Title: PSI 2010 - Theoretical Physics - Lecture 5A

Date: Aug 27, 2010 09:00 AM

URL: http://pirsa.org/10080010

Abstract:

perimeter scholars
international

$$\left(\alpha|\uparrow\rangle + \beta|\downarrow\rangle\right)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} \, |\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$$

$$\left(\alpha|\uparrow\rangle + \beta|\downarrow\rangle\right)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} \, |\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$$

N

$$\left(\alpha|\uparrow\rangle+\beta|\downarrow\rangle\right)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} \, |\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$$

$$\left(\frac{N_\uparrow}{N}\right)$$

$$\left(\alpha|\uparrow\rangle + \beta|\downarrow\rangle\right)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} \, |\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$$

$$\left(\frac{N_\uparrow}{N}\right) = \sum_k \binom{N}{k} \left(\frac{k}{N}\right) \alpha^k \beta^{N-k} \, |\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$$

$$\left(\alpha|\uparrow\rangle + \beta|\downarrow\rangle\right)^N = \sum_k \underbrace{\binom{N}{k} \alpha^k \beta^{N-k}} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

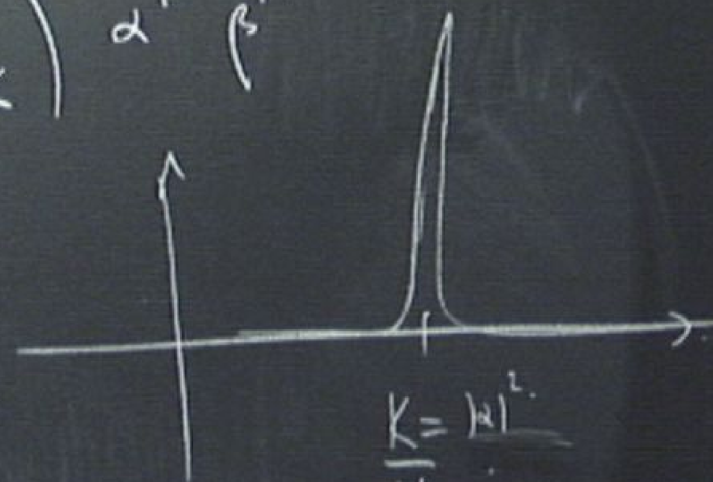
$$\left(\frac{N_\uparrow}{N}\right) = \sum_k \binom{N}{k}\left(\frac{k}{N}\right) \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

$\alpha^k \beta^{N-k}$. $|\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$

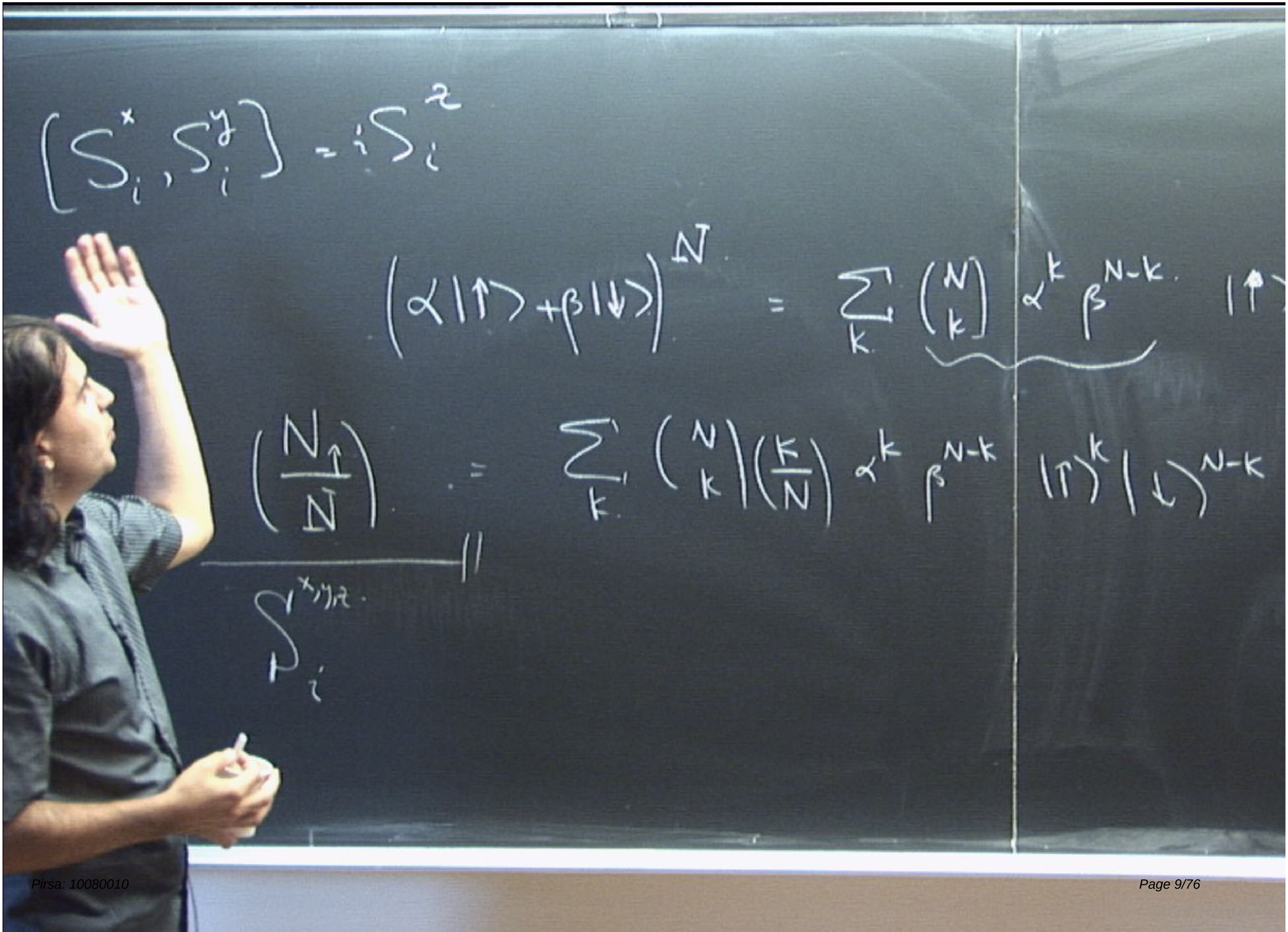
$|\uparrow\rangle^k \, |\downarrow\rangle^{N-k}$

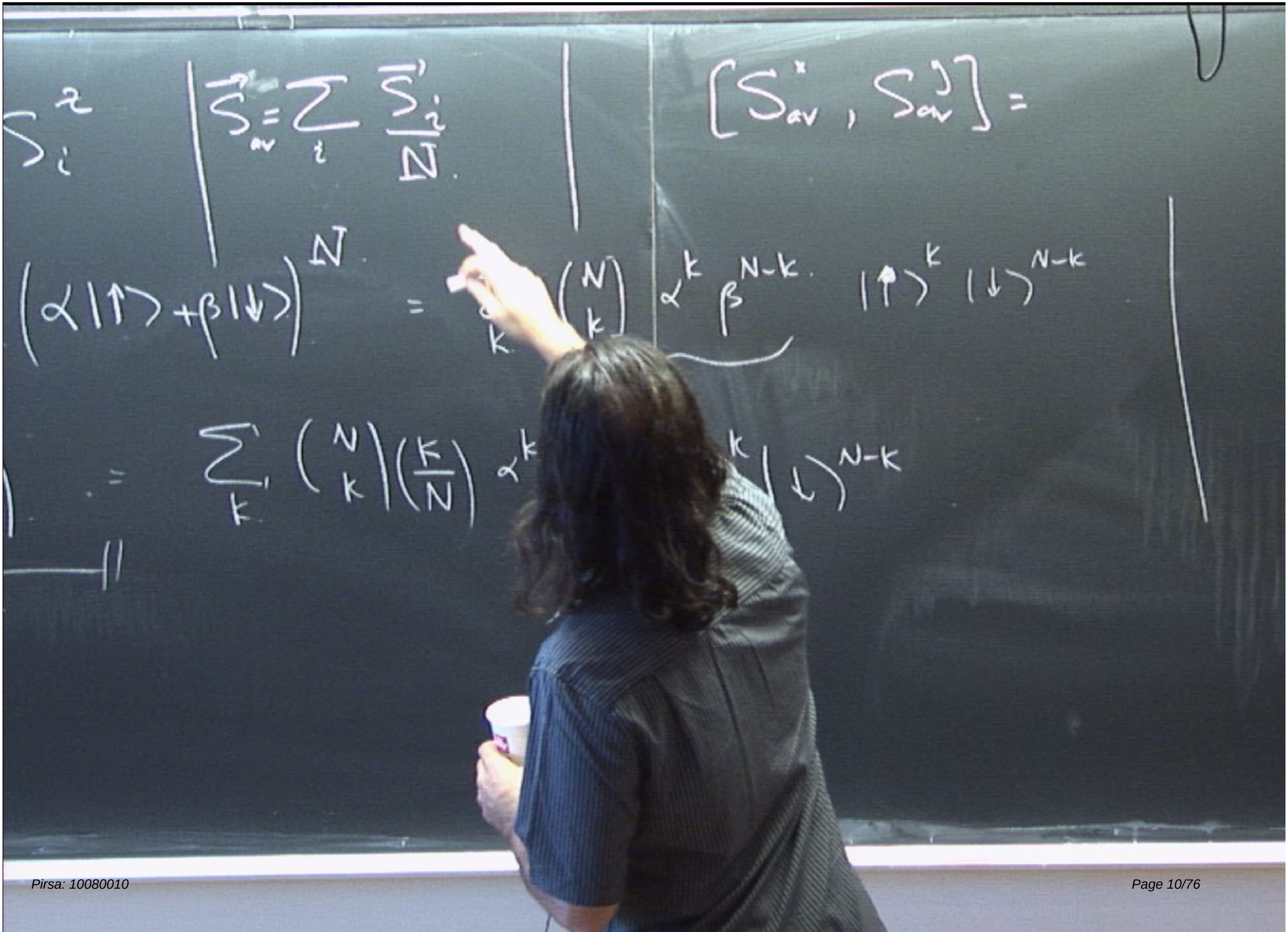
Check

$$\binom{N}{k} \alpha^k \beta^{N-k}.$$



$\frac{K}{N} = |\alpha|^2$.


$[S_i^x, S_i^y] = i S_i^z$
$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} |\uparrow$
$\left(\frac{N_\uparrow}{N}\right) = \sum_k \binom{N}{k}\left(\frac{k}{N}\right) \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$
$S_i^{x,y,z}$


$\vec{S}_{av} = \sum_i \frac{\vec{S}_i}{N}$
$[S^x_{av}, S^y_{av}] =$
$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \binom{N}{k} \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$
$= \sum_k \binom{N}{k} \left(\frac{k}{N}\right) \alpha^k$
$|\downarrow\rangle^{N-k}$

S_i^z

$$\vec{S}_{av} = \sum_i \frac{\vec{S}_i}{N}$$

$$[S_{av}^x, S_{av}^y] = \frac{1}{N^2}$$

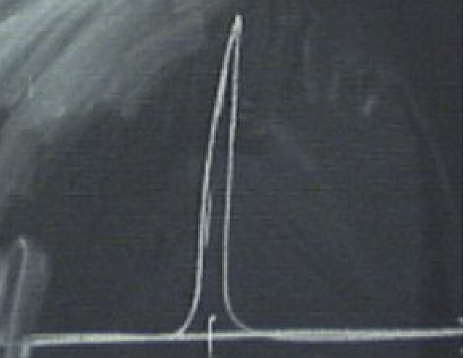
$$(\alpha|\uparrow\rangle + \beta|\downarrow\rangle)^N = \sum_k \underbrace{\binom{N}{k} \alpha^k \beta^{N-k}} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

$$= \sum_k \binom{N}{k}\left(\frac{k}{N}\right) \alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

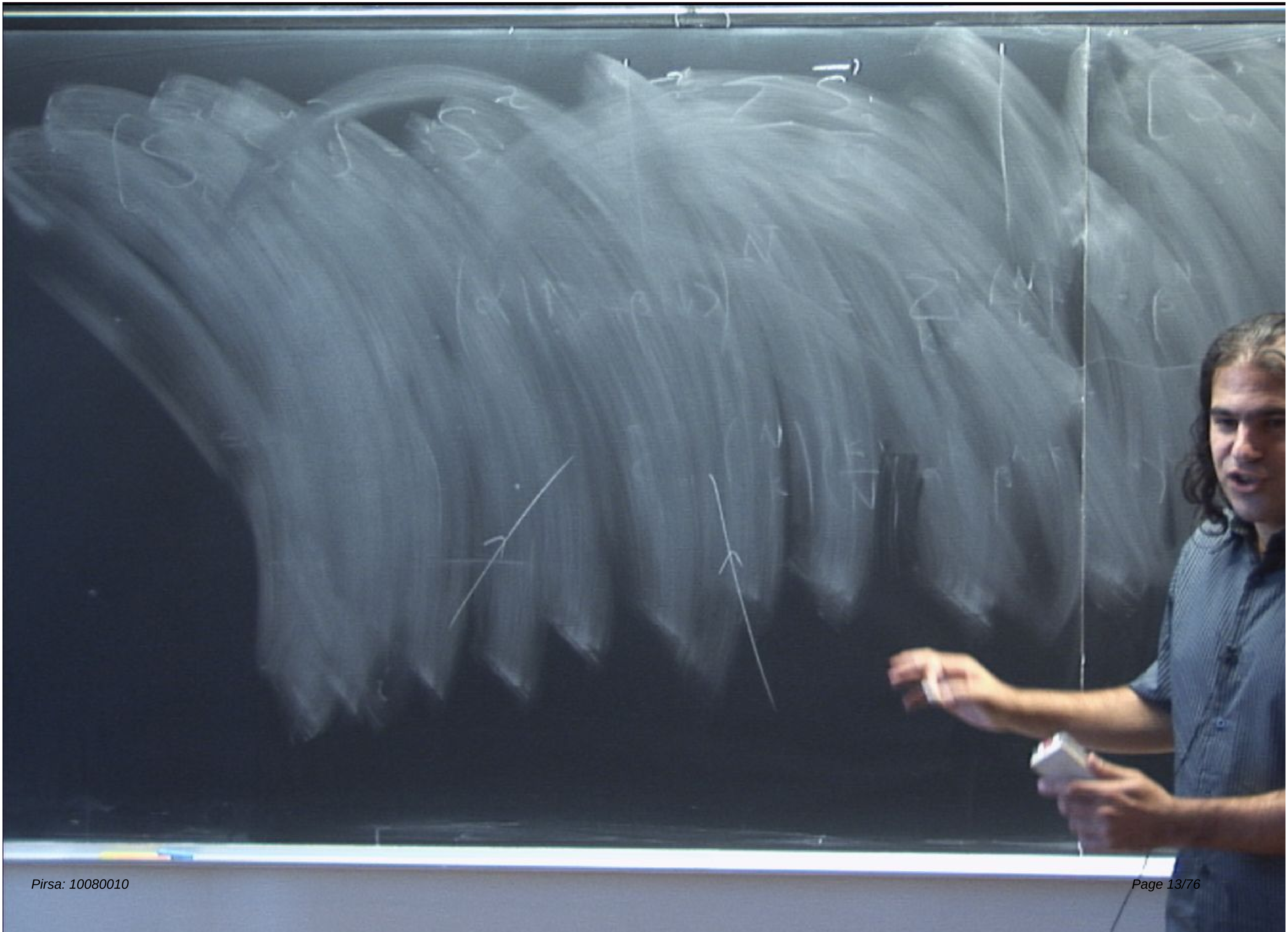
$$[S^x_{av}, S^y_{av}] = \frac{1}{N^2} \sum_i S^z_i = \frac{1}{N} S^z_{av}.$$

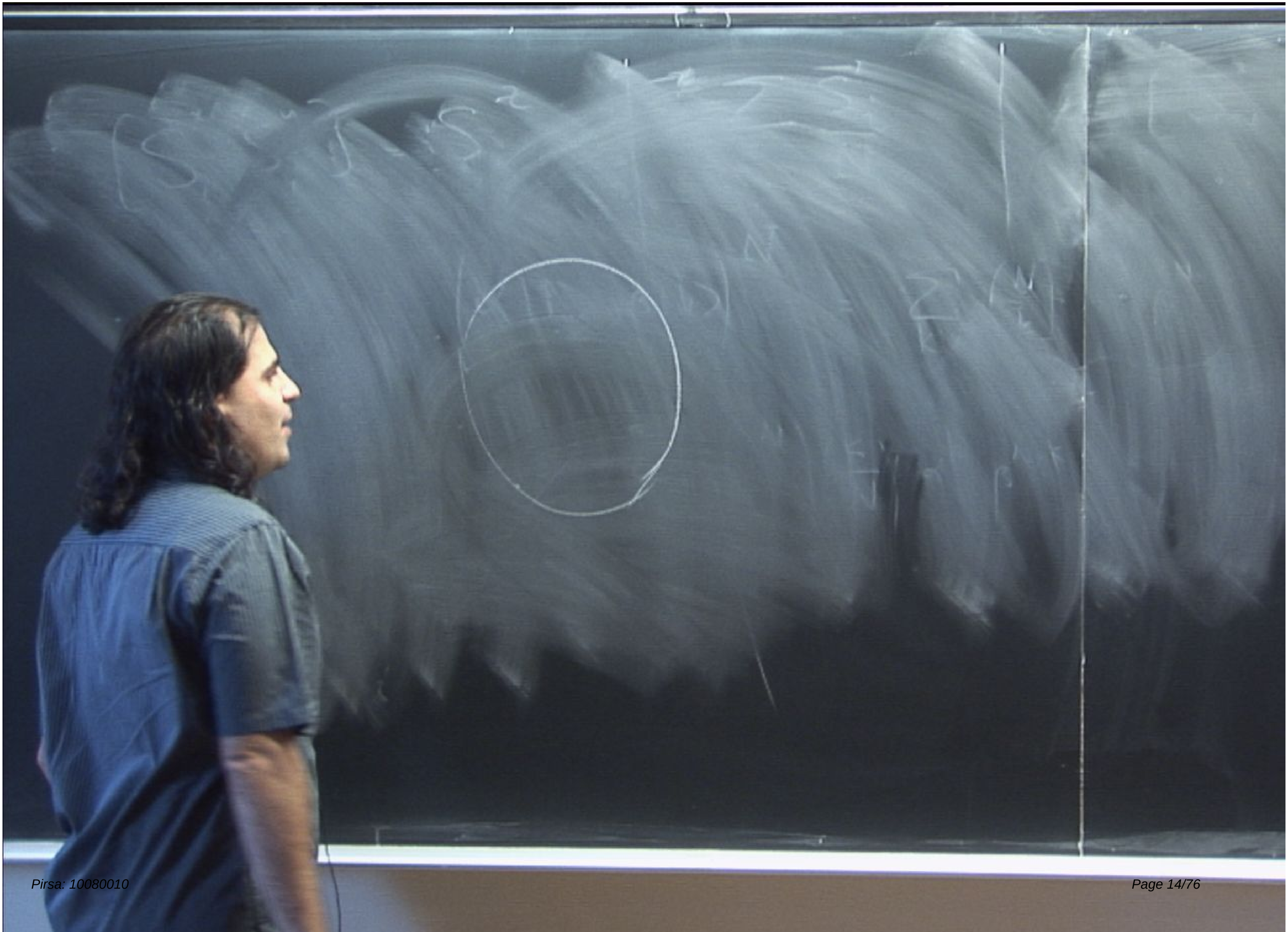
$$\sum \underbrace{\binom{N}{k} \alpha^k \beta^{N-k}} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

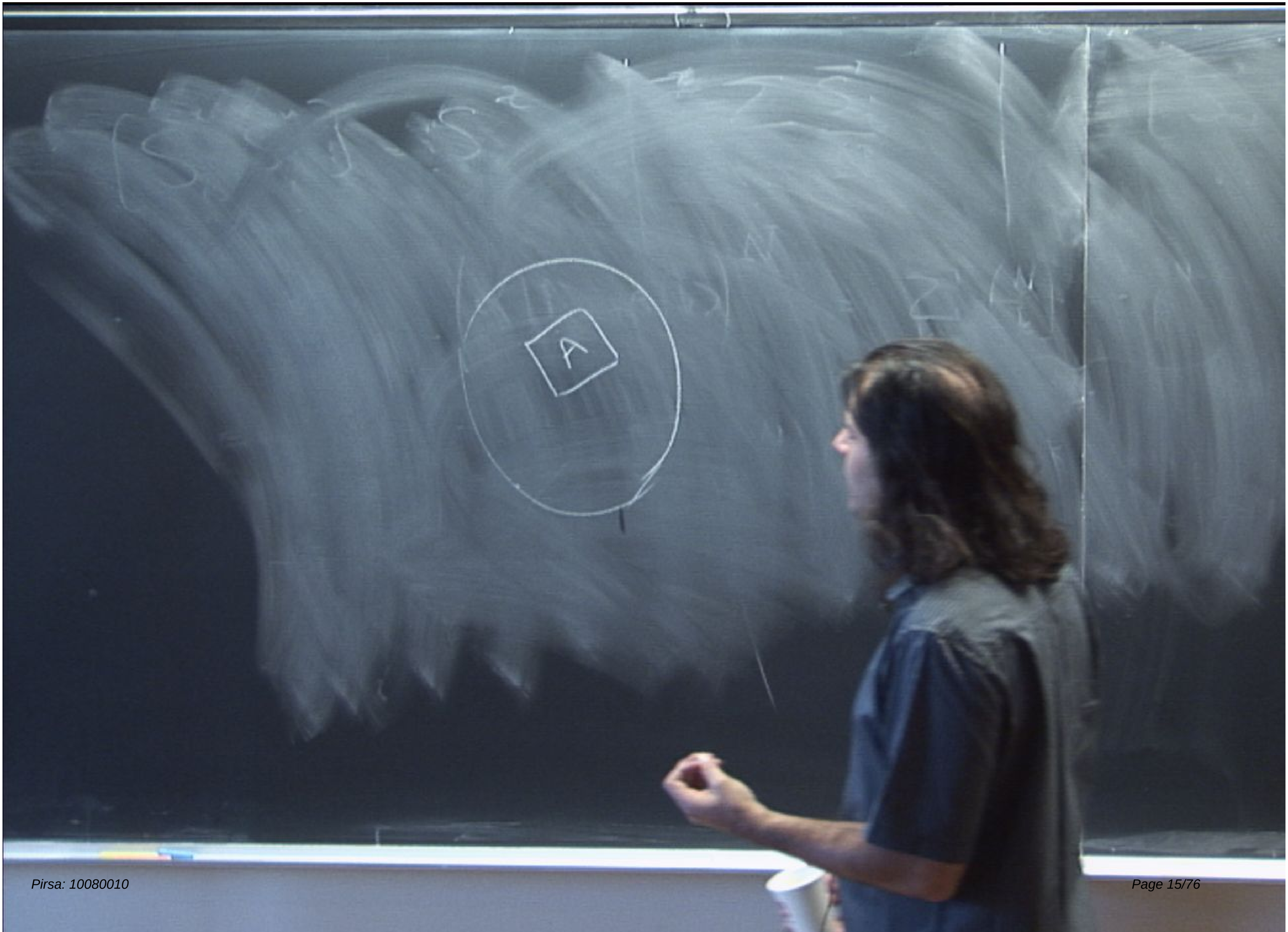
$$\alpha^k \beta^{N-k} |\uparrow\rangle^k |\downarrow\rangle^{N-k}$$

