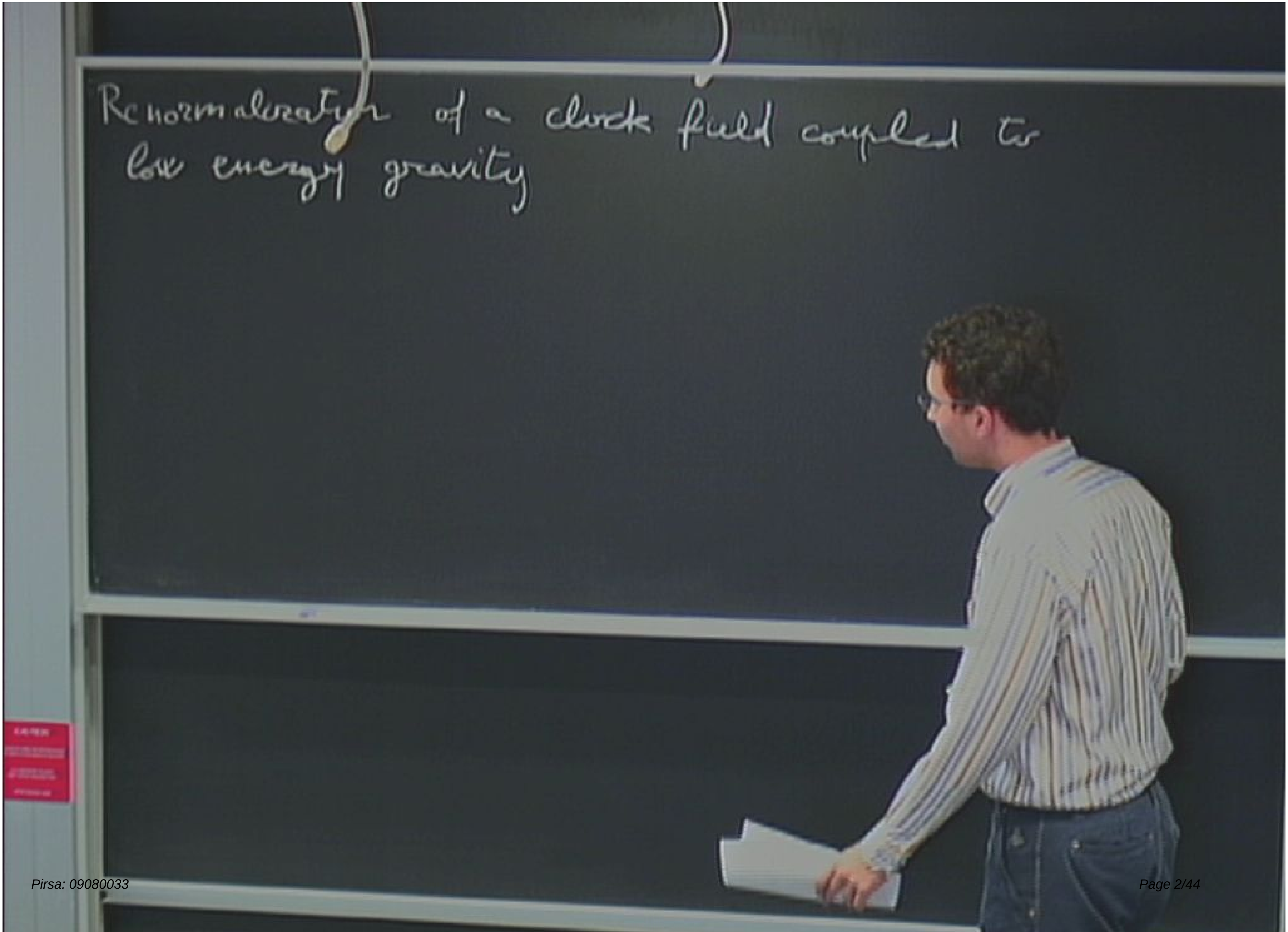
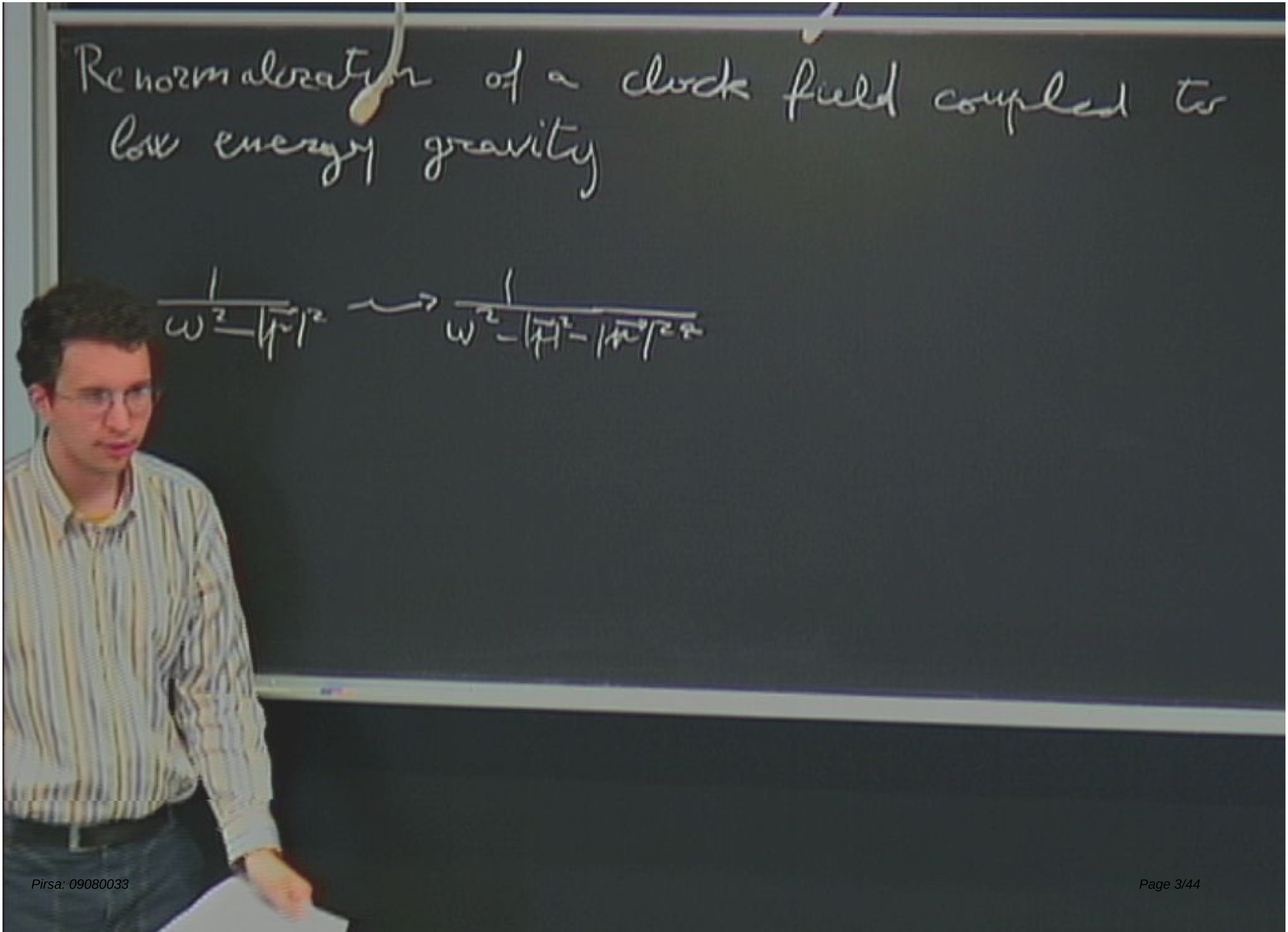
Title: Undergrad Research Project Talk

Date: Aug 20, 2009 03:00 PM

URL: http://pirsa.org/09080033

Abstract:


Renormalization of a clock field coupled to
low energy gravity

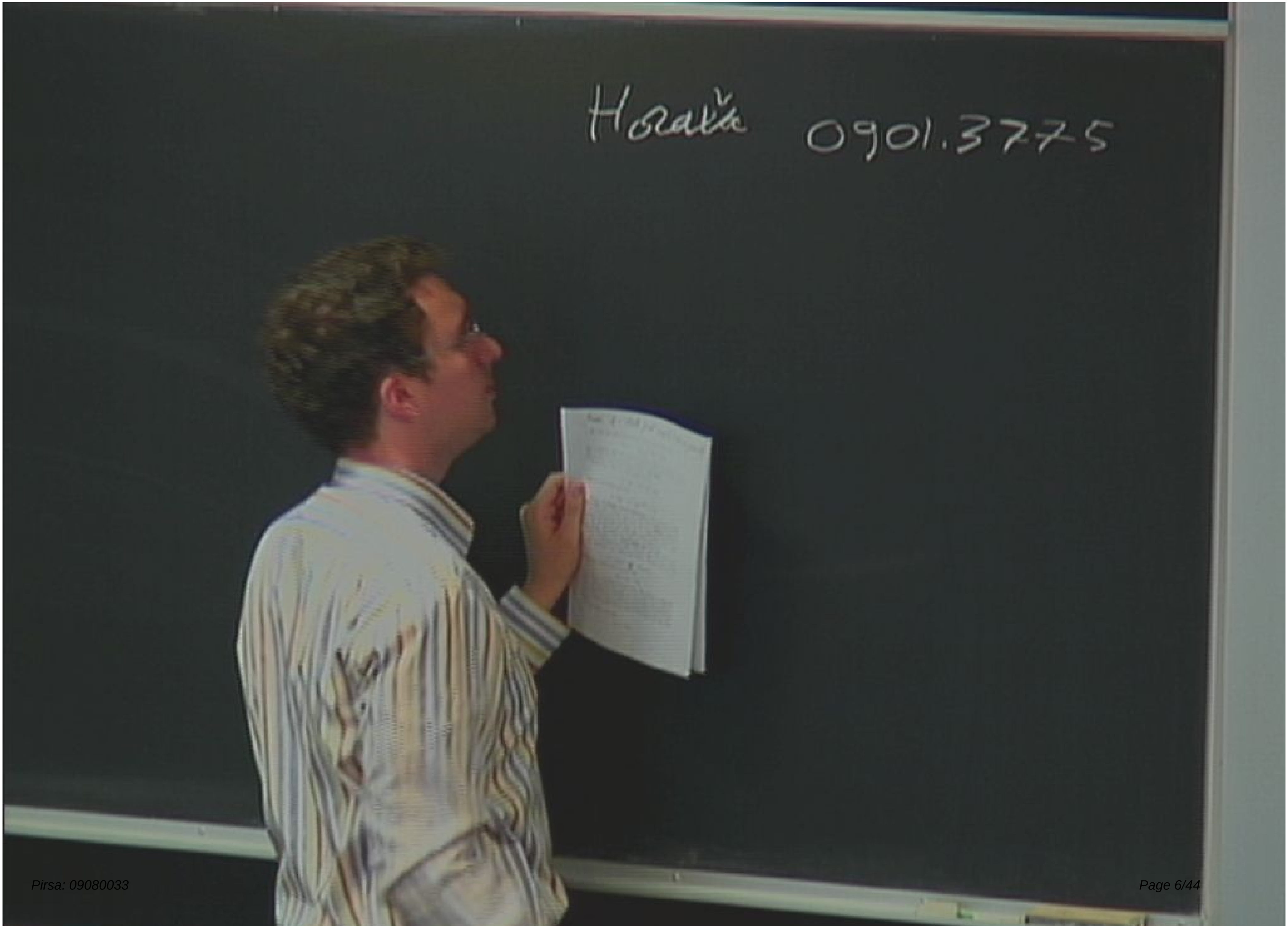

Renormalization of a clock field coupled to low energy gravity
$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^{2z}}$

Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^{2z}}$$

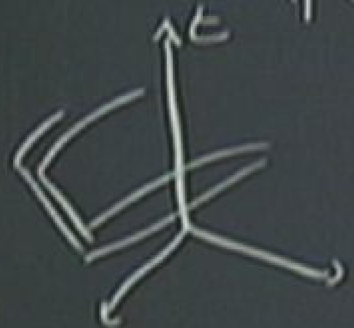
Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{k}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{k}|^2 - |\vec{k}|^{2z}}$$


Hořava 0901.3775

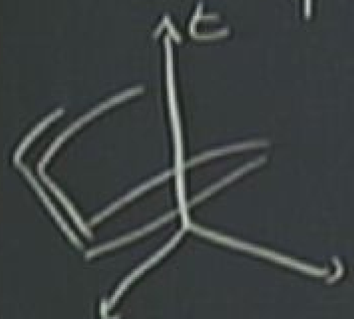
Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^{2z}}$$



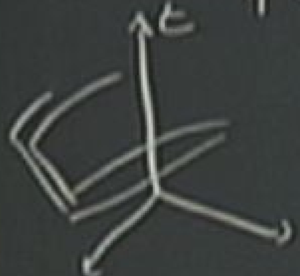
Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^{2z}} \approx \frac{1}{p_\mu p^\mu - \alpha\left(h_{\mu\nu} p^\mu p^\nu\right)^z}$$



Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^2 \alpha} \approx \frac{1}{p_\mu p^\mu - \alpha (h_{\mu\nu} p^\mu p^\nu)^2}$$

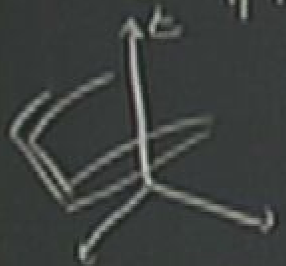


$$h_{\mu\nu} = g_{\mu\nu} + n_\mu n_\nu$$

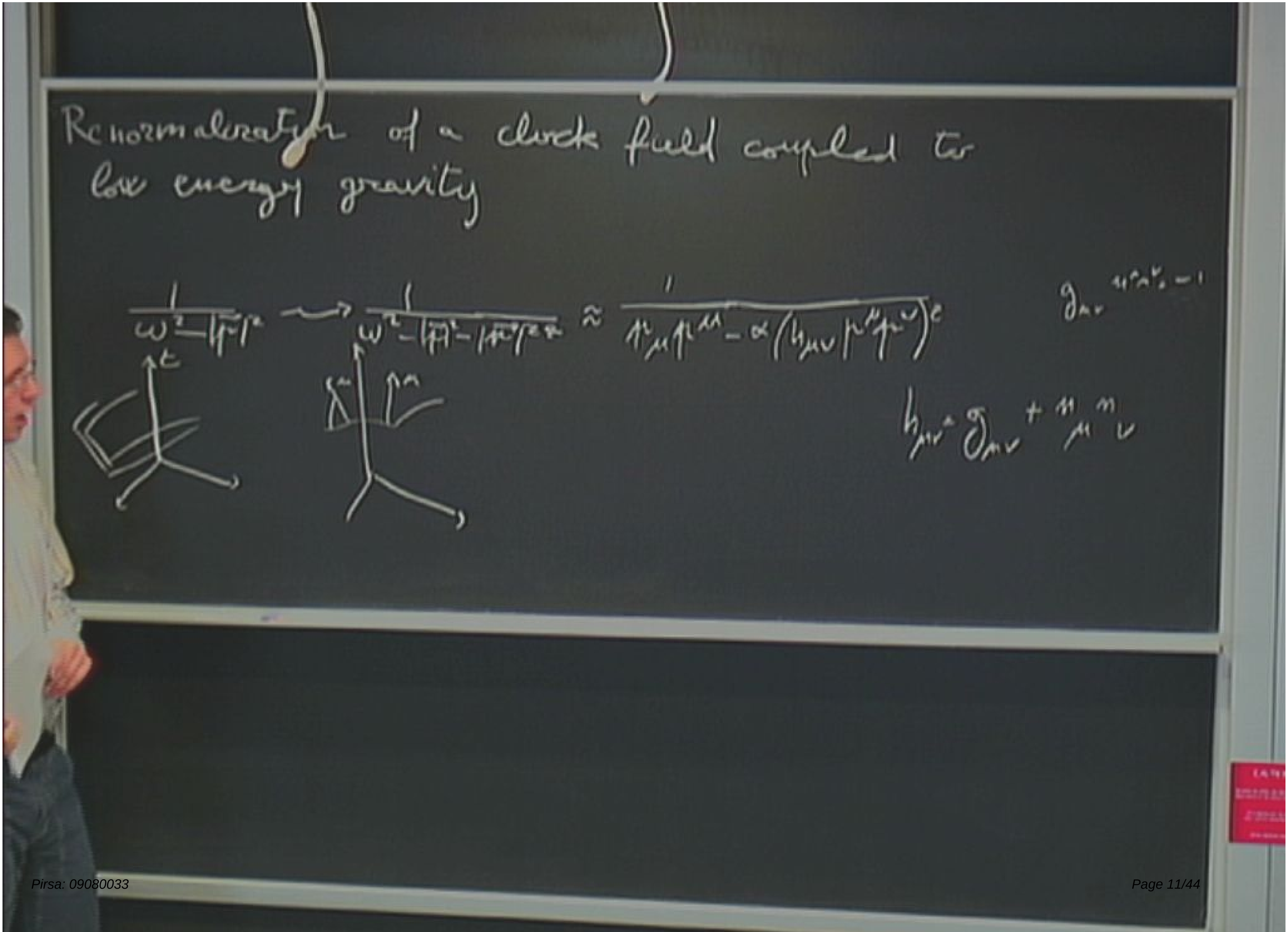
Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^4/E^2} \approx \frac{1}{p_\mu p^\mu - \alpha\left(h_{\mu\nu} p^\mu p^\nu\right)^2}$$

$g_{\mu\nu} \quad u^\mu u^\nu = 1$



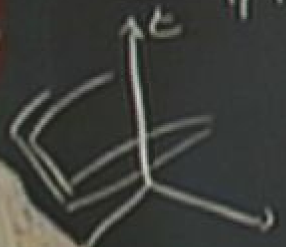
$h_{\mu\nu} = g_{\mu\nu} + u_\mu u_\nu$

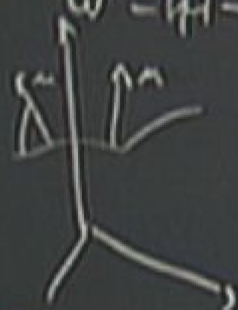

Renormalization of a clock field coupled to
low energy gravity

Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |p|^2} \rightsquigarrow \frac{1}{\omega^2 - |p|^2 - |p|^{2+\epsilon}} \approx \frac{1}{p_\mu p^\mu - \alpha\left(h_{\mu\nu} p^\mu p^\nu\right)^{\epsilon}}$$

$$g_{\mu\nu} n^\mu n^\nu = -1$$





$$h_{\mu\nu} = g_{\mu\nu} + n_\mu n_\nu$$

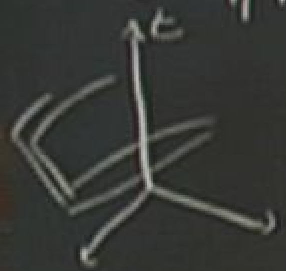
$$n_\mu = -N \partial_\mu \chi$$

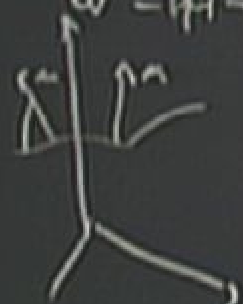
$$\Sigma_t = \{ x : \chi(x) = t \}$$

Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec p|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec p|^2 - |\vec p|^{2+n}} \approx \frac{1}{p_\mu p^\mu - \alpha (h_{\mu\nu} p^\mu p^\nu)^c}$$

$g_{\mu\nu} n^\mu n^\nu = -1$





$h_{\mu\nu} = g_{\mu\nu} + n_\mu n_\nu$

$n_\mu = -N \partial_\mu \chi$

$\Sigma_t = \{x : \chi(x) = t\}$

$K_{\mu\nu} = \mathcal{L}_n g_{\mu\nu} = D_\mu \partial_\nu \chi + D_\nu \partial_\mu \chi$

Renormalization of a clock field coupled to low energy gravity

$$\frac{1}{\omega^2 - |\vec{p}|^2} \rightsquigarrow \frac{1}{\omega^2 - |\vec{p}|^2 - |\vec{p}|^{2z}} \approx \frac{1}{p_\mu p^\mu - \alpha \left(h_{\mu\nu} p^\mu p^\nu\right)^z}$$

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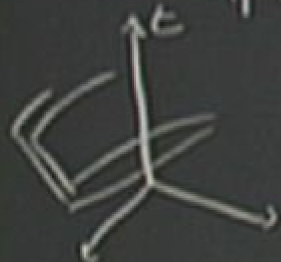

