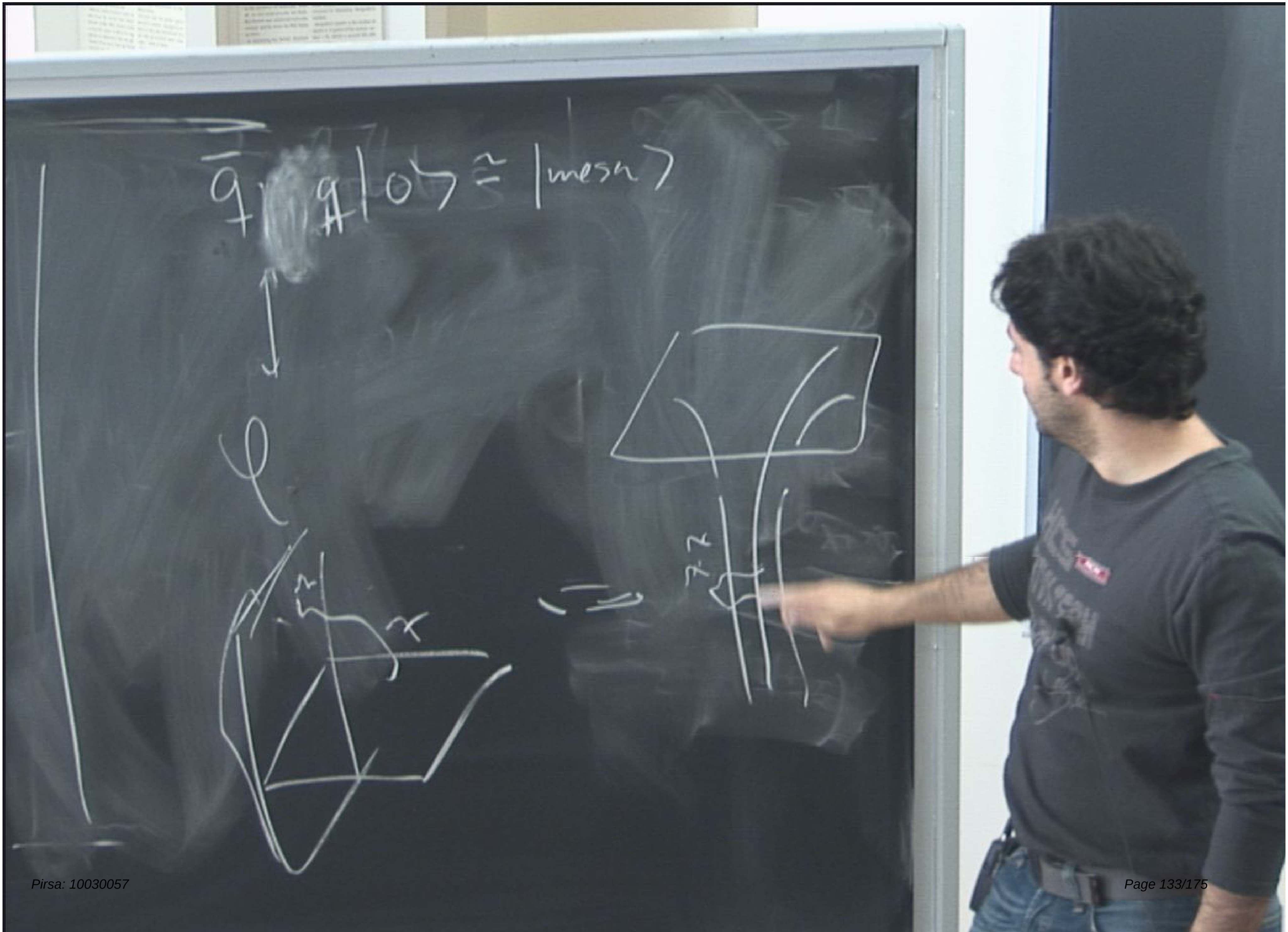

$\bar{q}q\,|0\rangle \simeq |\text{mesn}\rangle$

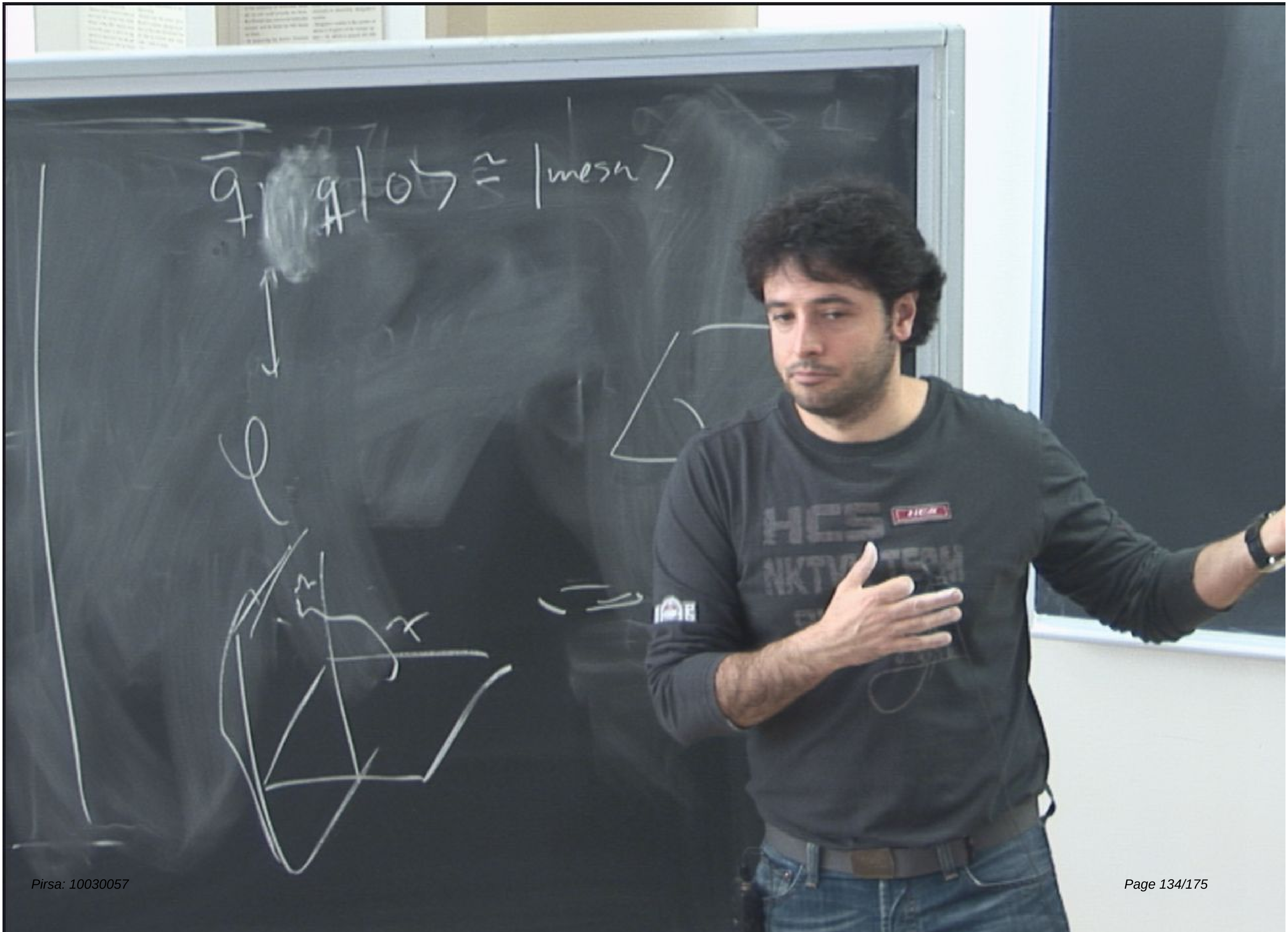

$\bar{q}q\,|0\rangle \cong |\mathrm{mesn}\rangle$

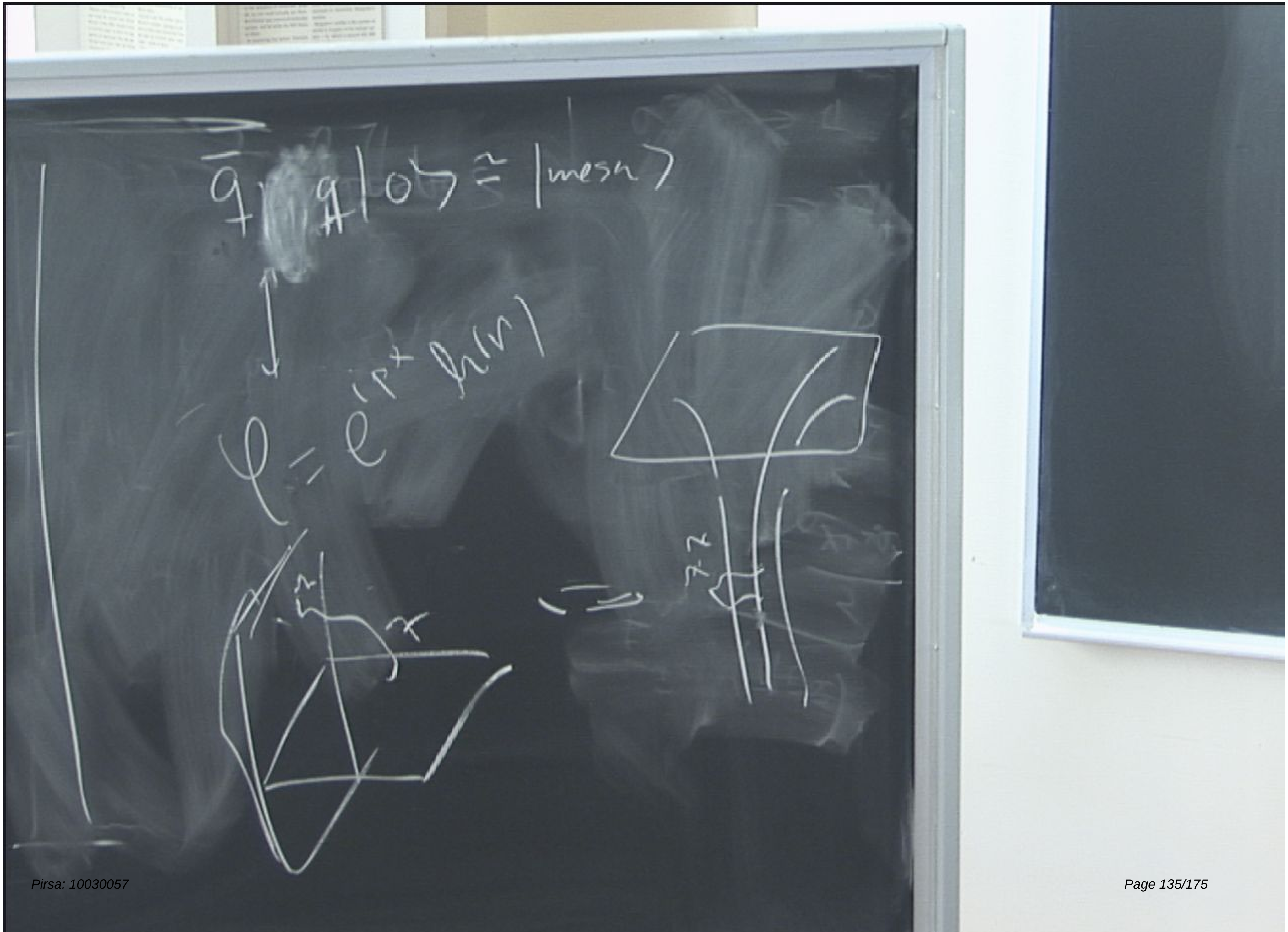


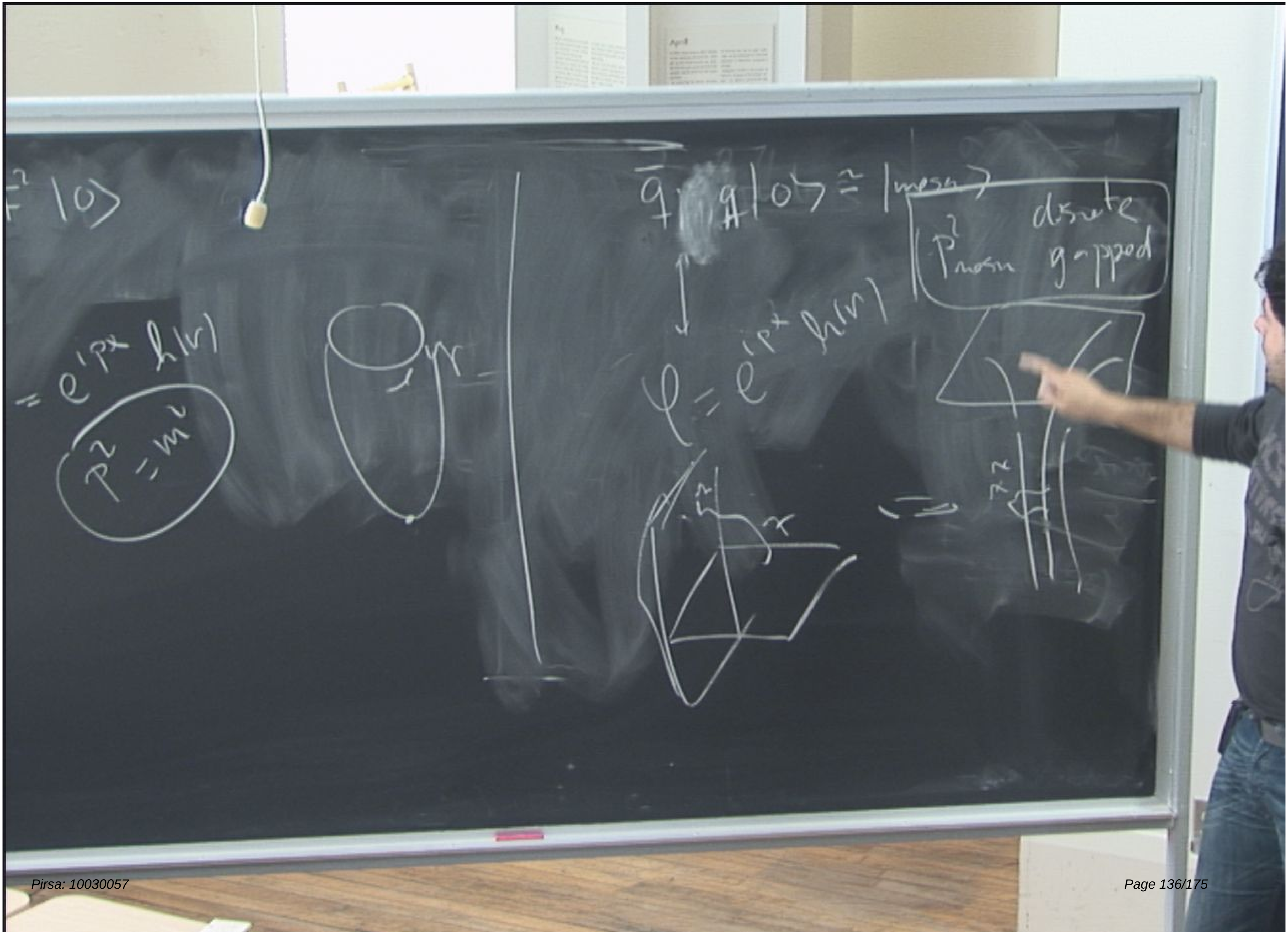

$\bar{q}\gamma_\mu q|0\rangle \cong |\text{mesn}\rangle$

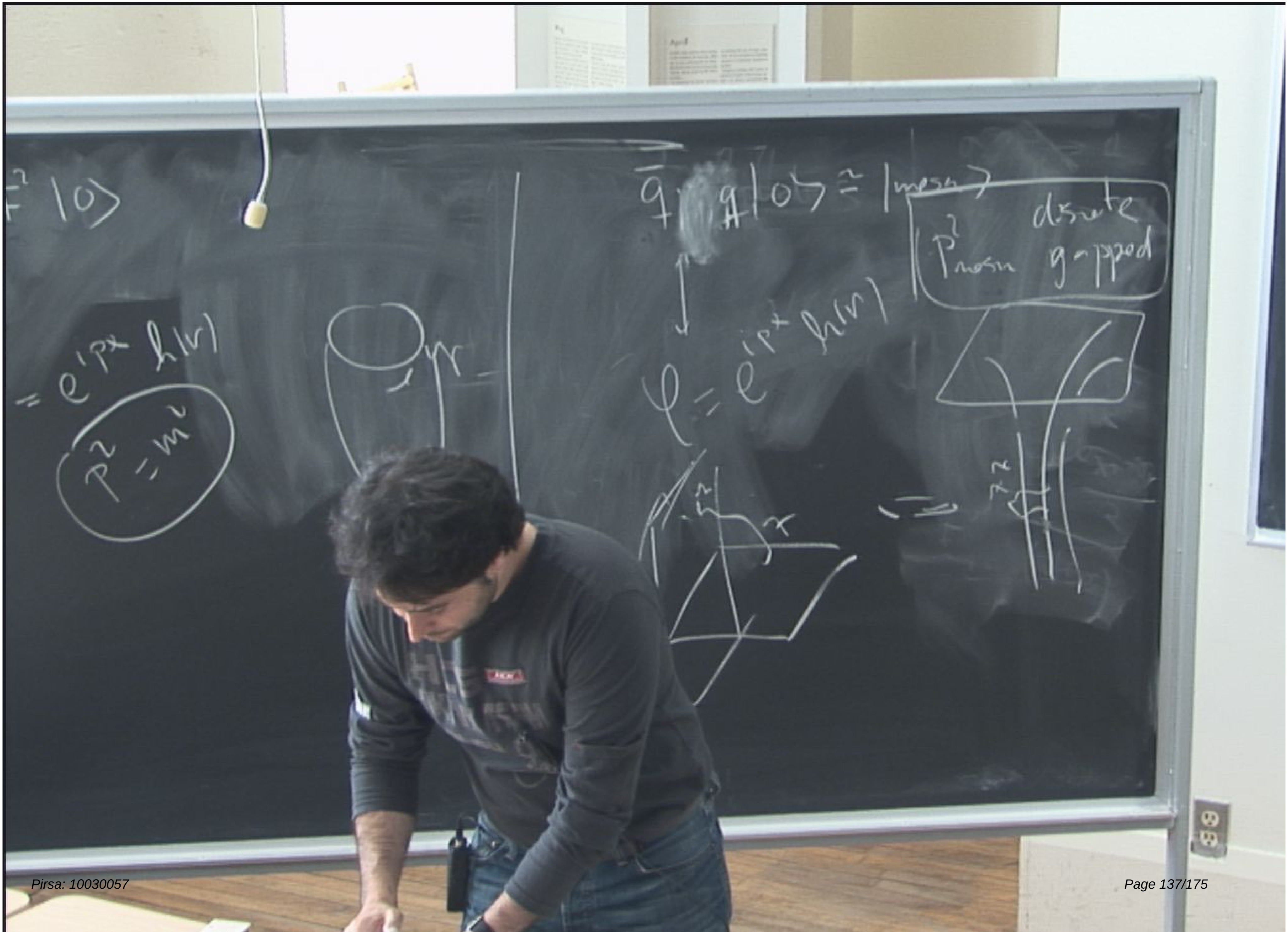

