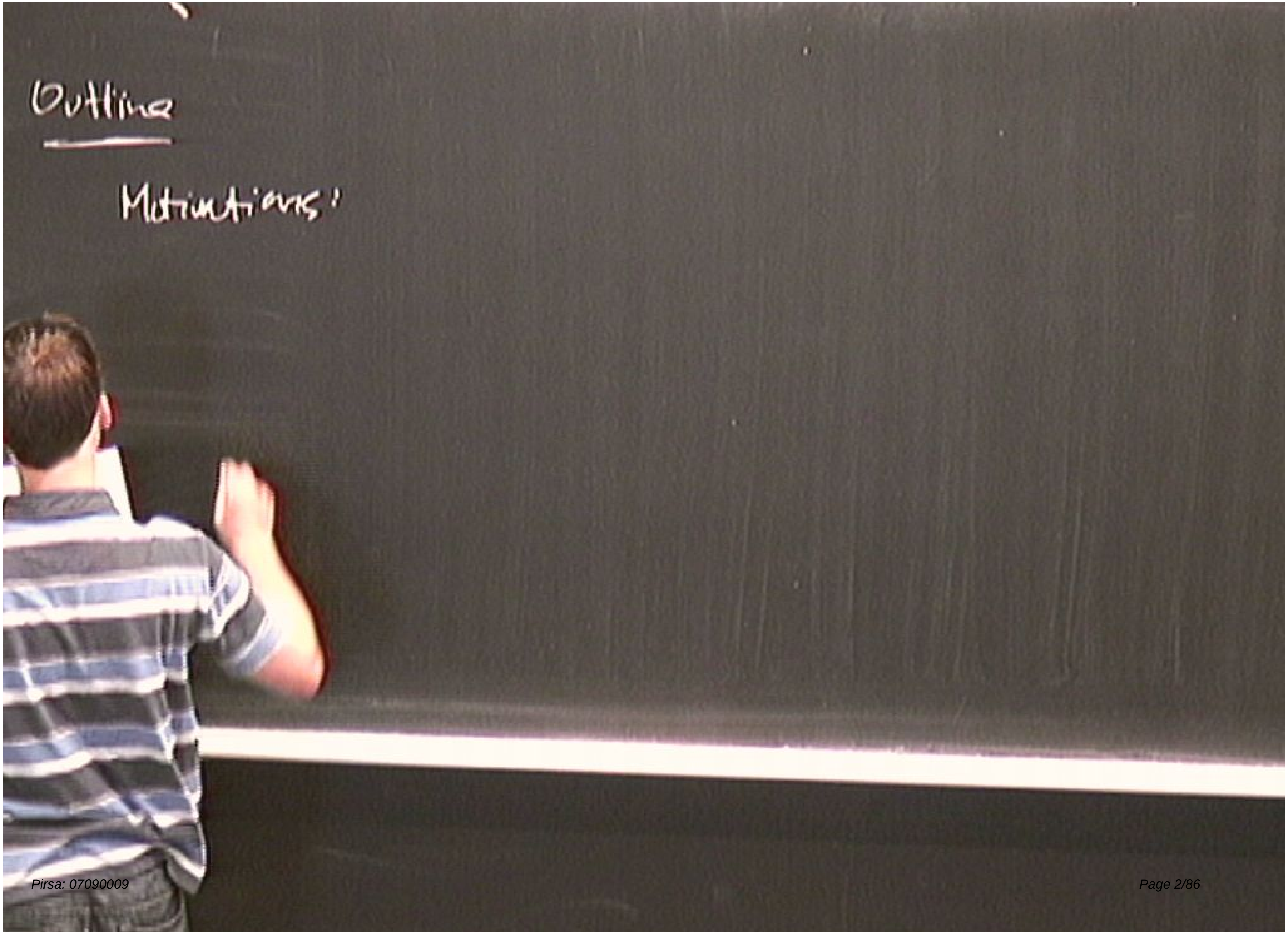
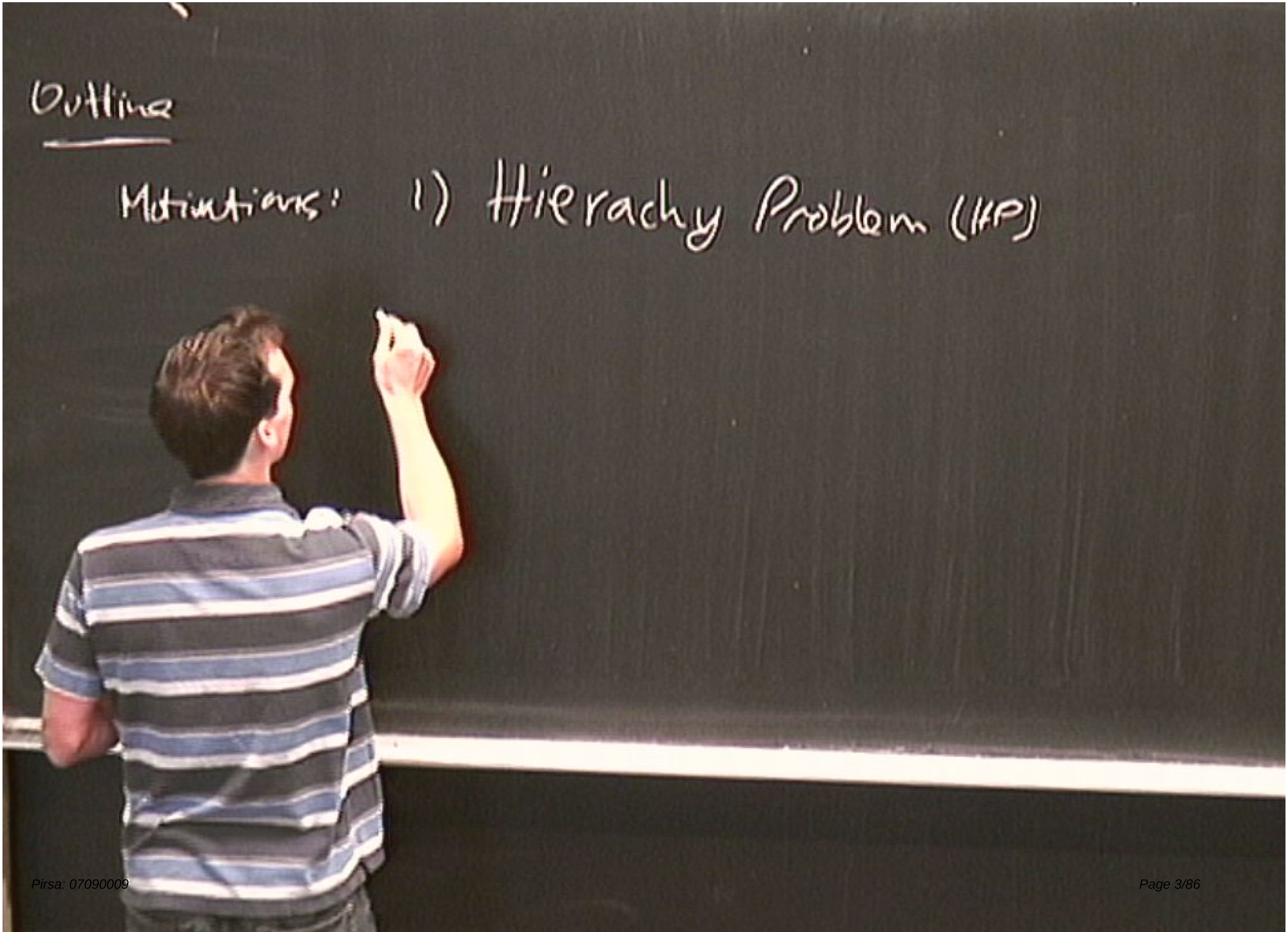
Title: UV Caps for 6D Gauged Chiral Supergravity

Date: Sep 08, 2007 08:30 AM

URL: http://pirsa.org/07090009

Abstract: I will discuss recent results in Supersymmetric Large Extra Dimensions (SLED), a scenario which shows promise towards solving both the hierarchy and the cosmological constant problems. One of the issues which arises in this programme is a direct result of the need to use codimension-2 branes, which can only consistently couple to gravity through a tension term in the action. This precludes us from asking certain interesting questions, such as what will happen when a phase transition occurs on the brane. In this talk, I will describe how these codim-2 branes can be modelled as codim-1, thus enabling us to work with more interesting brane actions.


Outline
Motivations:


Outline
Motivations: 1) Hierarchy Problem (HP)

Outline

Motivations:

1) Hierarchy Problem (HP)
2) Cosmol Const. Prob. (CC)

Outline

A Motivations: 1) Hierachy Problem (HP)

2) Cosmological. Prob. (CC)

↳ scale Inv.

B

Outline

A Motivations: 1) Problem (HP)

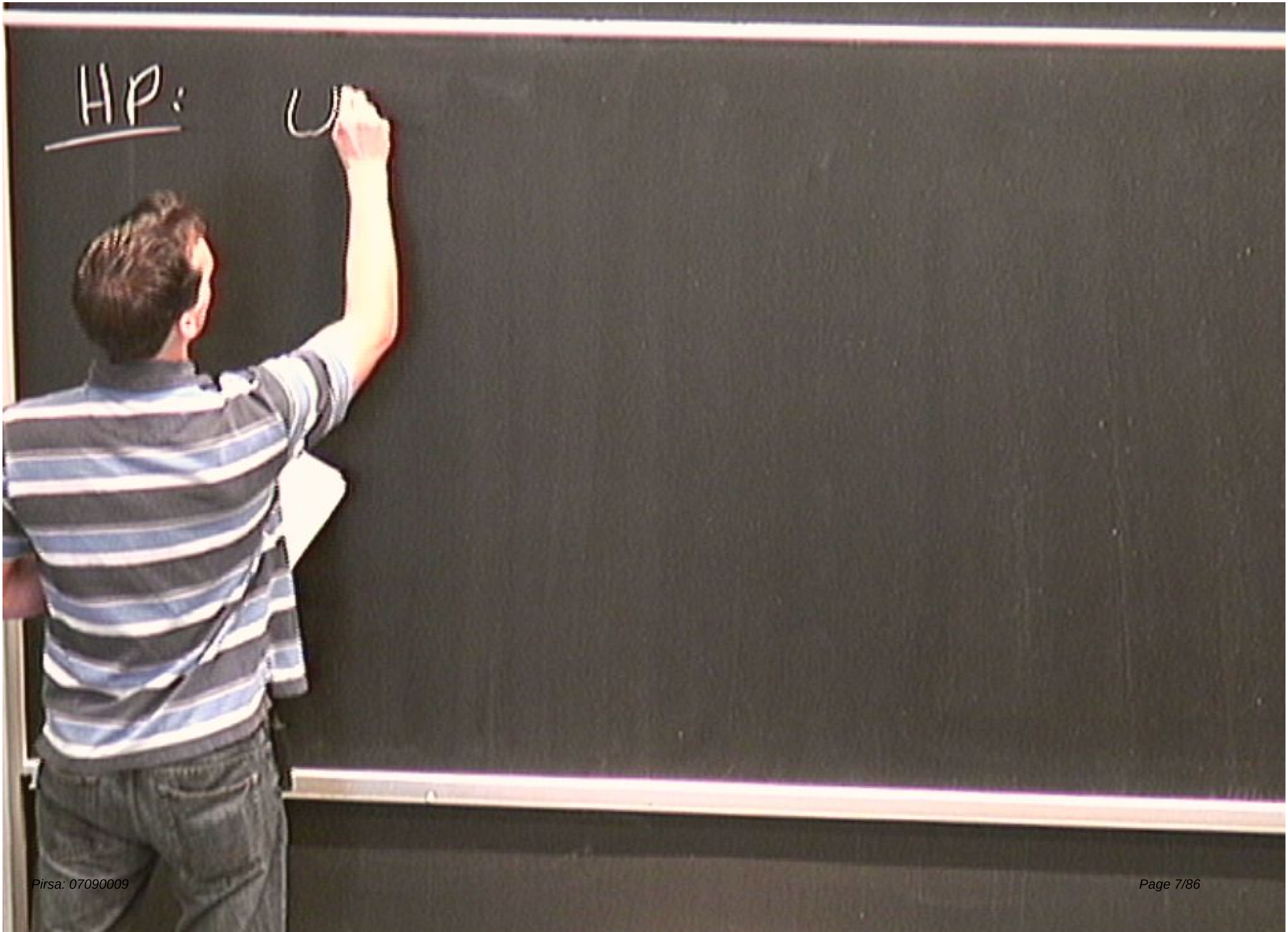
2) Cosmological Const. Prob. (CC)

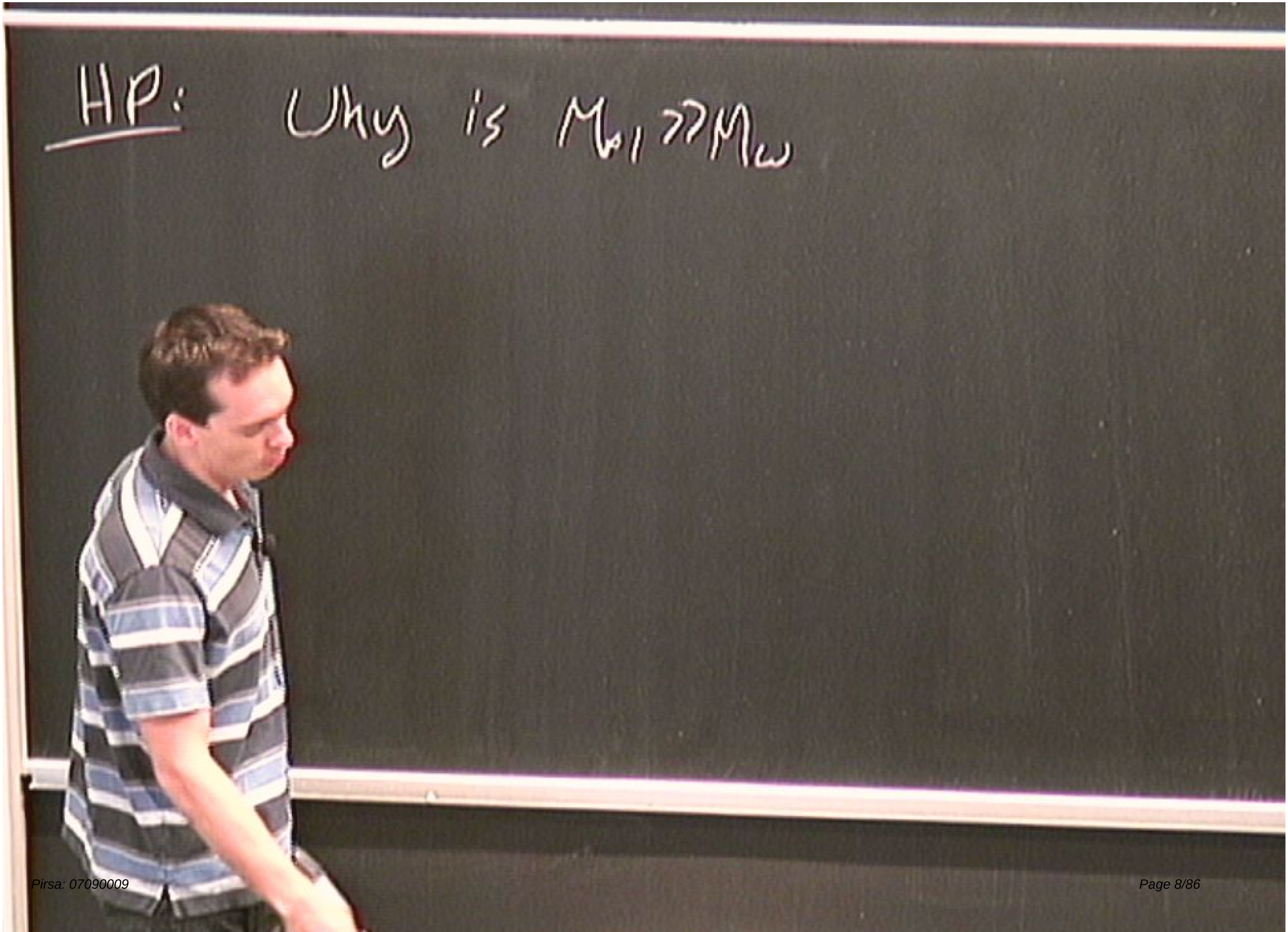
↳ scale Inv.

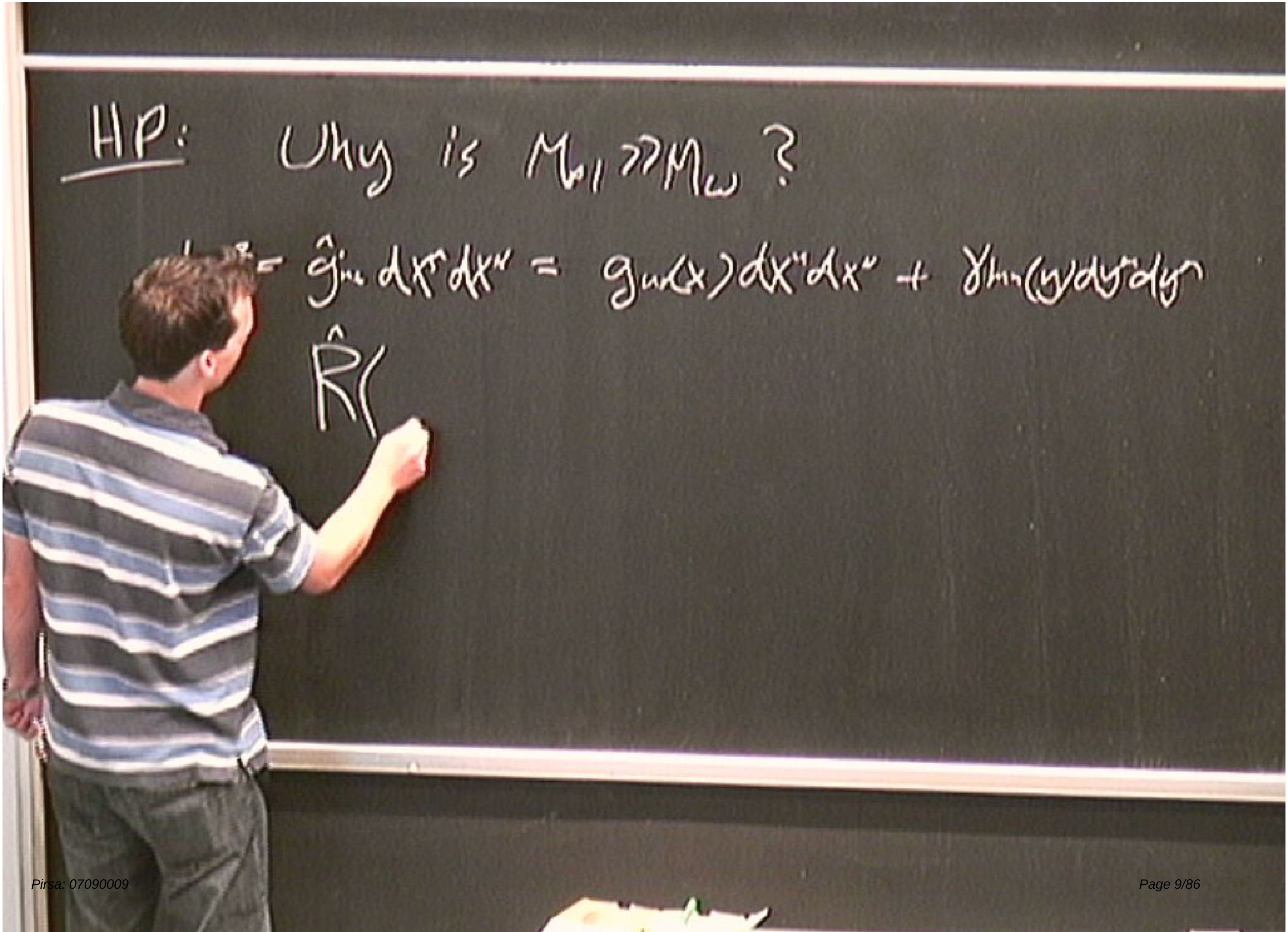
B 6D Model

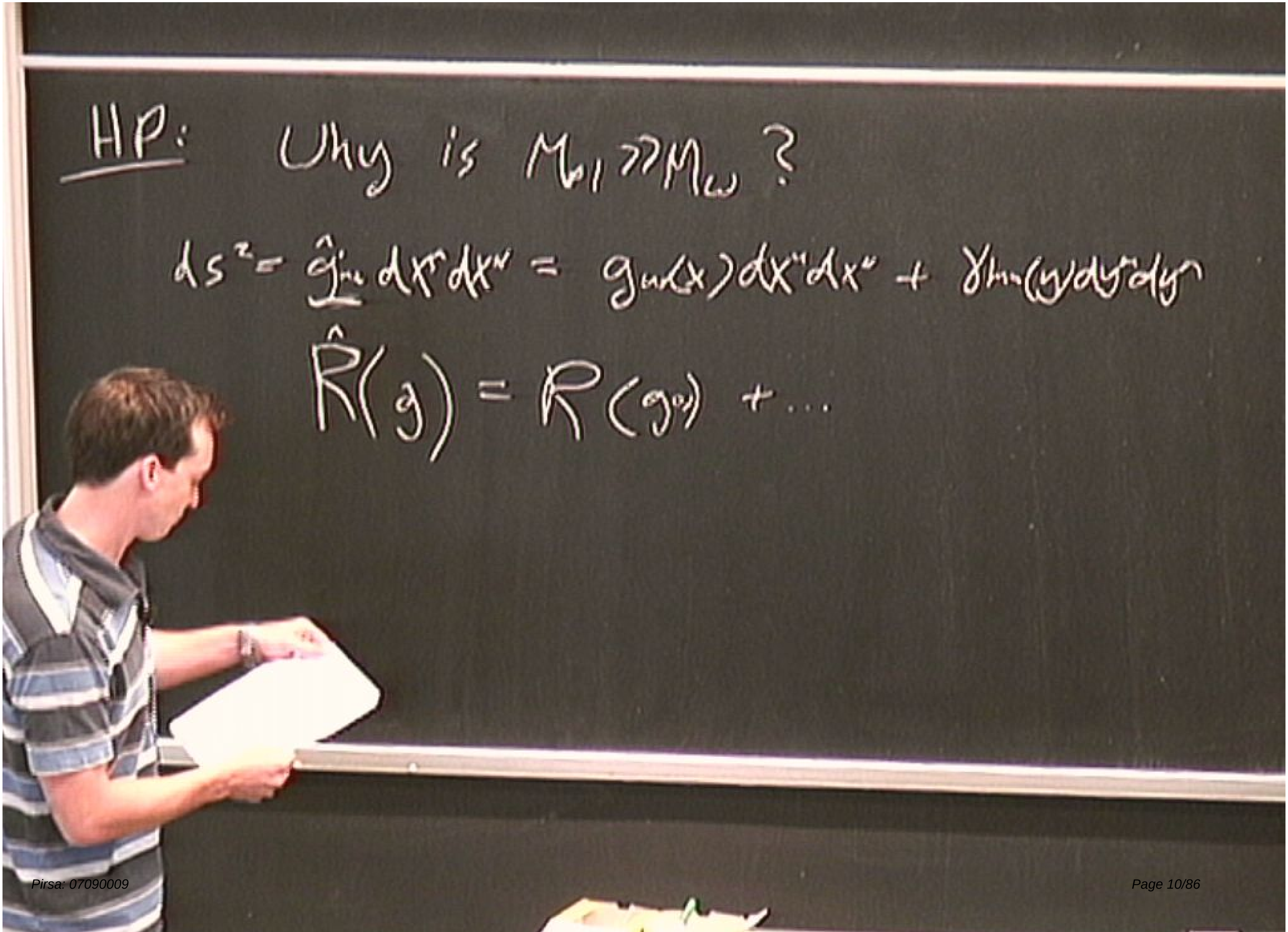
↳ general, 4D flat sol'ns

C UV Caps


HP:
U


HP: Why is $M_{Pl} \gg M_W$


HP: Why is $M_{pl} \gg M_W$?
$ds^2 = \hat{g}_{MN} dX^M dX^N = g_{\mu\nu}(x) dx^\mu dx^\nu + \gamma_{mn}(y) dy^m dy^n$
$\hat{R}($