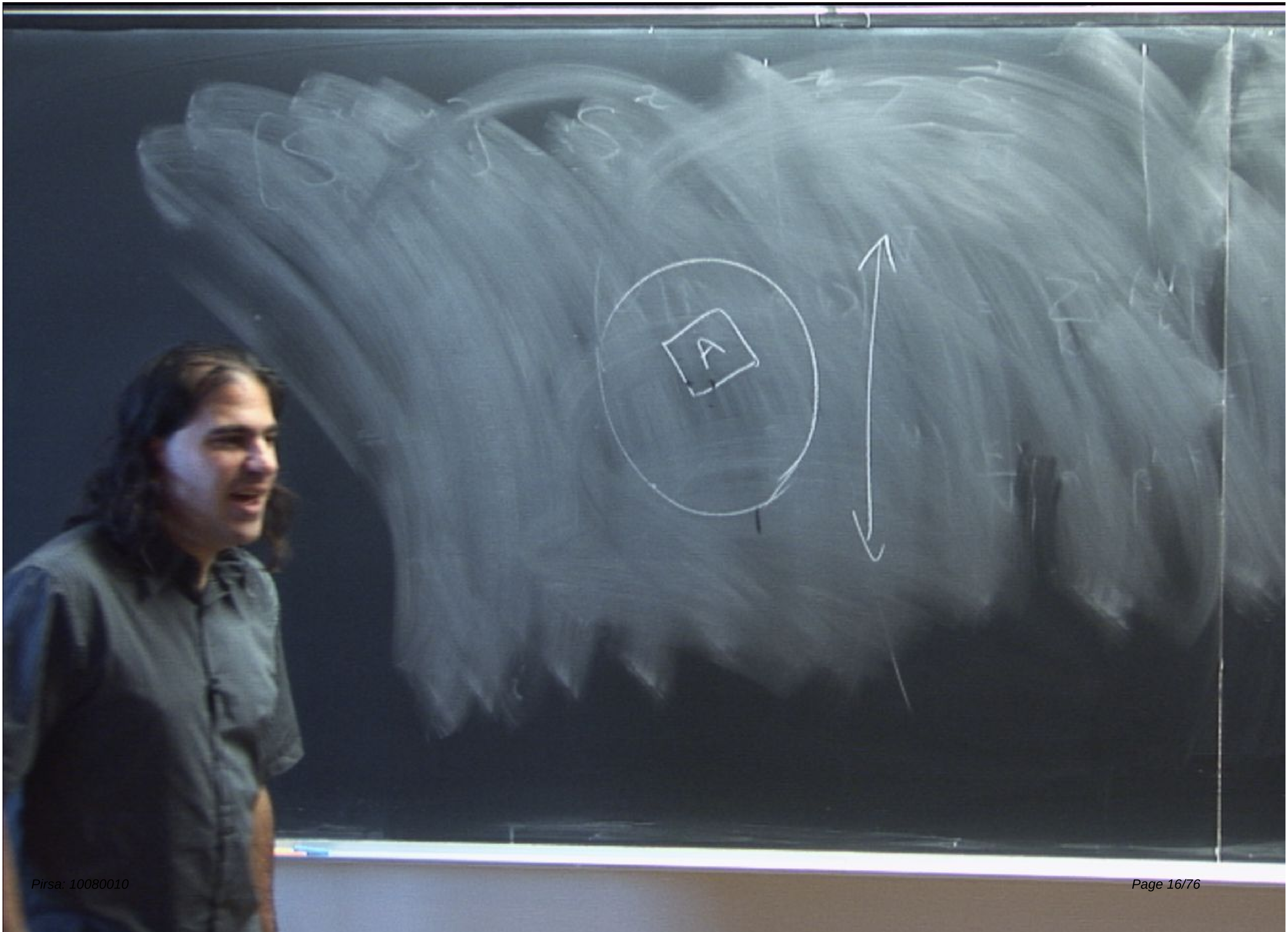


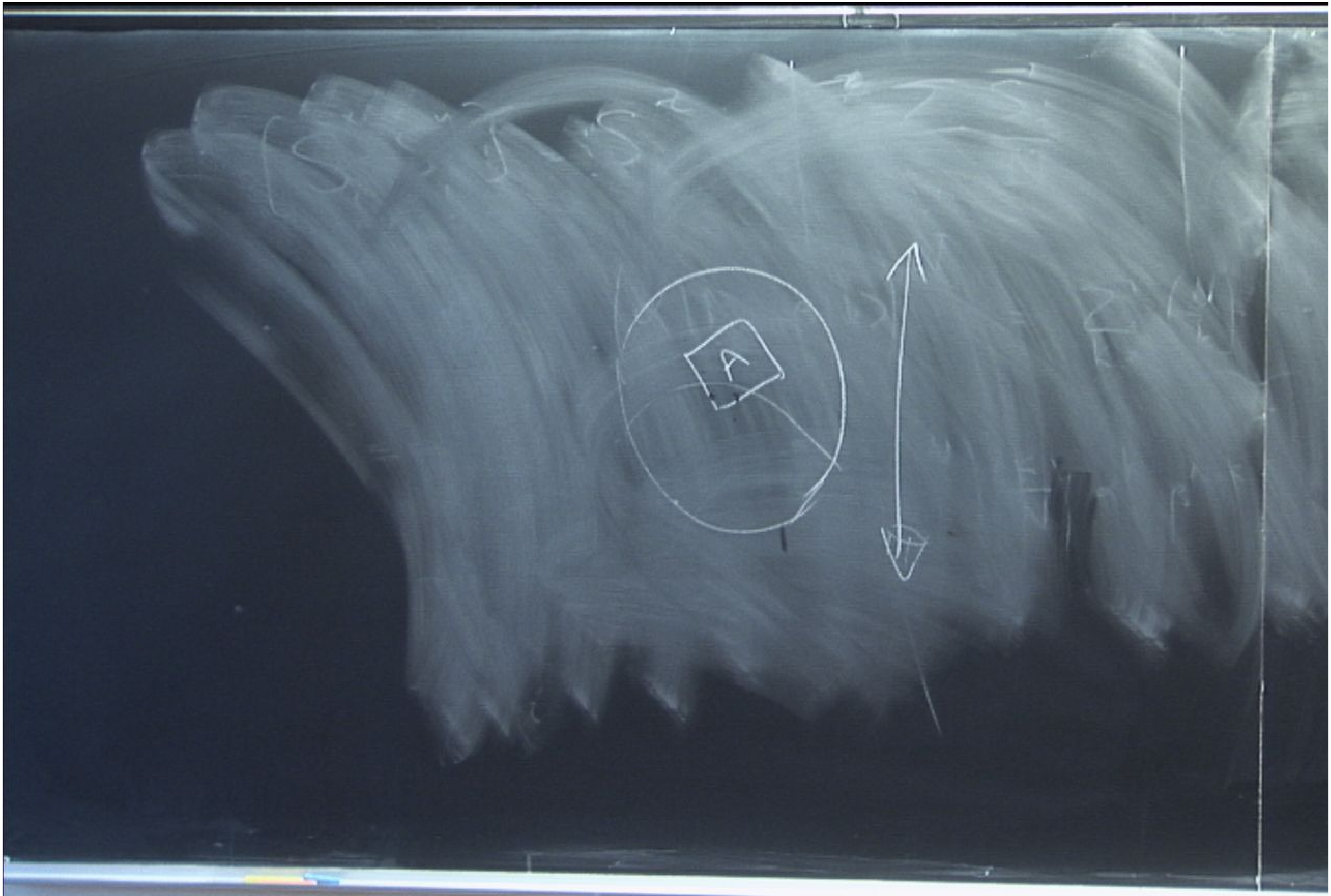
$$\frac{k}{N} = |\alpha|^2.$$

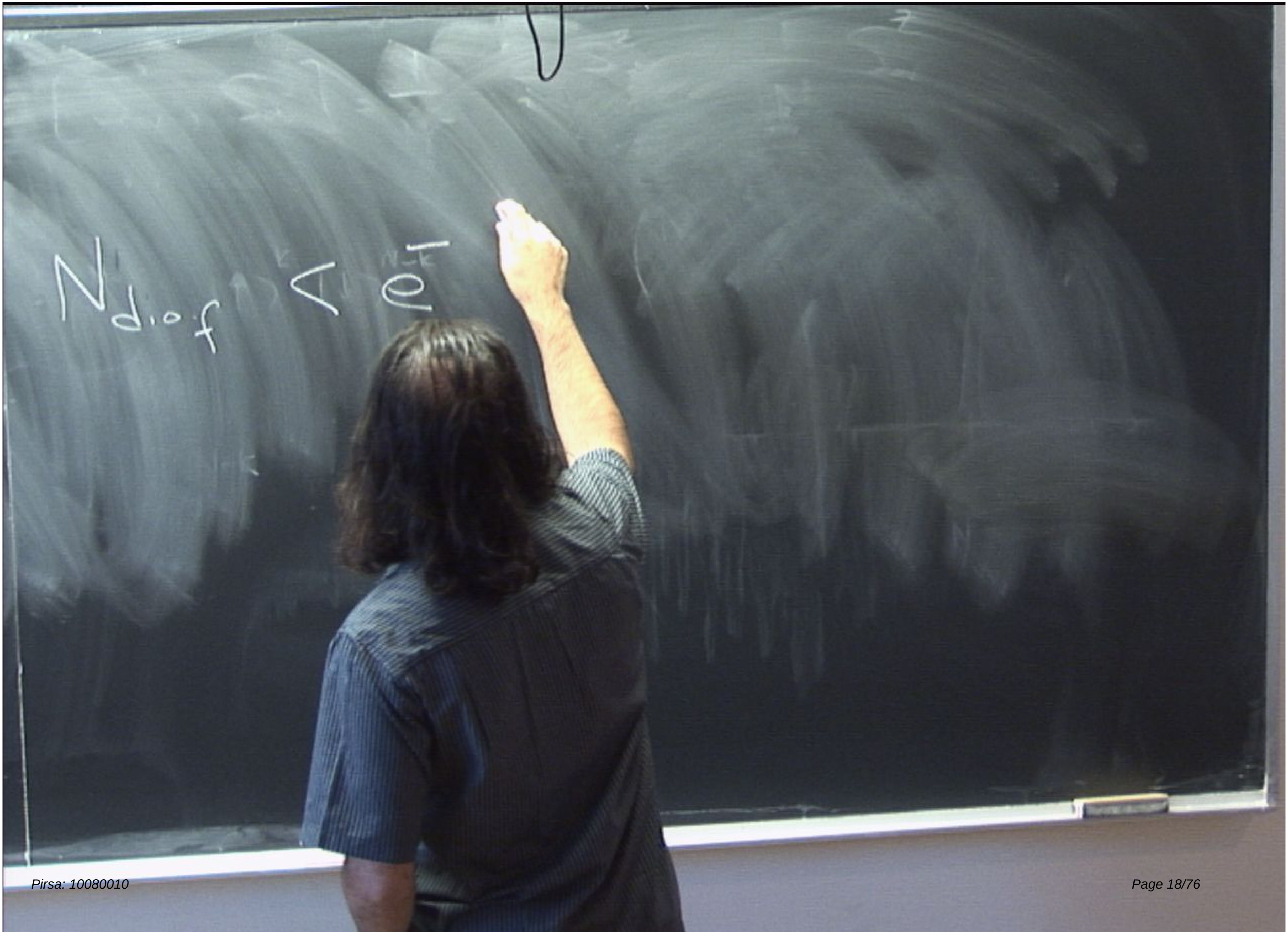


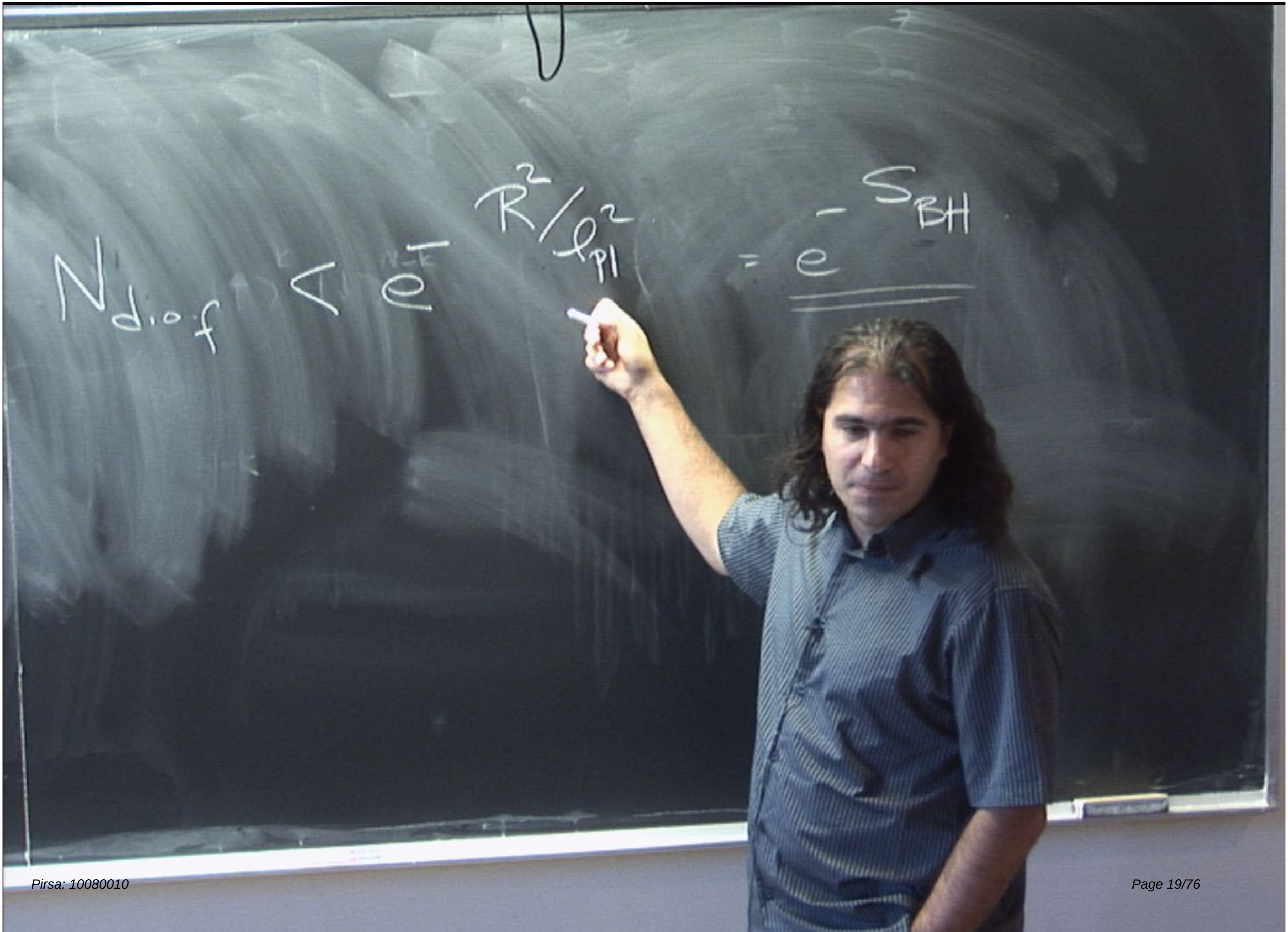


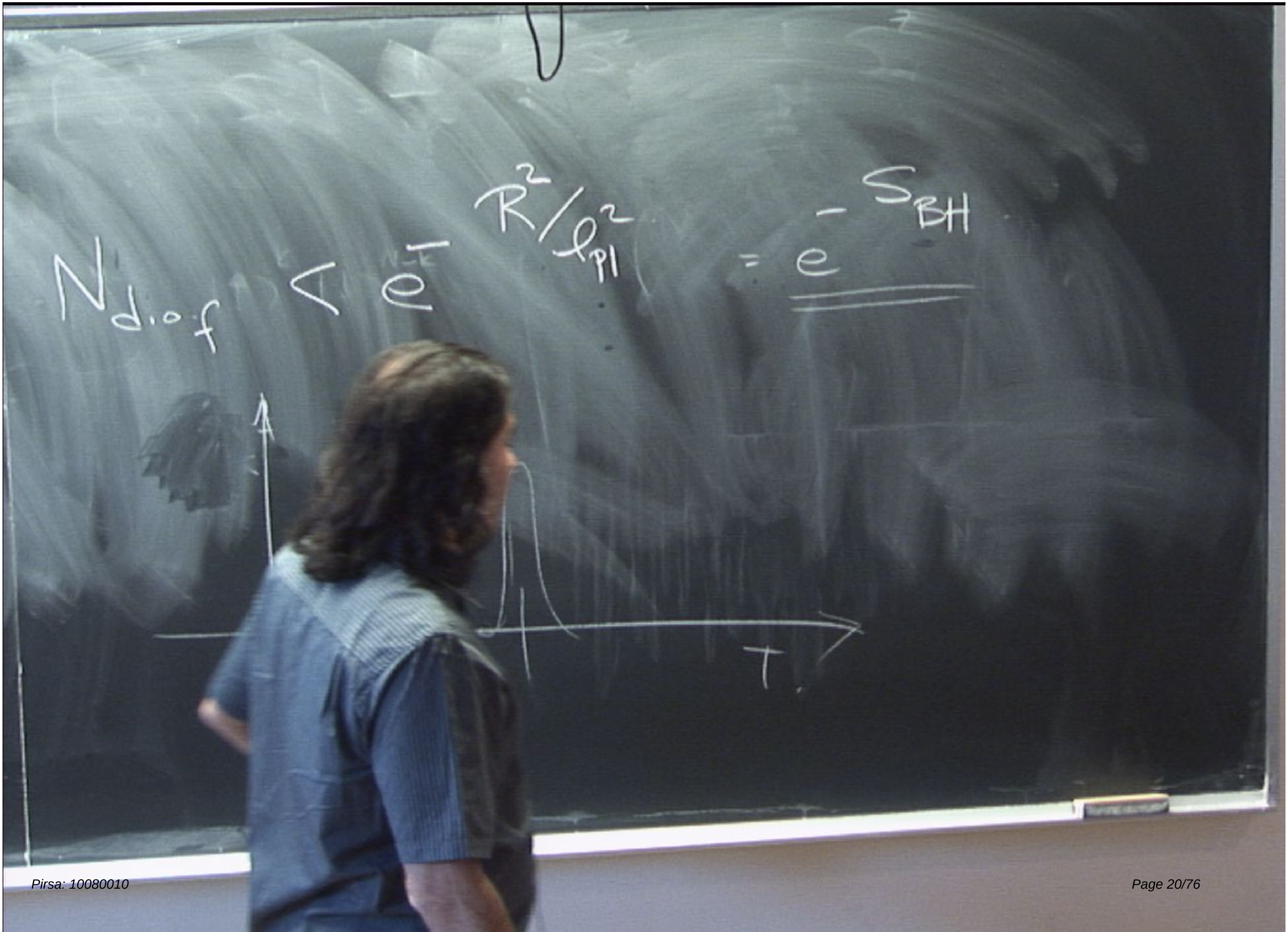

A

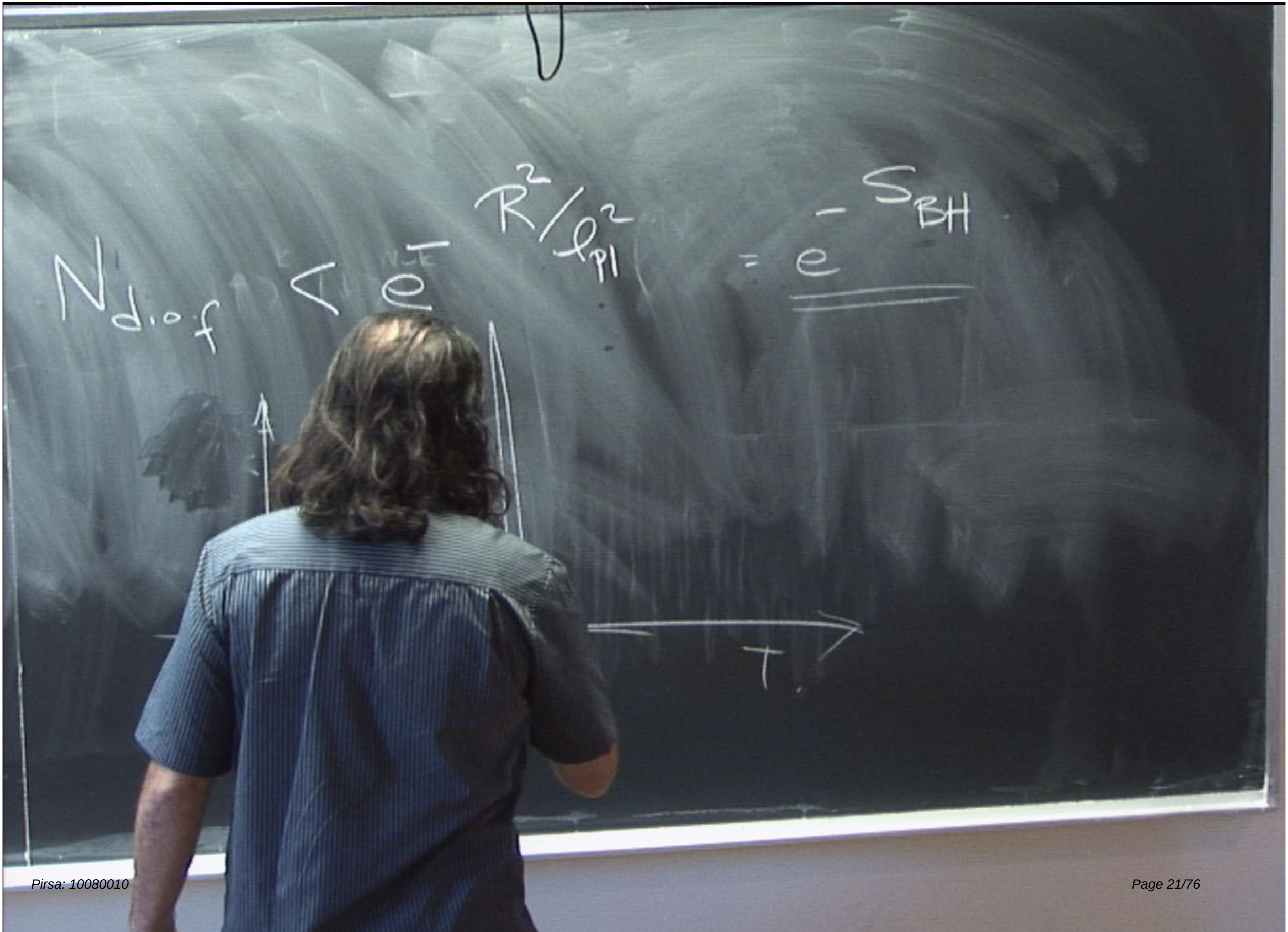

A

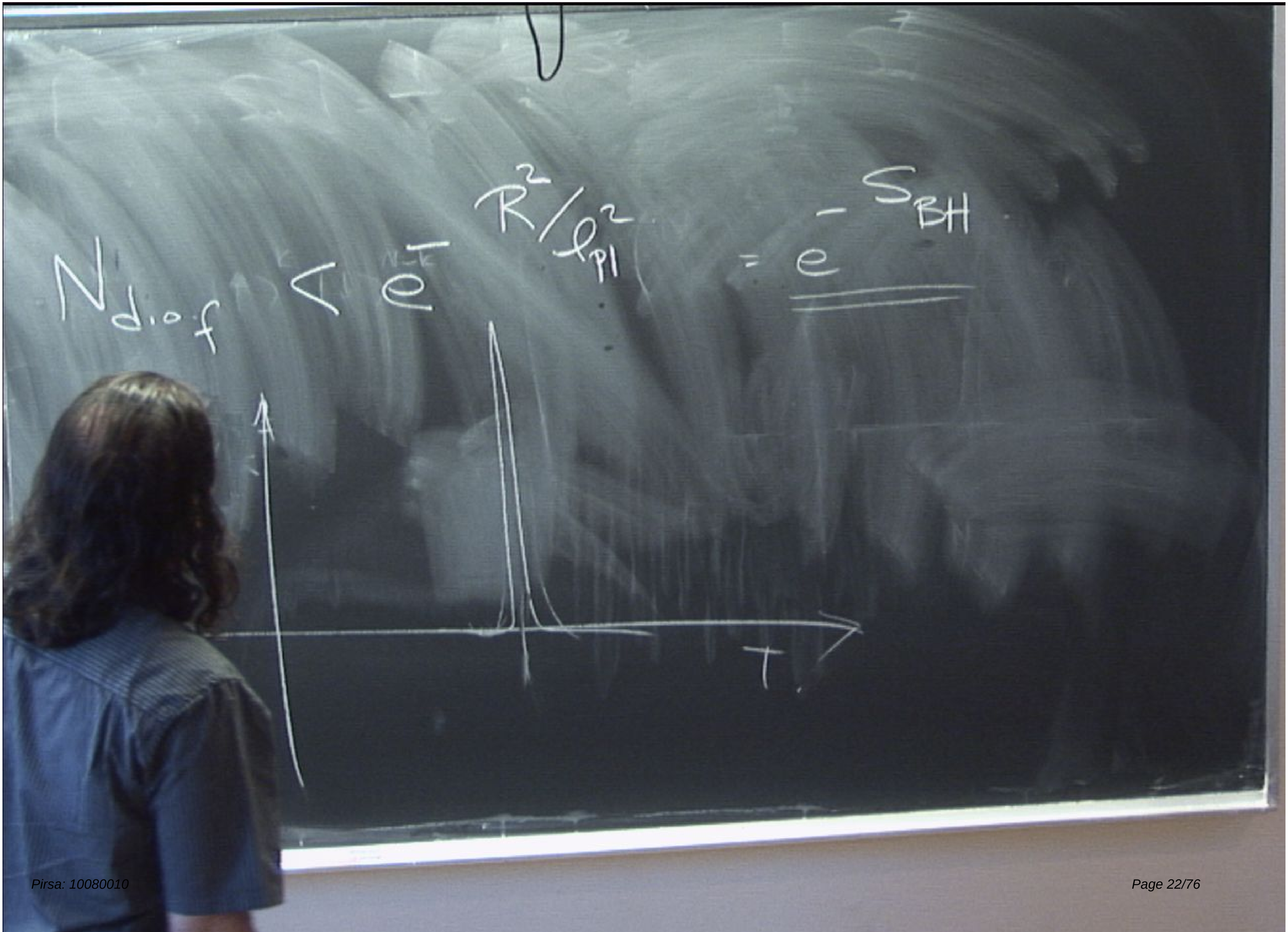

A

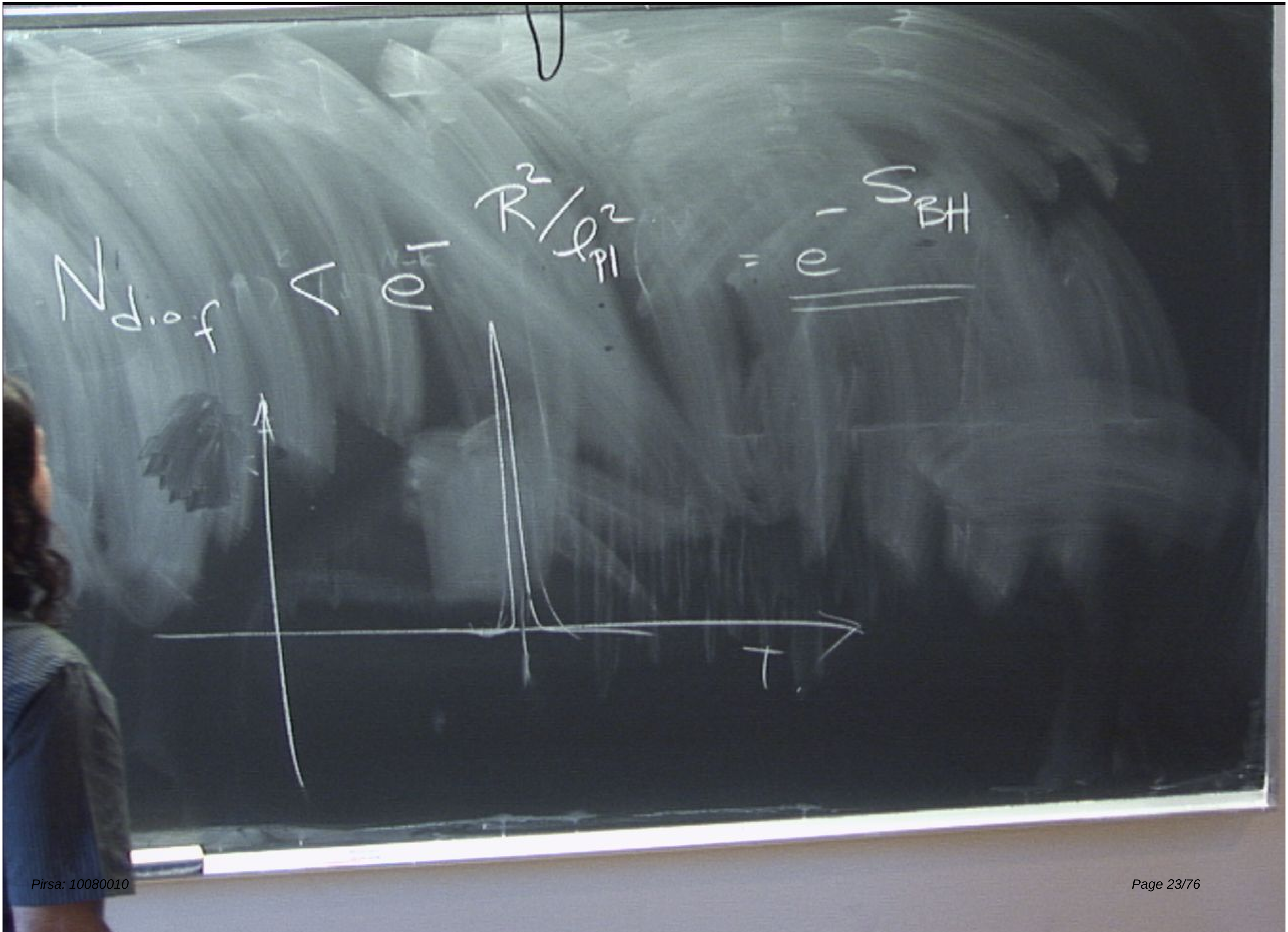

N d.o.f


$N_{d.o.f} < e^{R^2/\ell_{pl}^2} = e^{-S_{BH}}$