$\bar{q}\gamma A_\mu q|0\rangle \cong |\text{mesn}\rangle$

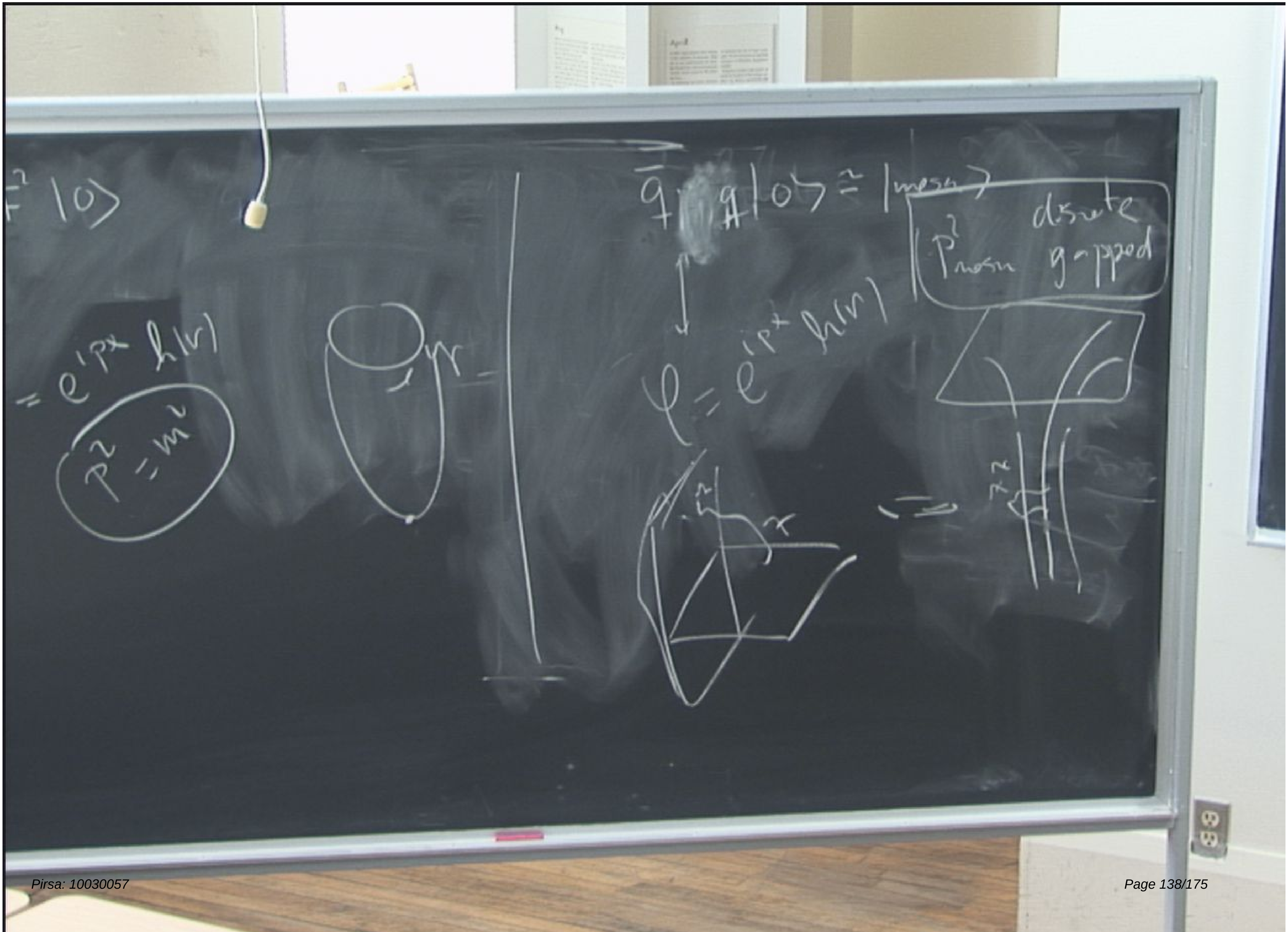


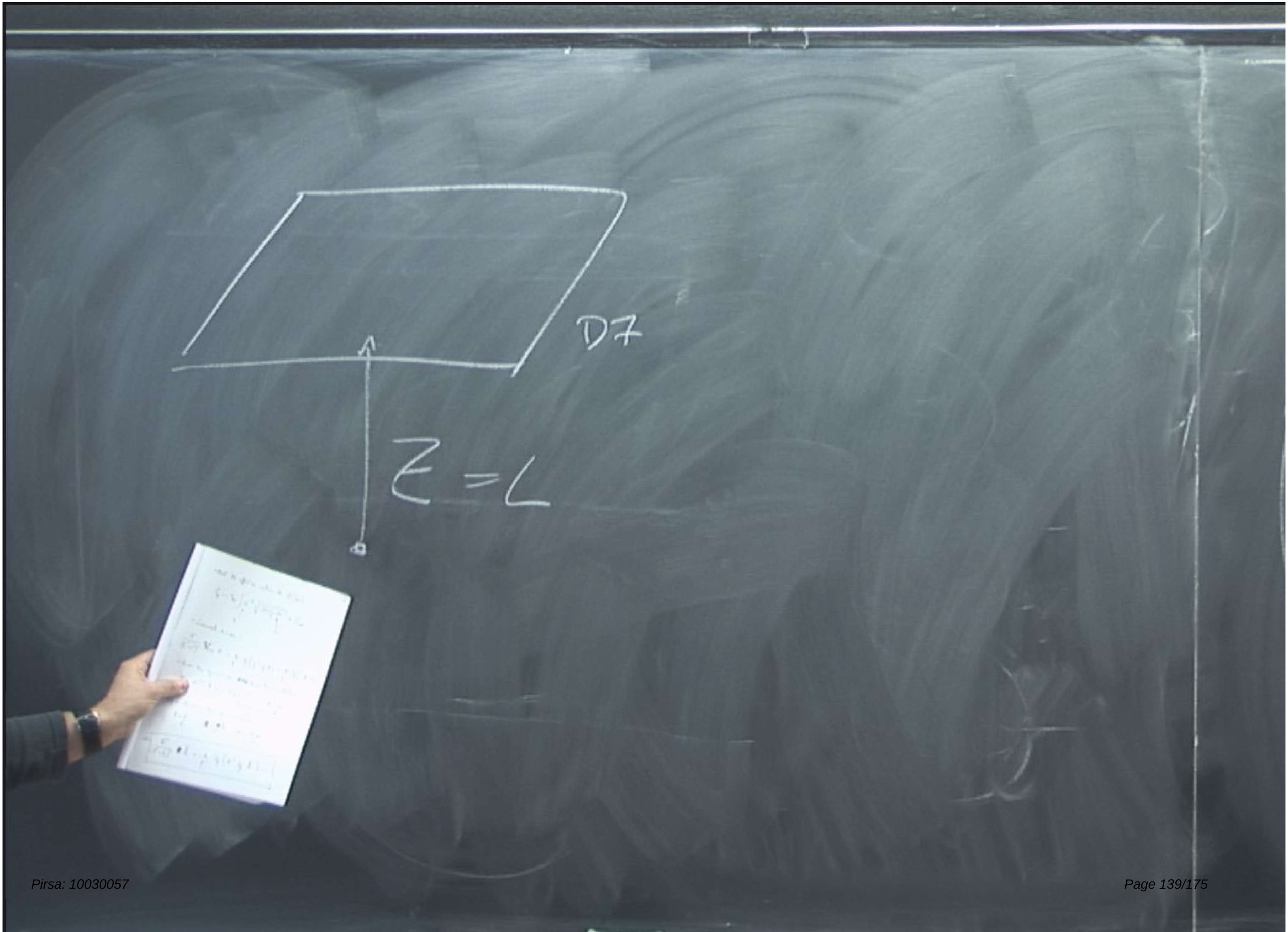


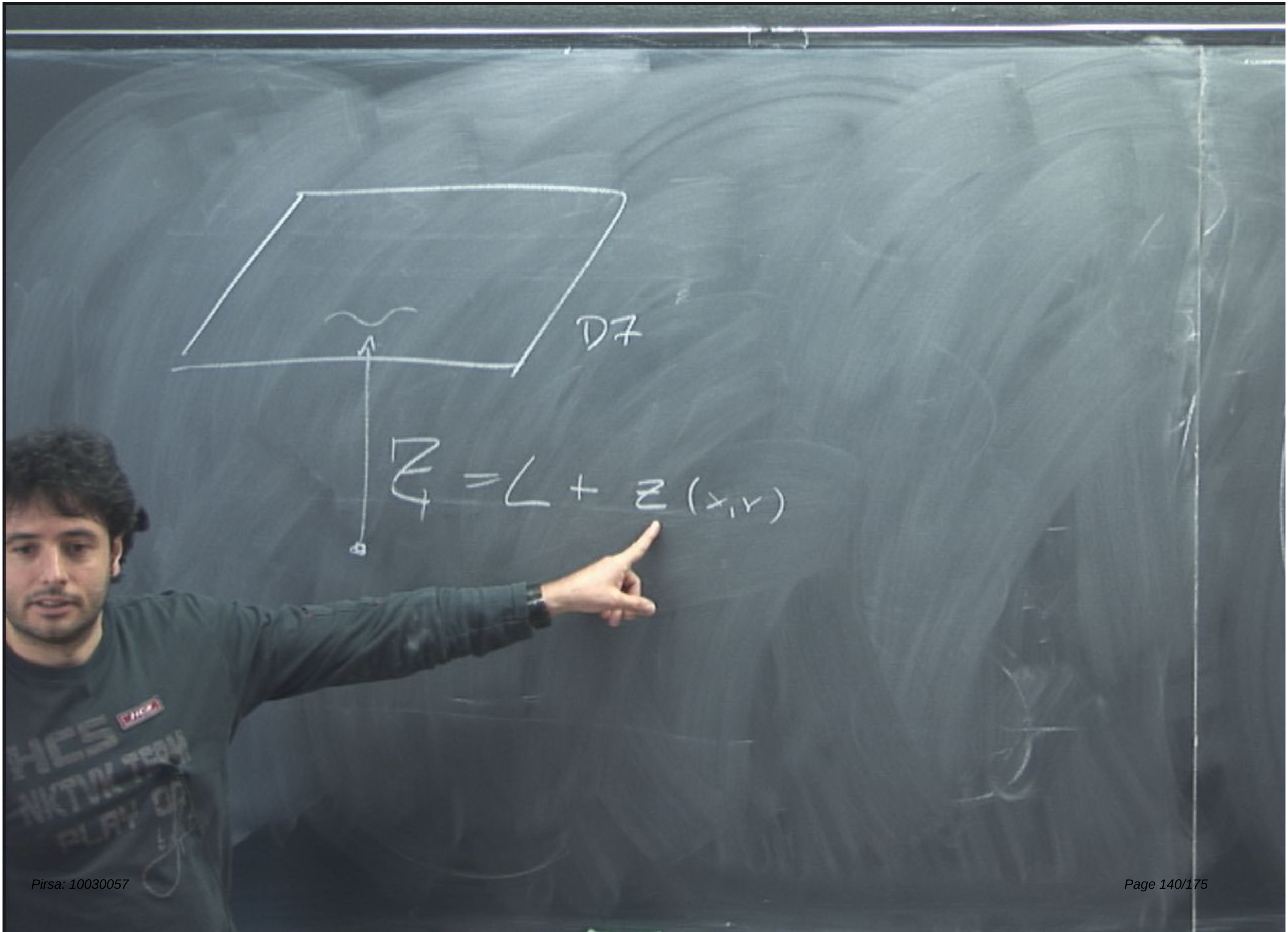

$\bar{q}\, q|0\rangle \cong |\text{mesn}\rangle$
$\varphi = e^{ipx} h(r)$

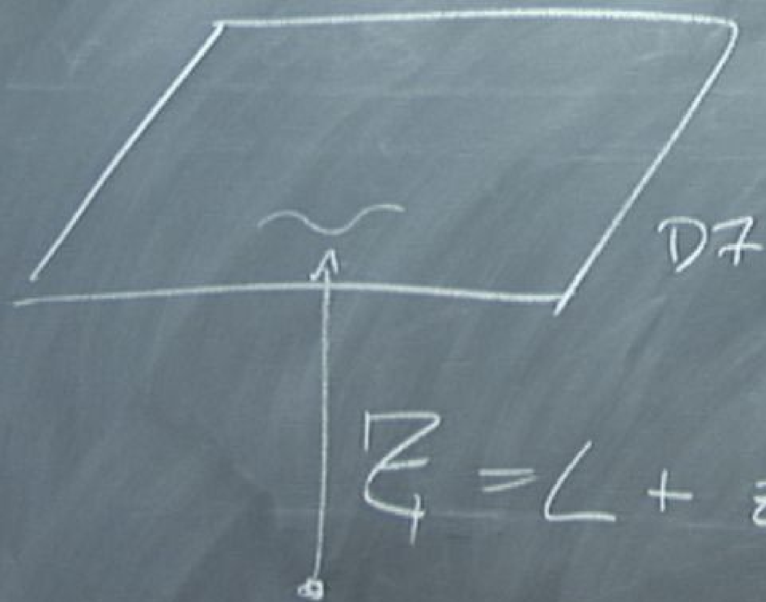

|0⟩
= e^{ipx} h(r)
p^2 = m^2
r
q̄ q |0⟩ ≃ |meson⟩