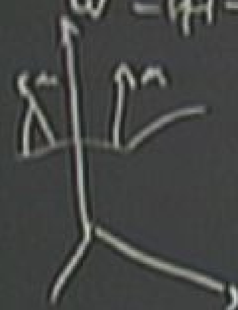

$$h_{\mu\nu} = g_{\mu\nu} + n_\mu n_\nu$$

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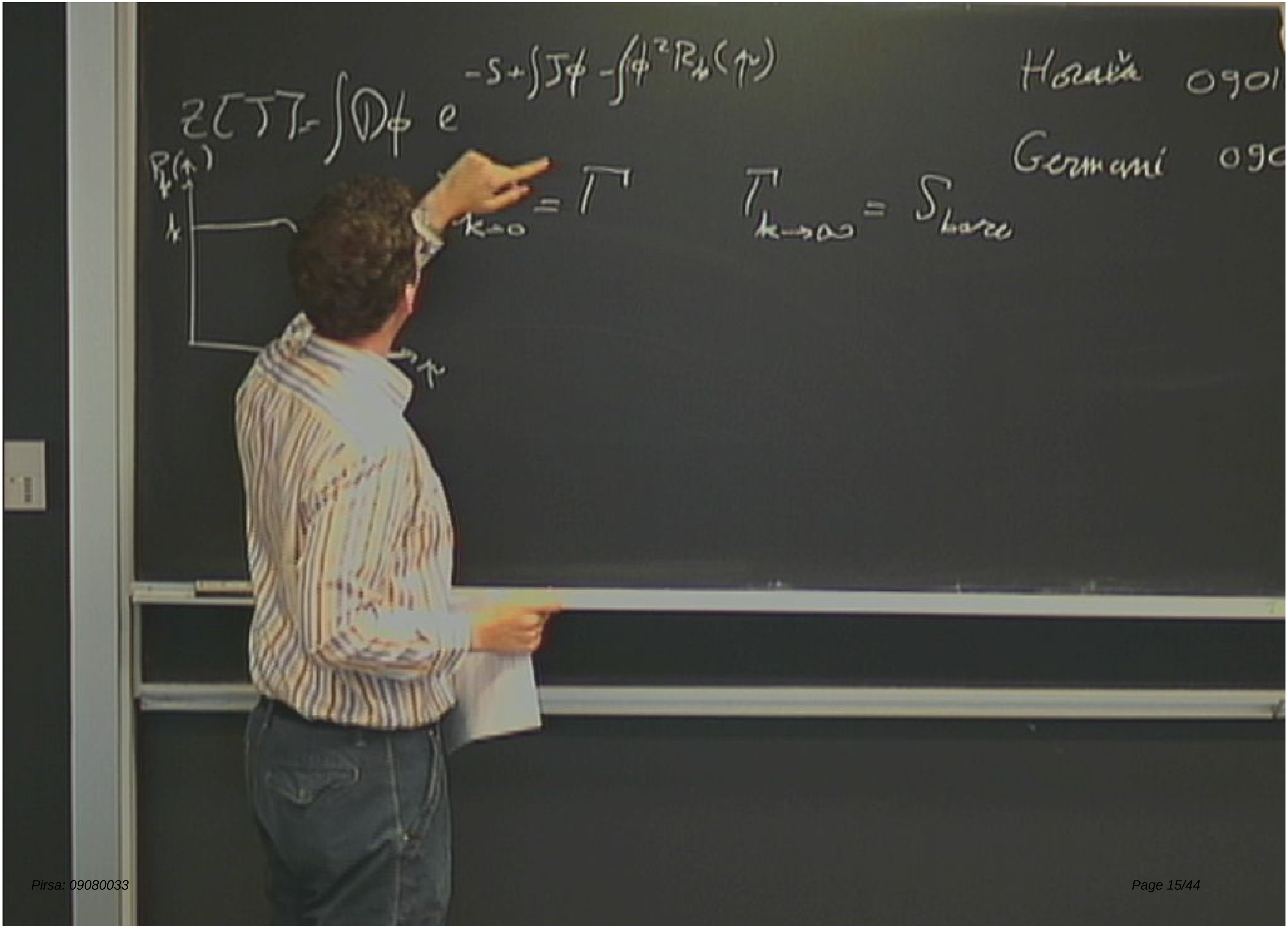
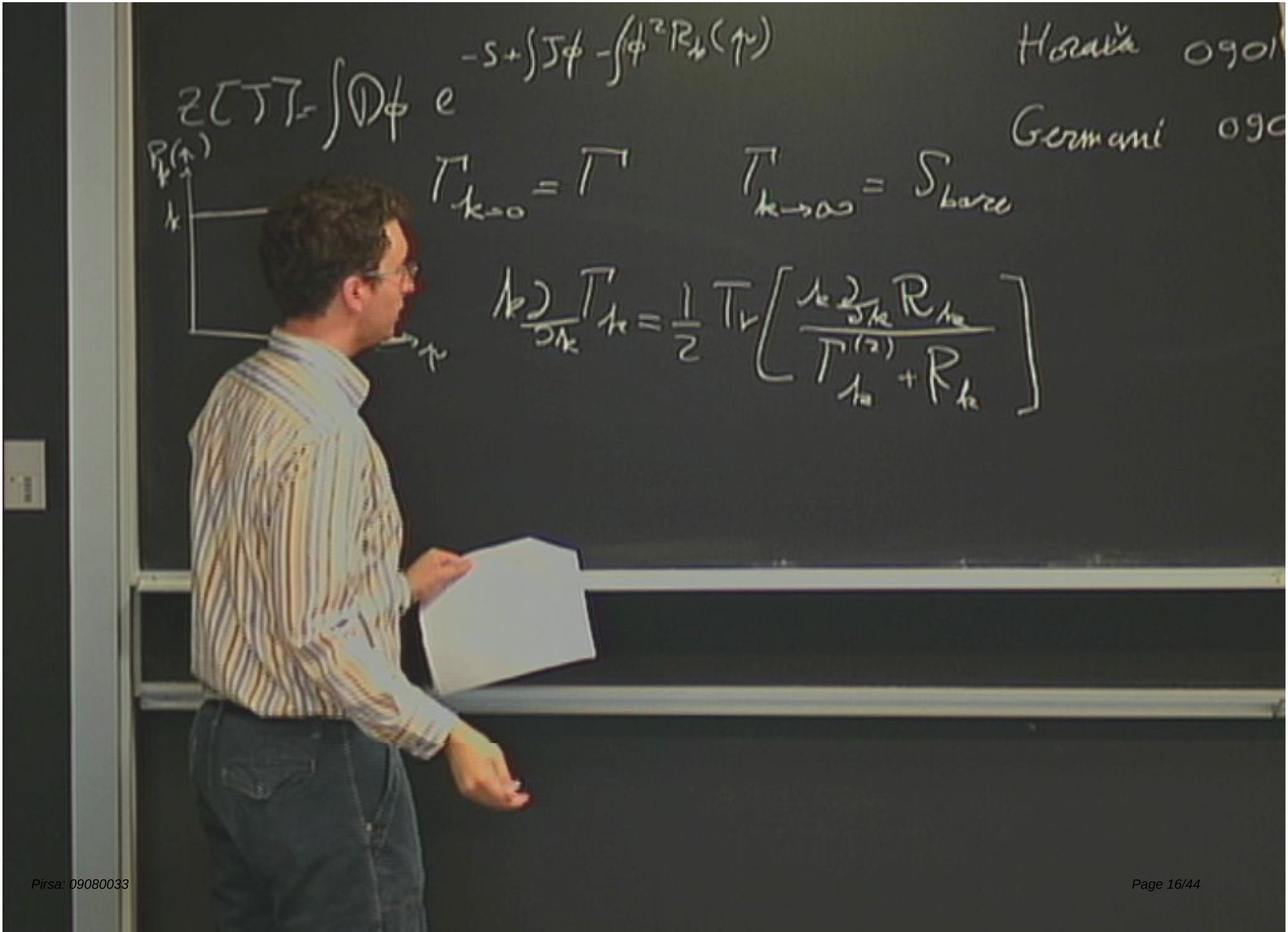
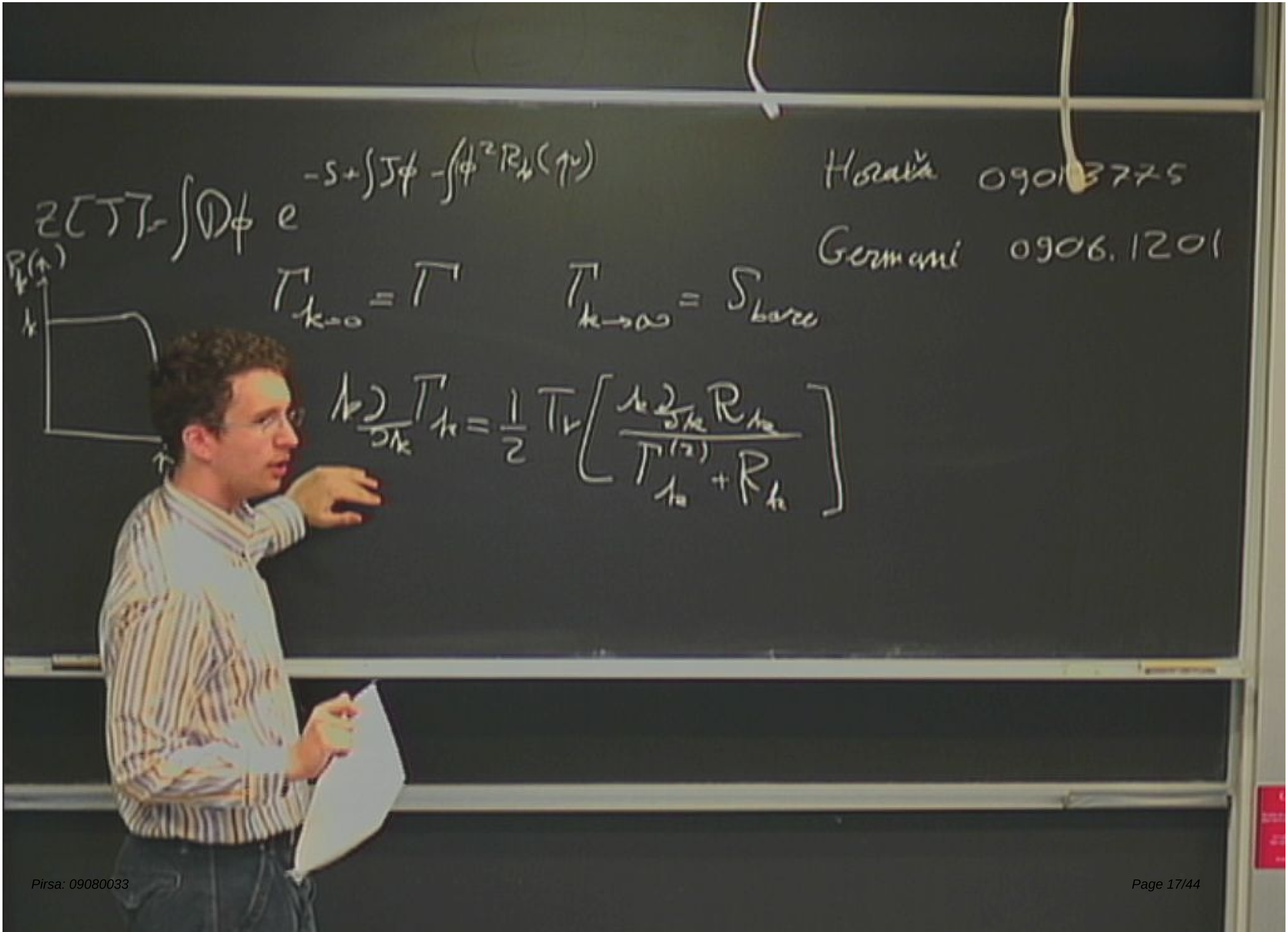


Z[J] = ∫Dφ e^{-S+∫Jφ - ∫φ² R_k(p²)}
Hořava 0901
Germani 090
R_k(p²)
k
p²
Γ_{k→0} = Γ
Γ_{k→∞} = S_bare


$Z[J] = \int D\phi \; e^{-S + \int J\phi - \int \phi^2 R_k(p)}$
Horák 0901
Germani 090
$R_k(p)$
k
p
$\Gamma_{k\to 0} = \Gamma$
$\Gamma_{k\to\infty} = S_{bare}$
$k\frac{\partial}{\partial k}\Gamma_k = \frac{1}{2}\,\mathrm{Tr}\left[\frac{k\frac{\partial}{\partial k}R_k}{\Gamma^{(2)}_k + R_k}\right]$