$N_{d.o.f} < e^{-R^2/\ell_{pl}^2} = e^{-S_{BH}}$
T


$N_{d.o.f} < e^{R^2/\ell_{pl}^2} = e^{-S_{BH}}$
T

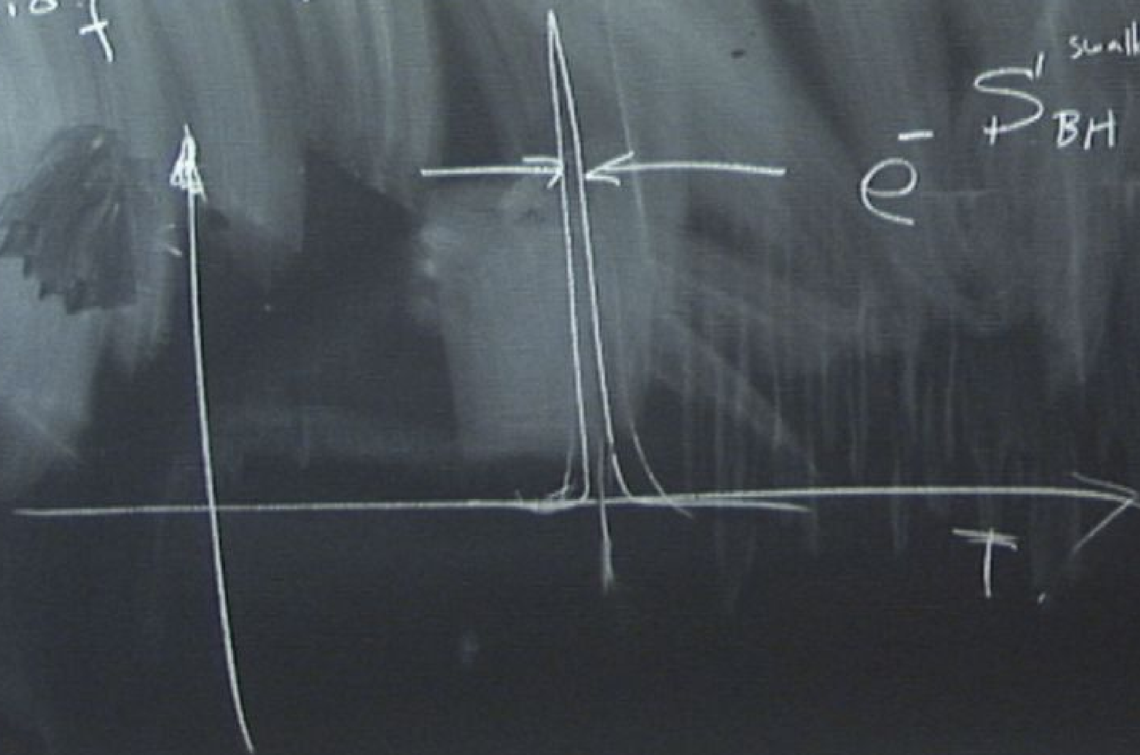

N d.o.f < e − R²/l pl² = e − S BH
t

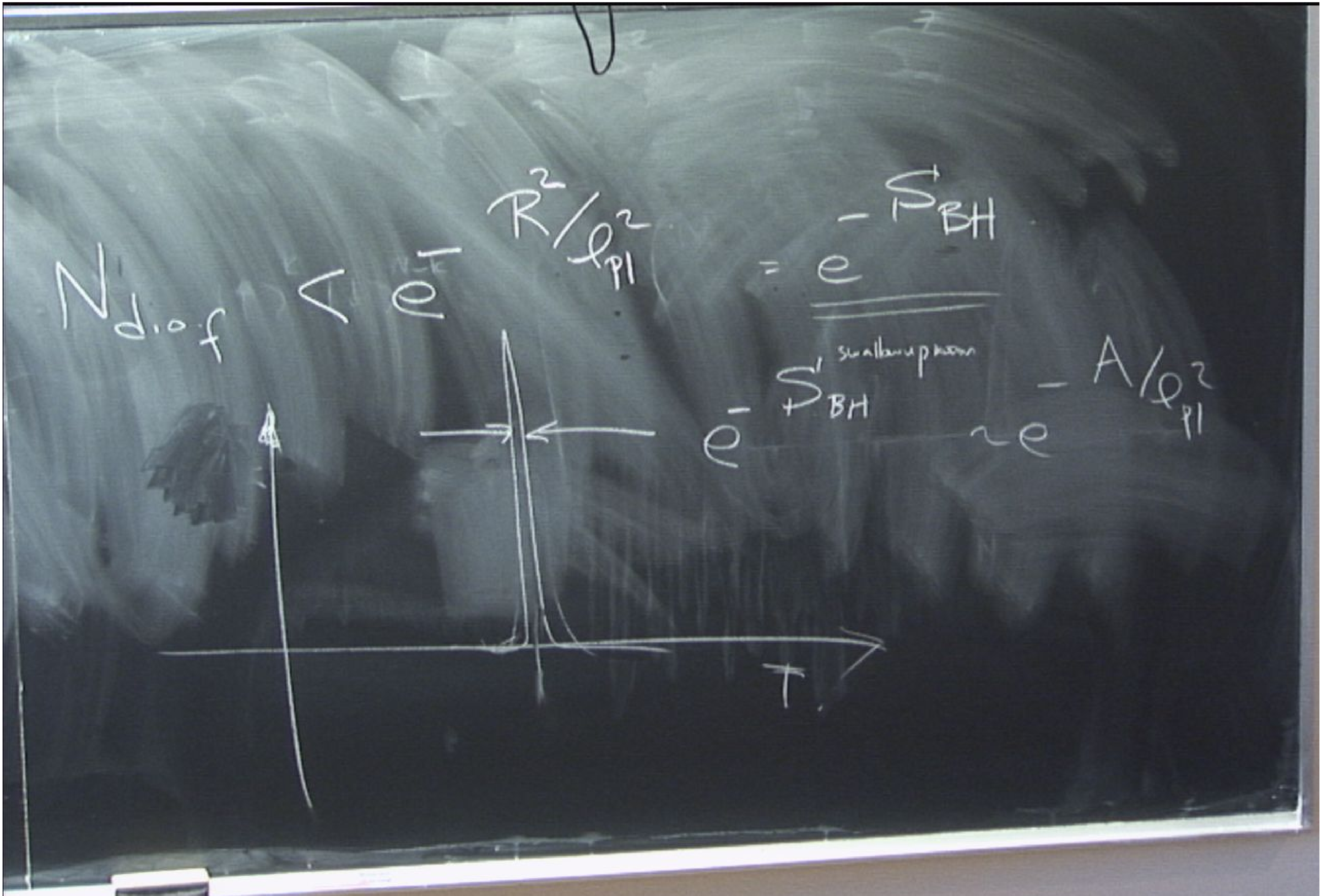

$N_{d.o.f} < e^{-R^2/\ell_{pl}^2} = e^{-S_{BH}}$
T

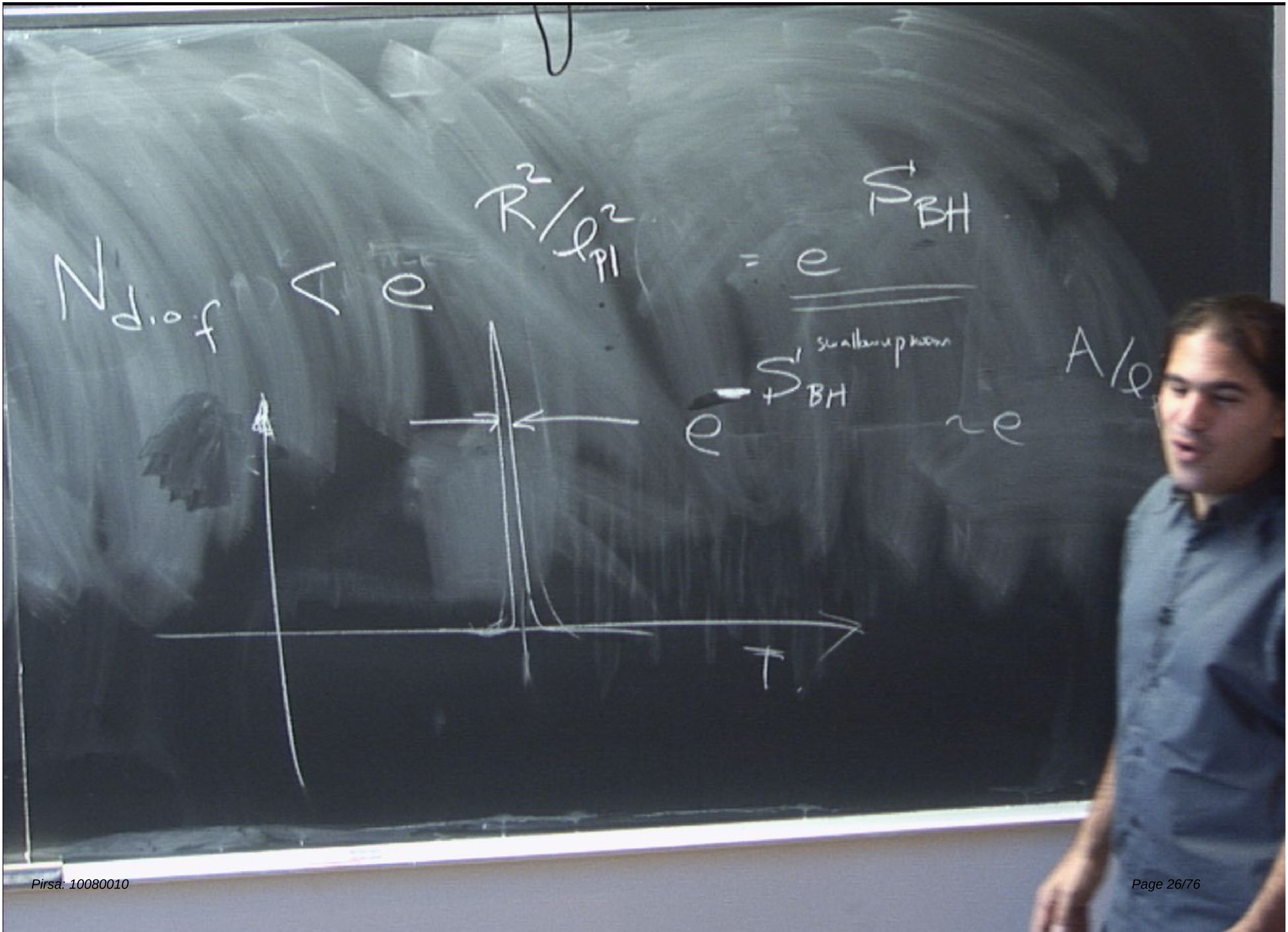
$$N_{d.o.f} \sim e^{-R^2/\ell_{pl}^2} = \underline{\underline{e^{-S_{BH}}}}$$