discrete
p^2_meson gapped
φ = e^{ipx} h(r)
x


|0⟩
= e^{ipx} h(r)
p^2 = m^2
q̄ q |0⟩ ≃ |meson⟩
p^2_meson
discrete
gapped
φ = e^{ipx} h(r)

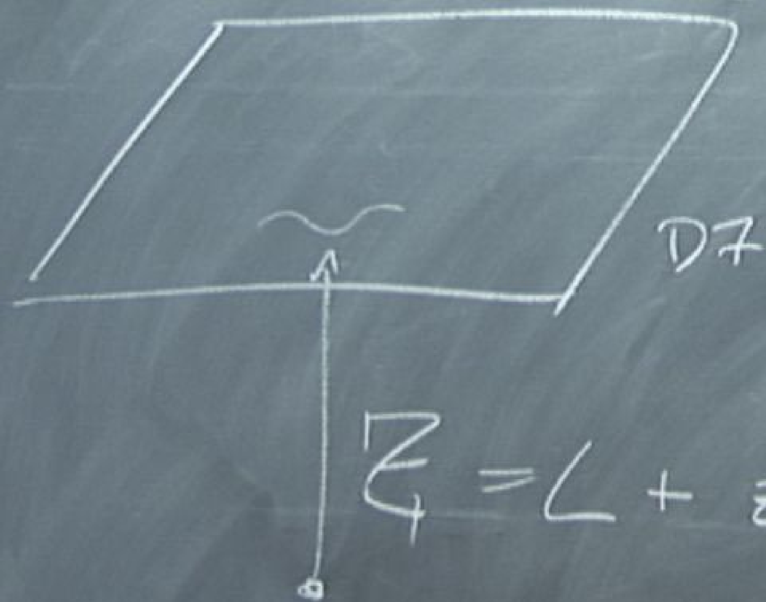

$F^2|0\rangle$
$= e^{ipx} h(r)$
$p^2 = m^2$
r
$\bar{q}\, q|0\rangle \cong |\text{meson}\rangle$
$\varphi = e^{ipx} h(r)$
p^2_{meson} discrete gapped
x


D7
Z = L


D7
Z = L + z (x,r)