HP: Why is $M_{Pl} \gg M_W$?
$ds^2 = \hat{g}_{\mu\nu} dx^\mu dx^\nu = g_{\mu\nu}(x) dx^\mu dx^\nu + \gamma_{mn}(y) dy^m dy^n$
$\hat{R}(g) = R(g_{\mu\nu}) + \dots$

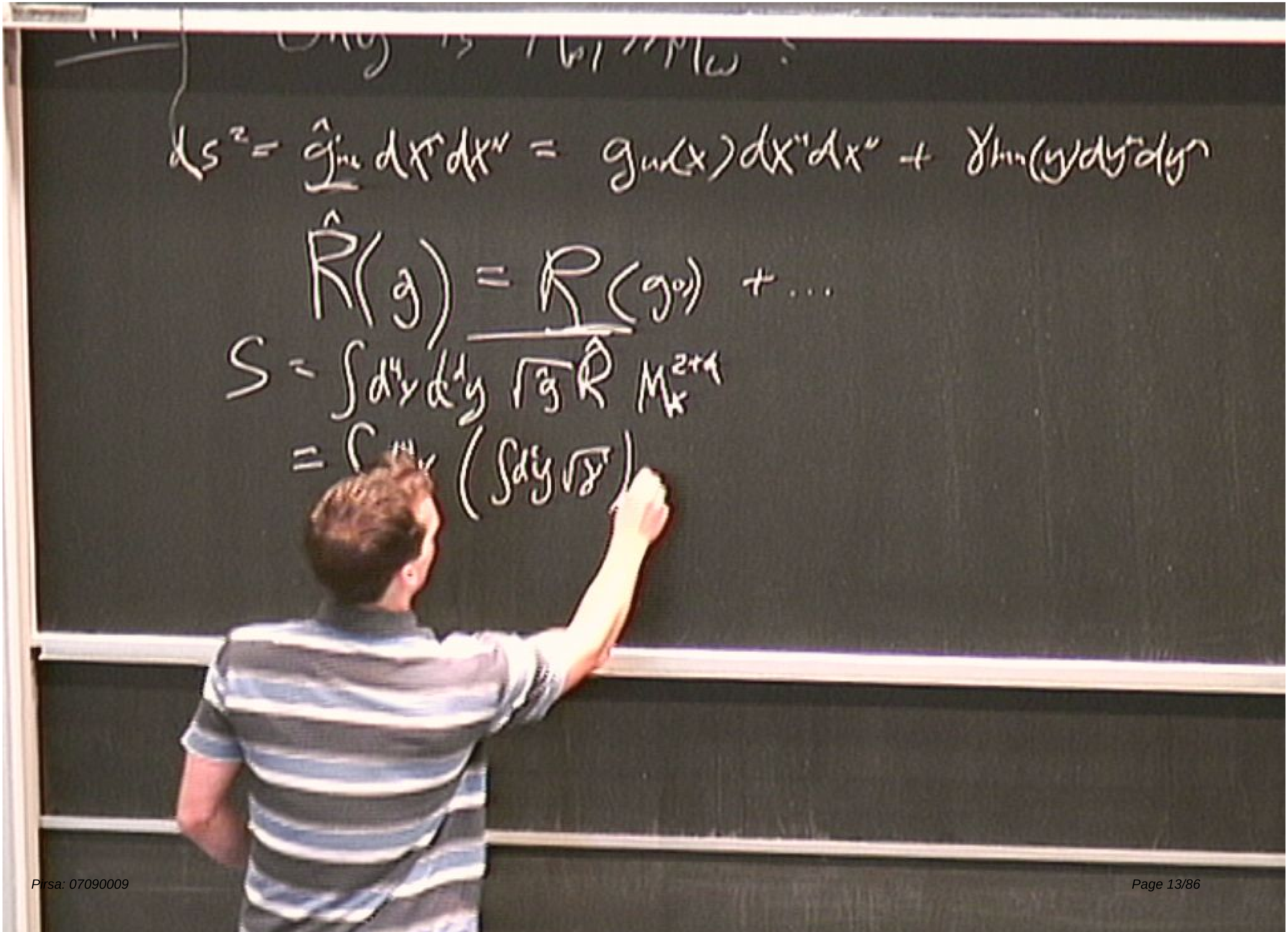
$$ds^2 = \hat{g}_{\mu\nu}\, dx^\mu dx^\nu = g_{\mu\nu}(x)\, dx^\mu dx^\nu + \gamma_{mn}(y)\, dy^m dy^n$$

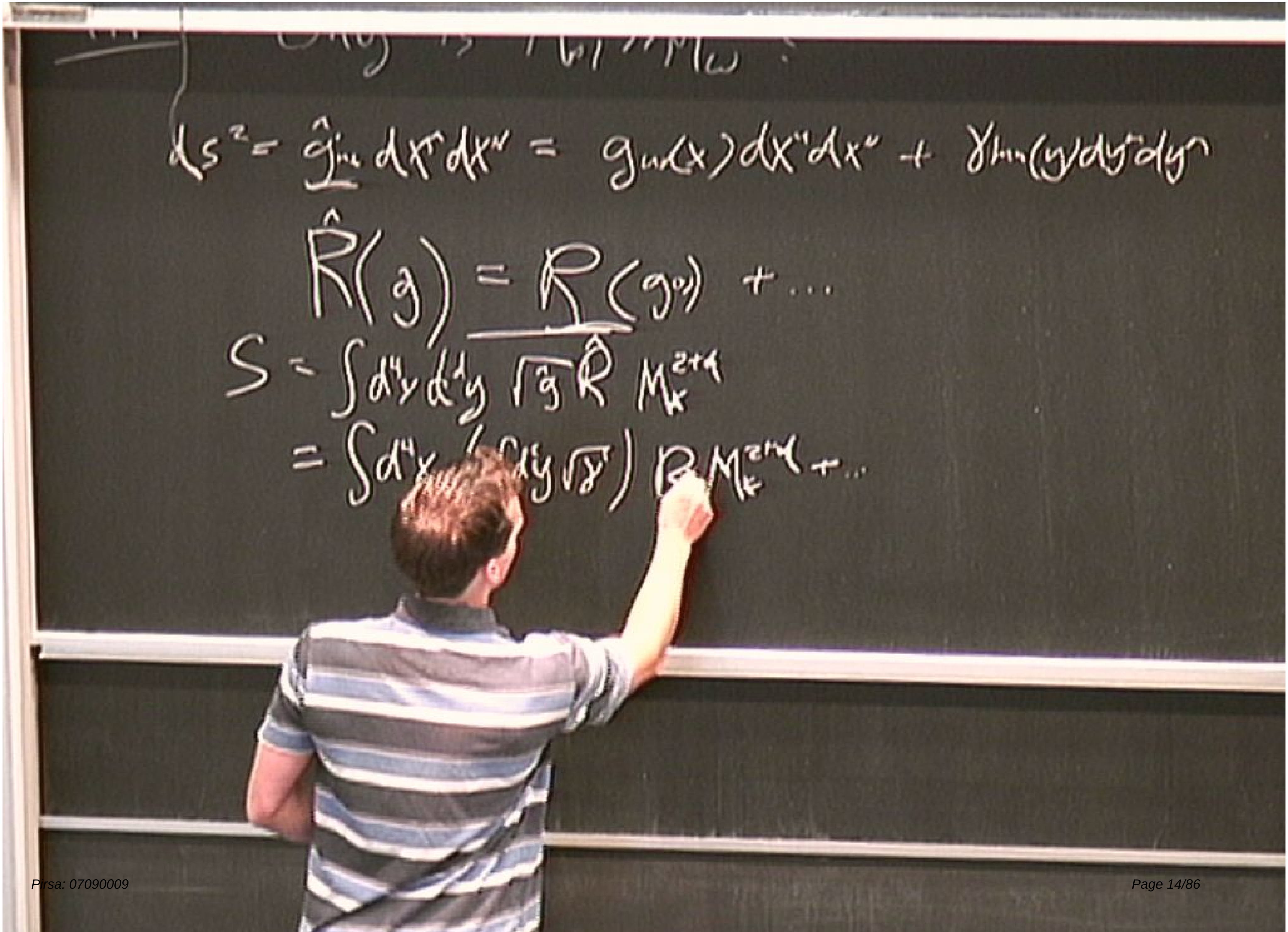
$$\hat{R}(\hat{g}) = R(g_{\mu\nu}) + \dots$$

$$ds^2 = \hat{g}_{MN}\, dx^M dx^N = g_{\mu\nu}(x)\, dx^\mu dx^\nu + \gamma_{mn}(y)\, dy^m dy^n$$

$$\hat{R}(\hat{g}) = R(g_{\mu\nu}) + \dots$$

$$S = \int d^4x\, d^d y\, \sqrt{\hat{g}}\, \hat{R}\, M_*^{2+d}$$


$ds^2 = \hat{g}_{\mu\nu} dx^\mu dx^\nu = g_{\mu\nu}(x) dx^\mu dx^\nu + \gamma_{mn}(y) dy^m dy^n$
$\hat{R}(g) = R(g_{\mu\nu}) + \dots$
$S = \int d^4x \, d^n y \sqrt{g} \, \hat{R} \, M_*^{2+n}$
$= \int d^4x \left(\int d^n y \sqrt{\gamma} \right)$


$ds^2 = \hat{g}_{MN} dx^M dx^N = g_{\mu\nu}(x) dx^\mu dx^\nu + \gamma_{mn}(y) dy^m dy^n$
$\hat{R}(\hat{g}) = R(g_{\mu\nu}) + \dots$
$S = \int d^4x \, d^d y \sqrt{\hat{g}} \hat{R} M_*^{2+d}$
$= \int d^4x \left(\int d^d y \sqrt{\gamma} \right) R M_*^{2+d} + \dots$

$$ds^2 = \hat{g}_{MN}\, dx^M dx^N = g_{\mu\nu}(x)\, dx^\mu dx^\nu + \gamma_{mn}(y)\, dy^m dy^n$$

$$\hat{R}(\hat{g}) = R(g_{\mu\nu}) + \dots$$

$$S = \int d^4x\, d^d y \sqrt{\hat{g}}\, \hat{R}\, M_*^{2+d}$$

$$= \int d^4x \left(\int d^d y \sqrt{\gamma} \right) R(g)\, M_*^{2+d} + \dots$$

$$ds^2 = \underline{\hat{g}_{MN}}\, dx^M dx^N = g_{\mu\nu}(x)\, dx^\mu dx^\nu + \gamma_{mn}(y)\, dy^m dy^n$$

$$\hat{R}(g) = \underline{R(g_{\mu\nu})} + \ldots$$

$$S = \int d^4x\, d^d y\, \sqrt{\hat{g}}\, \hat{R}\, M_*^{2+d}$$

$$= \int d^4x \left(\int d^d y \sqrt{\gamma} \right) R(g) M_*^{2+d} + \ldots$$

$$= \int d^4x \left(r^d M_*^{d+2} \right) R + \ldots$$

$$\boxed{M_{Pl}^2 = M_*^{2+d}\, r^d}$$

$$\boxed{M_{pl}^2 = M_*^{2+d} r^d}$$

#'s

$$r = 10^{30/d - 19} \text{ m}$$

$d = 1 \qquad r \simeq 10^{11} \text{ m}$

$$\boxed{M_{pl}^2 = M_*^{2+d}\, r^d}$$

#'s $\quad r = 10^{30/d - 17}\ m$

$d = 1, \quad r \approx 10^{11}\ m = 1\ AU \implies$ ruled out

#'s

$$r = 10^{30/d - 19}\ \text{m}$$

$d = 1$, $\quad r \approx 10^{11}\ \text{m} = 1\ \text{AU} \implies$ ruled out

$d = 2$, $\quad r = 10^{-4}\ \text{m} \implies$ NOT ruled out

$$\boxed{M_{Pl}^{2} = M_{*}^{2+d}\, r^{d}}$$

#'s

$$r = 10^{30/d - 19}\ \text{m}$$

$d = 1$, $r < 10^{11}$ m $= 1$ AU $\Rightarrow$ ruled out

$d = 2$, $r = 10^{-4}$ m $\Rightarrow$ NOT ruled out

$$\boxed{M_{pl}^2 = M_*^{2+d} r^d}$$

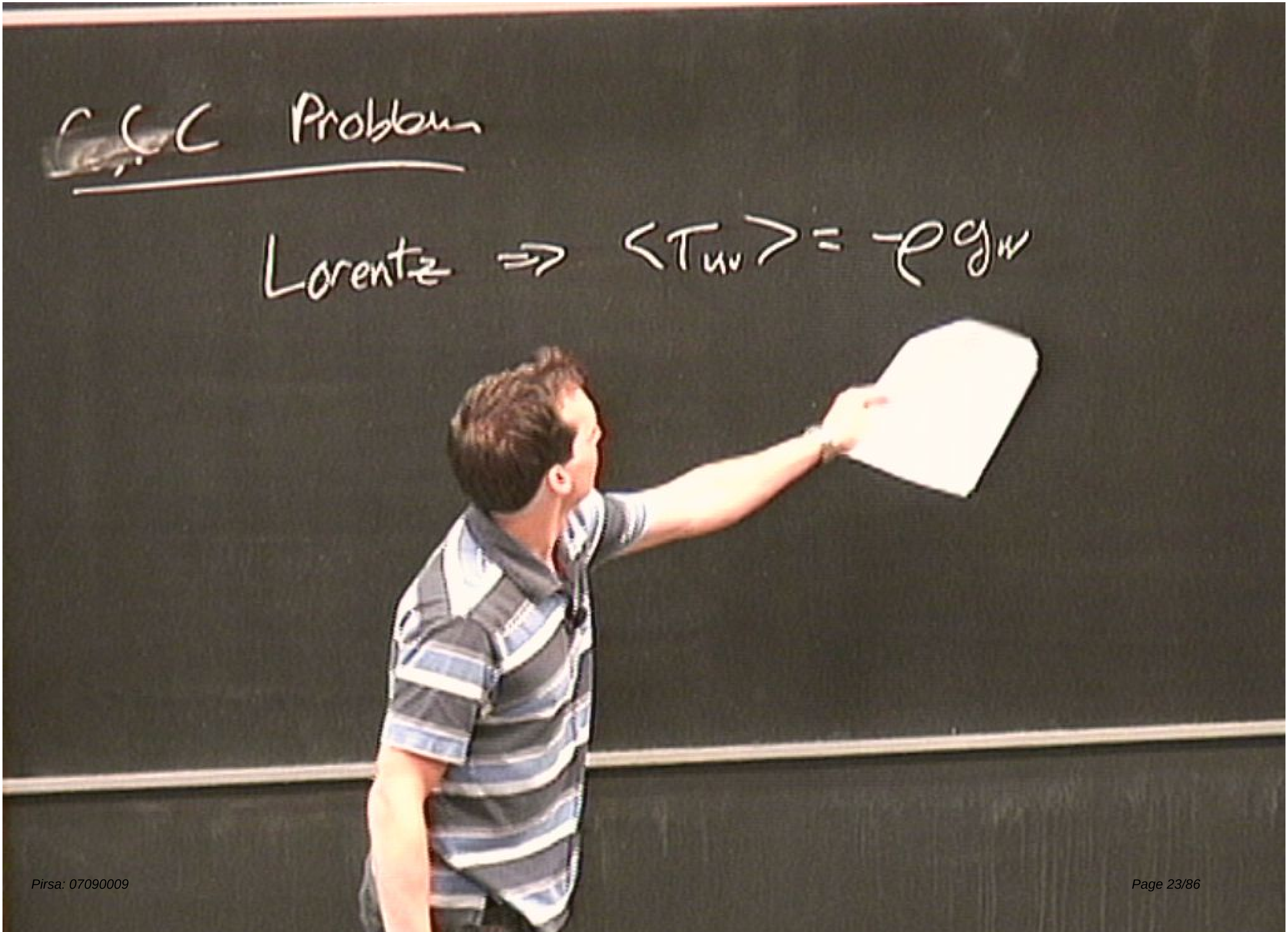
#'s

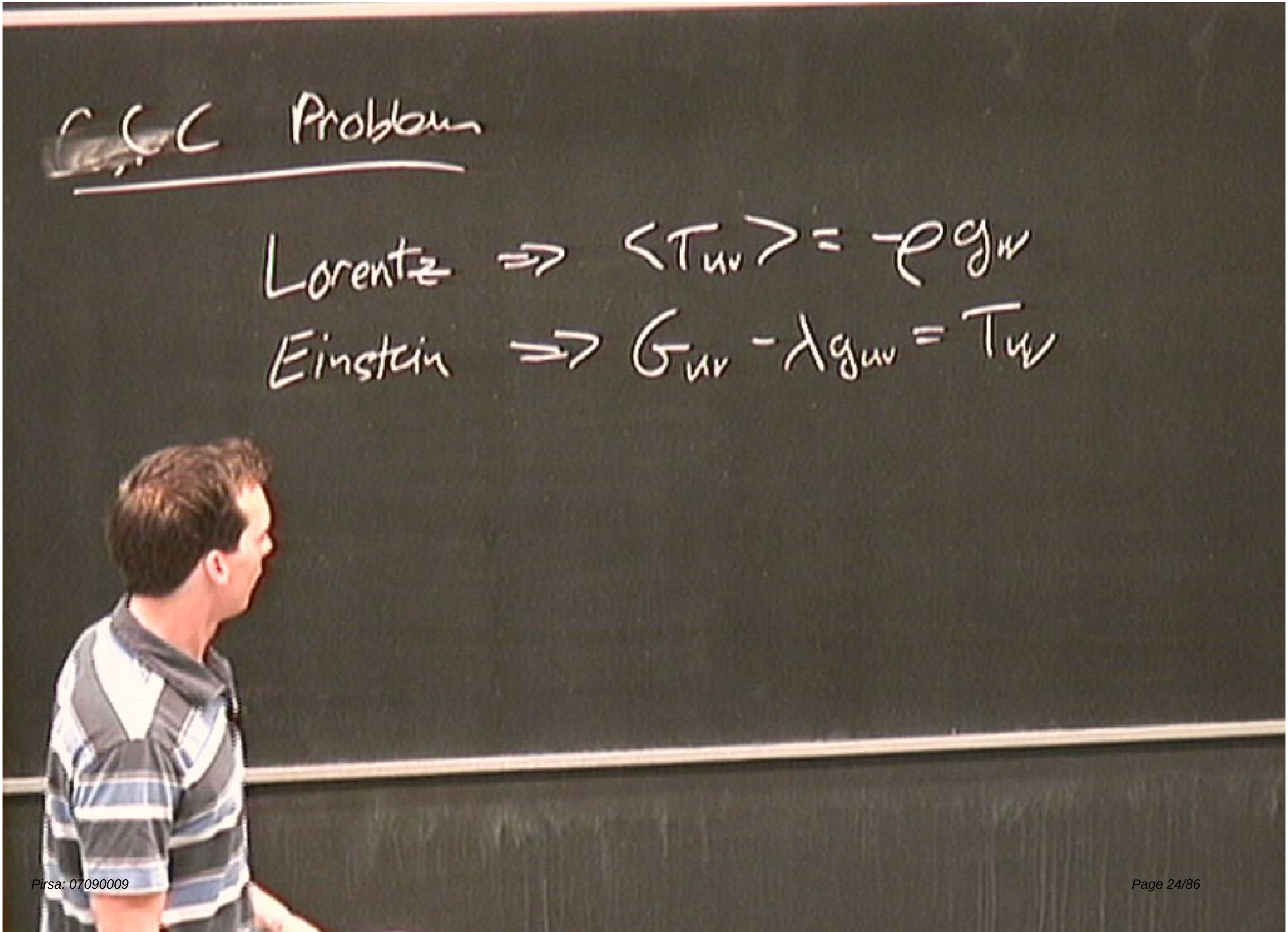
$r = 10^{30/d - 19}$ m

$d=1$, $r < 10^{11}$ m = 1 AU $\Rightarrow$ ruled out

$d=2$, $r = 10^{-4}$ m $\Rightarrow$ NOT ruled out

Coincidence $\frac{1}{r} \sim 10^{-3}$ eV $\left(\frac{1}{r}\right)^4 = \rho_{vac}$


C.C.C Problem
Lorentz ⇒ ⟨T_{μν}⟩ = −ρ g_{μν}


C.C.C Problem
Lorentz $\Rightarrow \langle T_{\mu\nu} \rangle = -\rho g_{\mu\nu}$
Einstein $\Rightarrow G_{\mu\nu} - \lambda g_{\mu\nu} = T_{\mu\nu}$

C C C Problem

$$\text{Lorentz} \Rightarrow \langle T_{\mu\nu} \rangle = -\rho\, g_{\mu\nu}$$

$$\text{Einstein} \Rightarrow G_{\mu\nu} - \lambda g_{\mu\nu} = T_{\mu\nu}$$

$$\lambda_{eff} = \lambda - \rho \qquad \rho \rightarrow \sim M^4 \gg$$

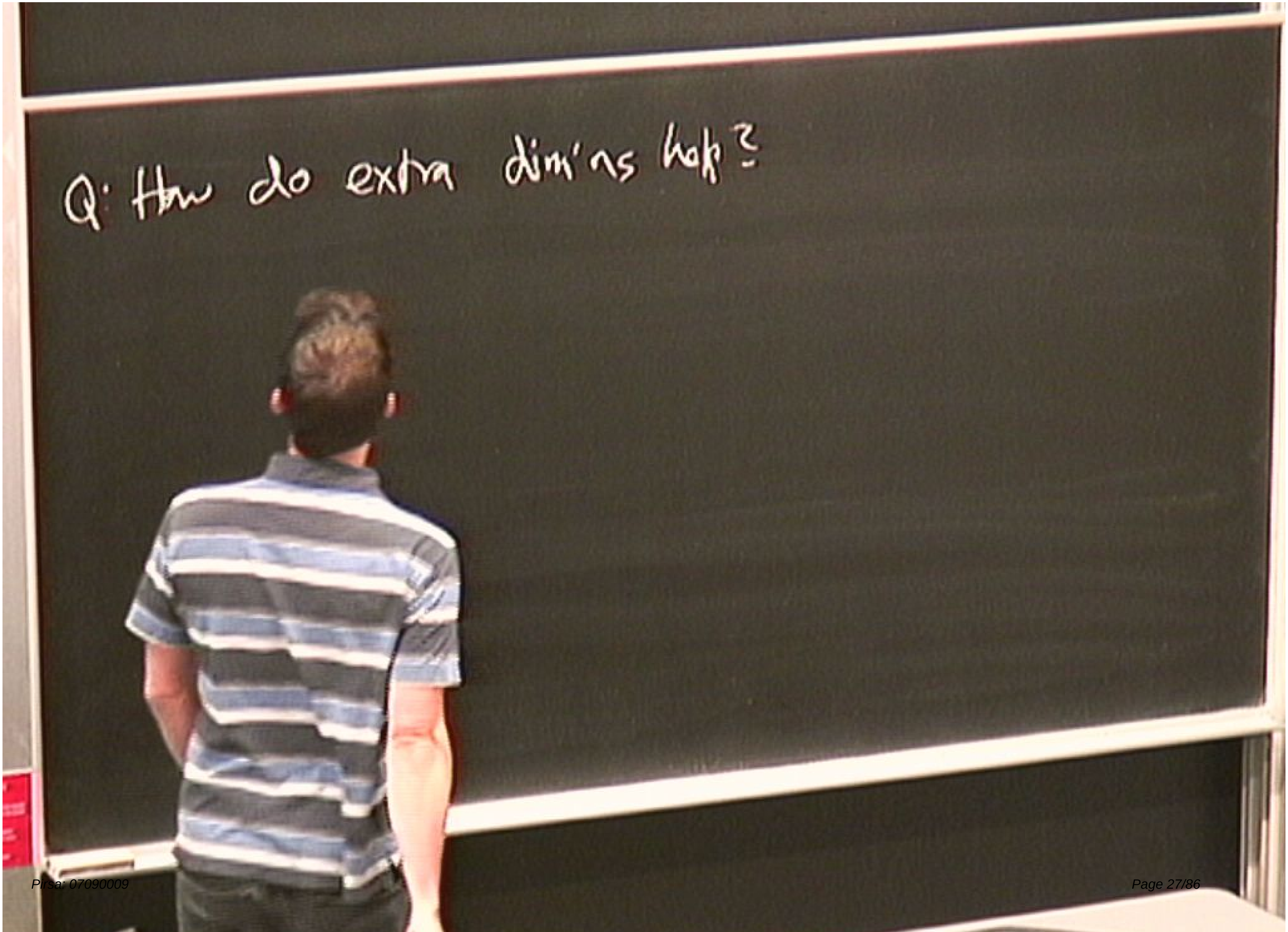
C.C. Problem

$$\text{Lorentz} \Rightarrow \langle T_{\mu\nu} \rangle = -\rho\, g_{\mu\nu}$$

$$\text{Einstein} \Rightarrow G_{\mu\nu} - \lambda g_{\mu\nu} = T_{\mu\nu}$$

$$\lambda_{eff} = \lambda - \rho \quad \rightarrow \sim M^4 \gg$$

CC problem: why is $\lambda_{eff} \lll \sim M^4$?