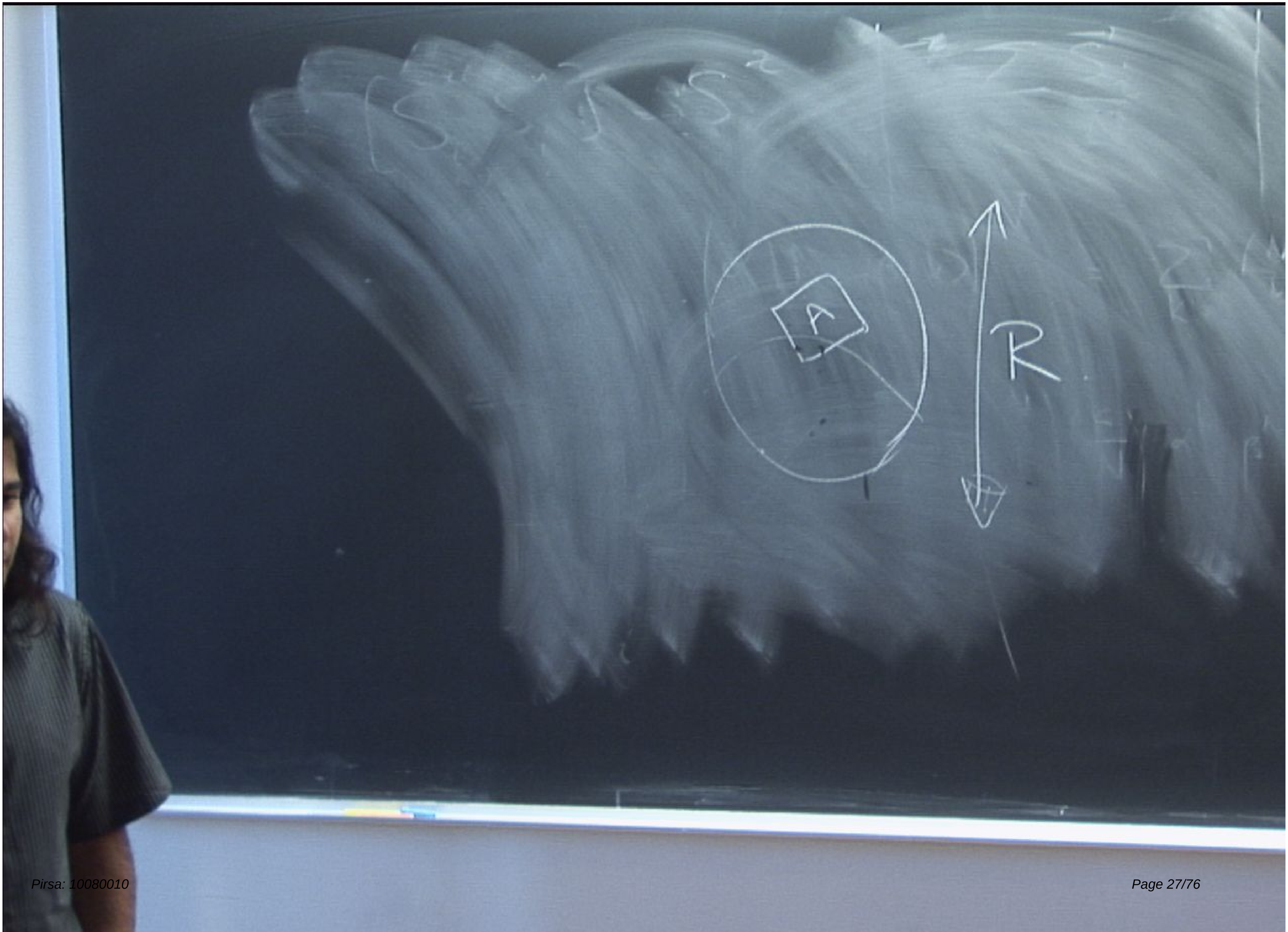
swallow up proton

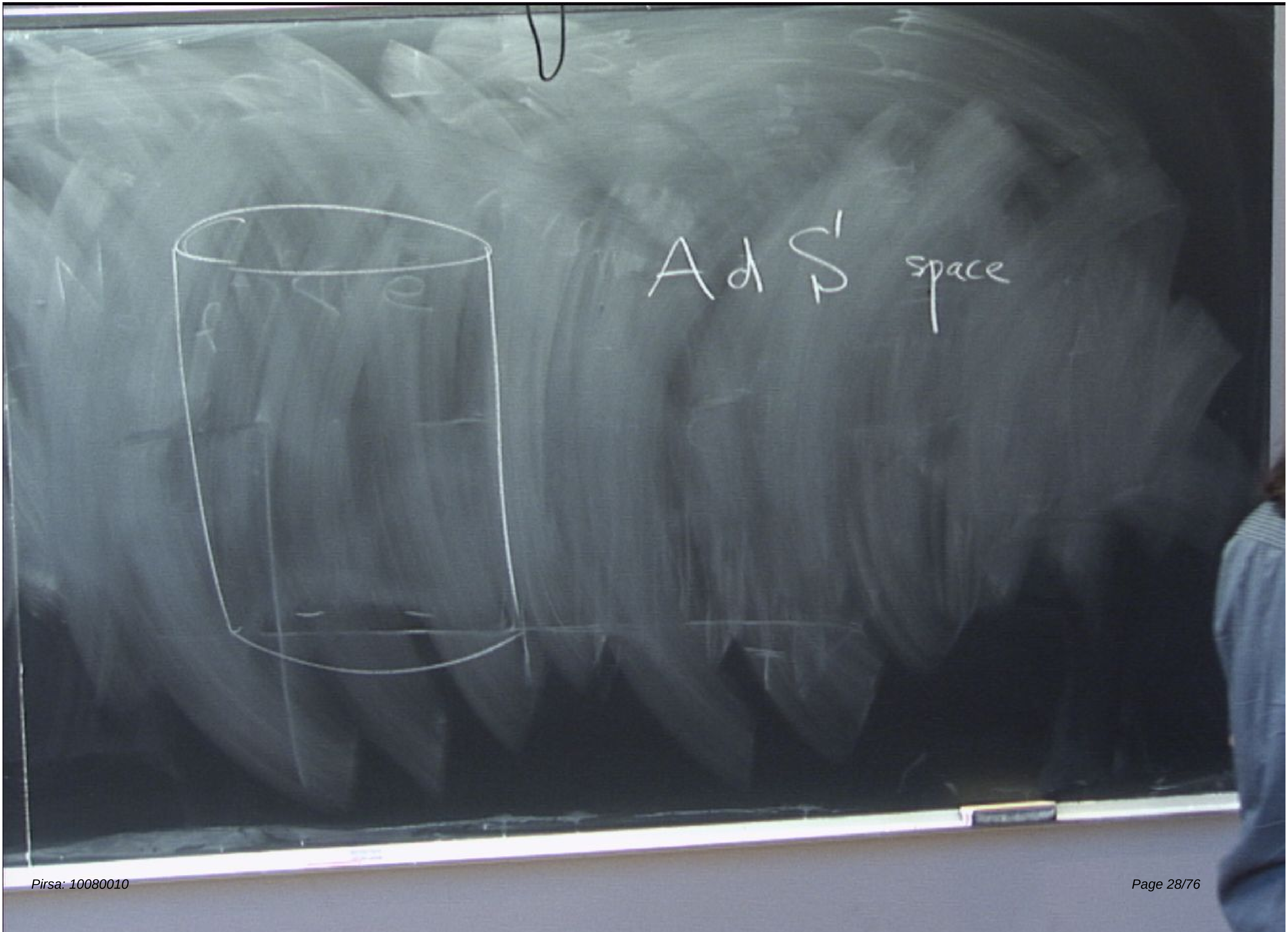
$$e^{-S'_{BH}} \sim e^{-A/\ell_{pl}^2}$$

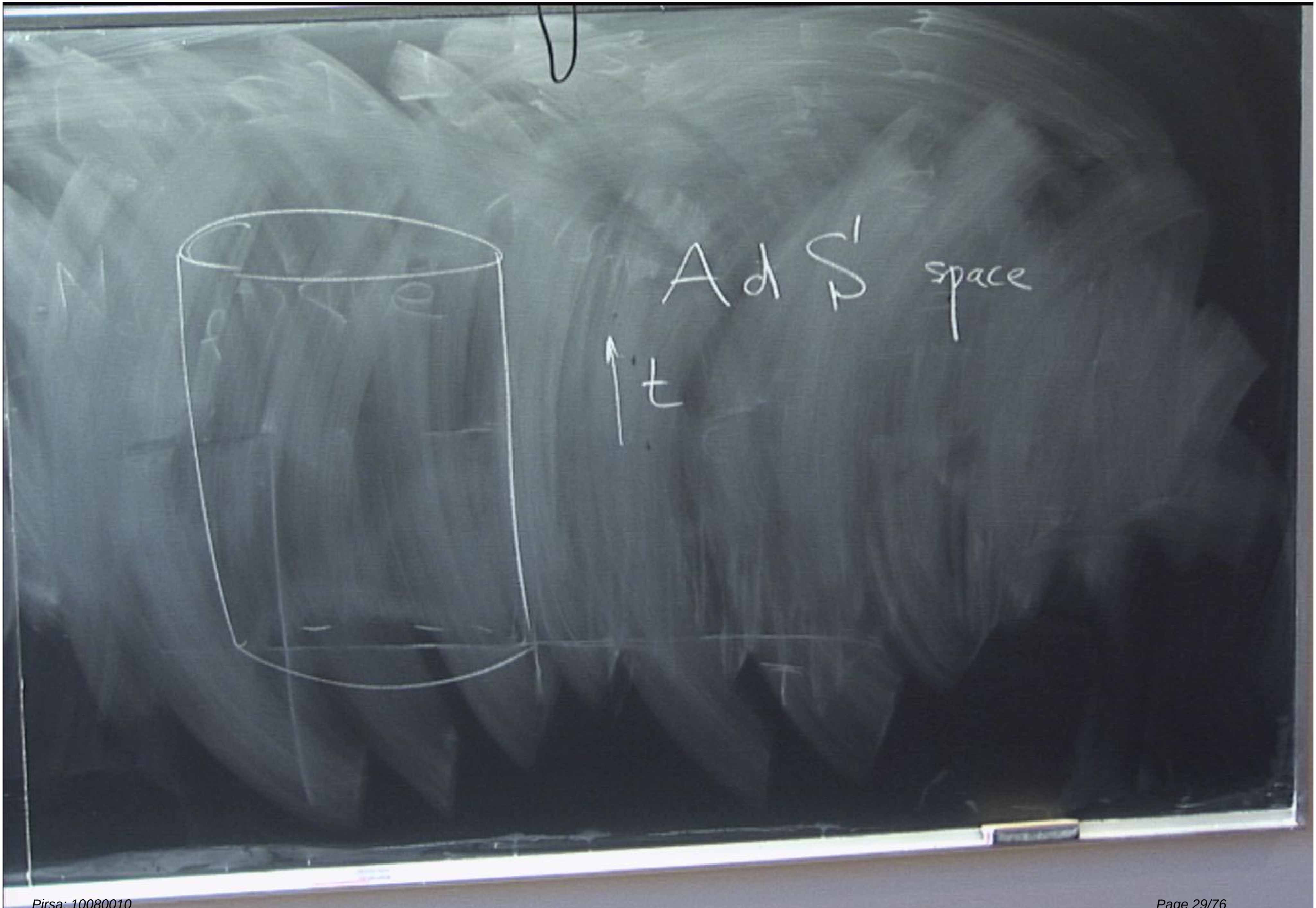


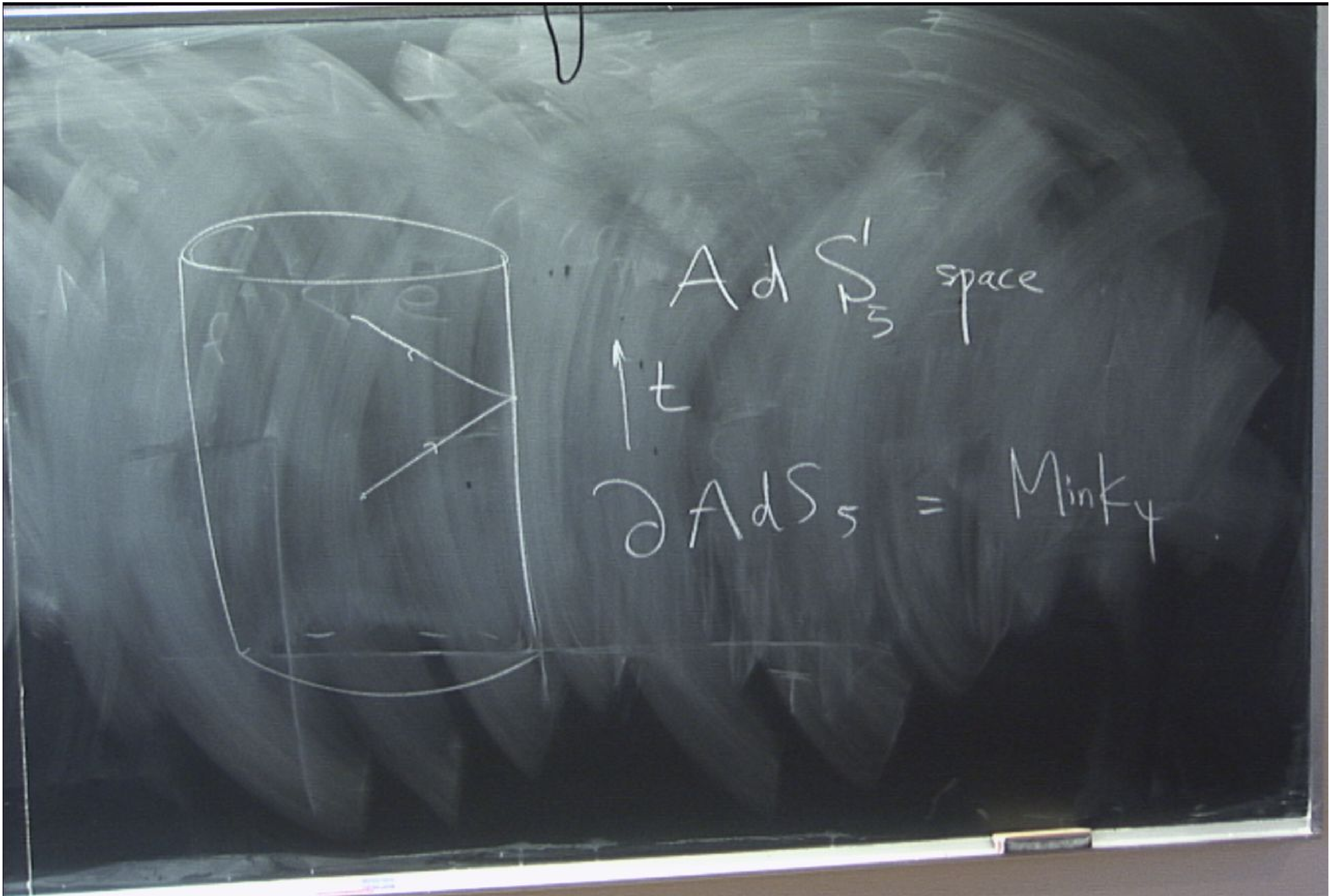

$N_{d.o.f} < e^{-R^2/\ell_{pl}^2} = e^{-S_{BH}}$
$e^{-S'_{BH}} \sim e^{-A/\ell_{pl}^2}$
T