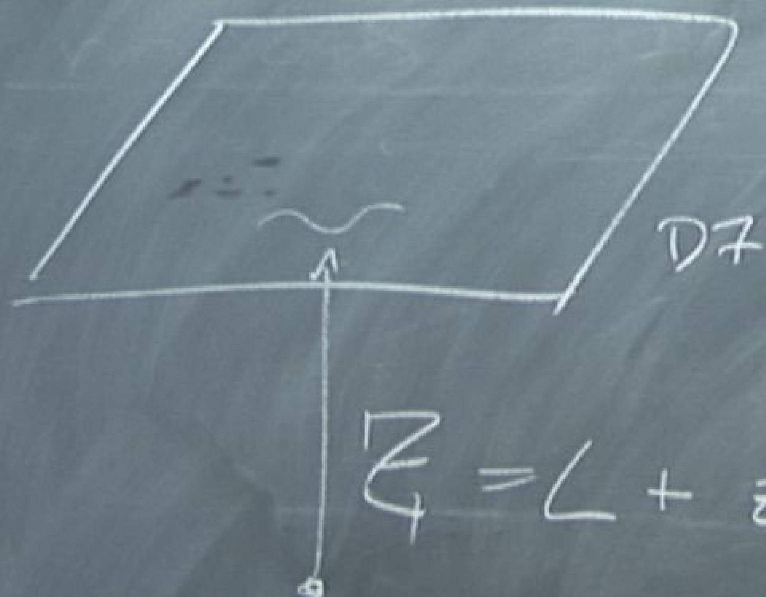


$$Z = L + z(x, r)$$

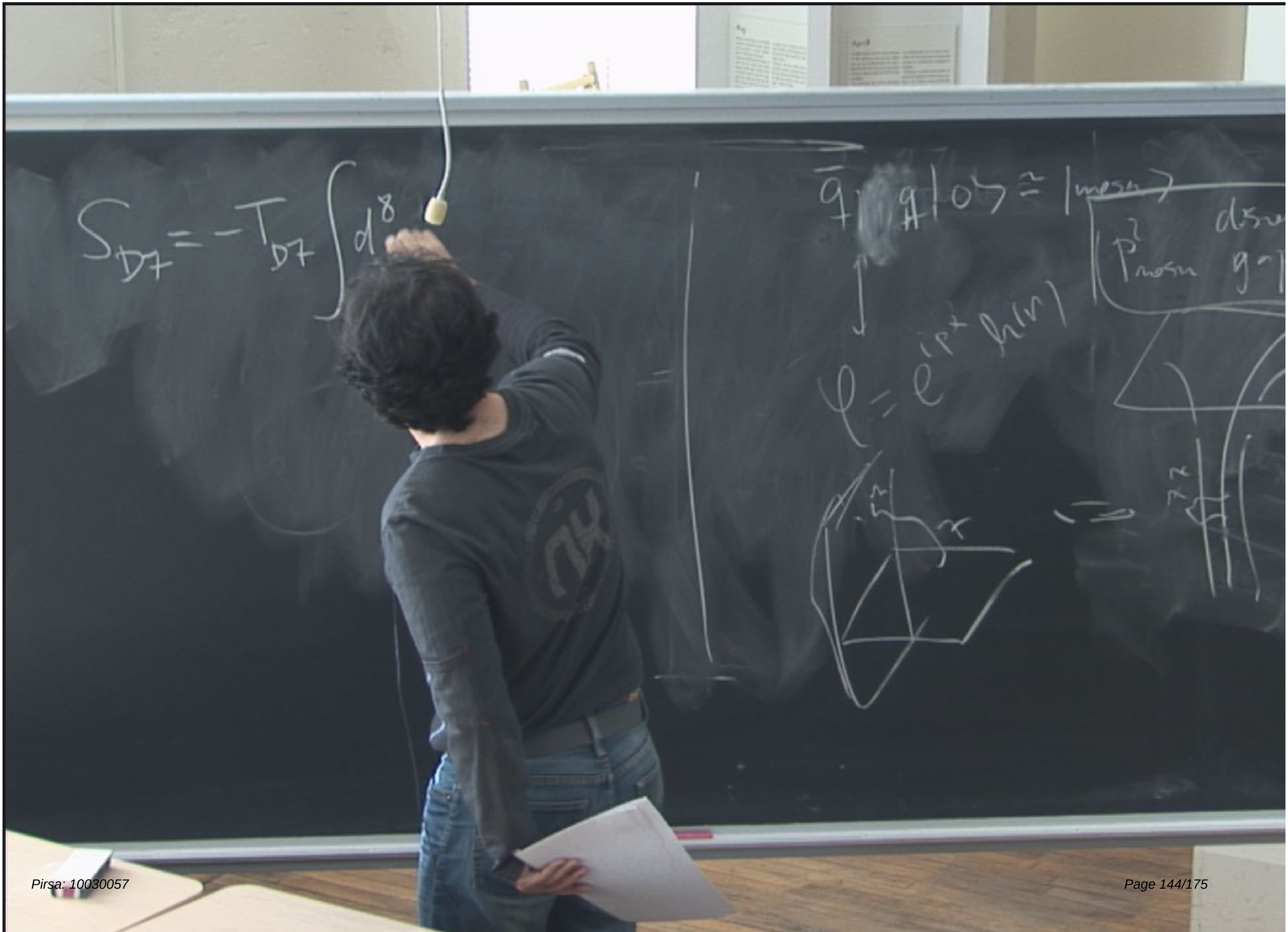


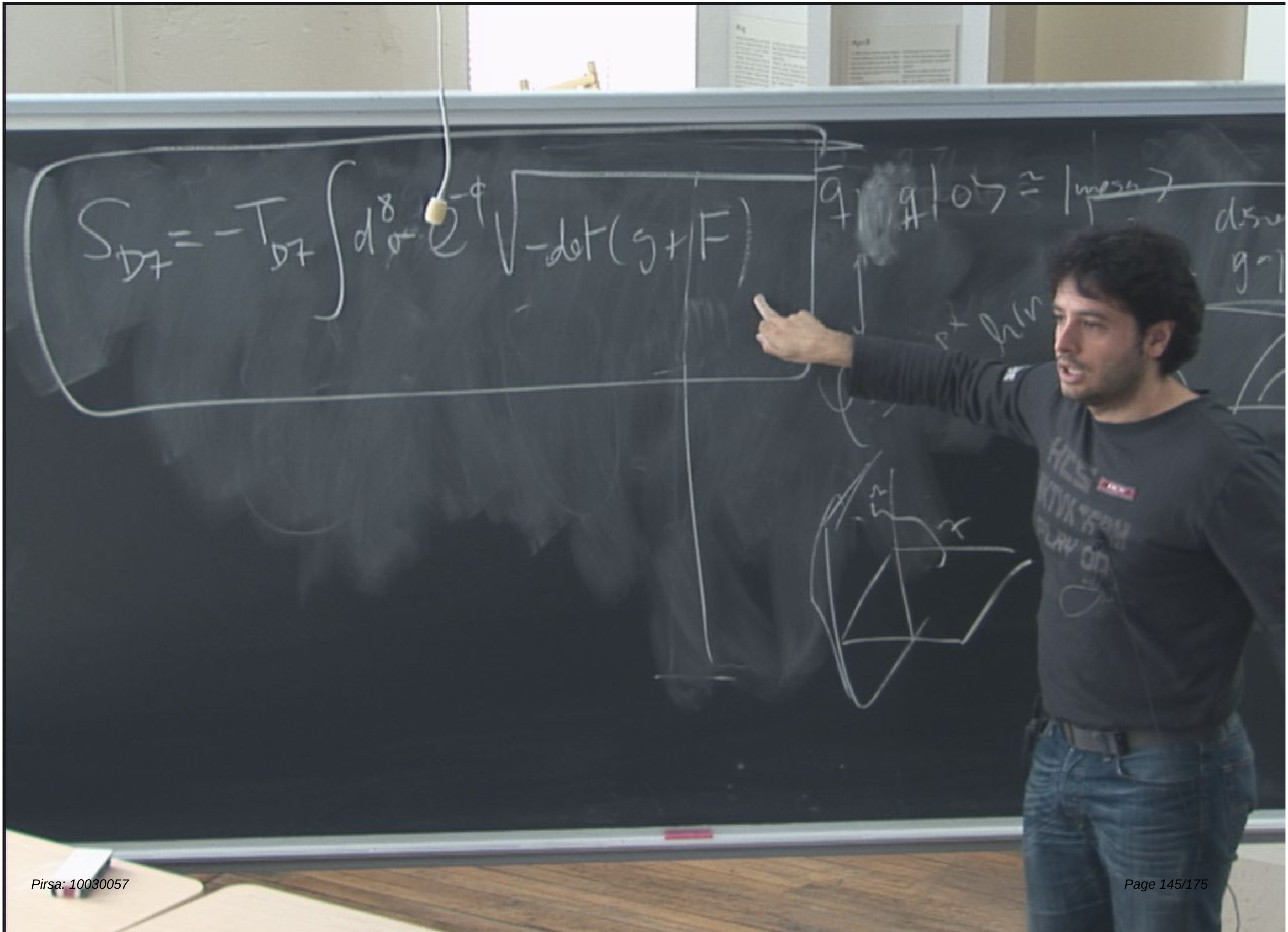
$$Z = L + z(x,r)$$

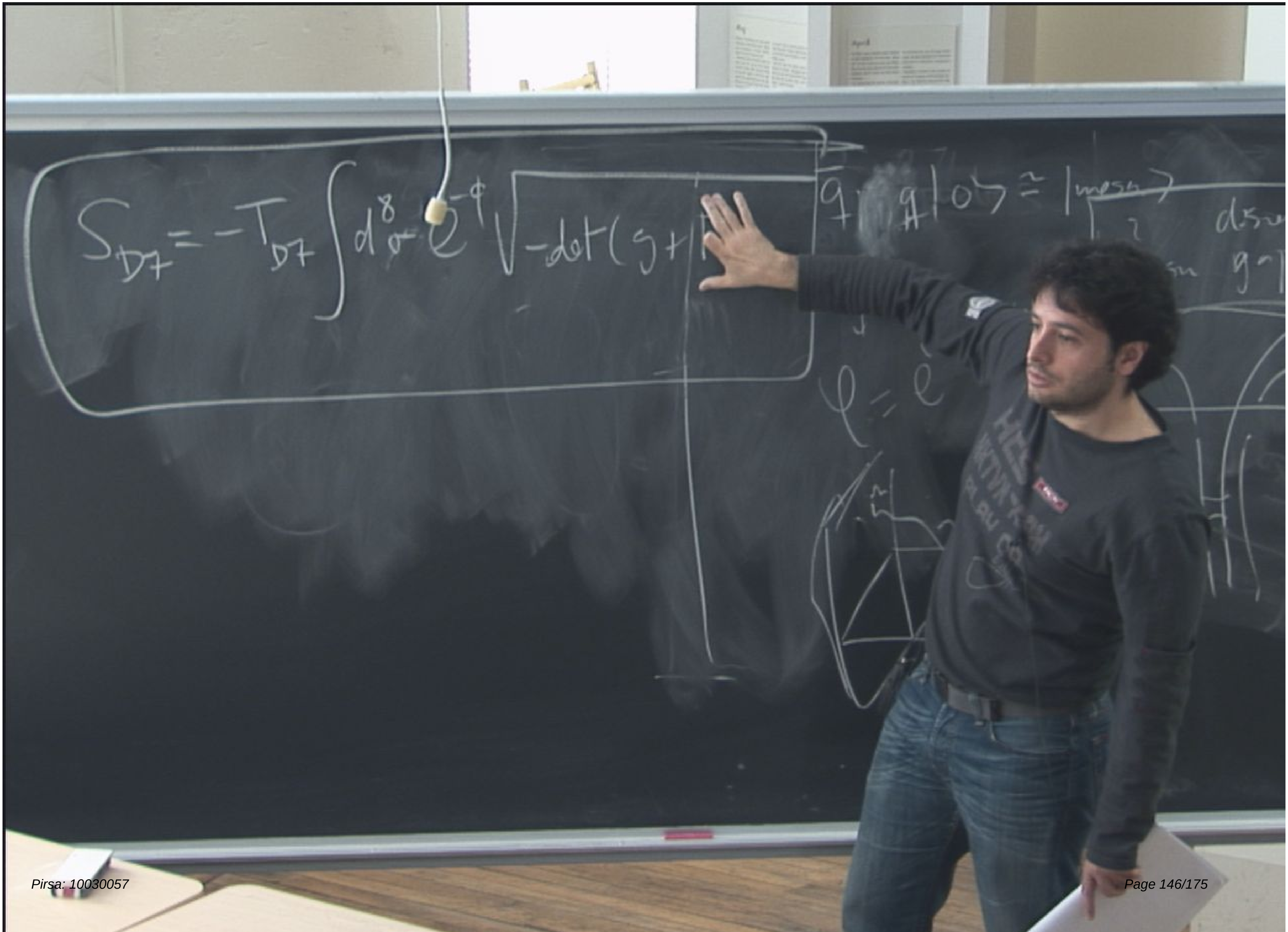
$$z(x,r) = e^{ipx}\,h(r)$$

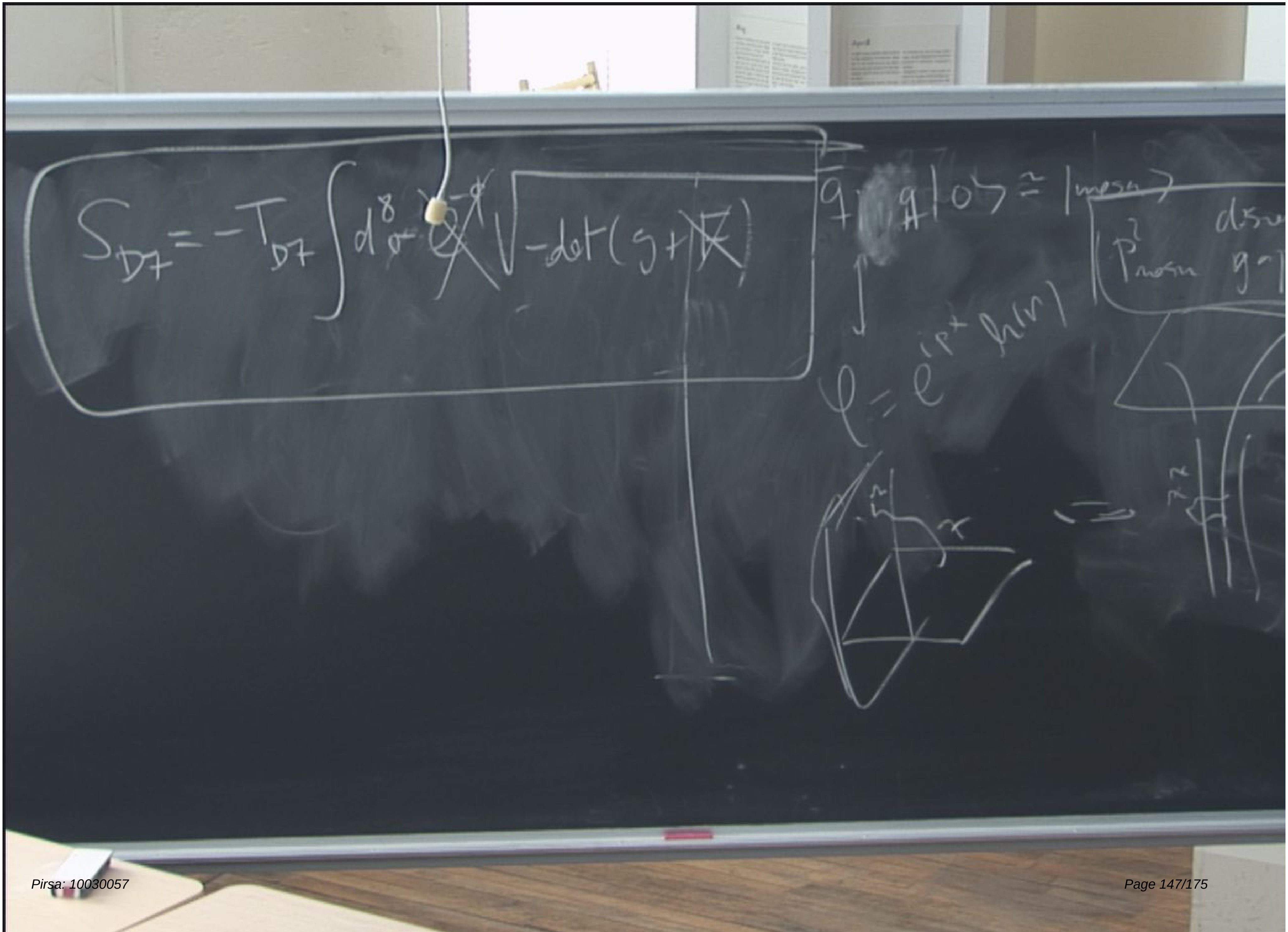


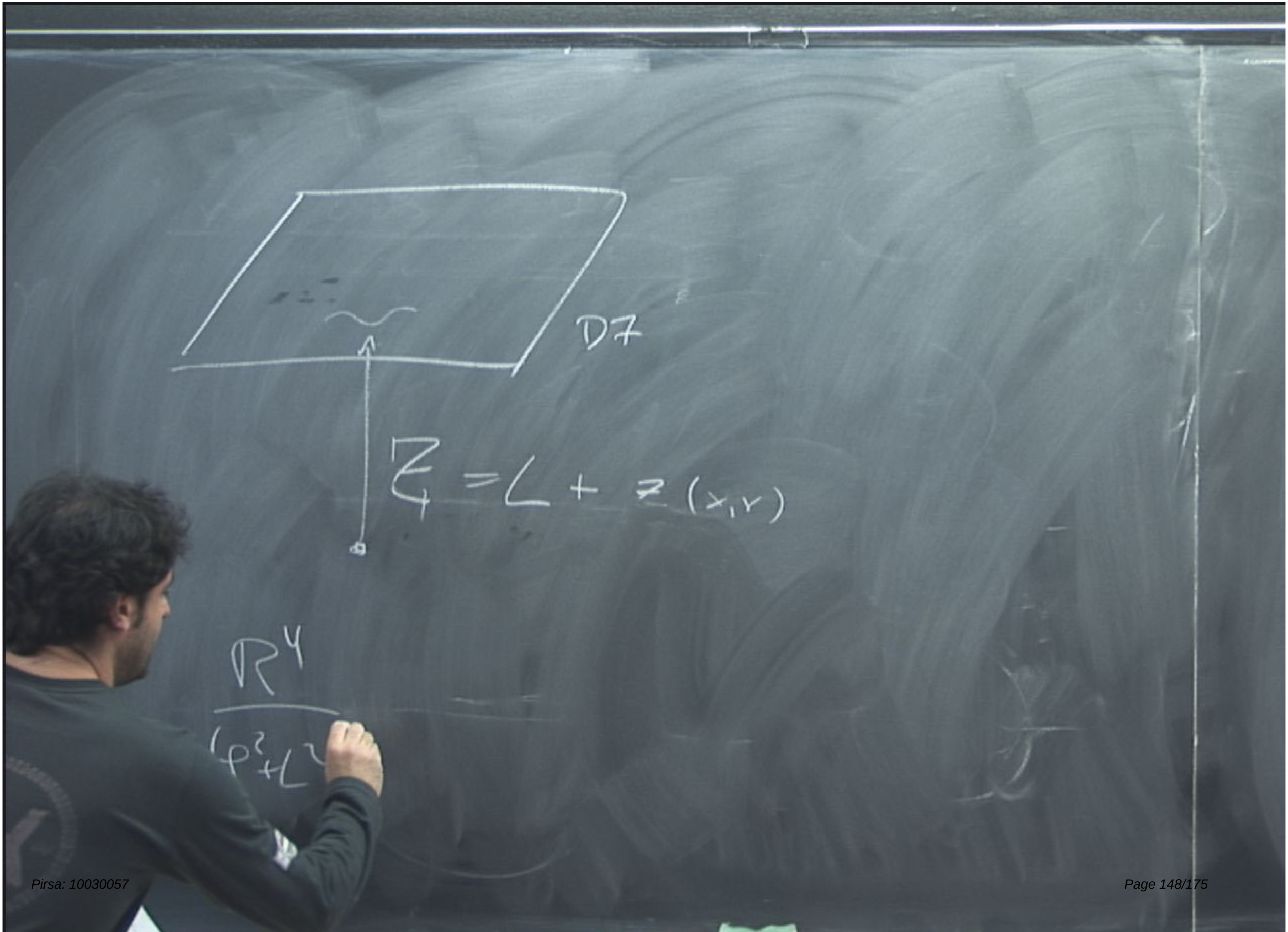
$$Z = L + z(x,r)$$
