Title: 13/14 PSI - String Theory Review - Lecture 10

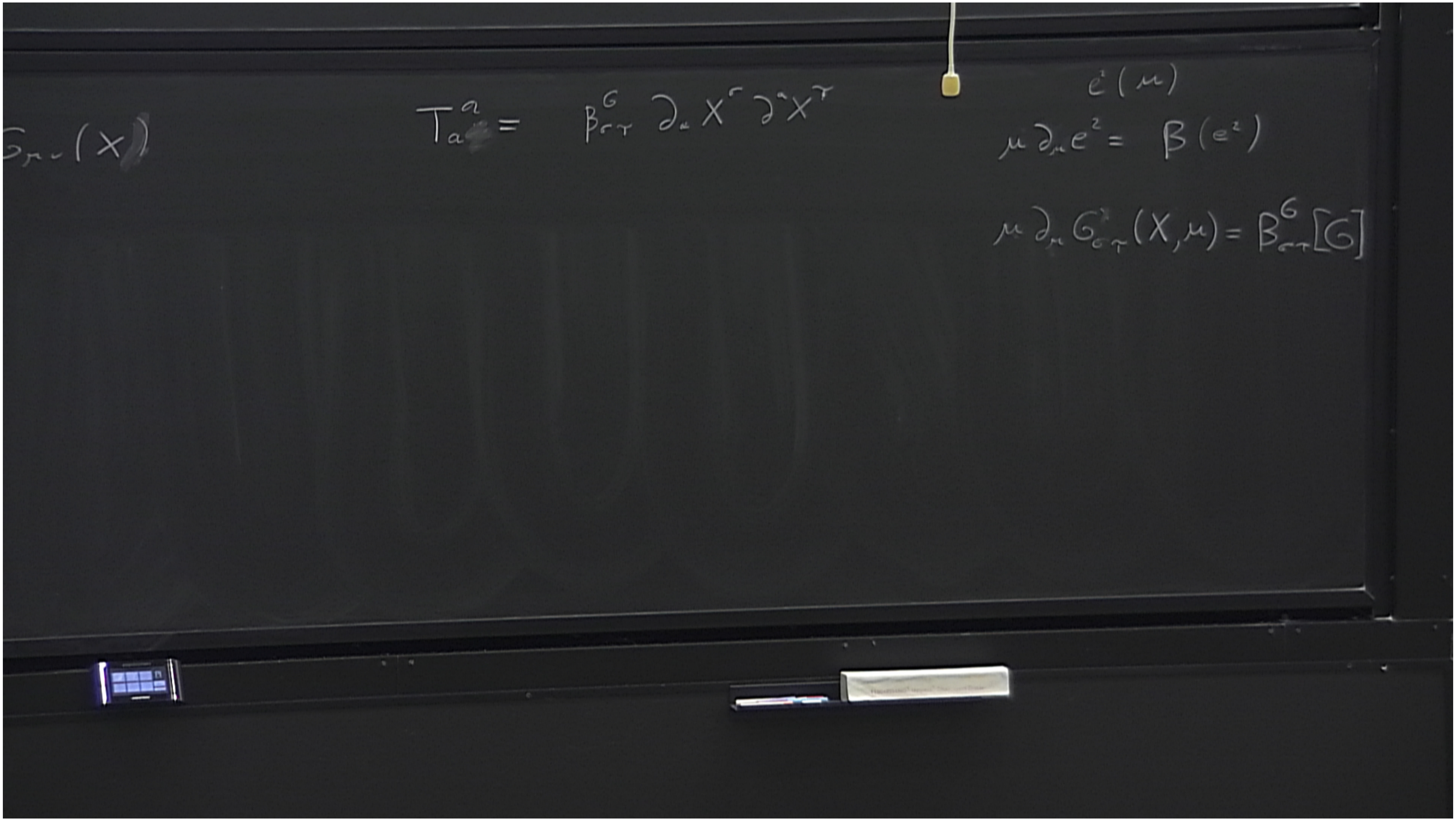
Date: Feb 10, 2014 10:15 AM

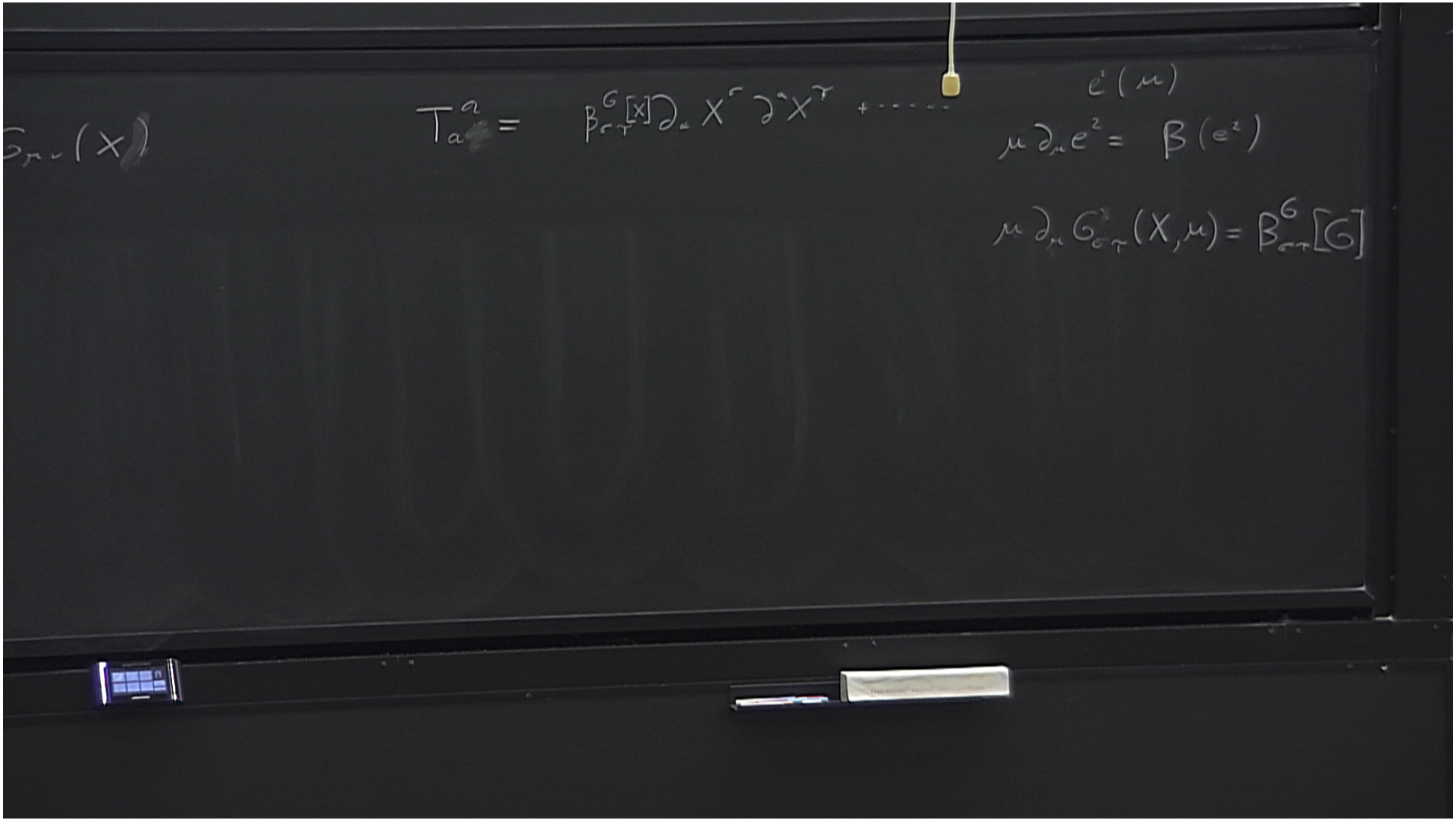
URL: http://pirsa.org/14020028

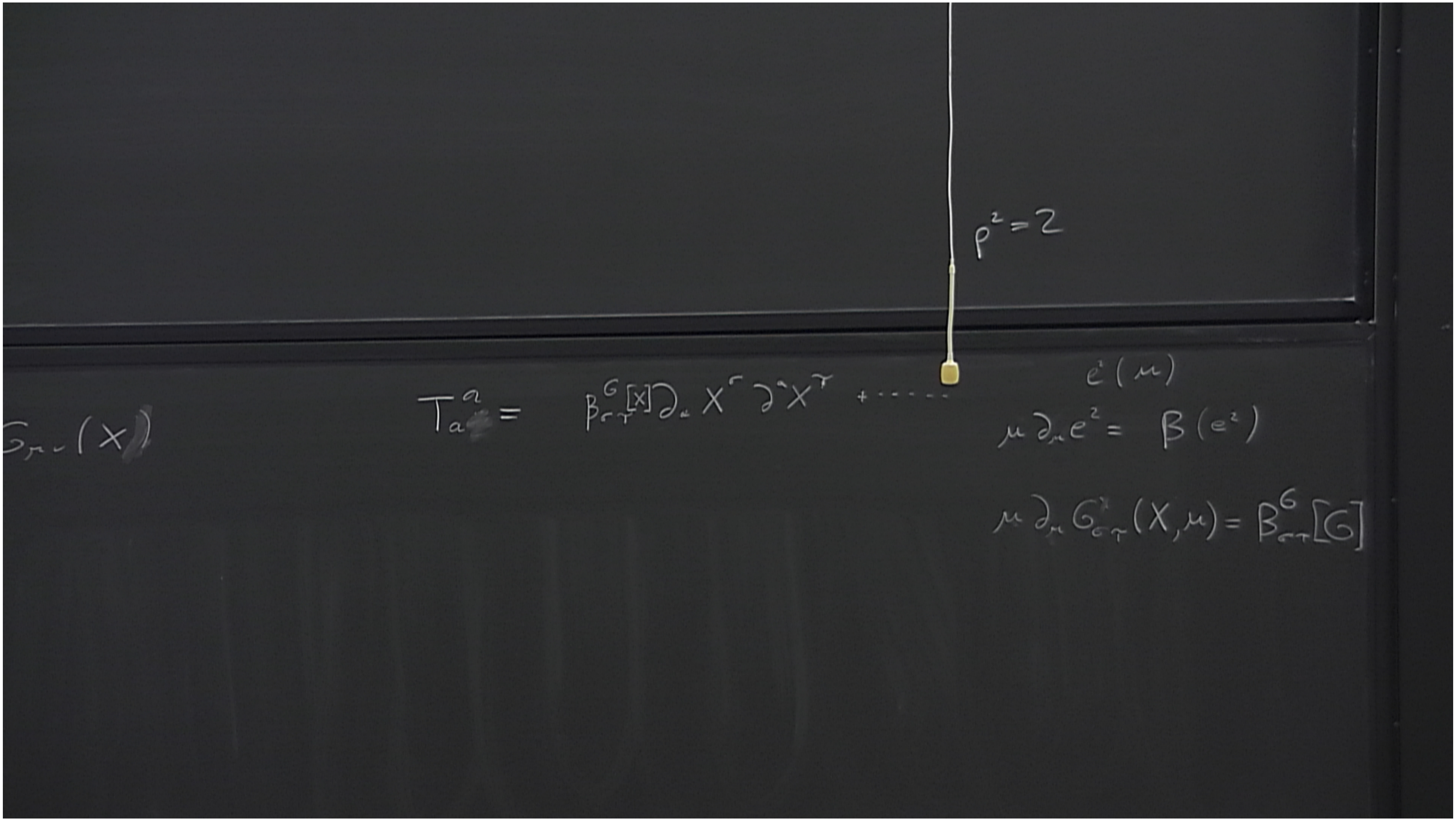
Abstract:

$$\int \sqrt{\det\left[G_{\mu\nu}(X)\,\frac{\partial X^\mu}{\partial u^a}\,\frac{\partial X^\nu}{\partial u^b}\right]}$$

$$\frac{1}{2}\int \sqrt{h}\; h^{ab}\,\frac{\partial X^\mu}{\partial u^a}\,\frac{\partial X^\nu}{\partial u^b}\,G_{\mu\nu}(X)$$


$G_{\mu\nu}(X)$
$T_a^a = \beta^G_{\sigma\tau} \partial_a X^\sigma \partial^a X^\tau$
$e^2(\mu)$
$\mu \partial_\mu e^2 = \beta(e^2)$
$\mu \partial_\mu G_{\sigma\tau}(X,\mu) = \beta^G_{\sigma\tau}[G]$