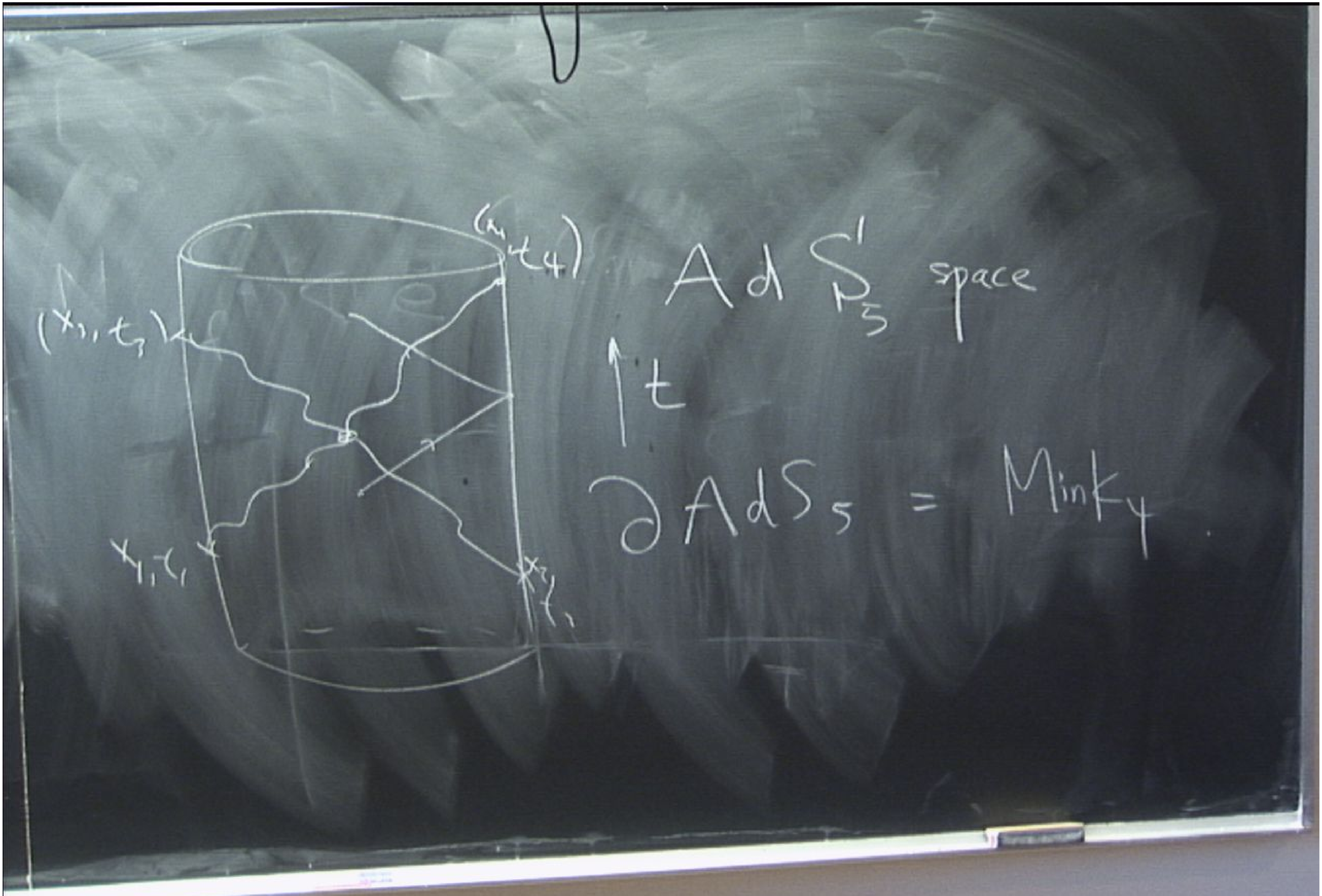

N_d.o.f < e^(R²/ℓ_pl²) = e^(S_BH)
e^(-S_BH) ~ e
A/ℓ
T

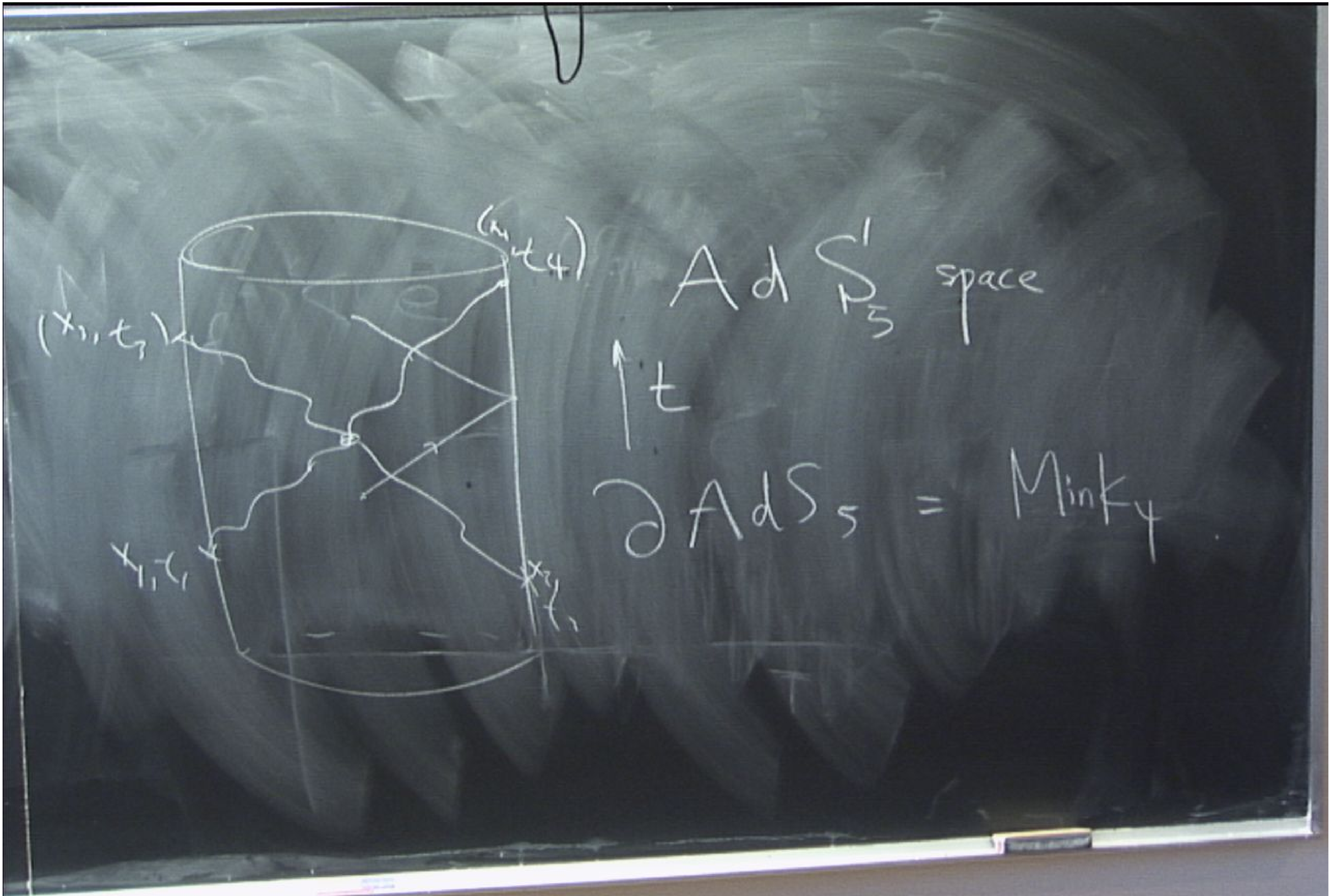

A
R

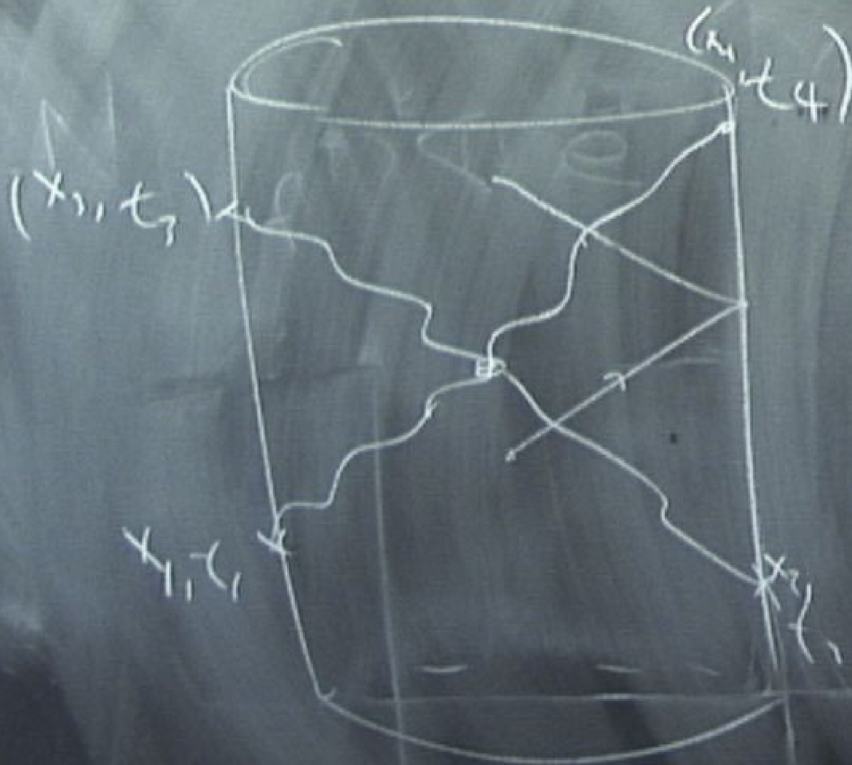

AdS' space


AdS' space
t


AdS5 space
t
∂AdS5 = Mink4


(x4, t4)
(x3, t3)
x1, t1
x2, t2
AdS5 space
t
∂AdS5 = Mink4

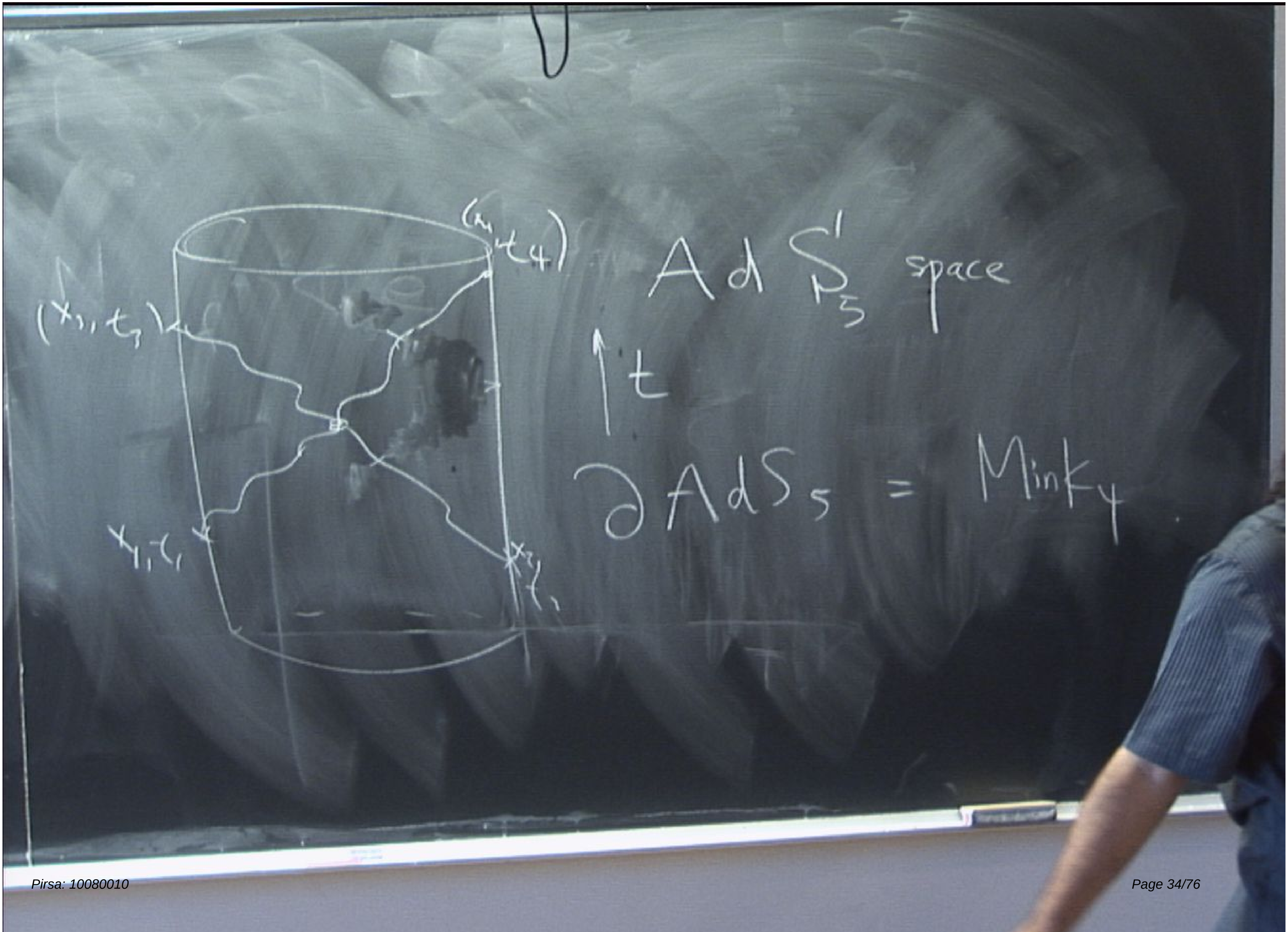

(x_4, t_4)
(x_3, t_3)
x_1, t_1
x_2, t_2
space
t
∂AdS_5 = Mink_4

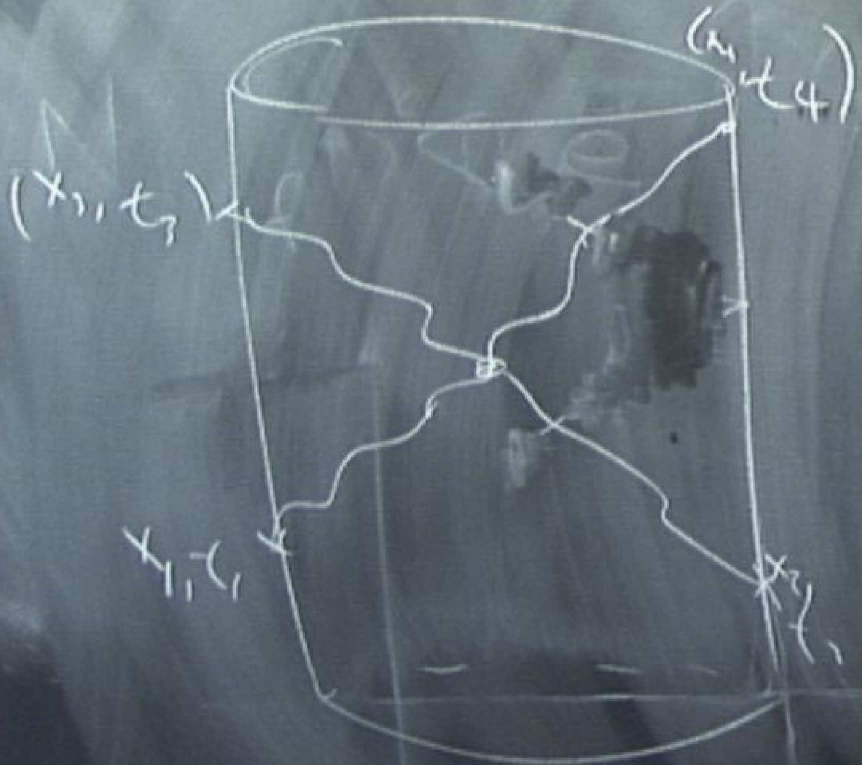


AdS_5 space

t

$\partial AdS_5 = Mink_4$

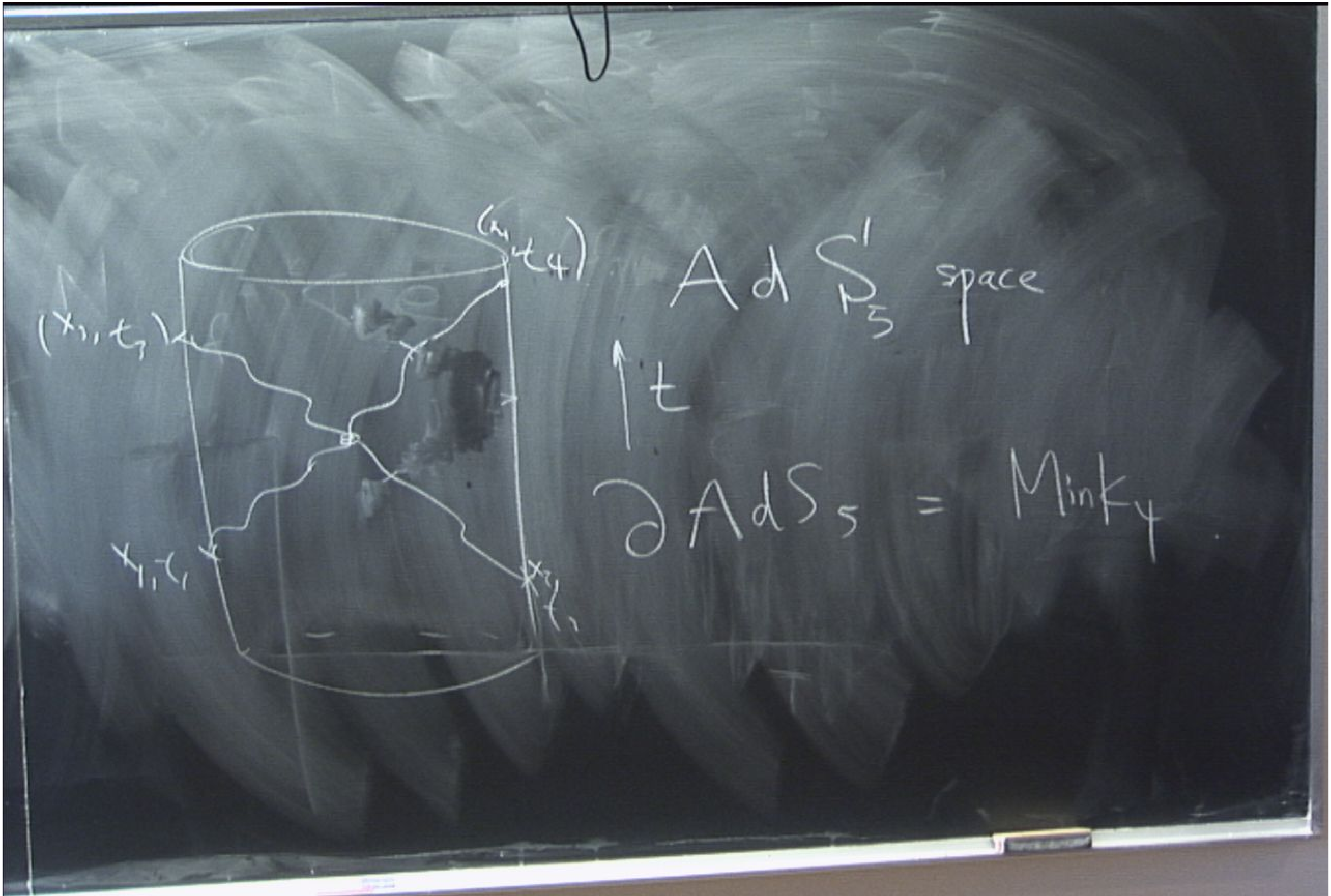

(x4, t4)
(x3, t3)
x1, t1
x2, t2