$Z[J] = \int \mathcal{D}\phi \, e^{-S + \int J\phi - \int \phi^2 R_k(p^2)}$
Horava 0901.3775
Germani 0906.1201
$R_k(p^2)$
k
p^2
$\Gamma_{k\to 0} = \Gamma$
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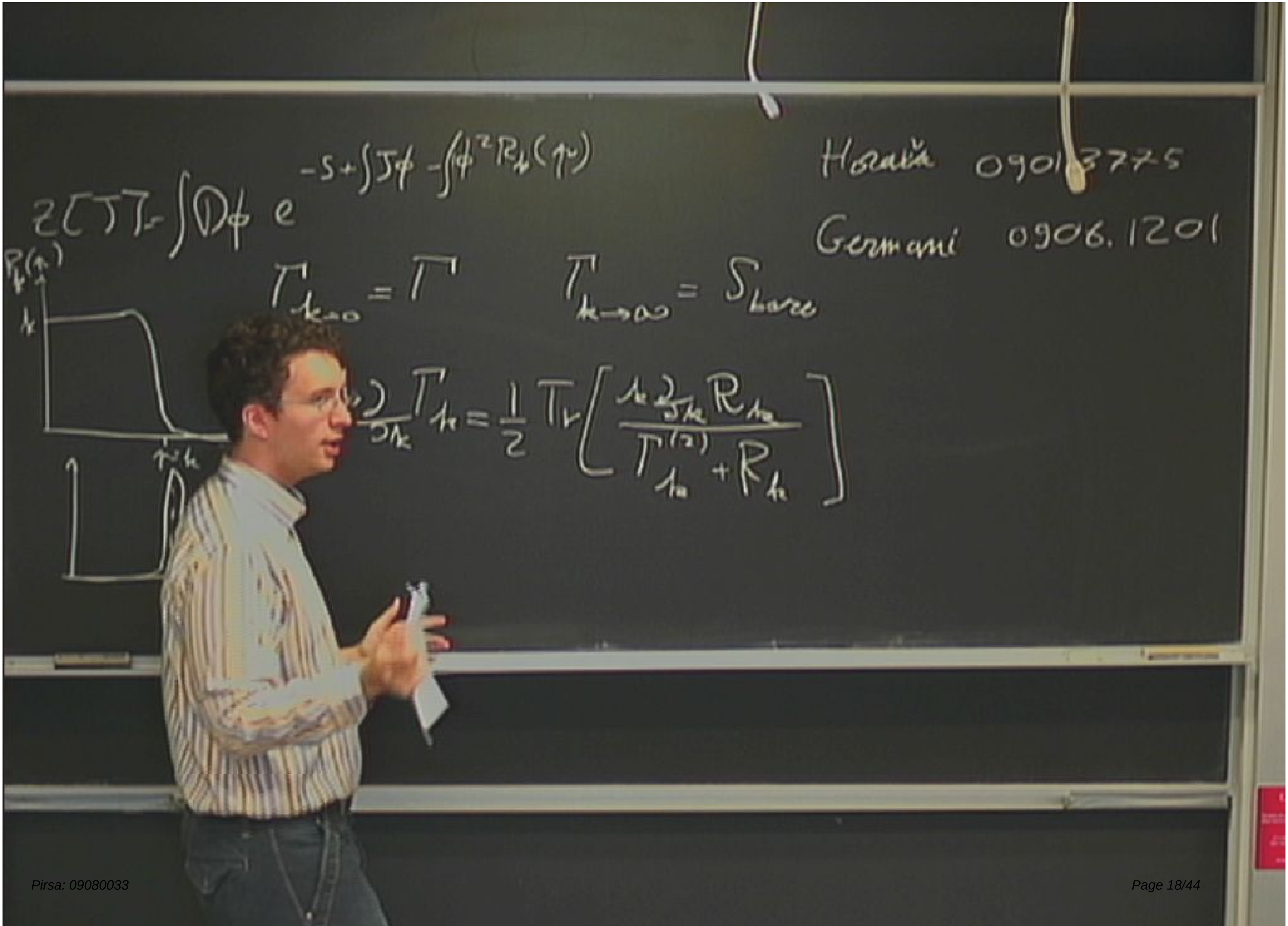
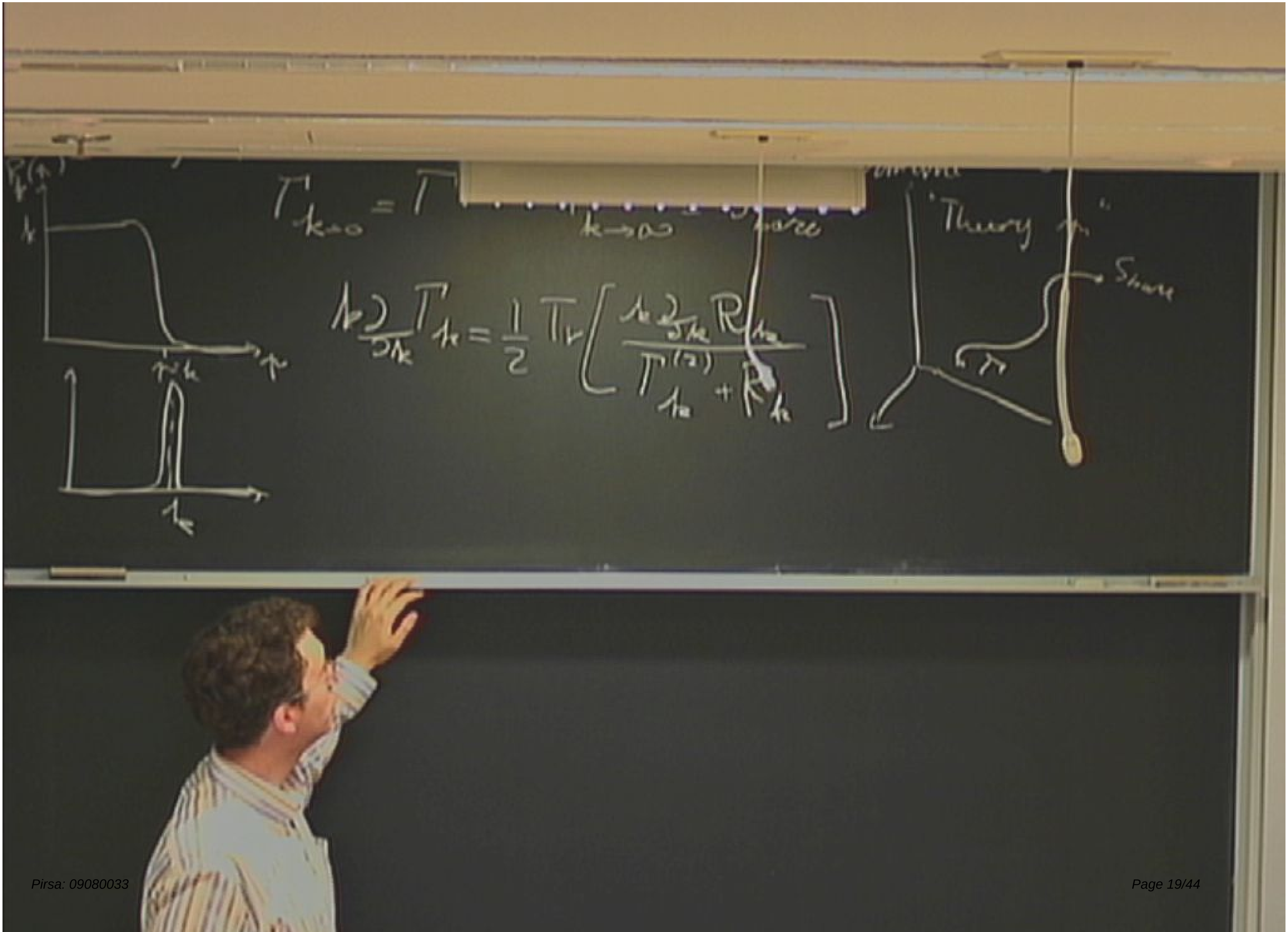
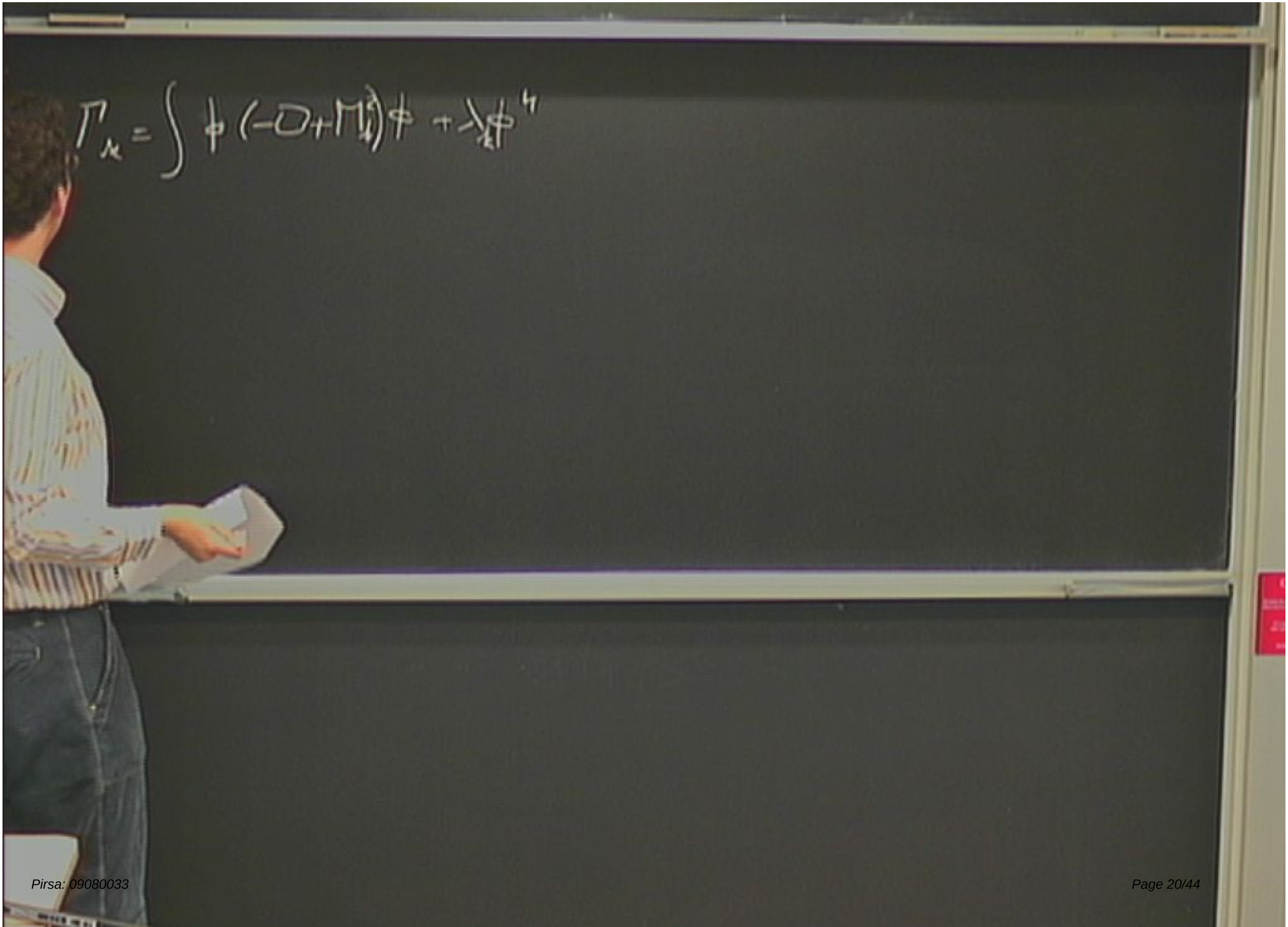
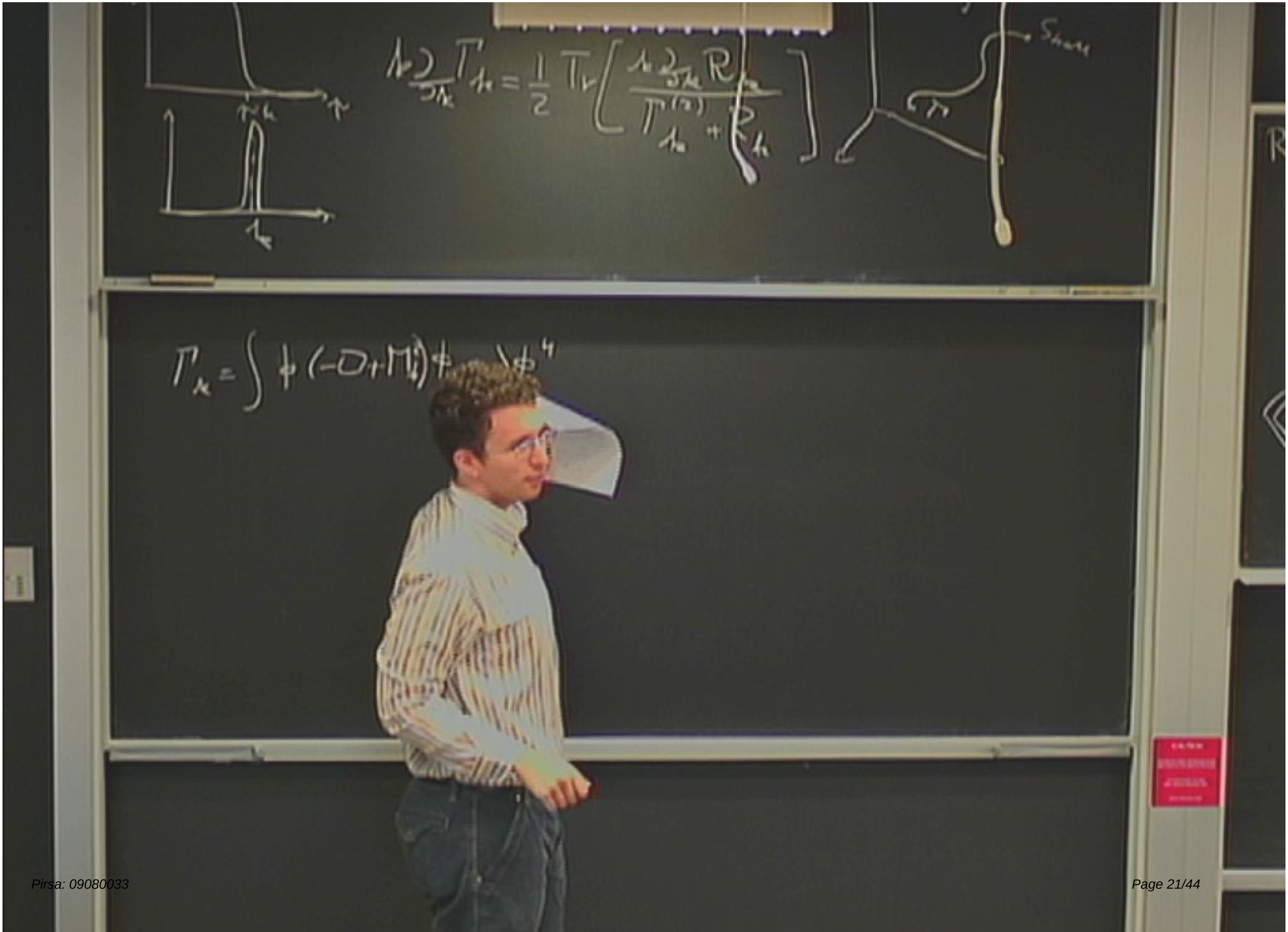
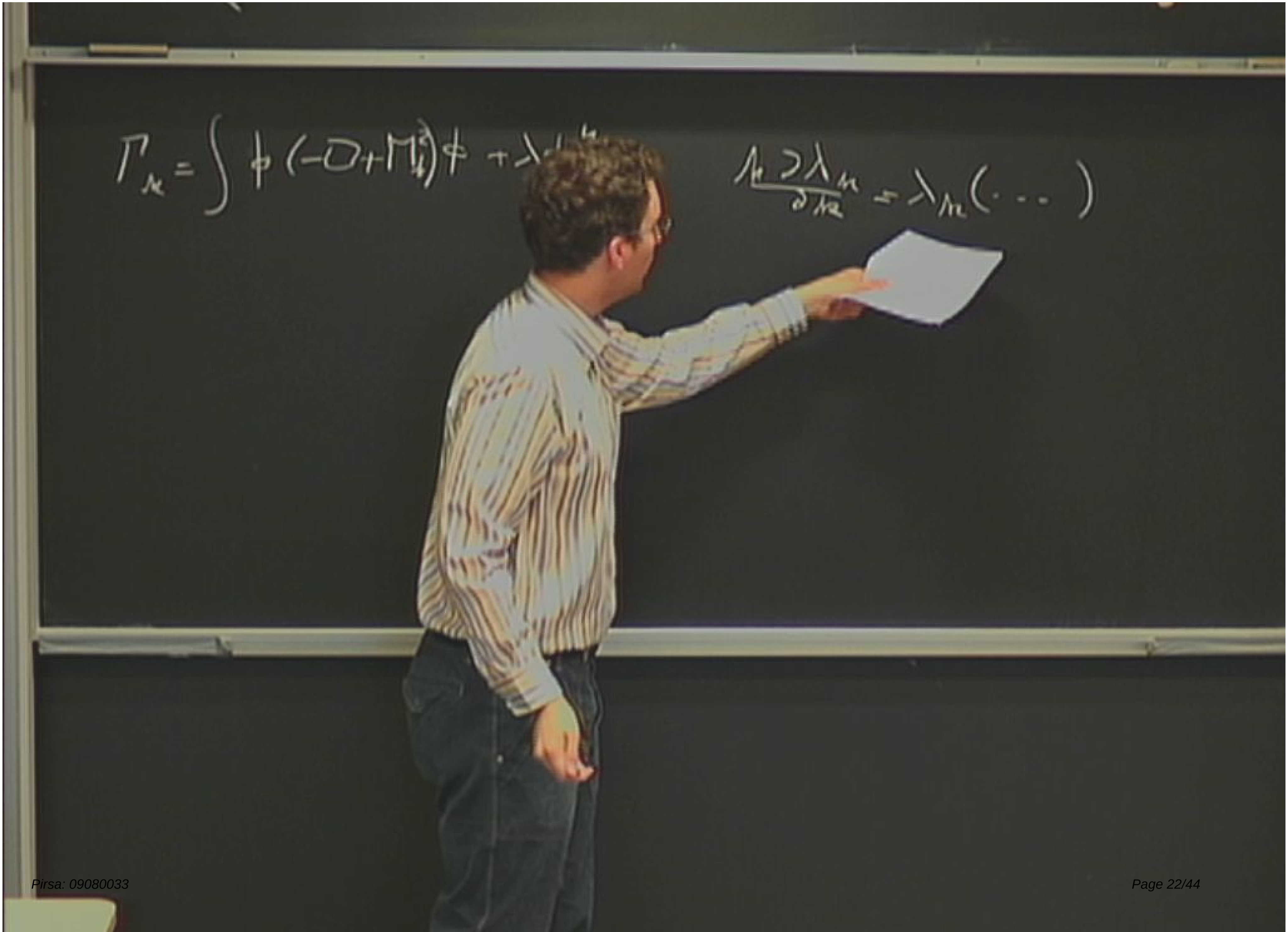
$k\frac{\partial}{\partial k}\Gamma_k = \frac{1}{2}\mathrm{Tr}\left[\frac{k\frac{\partial}{\partial k}R_k}{\Gamma_k^{(2)} + R_k}\right]$