$G_{\mu\nu}(X)$
$T_a^{\,a} = \beta^G_{\sigma\tau}[X]\partial_a X^\sigma \partial^a X^\tau + \cdots\cdots$
$e^2(\mu)$
$\mu\partial_\mu e^2 = \beta(e^2)$
$\mu\partial_\mu G_{\sigma\tau}(X,\mu) = \beta^G_{\sigma\tau}[G]$

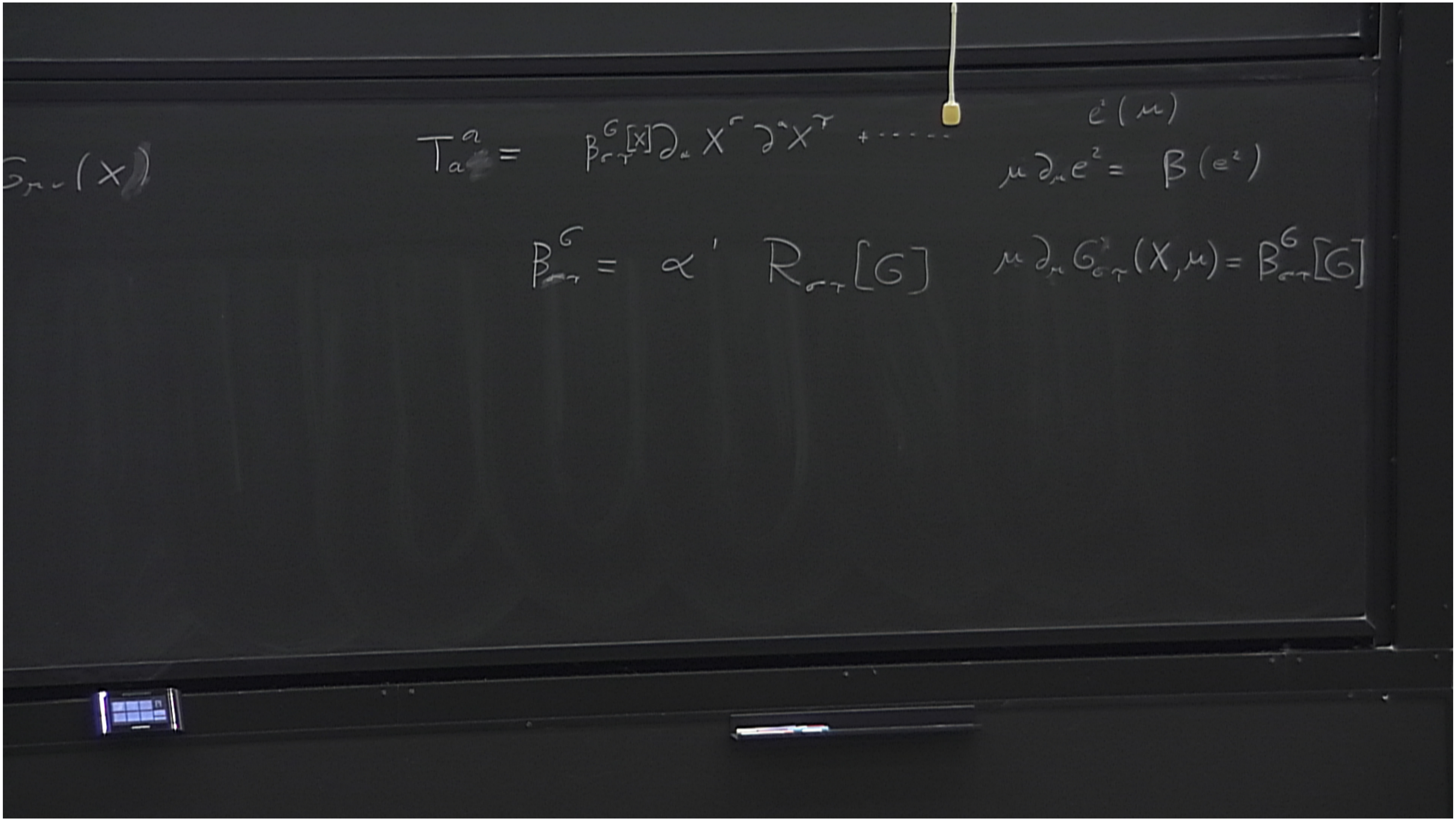

ρ² = 2
e²(μ)
T_a^a = β^G_στ[X] ∂_a X^σ ∂^a X^τ + ...
G_μν(X)
μ ∂_μ e² = β(e²)
μ ∂_μ G_στ(X, μ) = β^G_στ[G]

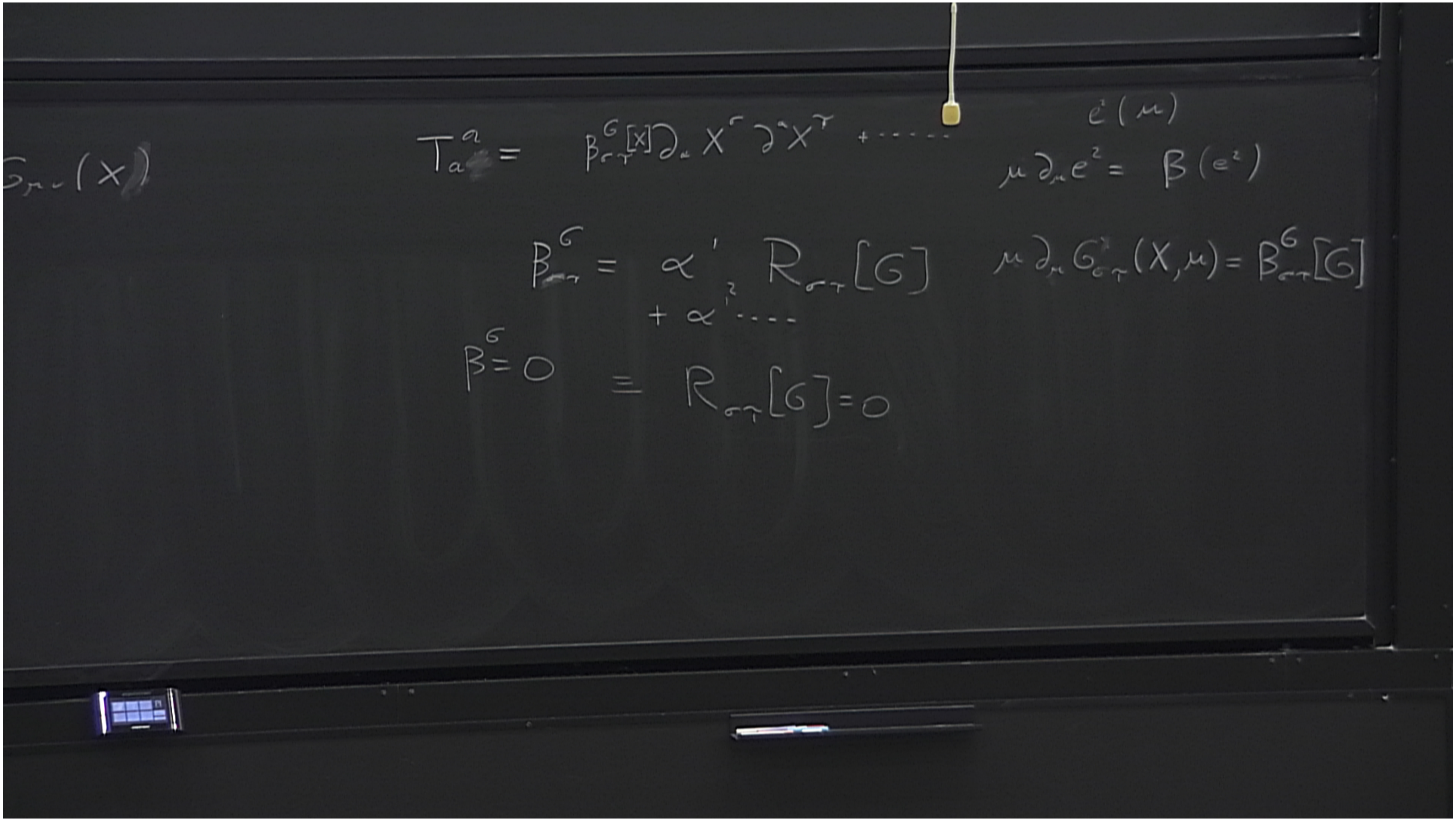
$$\int \sqrt{\det\left[G_{\mu\nu}(X)\,\frac{\partial X^\mu}{\partial \sigma^a}\,\frac{\partial X^\nu}{\partial \sigma^b}\right]}$$

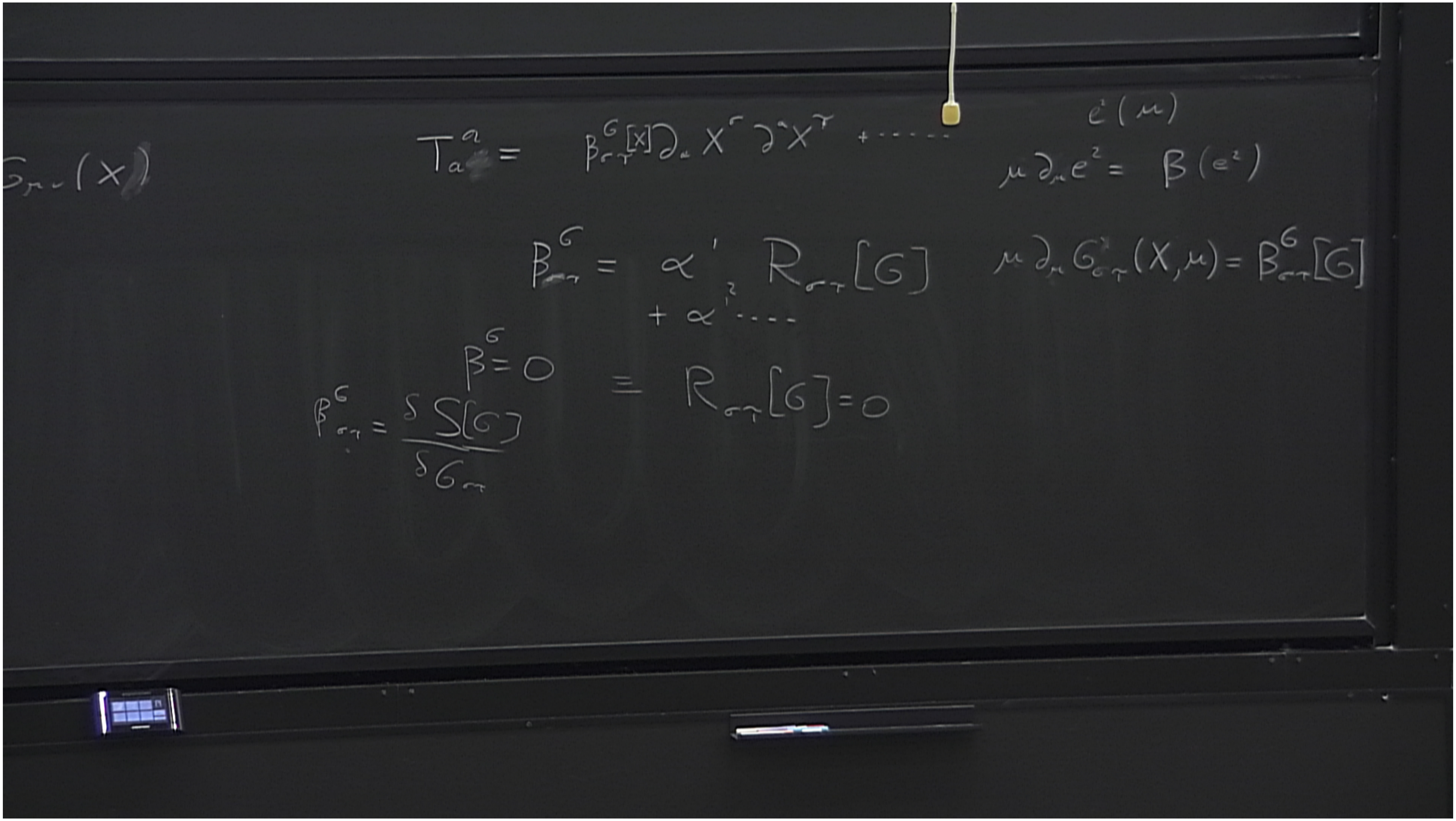
$$\frac{\alpha'}{2}\int \sqrt{h}\; h^{ab}\,\frac{\partial X^\mu}{\partial \sigma^a}\,\frac{\partial X^\nu}{\partial \sigma^b}\,G_{\mu\nu}(X)$$