AdS5 space
t
∂AdS5 = Mink4

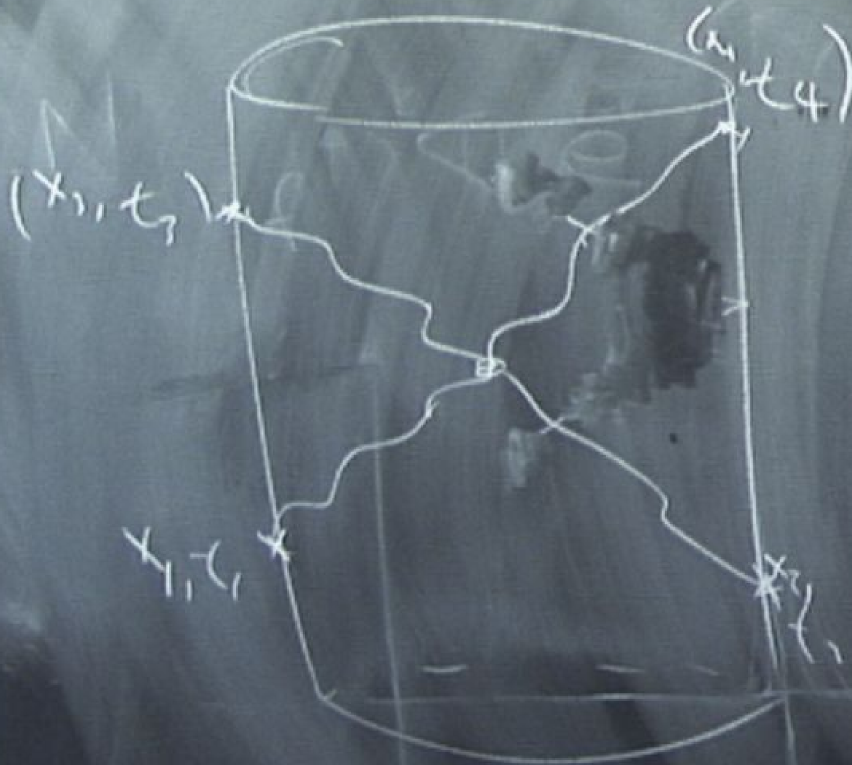


AdS_5' space

$\uparrow t$

$\partial AdS_5 = Mink_4$


(x_4, t_4)
(x_3, t_3)
x_1, t_1
x_2, t_2
AdS_5 space
t
∂AdS_5 = Mink_4

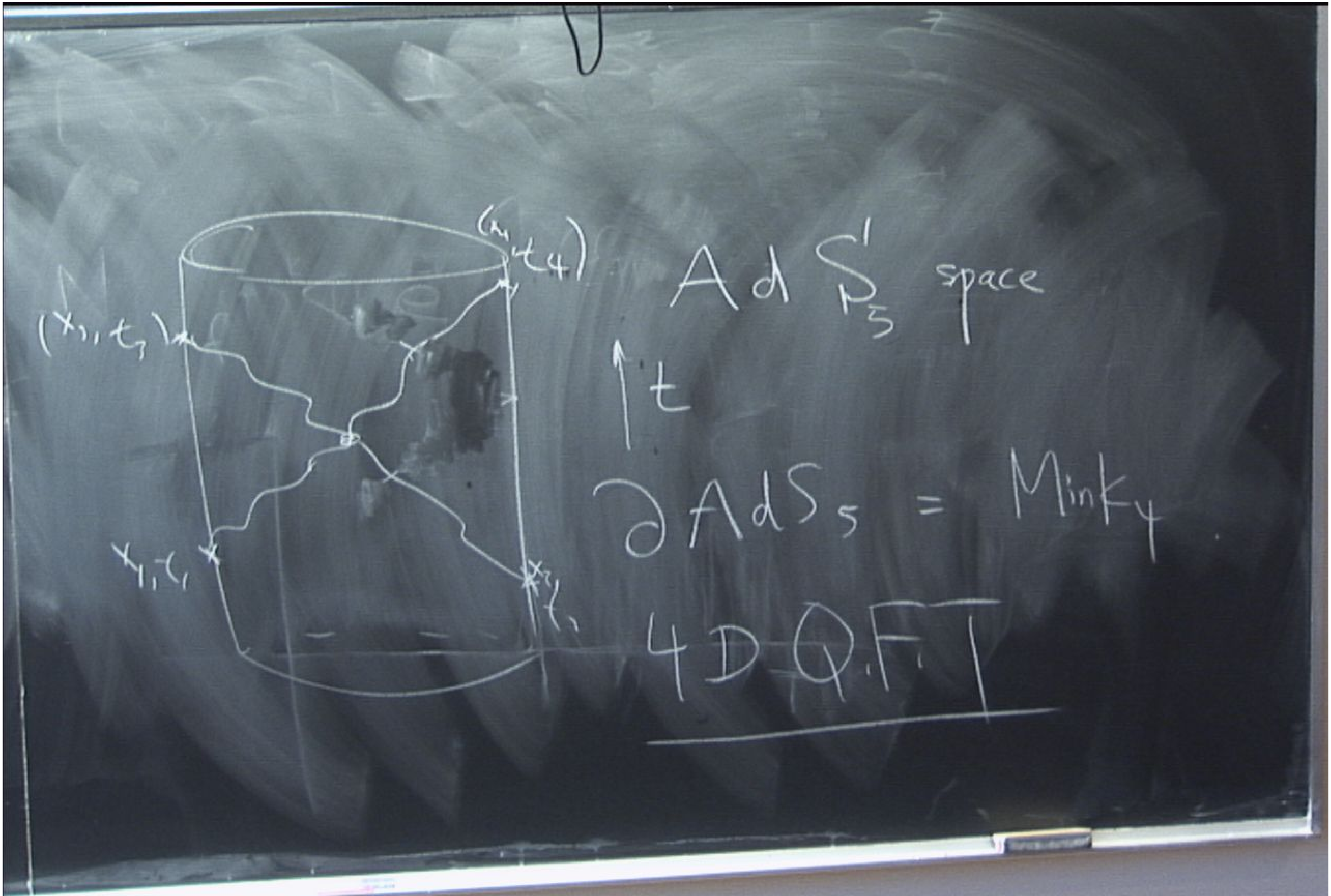


AdS_5 space

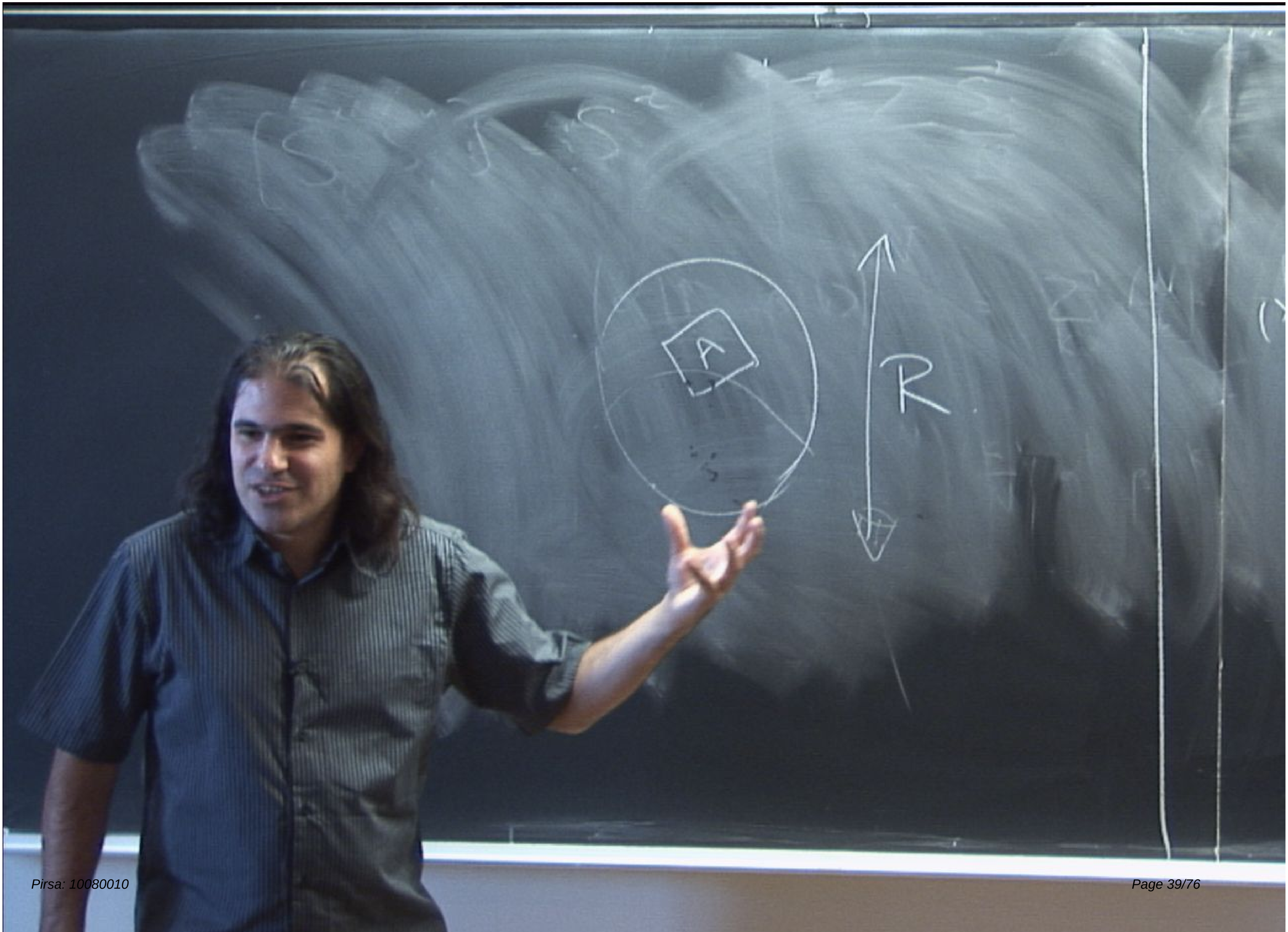
$\uparrow t$

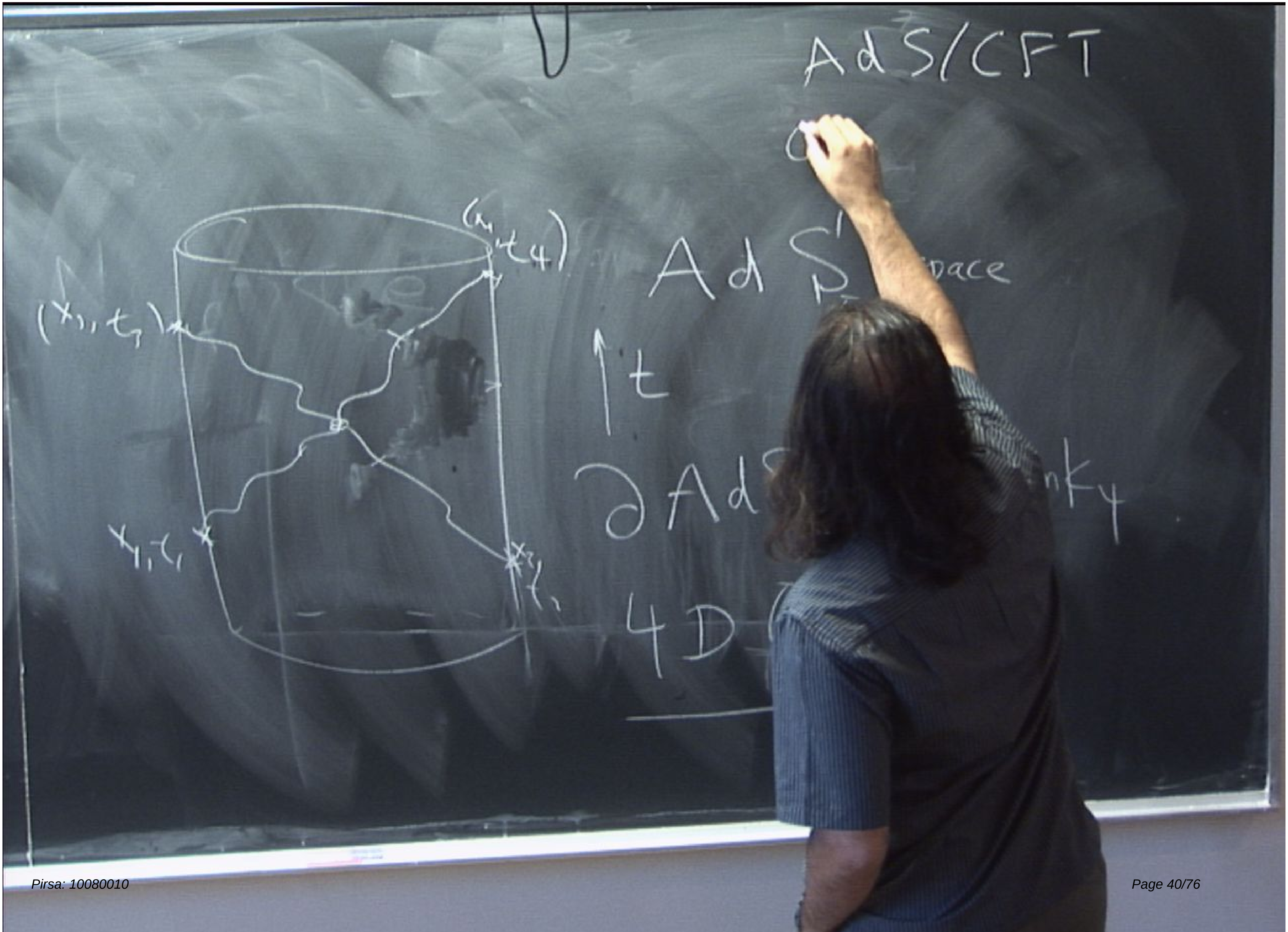
$\partial AdS_5 = Mink_4$

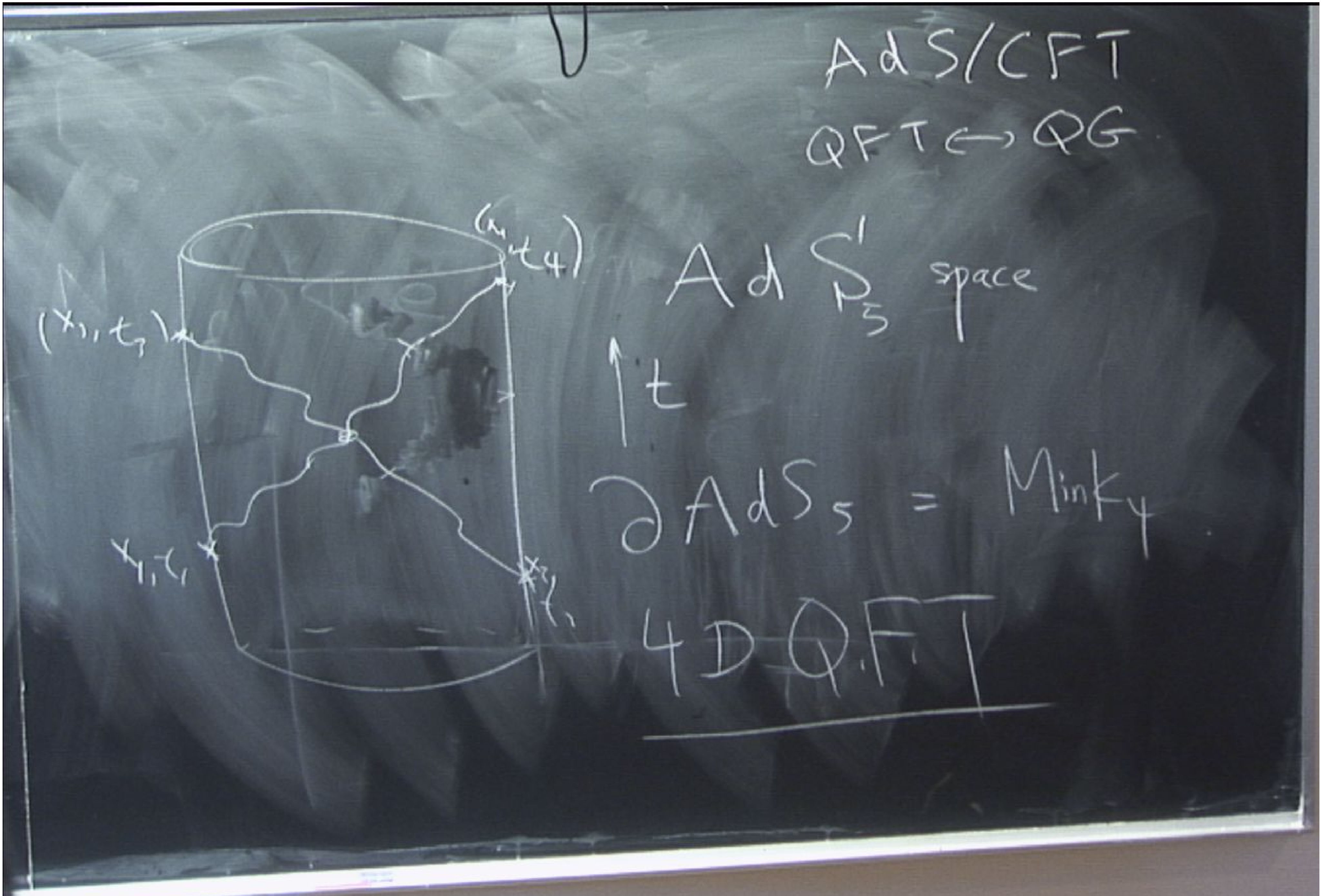
4D Q.F.T

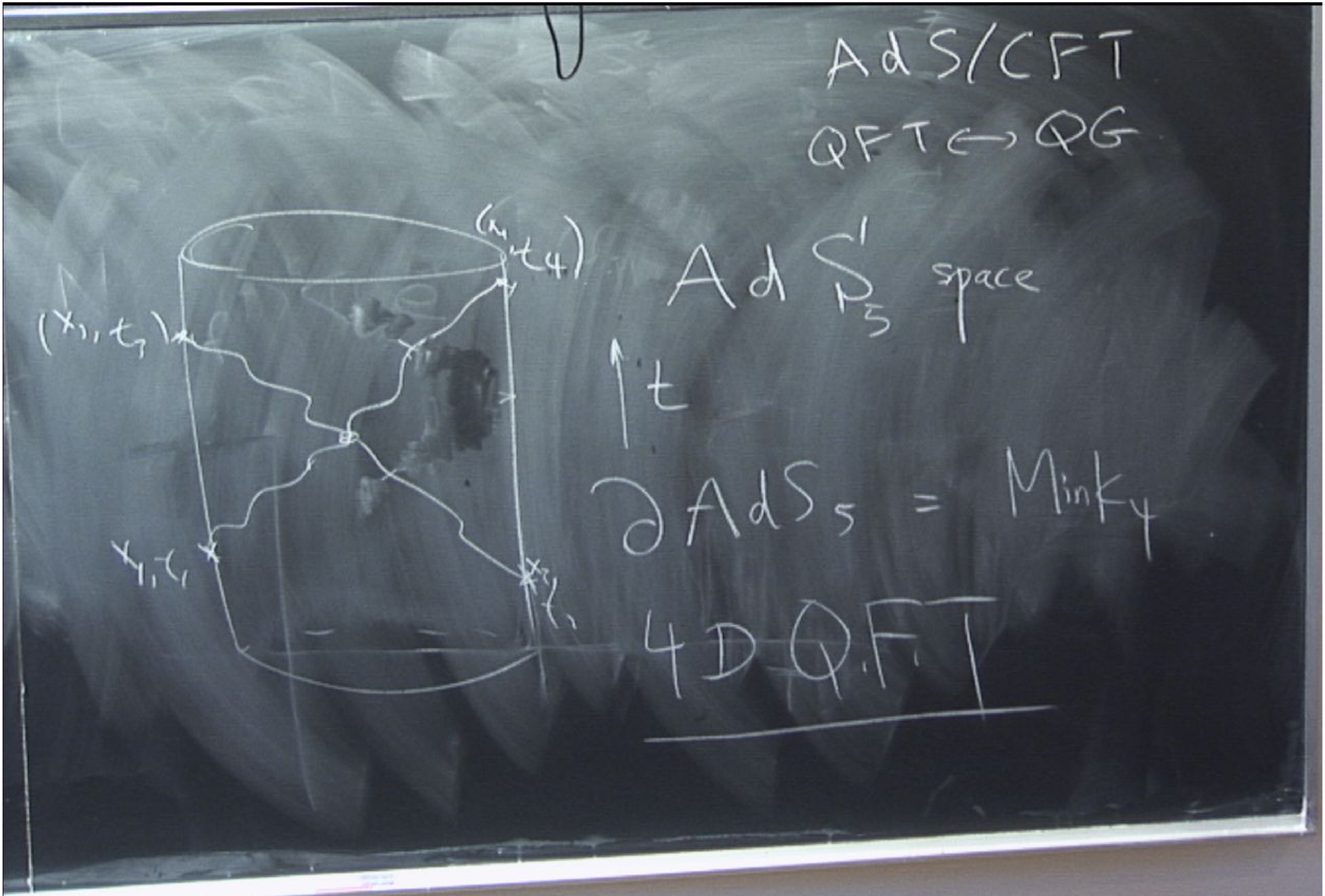


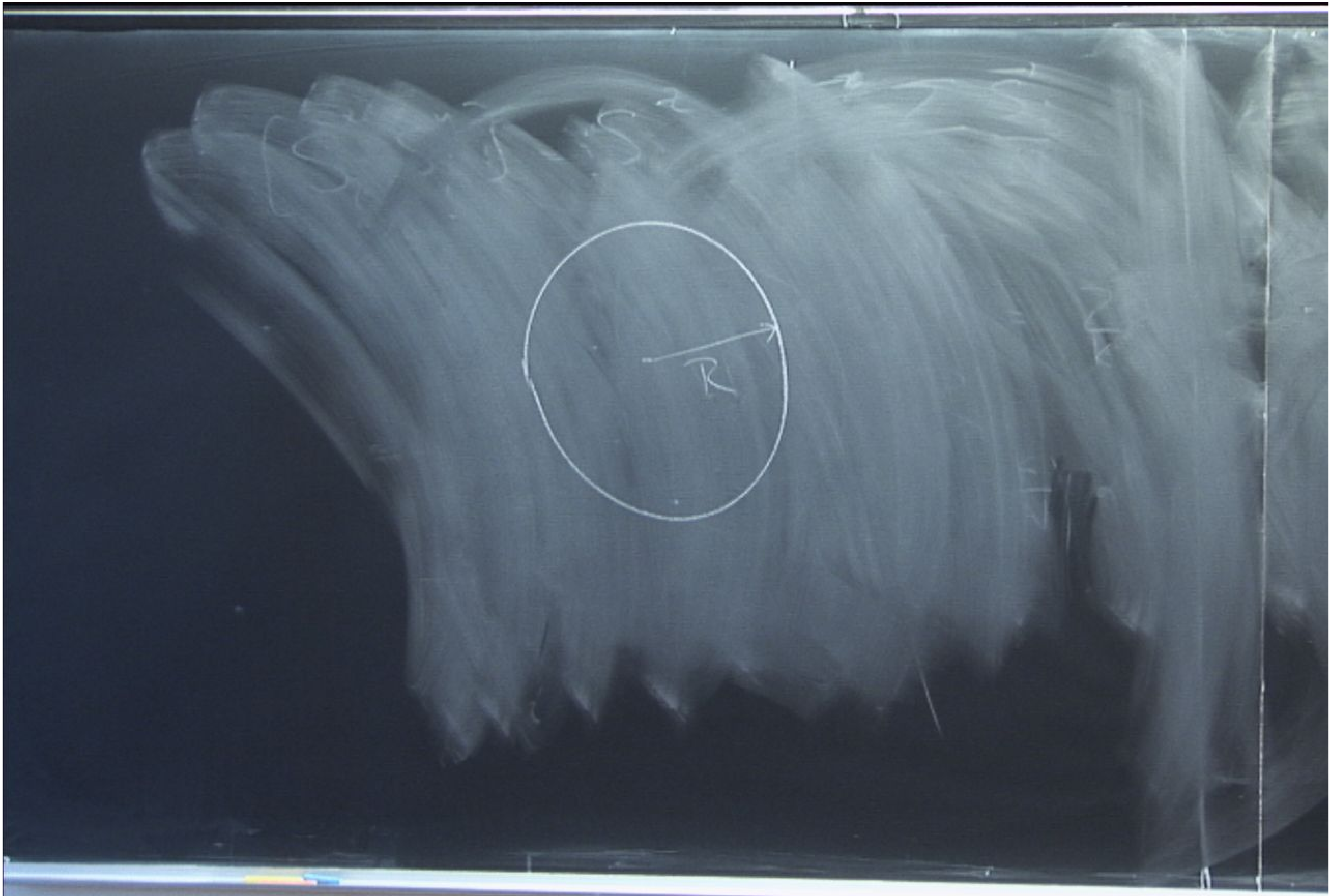
(x4,t4)
AdS'5 space
(x3,t3)
t
∂AdS5 = Mink4
x1,t1
x2,t2
4D Q.F.T