$$= e^{ipx} h(r)$$

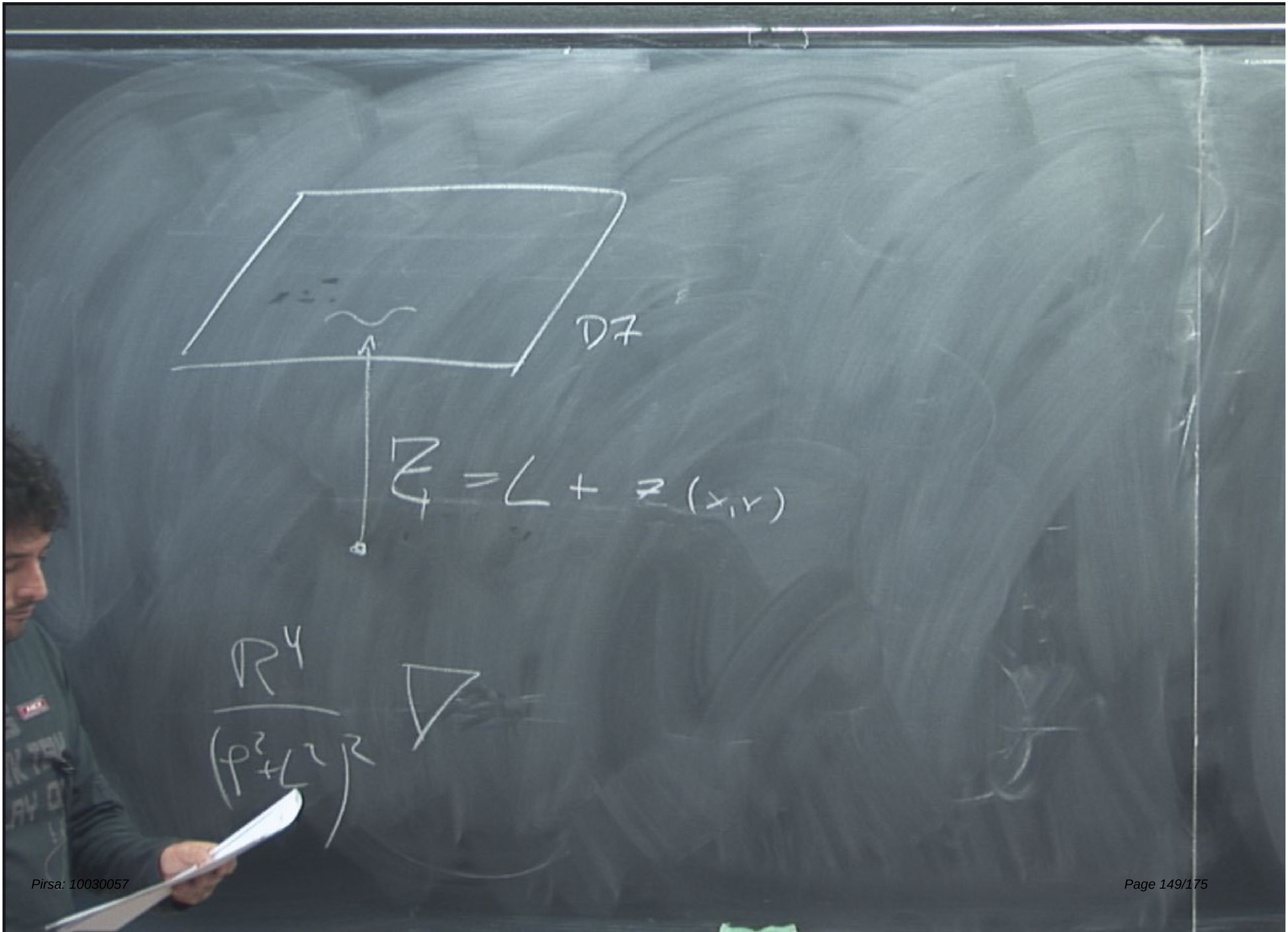

S_D7 = -T_D7 ∫d8

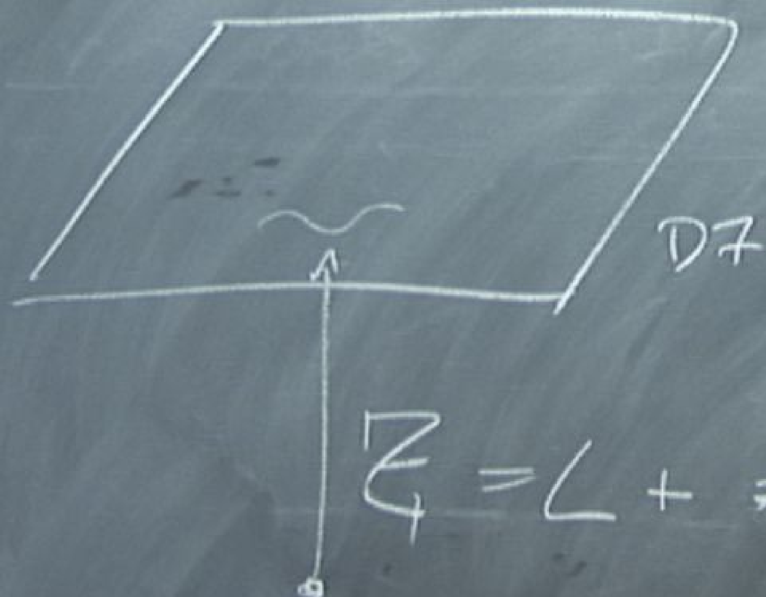

$S_{D7} = -T_{D7} \int d^8\sigma \, e^{-\phi} \sqrt{-\det(g+F)}$


$S_{D7} = -T_{D7} \int d^8\sigma \, e^{-\phi} \sqrt{-\det(g+}$


$S_{D7} = -T_{D7} \int d^8\sigma \sqrt{-\det(g+F)}$
$|\mathrm{meson}\rangle$
$\varphi = e^{ipx} h(r)$