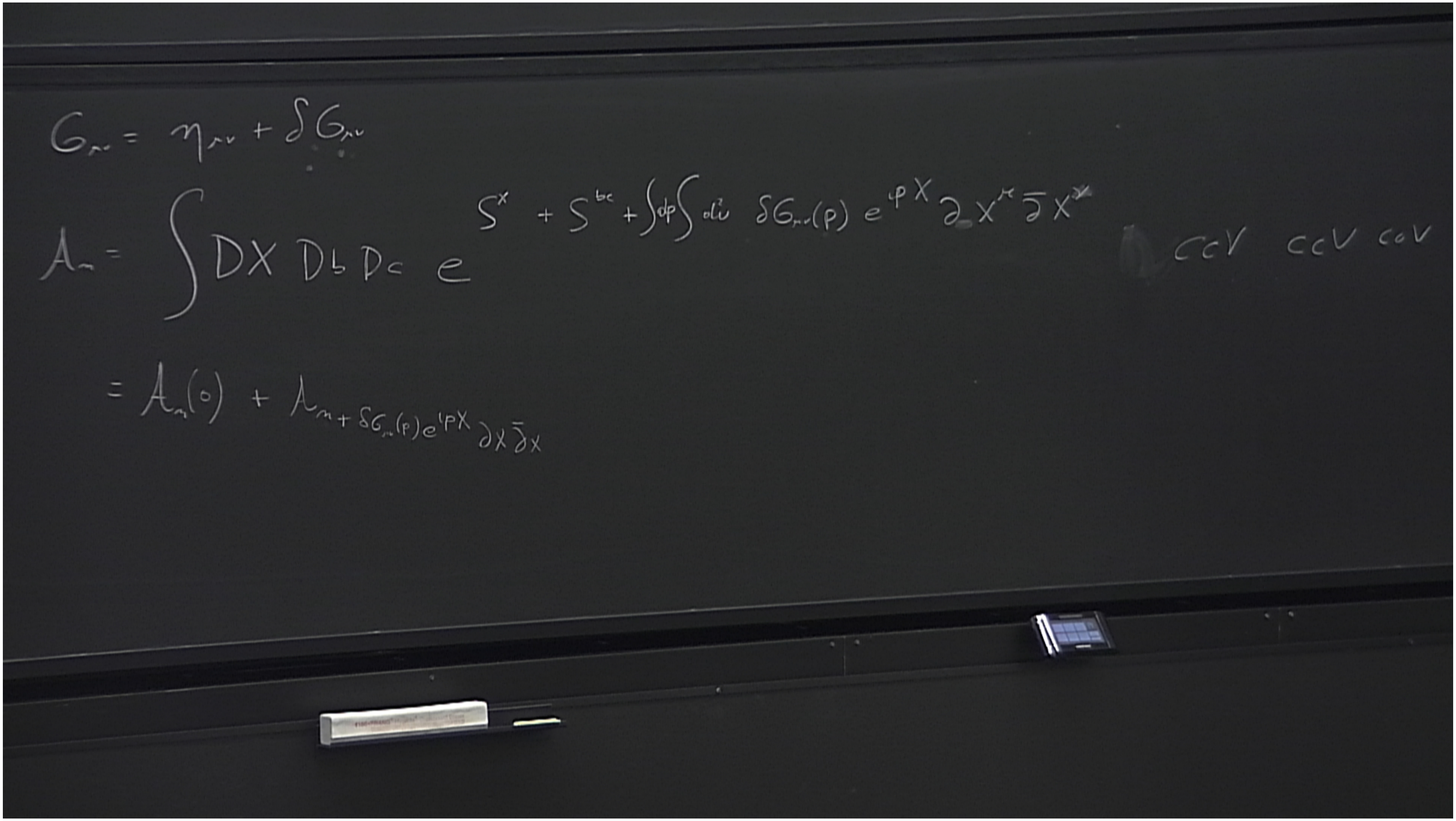
$$X^\mu = x^\mu + \sqrt{\alpha'}\,y^\mu$$

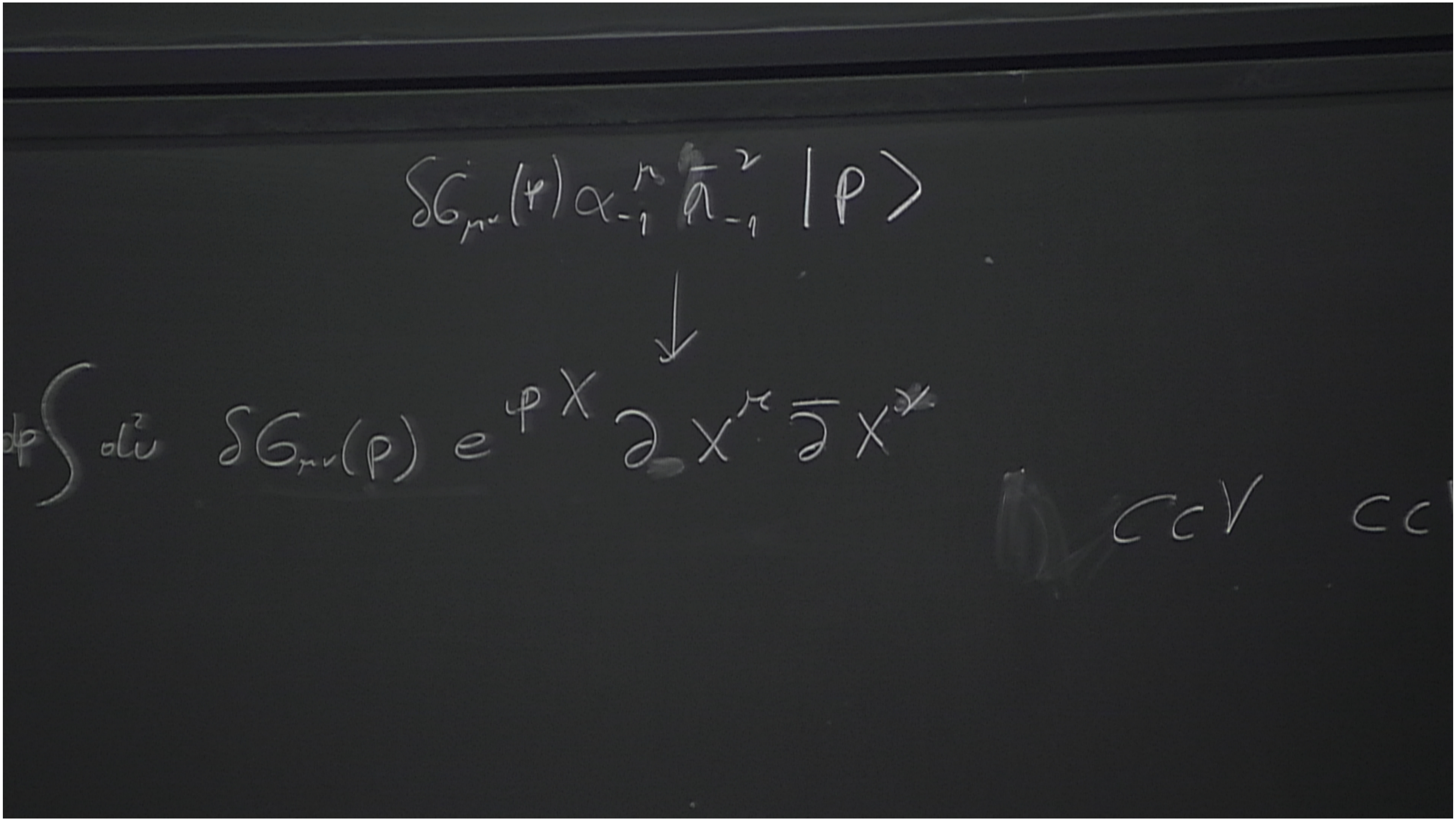
$$G_{\mu\nu} = \eta_{\mu\nu} + \dots$$

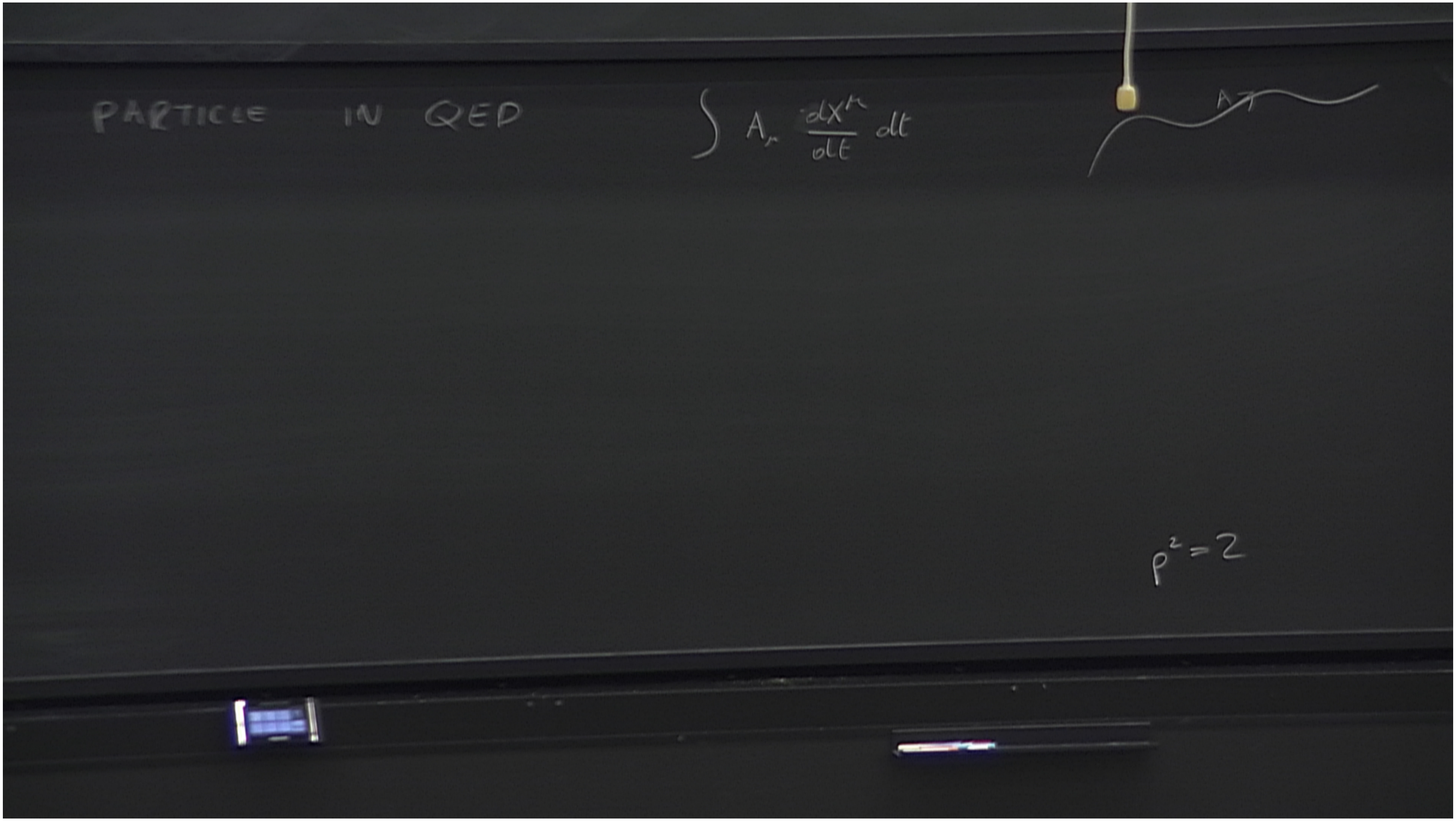

$G_{\mu\nu}(X)$
$T_a^a = \beta^G_{\sigma\tau}[X]\partial_\alpha X^\sigma \partial^\alpha X^\tau + \cdots$
$e^2(\mu)$
$\mu \partial_\mu e^2 = \beta(e^2)$
$\beta^G_{\sigma\tau} = \alpha' R_{\sigma\tau}[G]$
$\mu \partial_\mu G_{\sigma\tau}(X,\mu) = \beta^G_{\sigma\tau}[G]$