Q: How do extra dim'ns help?

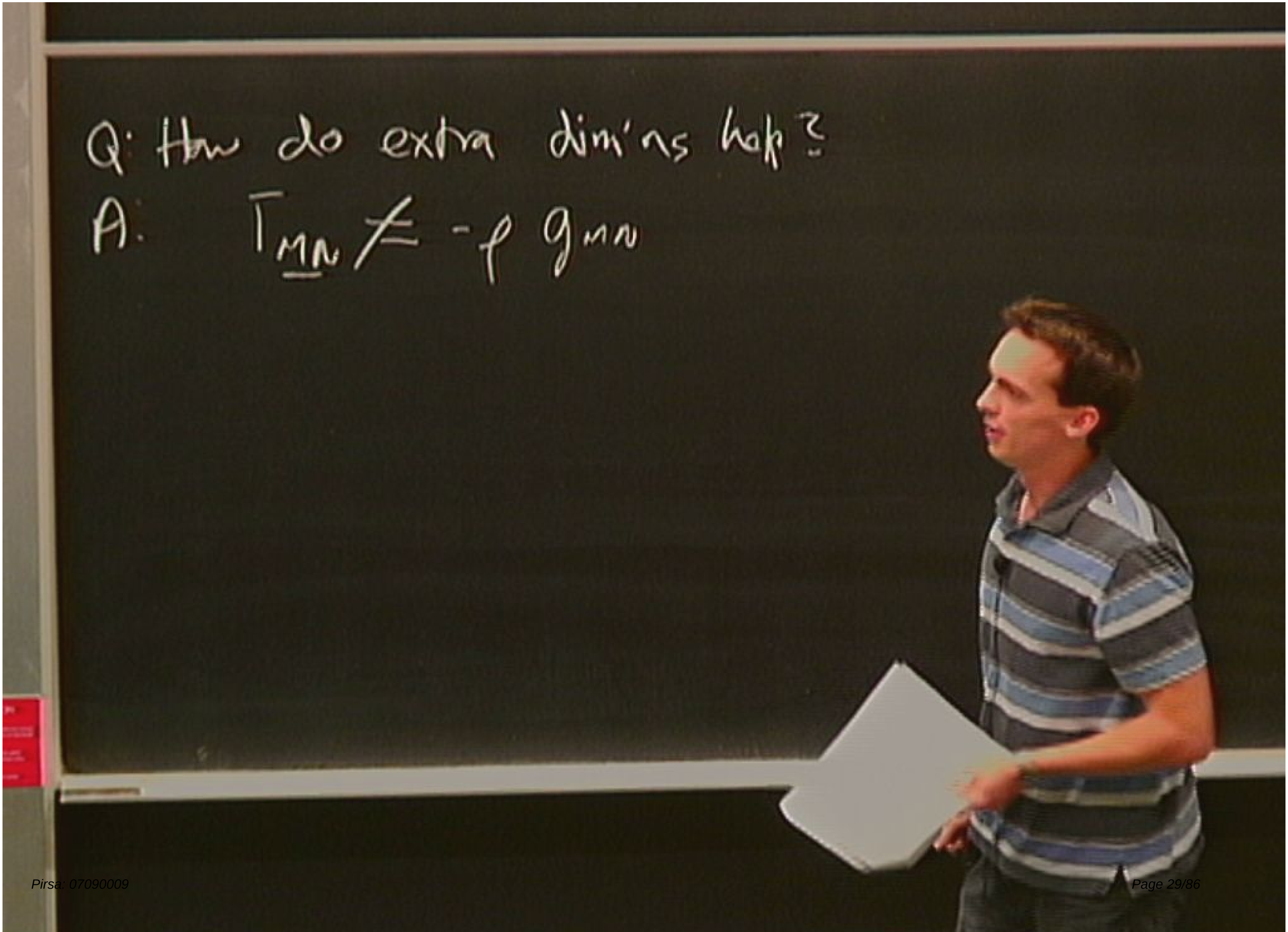
CC Problem

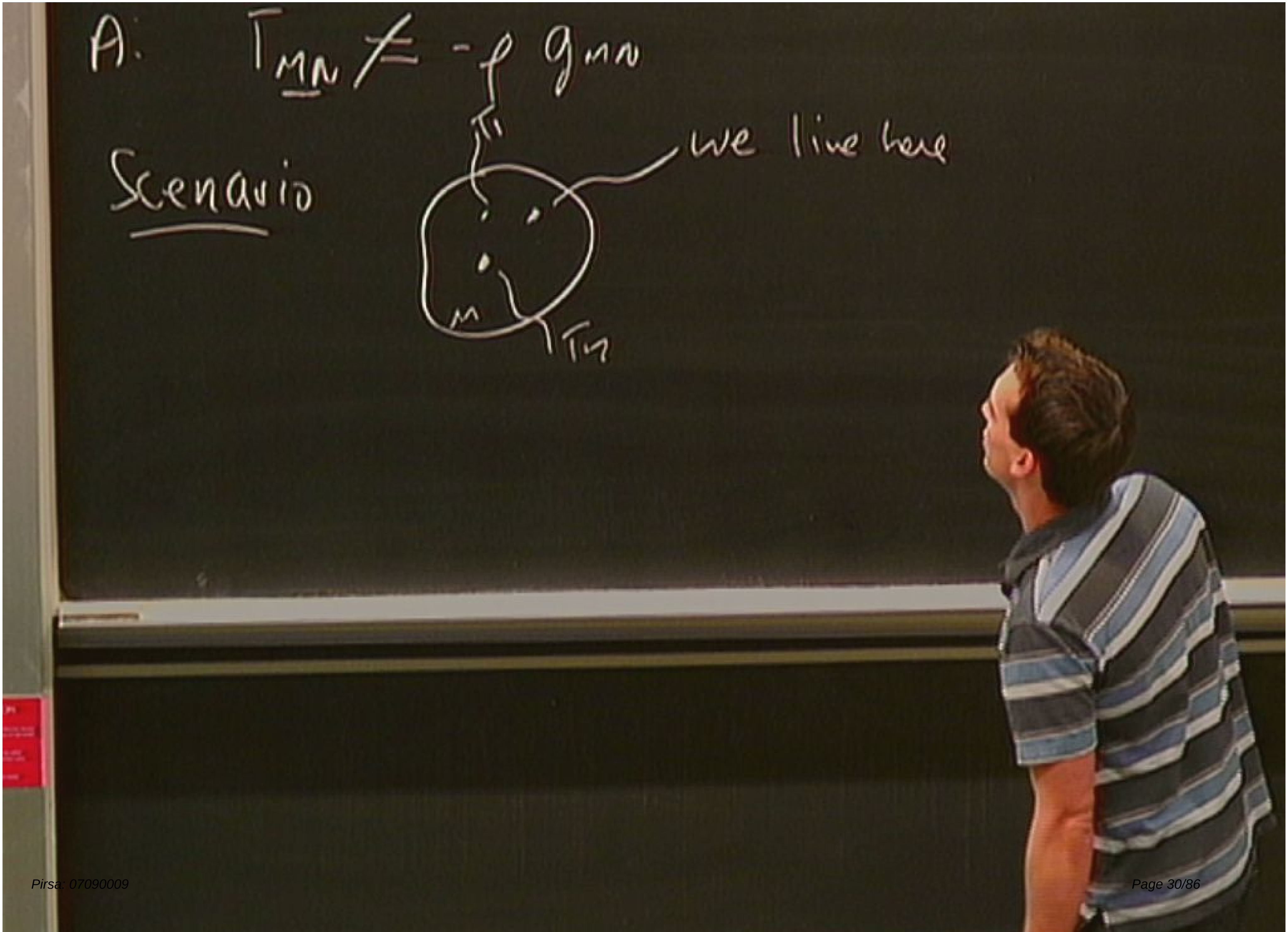
Lorentz $\Rightarrow \langle T_{\mu\nu} \rangle = -\rho g_{\mu\nu}$ ←

Einstein $\Rightarrow G_{\mu\nu} - \lambda g_{\mu\nu} = T_{\mu\nu}$

$\lambda_{eff} = \lambda - \rho$ $\rho \sim M^4$

CC problem: Why is $\lambda_{eff} \lll \rho \sim M^4$?

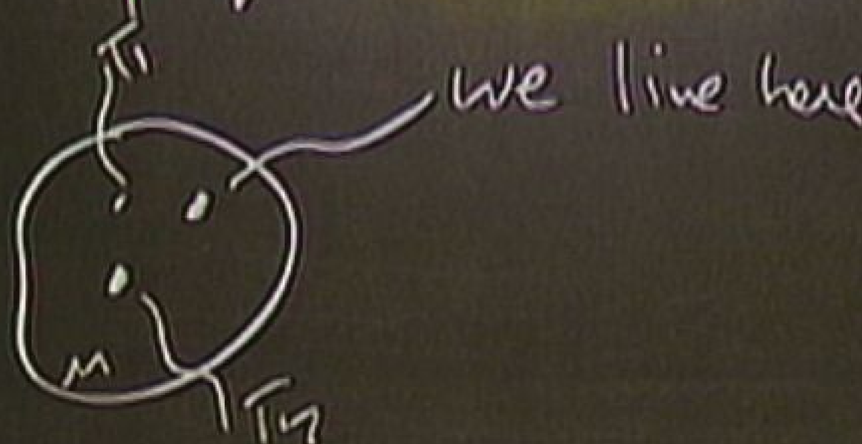

Q: How do extra dim'ns help?
A: $T_{\underline{MN}} \neq -\rho\, g_{MN}$


A: $T_{MN} \neq -\rho\, g_{MN}$
Scenario
we live here
M
$T_{\mu\nu}$

Q: How do extra dim'ns help?

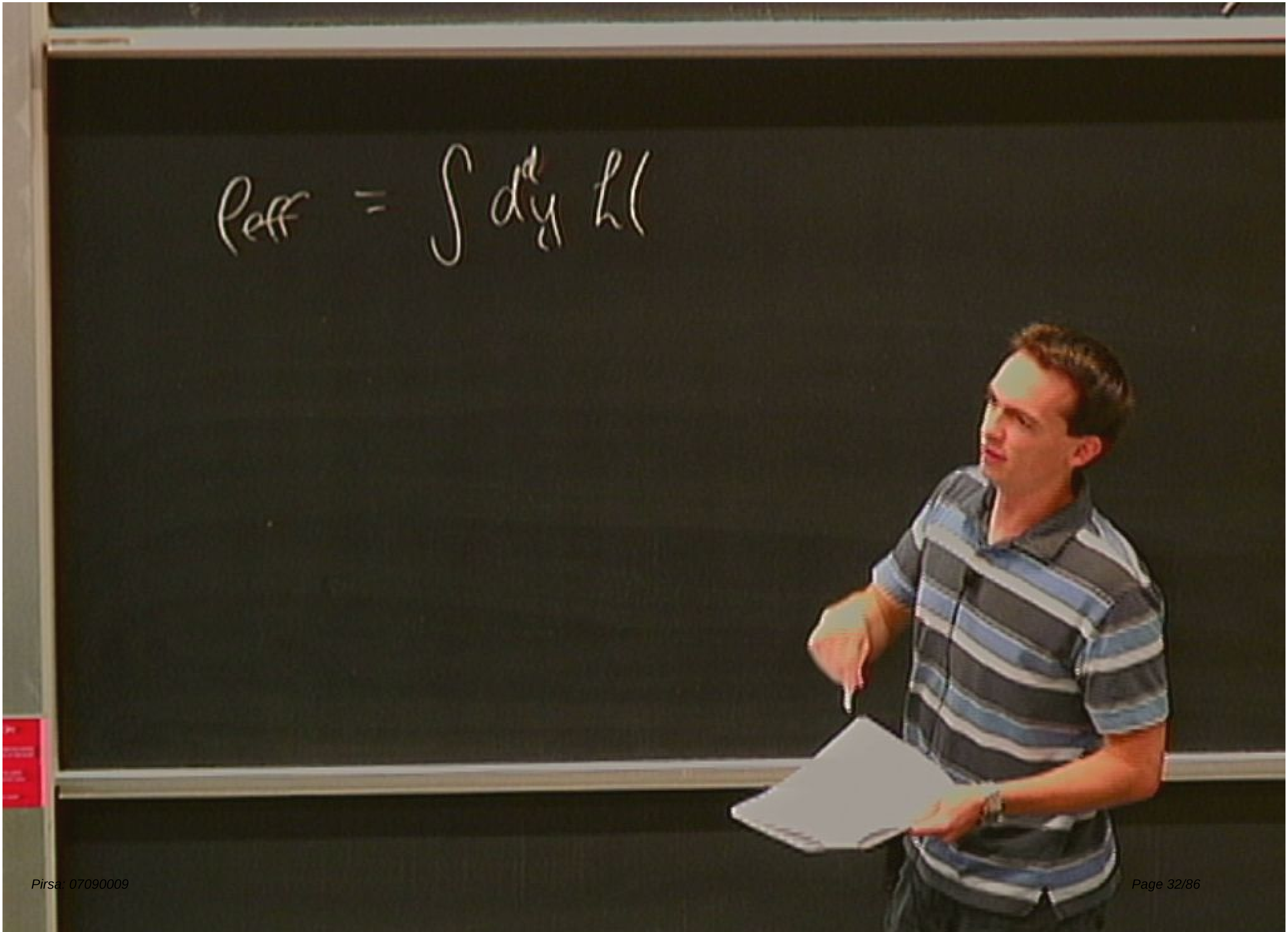
A: $T_{\underline{MN}} \neq -\rho\, g_{MN}$

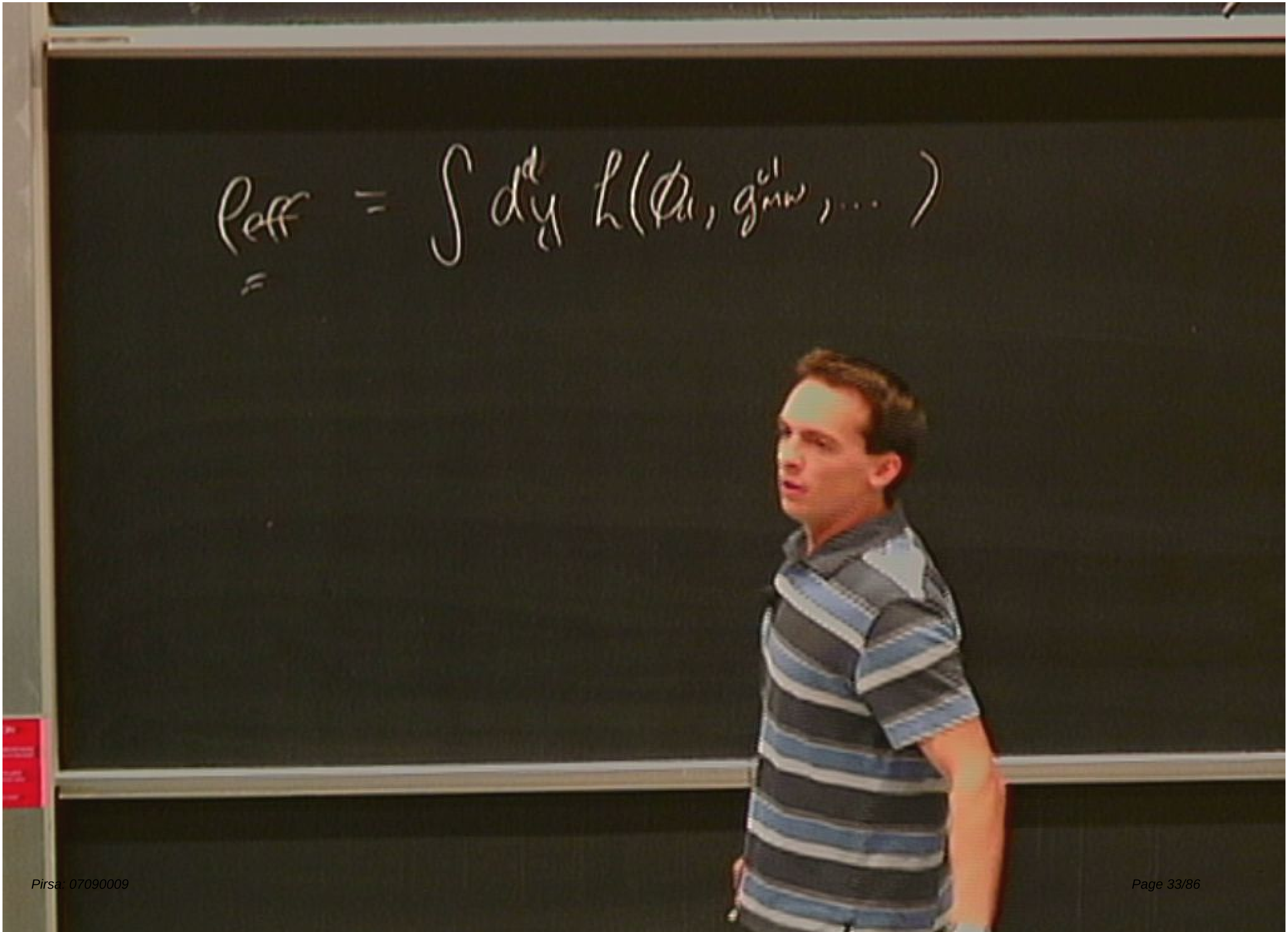
Scenario

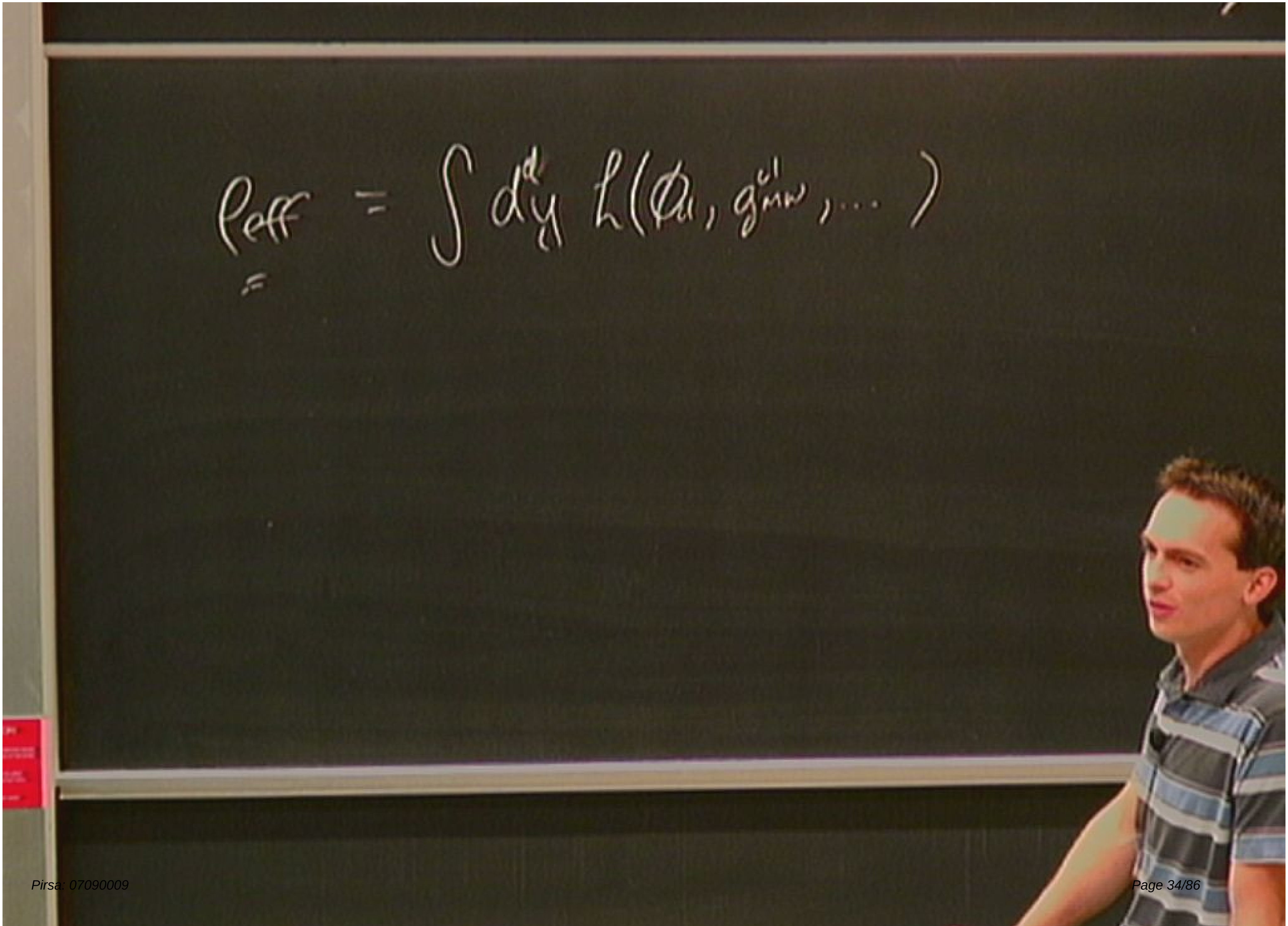


Q: What will L.E observer measure for

$\rho_{eff} = \int$


$\rho_{eff} = \int d^d y \, h($


$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_{cl}, g^{cl}_{mn}, \dots)$
$=$