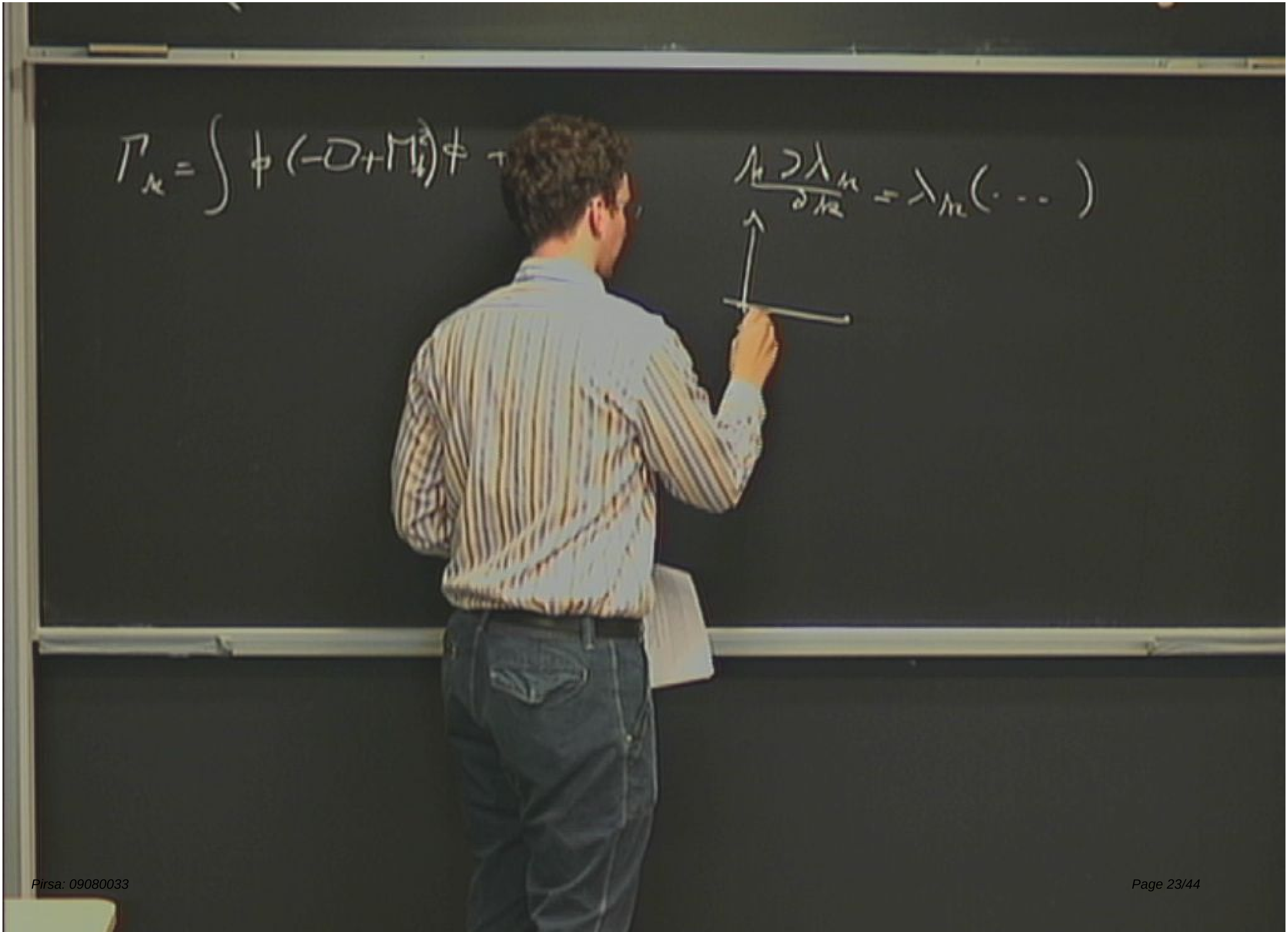

Hořava 0901.3775
Germani 0906.1201
Z[J] = ∫Dφ e^{-S+∫Jφ -∫φ²R_k(p²)}
Γ_{k→0} = Γ
Γ_{k→∞} = S_bare
∂Γ_k/∂k = 1/2 Tr[k ∂_k R_k / (Γ_k^{(2)} + R_k)]

