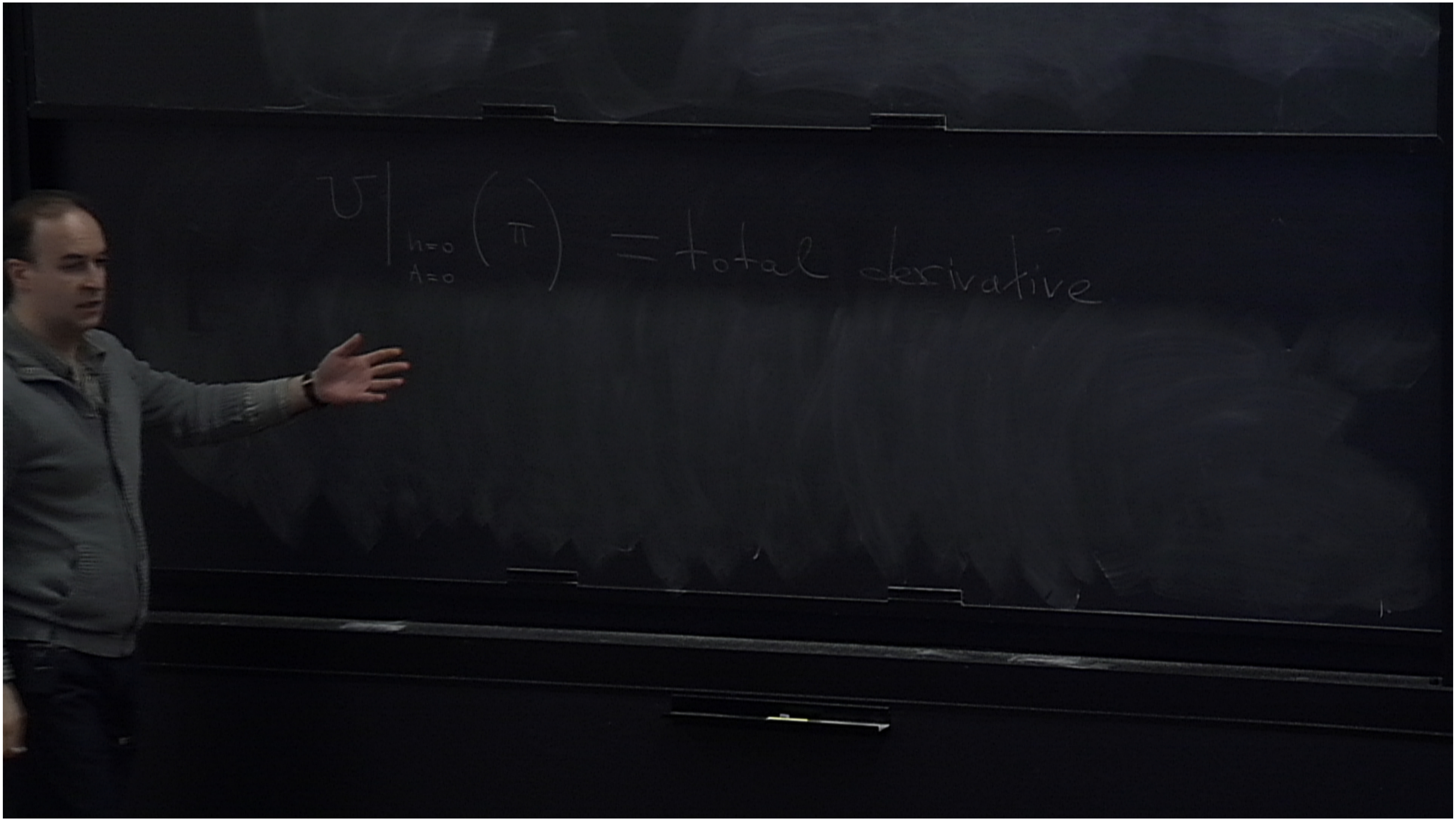
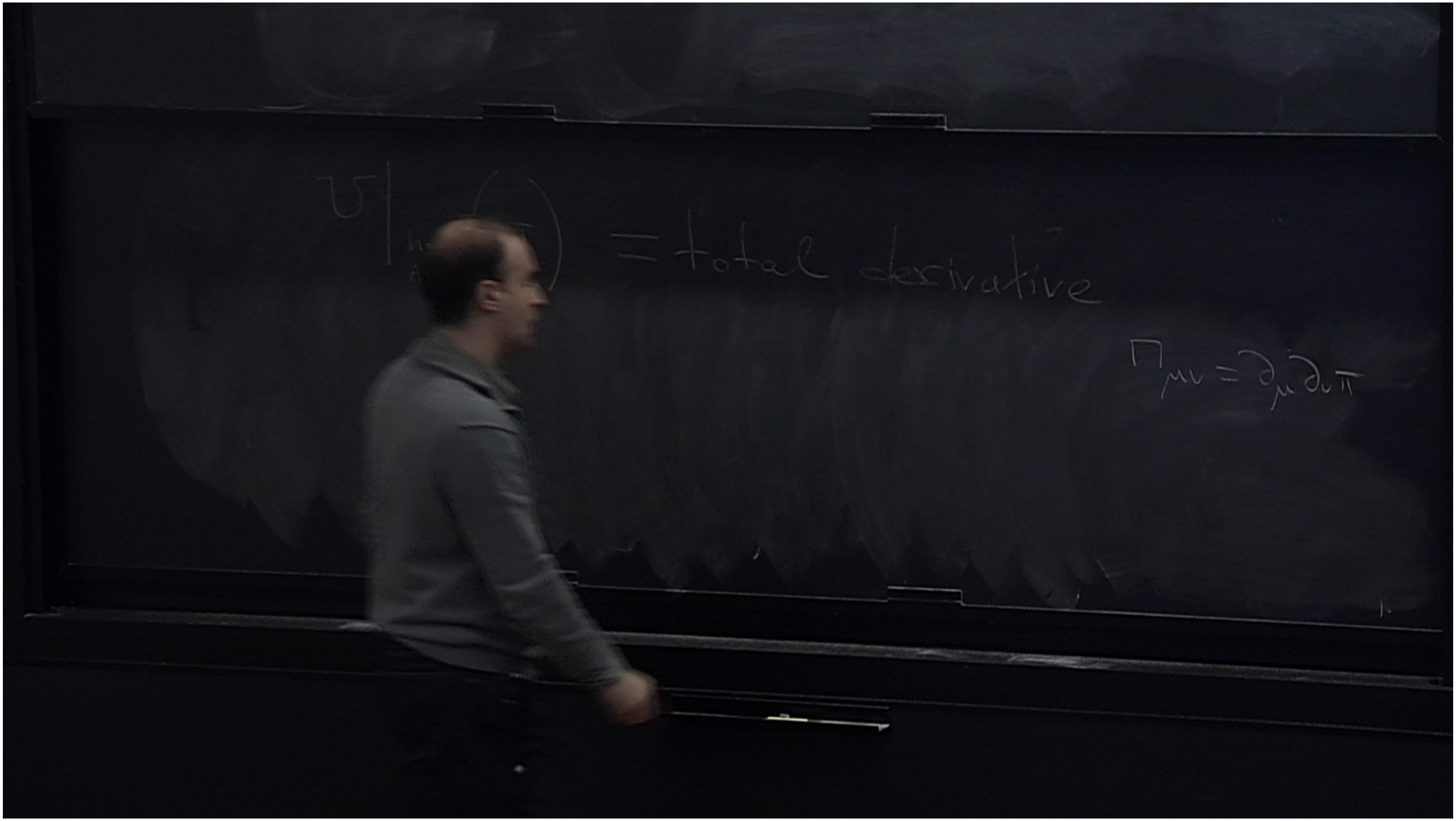
Title: Cosmology and Black Holes in Massive Gravity

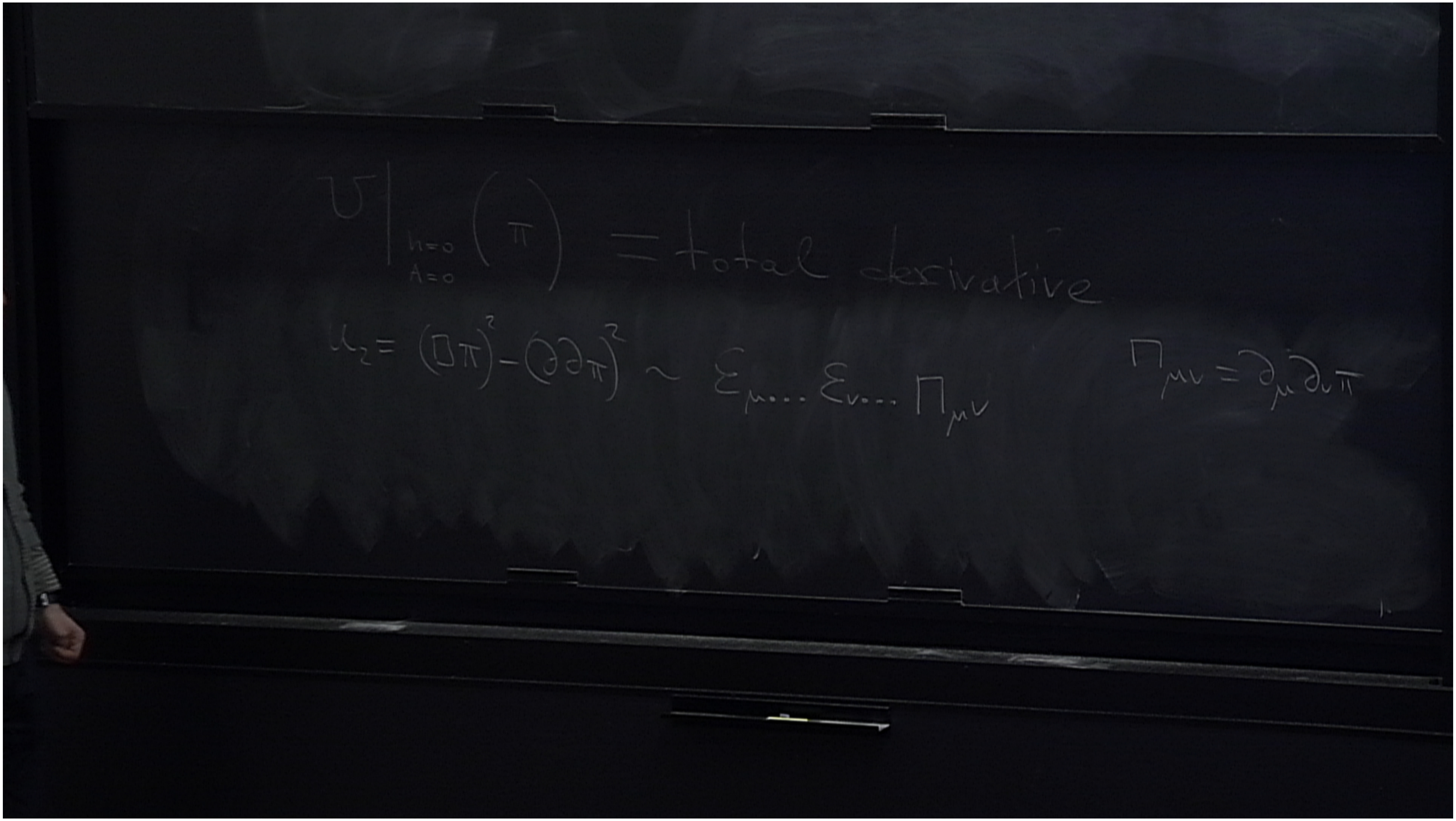
Date: Jan 31, 2012 03:30 PM

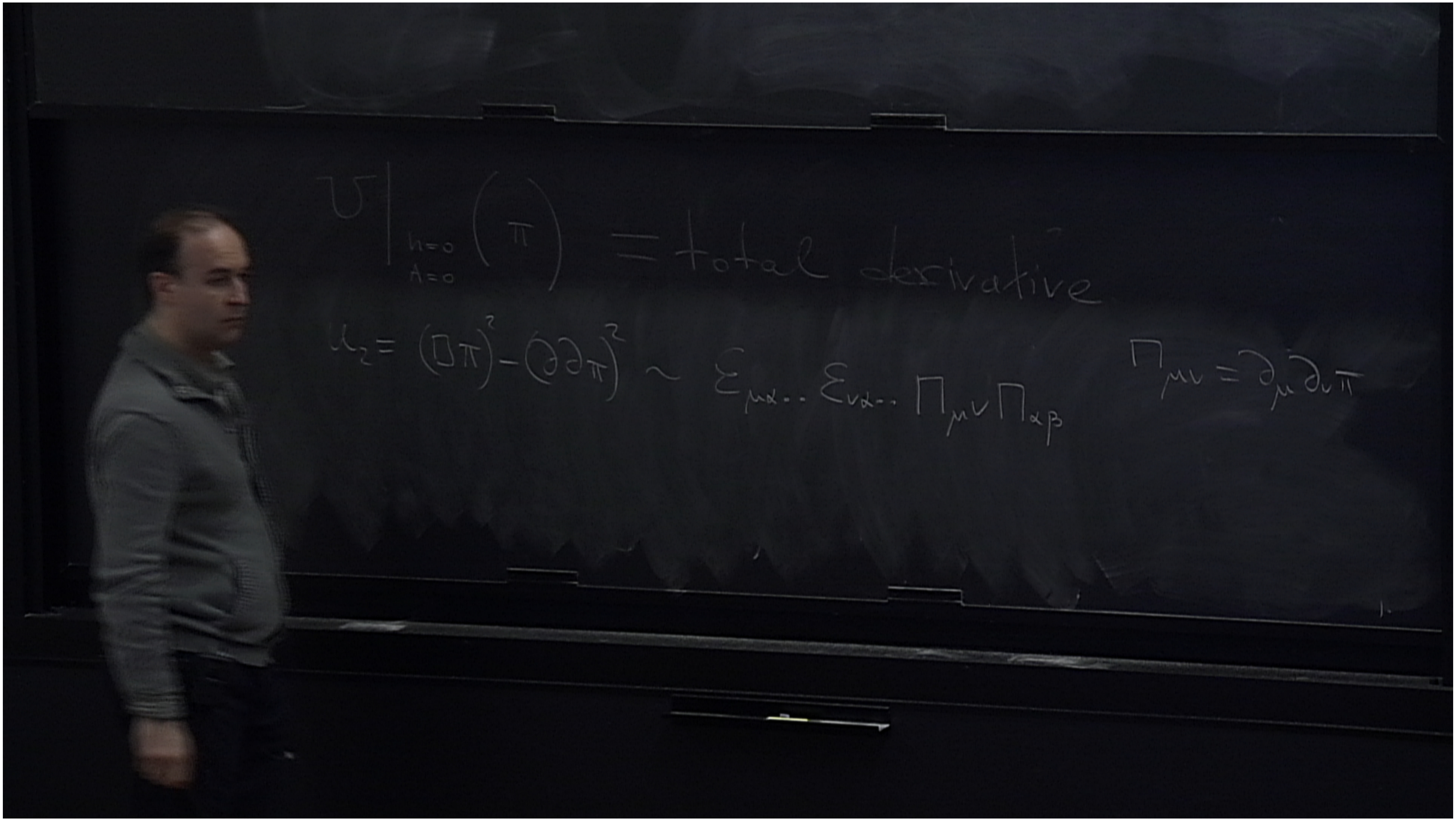
URL: http://pirsa.org/12010168

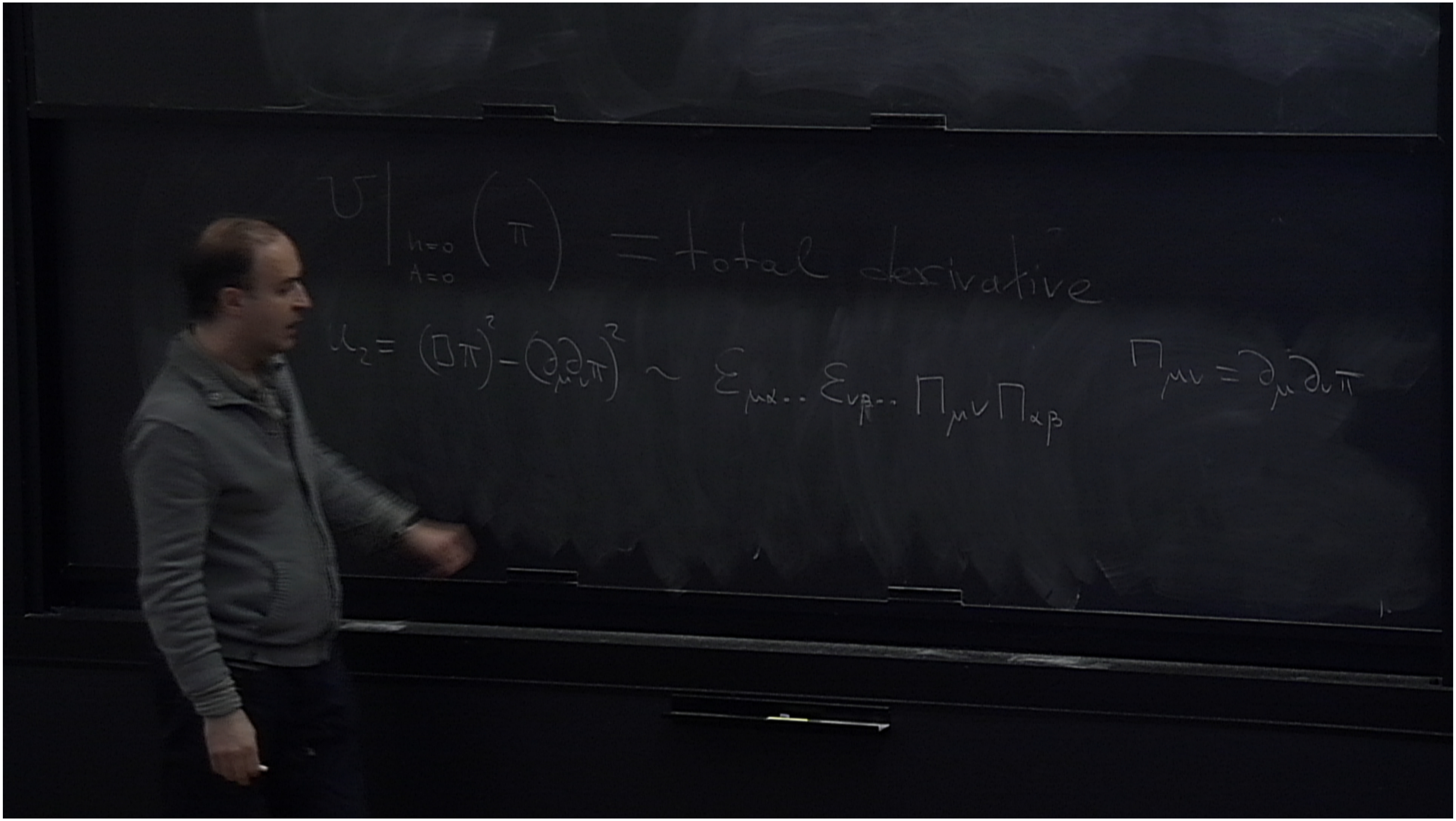
Abstract: For a long time it was believed that a classical nonlinear theory of a single massive spin-2 state does not exist.


U |h=0 A=0 (π) = total derivative


= total derivative
$\Pi_{\mu\nu} = \partial_\mu \partial_\nu \pi$


$\mathcal{L}|_{h=0, A=0}(\pi)$ = total derivative
$\mathcal{L}_2 = (\Box\pi)^2 - (\partial\partial\pi)^2 \sim \varepsilon_{\mu\ldots}\varepsilon_{\nu\ldots}\Pi_{\mu\nu}$
$\Pi_{\mu\nu} = \partial_\mu\partial_\nu\pi$


U|h=0 A=0 (π) = total derivative
L2 = (□π)² − (∂∂π)² ~ εμα.. ενα.. Πμν Παβ
Πμν = ∂μ∂νπ



U|h=0 A=0 (π) = total derivative
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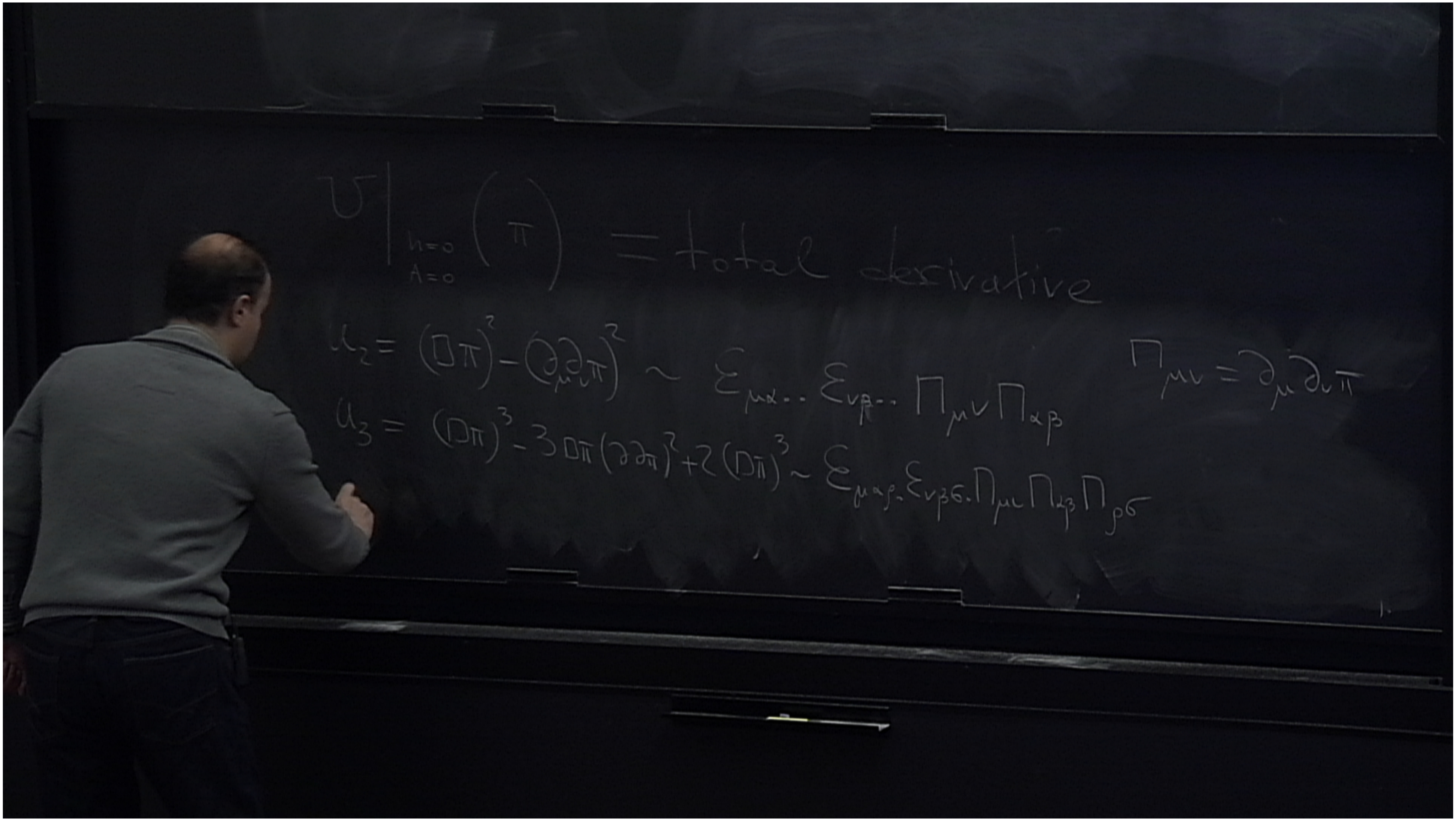
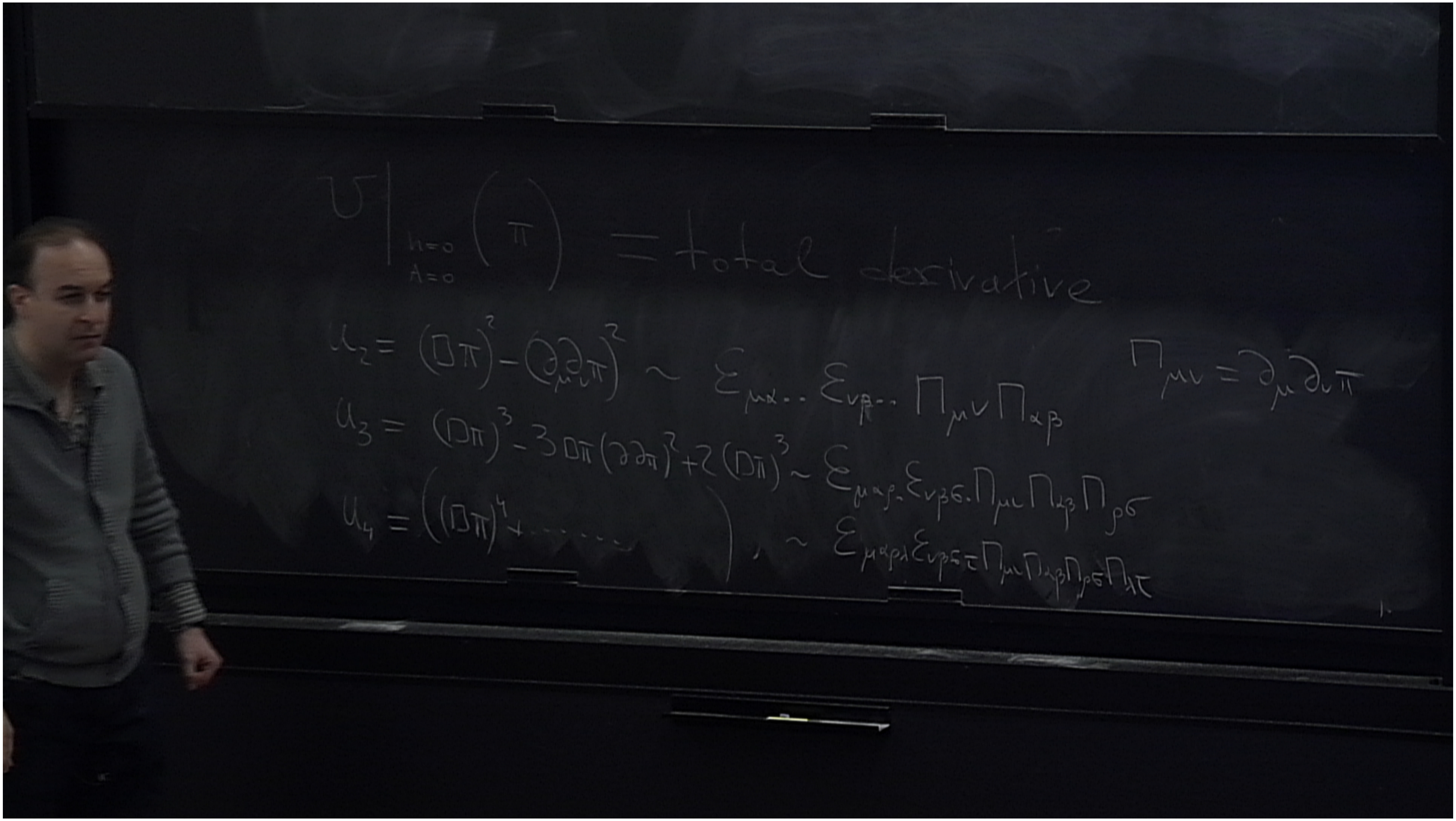
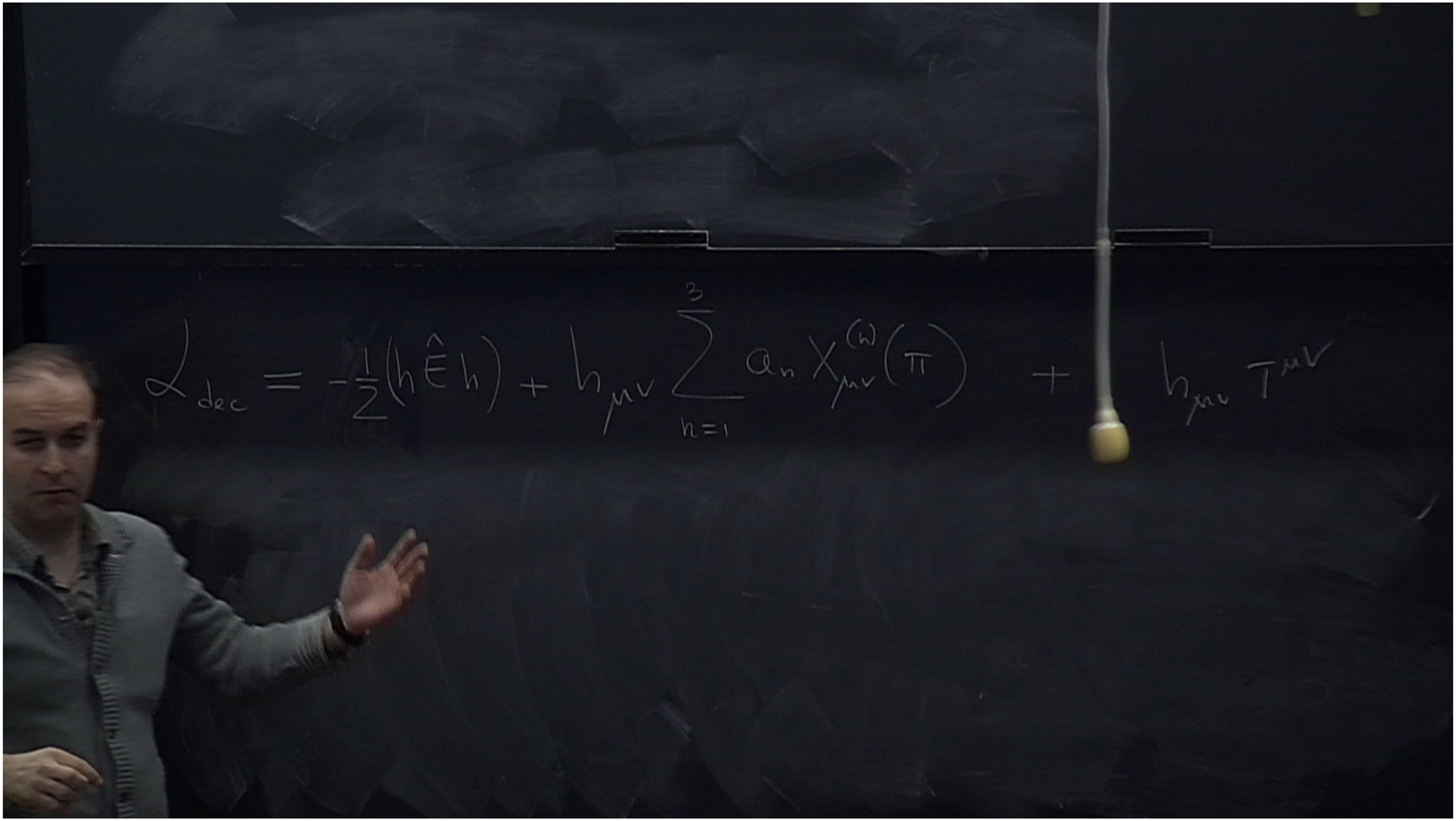
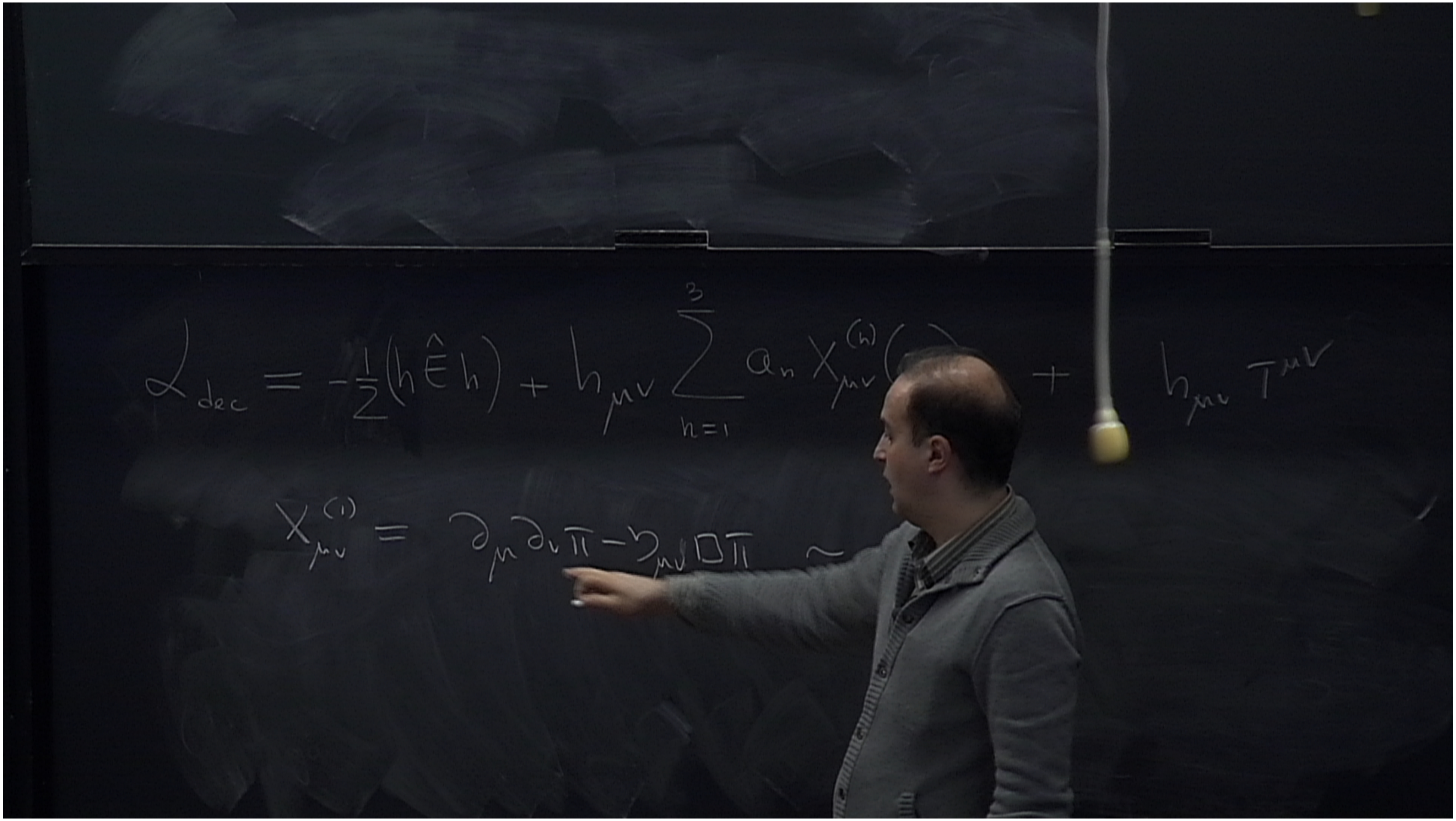
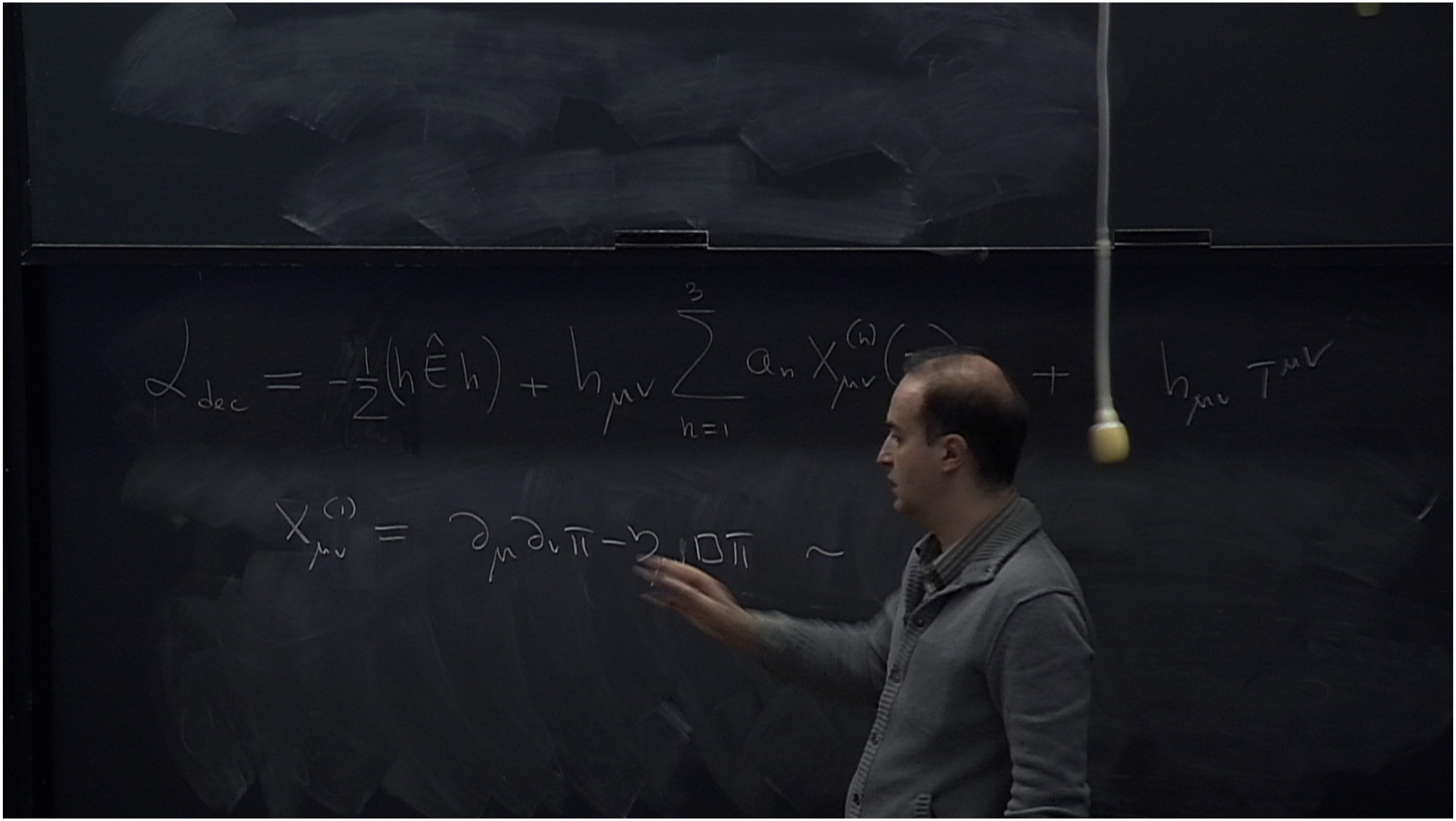
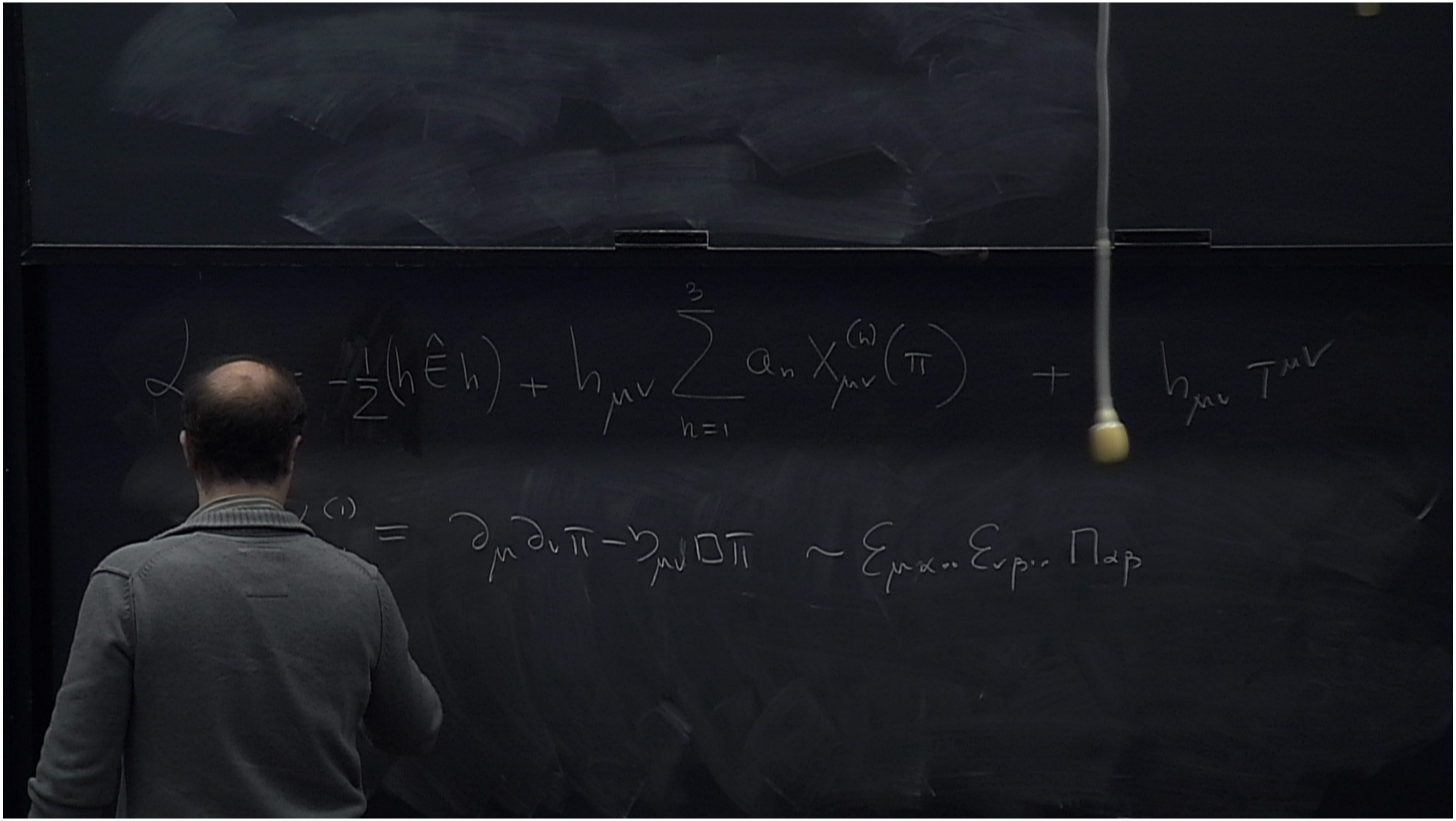