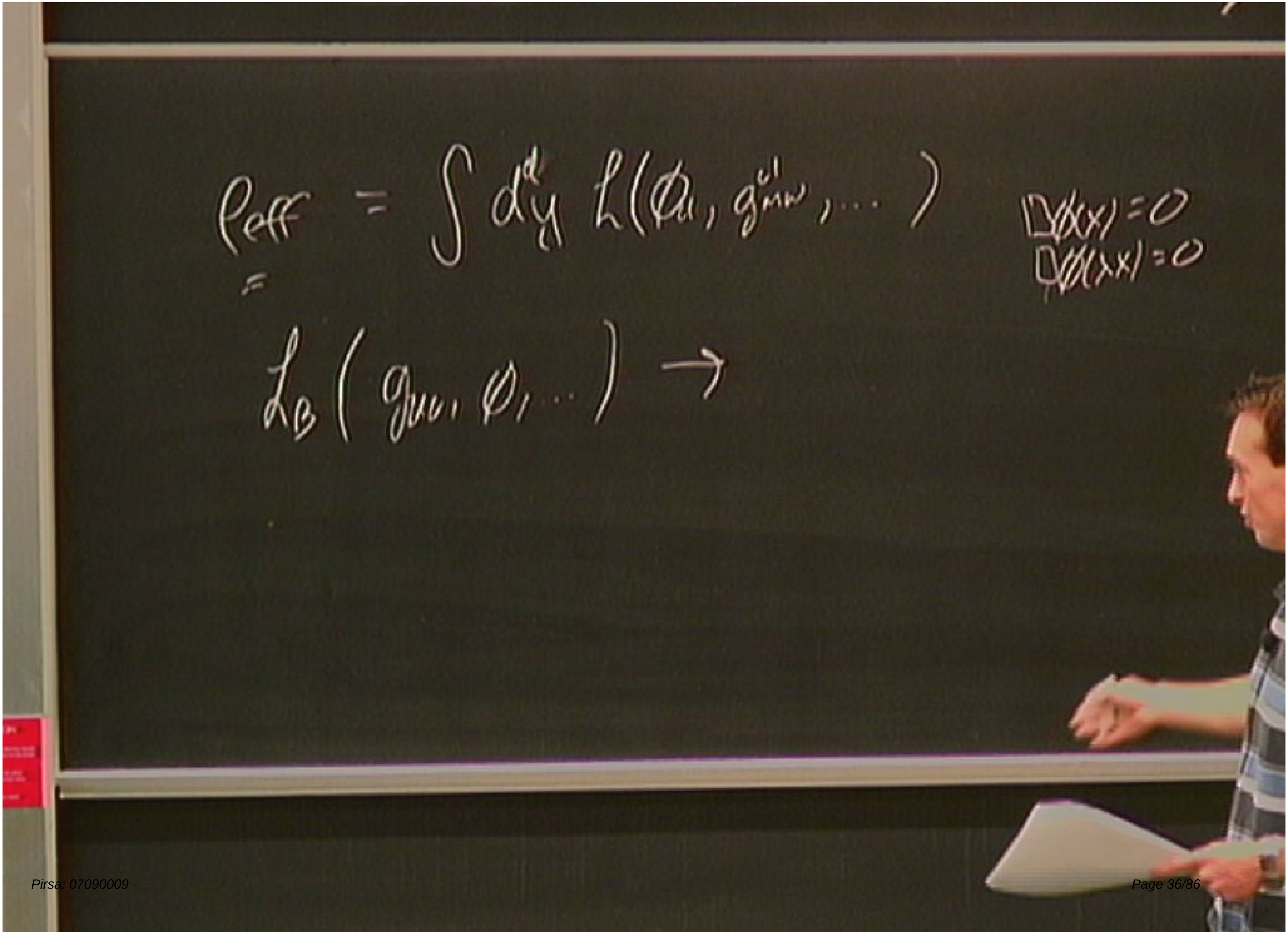


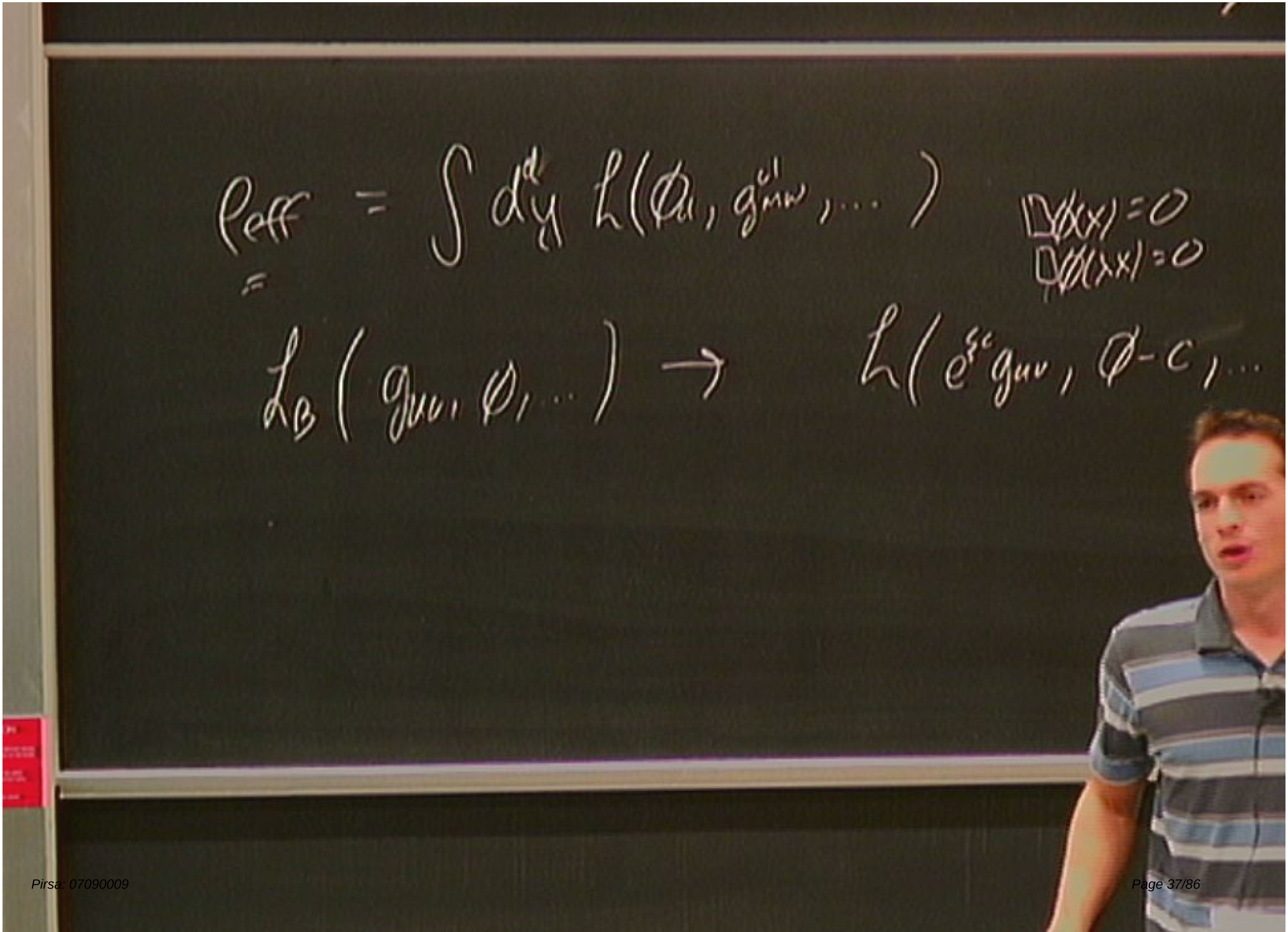
$$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_{cl}, g^{cl}_{\mu\nu}, \dots)$$

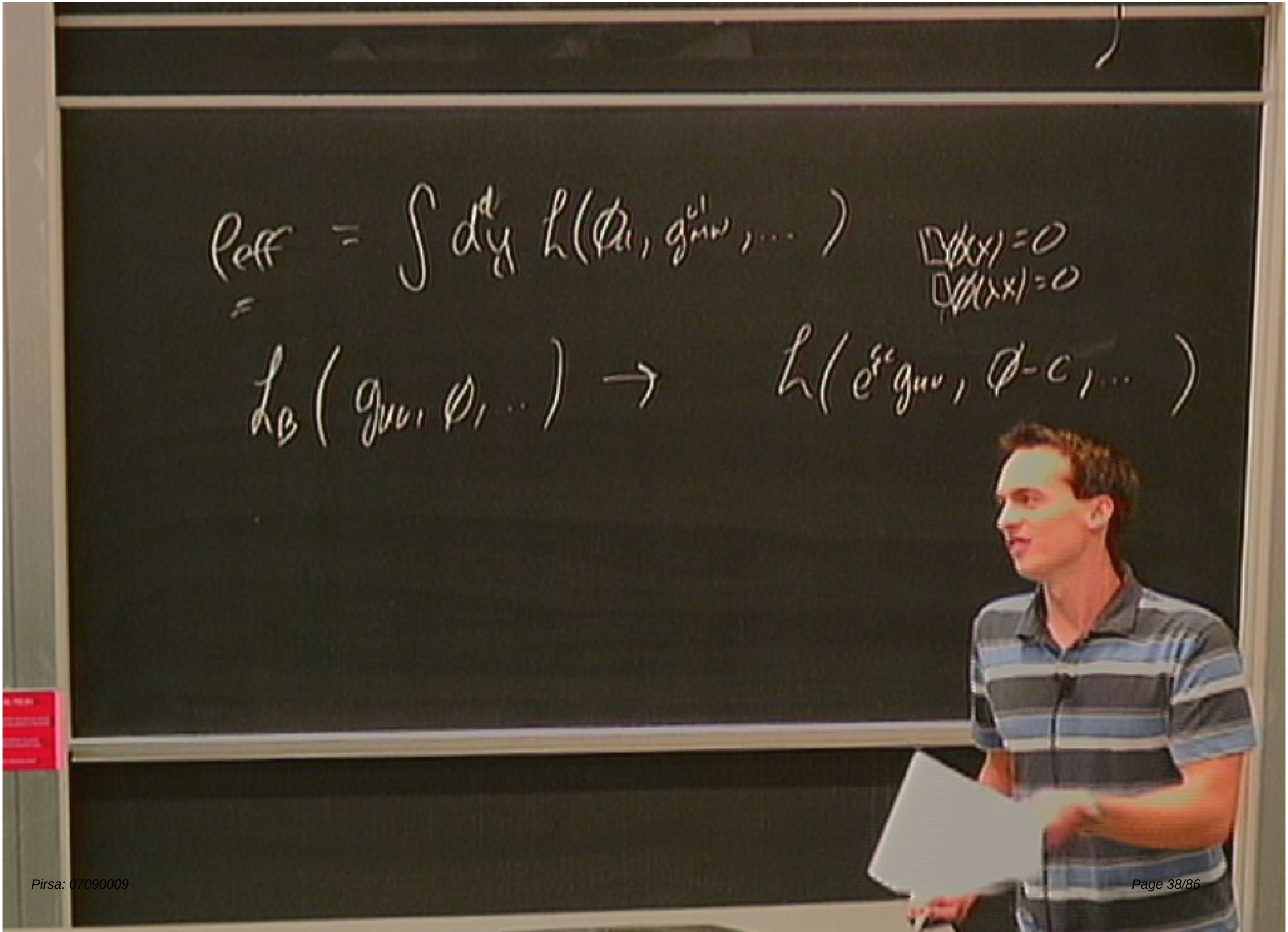
$=$

$$\rho_{eff} = \int d^d y \; \mathcal{L}(\phi_{ii}, g^{ii}_{\mu\nu}, \ldots) \qquad \Box\phi(x) = 0$$

$$= \mathcal{L}_B(g_{\mu\nu}, \phi, \ldots) \rightarrow$$


$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_{cl}, g^{cl}_{\mu\nu}, \ldots)$
$\Box\phi(x) = 0$
$\Box\phi(\lambda x) = 0$
$=$
$\mathcal{L}_B(g_{\mu\nu}, \phi, \ldots) \rightarrow$


$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_d, g^d_{\mu\nu}, \ldots)$
$\Box\phi(x) = 0$
$\Box\phi(\lambda x) = 0$
$\mathcal{L}_B(g_{\mu\nu}, \phi, \ldots) \rightarrow \mathcal{L}(e^{gc} g_{\mu\nu}, \phi - c, \ldots$


$\mathcal{L}_{eff} = \int d^d y \, \mathcal{L}(\phi_{cl}, g^{cl}_{\mu\nu}, \dots)$
$\Box\phi(x) = 0$
$\Box\phi(\lambda x) = 0$
$\mathcal{L}_B(g_{\mu\nu}, \phi, \dots) \to \mathcal{L}(e^{2c} g_{\mu\nu}, \phi - c, \dots)$

$$\mathcal{L}_{eff} = \int d^d y \, \mathcal{L}(\phi_{ii}, g^{ii}_{\mu\nu}, \ldots)$$

$$\Box\phi(x) = 0$$

$$\Box\phi(\lambda x) = 0$$

$$= \mathcal{L}_B(g_{\mu\nu}, \phi, \ldots) = e^{-\omega_B c} \mathcal{L}(e^{\beta c} g_{\mu\nu}, \phi - c, \ldots)$$

$$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_0, g^{mn}, \ldots) =$$

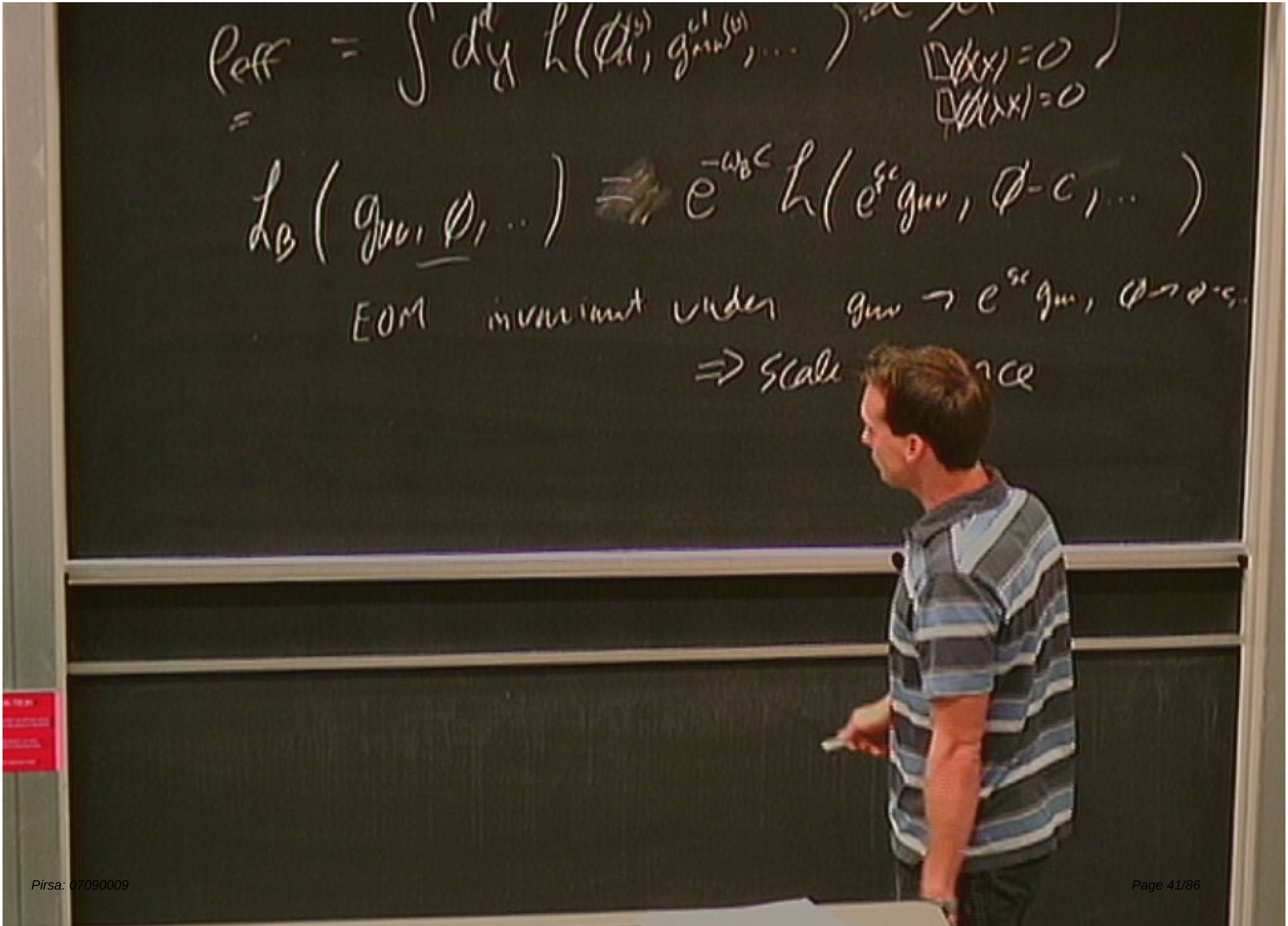
$\Box\psi(x) = 0$

$\Box\psi(\lambda x) = 0$

$$= \mathcal{L}_B(g_{\mu\nu}, \phi, \ldots) = e^{-\omega_B c} \, \mathcal{L}(e^{2c} g_{\mu\nu}, \phi - c, \ldots)$$

EOM invariant under $g_{\mu\nu} \to e^{2c} g_{\mu\nu}$,

$\Rightarrow$ scale invariance


$\rho_{eff} = \int d^d y \, L(\phi_{cl}^{(y)}, g_{\mu\nu}^{cl(y)}, \dots)$
$\partial\phi(x,x) = 0$
$\partial\phi(x,x) = 0$
$L_B(g_{\mu\nu}, \phi, \dots) = e^{-\omega_B c} L(e^{gc} g_{\mu\nu}, \phi - c, \dots)$
EOM invariant under $g_{\mu\nu} \to e^{gc} g_{\mu\nu}, \phi \to \phi - c$
$\Rightarrow$ scale

$$\mathcal{L}_{eff} = \int d^d y \, \mathcal{L}(\phi_{cl}^{(y)}, g_{\mu\nu}^{cl\,(y)}, \dots)$$

$\Box\phi(x) = 0$

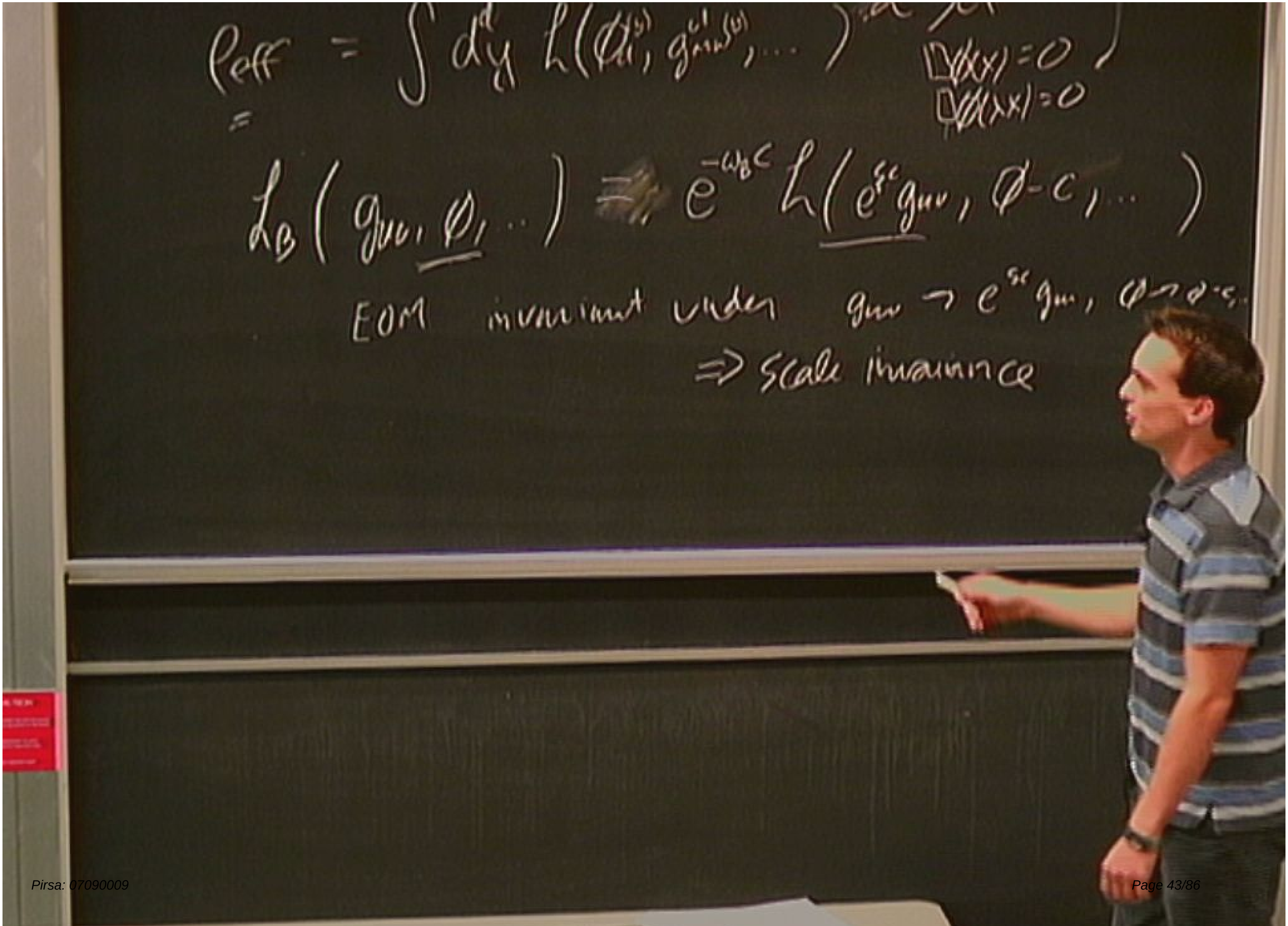
$\Box\phi(\lambda x) = 0$

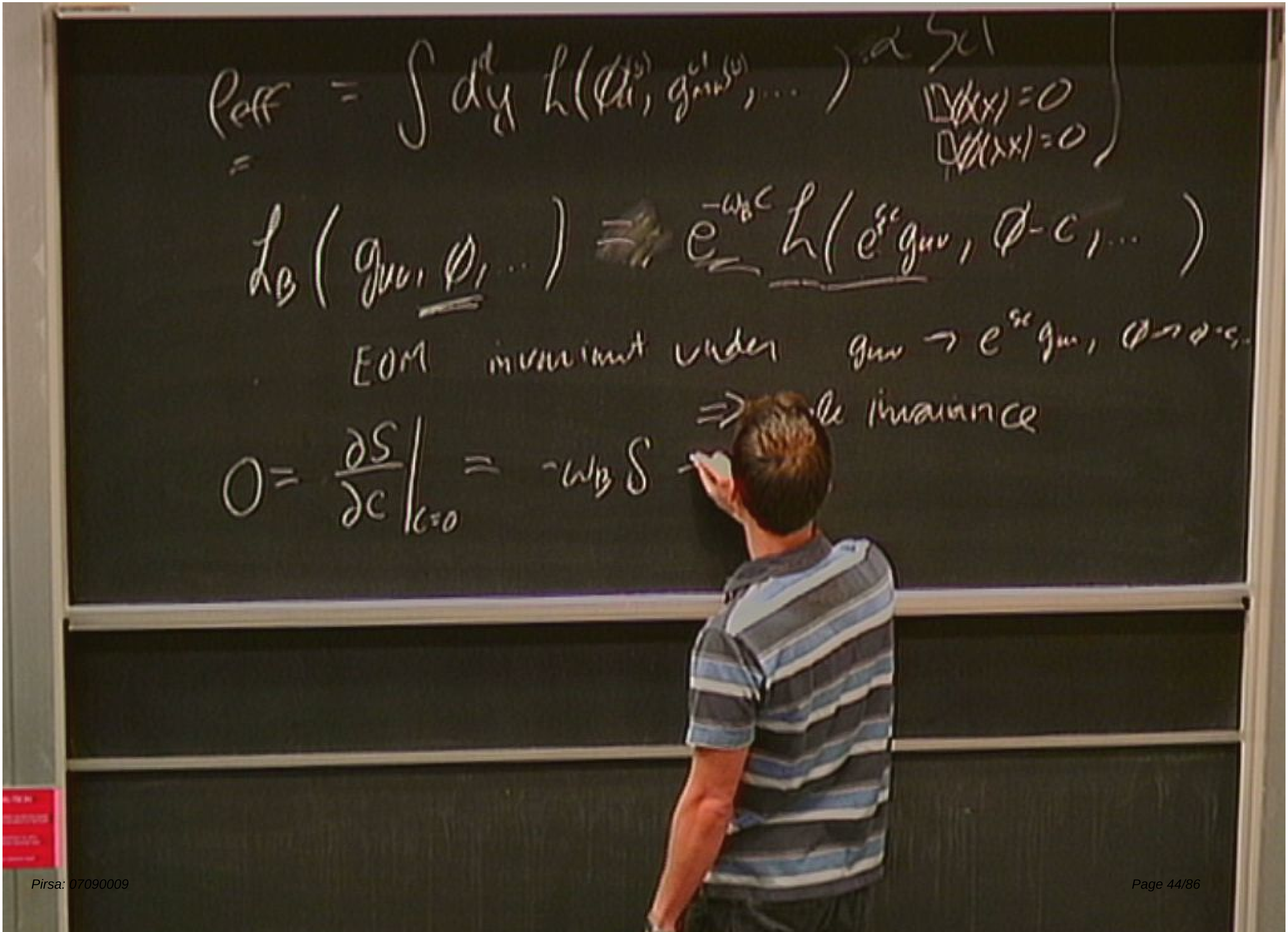
$=$

$$\mathcal{L}_B(g_{\mu\nu}, \underline{\phi}, \dots) = e^{-\omega_B c}\, \mathcal{L}(e^{\xi c} g_{\mu\nu}, \phi - c, \dots)$$