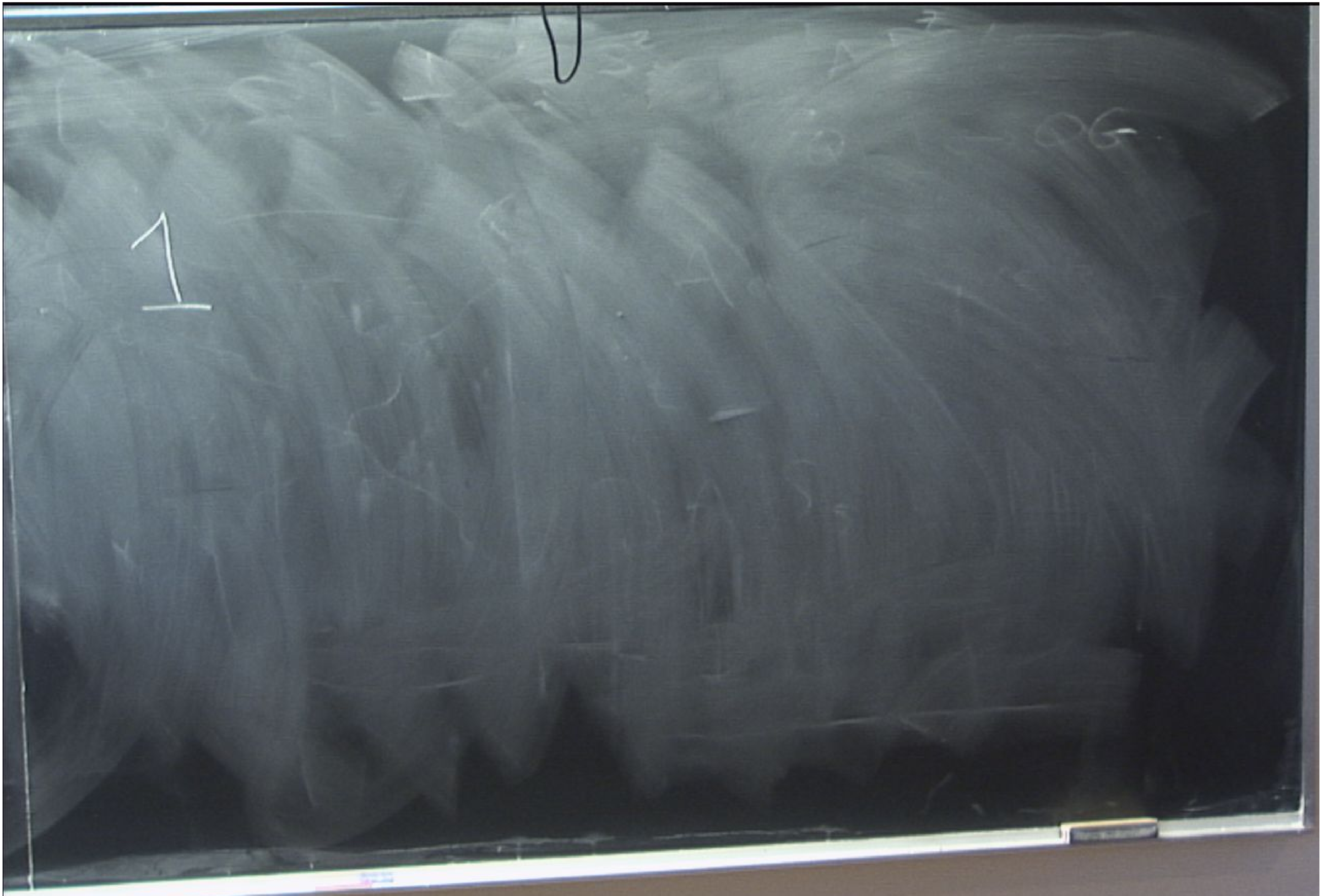

A
R

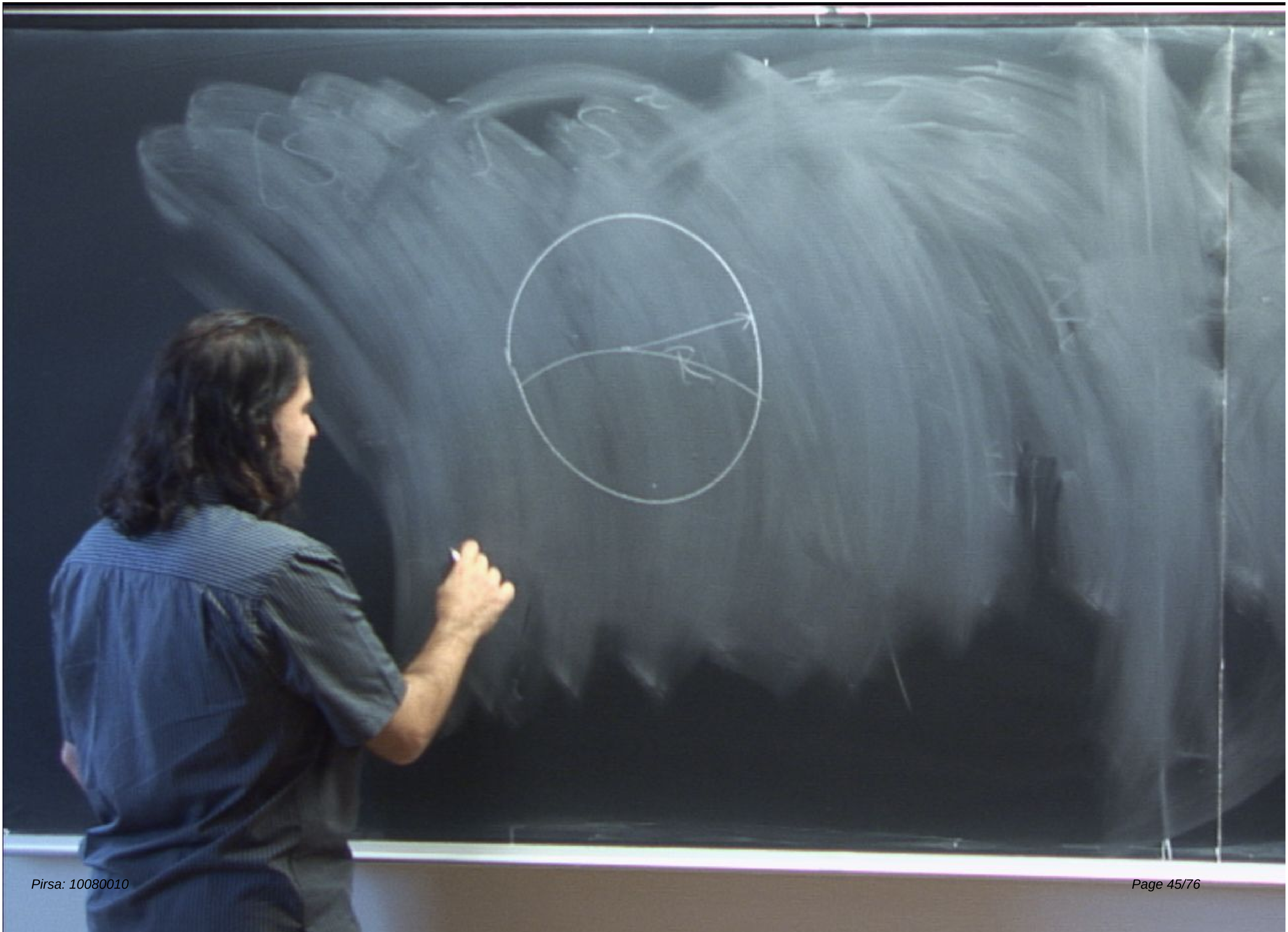

AdS/CFT
AdS
t
4D

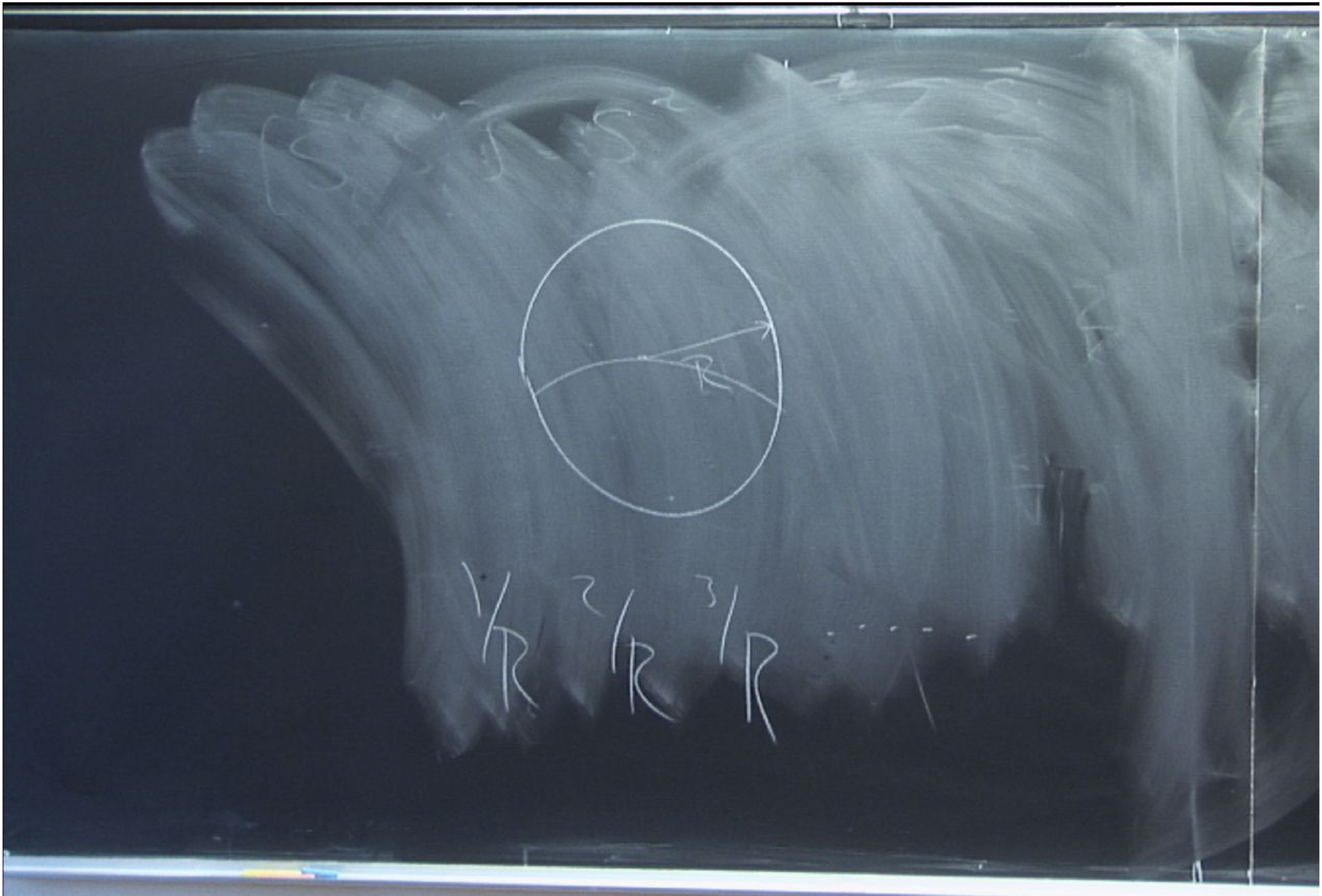

AdS/CFT
QFT ⟷ QG
(x1, t1)
(x4, t4)
AdS5 space
t
∂AdS5 = Mink4
4D QFT

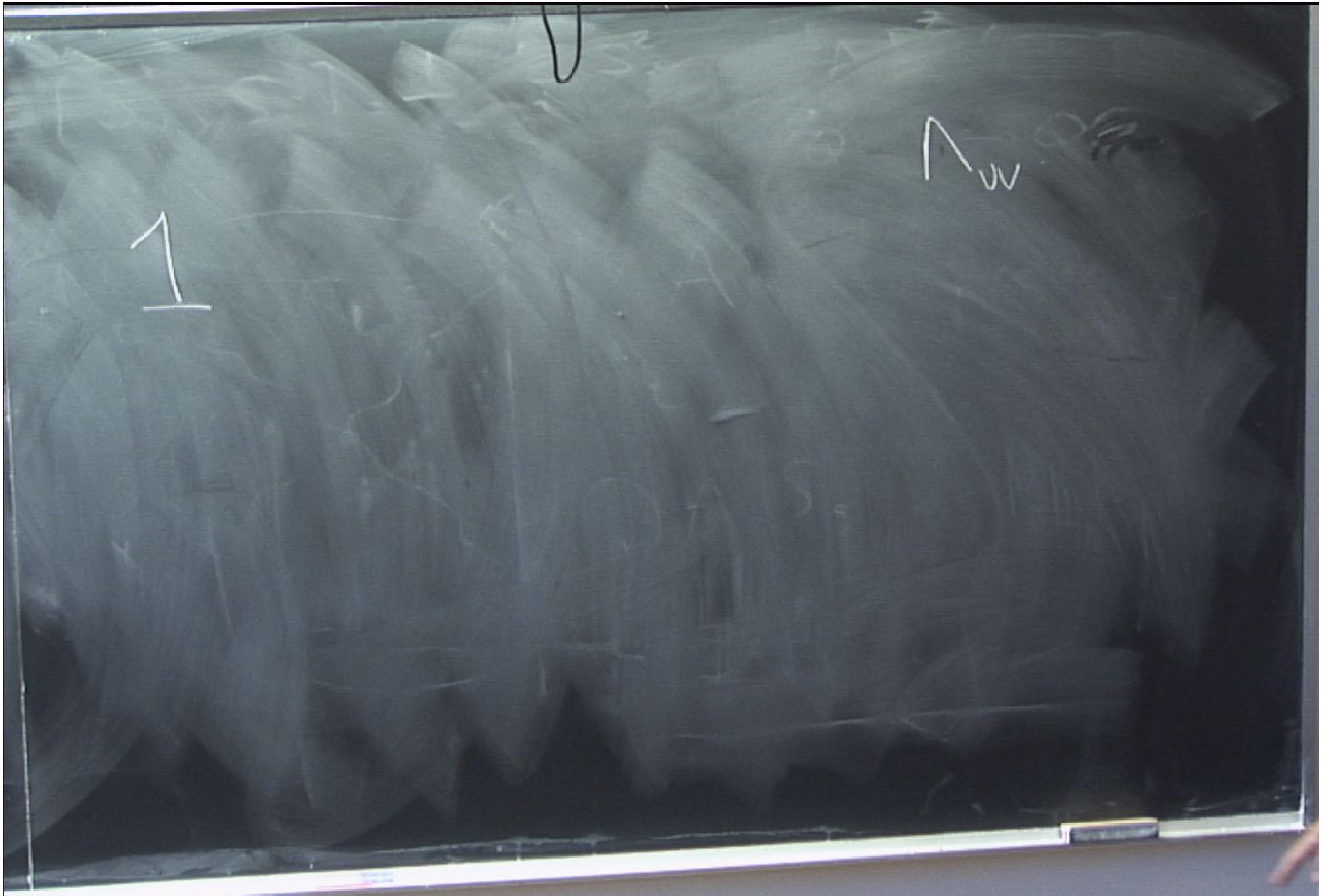

AdS/CFT
QFT ⟷ QG
AdS5 space
t
∂AdS5 = Mink4
4D QFT


R


1


R


R
1/R 2/R 3/R ......


1
Λ_{UV}

1

$$\Lambda_{UV}$$

$$N_{max}/R \sim \Lambda_{UV}$$

$$N_{max} \sim (\Lambda_{UV} R)$$

$$\underline{1} + (\Lambda_{UV} R)^3$$

$$\Lambda_{UV}$$

$$N_{max}/R \sim \Lambda_{UV}$$

$$N_{max} \sim (\Lambda_{UV} R)$$

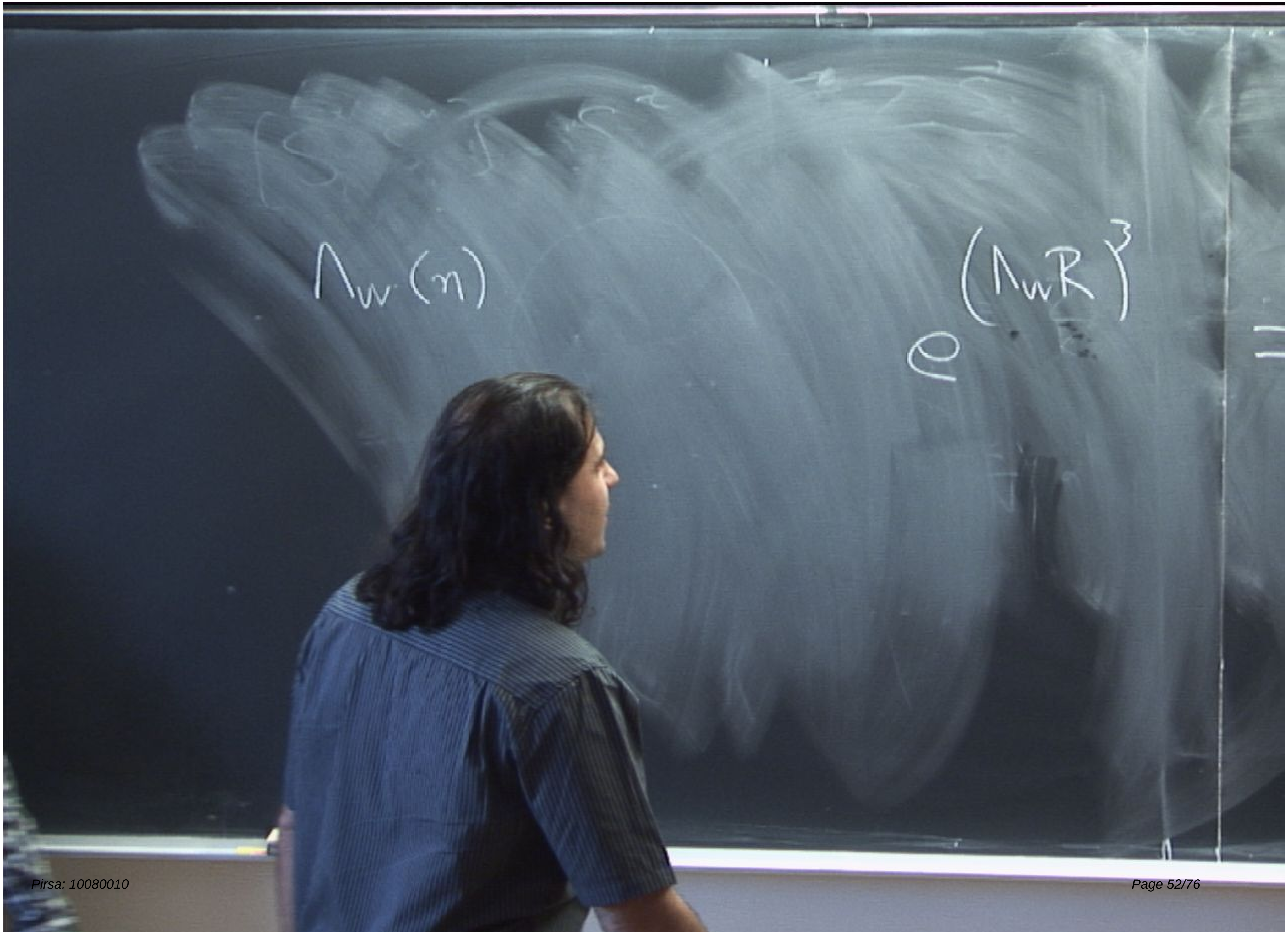
$$1 + (\Lambda_{UV} R)^3 + \frac{\left[(\Lambda_{UV} R)^3\right]^2}{2!} + \frac{\left[(\Lambda_{UV} R)^3\right]^3}{3!} + \cdots$$

$$\Lambda_{UV}$$

$$N_{max}/R \sim \Lambda_{UV}$$

$$N_{max} \sim (\Lambda_{UV} R)$$

$$e^{(\Lambda_{UV} R)^3} = 1 + (\Lambda_{UV} R)^3 + \frac{\left[(\Lambda_{UV} R)^3\right]^2}{2!} + \frac{\left[(\Lambda_{UV} R)^3\right]^3}{3!} + \cdots$$


$\Lambda_W(n)$
$e^{(\Lambda_W R)^3}$

$$\Lambda_{UV}(n)$$

$$e^{(\Lambda_{UV} R)^3}$$

$$\frac{1}{M_{pl}^2} \frac{n \Lambda_{UV}(n)}{R} \sim 1$$

$$\Lambda_{UV}(n) \sim \left(\frac{M_{pl}^2 R}{n}\right)$$

$$\Lambda_{uv}(n)$$

$$e^{(\Lambda_{uv} R)^3}$$

$$\frac{1}{M_{pl}^2} \frac{n \Lambda_{uv}(n)}{R} \sim 1$$

$$\Lambda_{uv}(n) \sim \left(\frac{M_{pl}^2 R}{n} \right)$$

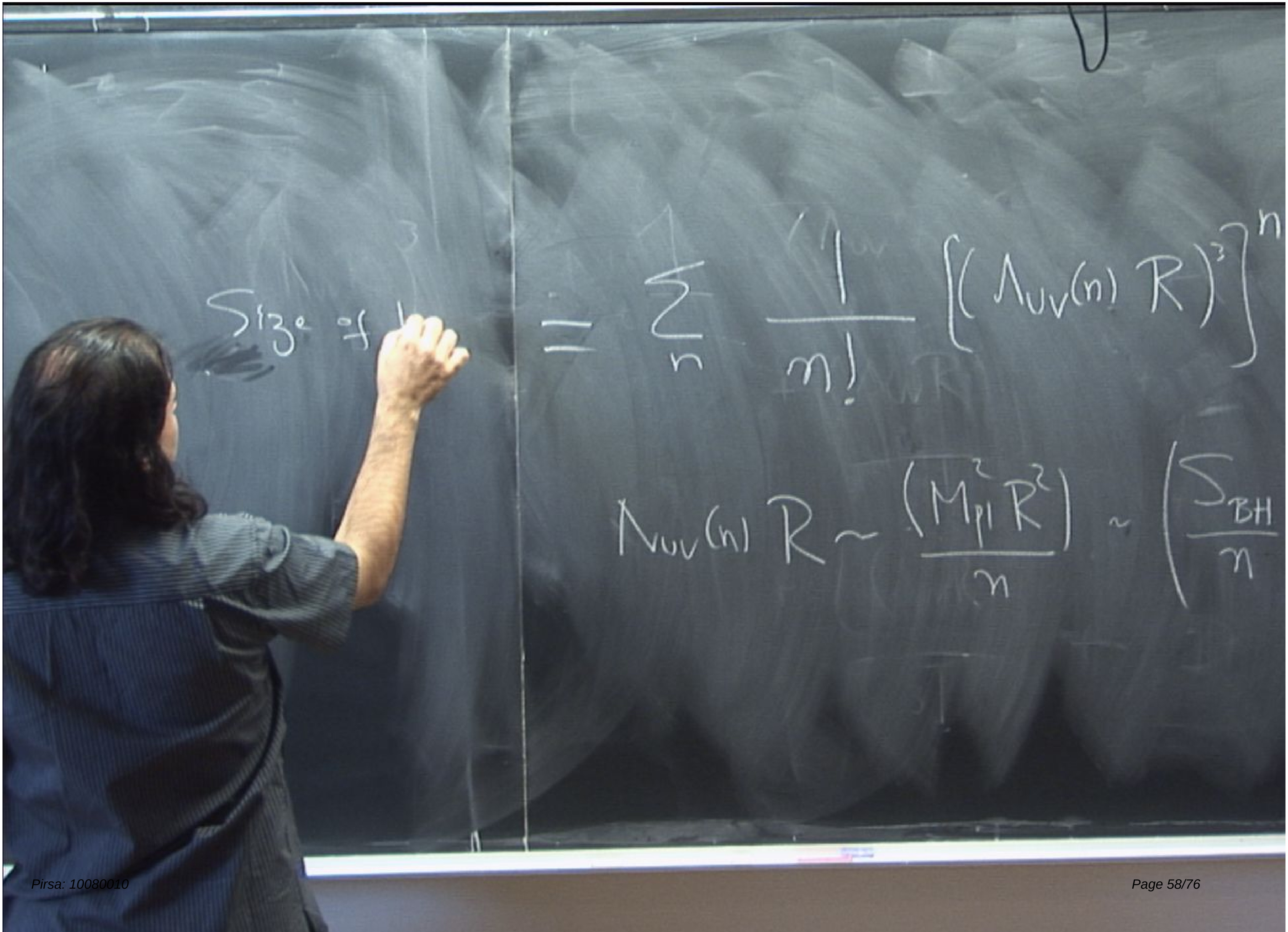
$$= \sum_n \frac{1}{n!} \left[\left(\Lambda_{UV}(n)\, R \right)^3 \right]^n$$

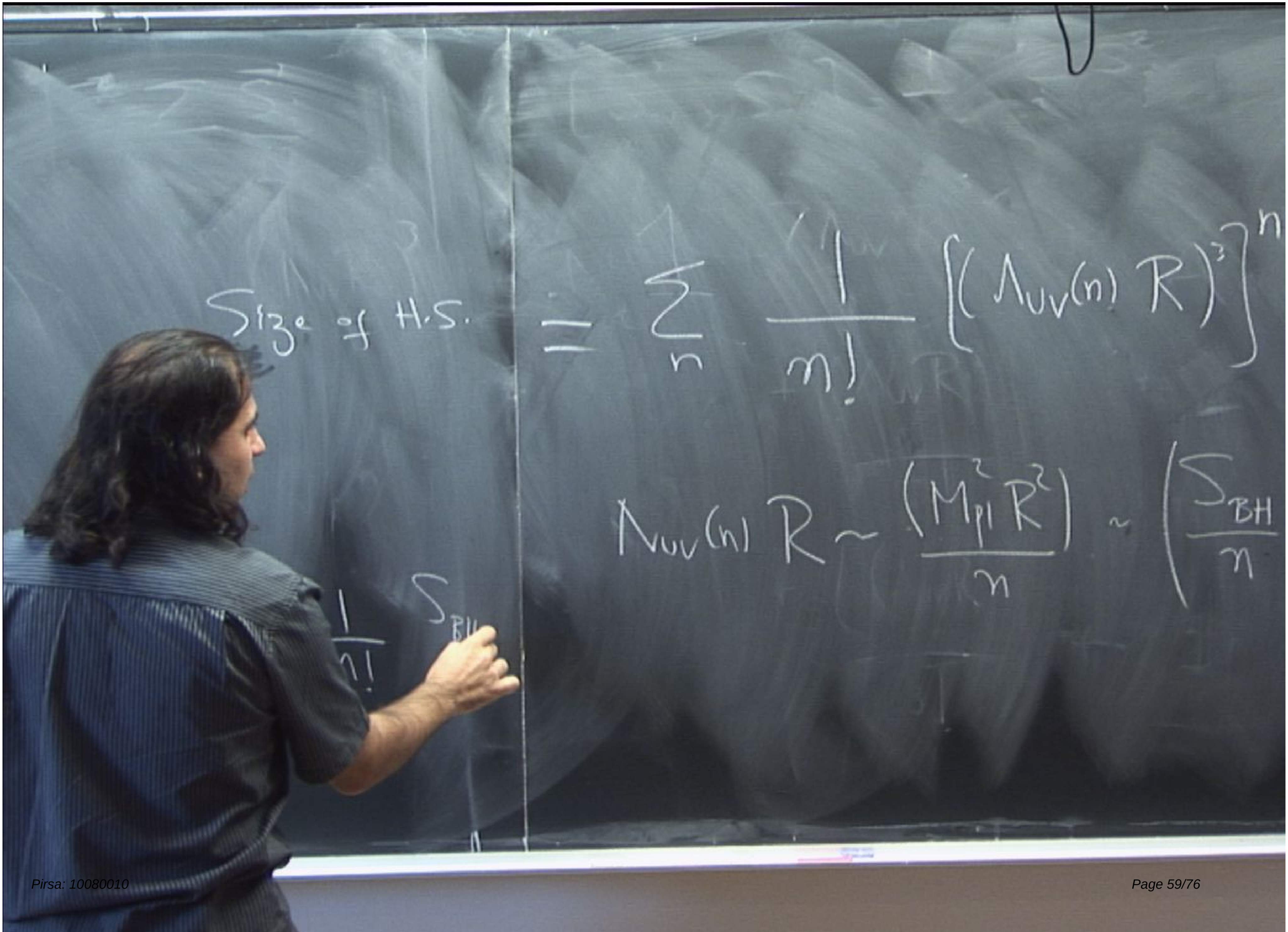
$$e^{(\Lambda_{UV} R)^3} = \sum_n \frac{1}{n!} \left[(\Lambda_{UV}(n)\, R)^3 \right]^n$$

$$\Lambda_{UV}(n)\, R \sim$$

$$e^{(\Lambda_{UV} R)^3} = \sum_n \frac{1}{n!} \left[(\Lambda_{UV}(n) R)^3 \right]^n$$

$$\Lambda_{UV}(n) R \sim \frac{(M_{pl}^2 R^2)}{n}$$

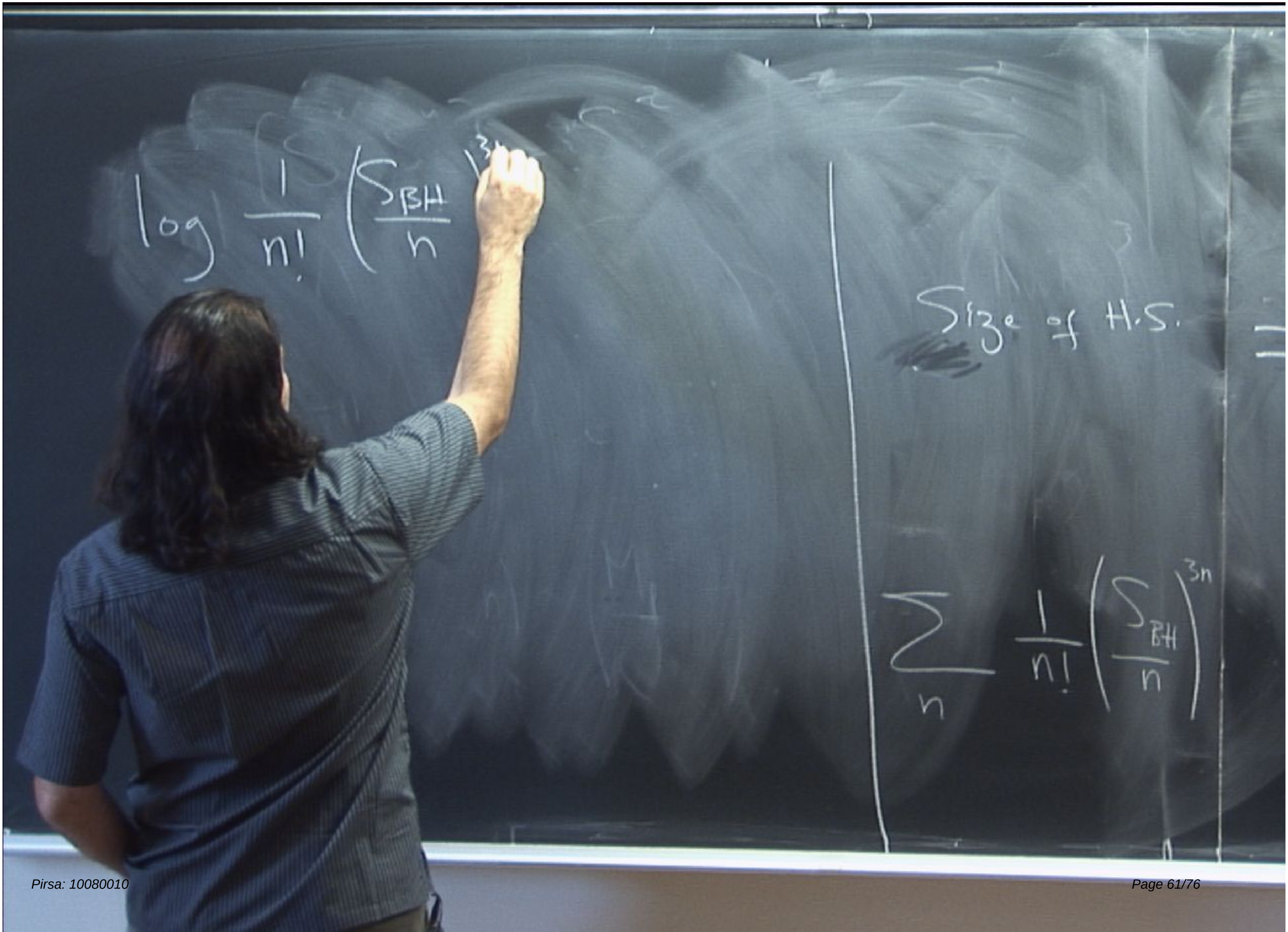

Size of
$= \sum_n \frac{1}{n!} \left[\left(\Lambda_{UV}(n) R \right)^3 \right]^n$
$\Lambda_{UV}(n) R \sim \frac{(M_{pl}^2 R^2)}{n} \sim \left(\frac{S_{BH}}{n} \right.$


Size of H.S. $= \sum_n \frac{1}{n!} \left[(\Lambda_{UV}(n) R)^3 \right]^n$
$\Lambda_{UV}(n) R \sim \frac{(M_{pl}^2 R^2)}{n} \sim \left(\frac{S_{BH}}{n} \right.$
$\frac{1}{n!}$ S_{BH}