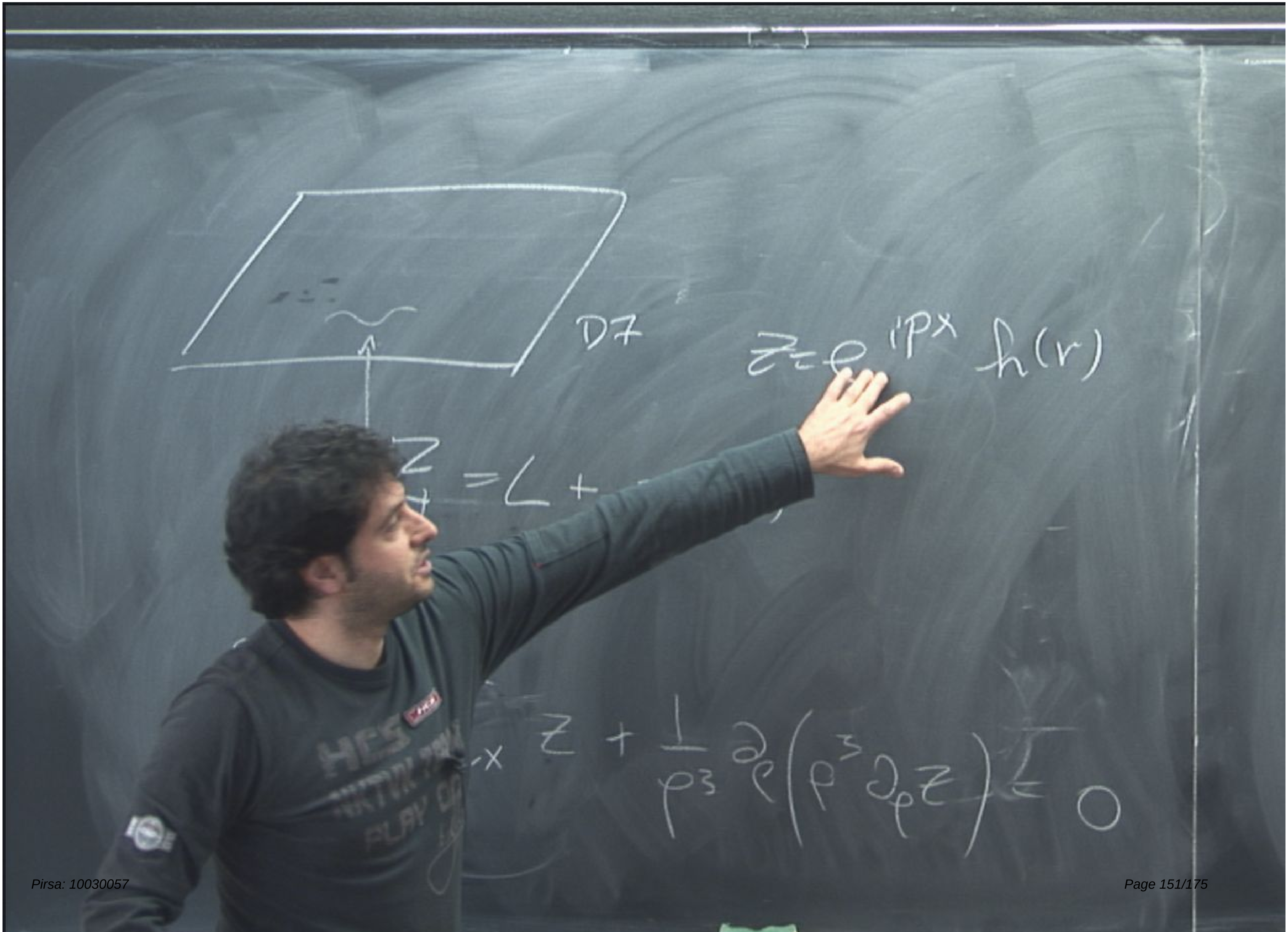

D7
Z4 = L + z(x,r)
R4
(ρ2+L2

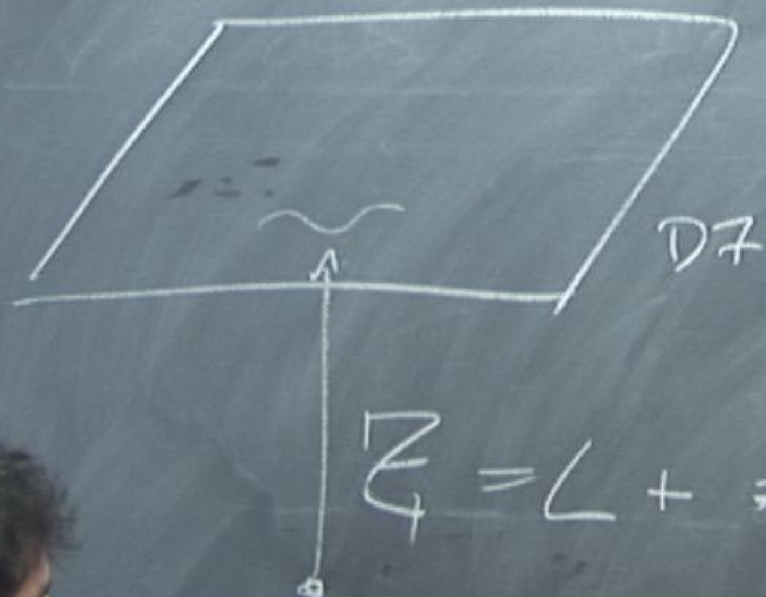

D7
$Z_4 = L + z(x,r)$
$\frac{R^4}{(\rho^2+L^2)^2}$



$$Z = L + z(x,r)$$

$$\frac{R^4}{(\rho^2+L^2)^2}\nabla^2_{t,x} z + \frac{1}{\rho^3}\partial_\rho\left(\rho^3\partial_\rho z\right) = 0$$


D7
Z = e^{ipx} h(r)
Z = L +
x Z + 1/ρ³ ∂ρ(ρ³ ∂ρ Z) = 0

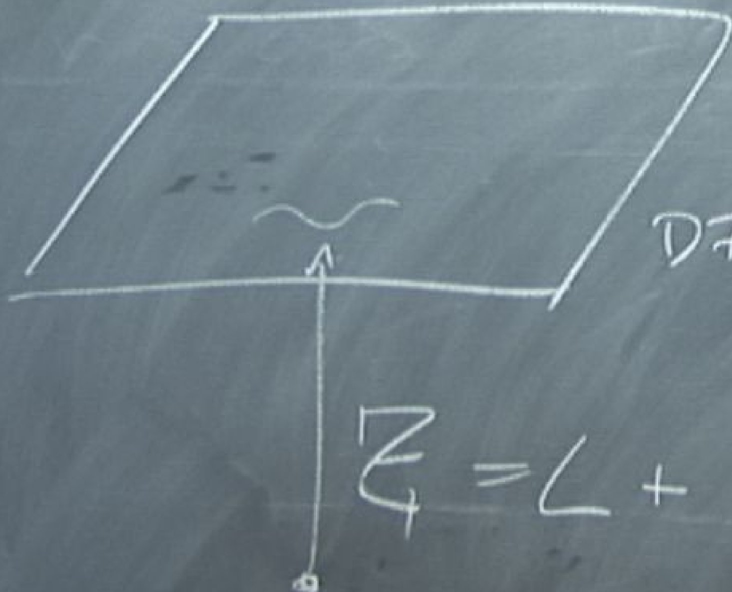


D7

$$Z = e^{ipx} h(r)$$

$$Z = L + z(x,r)$$

$$\frac{R^4}{\rho^2+r^2}\nabla^2_{t,x} Z + \frac{1}{\rho^3}\partial_\rho\left(\rho^3 \partial_\rho Z\right) = 0$$

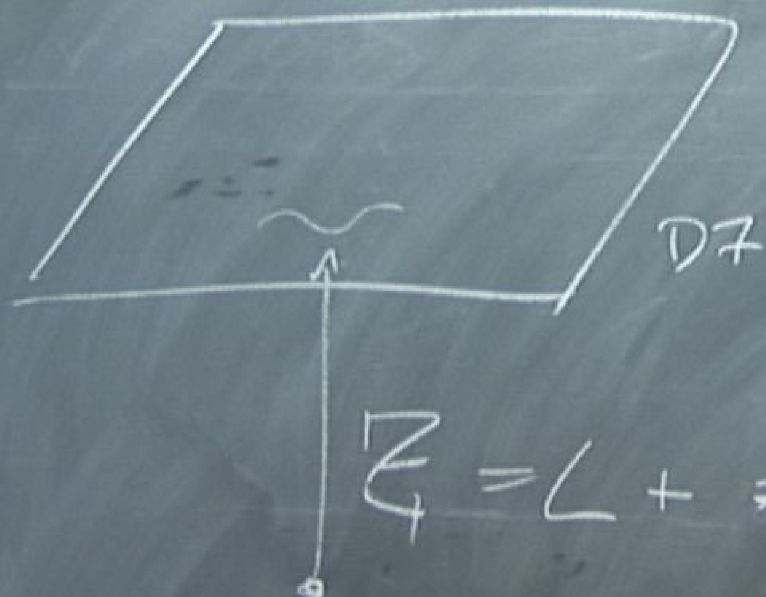


D7

$$z = e^{ipx} h(r)$$

$$Z = L + z(x,r)$$

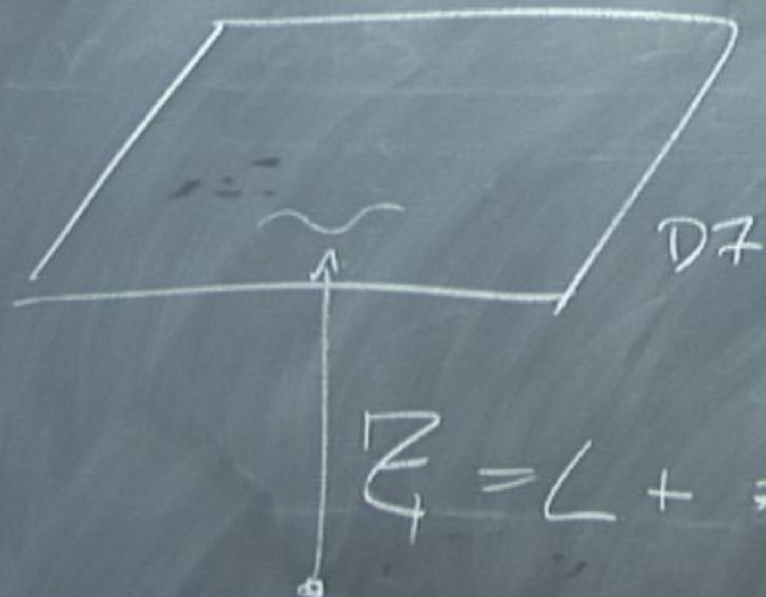
$$\frac{R^4}{(\rho^2+L^2)^2}(-p^2) z + \frac{1}{\rho^3}\partial_\rho\left(\rho^3 \partial_\rho z\right) = 0$$



$$z = e^{ipx} h(\rho)$$

$$Z_4 = L + z(x,r)$$

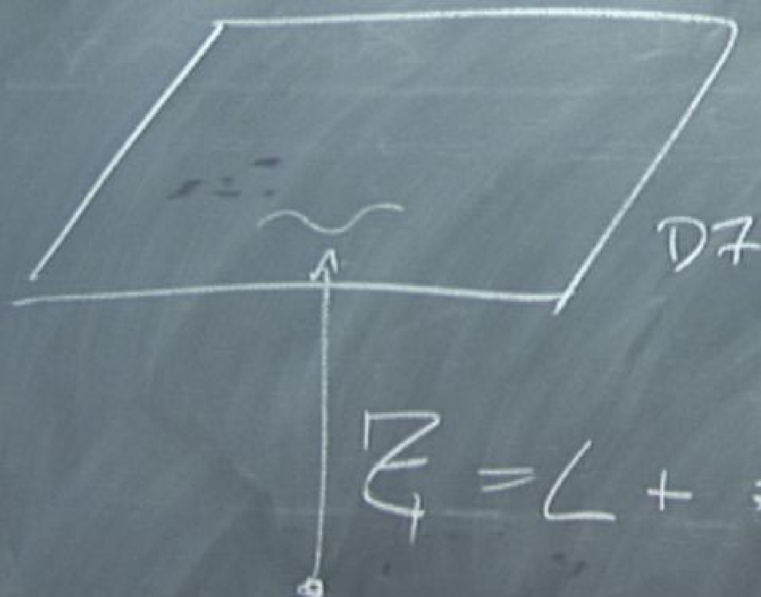
$$\frac{R^4}{(\rho^2+L^2)^2}\left(-p^2\right) h(\rho) + \frac{1}{\rho^3}\partial_\rho\left(\rho^3 \partial_\rho h(\rho)\right) = 0$$