$U|_{h=0, A=0}(\pi) = $ total derivative
$u_2 = (\Box\pi)^2 - (\partial_\mu\partial_\nu\pi)^2 \sim \varepsilon_{\mu\alpha..}\varepsilon_{\nu\beta..}\Pi_{\mu\nu}\Pi_{\alpha\beta}$
$\Pi_{\mu\nu} = \partial_\mu\partial_\nu\pi$
$u_3 = (\Box\pi)^3 - 3\Box\pi(\partial\partial\pi)^2 + 2(\partial\pi)^3 \sim \varepsilon_{\mu\alpha\rho..}\varepsilon_{\nu\beta\sigma..}\Pi_{\mu\nu}\Pi_{\alpha\beta}\Pi_{\rho\sigma}$

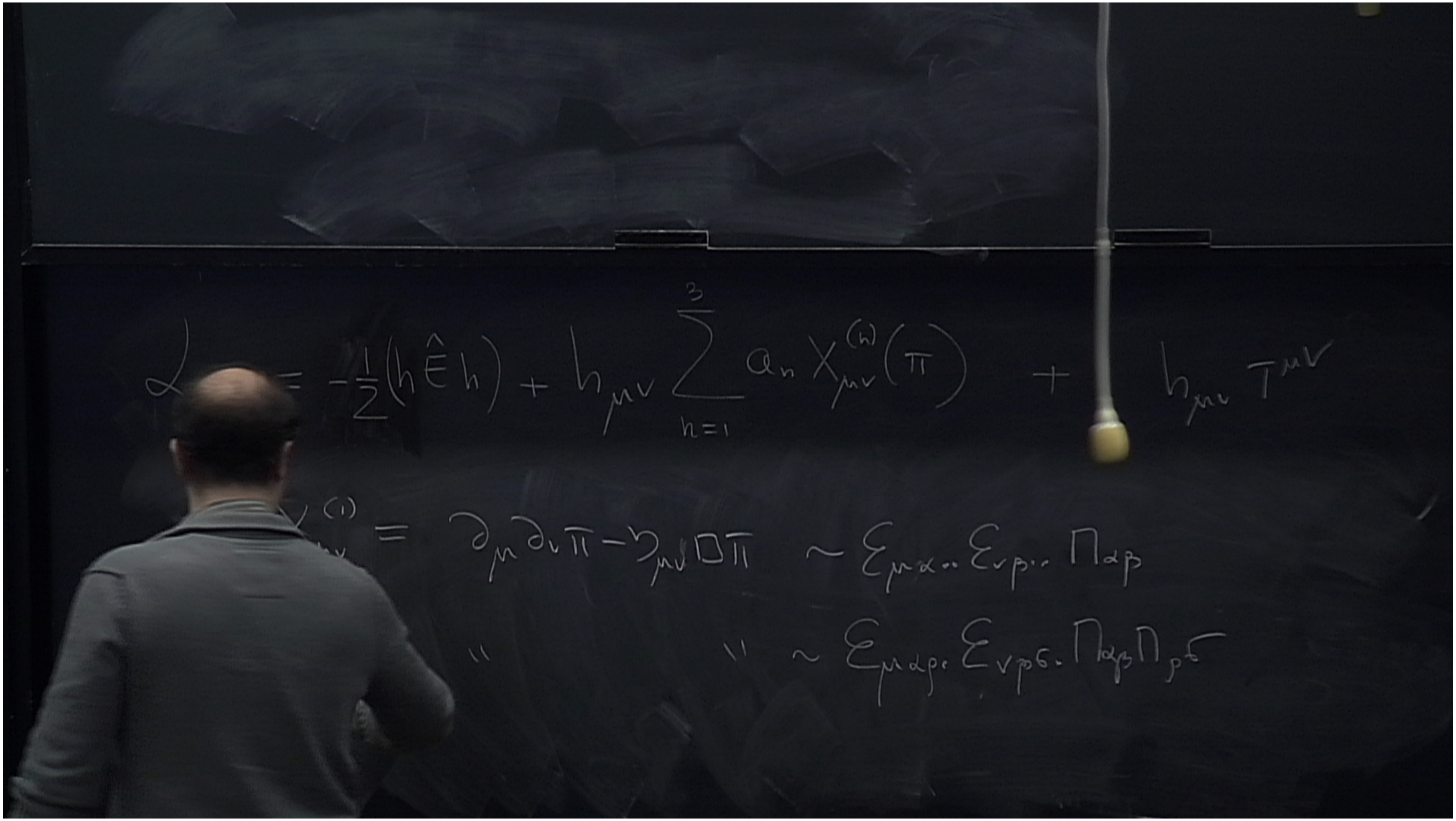

U|h=0, A=0 (π) = total derivative
u2 = (□π)^2 − (∂μ∂νπ)^2 ~ εμα.. ενβ.. Πμν Παβ
Πμν = ∂μ∂νπ
u3 = (□π)^3 − 3□π(∂∂π)^2 + 2(∂π)^3 ~ εμαρ. ενβσ. Πμν Παβ Πρσ
u4 = ((□π)^4 + ...) ~ εμαρλ ενβστ Πμν Παβ Πρσ Πλτ


$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{E}h) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$


$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{\mathcal{E}}h) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}(\ \ ) + h_{\mu\nu}T^{\mu\nu}$
$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim$


$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{E}h) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}$
$+ \quad h_{\mu\nu} T^{\mu\nu}$
$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \Box\pi \sim$


$\mathcal{L} = -\frac{1}{2}(h\hat{E}h) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$
$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha\cdot\cdot}\varepsilon_{\nu\beta\cdot\cdot}\Pi_{\alpha\beta}$

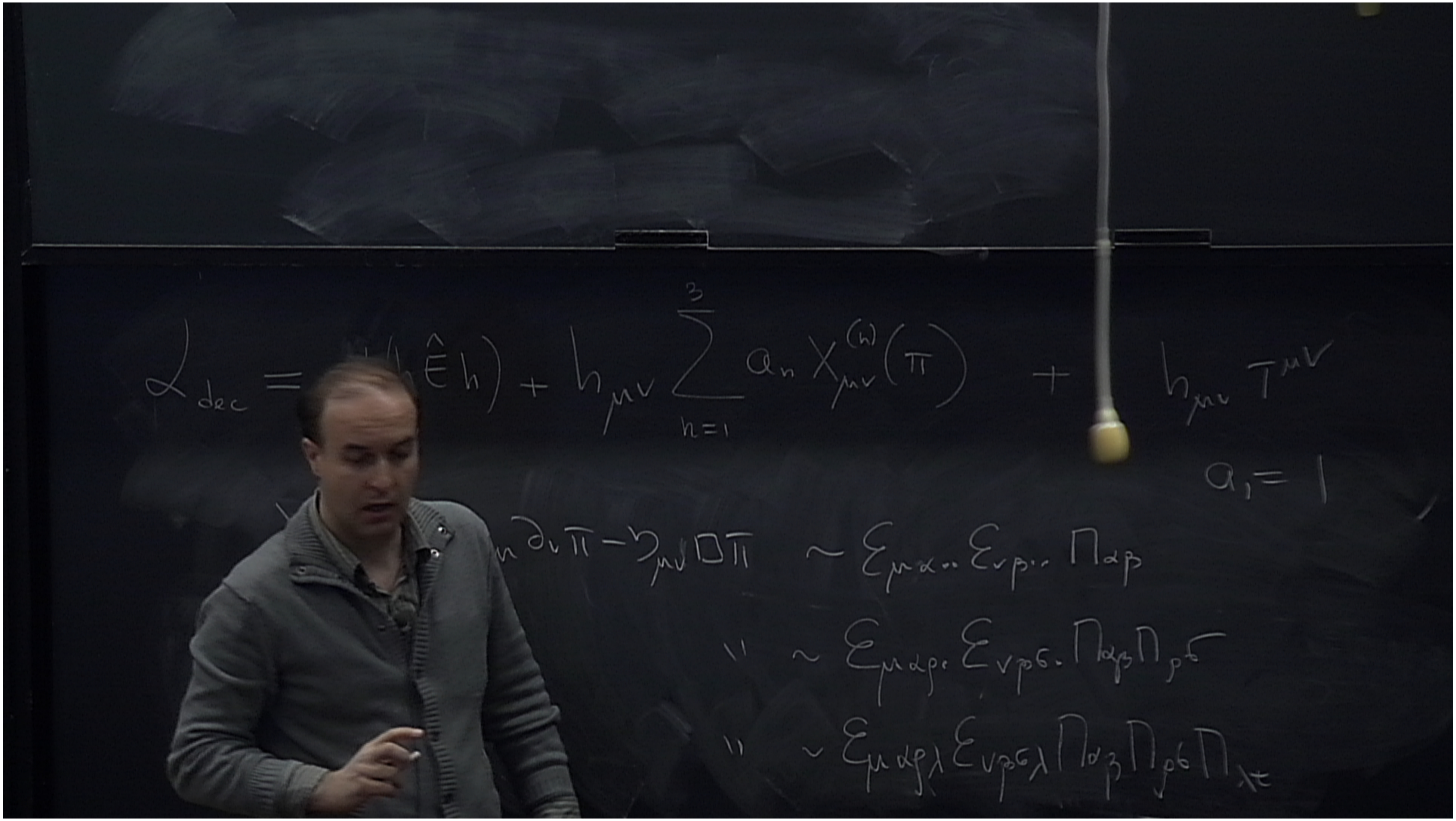

$\mathcal{L} = -\frac{1}{2}(h\hat{\mathcal{E}}h) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$
$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha\cdot\cdot}\varepsilon_{\nu\beta\cdot\cdot}\Pi_{\alpha\beta}$
" " $\sim \varepsilon_{\mu\alpha\rho\cdot}\varepsilon_{\nu\beta\sigma\cdot}\Pi_{\alpha\beta}\Pi_{\rho\sigma}$

$$\mathcal{L}_{dec} = -\frac{1}{2}\left(h\hat{\mathcal{E}}h\right) + h_{\mu\nu}\sum_{n=1}^{3} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$$

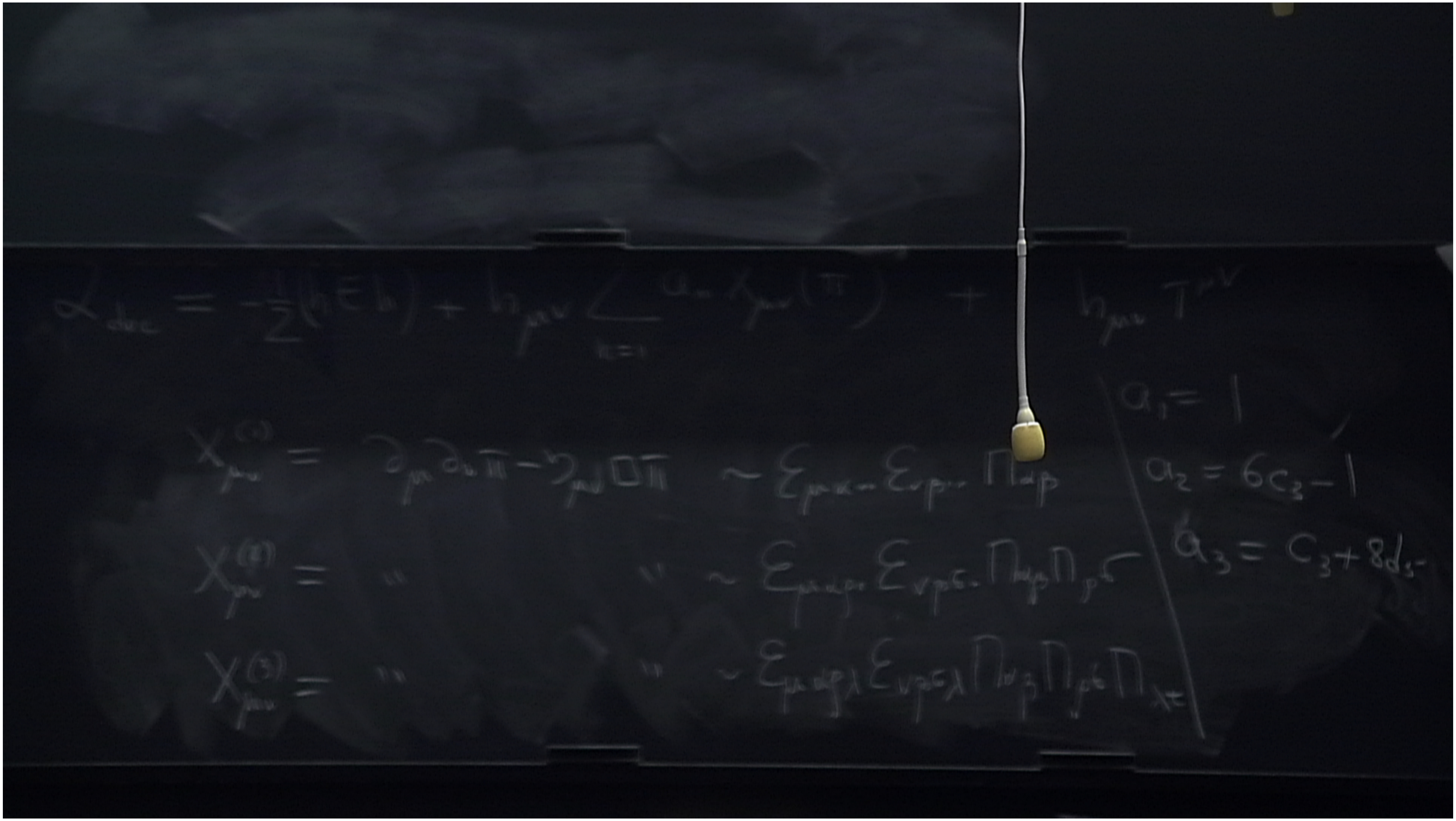
$$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha\cdot\cdot}\,\varepsilon_{\nu\beta\cdot\cdot}\,\Pi_{\alpha\beta}$$

$$X^{(2)}_{\mu\nu} = \quad " \qquad " \sim \varepsilon_{\mu\alpha\rho\cdot}\,\varepsilon_{\nu\beta\sigma\cdot}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}$$

$$X^{(3)}_{\mu\nu} = \quad " \qquad " \sim \varepsilon_{\mu\alpha\rho\lambda}\,\varepsilon_{\nu\beta\sigma\lambda}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}\Pi_{\lambda\tau}$$



a1 = 1


$\mathcal{L}_{dec} = -\frac{1}{2}(h \mathcal{E} h) + h_{\mu\nu} \sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu} T^{\mu\nu}$
$X^{(1)}_{\mu\nu} = \partial_\mu \partial_\nu \pi - \eta_{\mu\nu} \Box \pi \sim \varepsilon_{\mu\alpha\ldots} \varepsilon_{\nu\beta\ldots} \Pi_{\alpha\beta}$
$X^{(2)}_{\mu\nu} = \ldots \sim \varepsilon_{\mu\alpha\rho\ldots} \varepsilon_{\nu\beta\sigma\ldots} \Pi_{\alpha\beta} \Pi_{\rho\sigma}$
$X^{(3)}_{\mu\nu} = \ldots \sim \varepsilon_{\mu\alpha\rho\lambda} \varepsilon_{\nu\beta\sigma\lambda} \Pi_{\alpha\beta} \Pi_{\rho\sigma} \Pi_{\lambda\tau}$
$a_1 = 1$
$a_2 = 6c_3 - 1$
$a_3 = c_3 + 8d_5$

$$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{\mathcal{E}}h) + h_{\mu\nu}\sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$$

$$\pi \to \pi + c_\mu x_\mu + c$$

$$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha\cdot\cdot}\,\varepsilon_{\nu\beta\cdot\cdot}\,\Pi_{\alpha\beta}$$

$$X^{(2)}_{\mu\nu} = \text{''} \qquad \text{''} \sim \varepsilon_{\mu\alpha\rho\cdot}\,\varepsilon_{\nu\beta\sigma\cdot}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}$$

$$X^{(3)}_{\mu\nu} = \text{''} \qquad \text{''} \sim \varepsilon_{\mu\alpha\rho\lambda}\,\varepsilon_{\nu\beta\sigma\lambda}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}\Pi_{\lambda\tau}$$