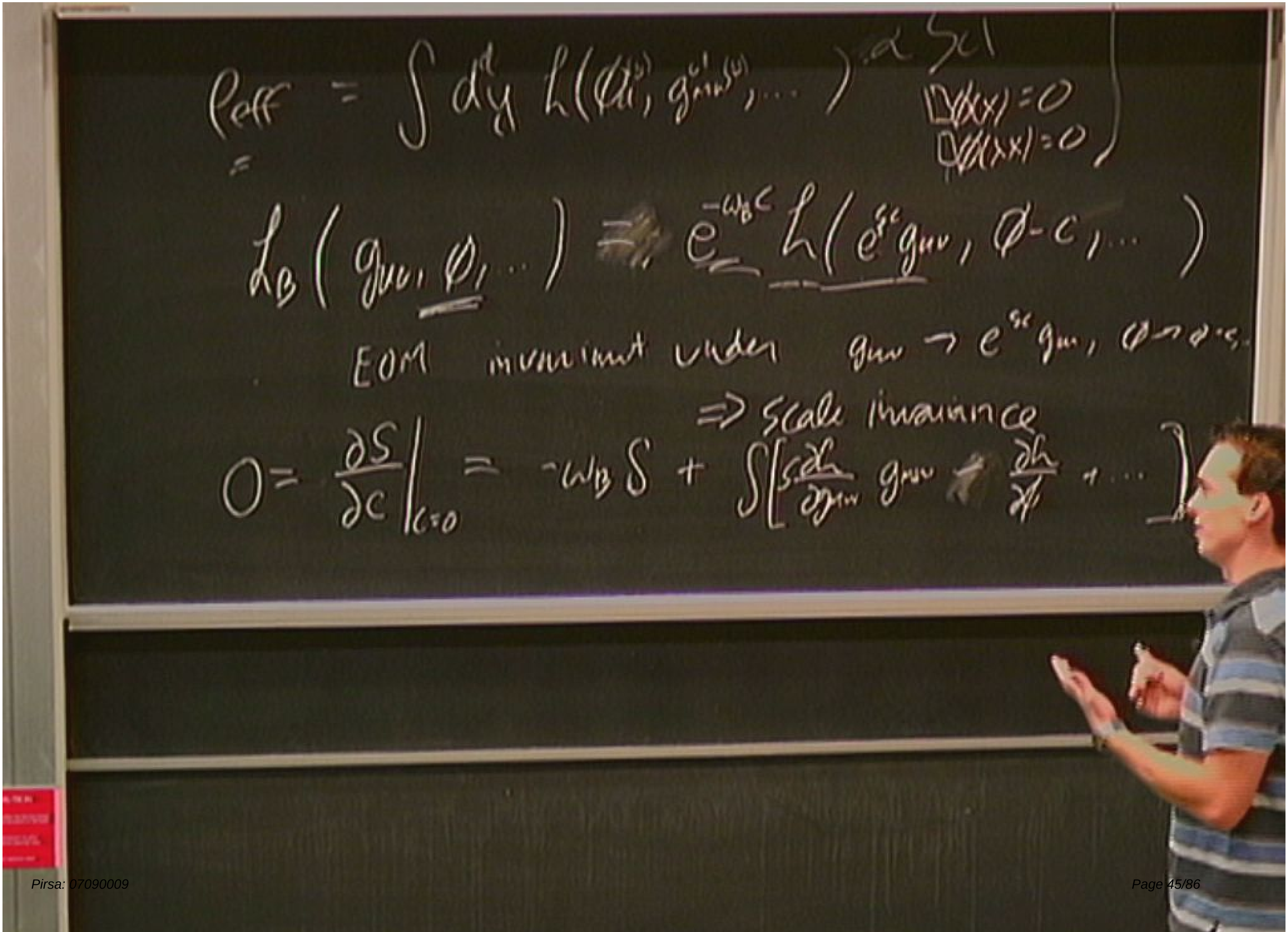
EOM invariant under $g_{\mu\nu} \to e^{\xi c} g_{\mu\nu}$, $\phi \to \phi - c, \dots$

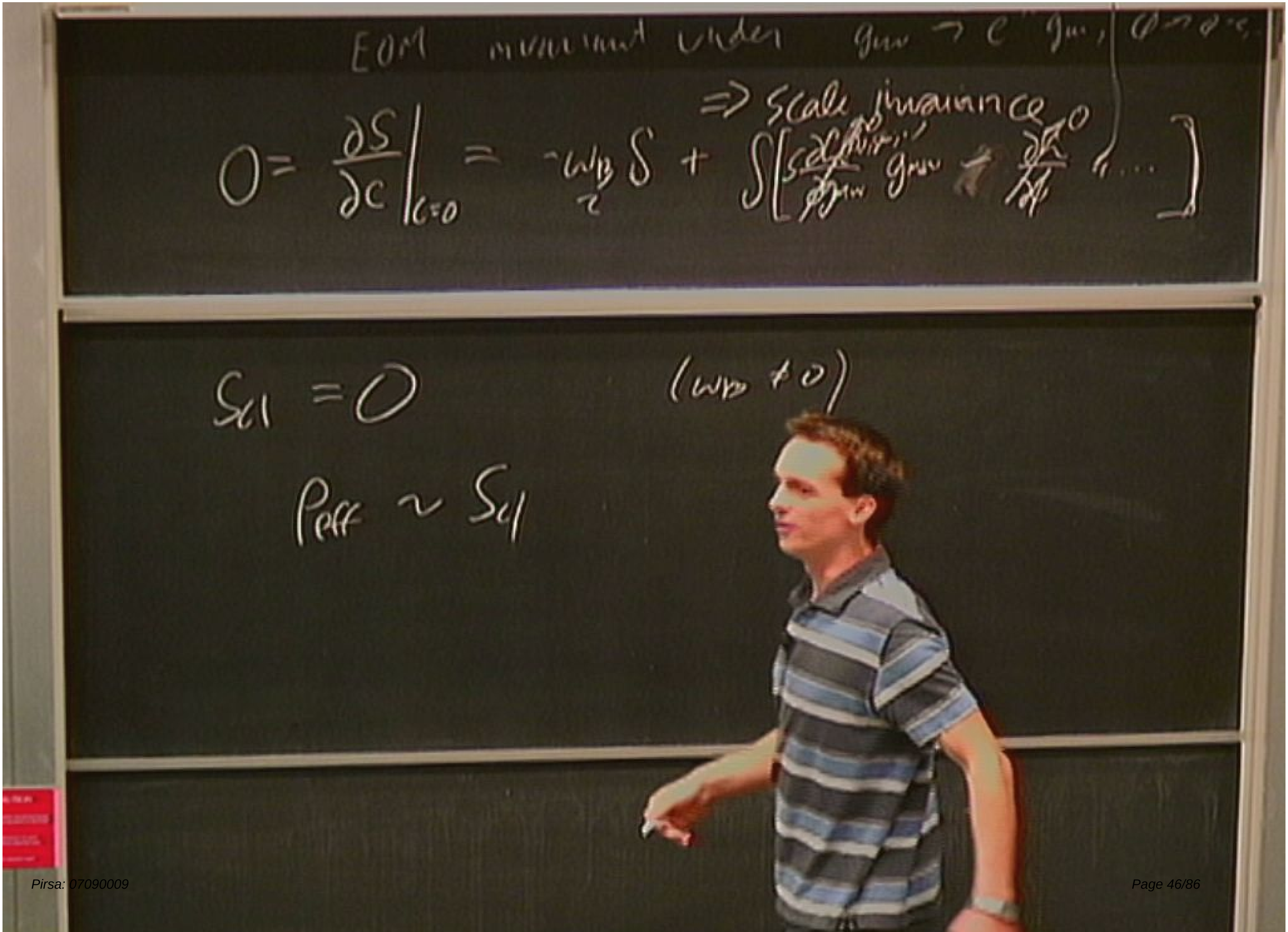
$\Rightarrow$ scale invariance


$P_{eff} = \int d^d y \, L(\phi^{(y)}, g^{(y)}_{\mu\nu}, \dots)$
$L_B(g_{\mu\nu}, \phi, \dots) = e^{-\omega_B c} L(e^{\beta c} g_{\mu\nu}, \phi - c, \dots)$
EOM invariant under $g_{\mu\nu} \to e^{\beta c} g_{\mu\nu}$, $\phi \to \phi - c$
$\Rightarrow$ scale invariance



$\mathcal{L}_{eff} = \int d^d y \; h(\phi_i^{(y)}, g_{\mu\nu}^{(y)}, \dots)$
$\mathcal{L}_B(g_{\mu\nu}, \phi, \dots) = e^{-\omega_B c} h(e^{c} g_{\mu\nu}, \phi - c, \dots)$
EOM invariant under $g_{\mu\nu} \to e^{c} g_{\mu\nu}$, $\phi \to \phi - c$
$\Rightarrow$ ...le invariance
$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\omega_B S$


$\rho_{eff} = \int d^d y \, \mathcal{L}(\phi_i(y), g_{\mu\nu}(y), \dots) \propto \delta c$
$\Box \phi(x) = 0$
$\Box \phi(\lambda x) = 0$
$\mathcal{L}_B(g_{\mu\nu}, \phi, \dots) = e^{-\omega_B c} \mathcal{L}(e^{2c} g_{\mu\nu}, \phi - c, \dots)$
EOM invariant under $g_{\mu\nu} \to e^{2c} g_{\mu\nu}$, $\phi \to \phi - c$
$\Rightarrow$ scale invariance
$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\omega_B S + \int \left[2 \frac{\partial \mathcal{L}}{\partial g_{\mu\nu}} g_{\mu\nu} - \frac{\partial \mathcal{L}}{\partial \phi} + \dots \right]$


EOM invariant under
⇒ scale invariance
S_cl = 0
(w_B ≠ 0)
P_eff ~ S_cl

EOM invariant under $g_{\mu\nu} \to c^{\,} g_{\mu\nu}$, $\phi \to \phi\, c$

$\Rightarrow$ scale invariance

$$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\frac{w_B}{2} S + \int \left[\frac{\partial \mathcal{L}}{\partial g_{\mu\nu}} g_{\mu\nu} + \frac{\partial \mathcal{L}^{\,0}}{\partial \phi} \phi \ldots \right]$$

$$S_{cl} = 0 \qquad (w_B \neq 0)$$

$$\rho_{eff} \sim S_{cl} = 0$$

EOM invariant under $g_{\mu\nu} \to e^{c} g_{\mu\nu}$, $\phi \to \phi - c$

$\Rightarrow$ scale invariance

$$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\frac{\omega_D}{2} S + \int \Big[\frac{\delta \mathcal{L}}{\delta g_{\mu\nu}} g_{\mu\nu} + \frac{\partial \mathcal{L}}{\partial \phi} + \dots \Big]$$

$S_{cl} = 0$ $(\omega_D \neq 0)$

$P_{eff} \sim S_{cl} = 0$

$$\mathcal{L}_b = e^{-\omega_D c} \mathcal{L}(g_{\mu\nu} e^{c}, \phi - c)$$

$\Rightarrow$ scale invariance

$$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\frac{w_B}{2} S + \int\left[\frac{\delta \mathcal{L}}{\delta g_{\mu\nu}} g_{\mu\nu} + \frac{\partial \mathcal{L}}{\partial \phi_i}^{0} \ldots \right]$$

$$S_{cl} = 0 \qquad (w_B \neq 0)$$

$$P_{eff} \sim S_{cl} = 0$$

$$\mathcal{L}_b = e^{-w_B c} \mathcal{L}(g_{\mu\nu} e^{2c}, \phi_c)$$

$\Rightarrow$ scale invariance

$$0 = \frac{\partial S}{\partial c}\bigg|_{c=0} = -\frac{\omega_B}{2} S + \int \left[\cancel{\frac{\delta \mathcal{L}}{\delta g_{\mu\nu}}} g_{\mu\nu} + \cancel{\frac{\partial \mathcal{L}}{\partial \phi}}^{0} \ldots \right]$$

$$S_{cl} = 0 \qquad (\omega_B \neq 0)$$

$$\rho_{eff} \sim S_{cl} = 0$$

$$\mathcal{L}_b = e^{-\omega_b c} \mathcal{L}(g_{\mu\nu} e^{sc}, \phi_c)$$

$$S_{cl} = \underbrace{\left(1 - \frac{\omega_b}{\omega_B}\right)}\int_M \mathcal{L}_b$$

$\Rightarrow$ scale invariance

$$0 = \frac{\partial S}{\partial c}\bigg|_{c=0} = -\frac{\omega_B}{2} S + \int \left[\frac{\delta \mathcal{L}}{\delta g_{\mu\nu}} g_{\mu\nu} + \cancel{\frac{\delta \mathcal{L}}{\delta \phi}}^{\,0} + \ldots \right]$$

$$S_{cl} = 0 \qquad (\omega_B \neq 0)$$

$$P_{eff} \sim S_{cl} = 0$$

$$\mathcal{L}_b = e^{-\omega_b c} \mathcal{L}(g_{\mu\nu} e^{sc}, \phi_c)$$

$$S_{cl} = \underbrace{\left(1 - \frac{\omega_b}{\omega_B}\right)}\int_{M}$$

$$0 = i(\ldots)$$

$\Rightarrow$ scale invariance

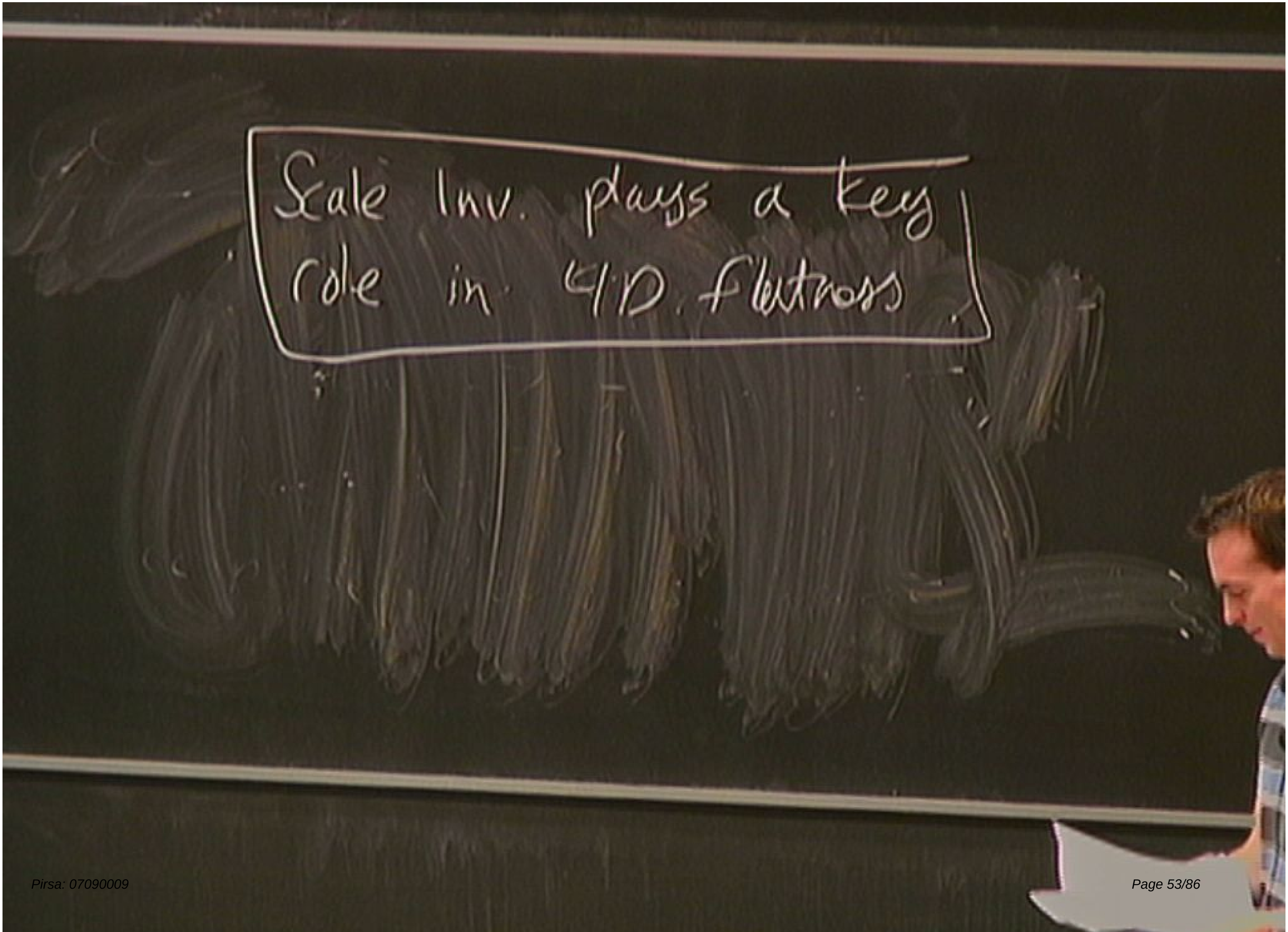
$$0 = \frac{\partial S}{\partial c}\Big|_{c=0} = -\frac{\omega_B}{\tau} S + \int \left[\cancel{\frac{\partial \mathcal{L}}{\partial g_{\mu\nu}}} g_{\mu\nu} + \cancel{\frac{\partial \mathcal{L}}{\partial \phi}}^{\,0} \cdots \right]$$

$$S_{cl} = 0 \qquad (\omega_B \neq 0)$$

$$P_{eff} \sim S_{cl} = 0$$

$$\mathcal{L}_b = e^{-\omega_b c} \mathcal{L}(g_{\mu\nu} e^{sc}, \phi_c)$$

$$S_{cl} = \underbrace{\left(1 - \frac{\omega_b}{\omega_B}\right)}_{0 \text{ if } \omega_b = \omega_B} \int \mathcal{L}_b$$


Scale Inv. plays a key
role in 4D flatness

Scale Inv. plays a key role in 4D flatness

6D Model

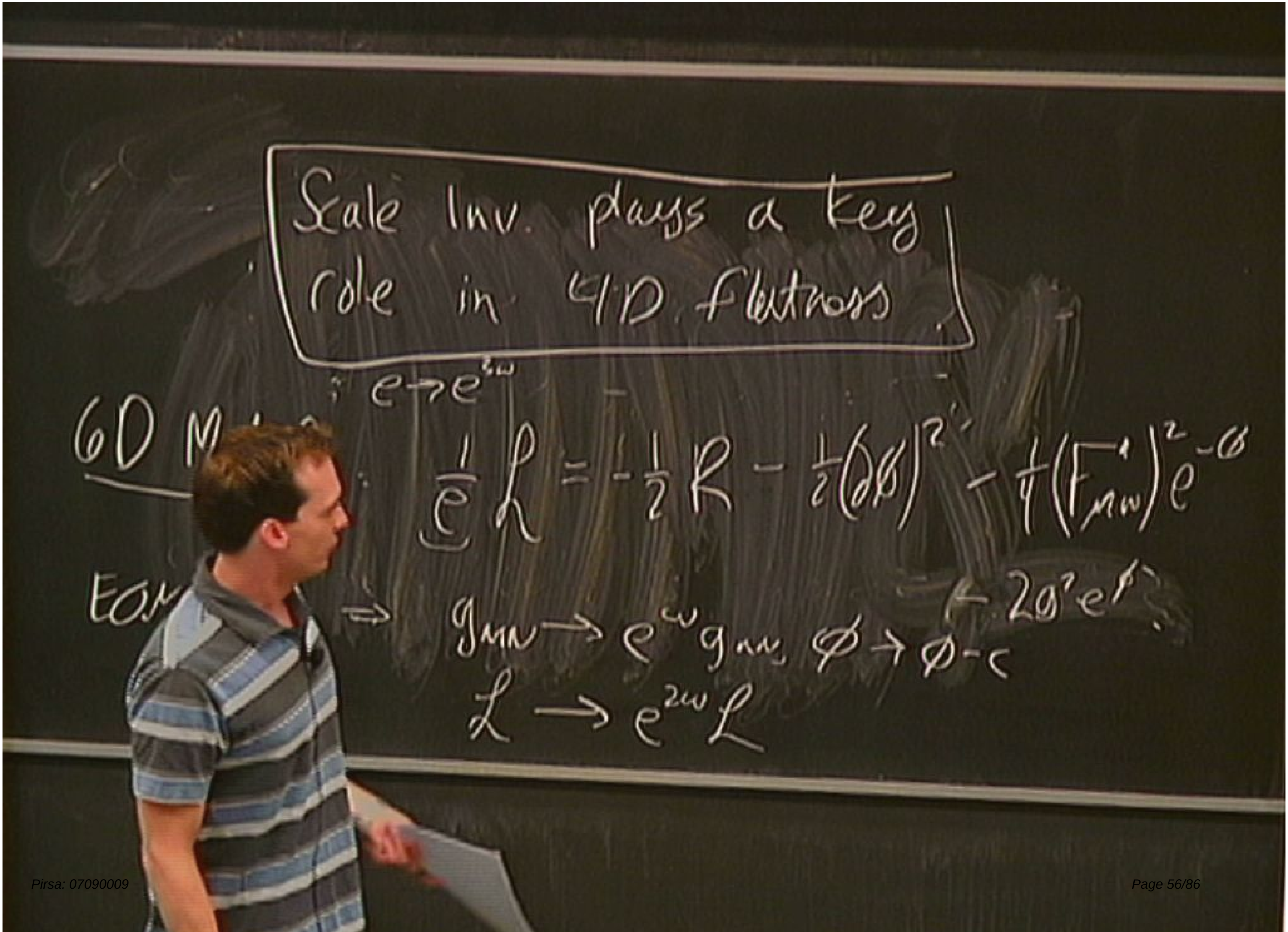
$$\frac{1}{e}\mathcal{L} = -\frac{1}{2}R - \frac{1}{2}(\partial\sigma)^2 - \frac{1}{4}(F_{\mu\nu})^2 e^{-\sigma} - 2g^2 e^{\sigma}$$

$$\boxed{\text{Scale Inv. plays a key role in 4D flatness}}$$

6D Model

$$\frac{1}{e}\mathcal{L} = -\frac{1}{2}R - \frac{1}{2}(\partial\phi)^2 - \frac{1}{4}(F_{MN})^2 e^{-\phi} - 2g^2 e^{\phi}$$