$$z = e^{ipx}\, h(\rho)$$

$$Z_4 = L + z(x,r)$$

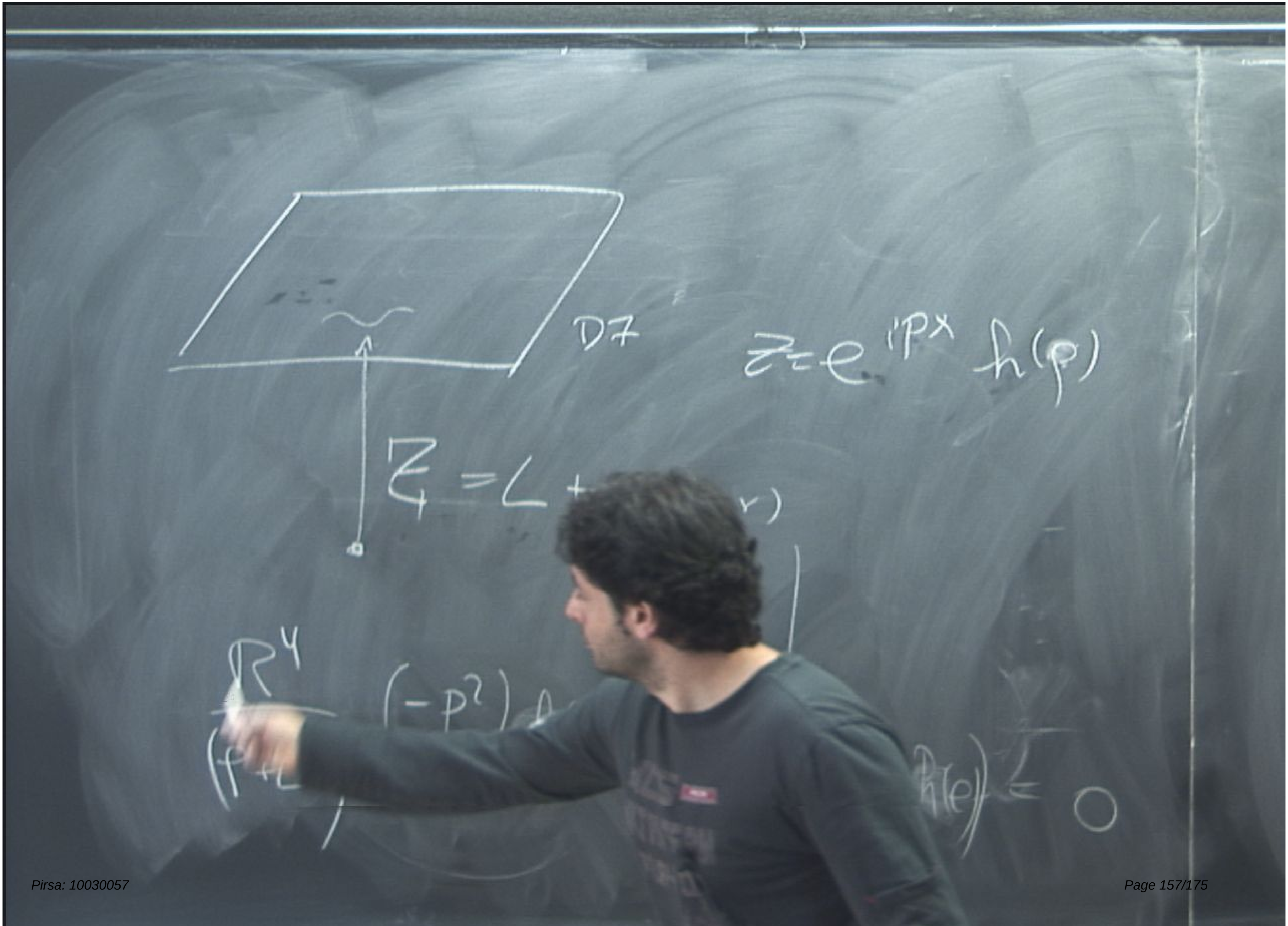
$$\frac{R^4}{(\rho^2+L^2)^2}\left(-p^2\right) h(\rho) + \frac{1}{\rho^3}\,\partial_\rho\left(\rho^3\,\partial_\rho h(\rho)\right) = 0$$

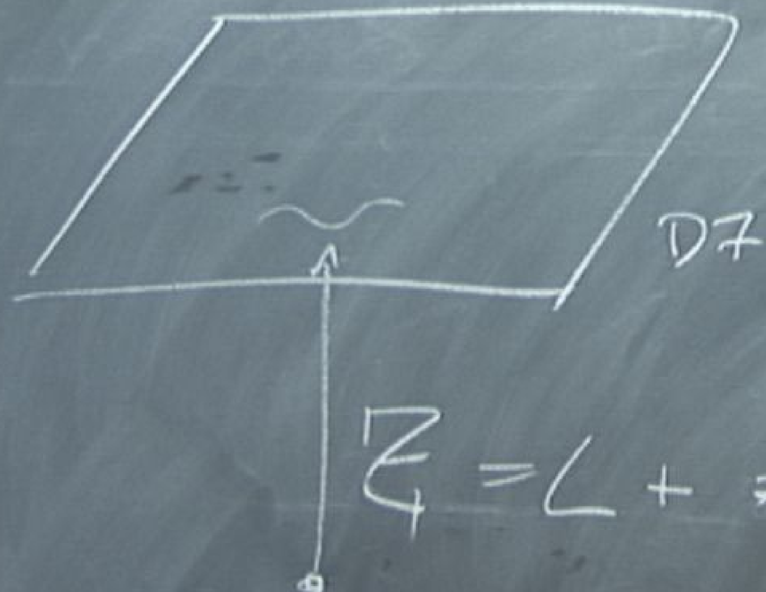


$$z = e^{ipx} h(\rho)$$

$$Z_4 = L + z(x,r)$$

$$\frac{R^4}{(\rho^2+L^2)^2}(-p^2)\,h(\rho) + \frac{1}{\rho^3}\partial_\rho\left(\rho^3 \partial_\rho h(\rho)\right) = 0$$


D7
Z = e^{ipx} h(ρ)
Z = L +
R^4
(-p^2)