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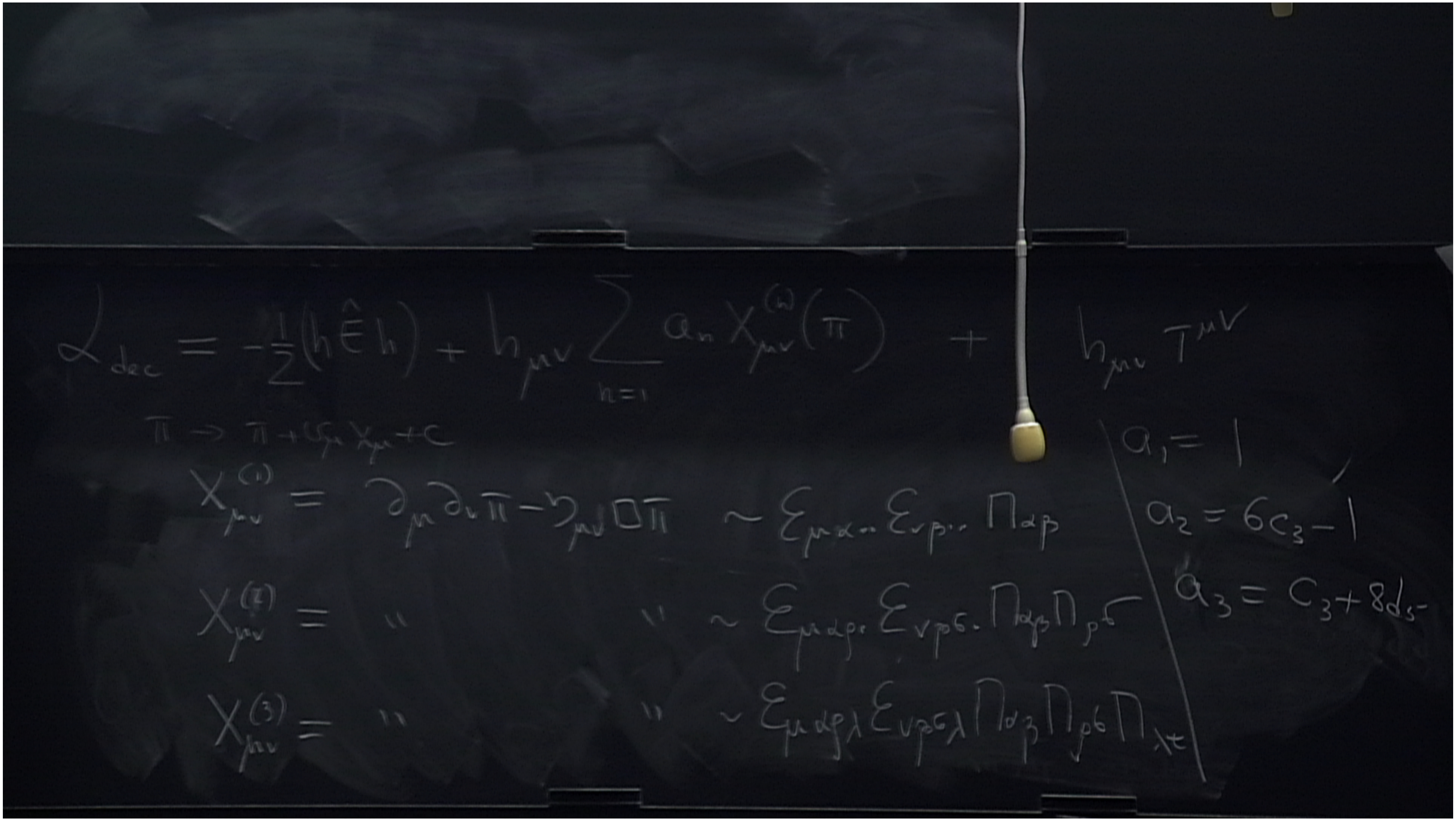
$$a_2 = 6c_3 - 1$$

$$a_3 = c_3 + 8d_5$$


$\mathcal{L}_{dec} = -\frac{1}{2}(h \hat{\mathcal{E}} h) + h_{\mu\nu} \sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu} T^{\mu\nu}$
$\pi \to \pi + c\, x_\mu + c$
$X^{(1)}_{\mu\nu} = \partial_\mu \partial_\nu \pi - \eta_{\mu\nu} \Box \pi \sim \varepsilon_{\mu\alpha..} \varepsilon_{\nu\beta..} \Pi_{\alpha\beta}$
$X^{(2)}_{\mu\nu} = " \quad " \sim \varepsilon_{\mu\alpha\rho.} \varepsilon_{\nu\beta\sigma.} \Pi_{\alpha\beta} \Pi_{\rho\sigma}$
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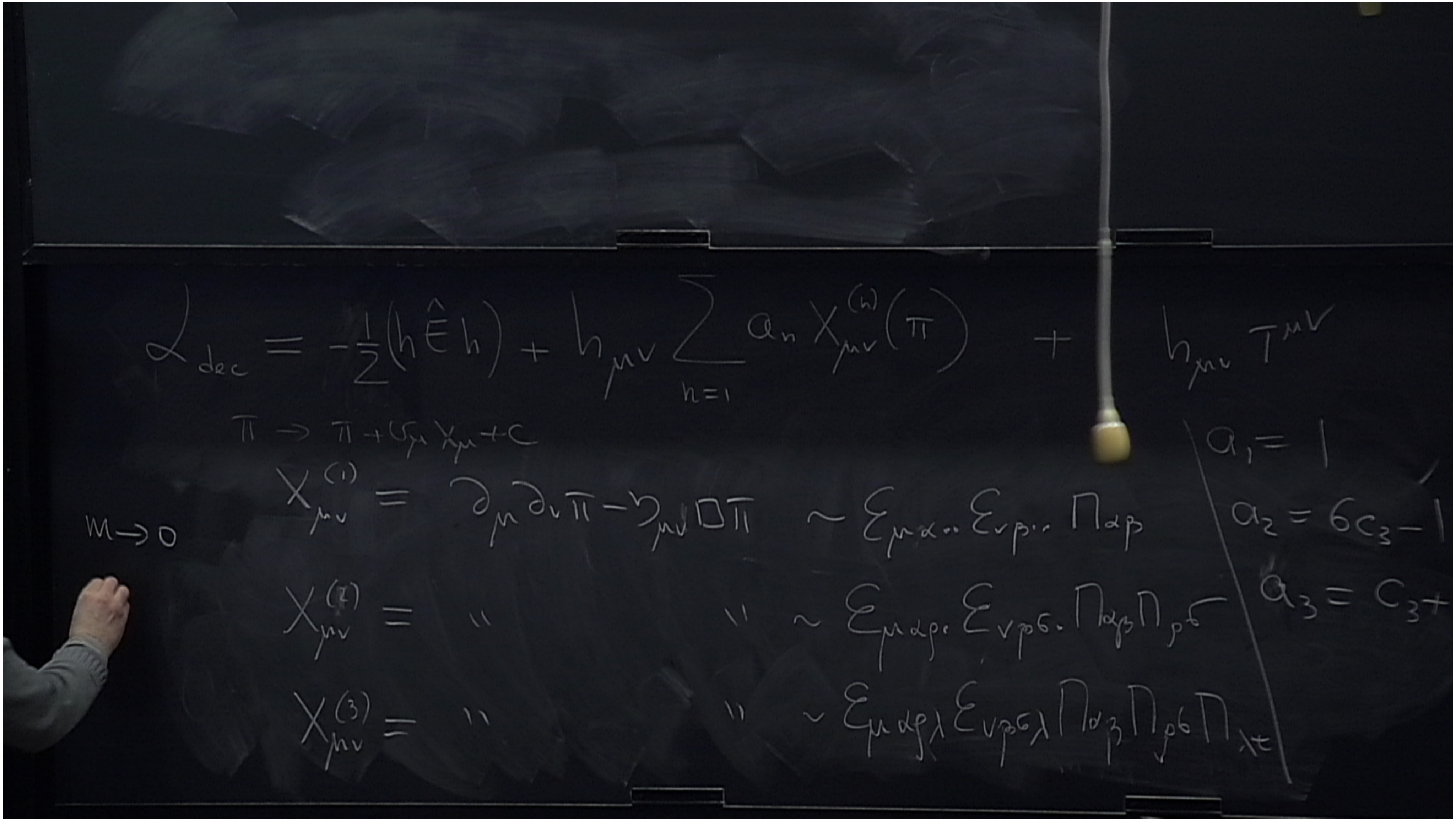
$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{E}h) + h_{\mu\nu}\sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$
$\pi \to \pi + c\,x_\mu + c$
$m \to 0$
$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha..}\varepsilon_{\nu\beta..}\Pi_{\alpha\beta}$
$X^{(2)}_{\mu\nu} = \sim \varepsilon_{\mu\alpha\rho.}\varepsilon_{\nu\beta\sigma.}\Pi_{\alpha\beta}\Pi_{\rho\sigma}$
$X^{(3)}_{\mu\nu} = \sim \varepsilon_{\mu\alpha\rho\lambda}\varepsilon_{\nu\beta\sigma\lambda}\Pi_{\alpha\beta}\Pi_{\rho\sigma}\Pi_{\lambda}$
$a_1 = 1$
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$$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{\mathcal{E}}h) + h_{\mu\nu}\sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) + h_{\mu\nu}T^{\mu\nu}$$

$$\pi \to \pi + c_\mu x_\mu + c$$

$m \to 0$

$M_p \to \infty$

$$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha..}\varepsilon_{\nu\beta..}\Pi_{\alpha\beta}$$

$$X^{(2)}_{\mu\nu} = \text{''} \quad \text{''} \sim \varepsilon_{\mu\alpha\rho.}\varepsilon_{\nu\beta\sigma.}\Pi_{\alpha\beta}\Pi_{\rho\sigma}$$

$$X^{(3)}_{\mu\nu} = \text{''} \quad \text{''} \sim \varepsilon_{\mu\alpha\rho\lambda}\varepsilon_{\nu\beta\sigma\lambda}\Pi_{\alpha\beta}\Pi_{\rho\sigma}\Pi_{\lambda\tau}$$

$a_1 = 1$

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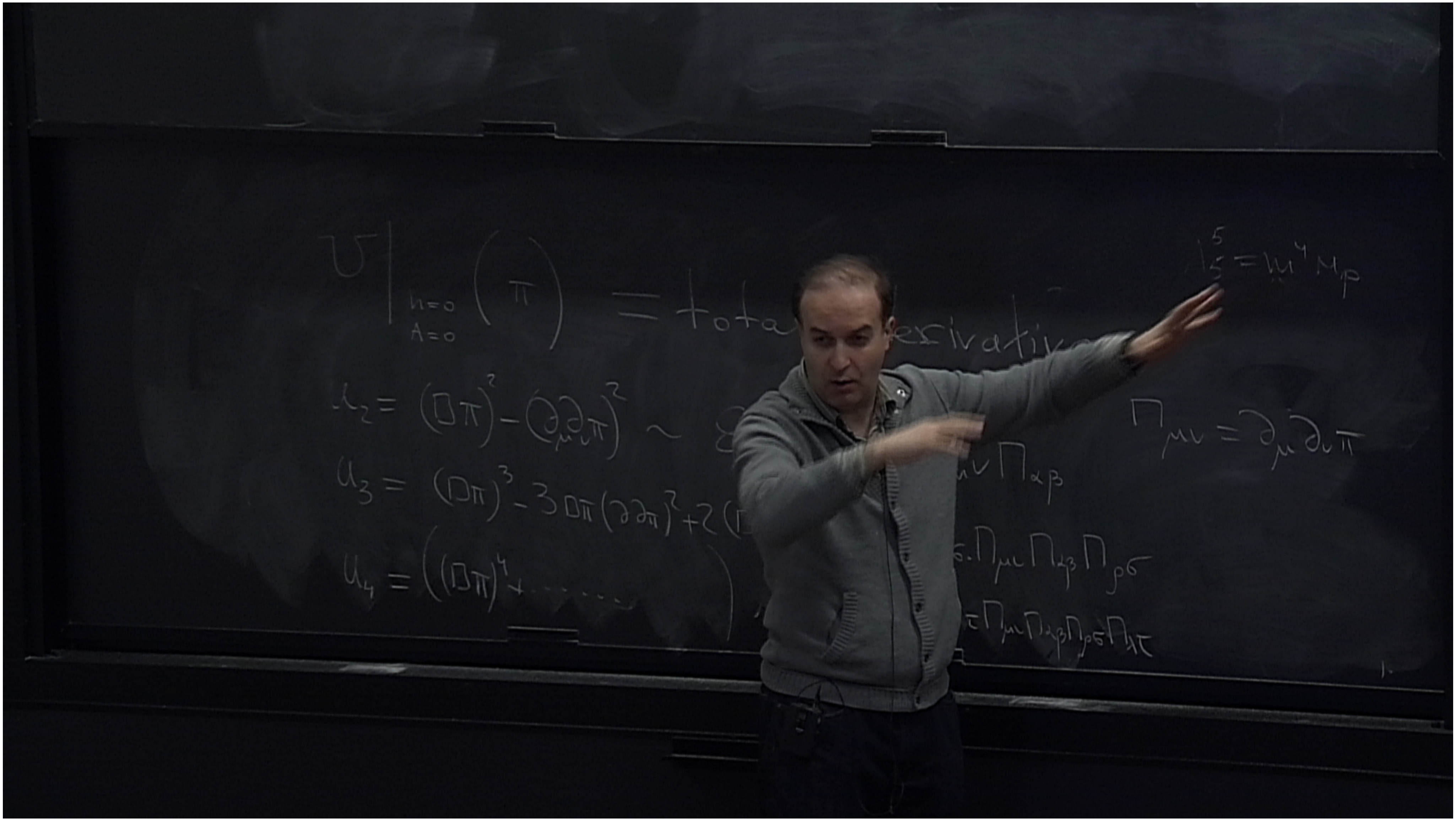
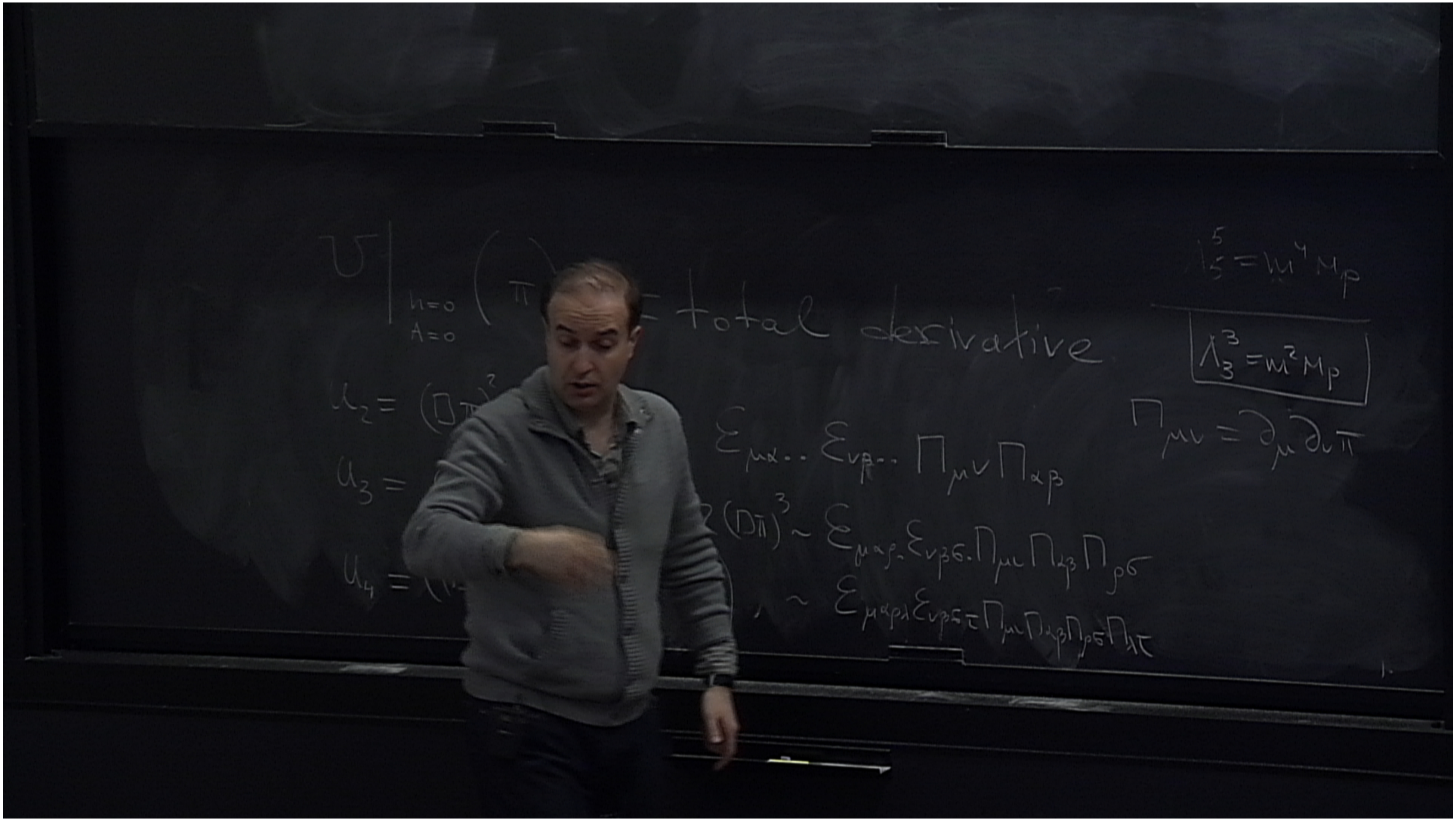
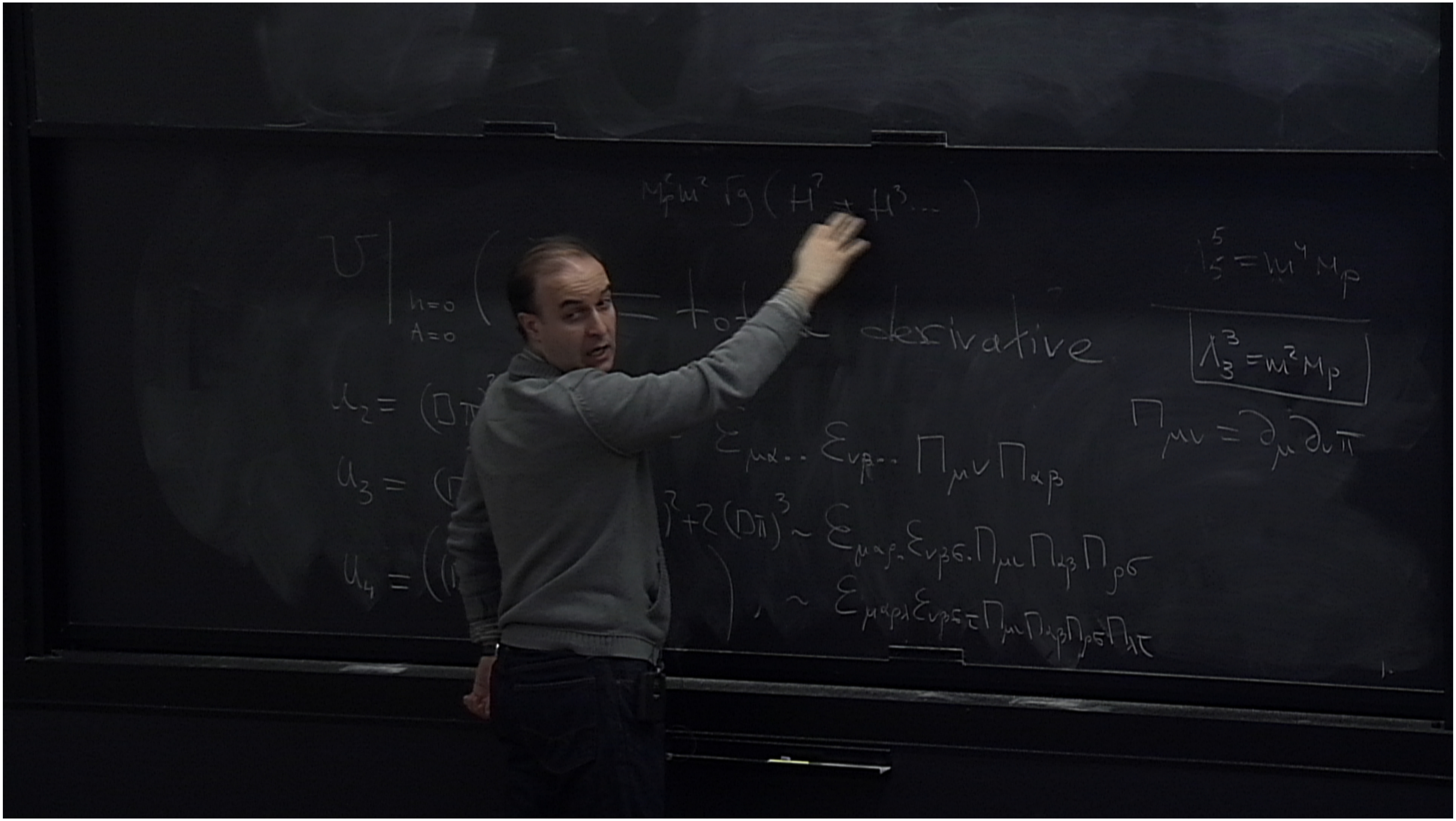


$\mathcal{L}\big|_{h=0, A=0}(\pi)$ = total derivative
$\Lambda_5^5 = m^4 M_p$
$\mathcal{L}_2 = (\Box\pi)^2 - (\partial_\mu\partial_\nu\pi)^2$
$\Pi_{\mu\nu} = \partial_\mu\partial_\nu\pi$
$\mathcal{L}_3 = (\Box\pi)^3 - 3\Box\pi(\partial\partial\pi)^2 + 2($
$\mathcal{L}_4 = ((\Box\pi)^4 + \dots)$




derivative
Λ_3^3 = m^2 M_p
Λ_5^5 = m^4 M_p
Π_μν = ∂_μ ∂_ν π
h=0
A=0

$$\mathcal{L}_{dec} = -\frac{1}{2}(h\hat{\mathcal{E}}h) + h_{\mu\nu}\sum_{n=1} a_n X^{(n)}_{\mu\nu}(\pi) \quad + \quad h_{\mu\nu}T^{\mu\nu}$$

$$\pi \to \pi + c_\mu x_\mu + c$$

$m \to 0$

$M_p \to \infty$

$$X^{(1)}_{\mu\nu} = \partial_\mu\partial_\nu\pi - \eta_{\mu\nu}\Box\pi \sim \varepsilon_{\mu\alpha\cdot\cdot}\,\varepsilon_{\nu\beta\cdot\cdot}\,\Pi_{\alpha\beta}$$

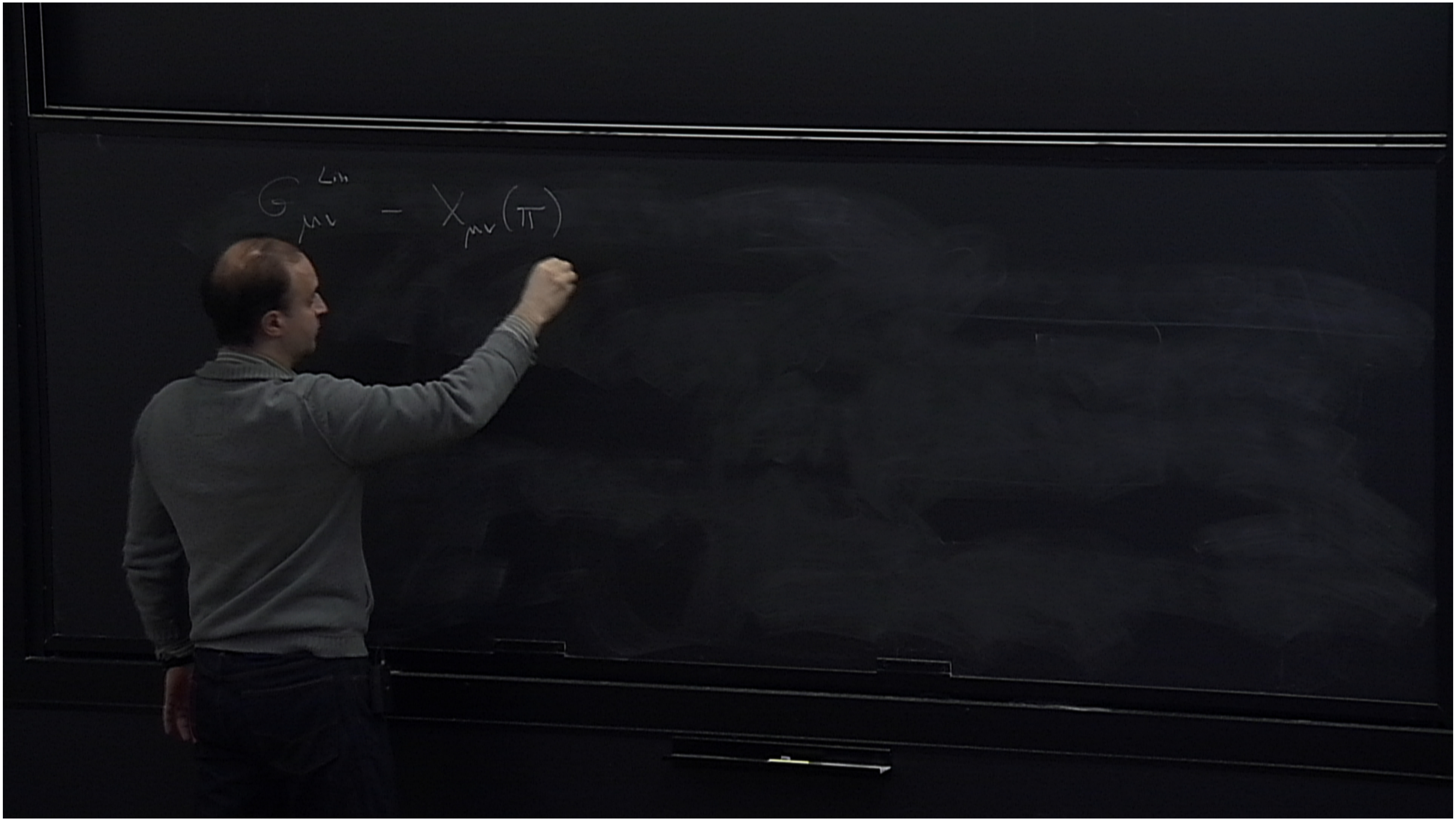
$$X^{(2)}_{\mu\nu} = \;'' \qquad '' \sim \varepsilon_{\mu\alpha\rho\cdot}\,\varepsilon_{\nu\beta\sigma\cdot}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}$$

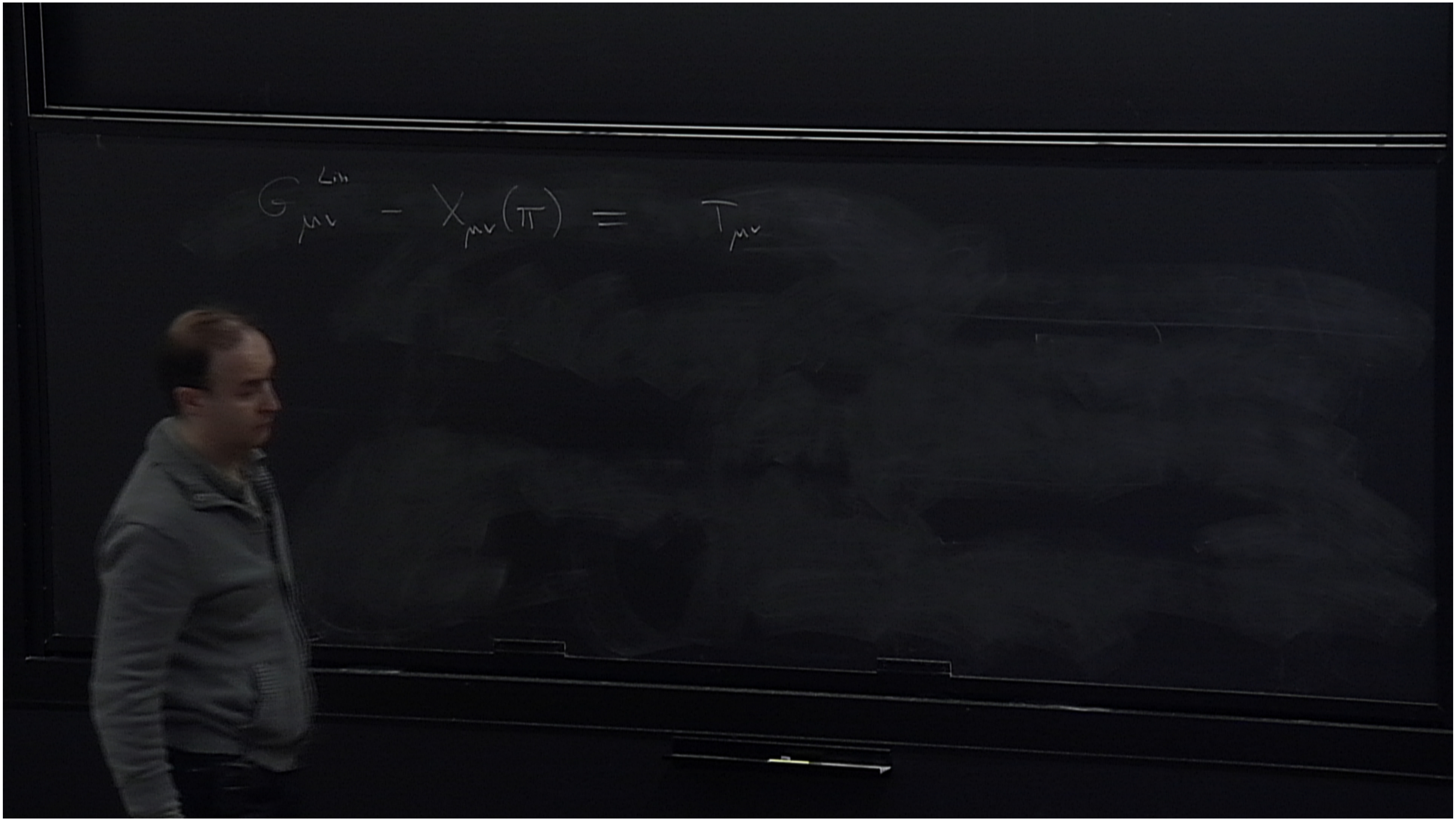
$$X^{(3)}_{\mu\nu} = \;'' \qquad '' \sim \varepsilon_{\mu\alpha\rho\lambda}\,\varepsilon_{\nu\beta\sigma\lambda}\,\Pi_{\alpha\beta}\Pi_{\rho\sigma}\Pi_{\lambda\tau}$$