EOM invar. $\Rightarrow$ $g_{MN} \to e^{\omega} g_{MN}$, $\phi \to \phi - c$


Scale Inv. plays a key
role in 4D flatness
$e \to e^{2\omega}$
6D
$\frac{1}{e}\mathcal{L} = -\frac{1}{2}R - \frac{1}{2}(\partial\phi)^2 - \frac{1}{4}(F_{MN})^2 e^{-\phi}$
$-2g^2 e^{\phi}$
EOM $\Rightarrow$
$g_{MN} \to e^{\omega} g_{MN}, \; \phi \to \phi - c$
$\mathcal{L} \to e^{2\omega}\mathcal{L}$

$$\boxed{\text{Scale Inv. plays a key role in 4D flatness}}$$

$e \to e^{3\omega}$

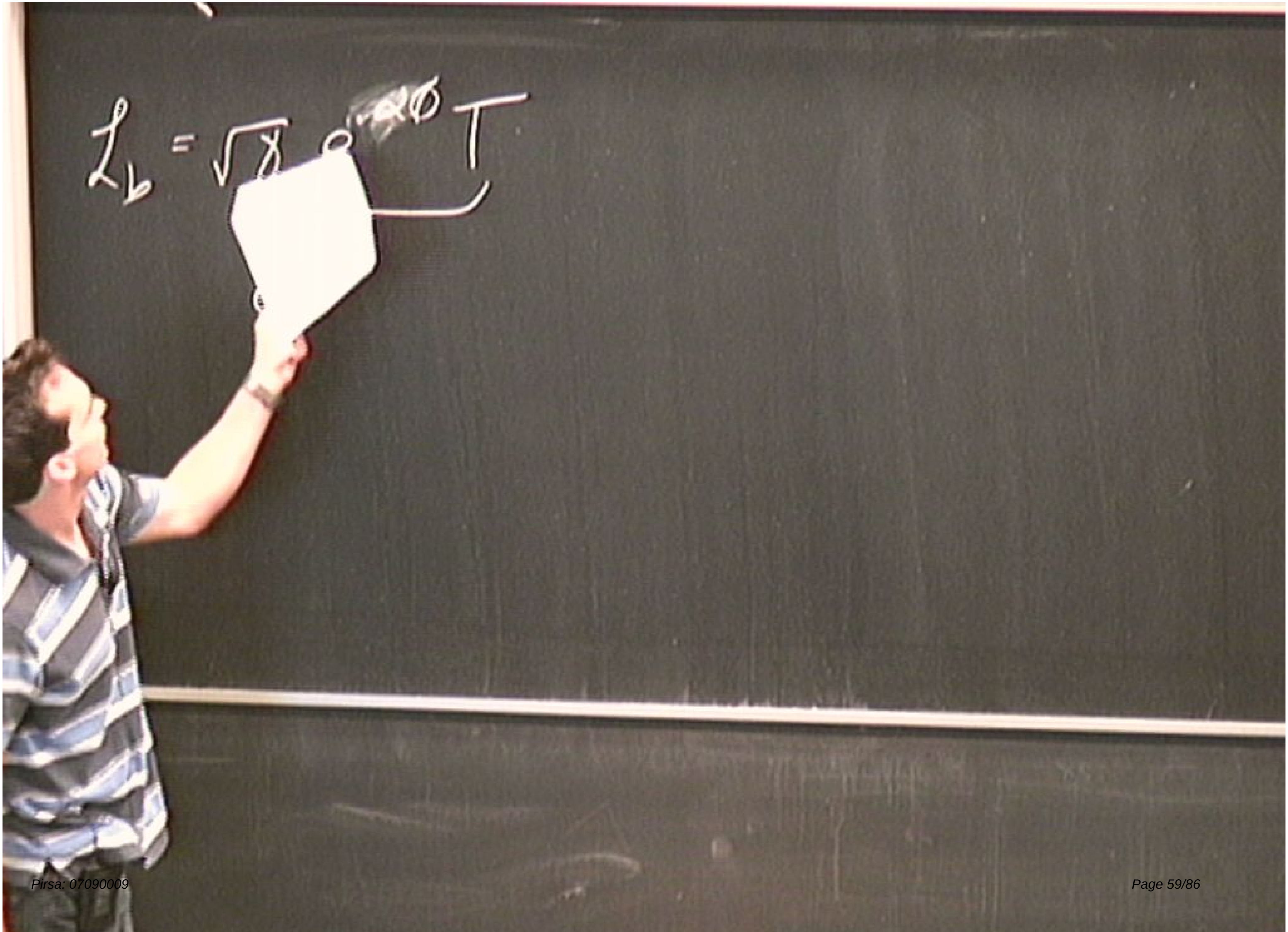
6D Model

$$\frac{1}{e}\mathcal{L} = -\frac{1}{2}R - \frac{1}{2}(\partial\phi)^2 - \frac{1}{4}(F_{MN})^2 e^{-\phi} - 2g^2 e^{\phi}$$

EOM invar. $\Rightarrow$ $g_{MN} \to e^{\omega} g_{MN}$, $\phi \to \phi - \omega$

$$\mathcal{L} \to e^{2\omega}\mathcal{L}$$

$$\mathcal{L}_b = \sqrt{\gamma}\, e^{-\alpha\phi}\, T$$


$\mathcal{L}_\nu = \sqrt{\gamma}\, e^{-\alpha\phi}\, T$

$$\mathcal{L}_b = \underbrace{\sqrt{\gamma}\, e^{-\alpha\phi}\, T}_{e^{\frac{\alpha}{2}\omega - \alpha c}}$$

$$\mathcal{L}_b = \underbrace{\sqrt{\gamma}\, e^{\alpha\phi}\, T}_{e^{\frac{4}{2}\omega - \alpha c}}$$

<u>5D</u> : scale inv $\Rightarrow$

$$\mathcal{L}_b = \underbrace{\sqrt{\gamma}\, e^{-\alpha\phi}\, T}_{e^{\frac{d}{2}\omega - \alpha \omega}}$$

$\underline{5D}$: scale inv $\Rightarrow$ $\alpha = \frac{1}{2}$

4

$$\mathcal{L}_b = \underbrace{\sqrt{\gamma}\, e^{-\alpha\phi}\, T}_{e^{\frac{3}{2}\omega - \alpha\phi}}$$

$\underline{5D}$: scale inv $\Rightarrow$ $\alpha = \frac{1}{2}$

$\underline{4D}$

$$\mathcal{L}_b = \underbrace{\sqrt{\gamma}\, e^{-\alpha\phi}\, T}_{e^{\frac{d}{2}\omega - \alpha\omega}}$$

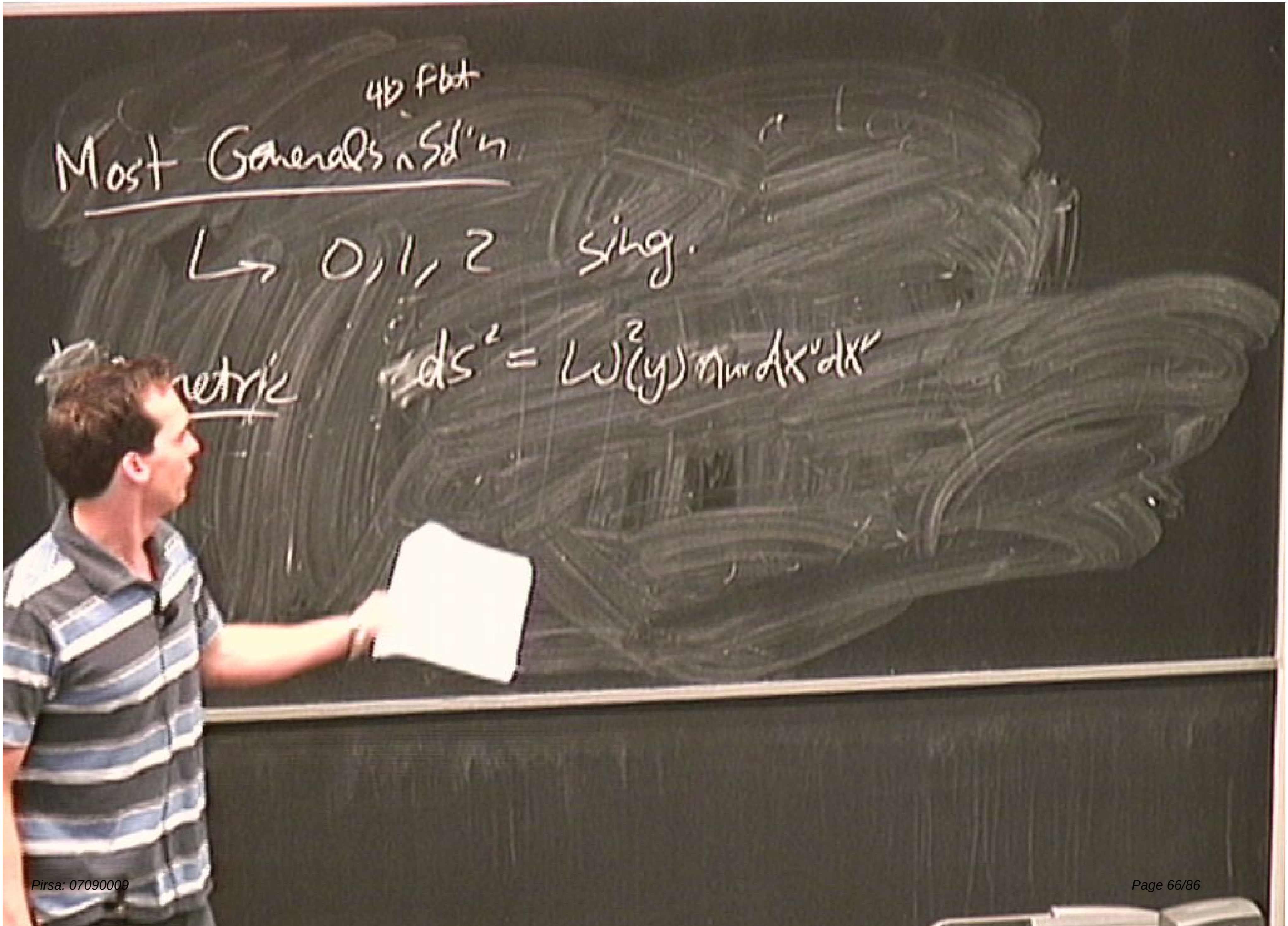
<u>5D</u> : scale inv $\Rightarrow$ $\alpha = \frac{1}{2}$

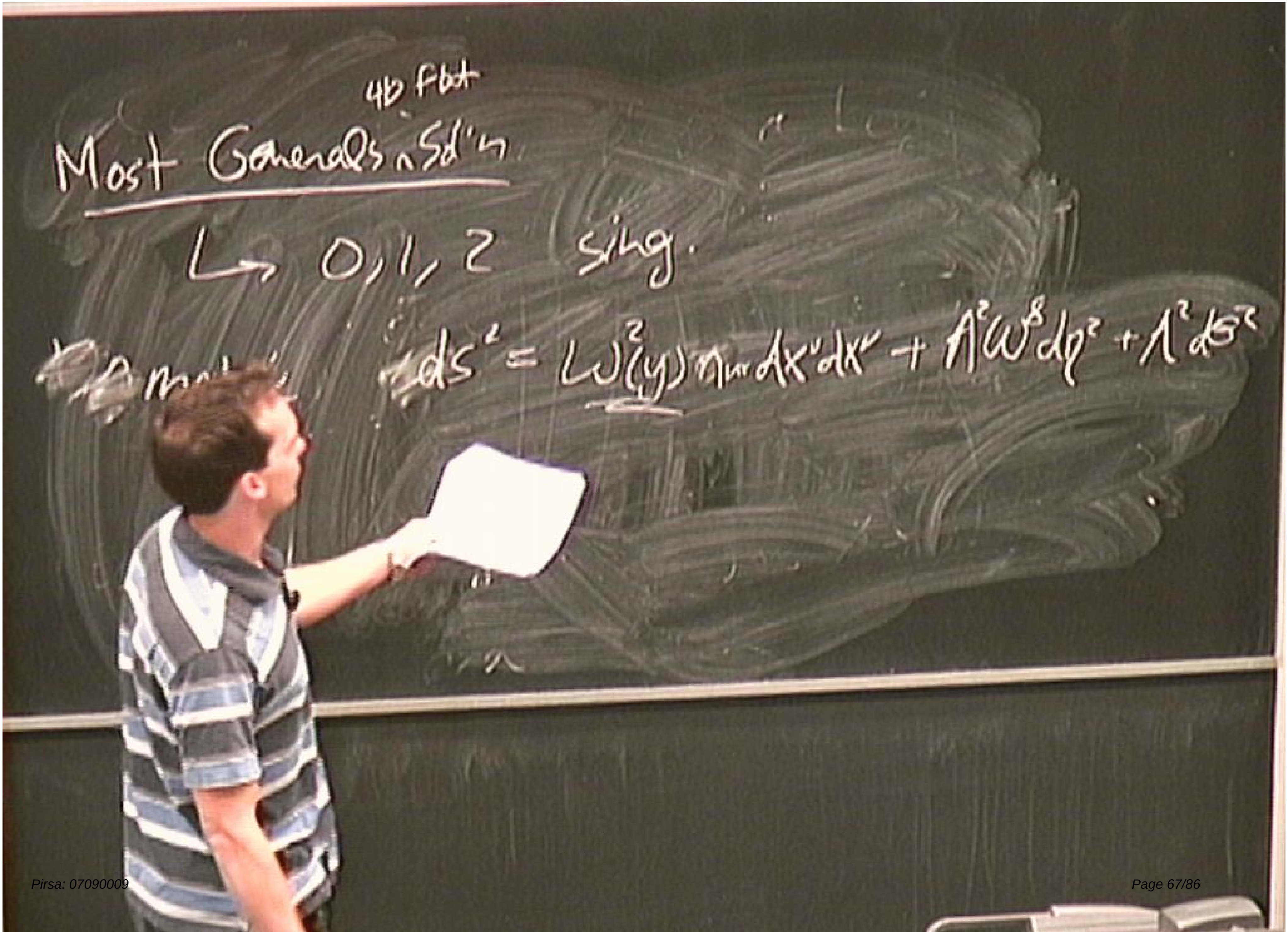
<u>4D</u> " $\Rightarrow$ $\alpha = 0$

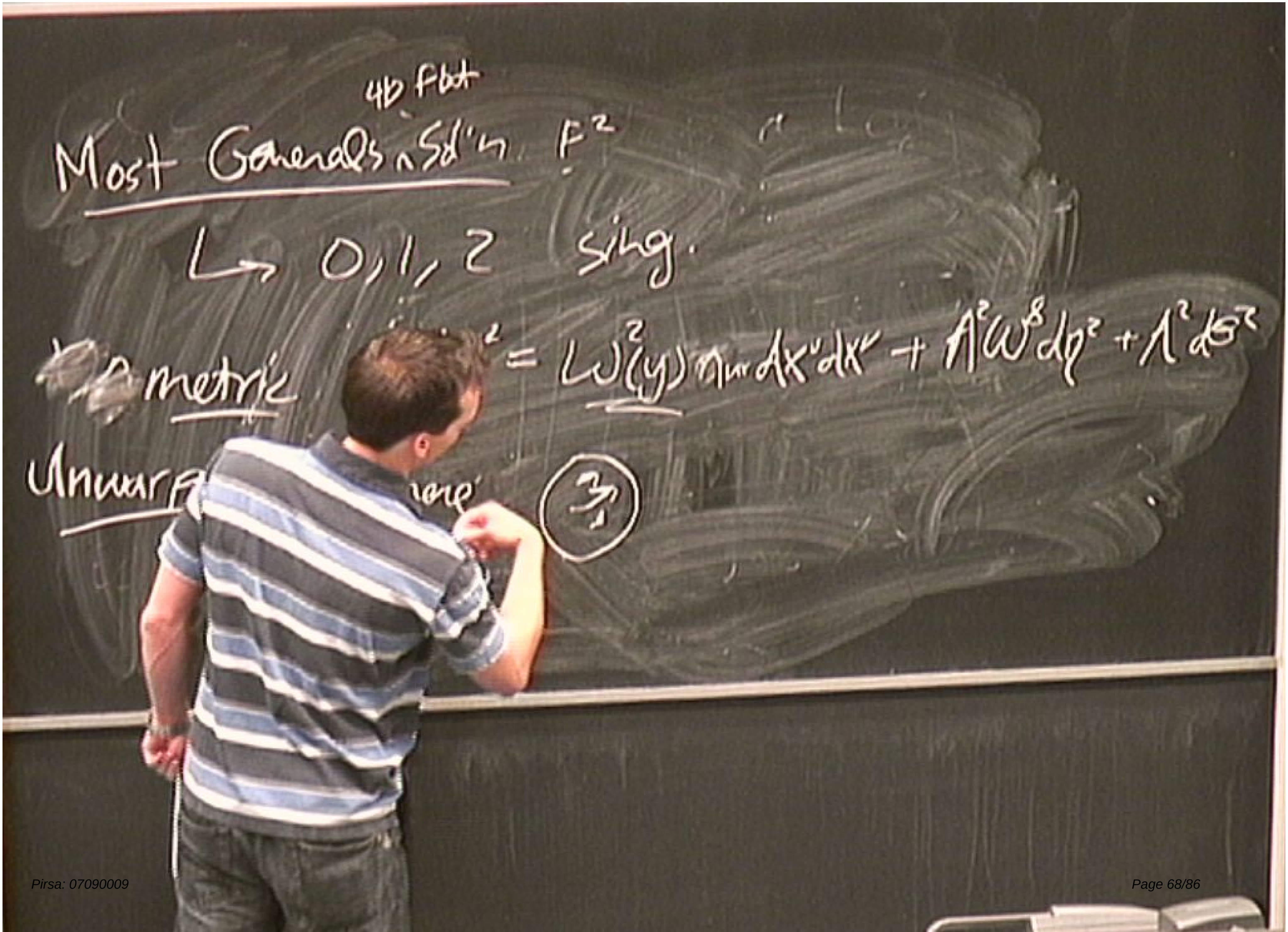
4D Fbst

Most General Sol'n

$\hookrightarrow$ 0, 1, 2 sing.


4D flat
Most General Sol'n
0, 1, 2 sing.
etric
$ds^2 = \omega^2(y)\,\eta_{\mu\nu}\,dx^\mu dx^\nu$


4D flat
Most General Sol'n
↳ 0, 1, 2 sing.
ds² = ω²(y) η_{μν} dx^μ dx^ν + λ²ω⁸ dρ² + λ² ds²


4D flat
Most General Sol'n F^2
$\hookrightarrow$ 0, 1, 2 sing.
metric
$= L\omega^2(y)\,\eta_{\mu\nu}dx^\mu dx^\nu + \Lambda^2\omega^8 d\rho^2 + \Lambda^2 d\sigma^2$

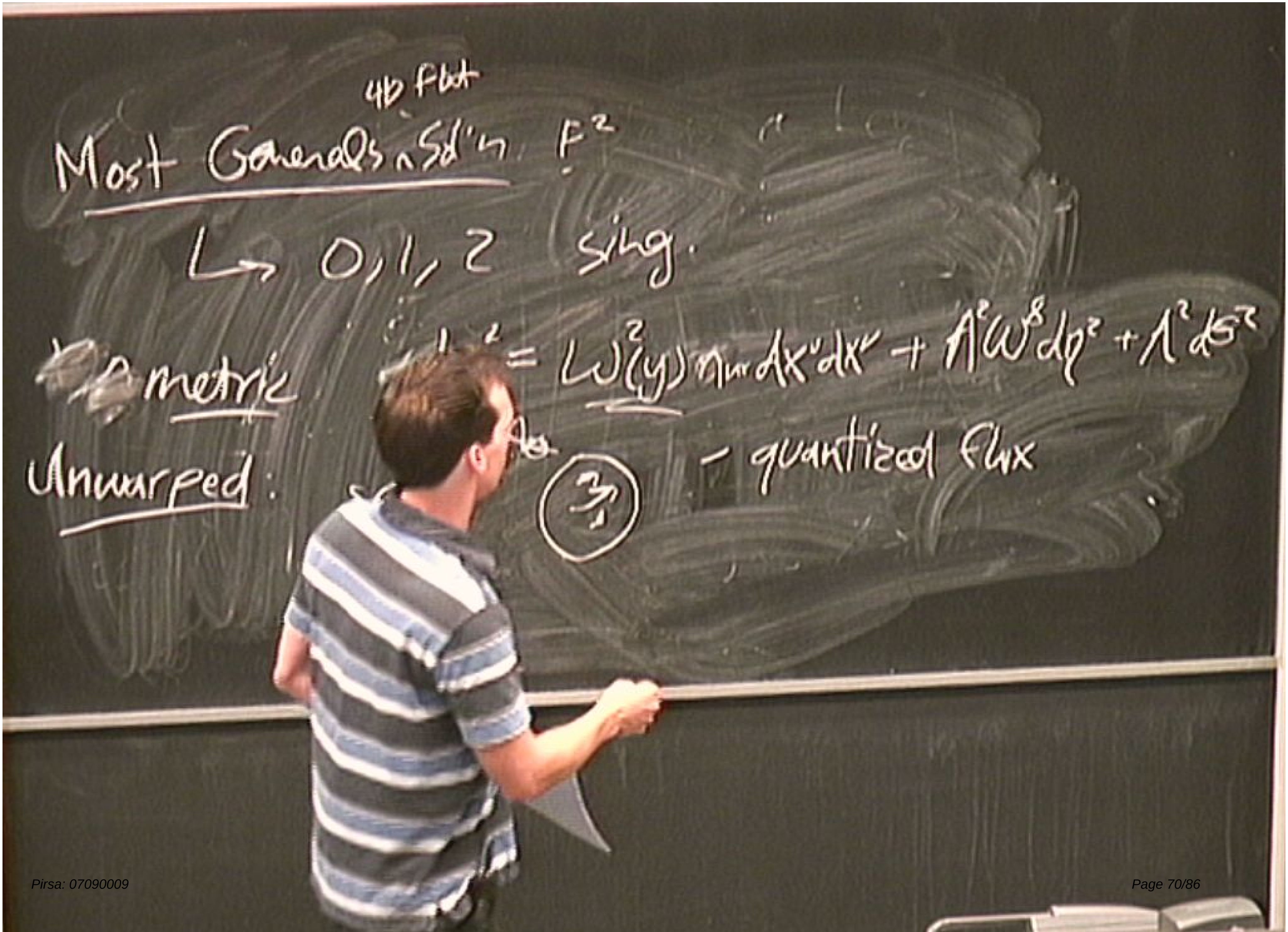
4D Pl'ot

Most General Sol'n F^2

$\hookrightarrow$ 0, 1, 2 sing.

metric $ds^2 = L\omega^2(y)\,\eta_{\mu\nu}\,dx^\mu dx^\nu + \Lambda^2\omega^8 d\rho^2 + \Lambda^2 d\Omega^2$