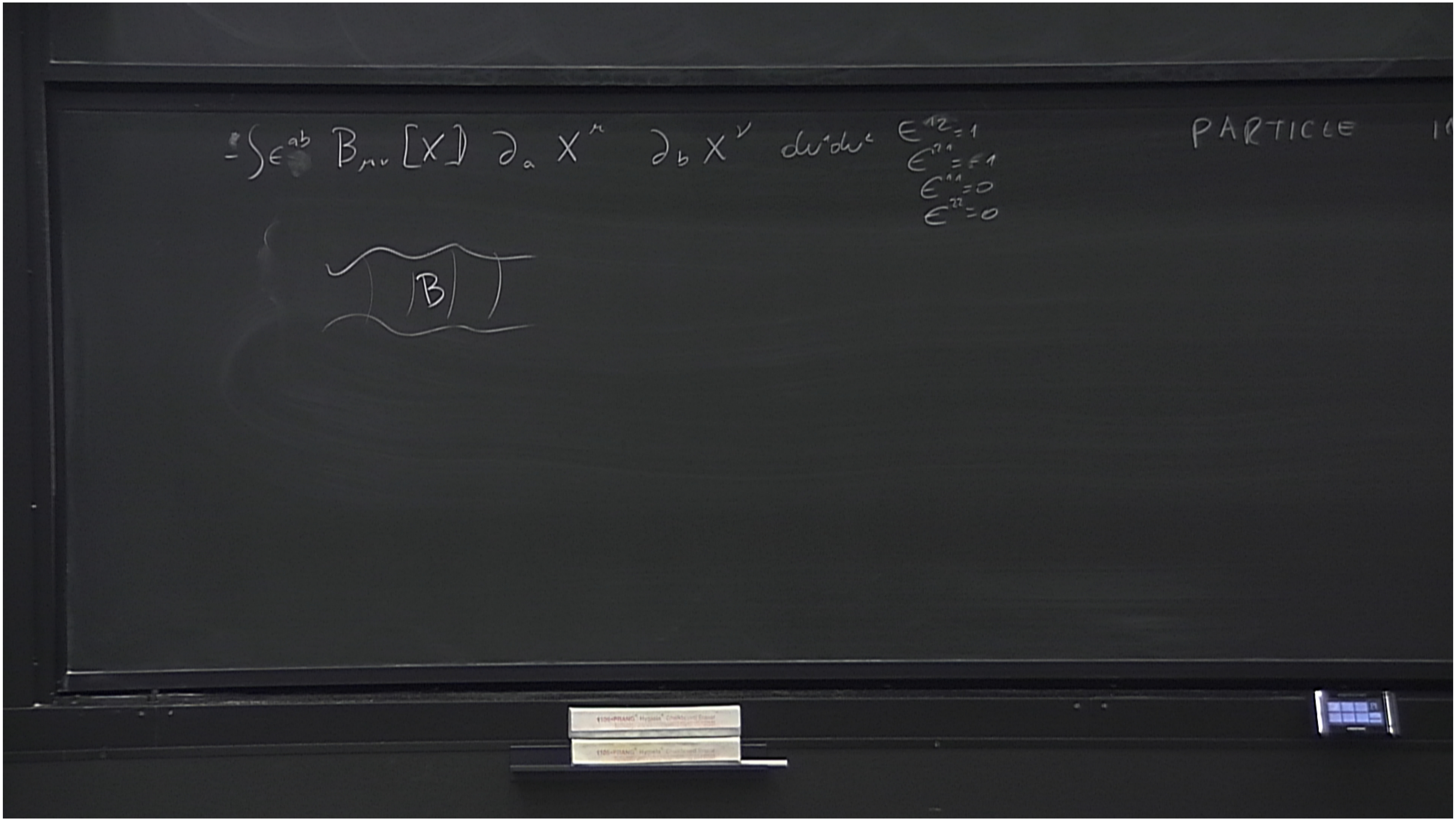

$G_{\mu\nu}(X)$
$T_a^a = \beta^G_{\sigma\tau}[X] \partial_a X^\sigma \partial^a X^\tau + \cdots$
$e^2(\mu)$
$\mu \partial_\mu e^2 = \beta(e^2)$
$\beta^G_{\sigma\tau} = \alpha' R_{\sigma\tau}[G] + \alpha'^2 \cdots$
$\mu \partial_\mu G_{\sigma\tau}(X,\mu) = \beta^G_{\sigma\tau}[G]$
$\beta^G = 0 \equiv R_{\sigma\tau}[G] = 0$

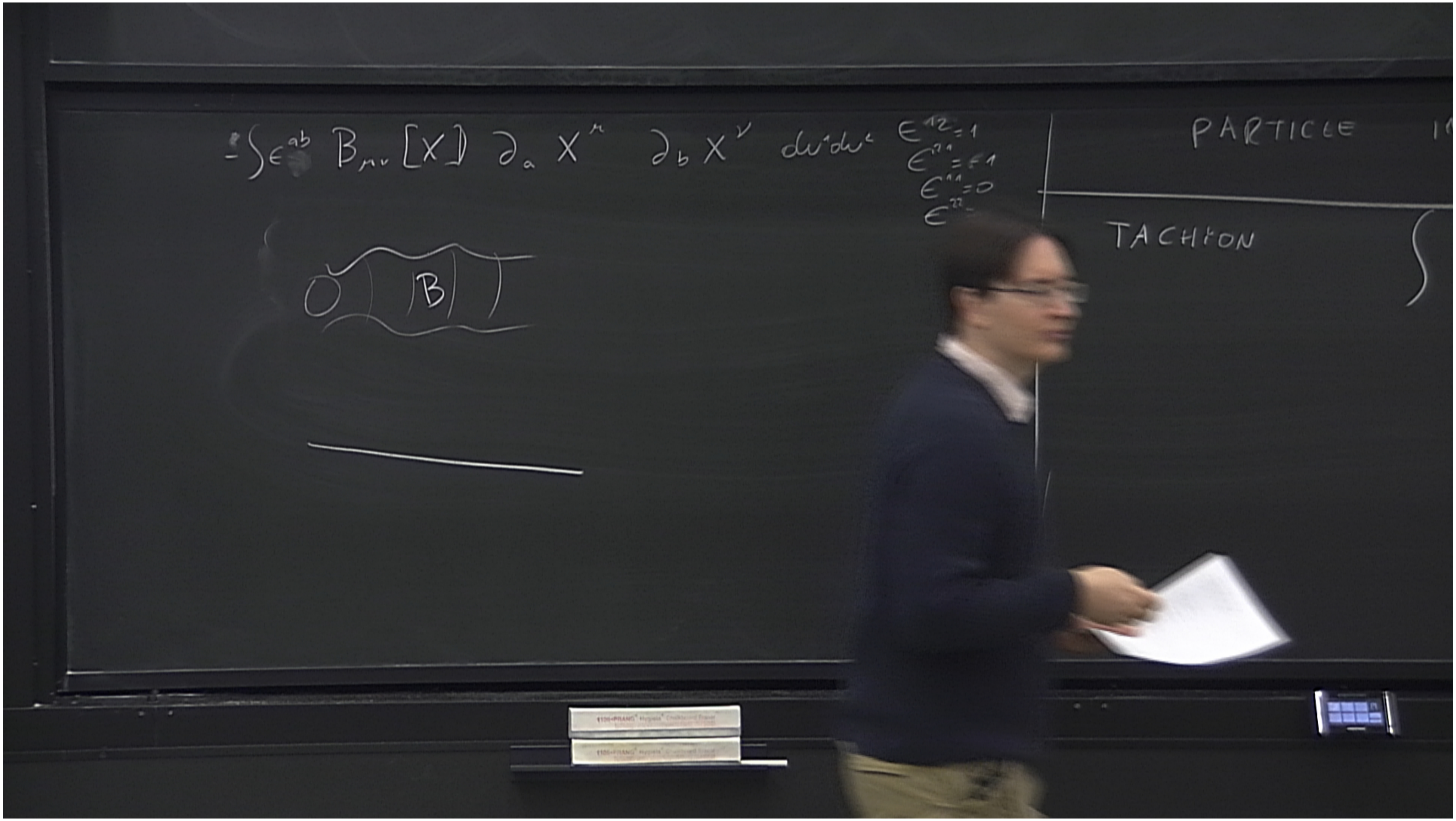

$G_{\mu\nu}(X)$
$T_a^a = \beta^G_{\sigma\tau}[X]\partial_a X^\sigma \partial^a X^\tau + \cdots$
$e^2(\mu)$
$\mu \partial_\mu e^2 = \beta(e^2)$
$\beta^G_{\sigma\tau} = \alpha' R_{\sigma\tau}[G] + \alpha'^2 \cdots$
$\mu \partial_\mu G_{\sigma\tau}(X,\mu) = \beta^G_{\sigma\tau}[G]$
$\beta^G = 0 \equiv R_{\sigma\tau}[G] = 0$
$\beta^G_{\sigma\tau} = \frac{\delta S[G]}{\delta G_{\sigma\tau}}$

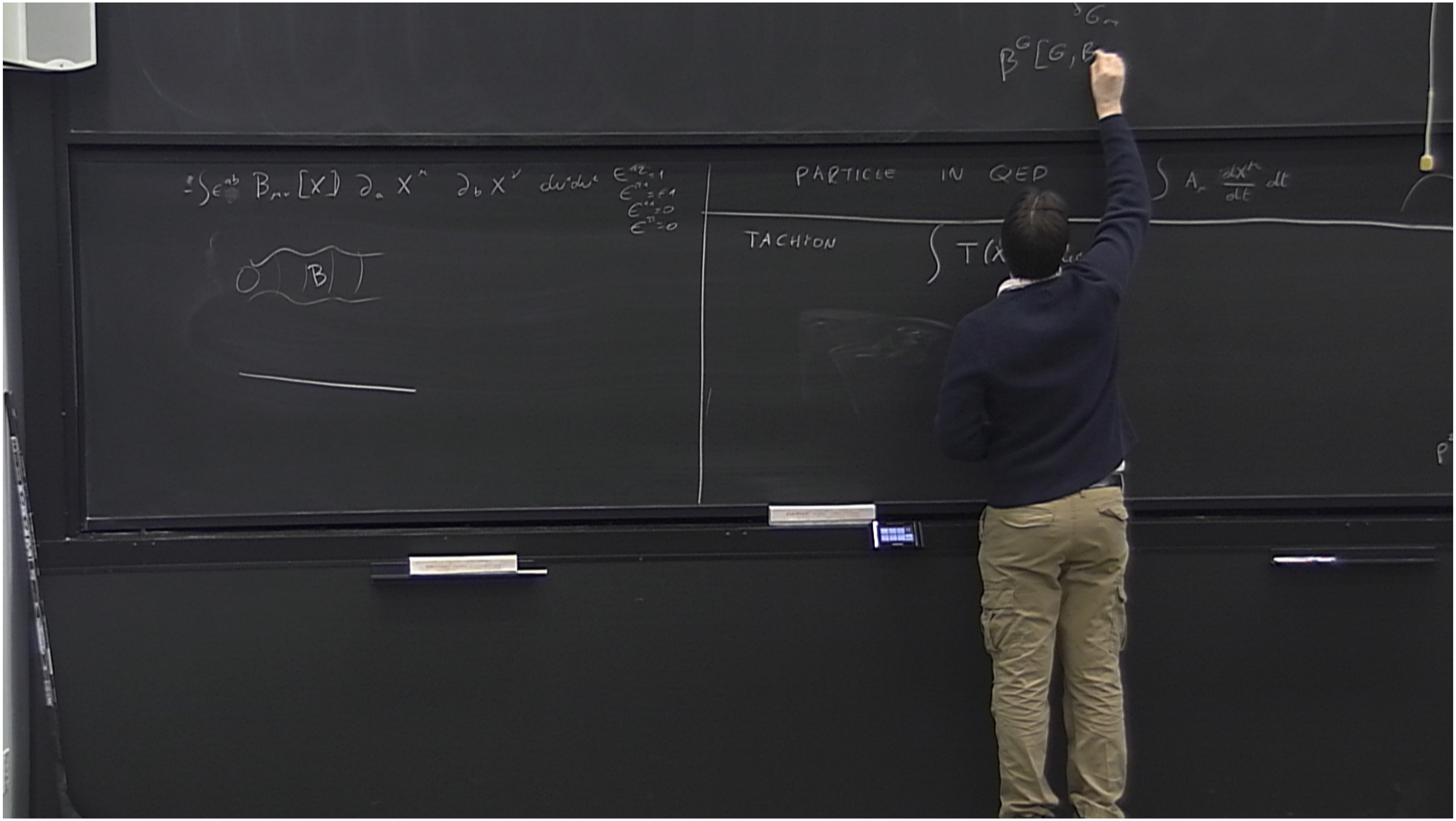

$G_{\mu\nu} = \eta_{\mu\nu} + \delta G_{\mu\nu}$
$A_n = \int DX\, Db\, Dc\; e^{S^X + S^{bc} + \int dp \int d^2\sigma\, \delta G_{\mu\nu}(p)\, e^{ipX} \partial X^\mu \bar\partial X^\nu}$
ccV ccV ccV
$= A_n(0) + A_{n+\delta G_{\mu\nu}(p) e^{ipX} \partial X \bar\partial X}$