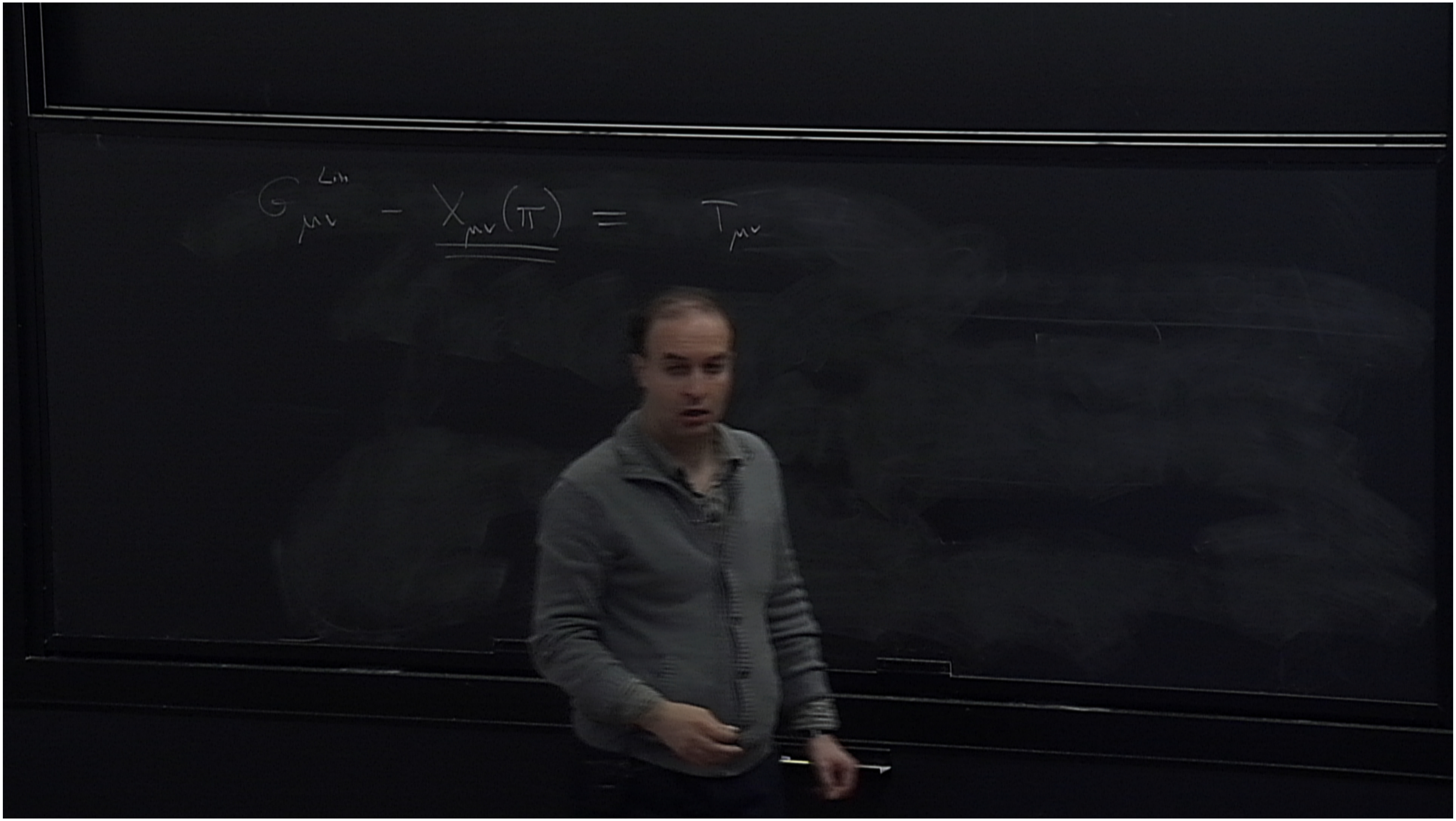
$a_1 = 1$

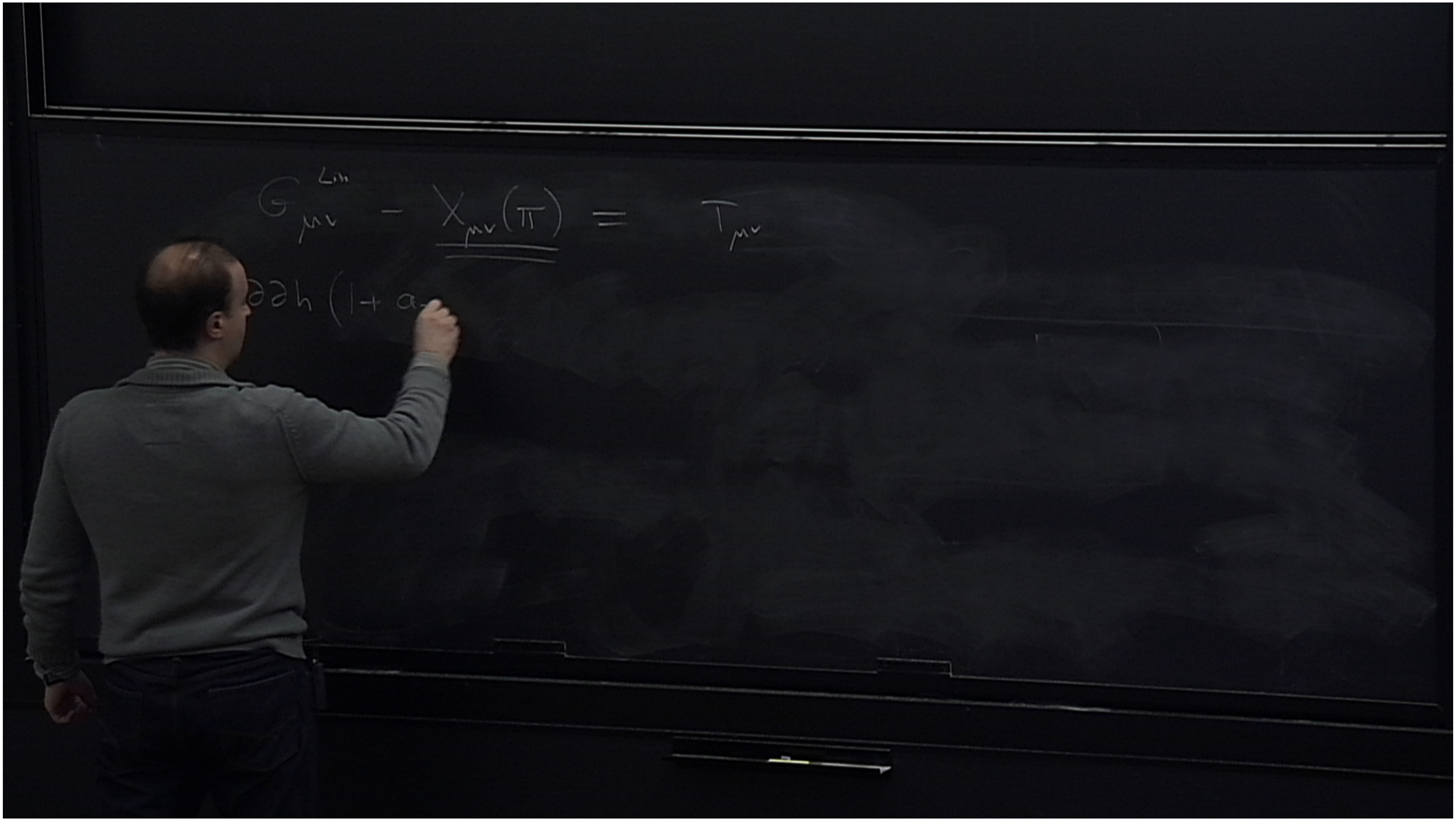
$a_2 = \frac{6c_3 - 1}{\Lambda_3^3}$

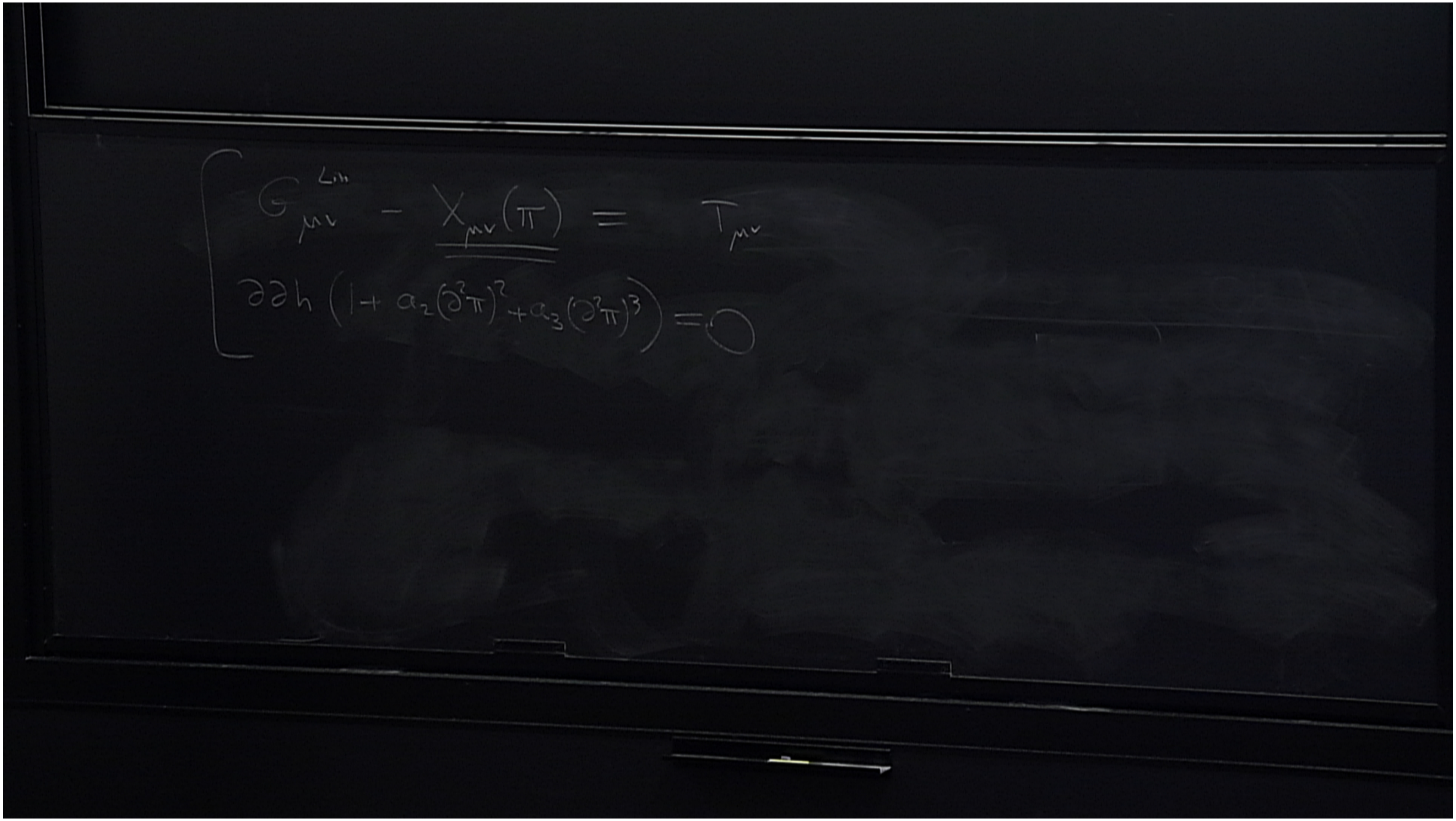
$a_3 = \frac{c_3 + \dots}{\Lambda \dots}$

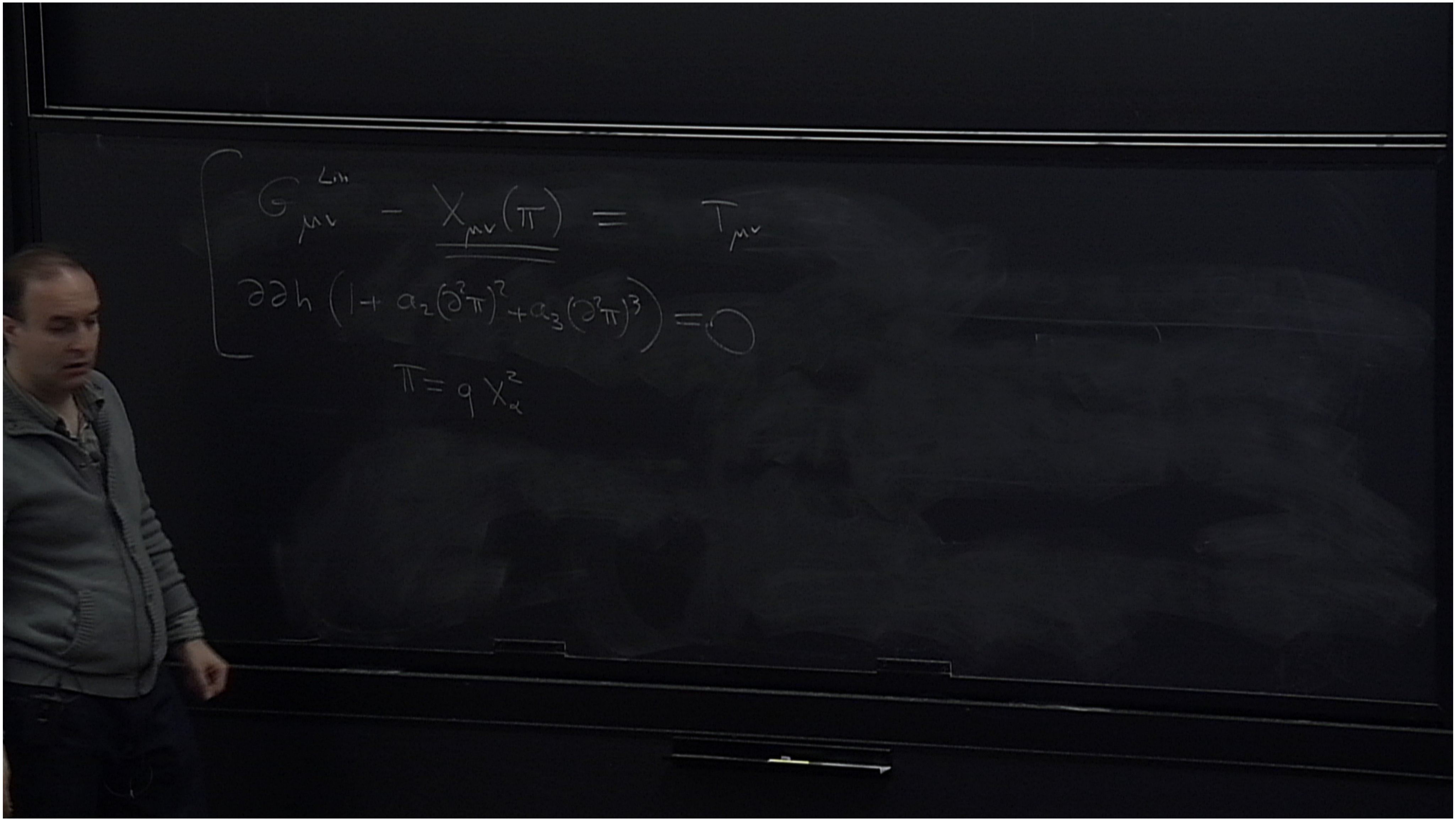

$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi)$


$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$

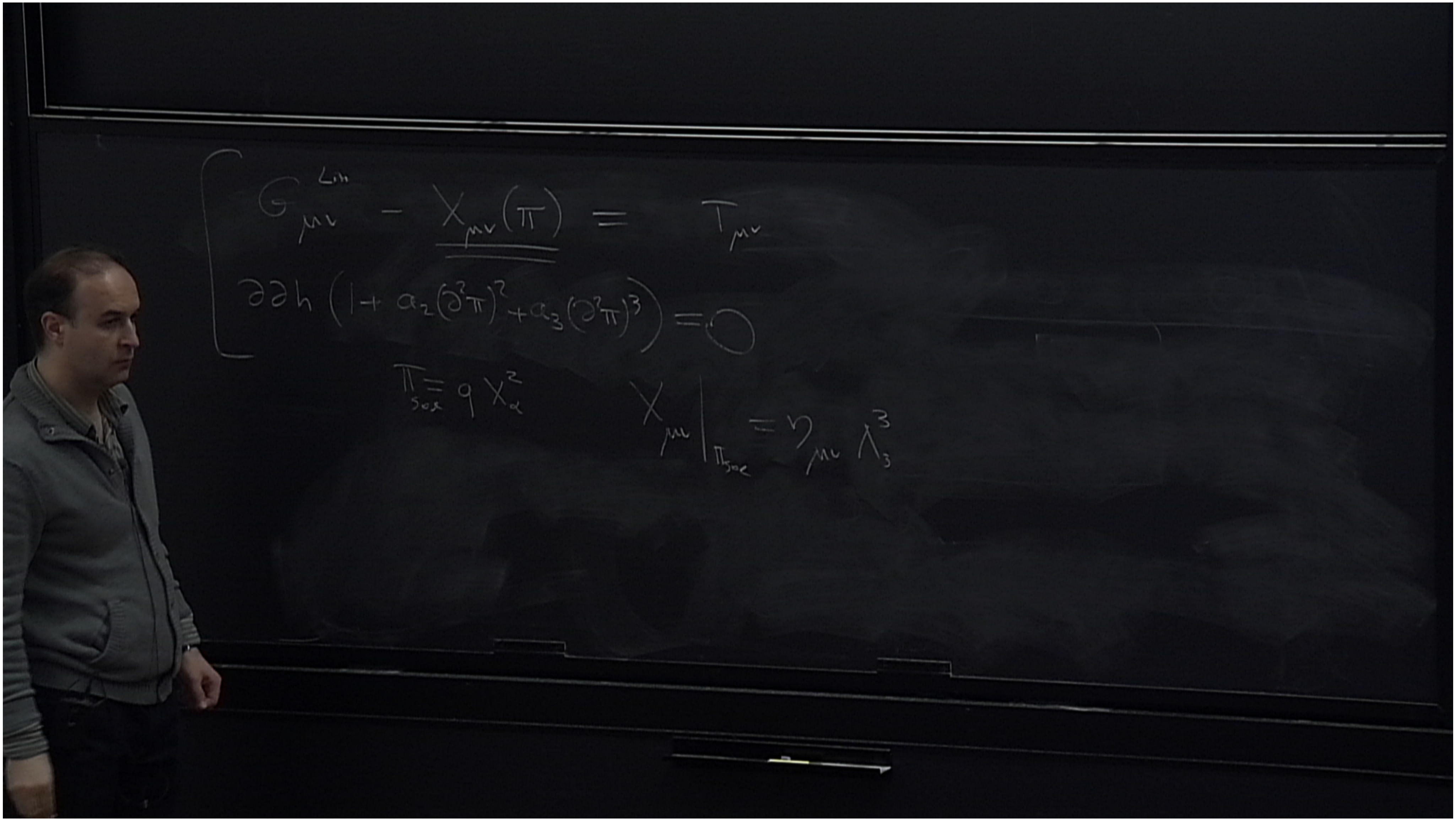

$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$

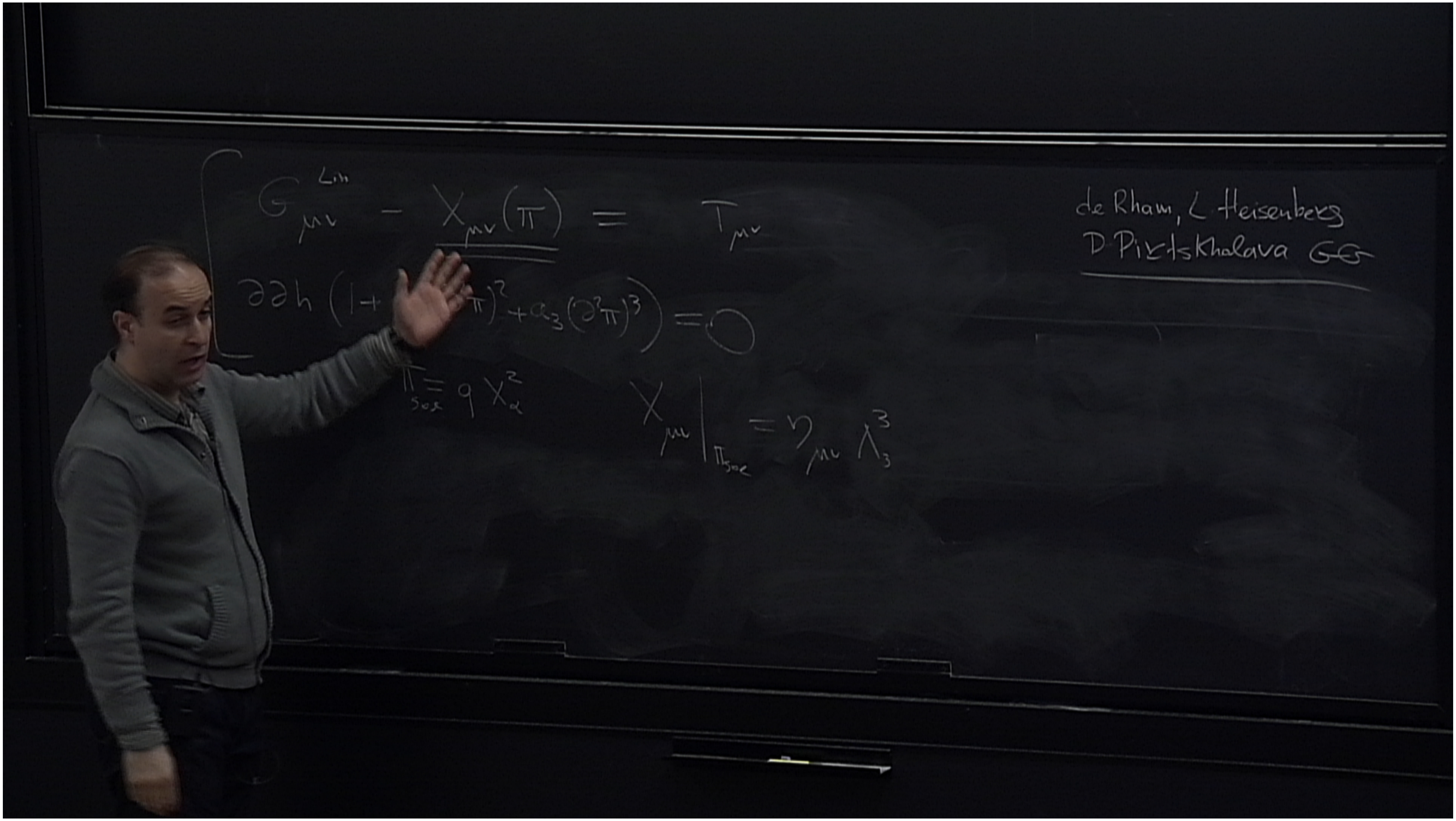

$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$
$\partial\partial h (1 + a$

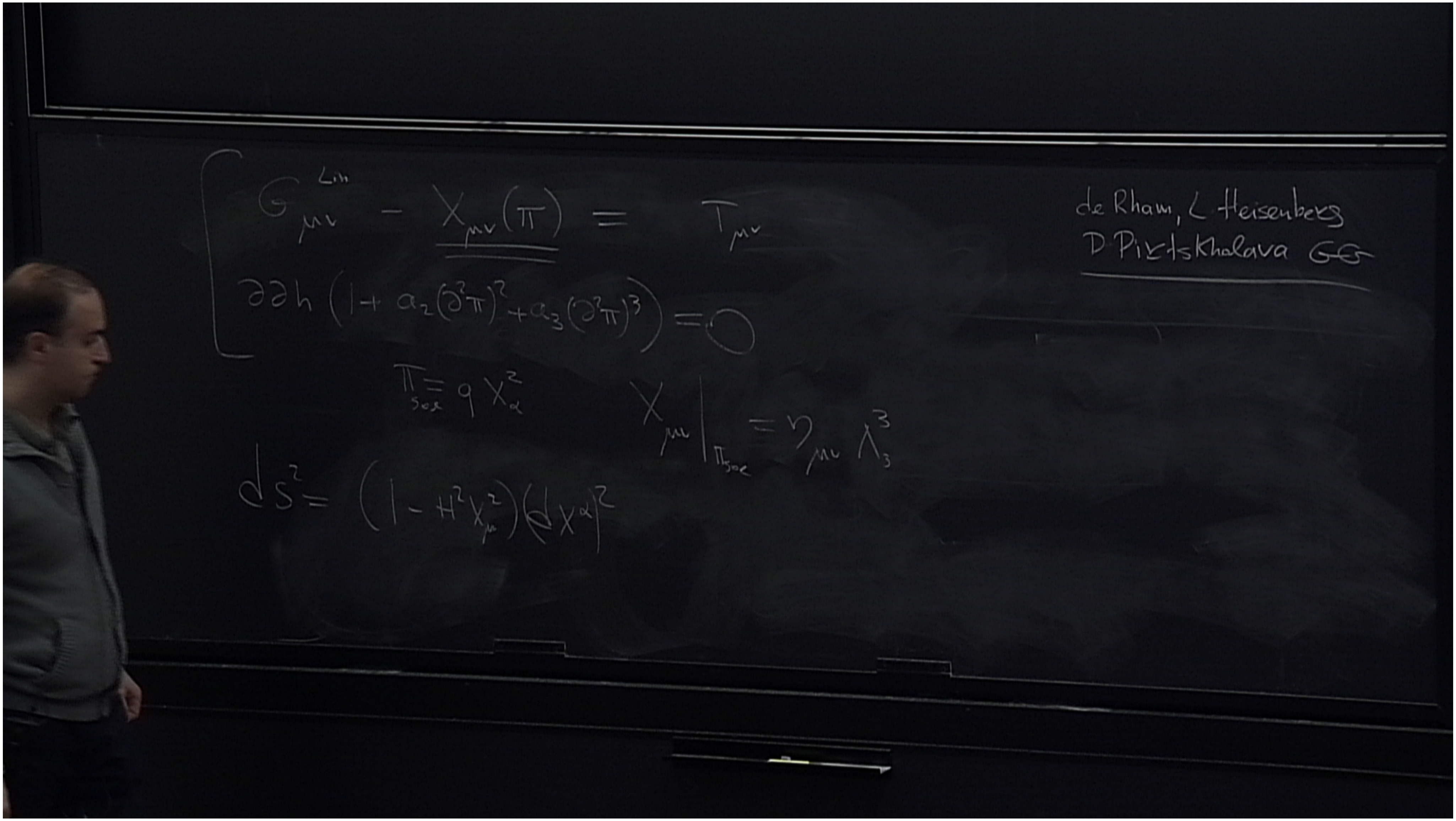

$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$
$\partial\partial h \left(1 + a_2(\partial^2\pi)^2 + a_3(\partial^2\pi)^3\right) = 0$



$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$
$\partial\partial h \left(1 + a_2(\partial^2\pi)^2 + a_3(\partial^2\pi)^3\right) = 0$
$\pi = q X_\alpha^2$


$G^{Lin}_{\mu\nu} - X_{\mu\nu}(\pi) = T_{\mu\nu}$
$\partial\partial h \left(1 + a_2(\partial^2\pi)^2 + a_3(\partial^2\pi)^3\right) = 0$
$\pi_{sol} = q\, x_\alpha^2$
$X_{\mu\nu}\big|_{\pi_{sol}} = \eta_{\mu\nu}\Lambda_3^3$