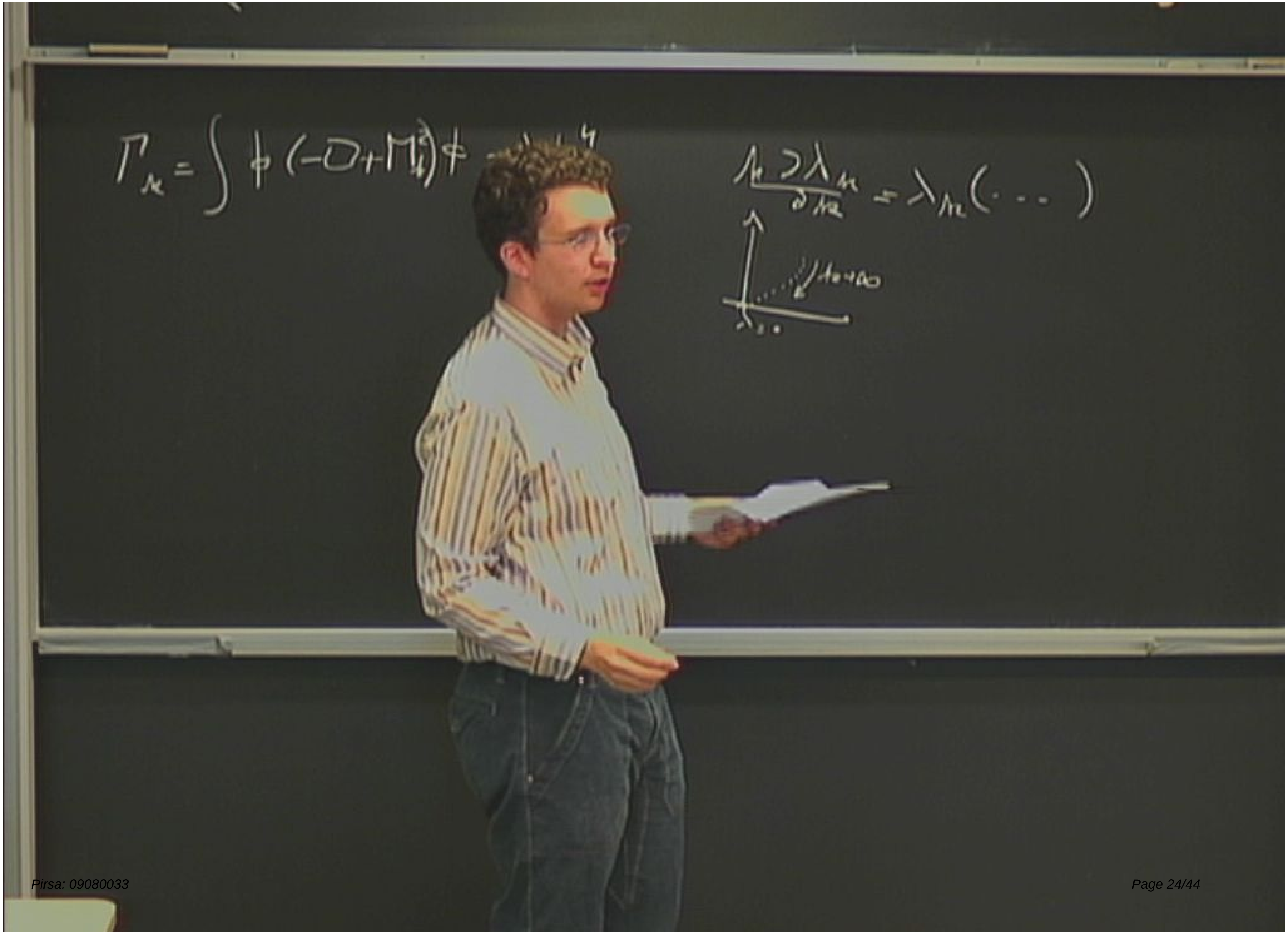


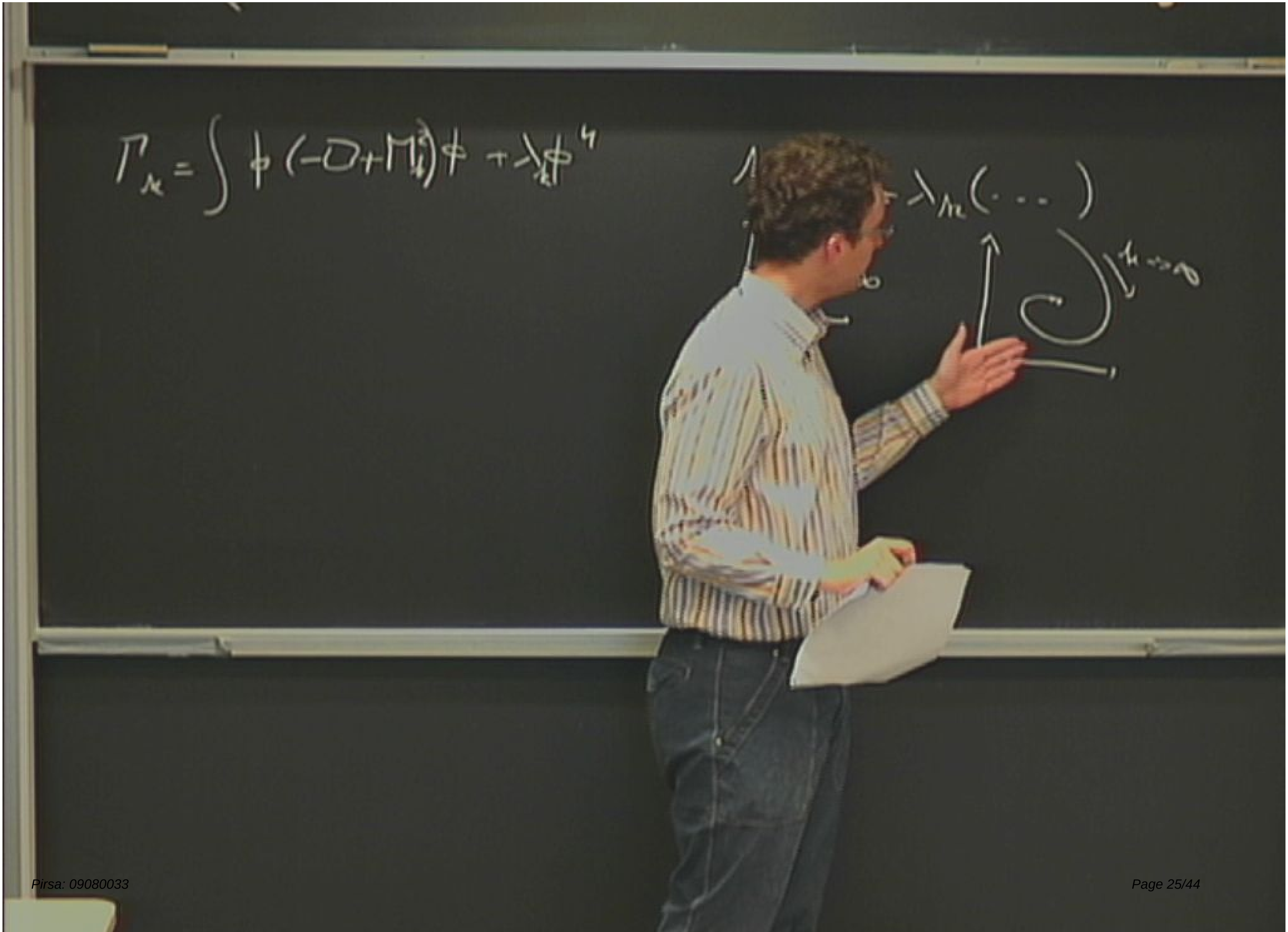

$\Gamma_k = \int \phi\,(-\Box + M_k^2)\,\phi + \lambda_k \phi^4$

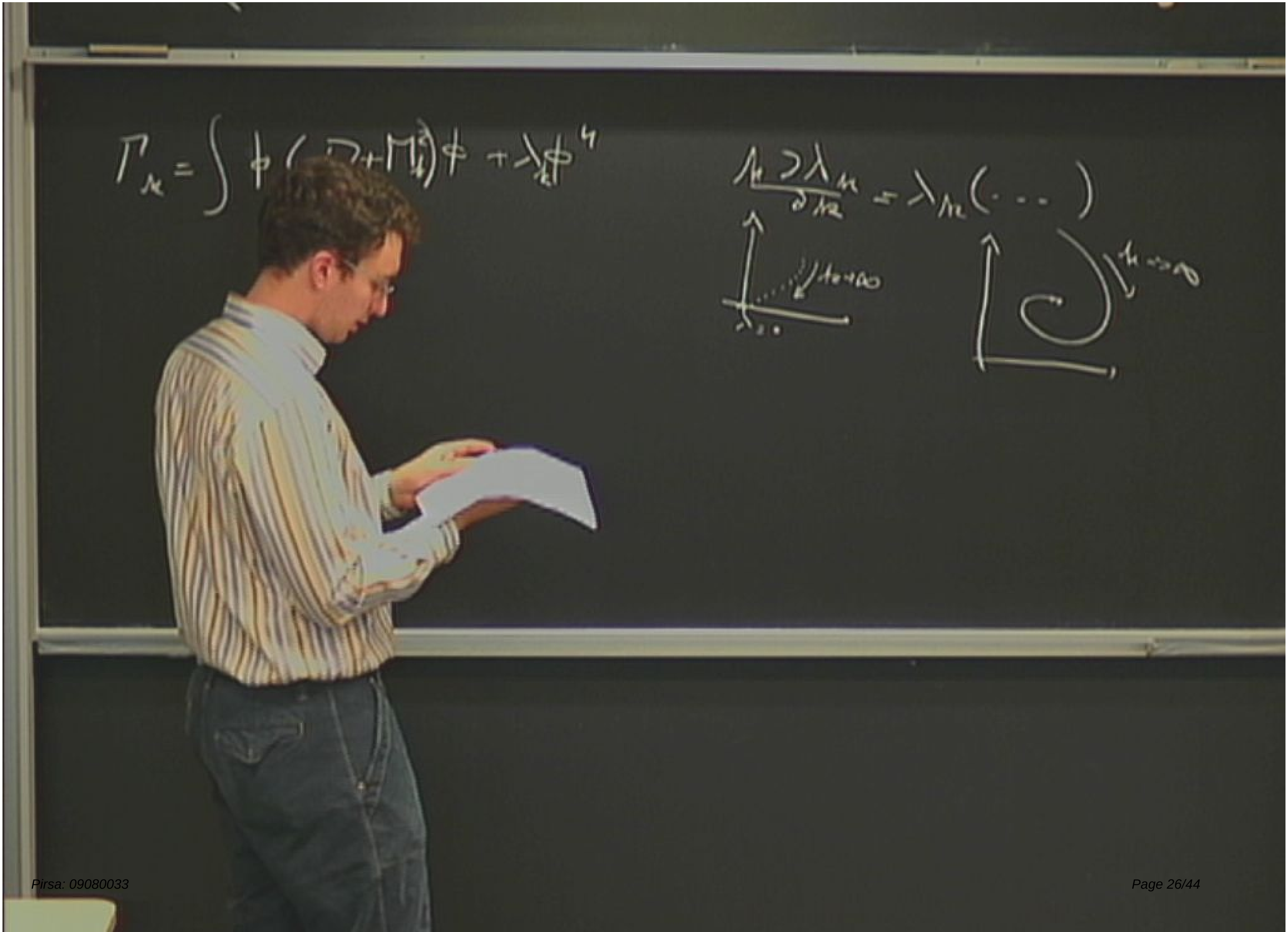

$k\partial_k \Gamma_k = \frac{1}{2}\mathrm{Tr}\left[\frac{k\partial_k R_k}{\Gamma^{(2)}_k + R_k}\right]$


$k \frac{\partial \lambda_k}{\partial k} = \lambda_k (\cdots)$


$\Gamma_k = \int \phi(-\Box + M_k^2)\phi +$
$k \frac{\partial \lambda_k}{\partial k} = \lambda_k(\ldots)$

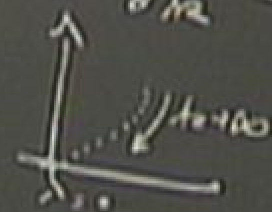

$\Gamma_k = \int \phi(-\Box + M_k^2)\phi$
$k \frac{\partial \lambda_k}{\partial k} = \lambda_k(\ldots)$
$k \to \infty$

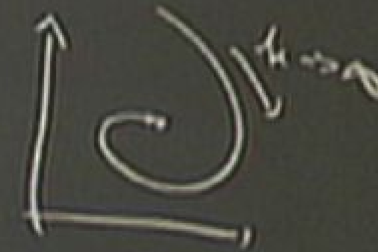

$\Gamma_k = \int \phi(-\Box + M_k^2)\phi + \lambda_k \phi^4$
$\lambda_k(\ldots)$
$k \to 0$