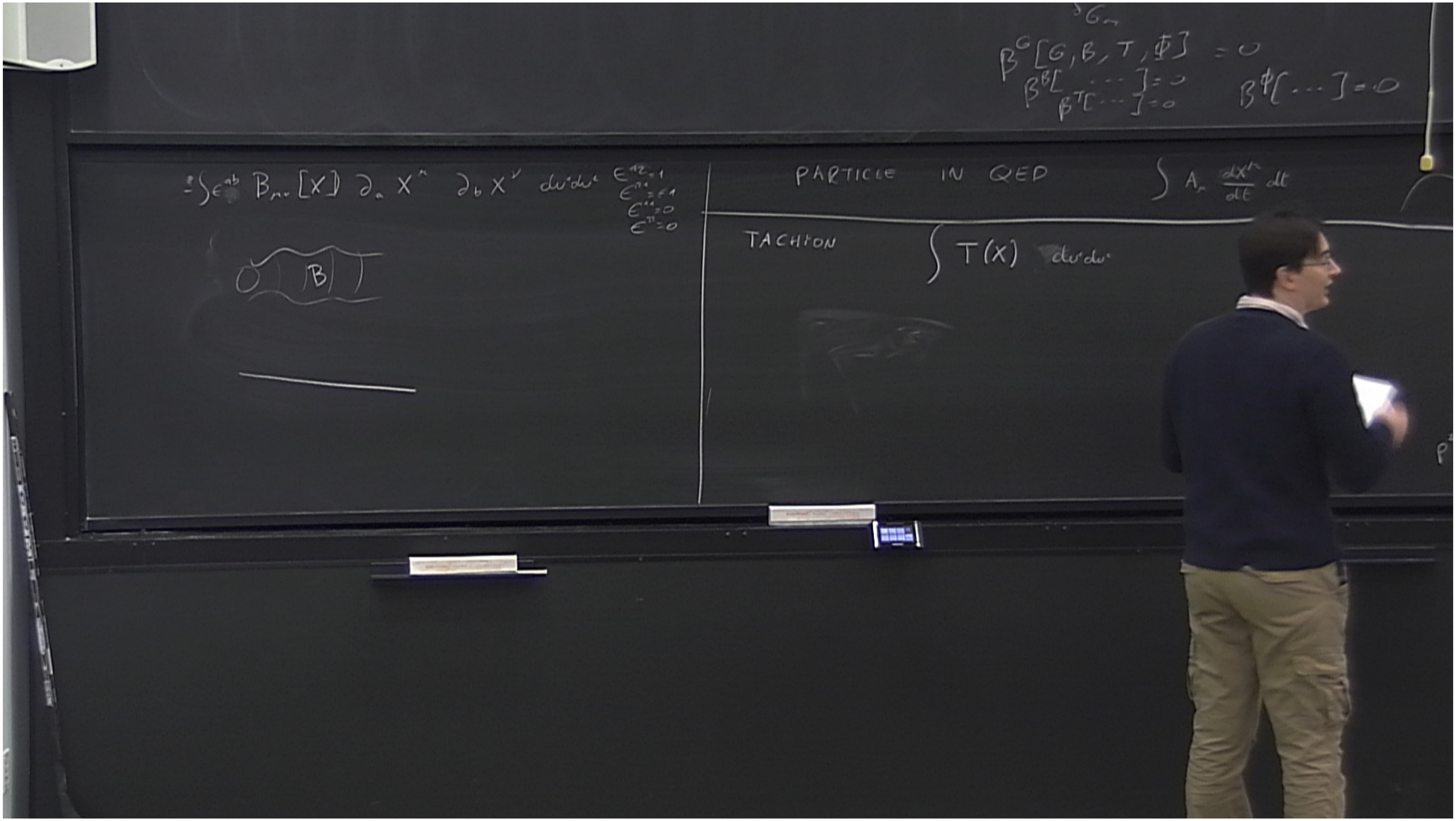

$\delta G_{\mu\nu}(p)\,\alpha^{\mu}_{-1}\,\bar{\alpha}^{\nu}_{-1}\,|p\rangle$
$\int d^2z\ \delta G_{\mu\nu}(p)\, e^{ipX}\, \partial X^{\mu}\, \bar{\partial} X^{\nu}$
$cc V$
cc

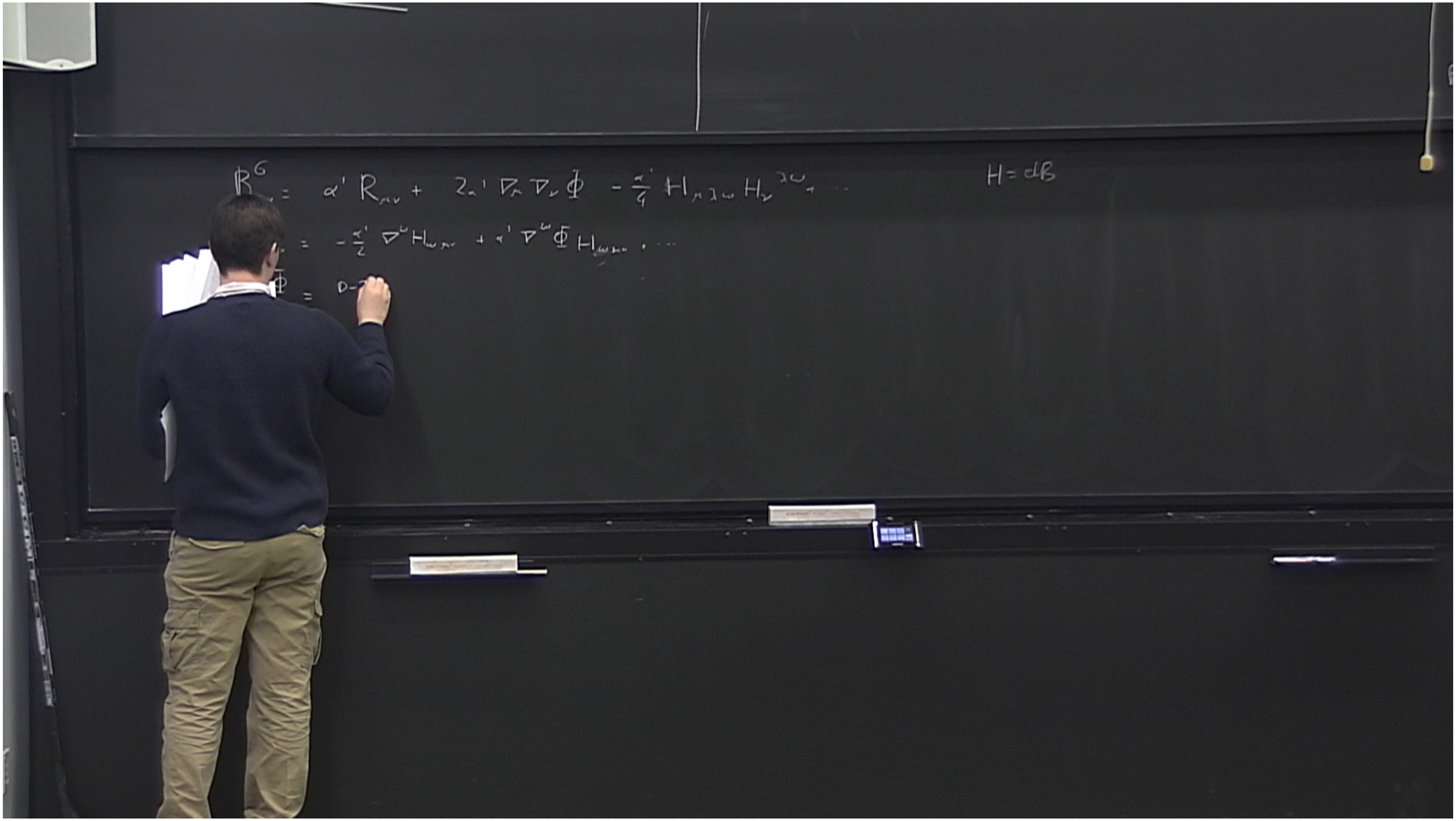

PARTICLE IN QED
$\int A_\mu \frac{dx^\mu}{dt} dt$
A
$p^2 = 2$


$-\int \epsilon^{ab} B_{\mu\nu}[X] \partial_a X^\mu \partial_b X^\nu dw^1 dw^2$
$\epsilon^{12}=1$
$\epsilon^{21}=-1$
$\epsilon^{11}=0$
$\epsilon^{22}=0$
PARTICLE
B