de Rham, L Heisenberg
D Pirtskhalava GG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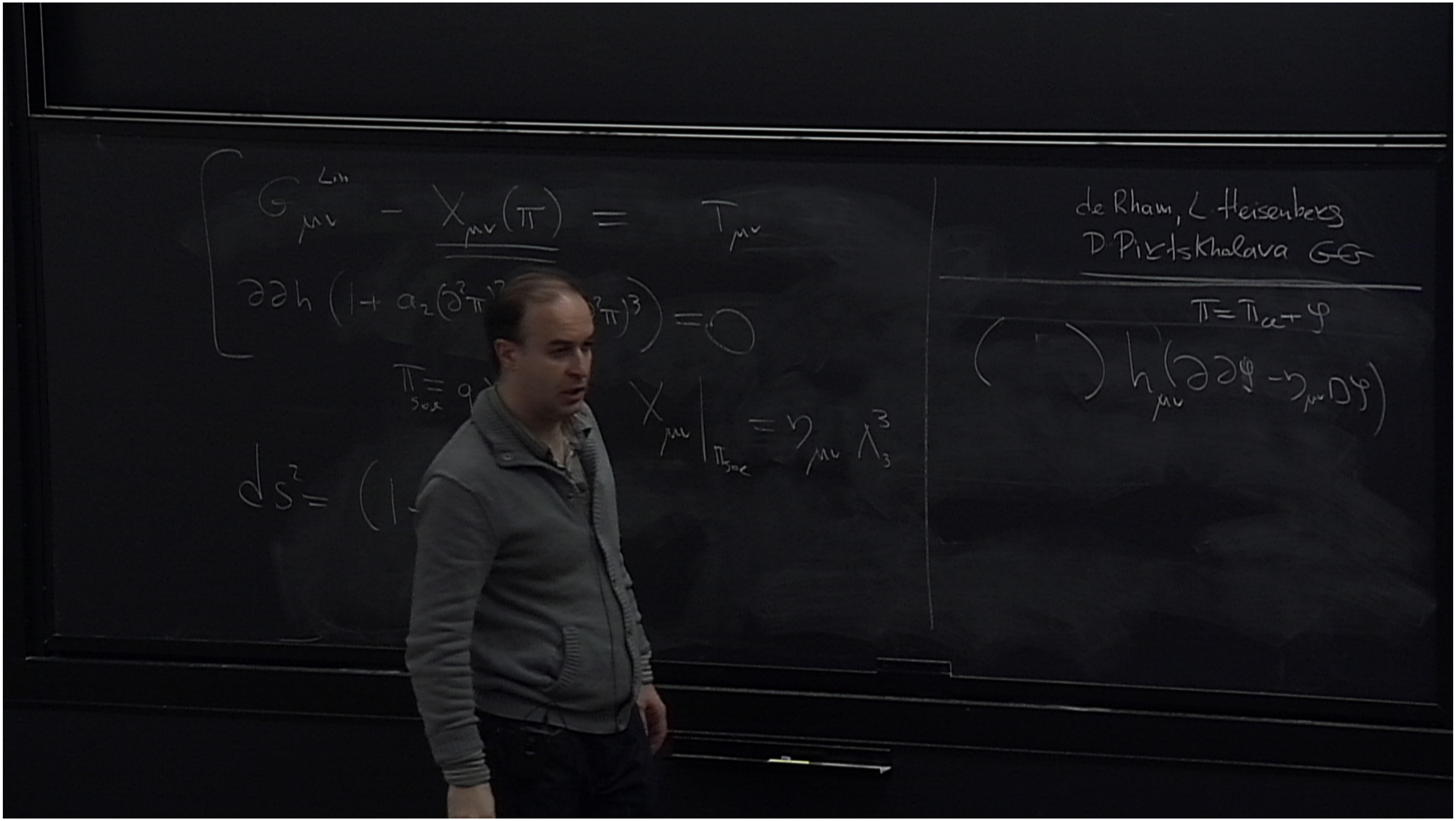
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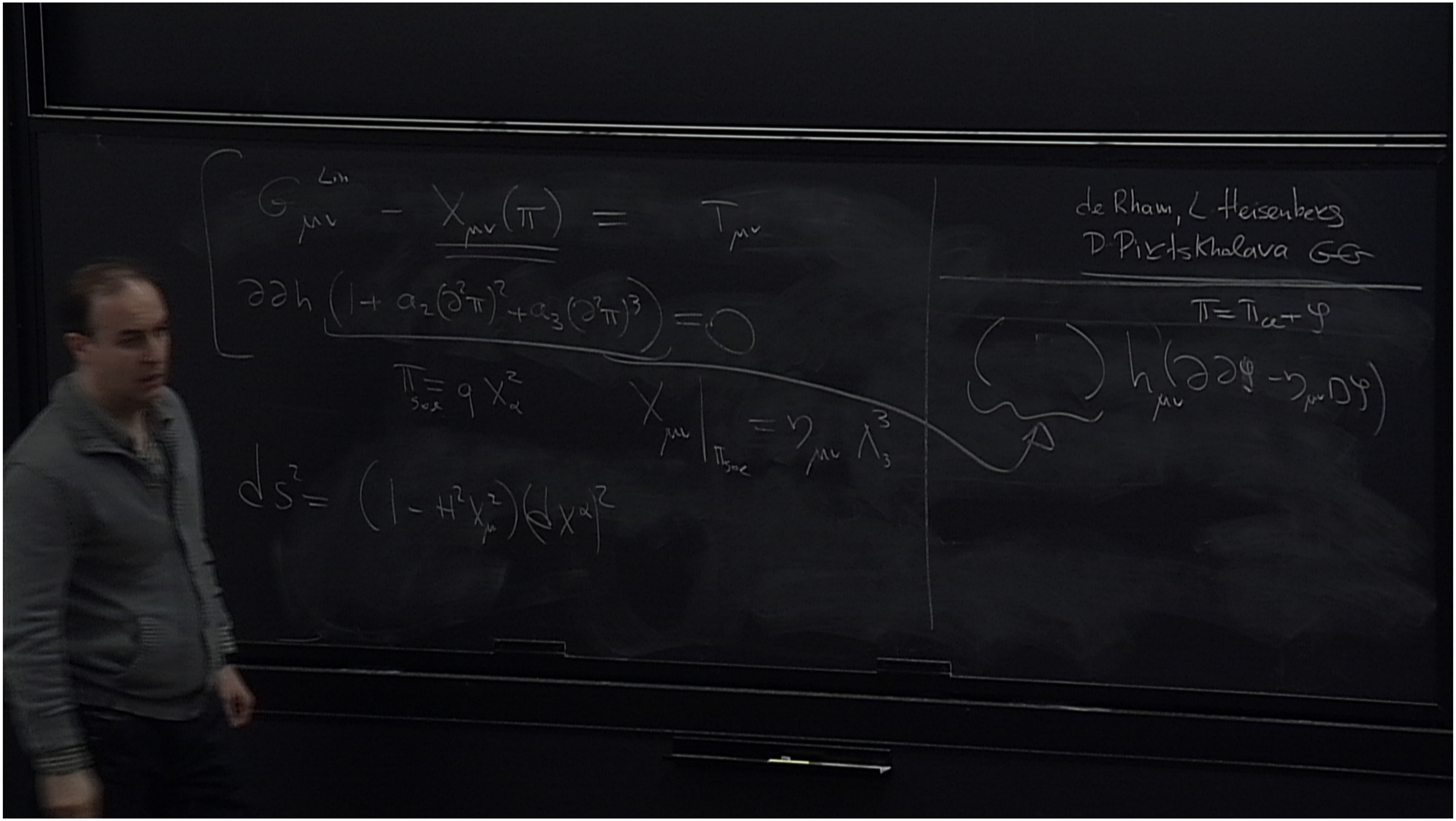
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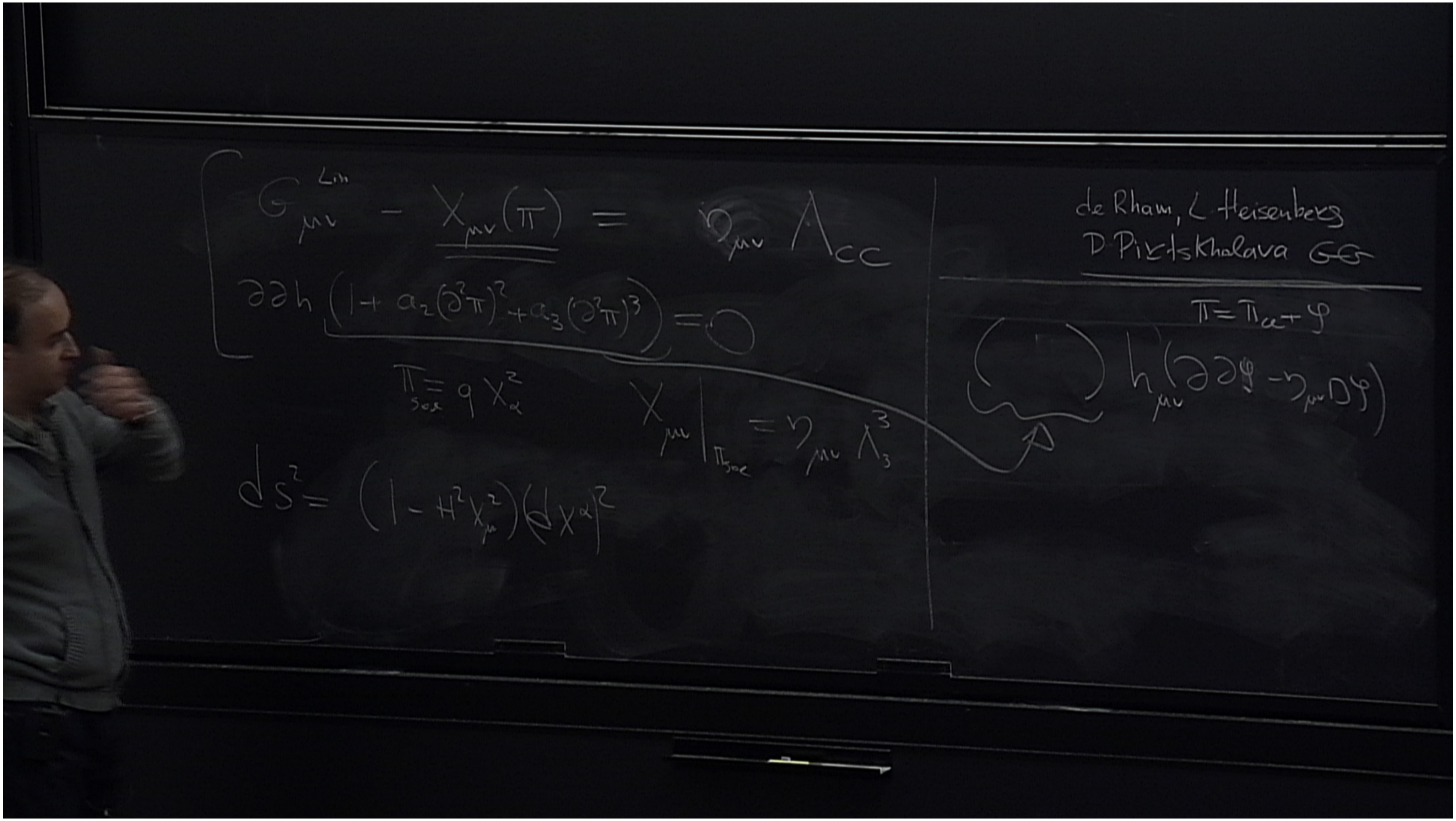
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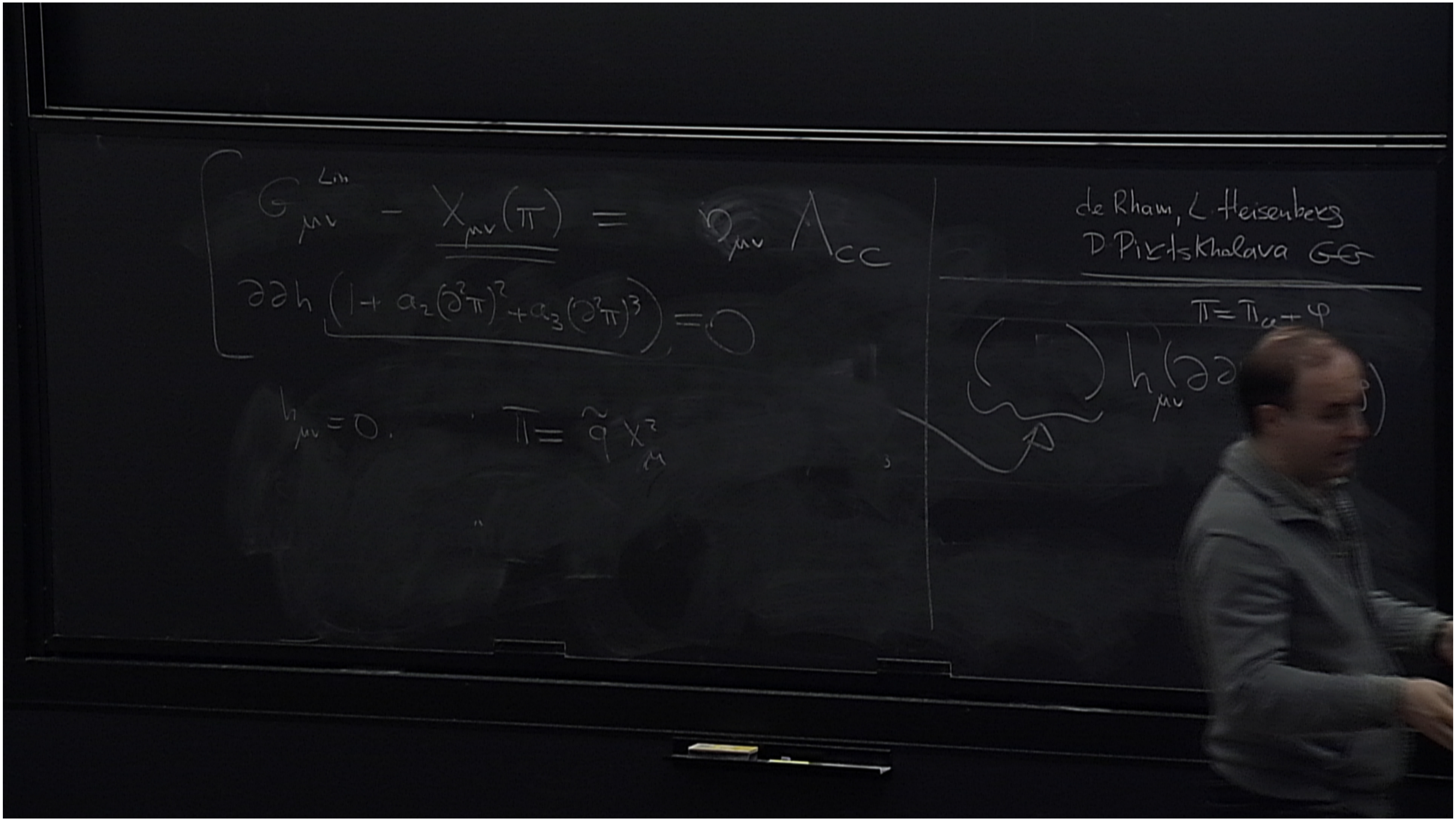
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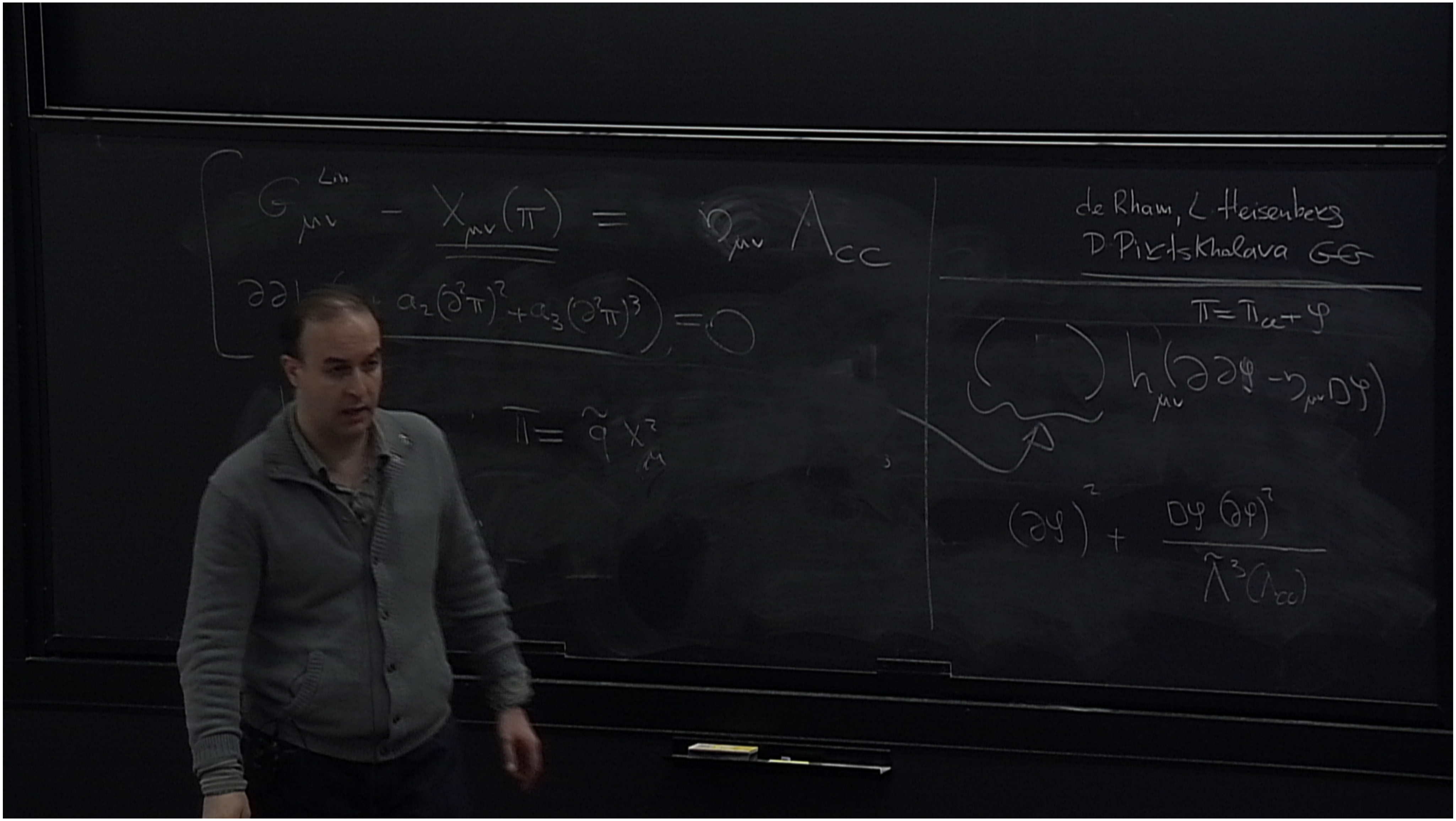
D Pirtskhalava GG
$G_{\mu\nu}^{Lin} - X_{\mu\nu}(\pi) = \eta_{\mu\nu}\Lambda_{cc}$
$\partial\partial h\,(1 + a_2(\partial^2\pi)^2 + a_3(\partial^2\pi)^3) = 0$
$h_{\mu\nu} = 0.$
$\pi = \tilde{q}\,x_\mu^2$
$\pi = \pi_{cl} + \varphi$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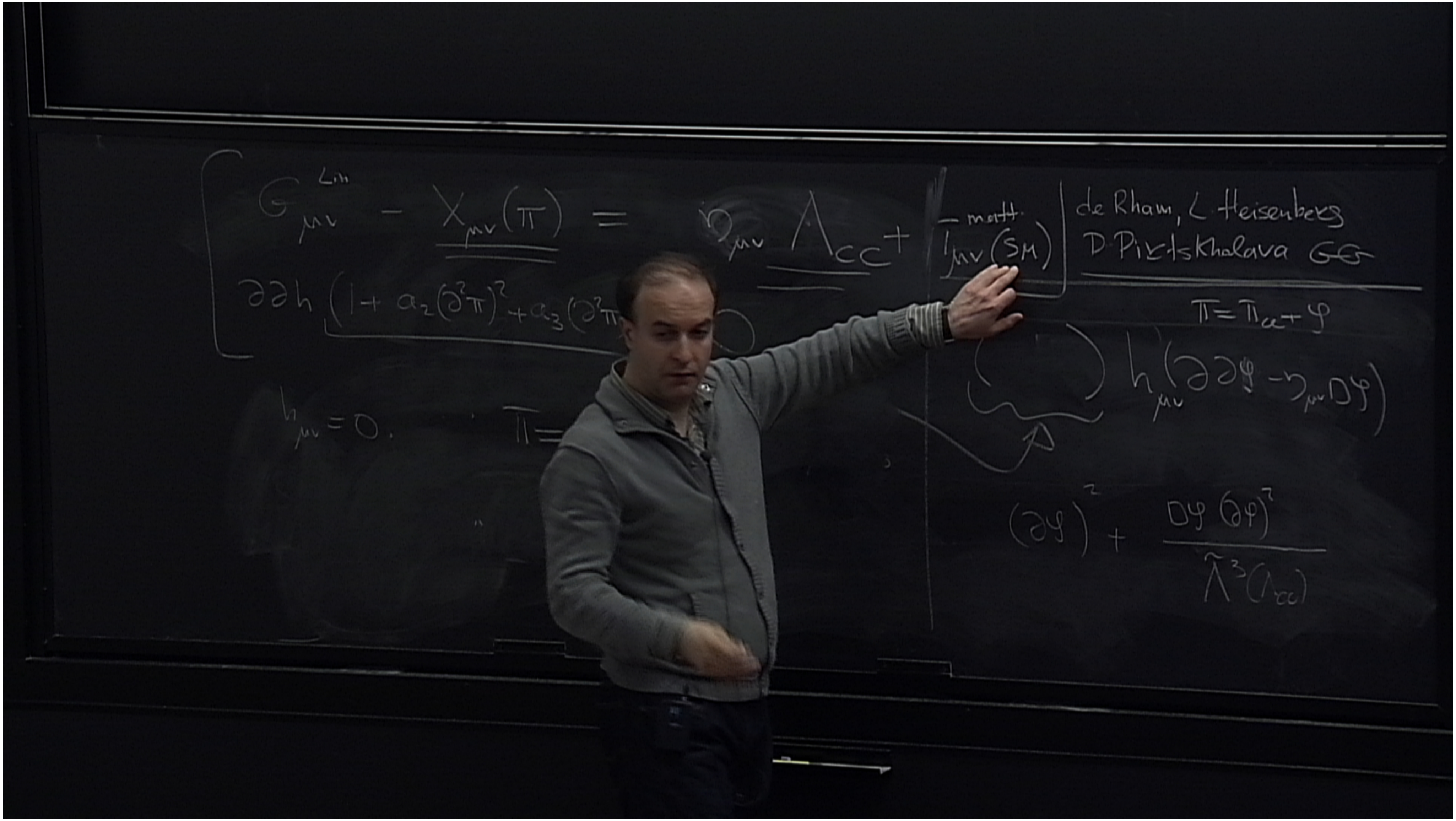
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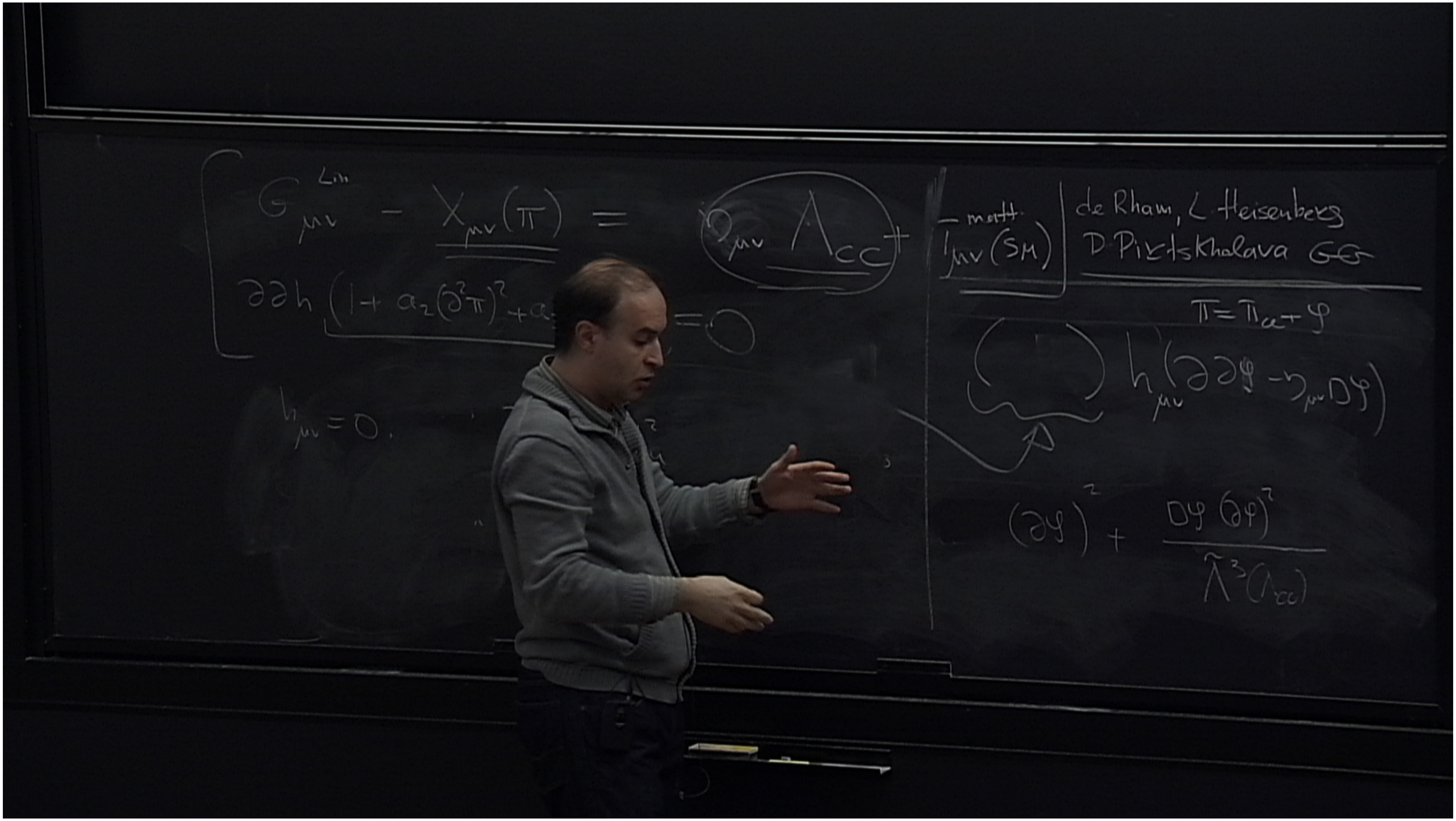
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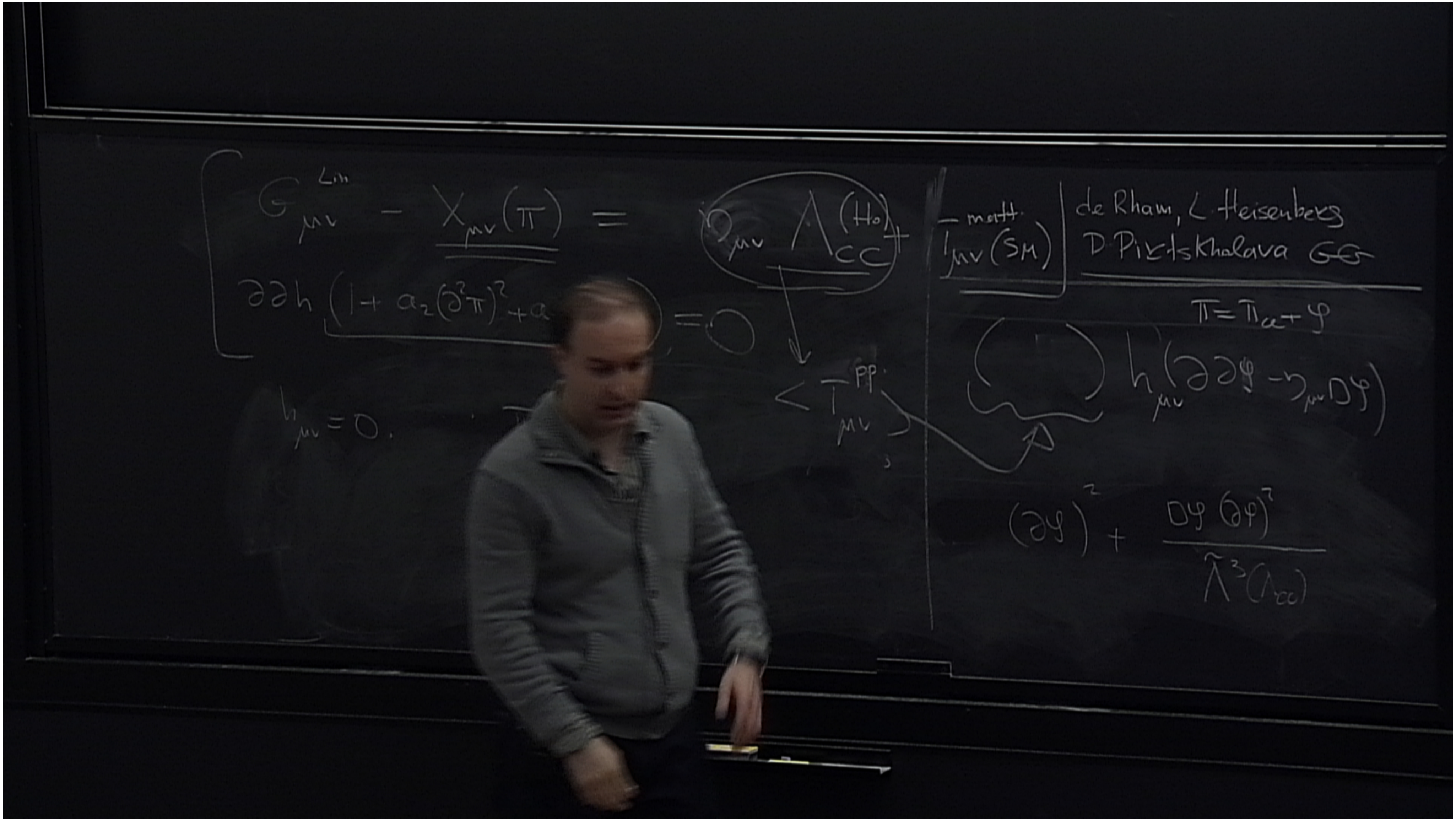
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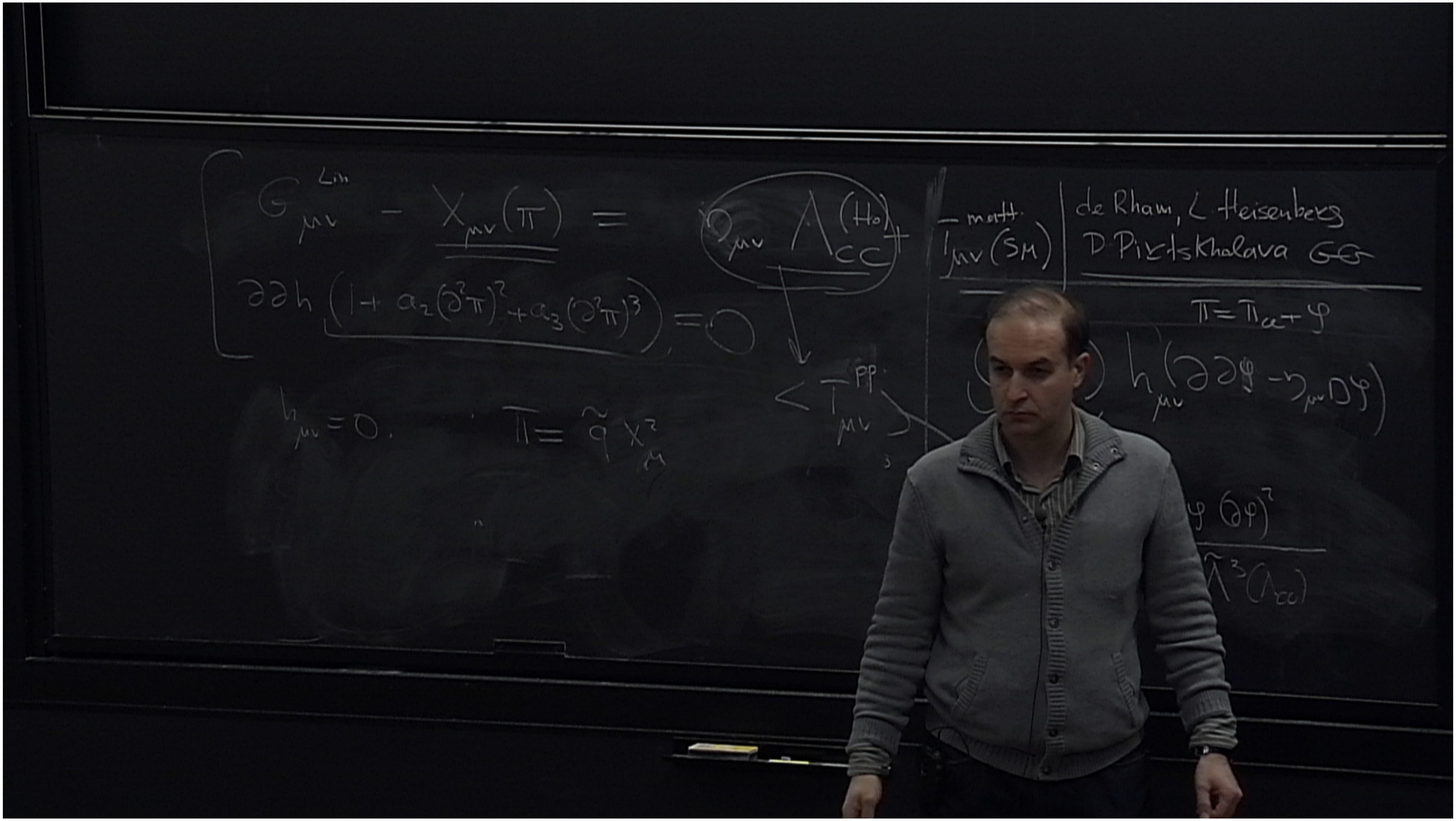
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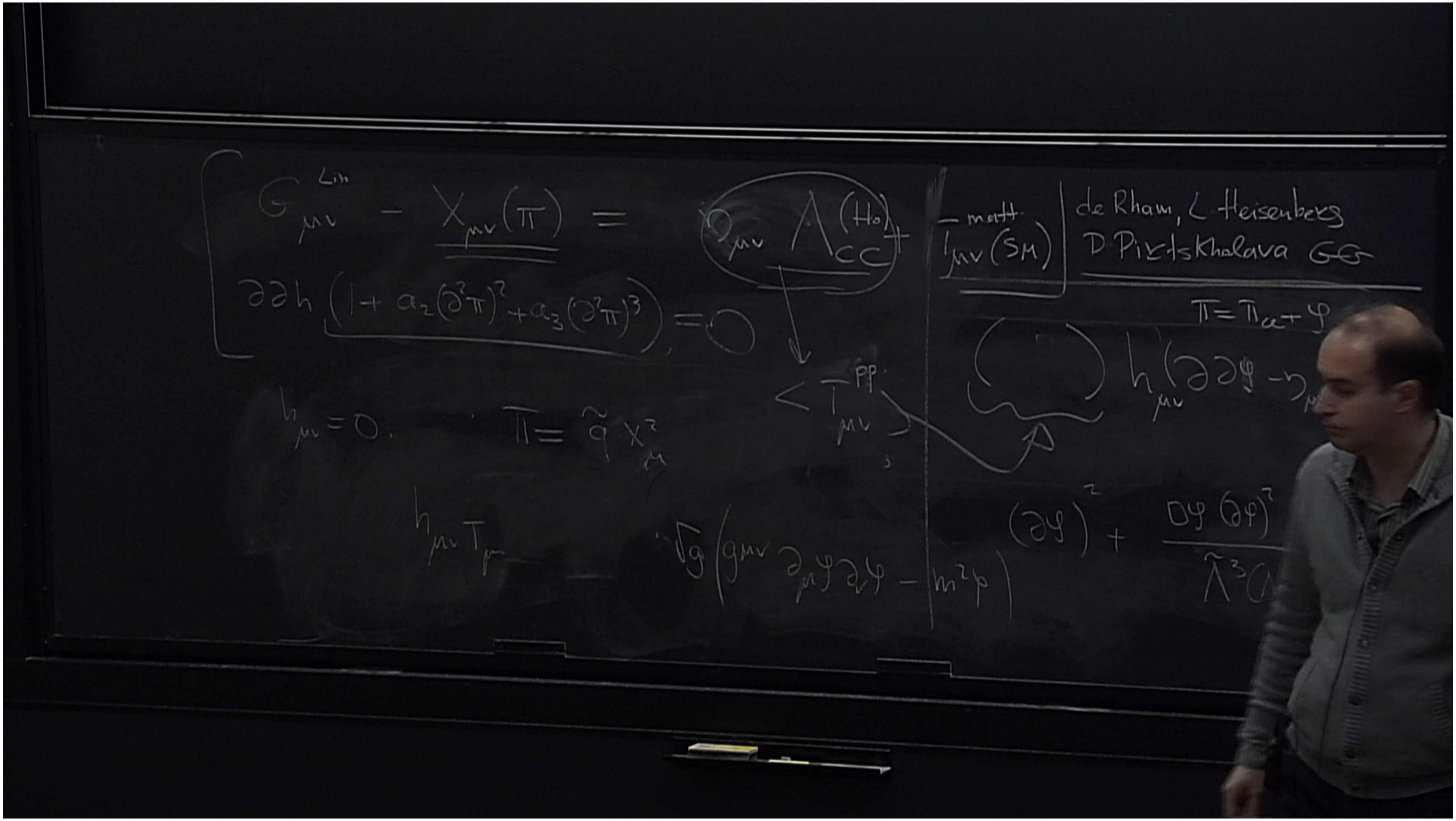
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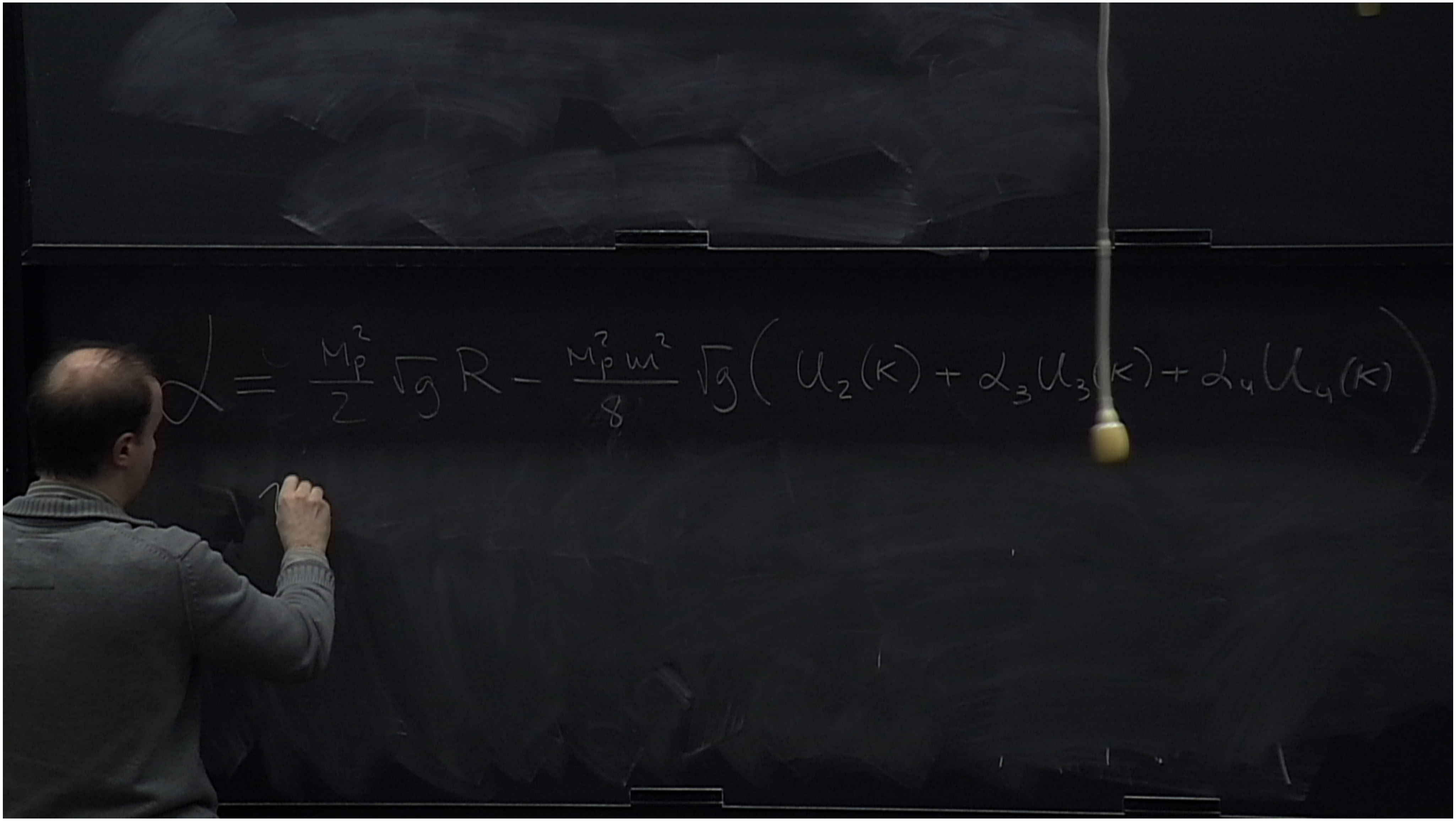
$$g_{\mu\nu} = \partial_\mu Y^a \partial_\nu Y^b \eta_{ab} + H_{\mu\nu}$$