$$z = e^{ipx} h(\rho)$$

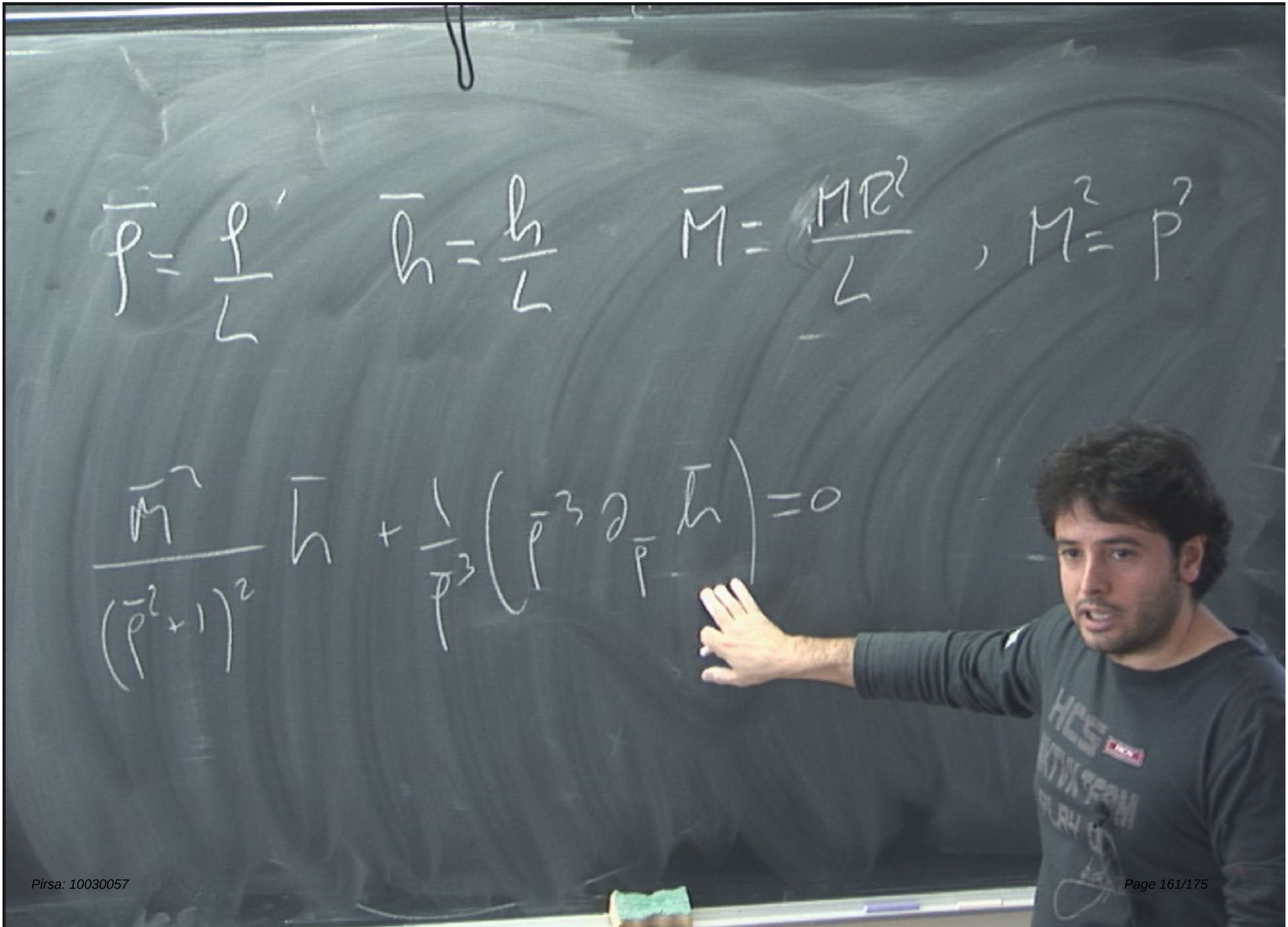
$$Z_4 = L + z(x,r)$$

$$\left(-\partial_t^2 + \partial_x^2\right)$$

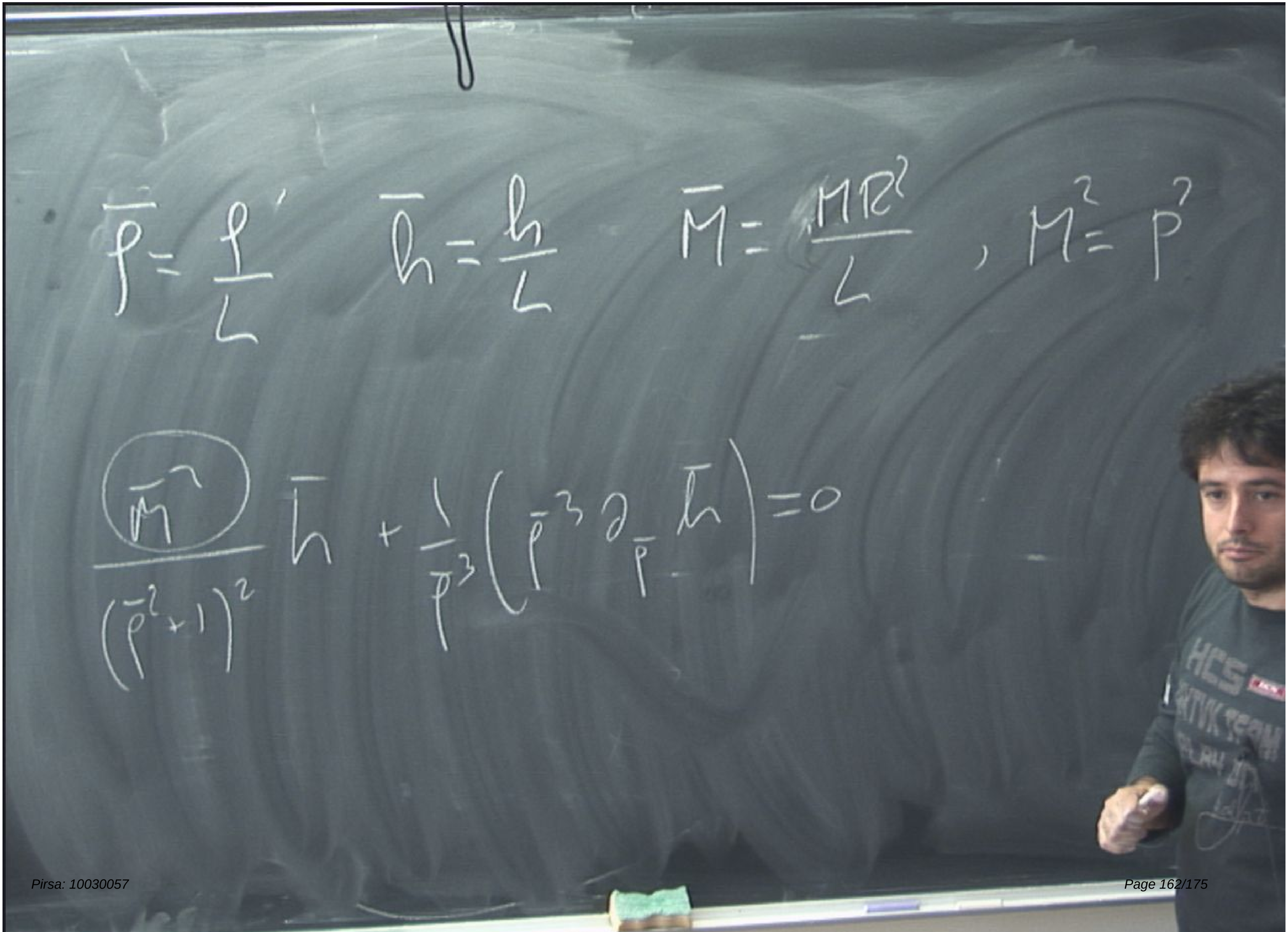
$$\frac{R^4}{(\rho^2+L^2)^2}\left(-p^2\right) h(\rho) + \frac{1}{\rho^3}\partial_\rho\left(\rho^3 \partial_\rho h(\rho)\right) = 0$$

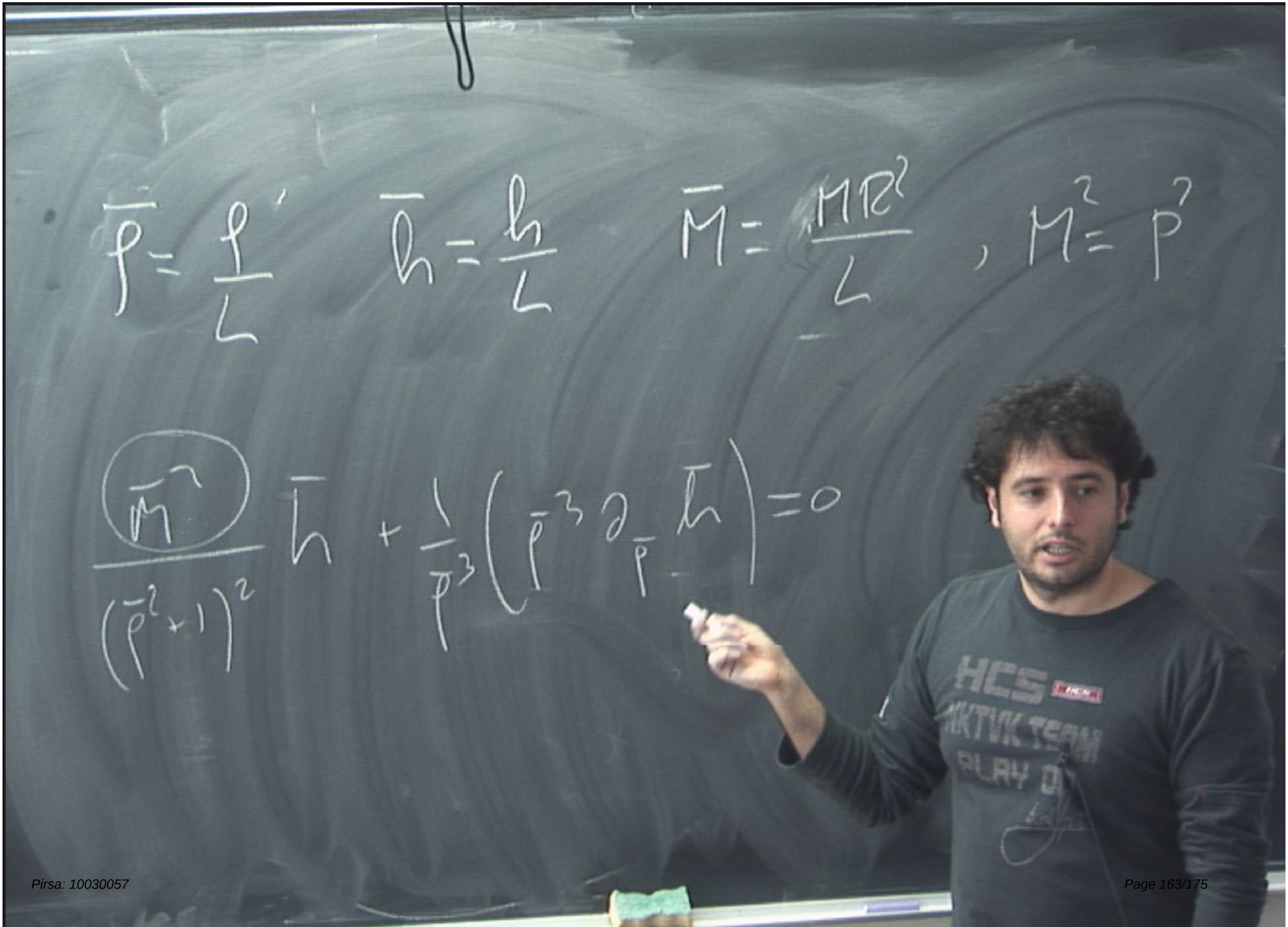
$$\bar{\rho} = \frac{\rho}{L}, \qquad \bar{h} = \frac{h}{L} \qquad \bar{M} = \frac{MR^2}{L}, \quad M =$$

$$\bar{\rho} = \frac{\rho'}{L} \qquad \bar{h} = \frac{h}{L} \qquad \bar{M} = \frac{MR^2}{L}, \quad M^2 = p^2$$



$\bar{\rho} = \frac{\rho}{L}$ $\bar{h} = \frac{h}{L}$ $\bar{M} = \frac{MR^2}{L}$, $M^2 = p^2$
$\frac{\bar{m}^2}{(\bar{\rho}^2+1)^2}\bar{h} + \frac{1}{\bar{\rho}^3}\left(\bar{\rho}^3\partial_{\bar{\rho}}\bar{h}\right) = 0$


$\bar{\rho} = \frac{\rho}{L}$ $\bar{h} = \frac{h}{L}$ $\bar{M} = \frac{MR^2}{L}$, $M^2 = p^2$
$\frac{\bar{M}^2}{(\bar{\rho}^2+1)^2}\bar{h} + \frac{1}{\bar{\rho}^3}\left(\bar{\rho}^3 \partial_{\bar{\rho}} \bar{h}\right) = 0$


$\bar{\rho} = \frac{\rho}{L}$ $\bar{h} = \frac{h}{L}$ $\bar{M} = \frac{M R^2}{L}$, $M^2 = P^2$
$\frac{\bar{M}^2}{(\bar{\rho}^2+1)^2} \bar{h} + \frac{1}{\bar{\rho}^3} \left(\bar{\rho}^3 \partial_{\bar{\rho}} \bar{h} \right) = 0$
HCS
AKTVK TEAM
PLAY O

$$\bar{\rho} = \frac{\rho}{L} \qquad \bar{h} = \frac{h}{L} \qquad \bar{M} = \frac{MR^2}{L}, \quad M^2 = p^2$$

$$\frac{\bar{M}^2}{(\bar{\rho}^2+1)^2}\bar{h} + \frac{1}{\bar{\rho}^3}\left(\bar{\rho}^3 \partial_{\bar{\rho}} \bar{h}\right) = 0 \qquad \bar{M} \sim \# O$$

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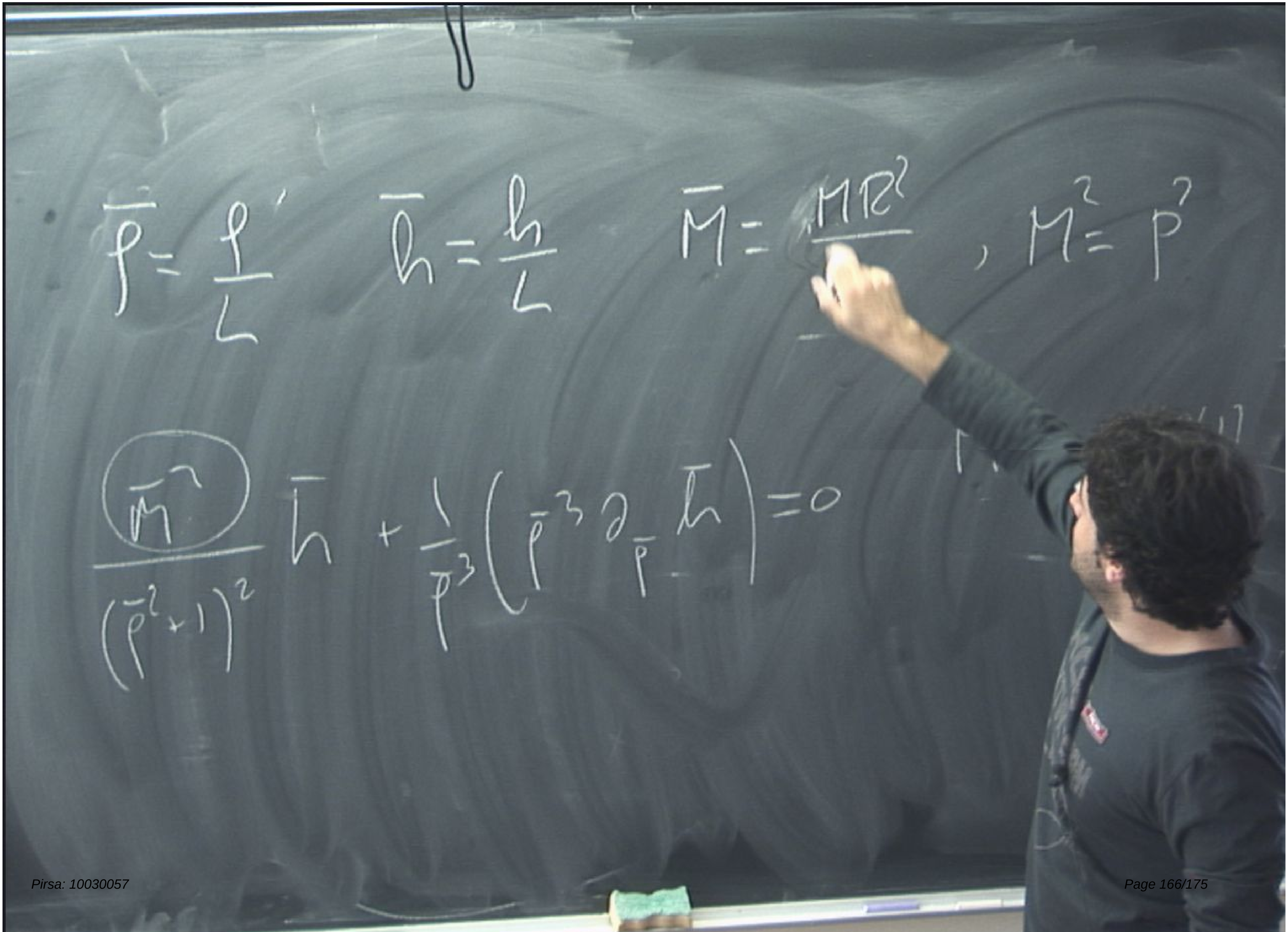
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Baryons $M \sim N_c$