Unwarped: sphere


4D flat
Most General Sol'n F^2
$\hookrightarrow$ 0, 1, 2 sing.
metric $ds^2 = L\,\omega^2(y)\,\eta_{\mu\nu}\,dx^\mu dx^\nu + \Lambda^2 \omega^8 d\rho^2 + \Lambda^2 d\tilde{s}^2$
Unwarped:
quantized flux

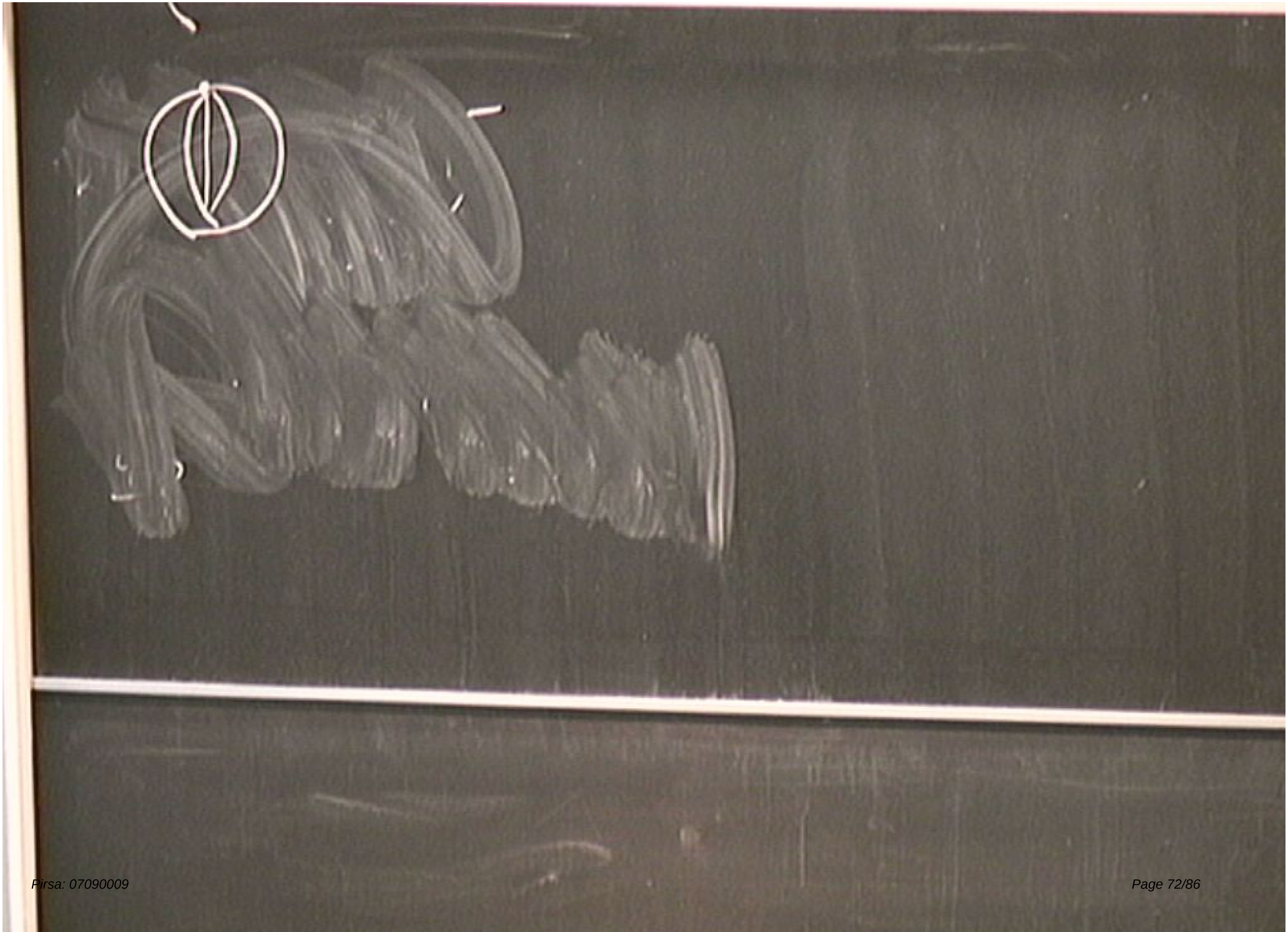
4D flat

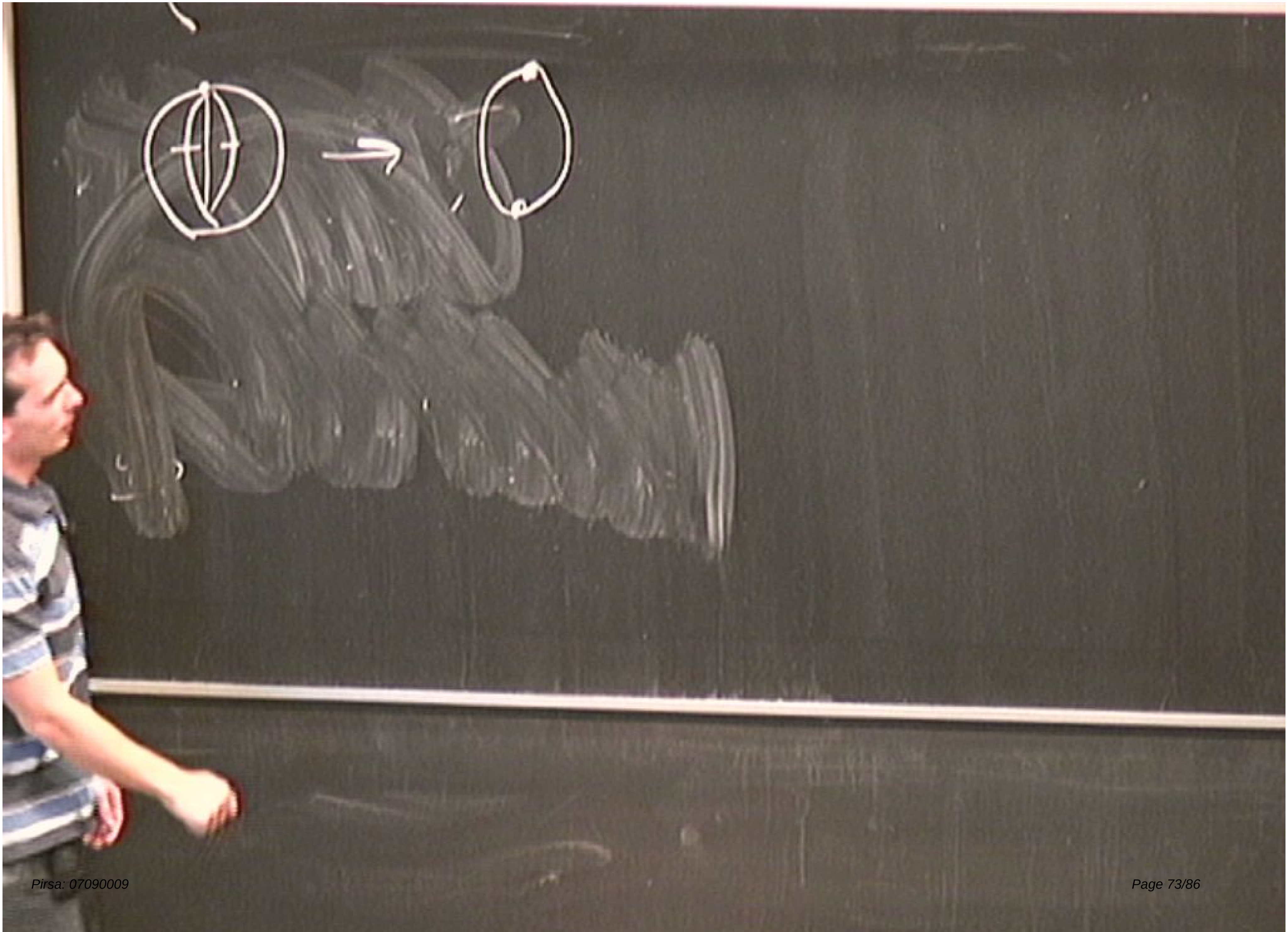
Most General Sol'n F^2

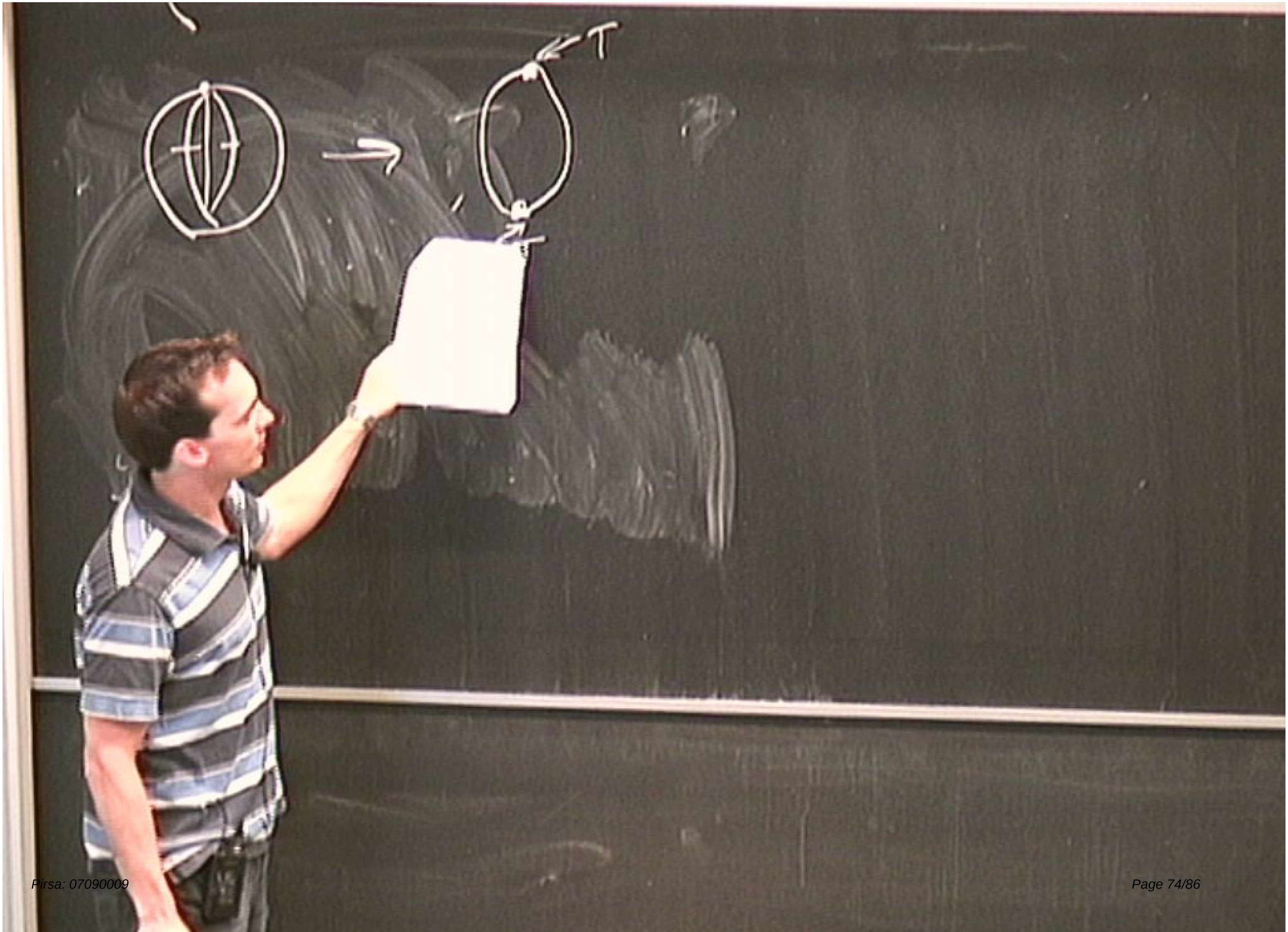
$\hookrightarrow$ 0, 1, 2 sing.

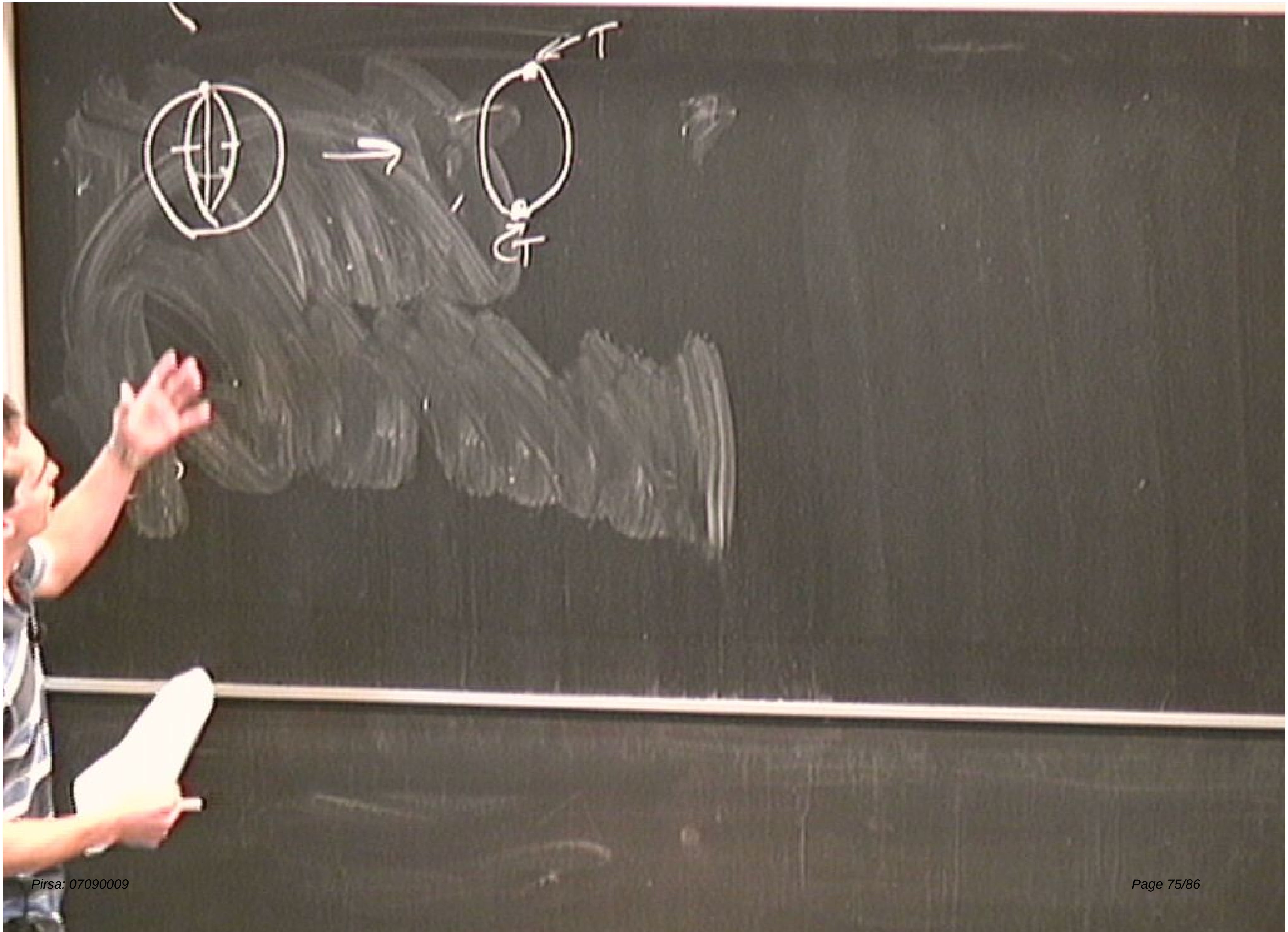
metric $ds^2 = W^2(y)\,\eta_{\mu\nu}\,dx^\mu dx^\nu + r_0^2 W^8 dy^2 + \lambda^2 d\xi^2$

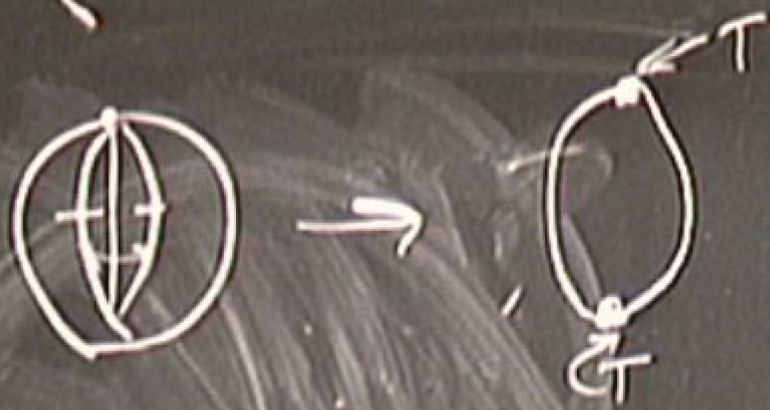
Unwarped: sphere 3/1 - quantized flux
- ϕ const.
- 3* parameters







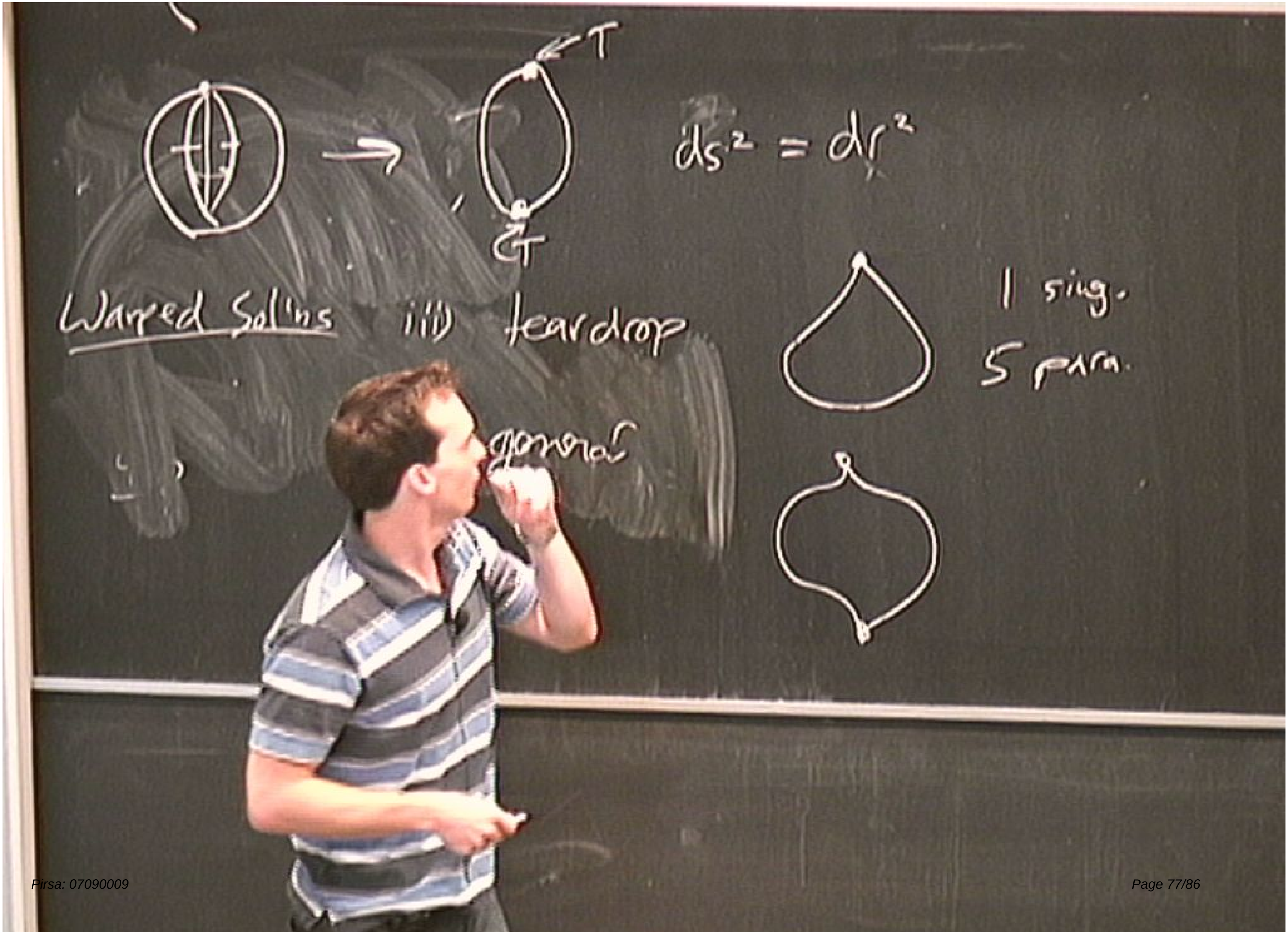

T
T

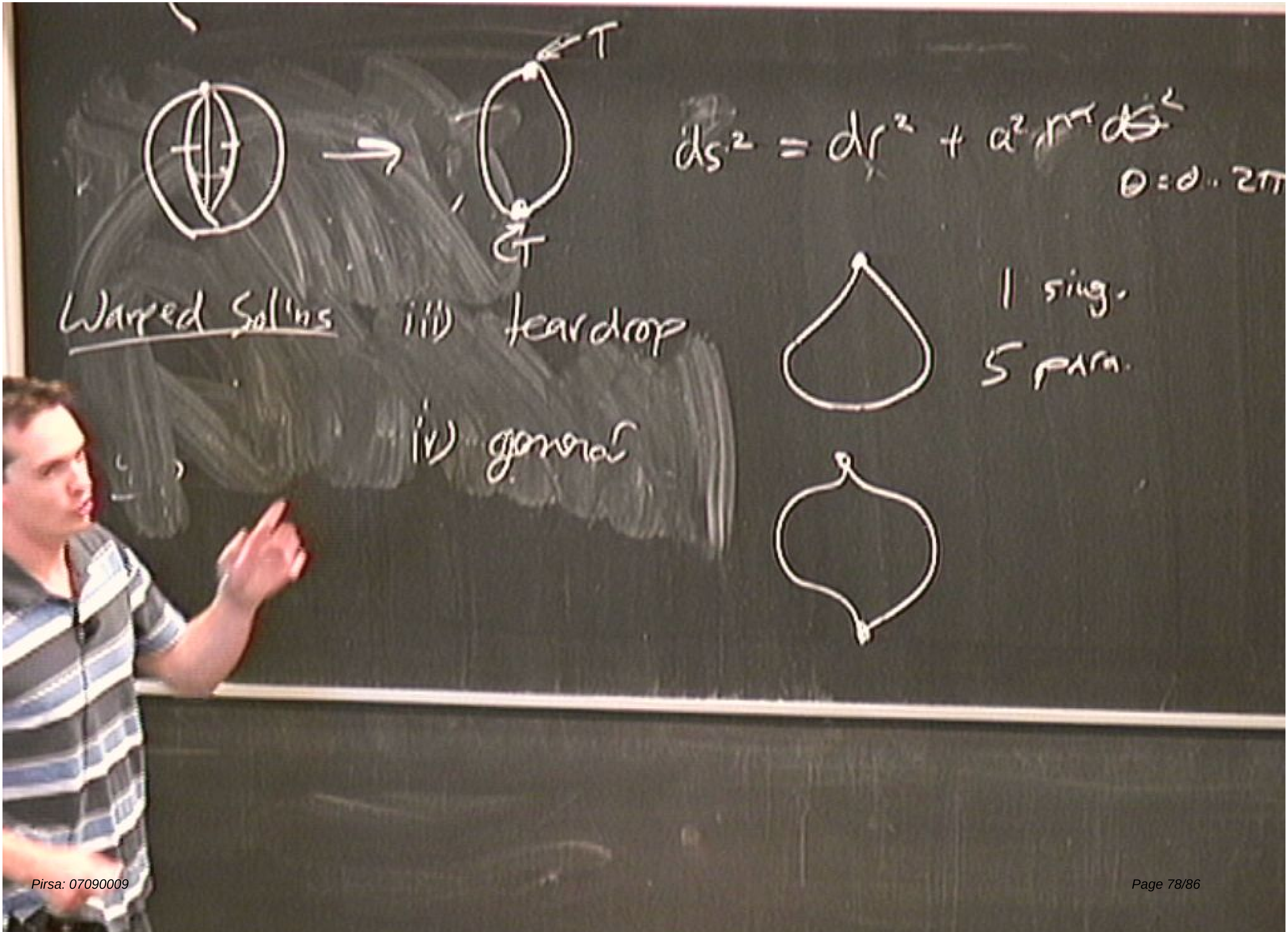


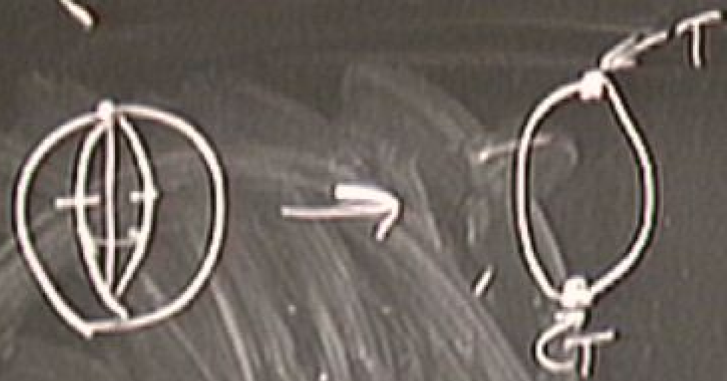
<u>Warped Sol'ns</u>   iii) teardrop

1 sing.
5 para.

iv) general


T
T
ds² = dr²
Warped Sol'ns
iii) teardrop
1 sing.
5 para.
general


T
T
ds² = dr² + a² r^? dθ²
θ = 0 .. 2π
Warped Sol'ns
iii) teardrop
1 sing.
5 param.
iv) general



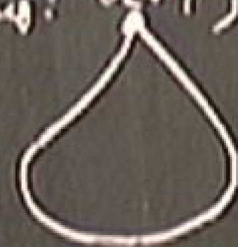
$$ds^2 = dr^2 + a^2 r^\tau d\theta^2 \qquad \theta = 0 .. 2\pi$$

no sing: $a = 1,\ \tau = 2$

conical sing: $a \neq 1,\ \alpha = 2$

Warped Sol'ns

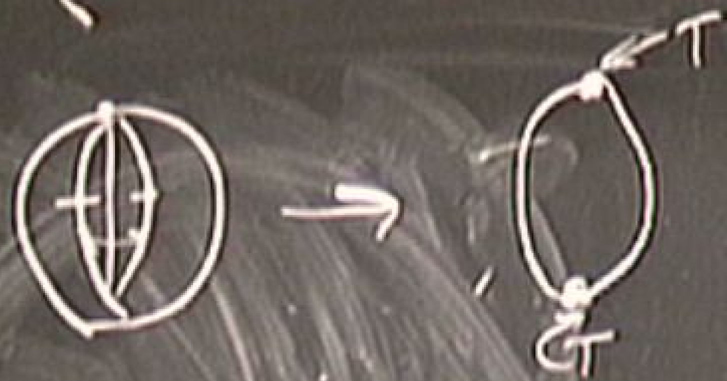
iii) teardrop



1 sing.