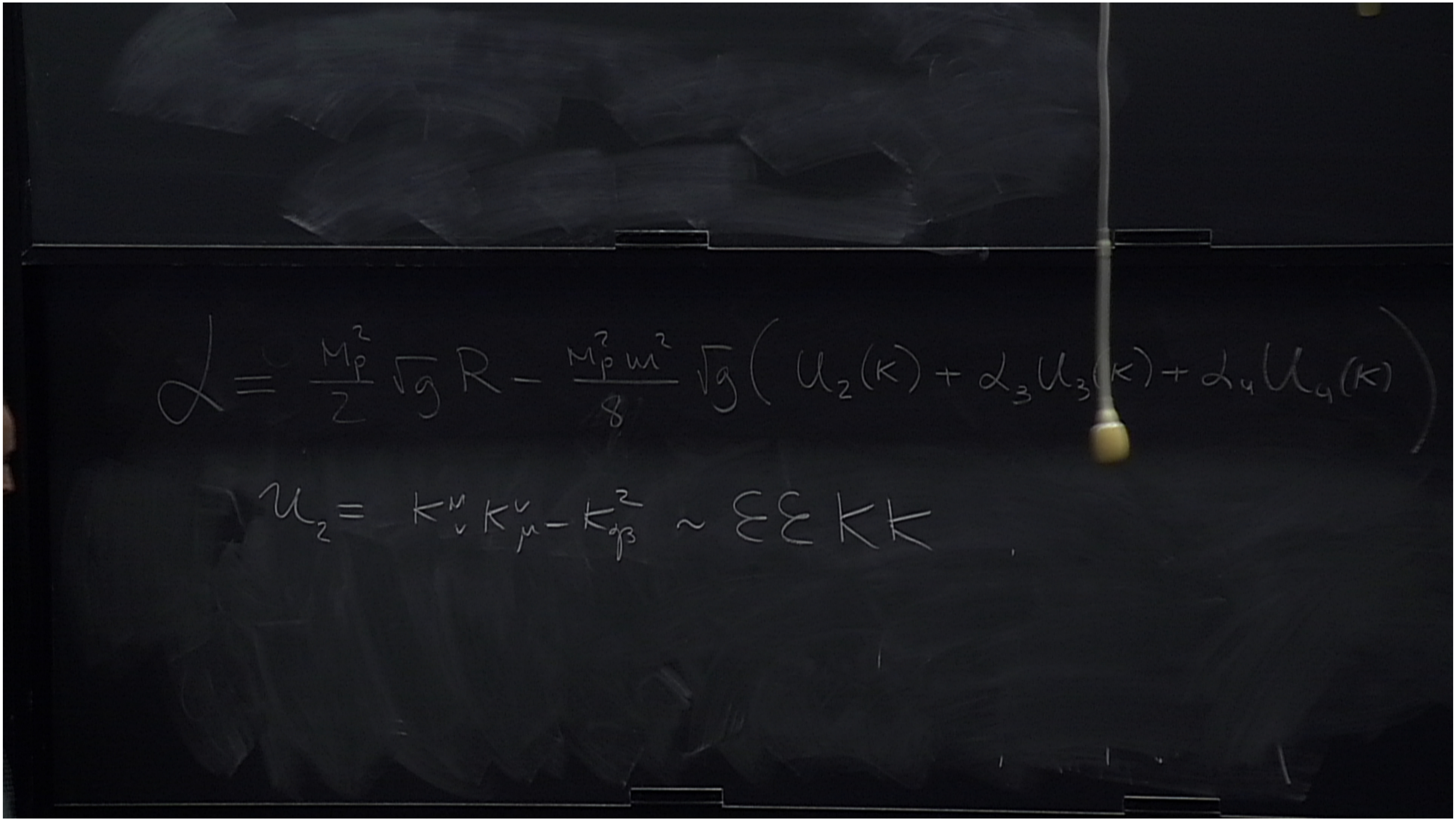
$h_{\mu\nu} T^{\mu\nu}$

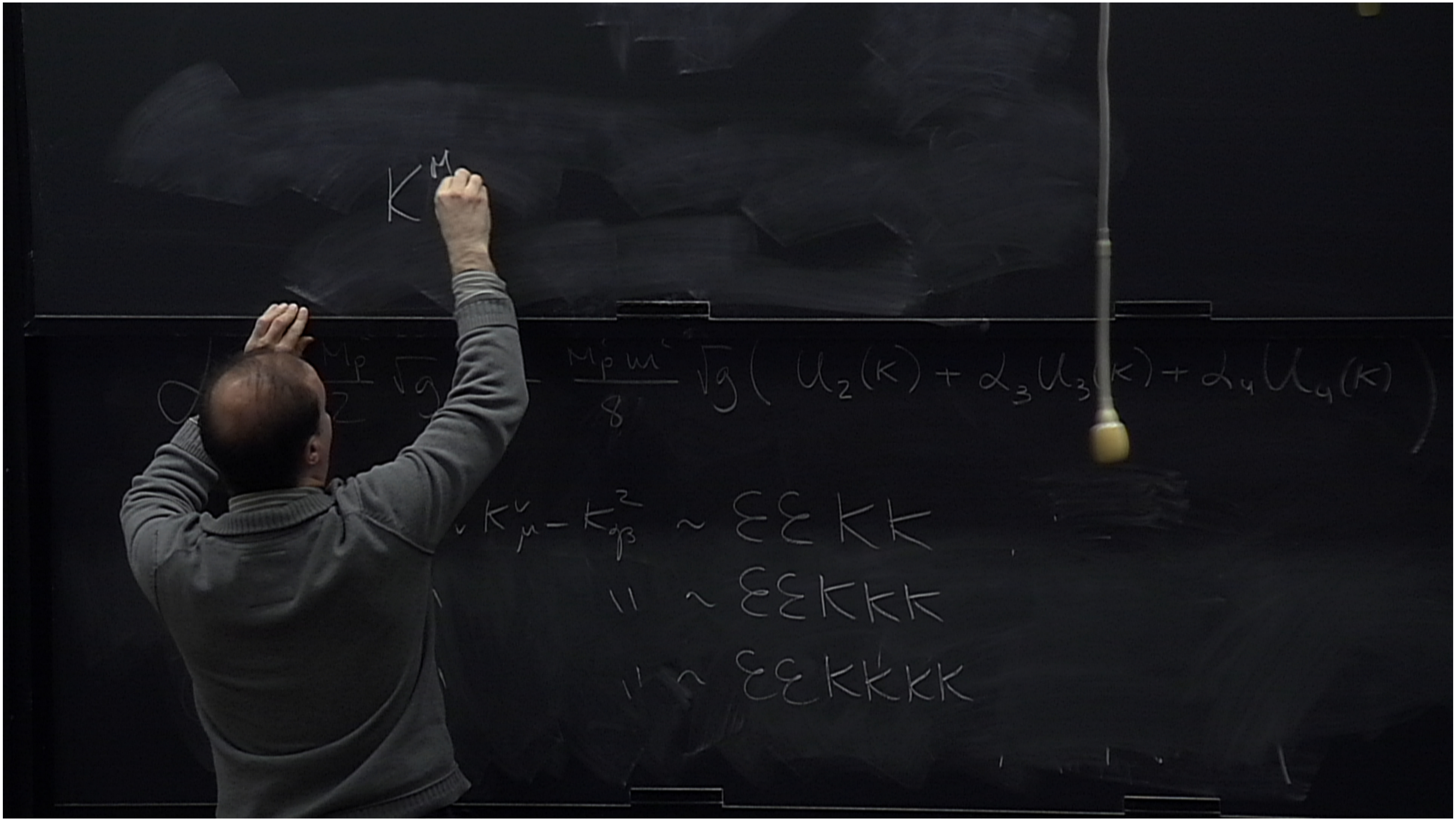
$a_1 = 1$

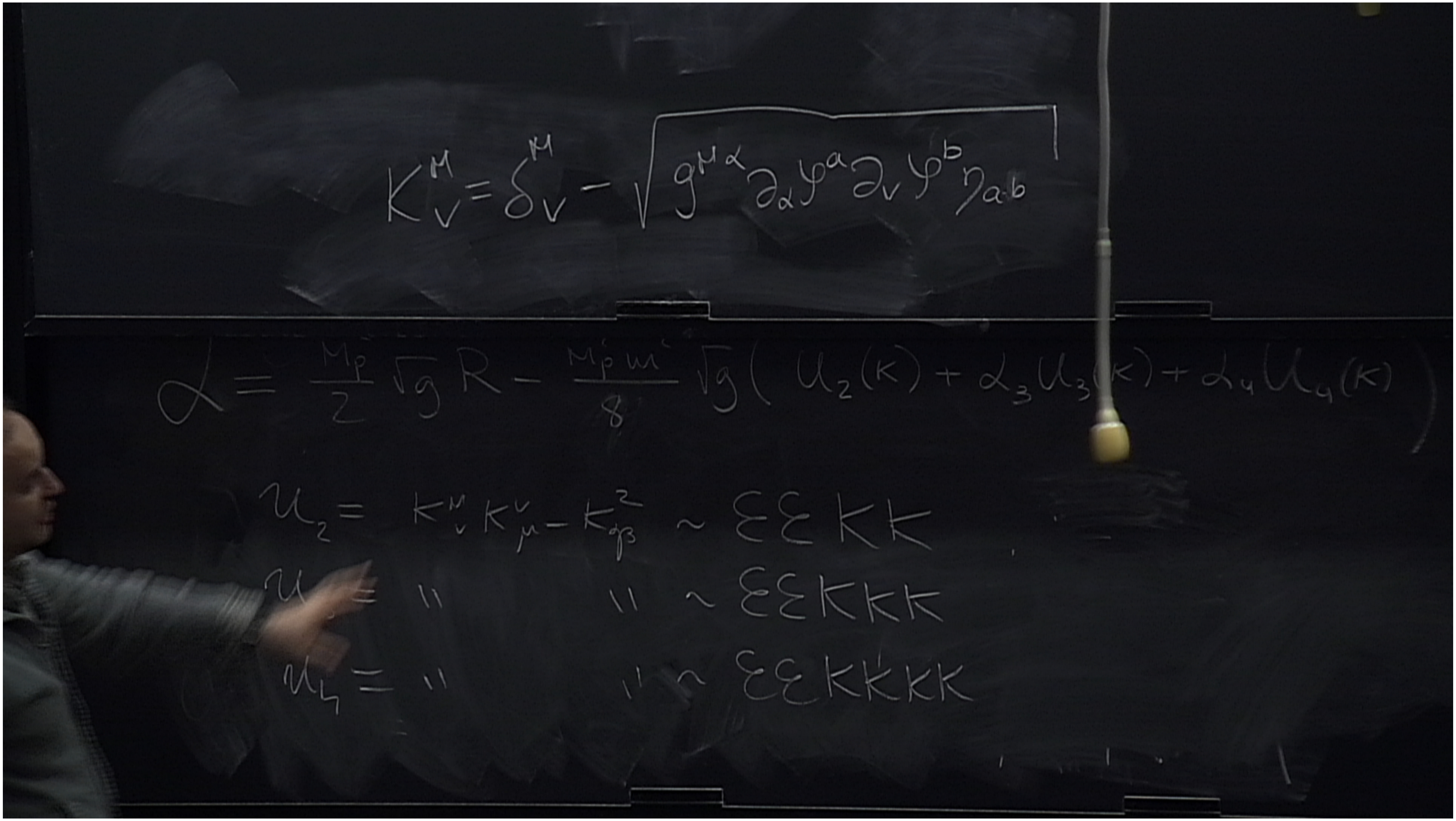
$a_2 = \frac{6c_3 - 1}{\Lambda_3^3}$

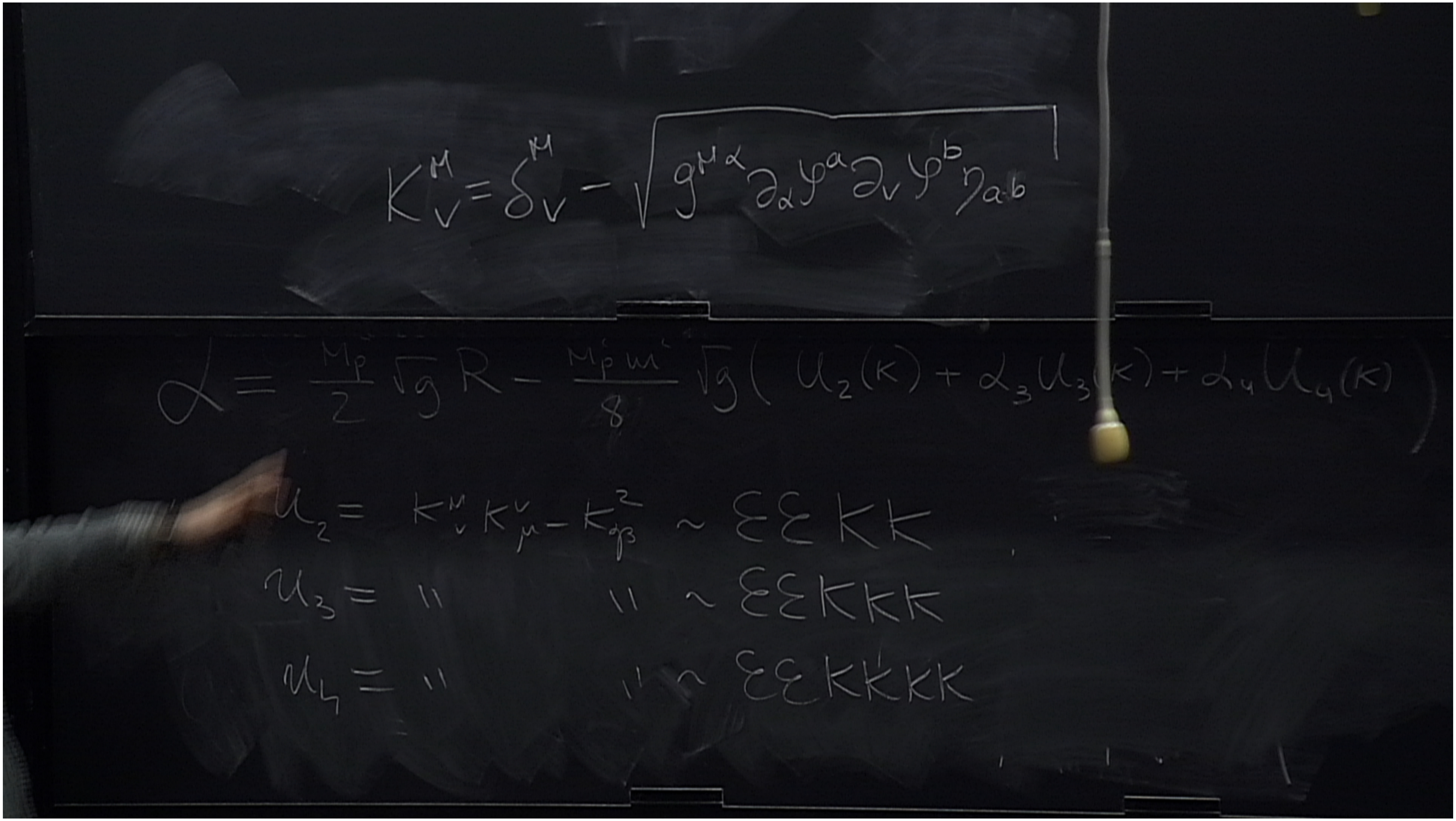
$a_3 = \frac{c_3 +}{\Lambda}$


$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}\,R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(U_2(K) + \alpha_3 U_3(K) + \alpha_4 U_4(K) \right)$


$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}\,R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(\mathcal{U}_2(K) + \alpha_3\,\mathcal{U}_3(K) + \alpha_4\,\mathcal{U}_4(K)\right)$
$\mathcal{U}_2 = K^\mu_\nu K^\nu_\mu - K^2_{\alpha\beta} \sim \varepsilon\varepsilon KK$


~ εεKK
~ εεKKK
~ εεKKKK


$K^{\mu}_{\nu} = \delta^{\mu}_{\nu} - \sqrt{g^{\mu\alpha}\partial_\alpha \varphi^a \partial_\nu \varphi^b \eta_{ab}}$
$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(U_2(K) + \alpha_3 U_3(K) + \alpha_4 U_4(K) \right)$
$U_2 = K^{\mu}_{\nu}K^{\nu}_{\mu} - K^2_{\alpha\beta} \sim \varepsilon\varepsilon KK$
$U_3 = \text{"} \quad \text{"} \sim \varepsilon\varepsilon KKK$
$U_4 = \text{"} \quad \text{"} \sim \varepsilon\varepsilon KKKK$


$K^\mu_\nu = \delta^\mu_\nu - \sqrt{g^{\mu\alpha}\partial_\alpha\varphi^a\partial_\nu\varphi^b\eta_{ab}}$
$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(U_2(K) + \alpha_3 U_3(K) + \alpha_4 U_4(K)\right)$
$U_2 = K^\mu_\nu K^\nu_\mu - K^2 \sim \varepsilon\varepsilon KK$
$U_3 =$ " " $\sim \varepsilon\varepsilon KKK$
$U_4 =$ " " $\sim \varepsilon\varepsilon KKKK$

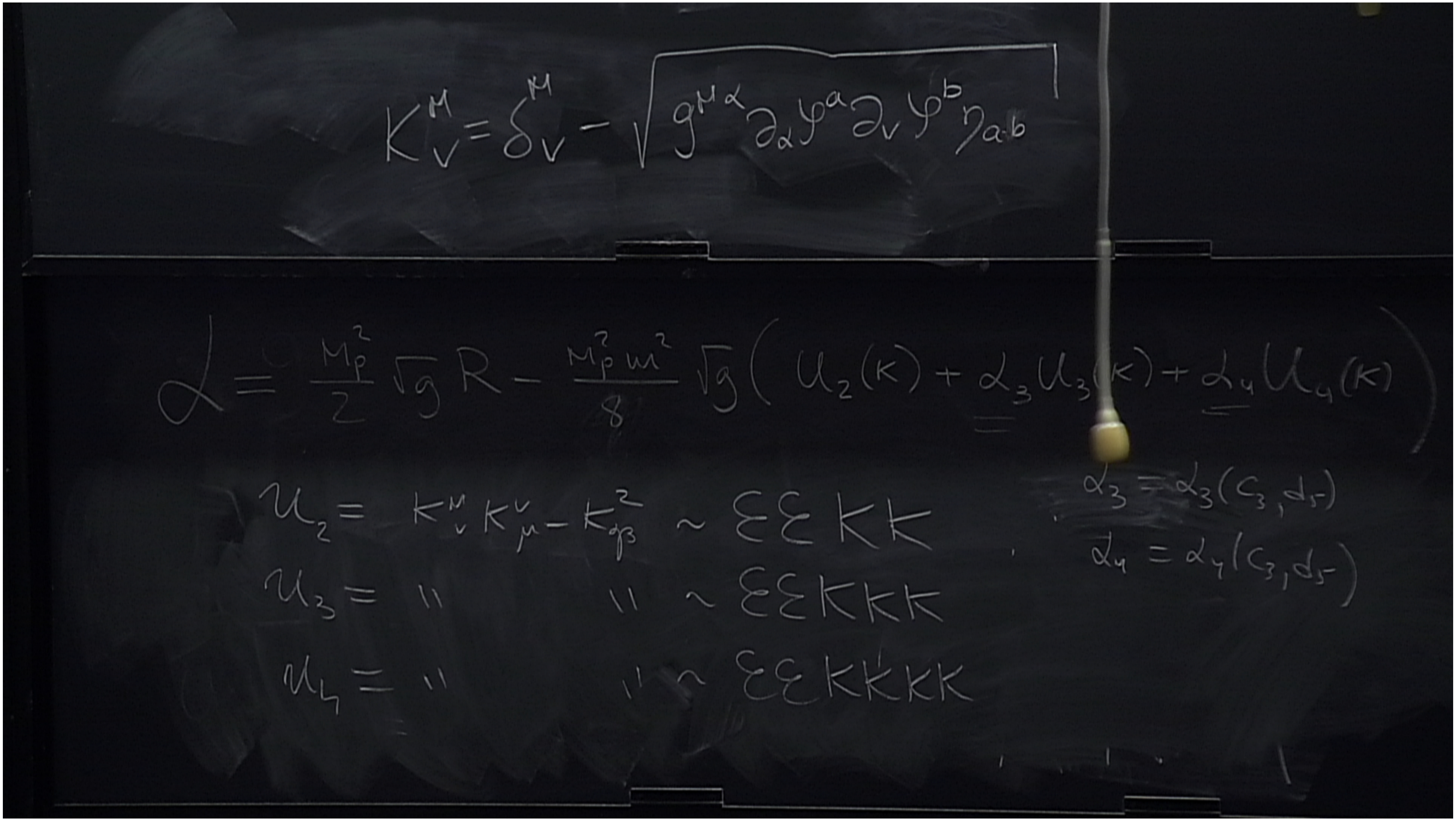
$$K^{\mu}_{\nu} = \delta^{\mu}_{\nu} - \sqrt{g^{\mu\alpha}\partial_\alpha \varphi^a \partial_\nu \varphi^b \eta_{ab}}$$

$$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}\,R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(\mathcal{U}_2(K) + \alpha_3 \mathcal{U}_3(K) + \alpha_4 \mathcal{U}_4(K) \right)$$

$$\mathcal{U}_2 = K^{\mu}_{\nu} K^{\nu}_{\mu} - K^2 \sim \varepsilon\varepsilon KK$$

$$\mathcal{U}_3 = \;〃 \qquad 〃 \sim \varepsilon\varepsilon KKK$$

$$\mathcal{U}_4 = \;〃 \qquad 〃 \sim \varepsilon\varepsilon KKKK$$


$K^\mu_\nu = \delta^\mu_\nu - \sqrt{g^{\mu\alpha}\partial_\alpha\varphi^a\partial_\nu\varphi^b\eta_{ab}}$
$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(U_2(K) + \alpha_3 U_3(K) + \alpha_4 U_4(K) \right)$
$U_2 = K^\mu_\nu K^\nu_\mu - K^2_{\alpha\beta} \sim \epsilon\epsilon KK$
$U_3 = \;'' \qquad '' \sim \epsilon\epsilon KKK$
$U_4 = \;'' \qquad '' \sim \epsilon\epsilon KKKK$
$\alpha_3 = \alpha_3(c_3, d_5)$
$\alpha_4 = \alpha_4(c_3, d_5)$

$$K^\mu_\nu = \delta^\mu_\nu - \sqrt{g^{\mu\alpha}\partial_\alpha\varphi^a\partial_\nu\varphi^b\eta_{ab}}$$

$$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}\,R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(\mathcal{U}_2(K) + \alpha_3\,\mathcal{U}_3(K) + \alpha_4\,\mathcal{U}_4(K)\right)$$

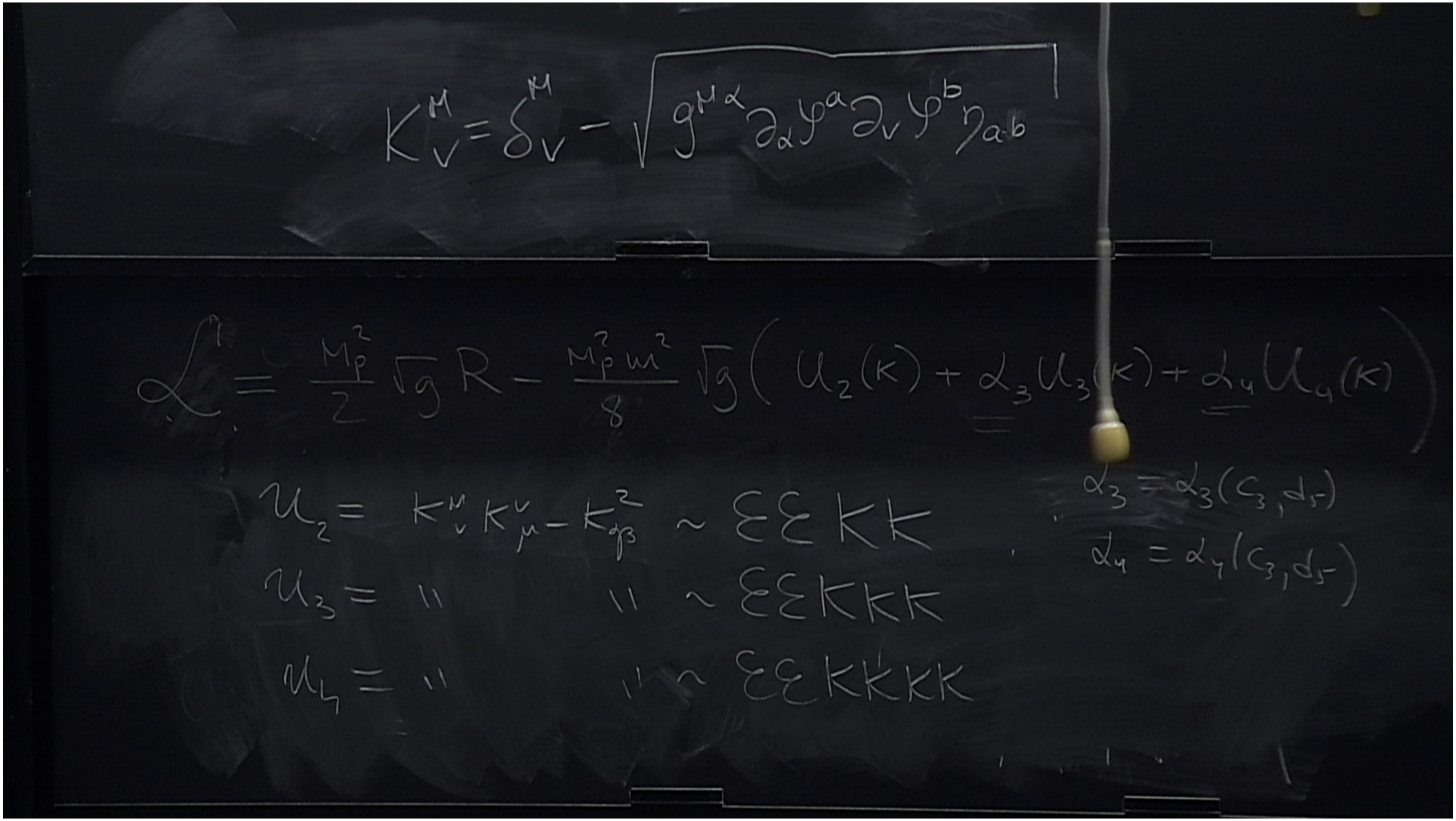
$$\mathcal{U}_2 = K^\mu_\nu K^\nu_\mu - K^2_{\alpha\beta} \sim \varepsilon\varepsilon KK$$