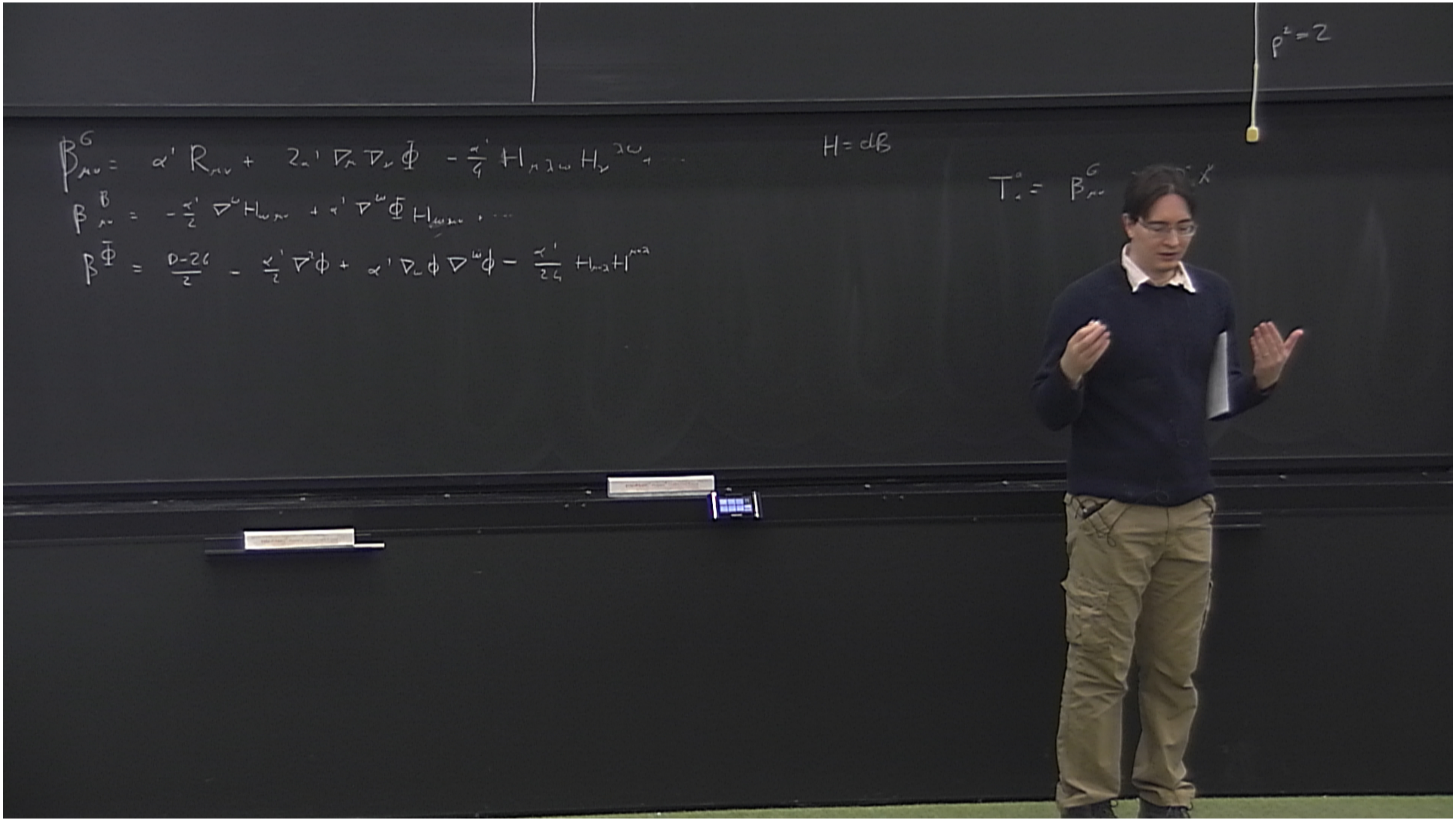

PARTICLE
TACHION
B

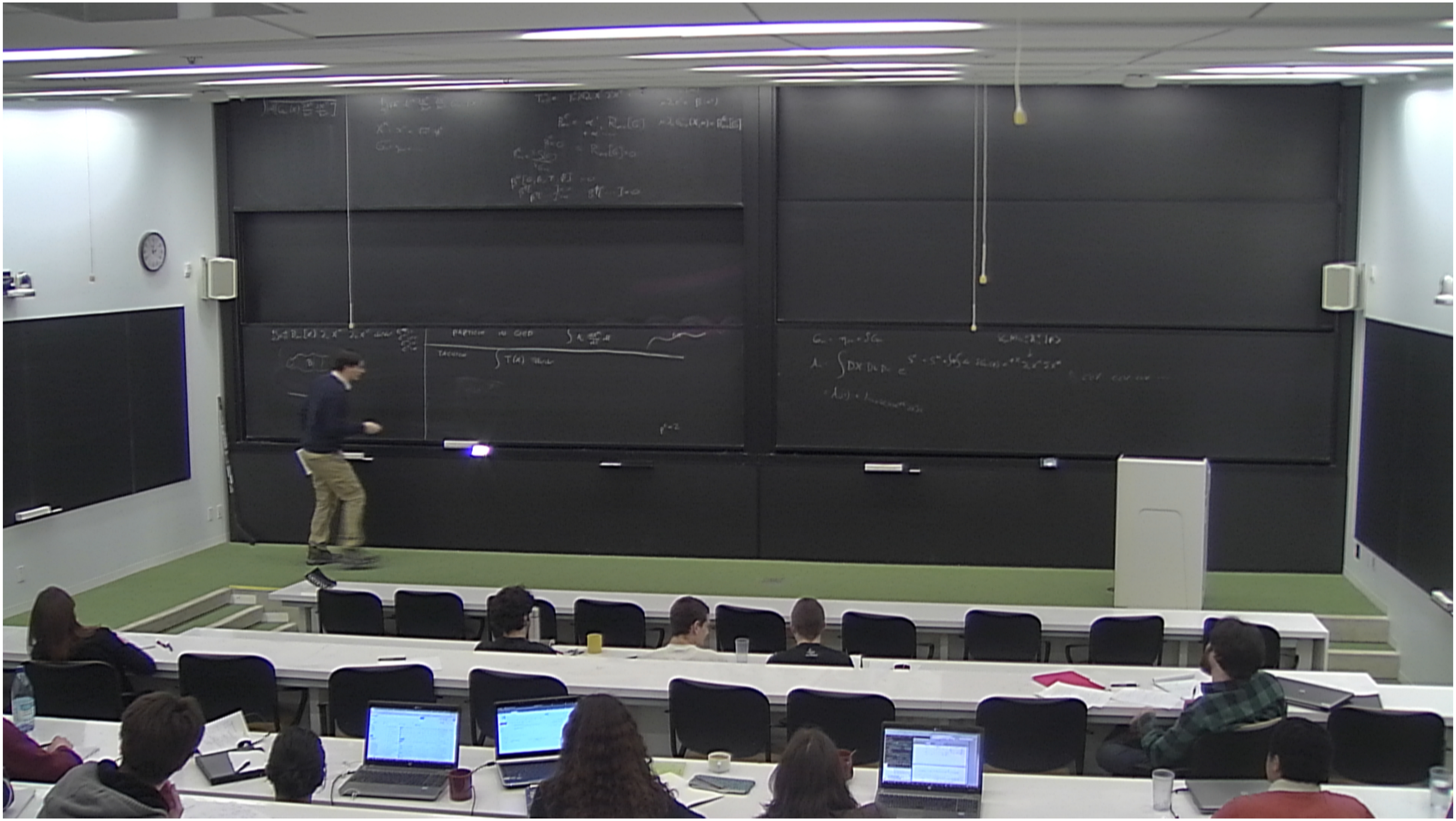

PARTICLE IN QED
TACHION

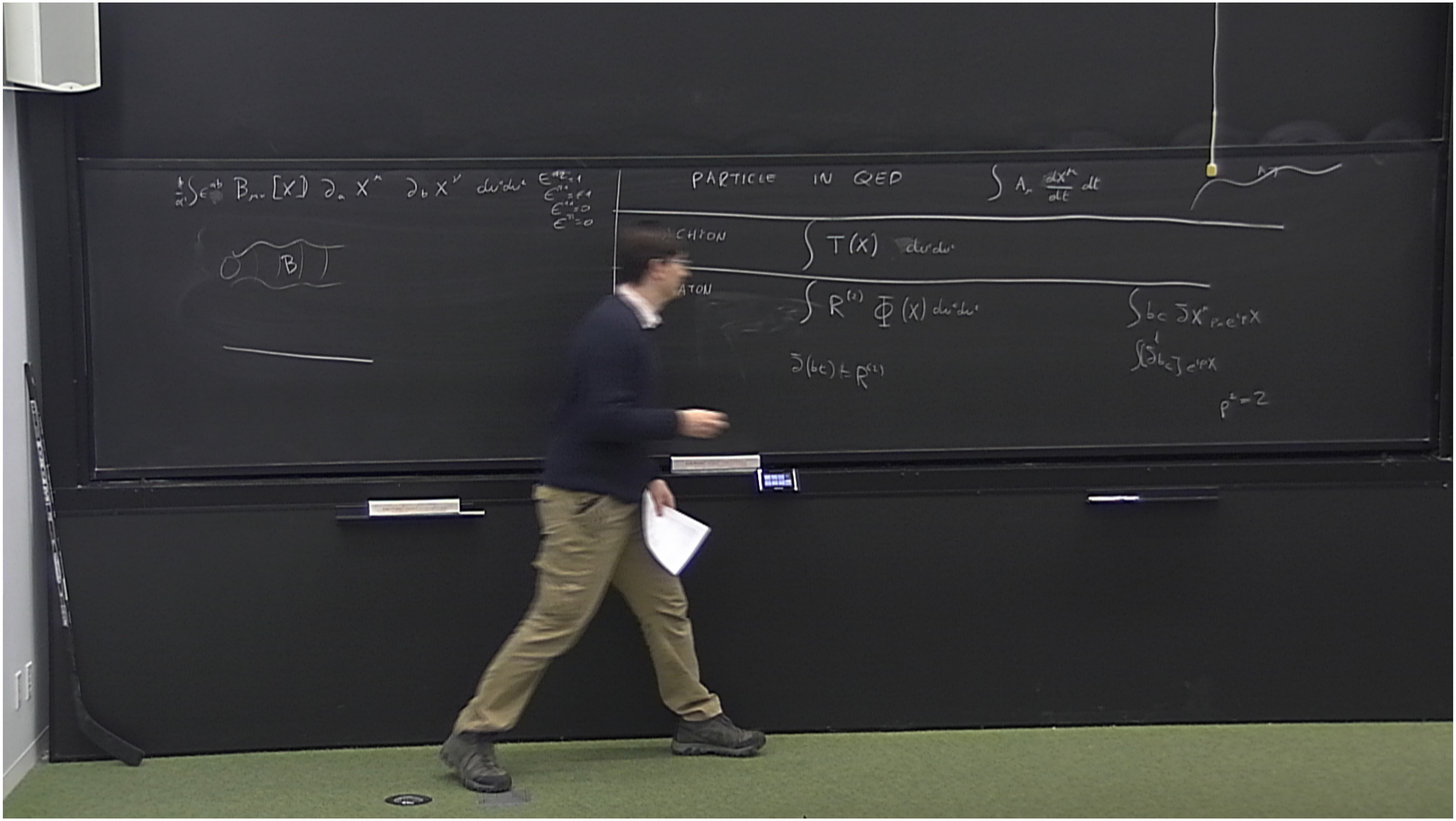

β^G[G, B, T, Φ] = 0
β^B[. . .] = 0
β^T[. . .] = 0
β^Φ[. . .] = 0
∫ε^ab B_μν[X] ∂_a X^μ ∂_b X^ν dσ¹dσ²
ε^12 = 1
ε^21 = −1
ε^11 = 0
ε^22 = 0
B
PARTICLE IN QED
∫ A_μ dX^μ/dt dt
TACHION
∫ T(X) dσ¹dσ²