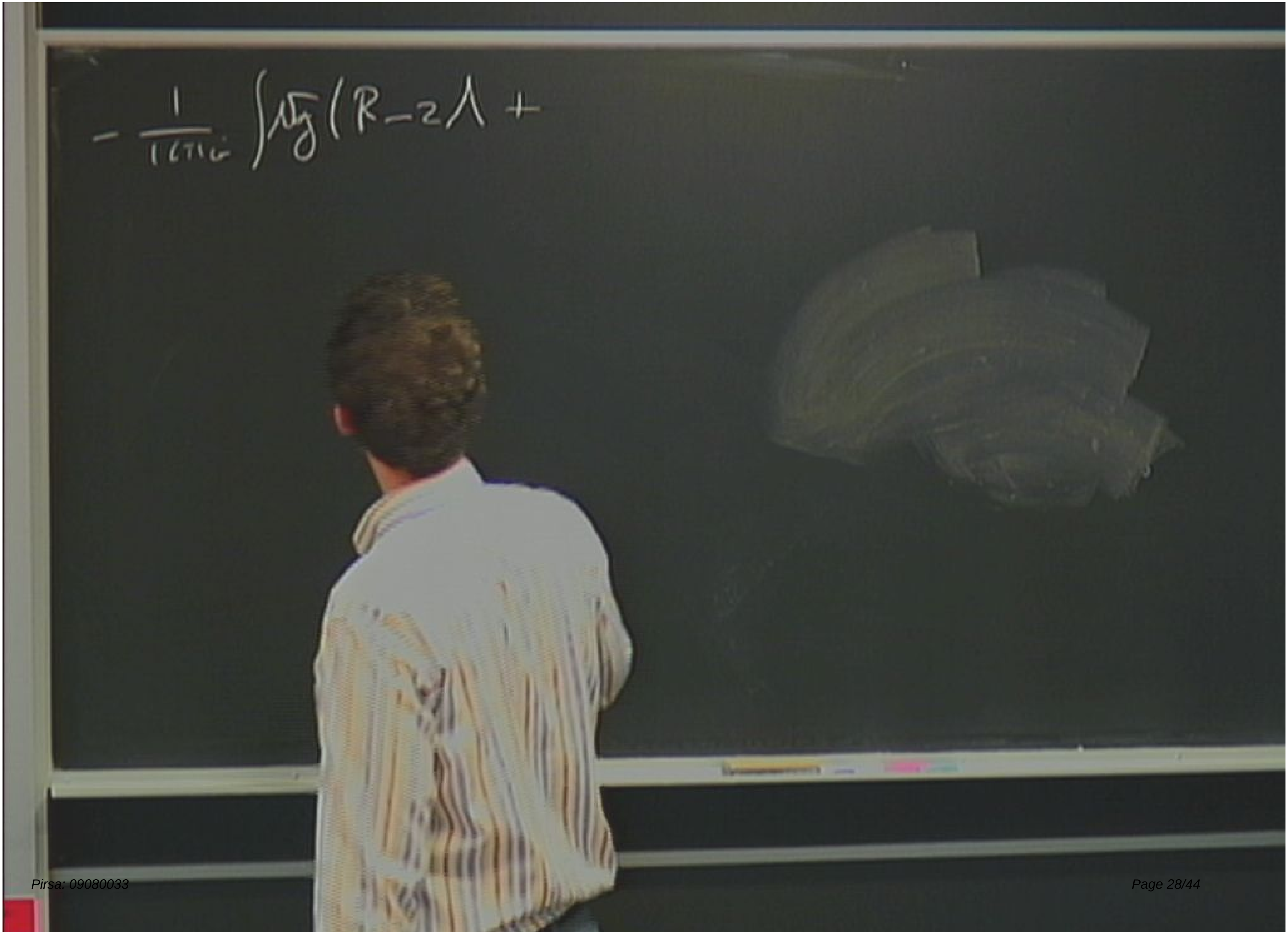


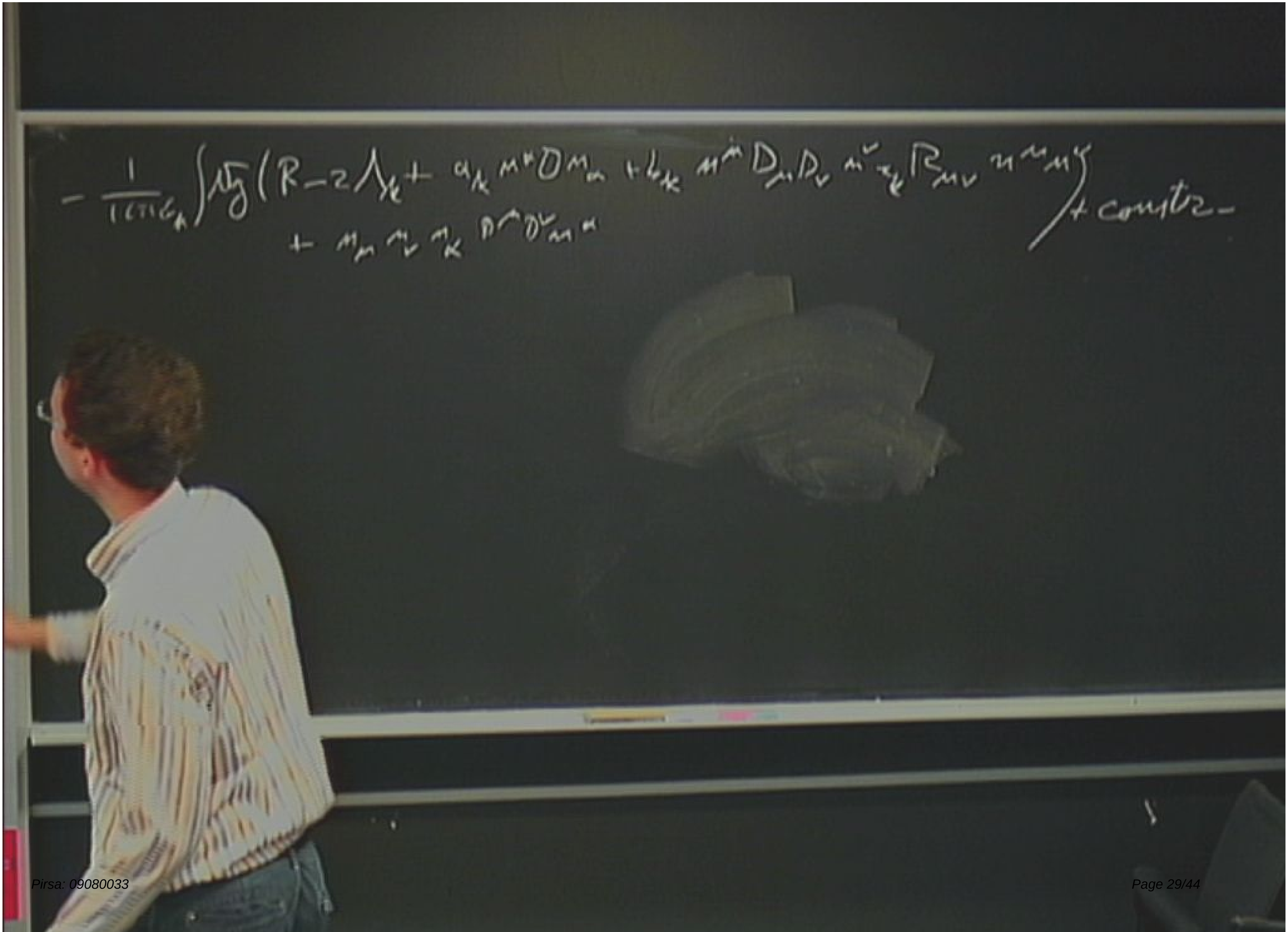
$$\Gamma_k = \int \phi\left(-\Box + M_k^2\right)\phi + \lambda_k \phi^4$$

$$k \frac{\partial \lambda_k}{\partial k} = \lambda_k(\ldots)$$






$-\frac{1}{16\pi G}\int\sqrt{g}\,(R-2\Lambda +$


$-\frac{1}{16\pi G_k}\int\sqrt{g}\,\big(R-2\Lambda_k + a_k\, n^\mu \Box n_\mu + b_k\, n^\mu D_\mu D_\nu n^\nu + c_k\, R_{\mu\nu} n^\mu n^\nu$
$+\, n_\mu n_\nu n_\kappa D^\mu D^\nu n^\kappa\big) + \text{constr.}$

$$-\frac{1}{16\pi G_N}\int\sqrt{g}\,\Big(R-2\Lambda_k+a_k\, n^\alpha \Box n_\alpha + b_k\, n^\mu D_\mu D_\nu n^\nu + \xi_k R_{\mu\nu} n^\mu n^\nu$$

$$+\, n_\mu n_\nu \eta_k D^\mu D^\nu n^\alpha \Big) + \text{constr.}$$

clock field coupled to

y

$$\frac{}{-|\vec{p}|^{2+2}} \approx \frac{1}{p_\mu p^\mu - \alpha (h_{\mu\nu} p^\mu p^\nu)^{\varepsilon}}$$