$$\mathcal{U}_3 = \;'' \qquad '' \sim \varepsilon\varepsilon KKK$$

$$\mathcal{U}_4 = \;'' \qquad '' \sim \varepsilon\varepsilon KKKK$$

$$\alpha_3 = \alpha_3(c_3, d_5)$$

$$\alpha_4 = \alpha_4(c_3, d_5)$$


$K^\mu_\nu = \delta^\mu_\nu - \sqrt{g^{\mu\alpha}\partial_\alpha \varphi^a \partial_\nu \varphi^b \eta_{ab}}$
$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(U_2(K) + \alpha_3 U_3(K) + \alpha_4 U_4(K) \right)$
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$\alpha_3 = \alpha_3(c_3, d_5)$
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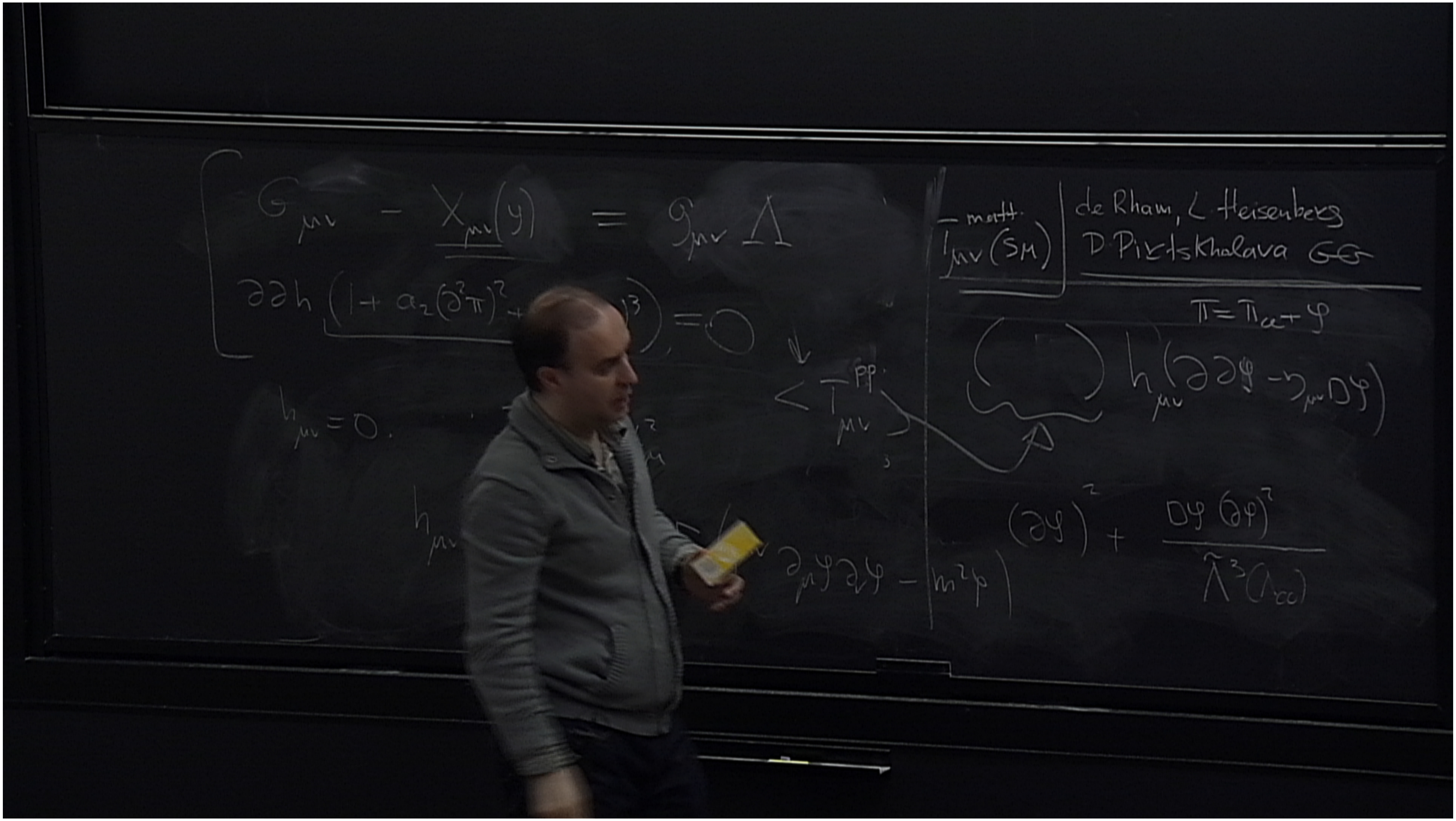
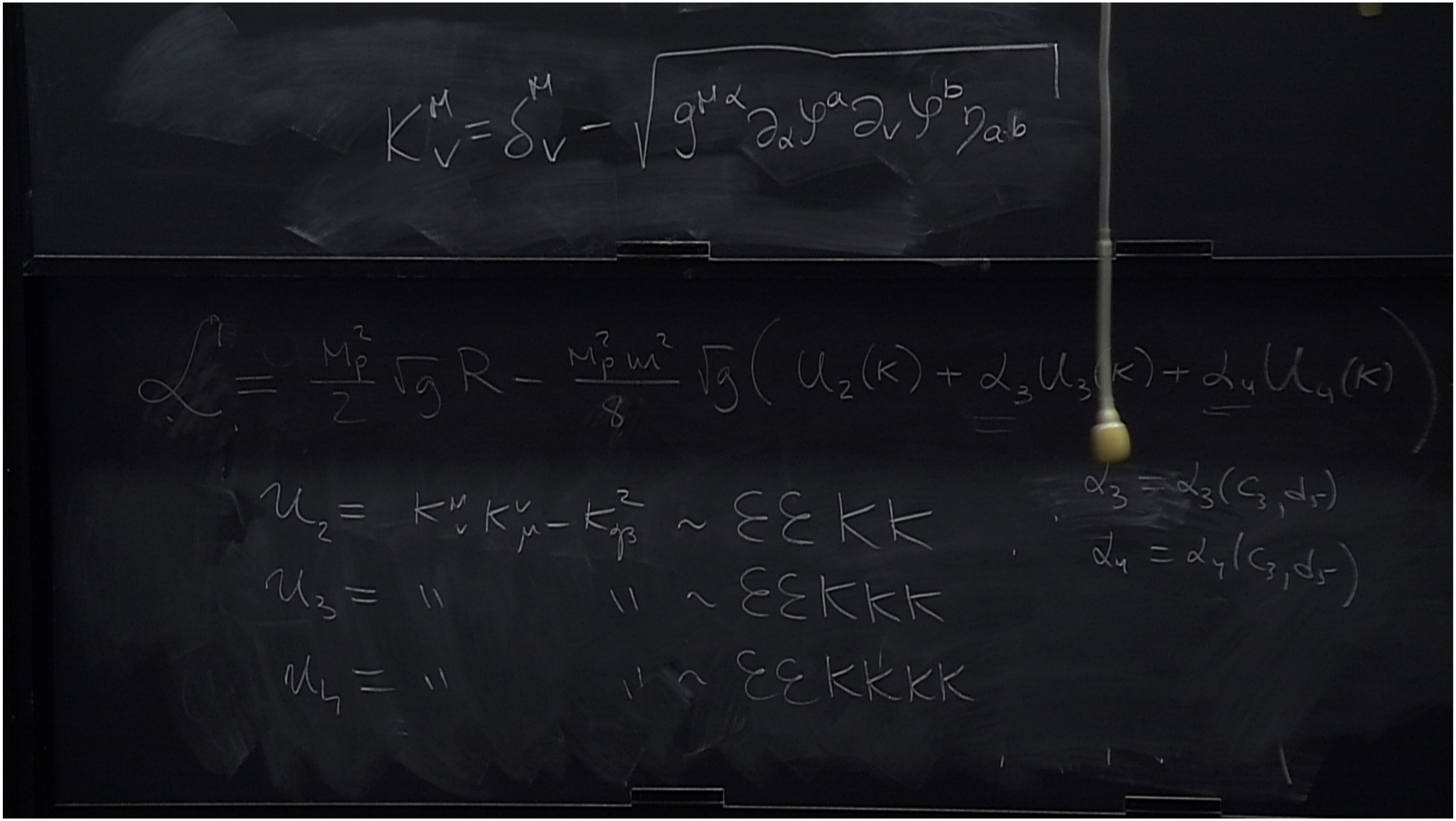

de Rham,
Heisenberg


$K^{\mu}_{\nu} = \delta^{\mu}_{\nu} - \sqrt{g^{\mu\alpha}\partial_{\alpha}\varphi^{a}\partial_{\nu}\varphi^{b}\eta_{ab}}$
$\mathcal{L} = \frac{M_p^2}{2}\sqrt{g}R - \frac{M_p^2 m^2}{8}\sqrt{g}\left(\mathcal{U}_2(K) + \alpha_3 \mathcal{U}_3(K) + \alpha_4 \mathcal{U}_4(K) \right)$
$\mathcal{U}_2 = K^{\mu}_{\nu}K^{\nu}_{\mu} - K^2_{\alpha\beta} \sim \varepsilon\varepsilon KK$
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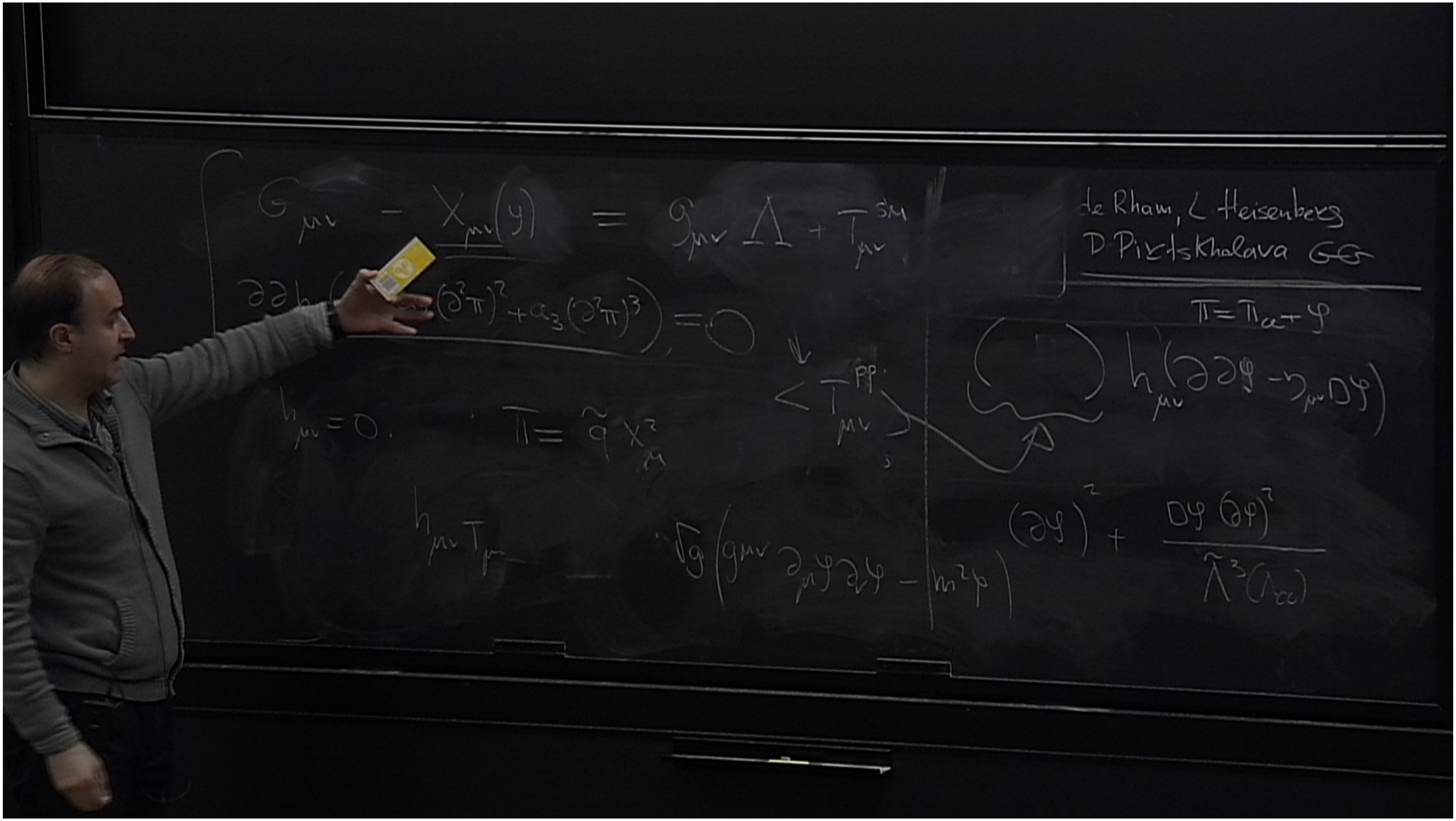
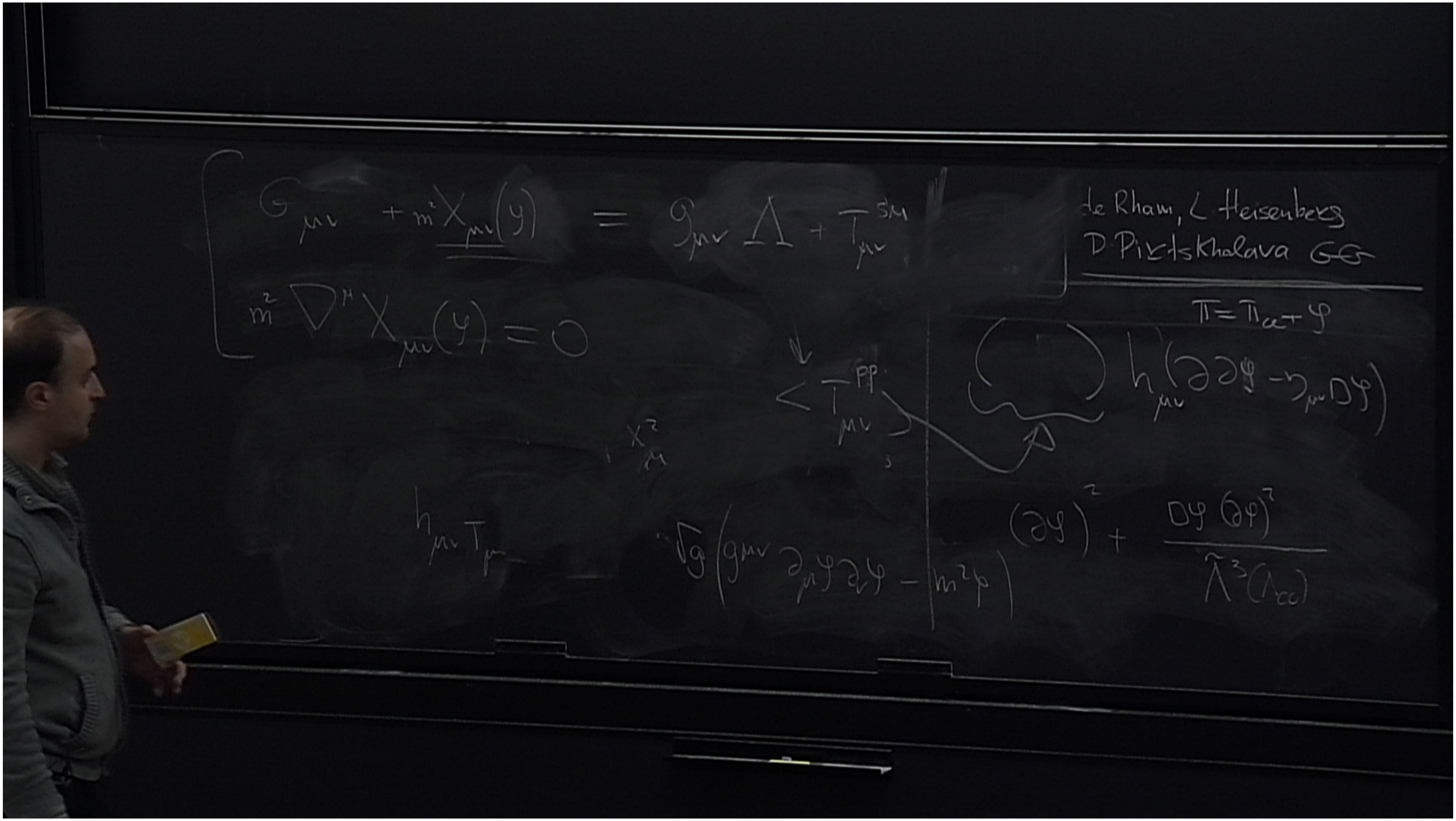
$\alpha_3 = \alpha_3(c_3, d_5)$
$\alpha_4 = \alpha_4(c_3, d_5)$


de Rham, L Heisenberg
D Pirtskhalava GG
h_{μν} = 0.
h_{μν} T_{μν}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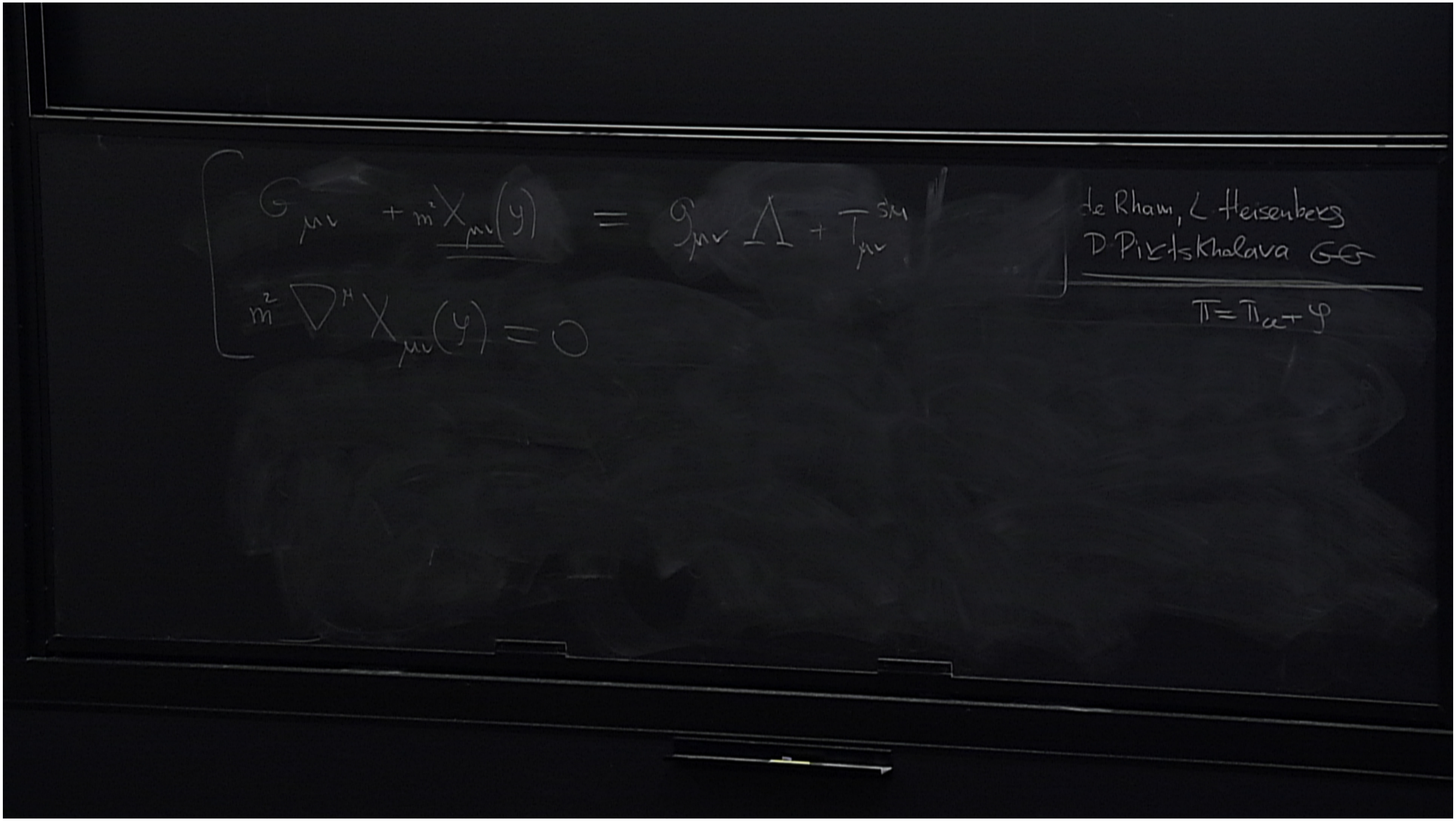
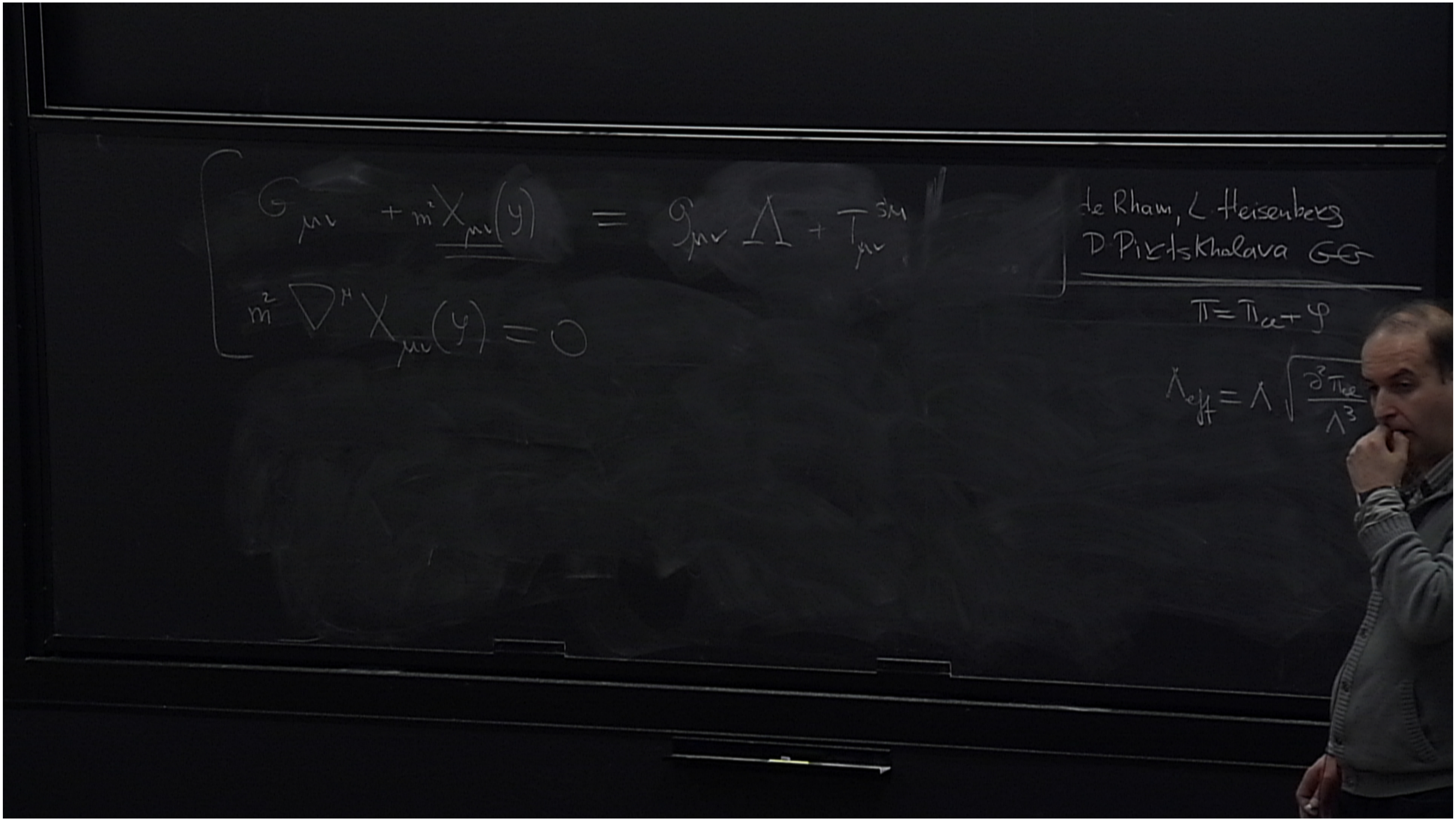
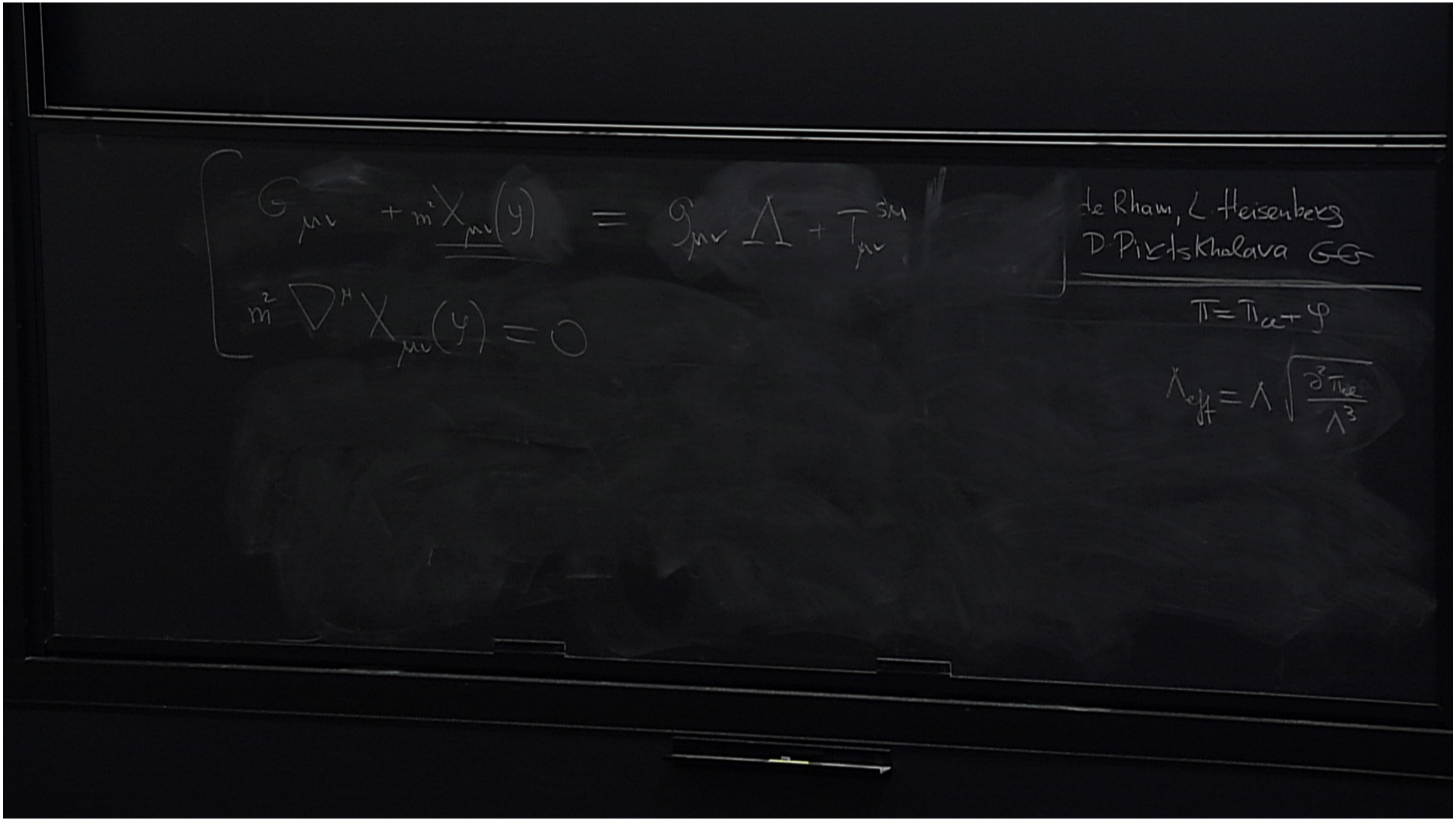
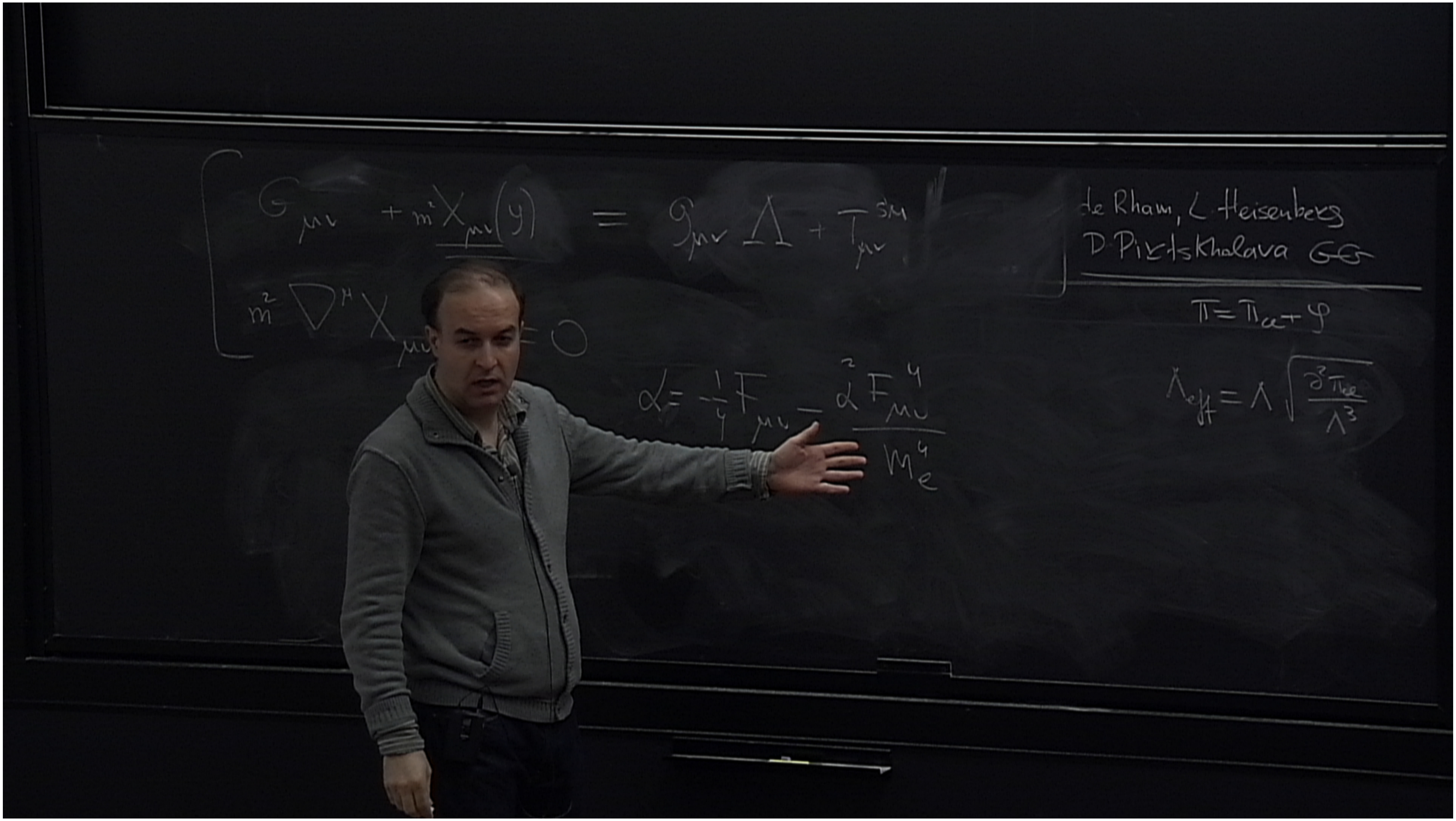
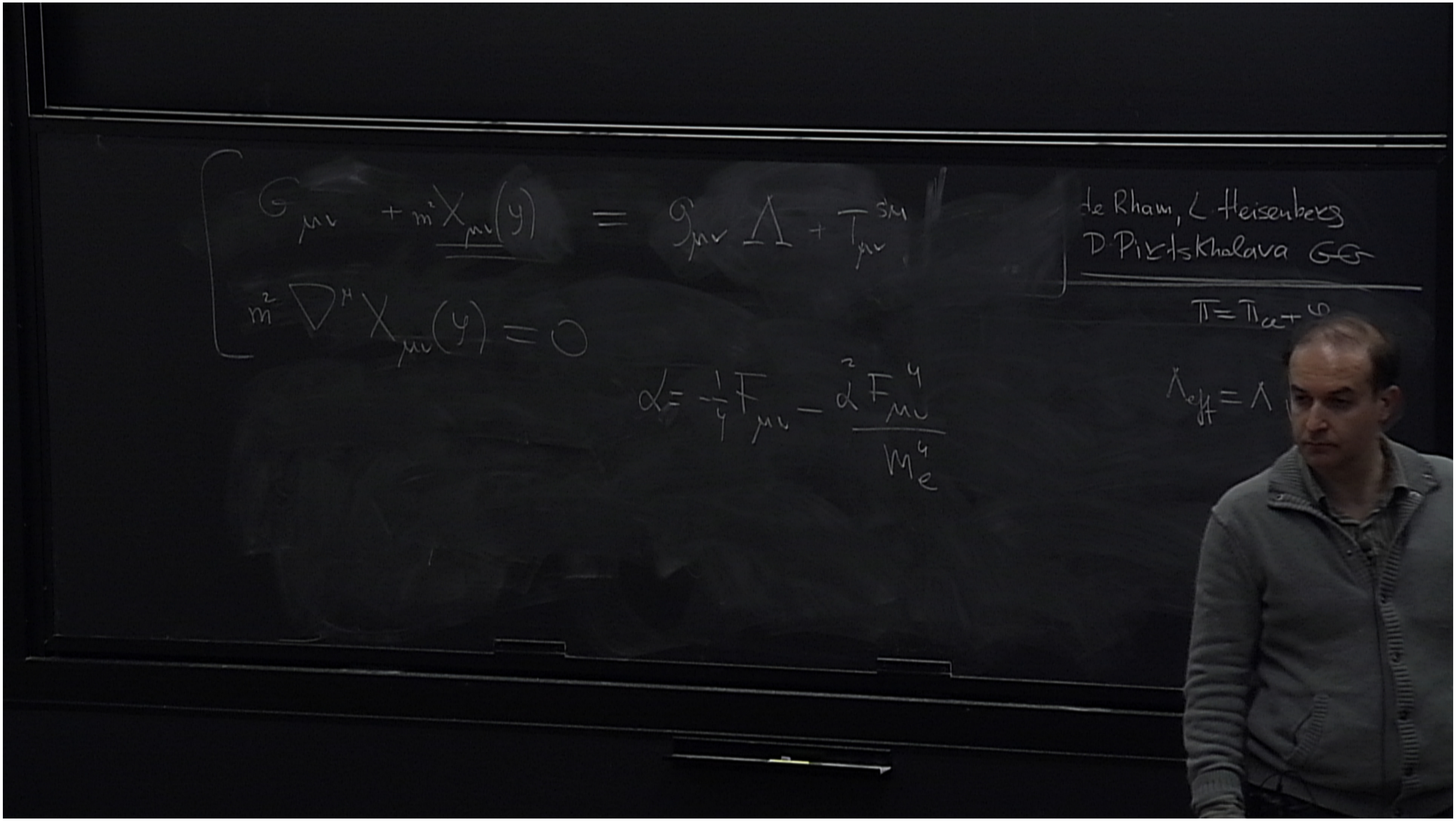
D. Pirtskhalava GG