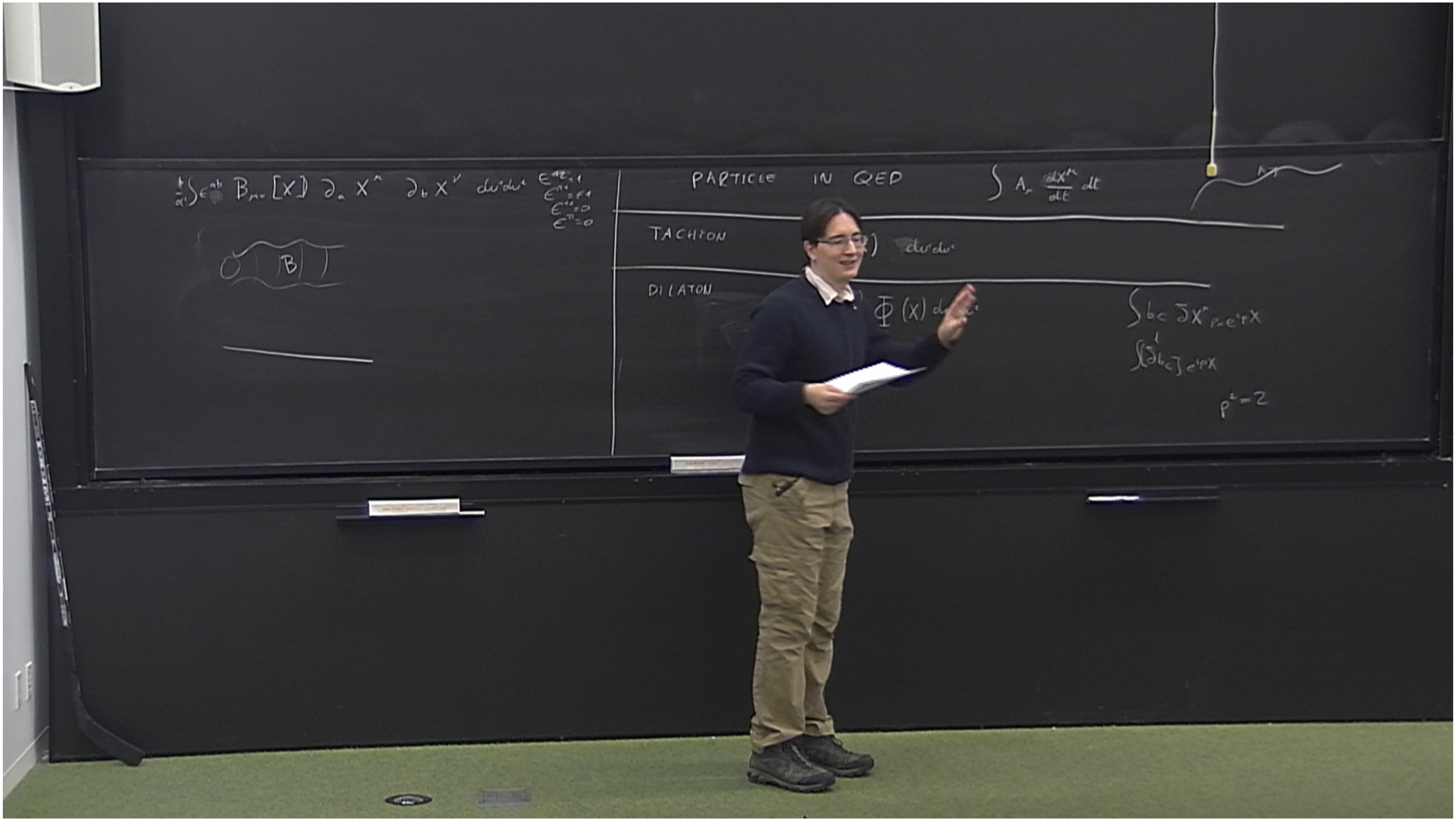


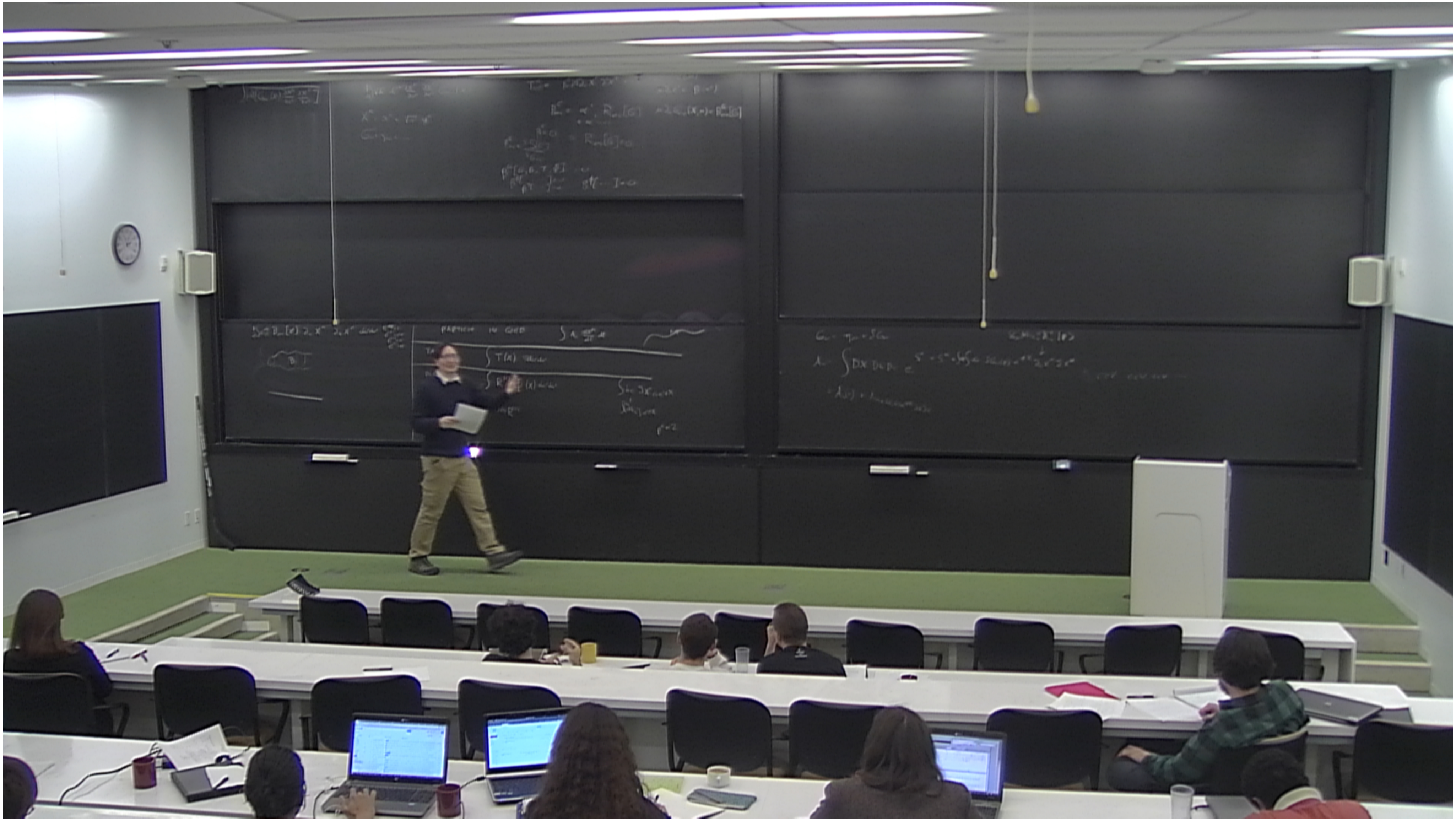
$\beta^G_{\mu\nu} = \alpha' R_{\mu\nu} + 2\alpha' \nabla_\mu \nabla_\nu \Phi - \frac{\alpha'}{4} H_{\mu\lambda\omega} H_\nu{}^{\lambda\omega} + \dots$
$= -\frac{\alpha'}{2} \nabla^\omega H_{\omega\mu\nu} + \alpha' \nabla^\omega \Phi H_{\omega\mu\nu} + \dots$
$H = dB$