5 param.

iv) general



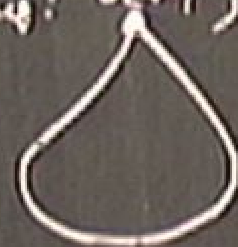
$$ds^2 = dr^2 + \alpha^2 r^\tau d\theta^2 \qquad \theta = 0 .. 2\pi$$

no sing: $\alpha = 1, \tau = 2$

conical sing: $\alpha \neq 1, \alpha = 2$

Warped Sol'ns

iii) teardrop



1 sing.

5 param.

iv) general

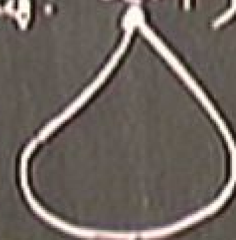
$$ds^2 = dr^2 + \alpha^2 r^\tau d\theta^2 \qquad \theta = 0 .. 2\pi$$

no sing: $\alpha = 1, \tau = 2$

conical sing: $\alpha \neq 1, \tau = 2$

Warped Sol'ns

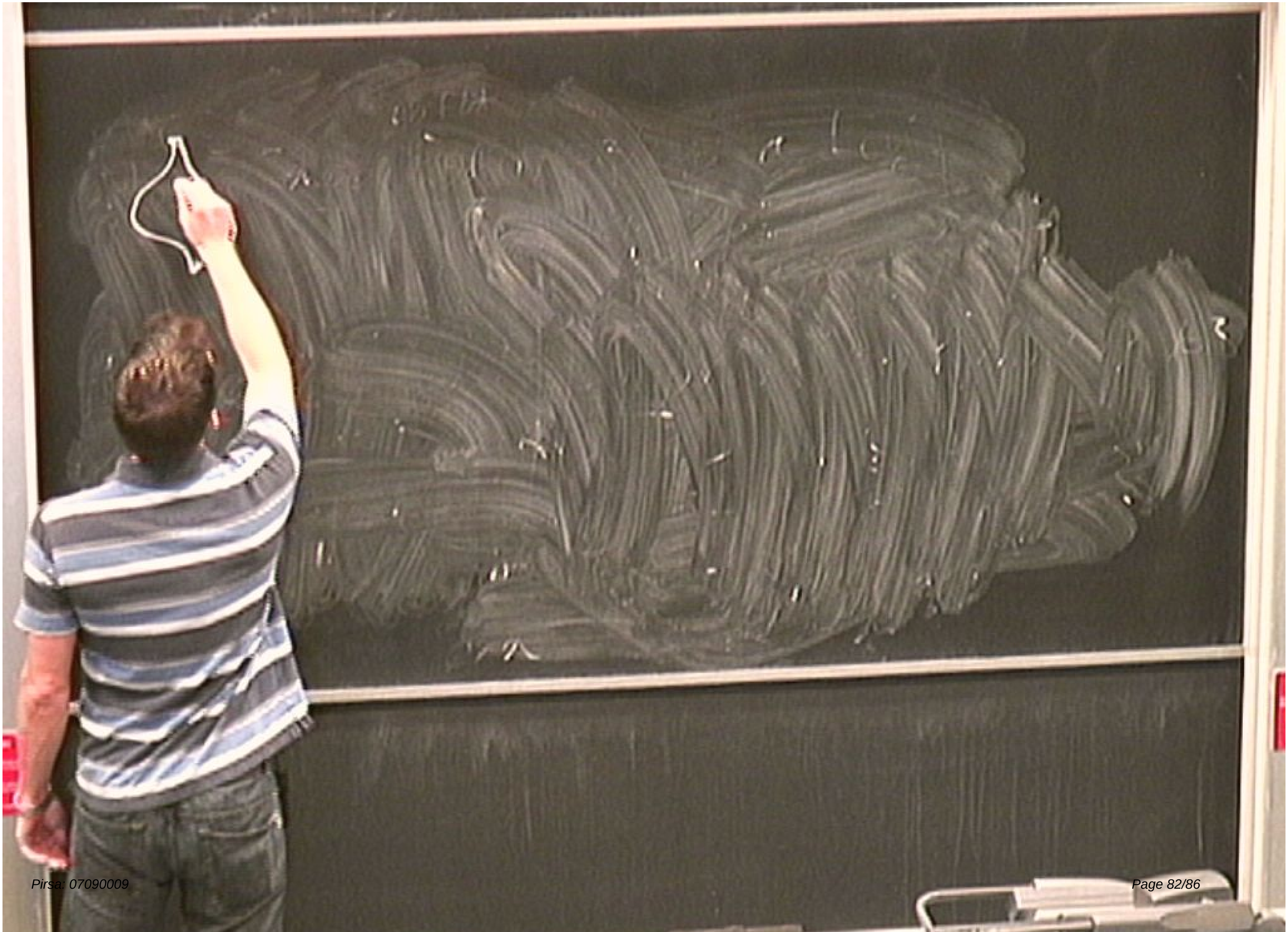
iii) teardrop

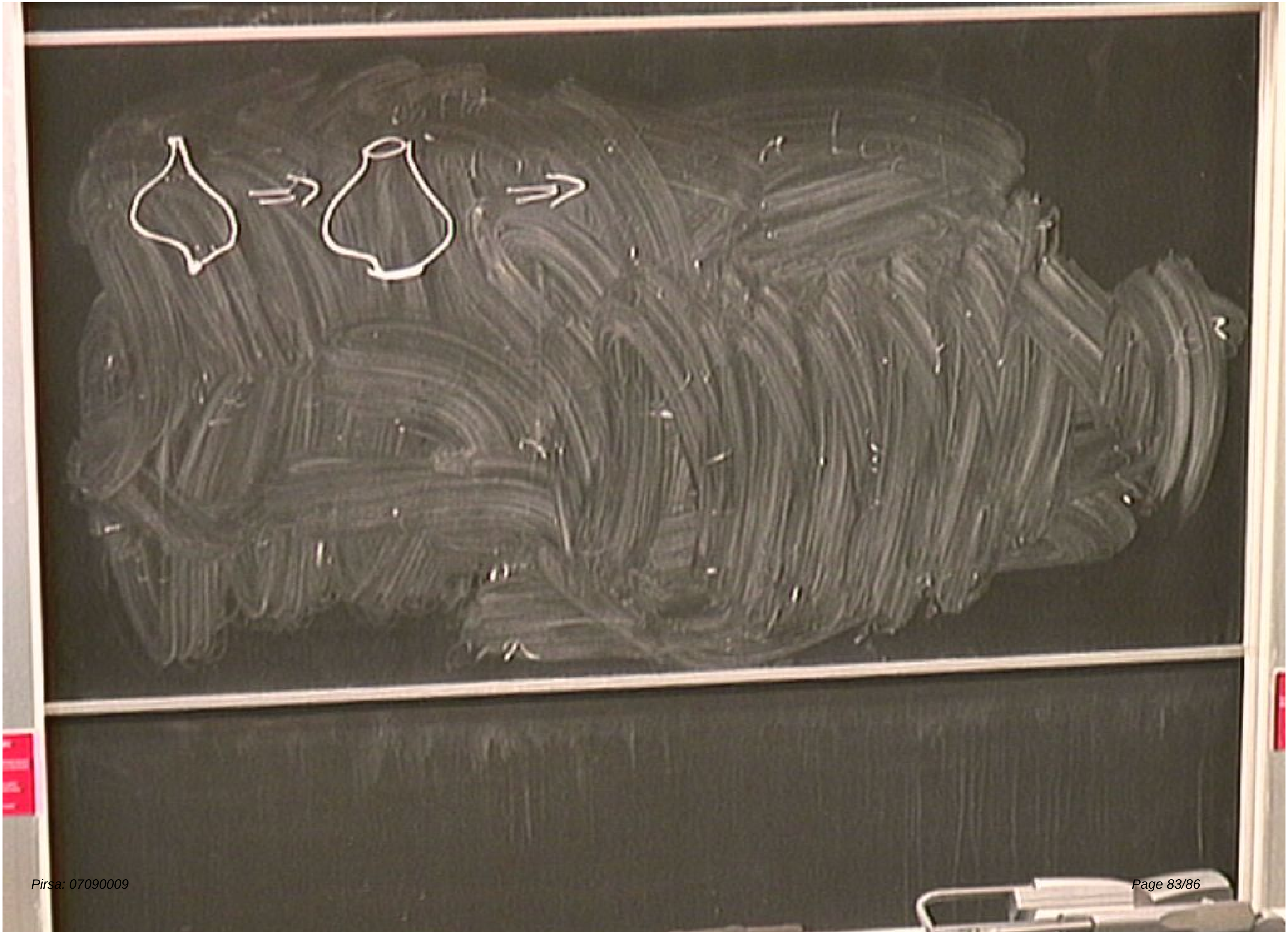


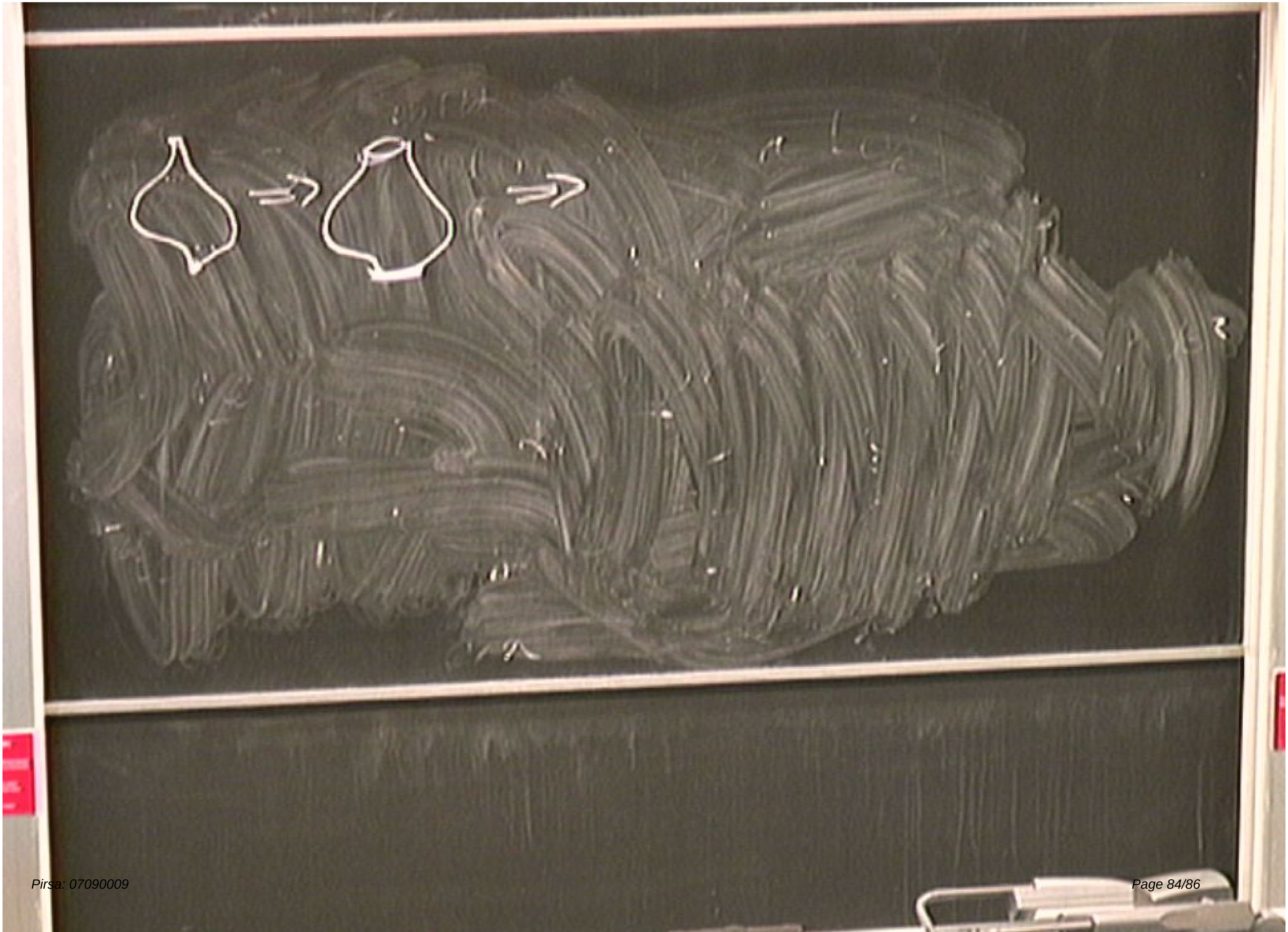
1 sing.

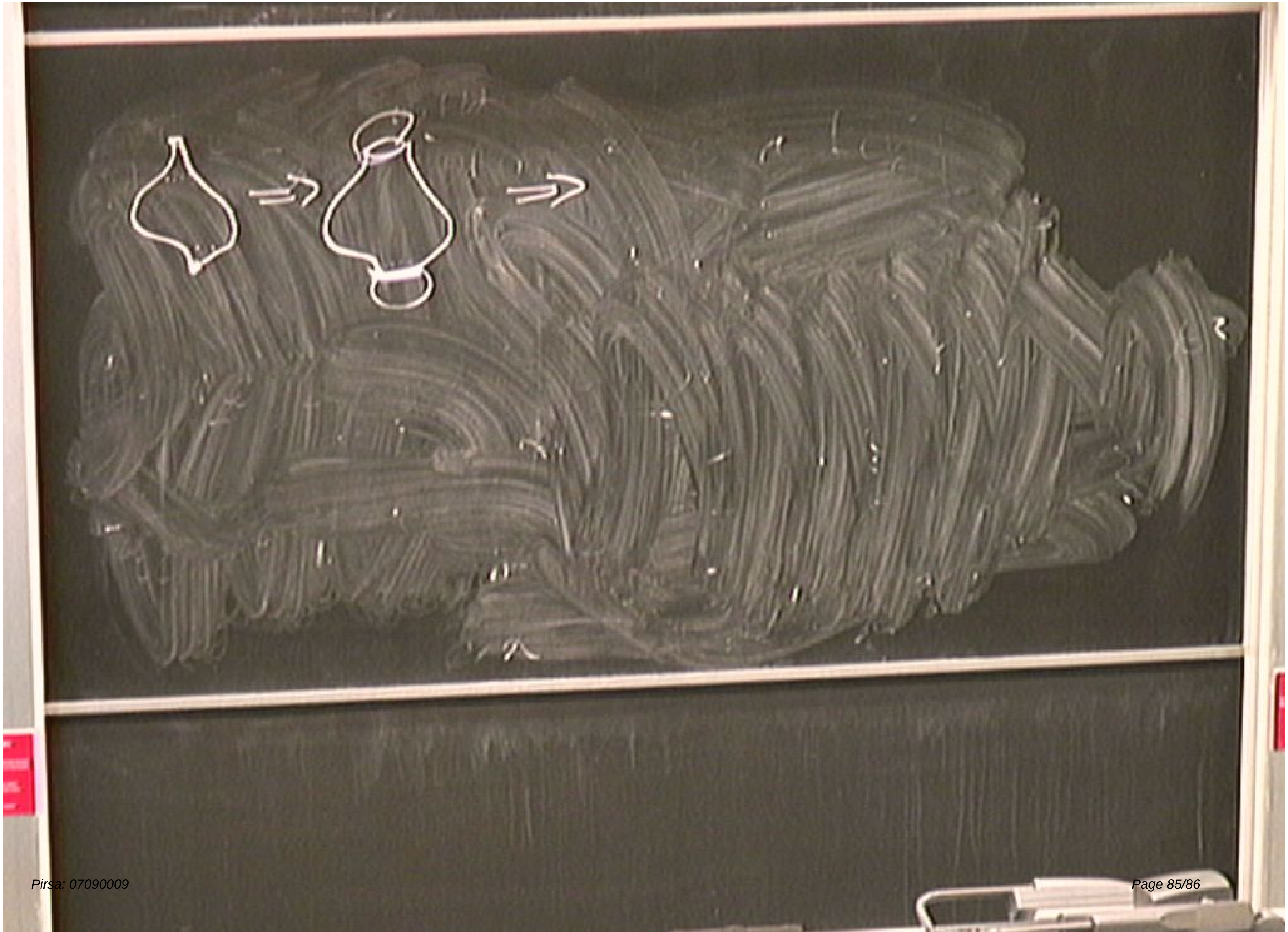
5 parm.

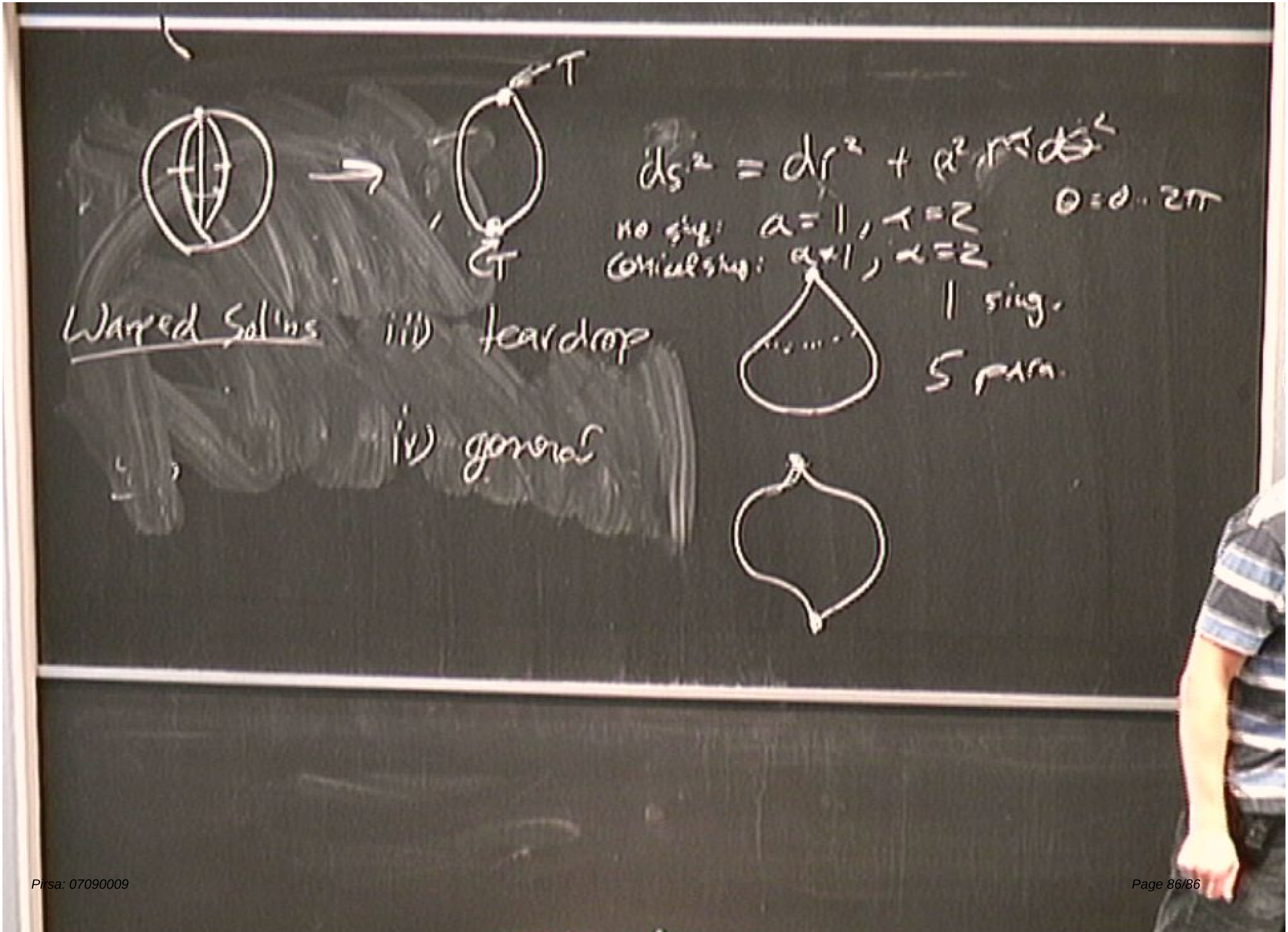
iv) general










T
ds² = dr² + α² r^τ dθ²
θ = 0 .. 2π
no sing: α = 1, τ = 2
conical sing: α ≠ 1, α = 2
Warped Sol'ns
iii) teardrop
1 sing.
5 param.
iv) general