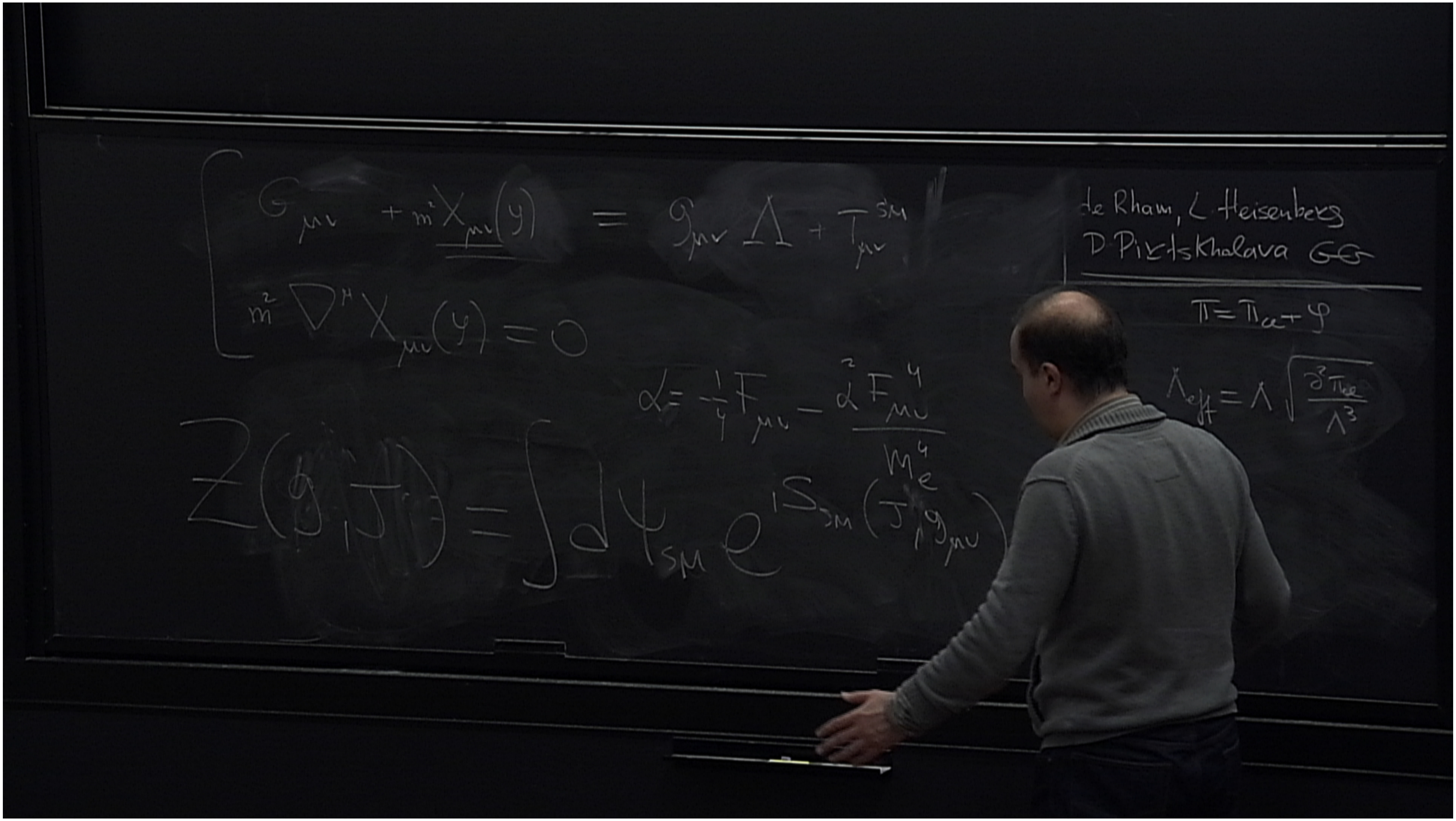

$G_{\mu\nu} + m^2 X_{\mu\nu}(g) = g_{\mu\nu}\Lambda + T_{\mu\nu}^{SM}$
$m^2 \nabla^\mu X_{\mu\nu}(g) = 0$
de Rham, L. Heisenberg
D. Pirtskhalava GG
$\pi = \pi_{cl} + \varphi$

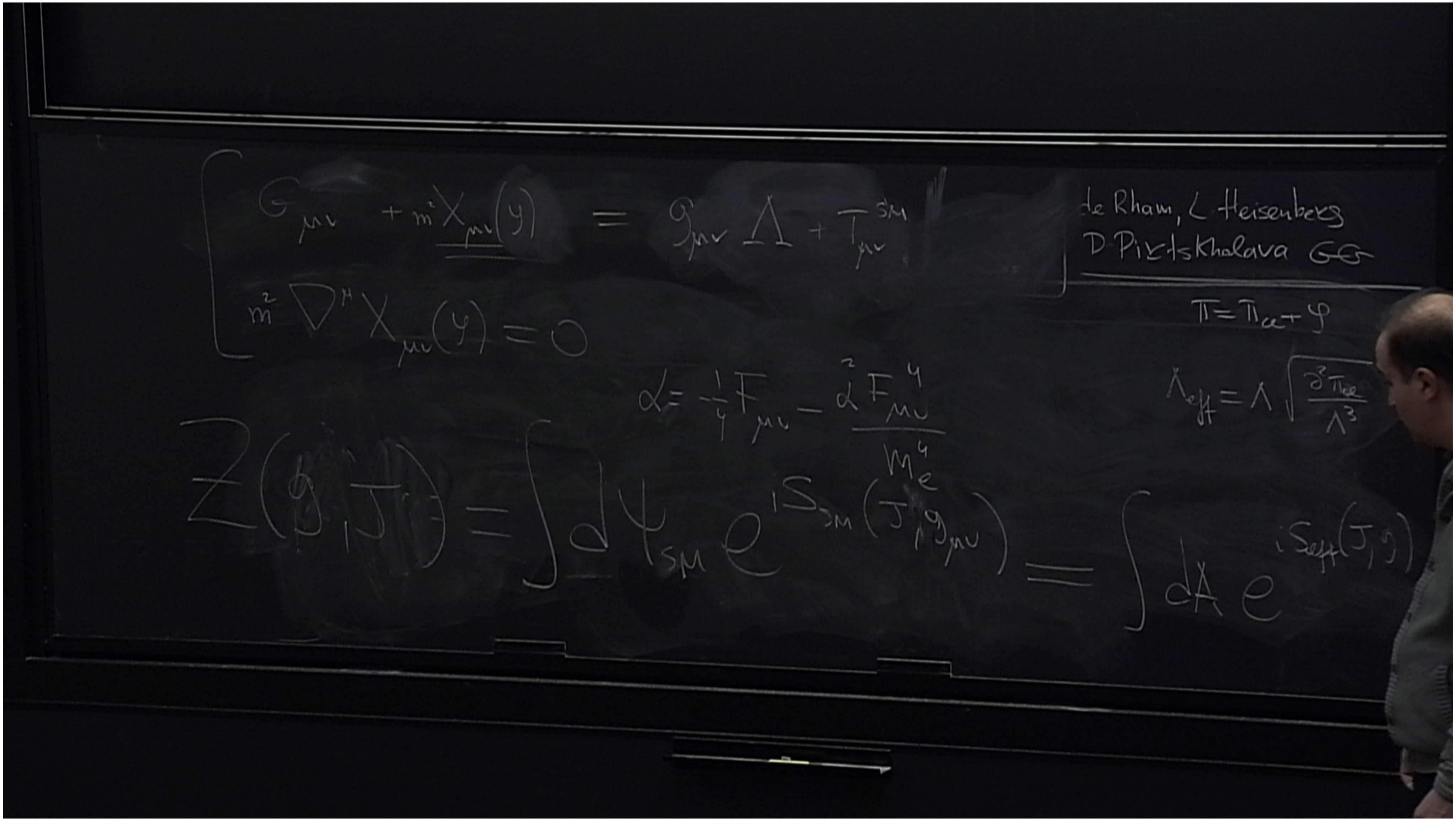

G_{μν} + m² X_{μν}(g) = g_{μν} Λ + T_{μν}^{SM}
m² ∇^μ X_{μν}(g) = 0
de Rham, L Heisenberg
D Pirtskhalava GG
π = π_cl + φ
Λ_eff = Λ √(∂²π_cl / Λ³)

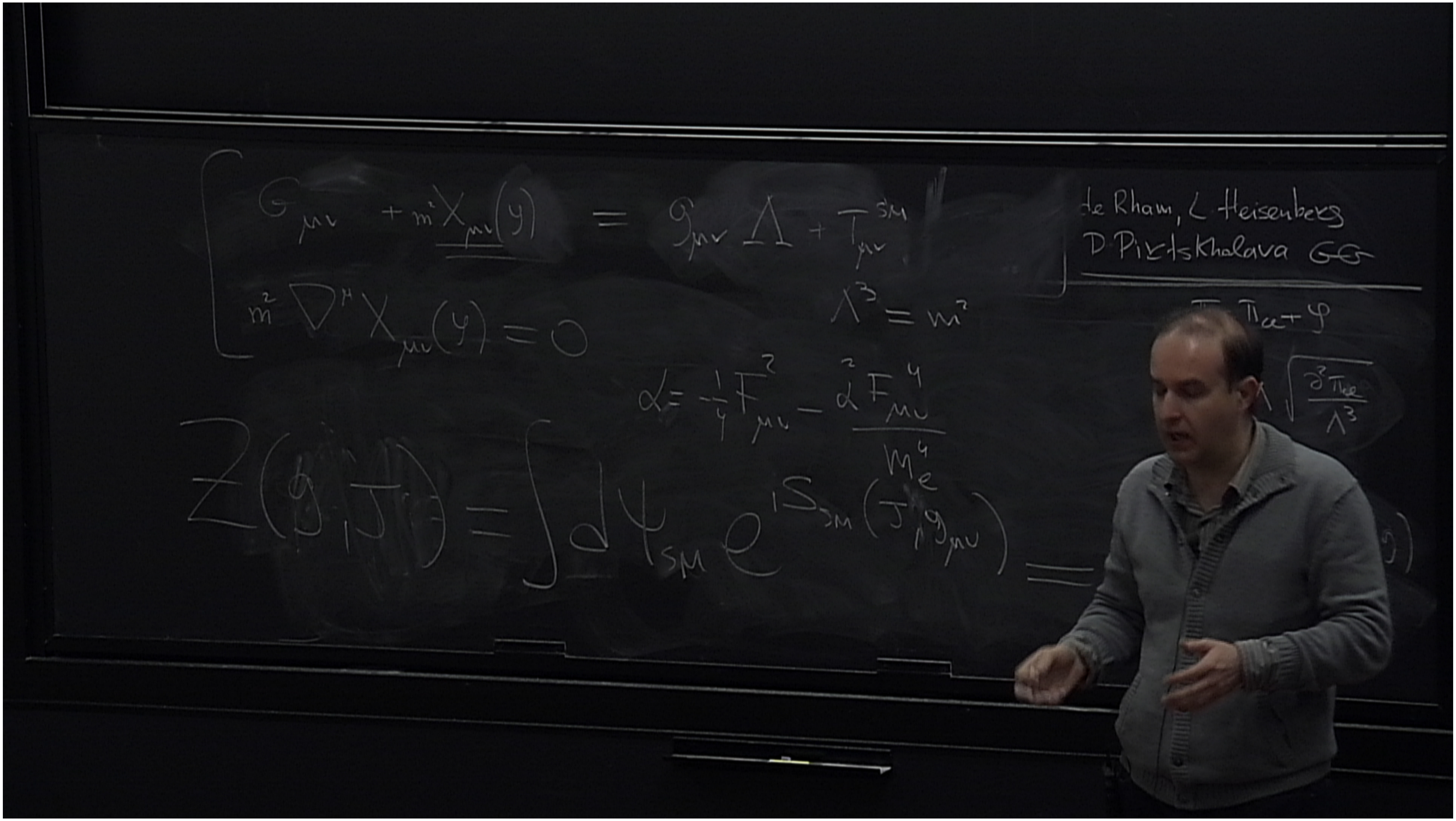

G_μν + m² X_μν(Ψ) = g_μν Λ + T_μν^SM
m² ∇^μ X_μν(Ψ) = 0
de Rham, L. Heisenberg
D. Pirtskhalava GG
π = π_cl + φ
Λ_eff = Λ √(∂²π_cl / Λ³)

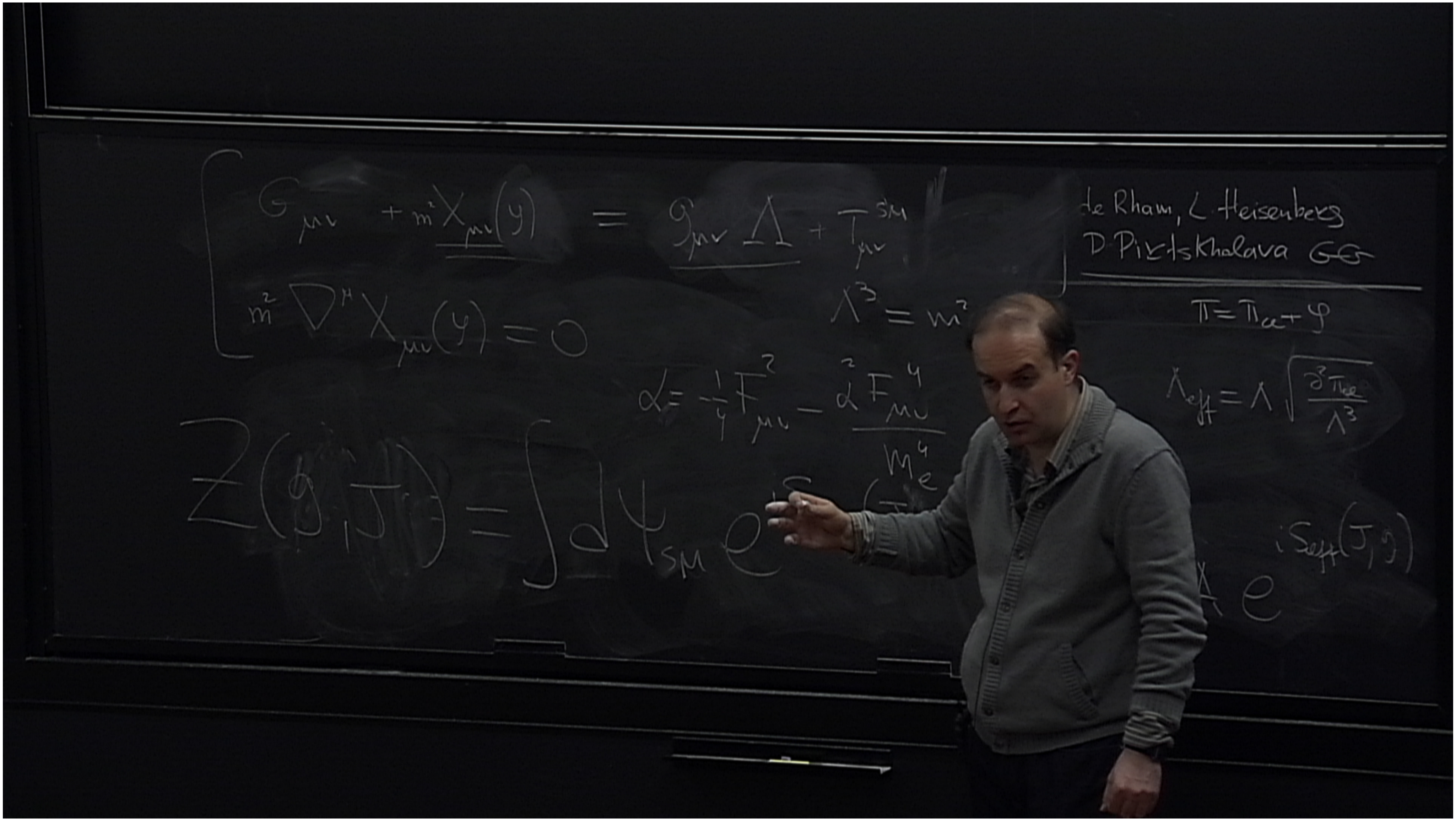

de Rham, L. Heisenberg
D. Pirtskhalava

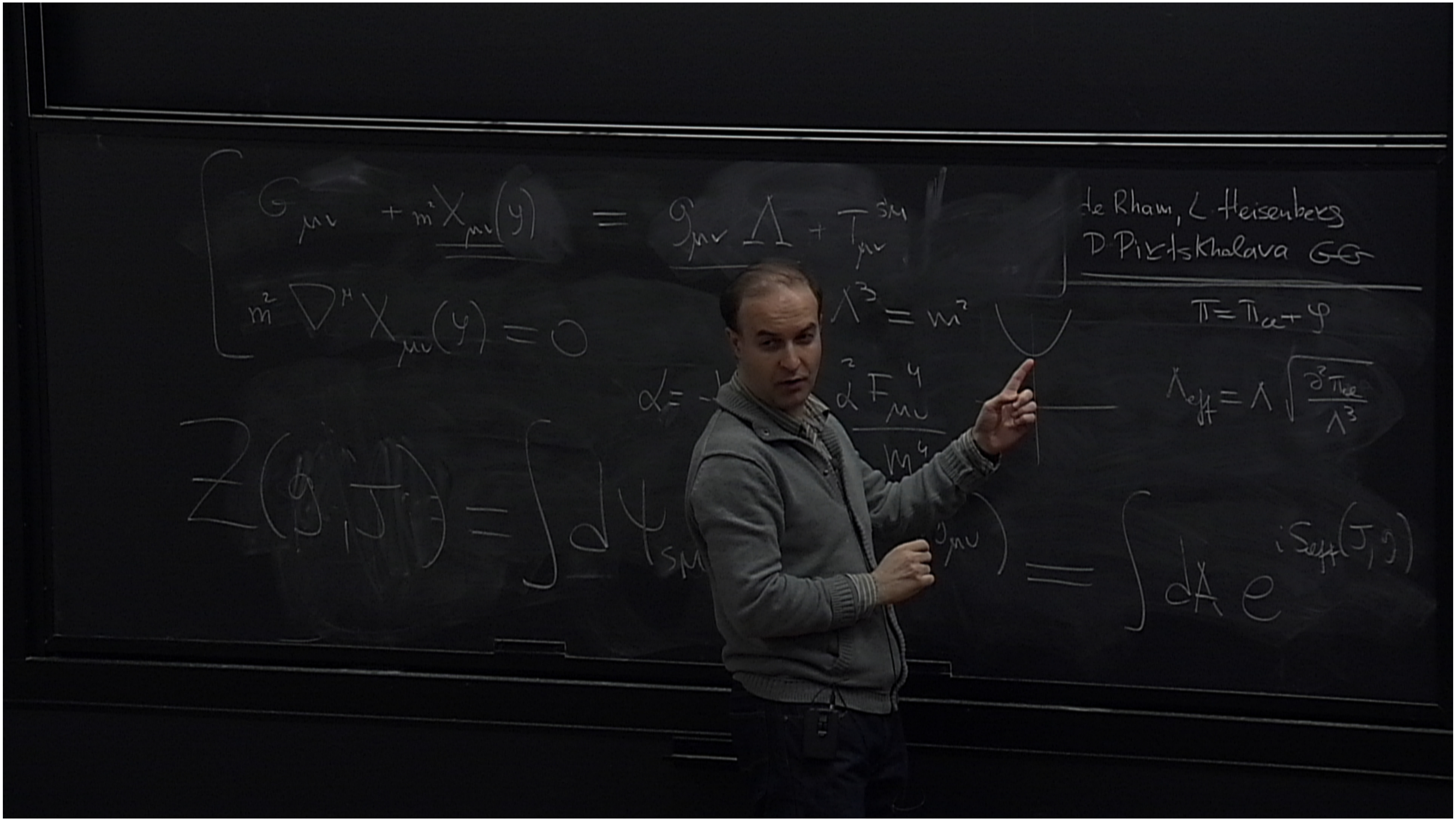

$G_{\mu\nu} + m^2 X_{\mu\nu}(g) = g_{\mu\nu}\Lambda + T^{SM}_{\mu\nu}$
$m^2 \nabla^\mu X_{\mu\nu}(g) = 0$
de Rham, L Heisenberg
D Pirtskhalava GG
$\mathcal{L} = -\frac{1}{4}F_{\mu\nu} - \alpha^2 \frac{F^4_{\mu\nu}}{M_e^4}$
$\Lambda_{eff} = \Lambda$

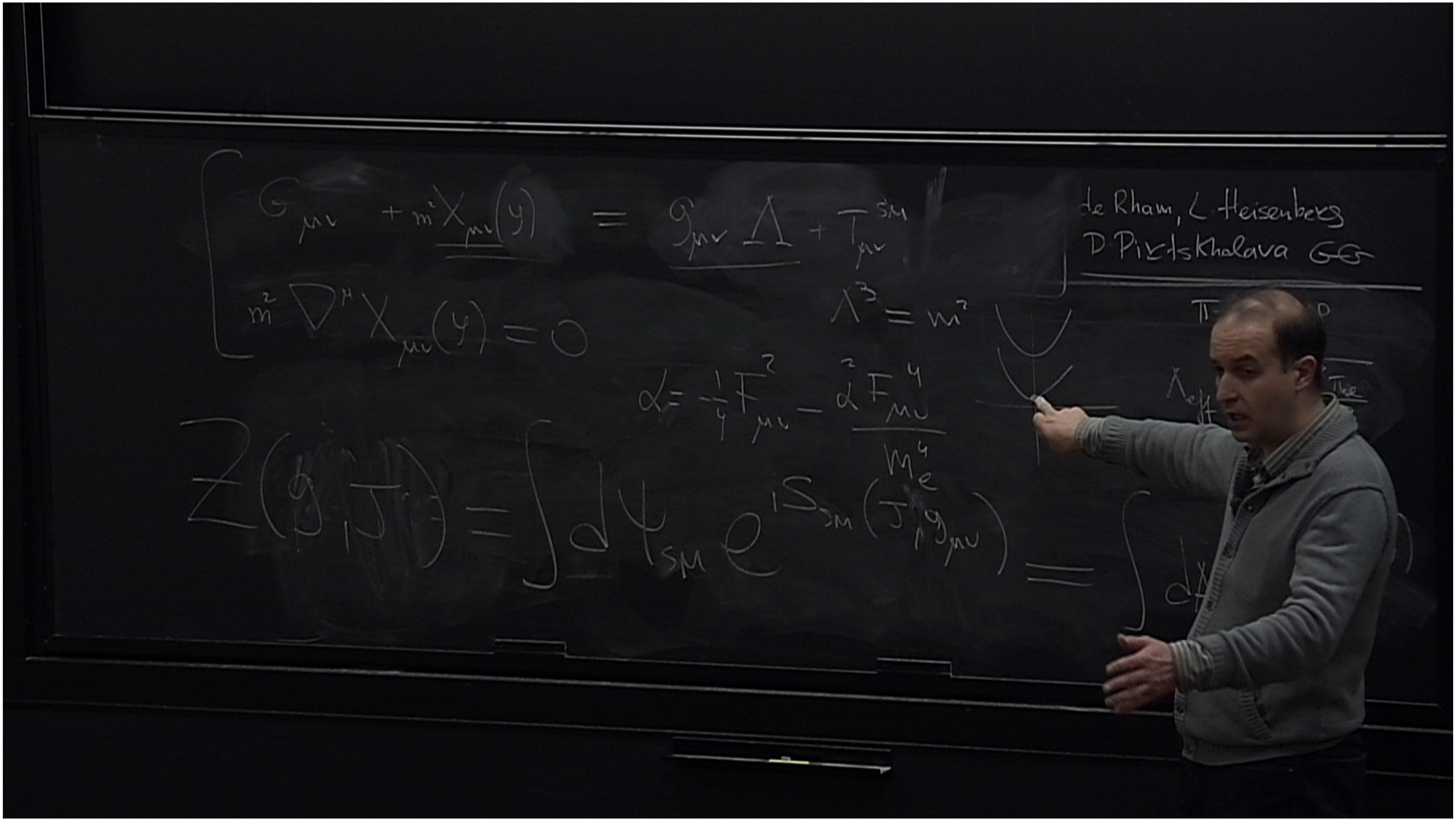

de Rham, L Heisenberg
D Pirtskhalava GG

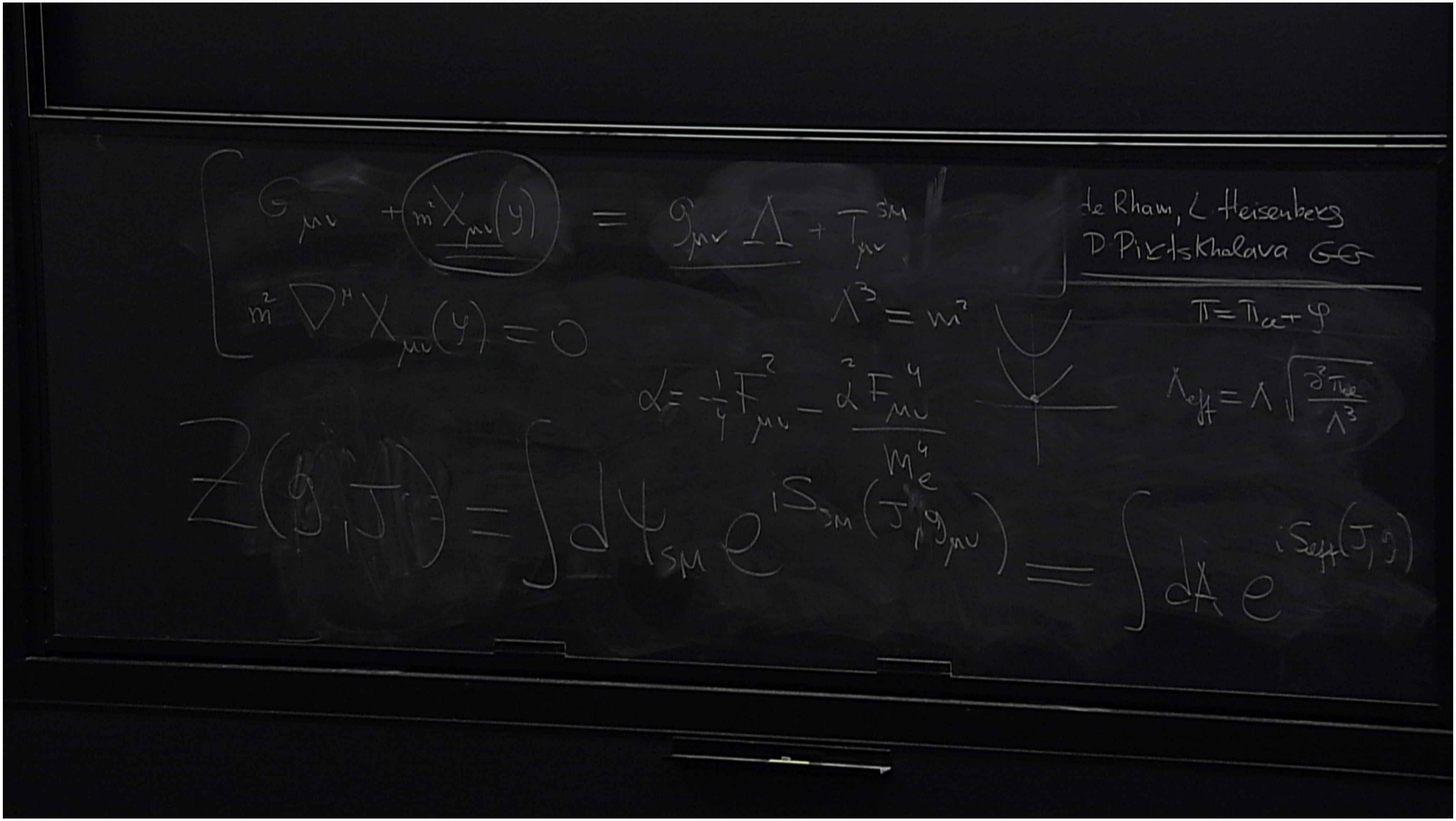

de Rham, L. Heisenberg
D. Pirtskhalava GG
$G_{\mu\nu} + m^2 X_{\mu\nu}(g) = g_{\mu\nu}\Lambda + T^{SM}_{\mu\nu}$
$m^2 \nabla^\mu X_{\mu\nu}(g) = 0$
$\pi = \pi_{cl} + \varphi$
$\Lambda_{eff} = \Lambda \sqrt{\frac{\partial^2 \pi_{cl}}{\Lambda^3}}$
$\mathcal{L} = -\frac{1}{4}F_{\mu\nu} - \frac{\alpha^2 F^4_{\mu\nu}}{M_e^4}$
$Z(g, J) = \int d\psi_{SM}\, e^{iS_{SM}(J, g_{\mu\nu})} = \int dA\, e^{iS_{eff}(J, g)}$


de Rham, L Heisenberg
D Pirtskhalava


de Rham, L. Heisenberg
D. Pirtskhalava GG


G_μν + m² X_μν(g) = g_μν Λ + T_μν^SM
m² ∇^μ X_μν(g) = 0
de Rham, L. Heisenberg
D Pirtskhalava GG
Λ³ = m²
π = π_cl + φ
Λ_eff = Λ √(∂²π_cl / Λ³)
Z(g, J) = ∫ dψ_SM
= ∫ dA e^(iS_eff(J, g))


de Rham, L. Heisenberg
D Pirtskhalava GG


de Rham, L. Heisenberg
D Pirtskhalava GG
$G_{\mu\nu} + m^2 X_{\mu\nu}(g) = g_{\mu\nu}\Lambda + T_{\mu\nu}^{SM}$
$m^2 \nabla^\mu X_{\mu\nu}(g) = 0$
$\Lambda^3 = m^2$
$\pi = \pi_{cl} + \varphi$
$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}^2 - \alpha^2 \frac{F_{\mu\nu}^4}{m_e^4}$
$\Lambda_{eff} = \Lambda \sqrt{\frac{\partial^2 \pi_{cl}}{\Lambda^3}}$
$Z(g, J) = \int d\psi_{SM}\, e^{iS_{SM}(J, g_{\mu\nu})} = \int dA\, e^{iS_{eff}(J, g)}$