Size of H.S. $= \sum_n \frac{1}{n!} \left[\left(\Lambda_{UV}(n)\, R \right)^3 \right]^n$

$\Lambda_{UV}(n)\, R \sim \left(\frac{M_{pl}^2 R^2}{n} \right) \sim \left(\frac{S_{BH}}{n} \right.$

$\sum_n \frac{1}{n!} \left(\frac{S_{BH}}{n} \right)^{3n}$


$\log \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3}$
Size of H.S.
$\sum_n \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$

$$\log \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

$$\sim 3n \log\left(\frac{S_{BH}}{n}\right) - \log n!$$

$$\sim 3n \log S_{BH} - 3n \log n - n \log n$$

Size of H.S. =

$$\sum_n \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

$$\log n! \sim n \log n - n$$

$$\log \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

$$\sim 3n \log\left(\frac{S_{BH}}{n}\right) - \log n!$$

$$\sim 3n \log S_{BH} - 3n \log n - n \log n$$

Size of H.S.

$$\sum_n \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

$\log n! \sim n \log n - n$

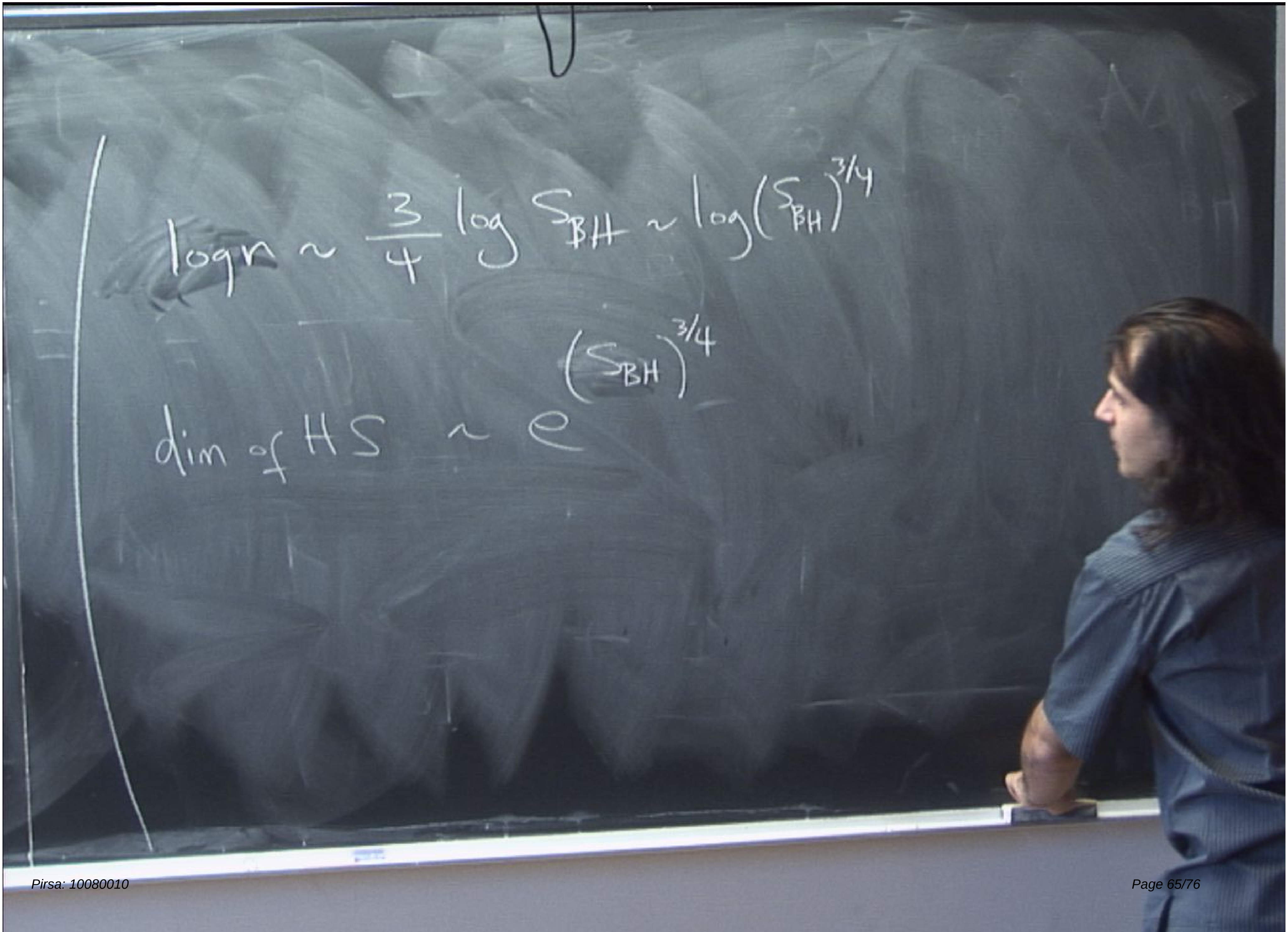
$$\log \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

$$\sim 3n \log\left(\frac{S_{BH}}{n}\right) - \log n!$$

$$\sim 3n \log S_{BH} - 3n \log n - n \log n$$

$$\sim 3n \log S_{BH} - 4n \log n$$

$$\sum_n \frac{1}{n!}\left(\frac{S_{BH}}{n}\right)^{3n}$$

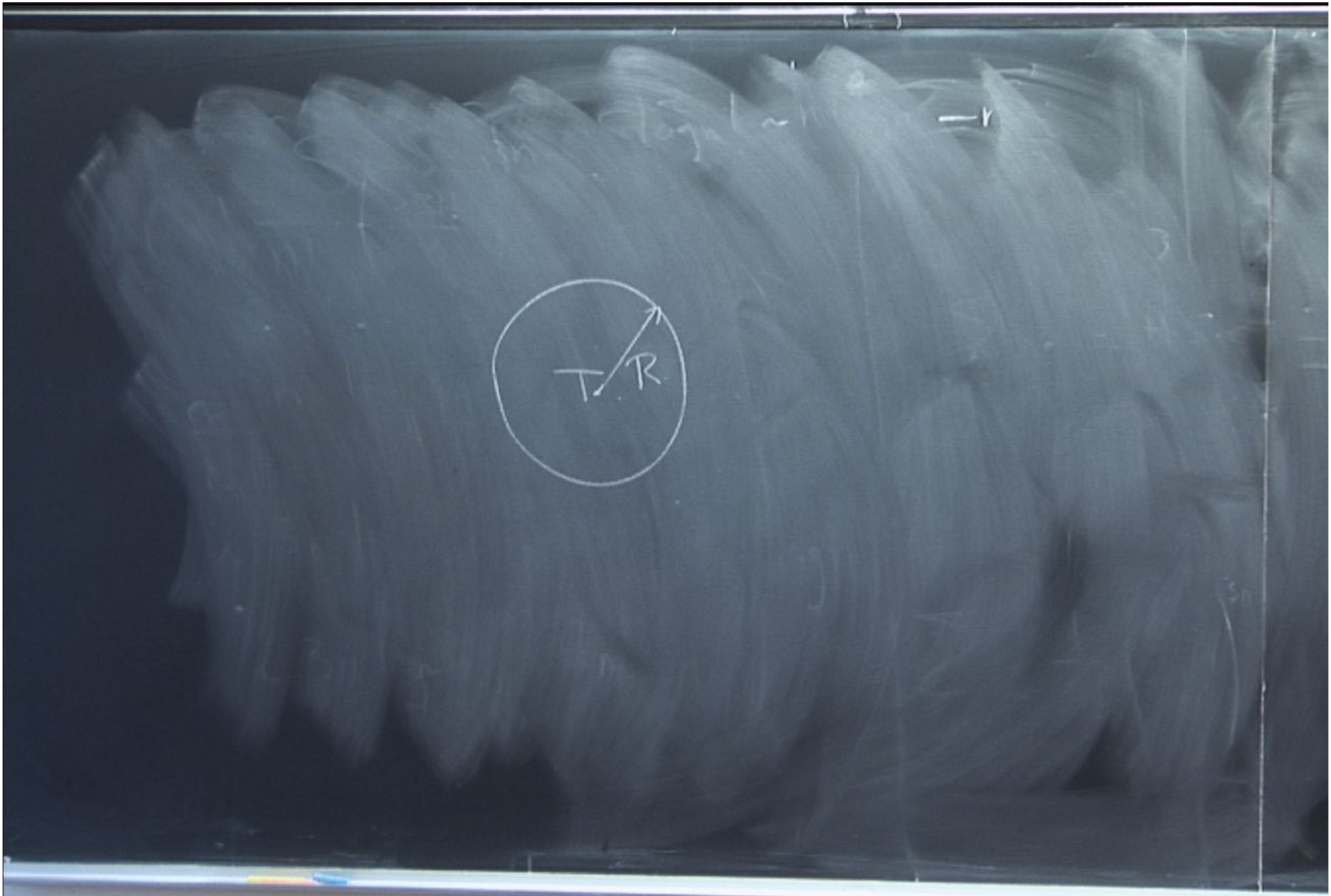

$\log n \sim \frac{3}{4} \log S_{BH} \sim \log (S_{BH})^{3/4}$
dim of HS $\sim e^{(S_{BH})^{3/4}}$

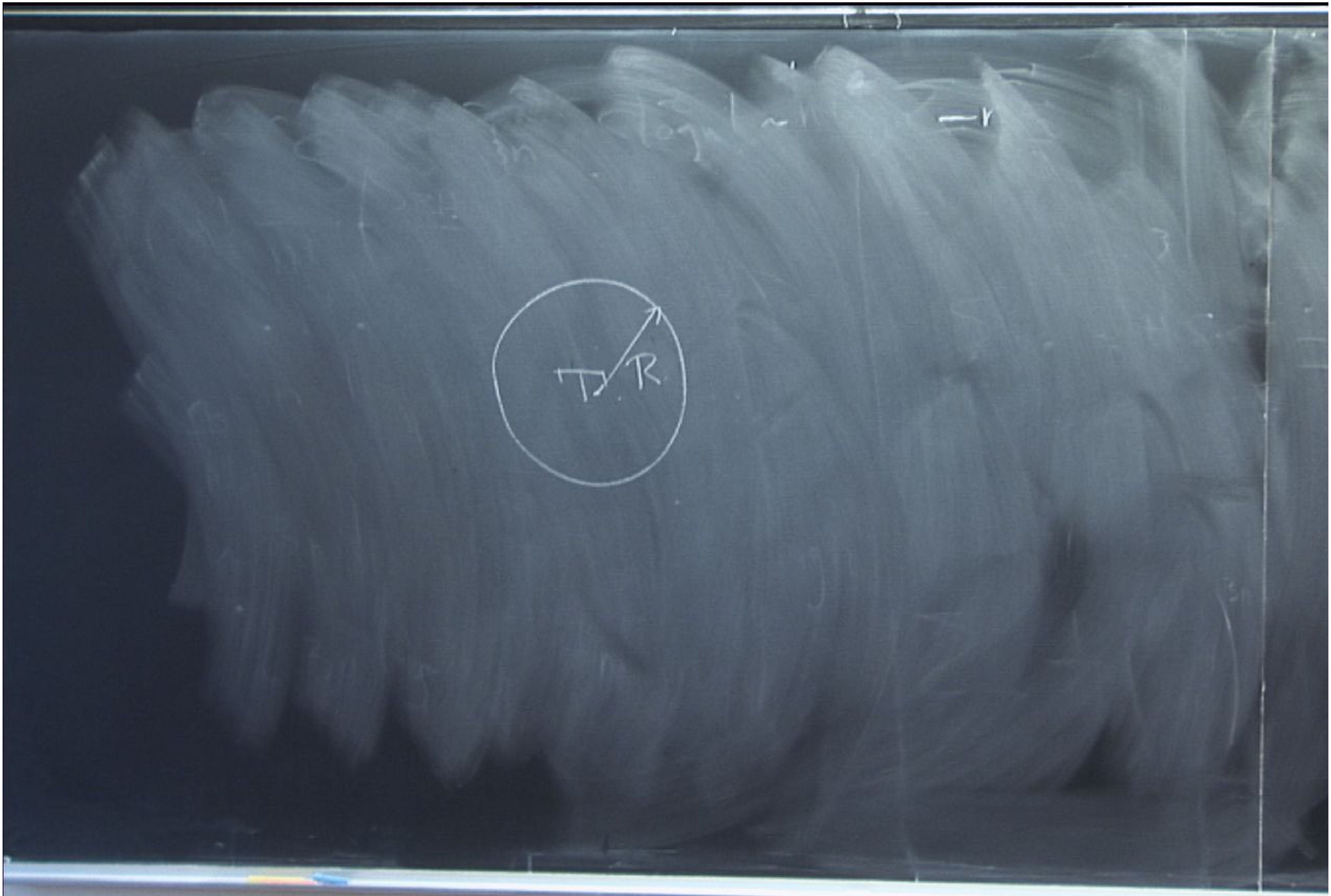
$$\log n \sim \frac{3}{4} \log S_{BH} \sim \log (S_{BH})^{3/4}$$

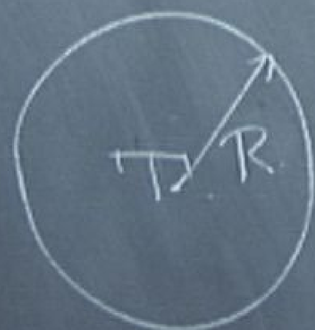
$$\text{dim of HS} \sim e^{(S_{BH})^{3/4}}$$

$$\log n \sim \frac{3}{4}\log S_{BH} \sim \log (S_{BH})^{3/4}$$

$$\text{dim of HS} \sim e^{(S_{BH})^{3/4}} \ll e^{S_{BH}}$$


T
R

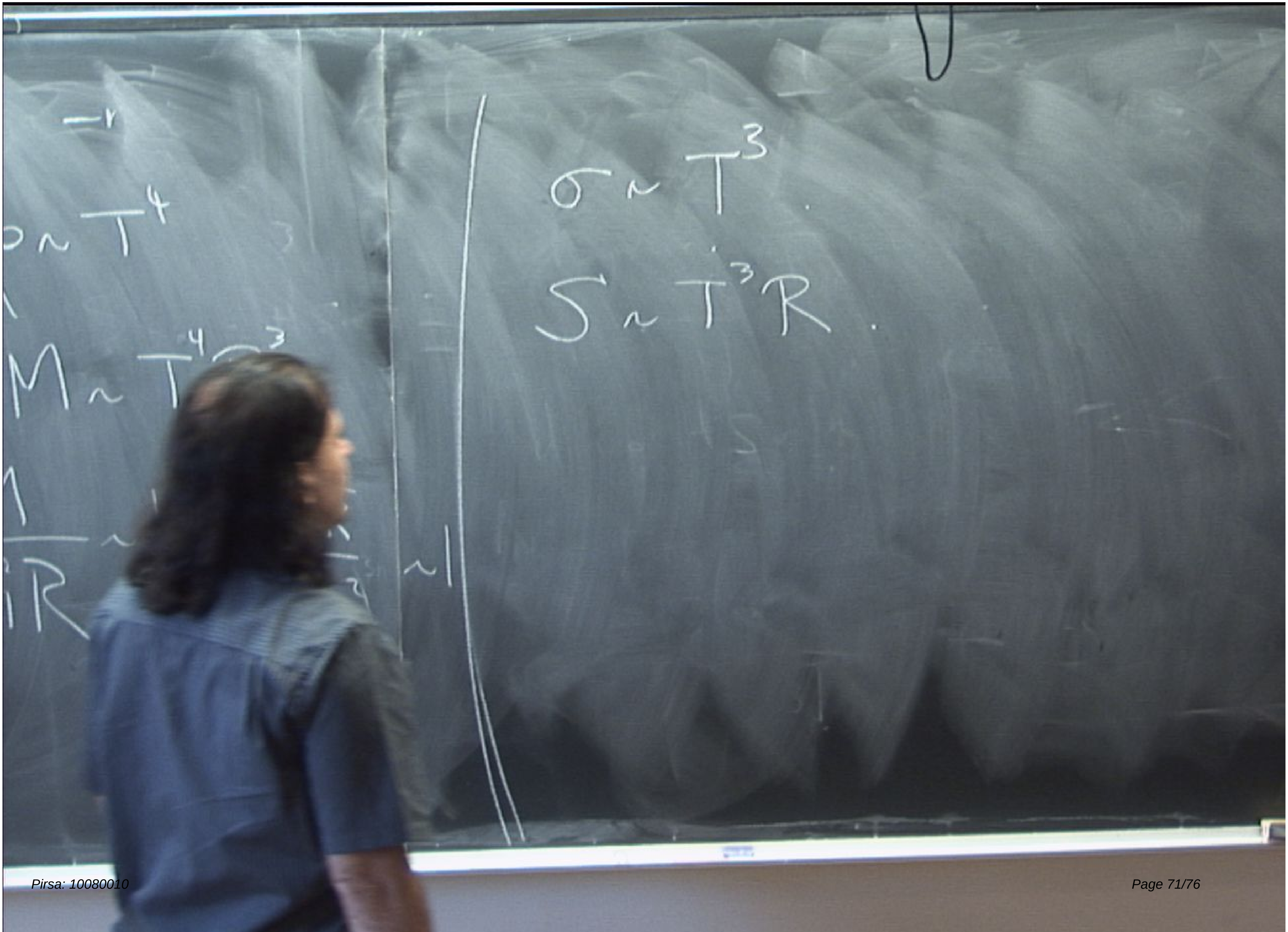

T
R



$$\rho \sim T^4$$

$$M \sim T^4 R^3$$

$$\frac{M}{M_{pl}^2 R} \sim 1 \qquad \frac{T^4 R^2}{M_{pl}^2} \sim 1$$


σ ~ T³
S ~ T³R

$\rho \sim T^4$

$M \sim T^4 R^3$

$\dfrac{M}{M_{pl}^2 R} \sim 1 \qquad \dfrac{T^4 R^2}{M_{pl}^2} \sim 1$

$\sigma \sim T^3$

$S \sim T^3 R^3 \sim (S_{BH})^{3/4}$

$T^4 R^2 \sim M_{pl}^2$

$T^4 R^4 \sim M_{pl}^2 R^2 \sim A/\ell_{pl}^2 \sim S_{BH}$

$\rho \sim T^4$

$M \sim T^4 R^3$

$\frac{M}{M_{pl}^2 R} \sim 1 \qquad \frac{T^4 R^2}{M_{pl}^2} \sim 1$

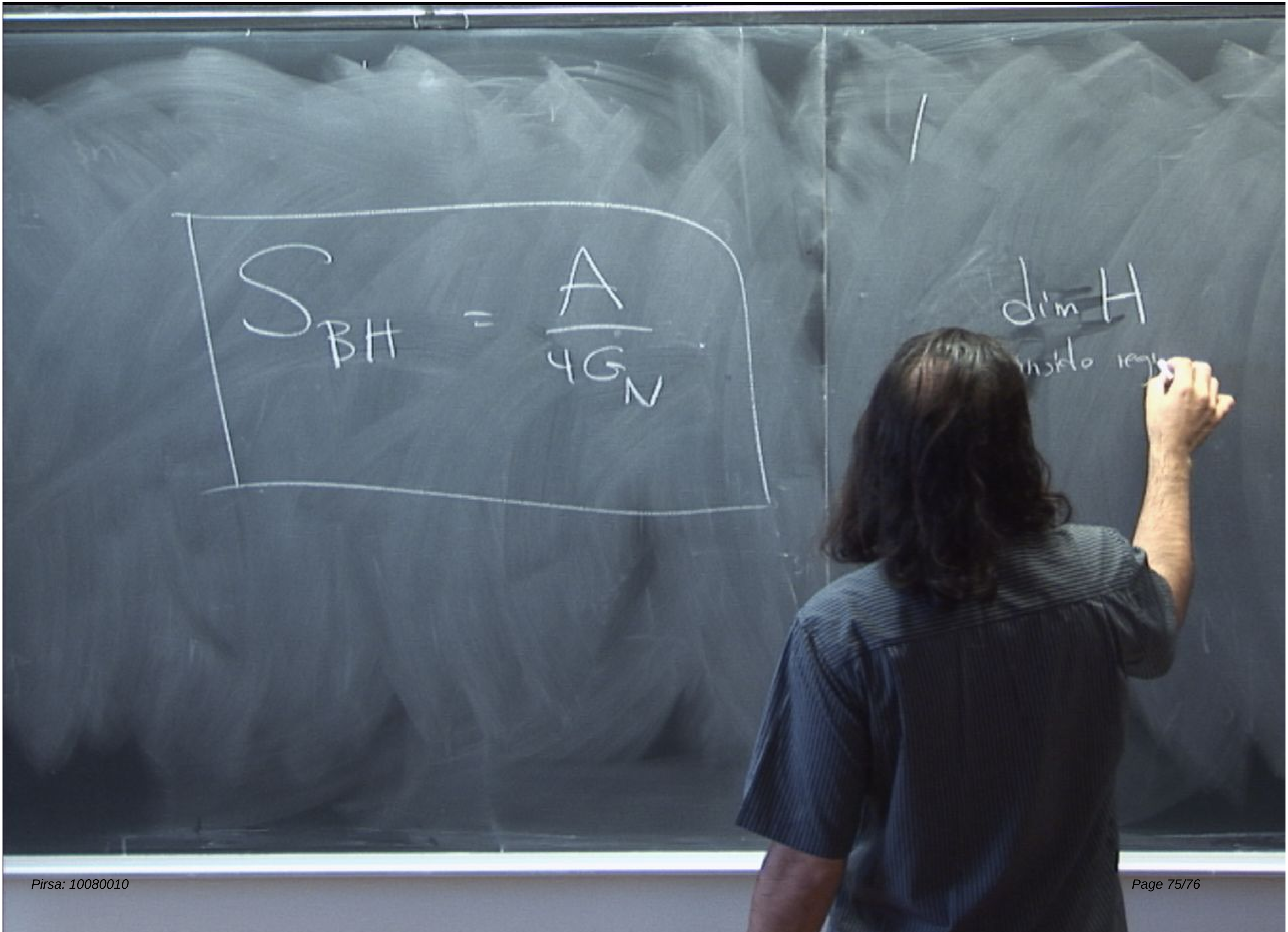
$\sigma \sim T^3$

$S \sim T^3 R^3 \sim (S_{BH})^{3/4}$

$T^4 R^2 \sim M_{pl}^2$

$T^4 R^4 \sim M_{pl}^2 R^2 \sim A/\ell_{pl}^2 \sim S_{BH}$

$$\boxed{S_{BH} = \frac{A}{4G_N}.}$$


S_BH = A / 4G_N
dim H

$$\boxed{= \frac{A}{4G_N}}$$

$$\dim H_{\text{inside region}} < e^{A_{\text{region}}/4G_N}$$