$g_{\mu\nu} n^\mu n^\nu = -1$

$D_\mu n_\nu = D_\nu n_\mu$

$h_{\mu\nu} = g_{\mu\nu} + n_\mu n_\nu$

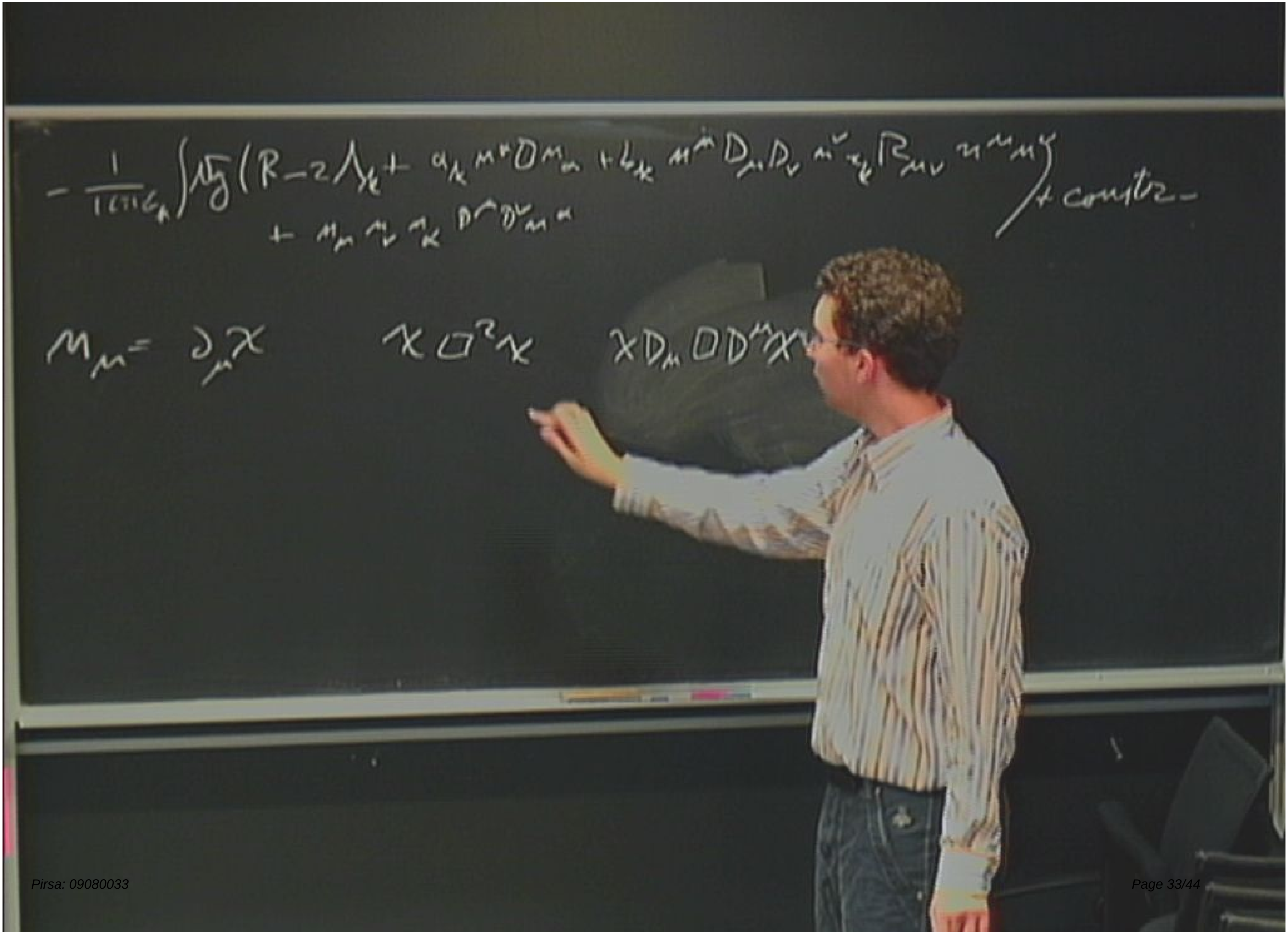
$n_\mu = -N \partial_\mu \chi$

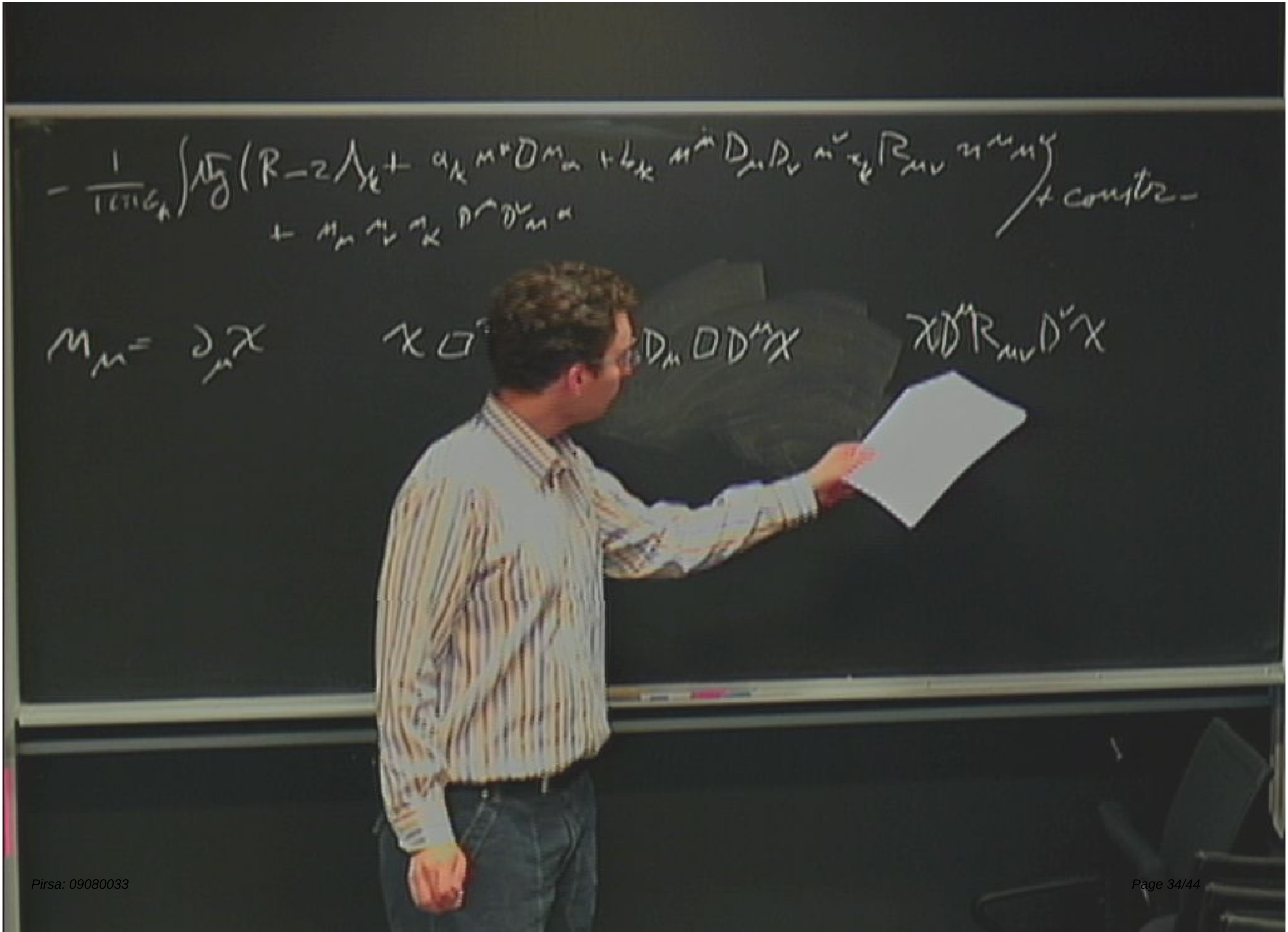
$\Sigma_t = \{ x ; \chi(x) = t \}$

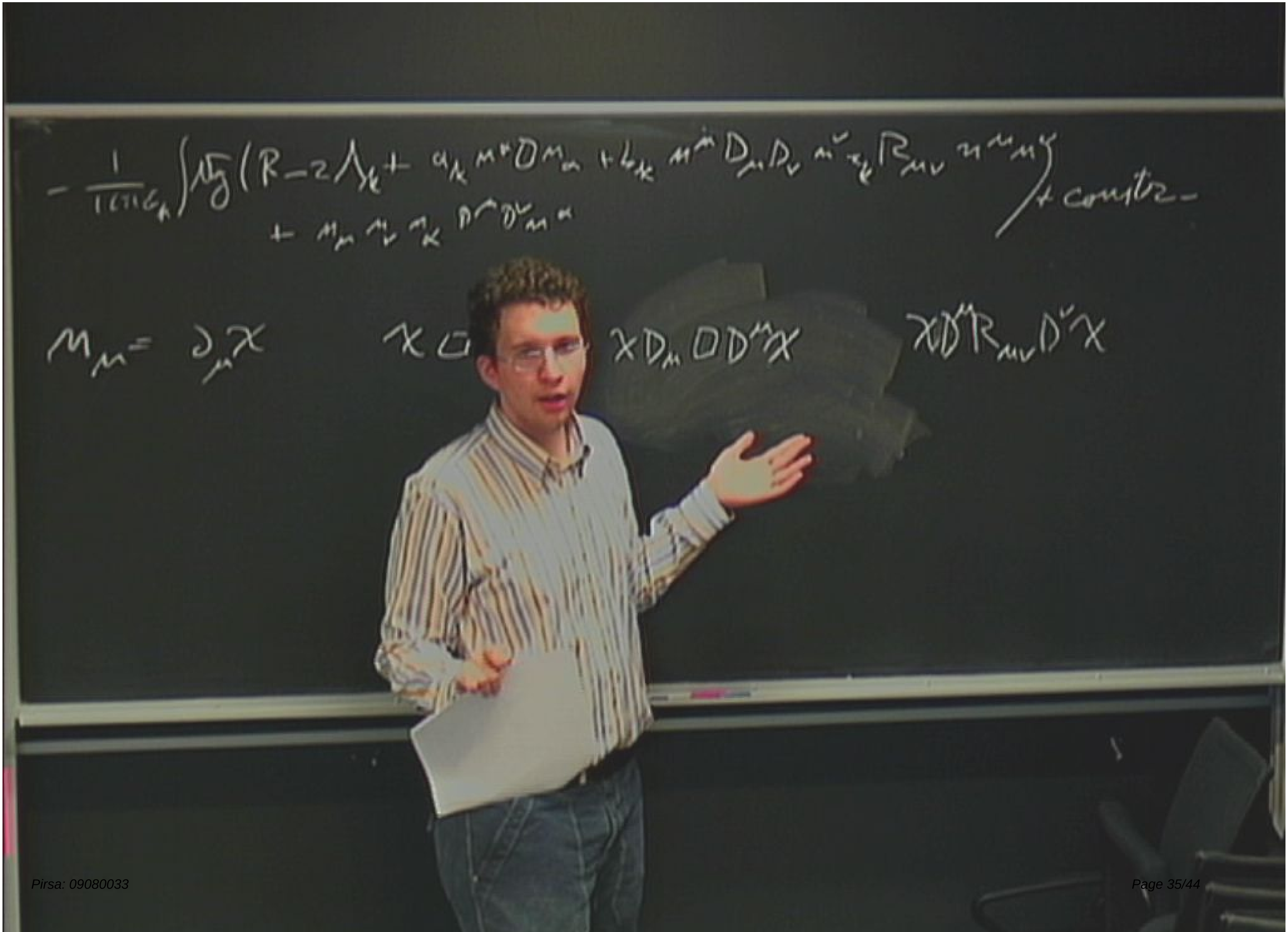
$K_{\mu\nu} = \frac{1}{2} \mathcal{L}_n g_{\mu\nu} = D_\mu \partial_\nu \chi + D_\nu \partial_\mu \chi$

$$-\frac{1}{16\pi G_k}\int\sqrt{g}\Big(R-2\Lambda_k+a_k\, u^\mu \Box u_\mu + b_k\, u^\mu D_\mu D_\nu u^\nu + c_k R_{\mu\nu} u^\mu u^\nu + u_\mu u_\nu u_\kappa D^\mu D^\nu u^\kappa\Big) + \text{counter}\ldots$$

$$u_\mu = \partial_\mu \chi$$


$-\frac{1}{16\pi G_k}\int\sqrt{g}\,(R-2\Lambda_k+a_k u^\mu\Box u_\mu+b_k u^\mu D_\mu D_\nu u^\nu+c_k R_{\mu\nu}u^\mu u^\nu$
$+\,u_\mu u_\nu u_\kappa D^\mu D^\nu u^\kappa)$ + counter..
$u_\mu=\partial_\mu\chi$
$\chi\Box^2\chi$
$\chi D_\mu\Box D^\mu\chi$


$-\frac{1}{16\pi G_k}\int\sqrt{g}\,(R-2\Lambda_k + a_k u^\mu \Box u_\mu + b_k u^\mu D_\mu D_\nu u^\nu + c_k R_{\mu\nu} u^\mu u^\nu$
$+ u_\mu u_\nu u_\kappa D^\mu D^\nu u^\kappa)$ + counter-
$u_\mu = \partial_\mu \chi$
$\chi D^\mu R_{\mu\nu} D^\nu \chi$


$-\frac{1}{16\pi G_k}\int\sqrt{g}\,(R-2\Lambda_k + a_k n^\mu \Box n_\mu + b_k n^\mu D_\mu D_\nu n^\nu + c_k R_{\mu\nu} n^\mu n^\nu$
$+ n_\mu n_\nu n_\kappa D^\mu D^\nu n^\kappa$
$) + \text{constr.}$
$n_\mu = \partial_\mu \chi$
$\chi D_\mu \Box D^\mu \chi$
$\chi D^\mu R_{\mu\nu} D^\nu \chi$

$$-\frac{1}{16\pi G_k}\int\sqrt{g}\,\Big(R-2\Lambda_k + a_k\, n^\mu \Box n_\mu + b_k\, n^\mu D_\mu D_\nu n^\nu + c_k R_{\mu\nu} n^\mu n^\nu$$

$$+\, n_\mu n_\nu n_\kappa D^\mu D^\nu n^\kappa\Big) + \text{constr.}$$

$$n_\mu = \partial_\mu \chi \qquad \alpha_k \chi \Box^2 \chi \approx \chi D_\mu \Box D^\mu \chi \qquad \chi D^\mu R_{\mu\nu} D^\nu \chi$$

$$-\frac{1}{16\pi G_k}\int\sqrt{g}\,\Big(R-2\Lambda_k + a_k\, m^\mu \Box m_\mu + b_k\, m^\mu D_\mu D_\nu m^\nu + c_k R_{\mu\nu} m^\mu m^\nu$$

$$+\, m_\mu m_\nu m_\kappa D^\mu D^\nu m^\kappa\Big) + \text{counter-}$$

$$m_\mu = \partial_\mu \chi \qquad \alpha_k\, \chi \Box^2 \chi \approx \chi D_\mu \Box D^\mu \chi \qquad \chi D^\mu R_{\mu\nu} D^\nu \chi$$

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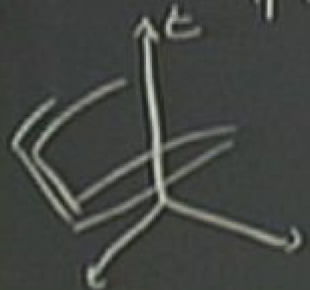
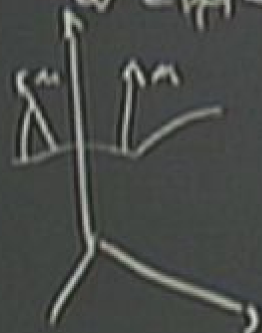
$g_{\mu\nu} n^\mu n^\nu \ldots$

$D_\mu n_\nu = \ldots$





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