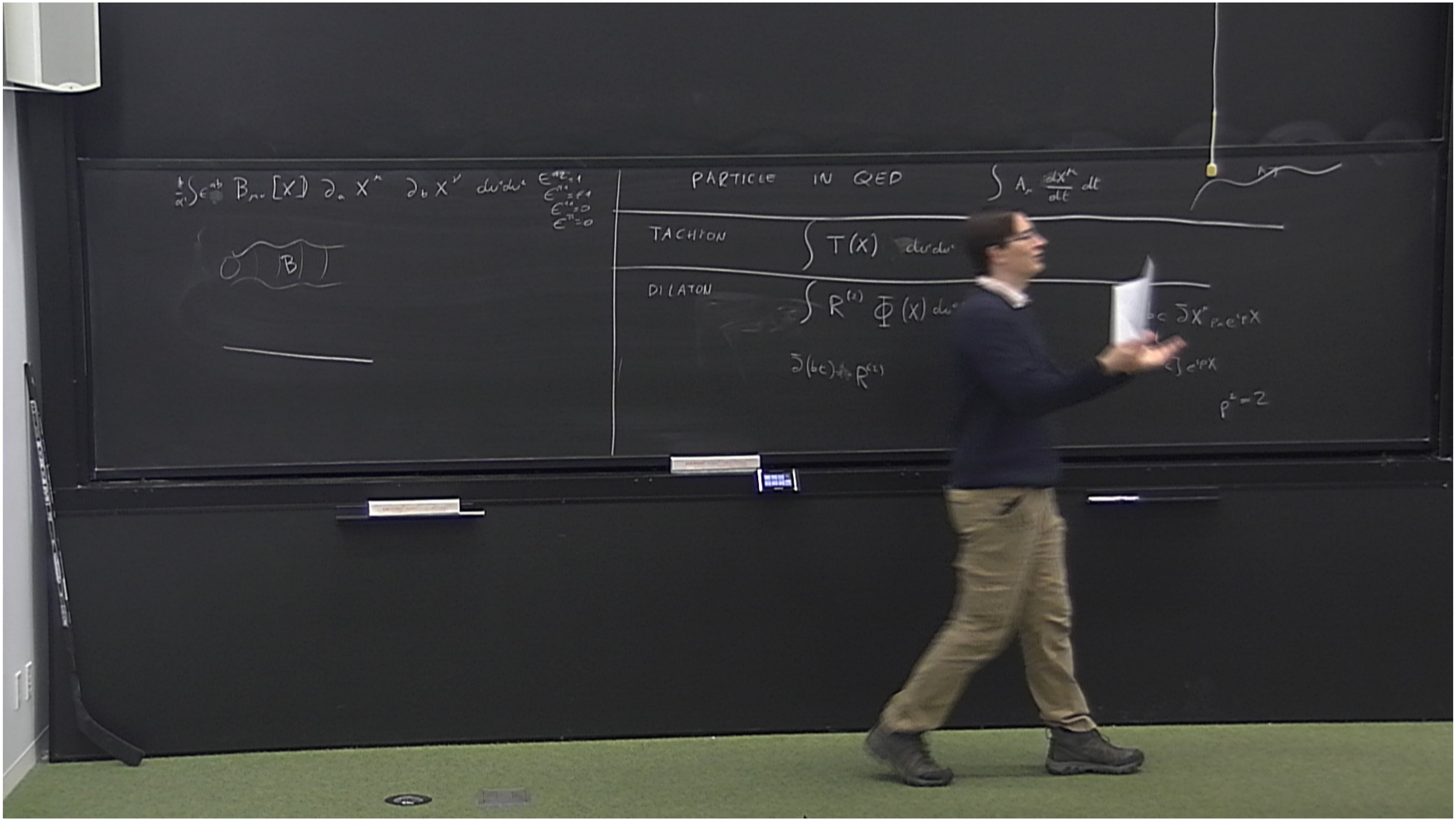

H = dB

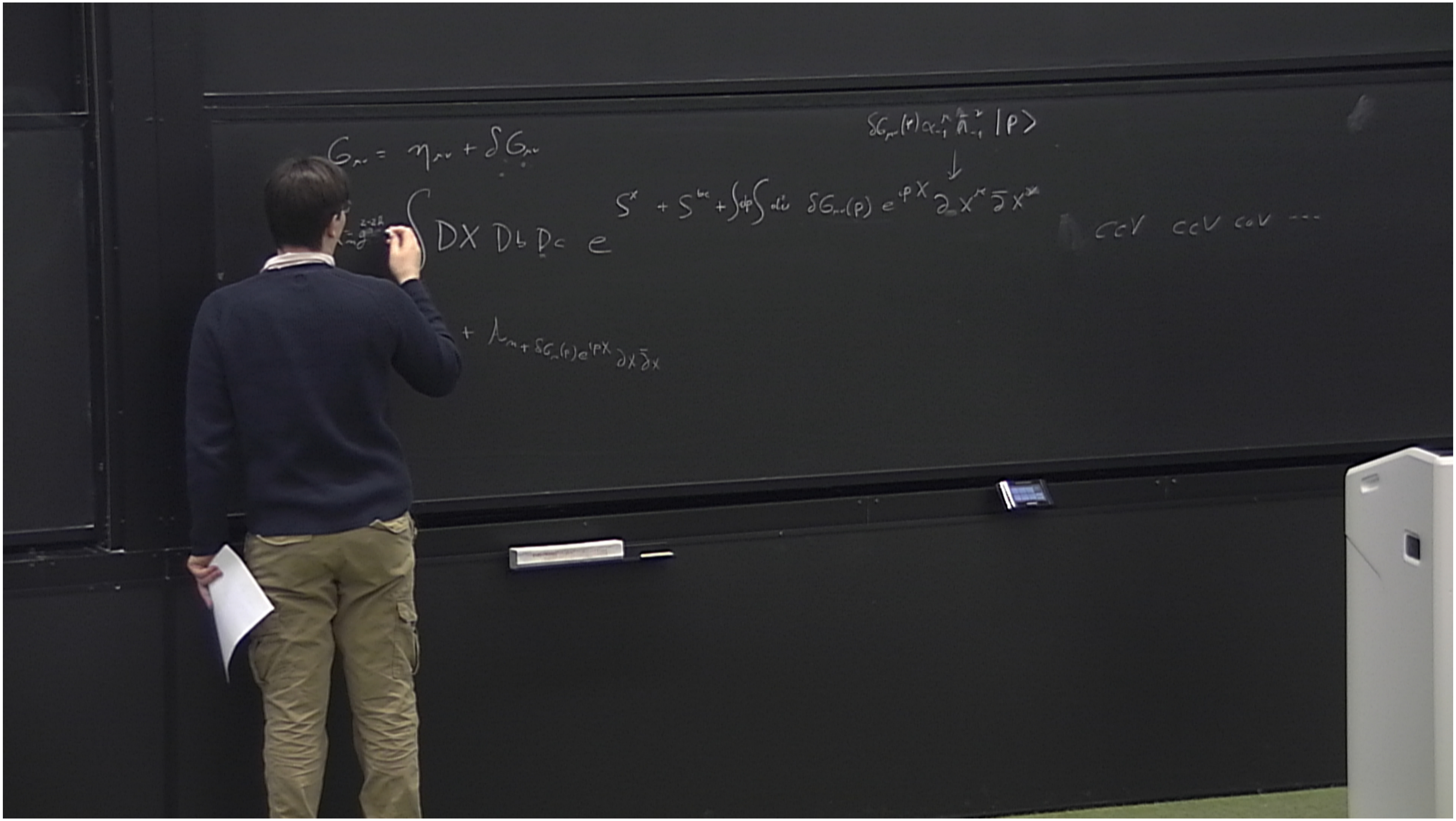


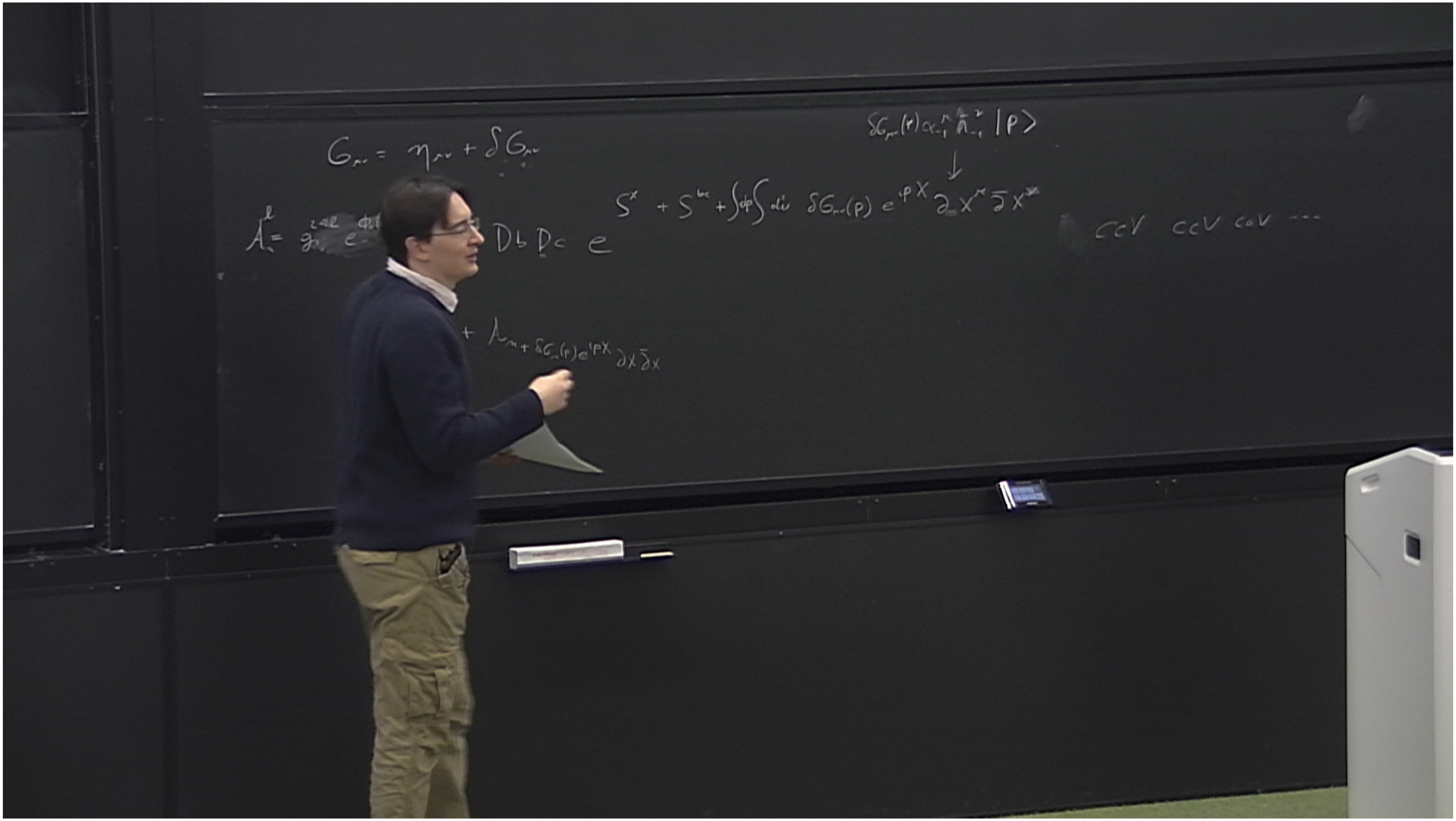

PARTICLE IN QED

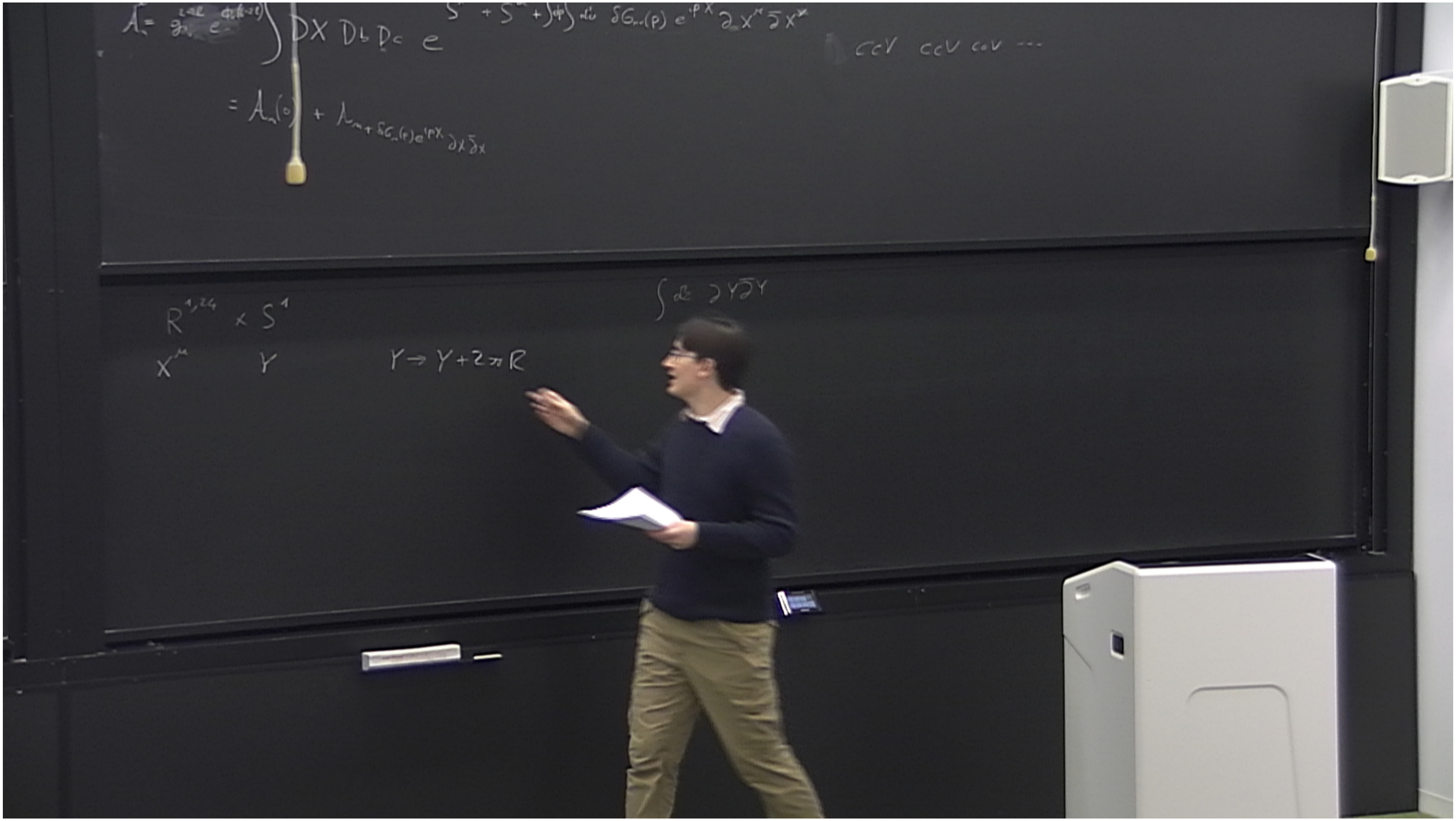

PARTICLE IN QED
TACHION
DILATON
p²=2

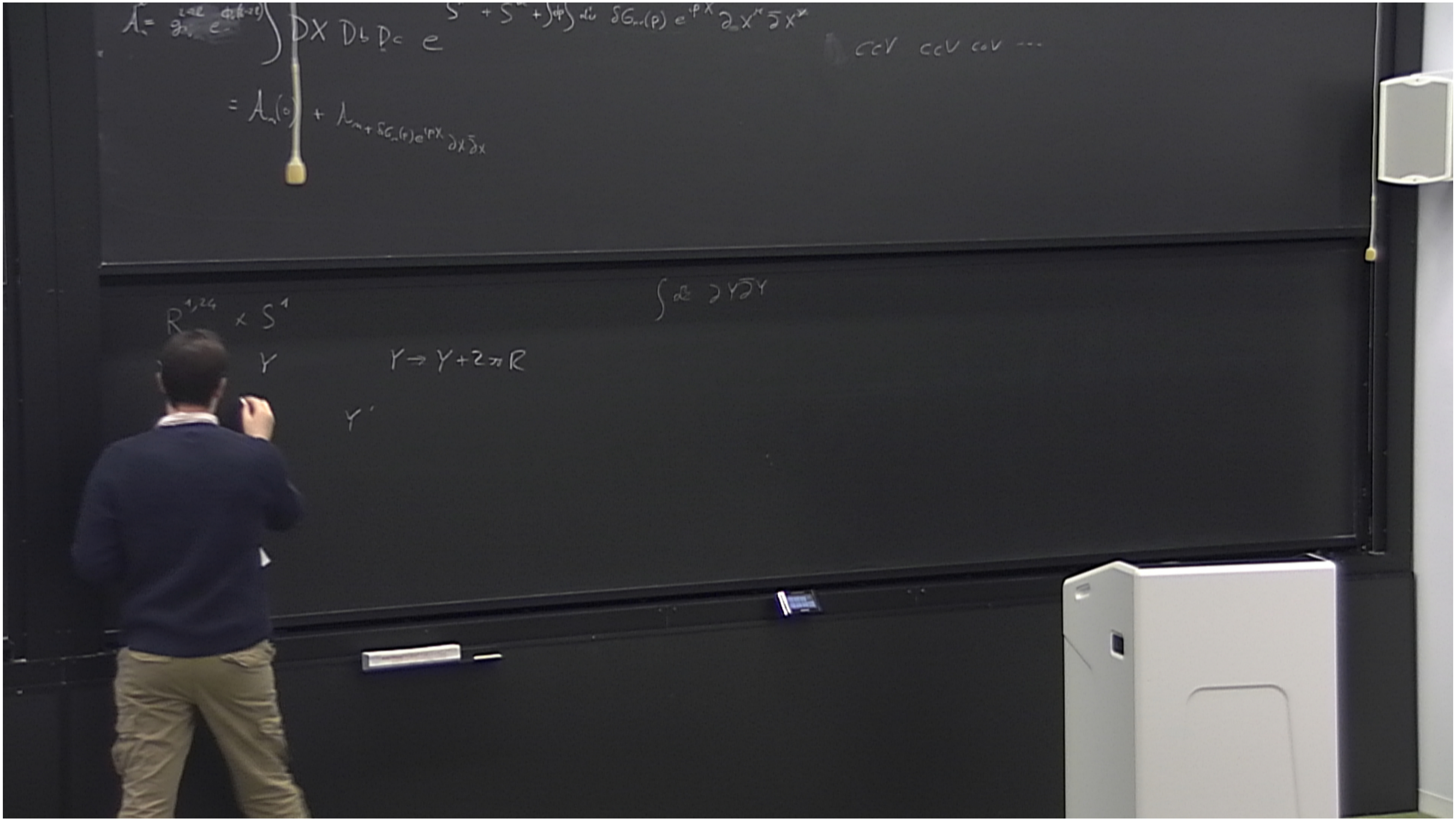


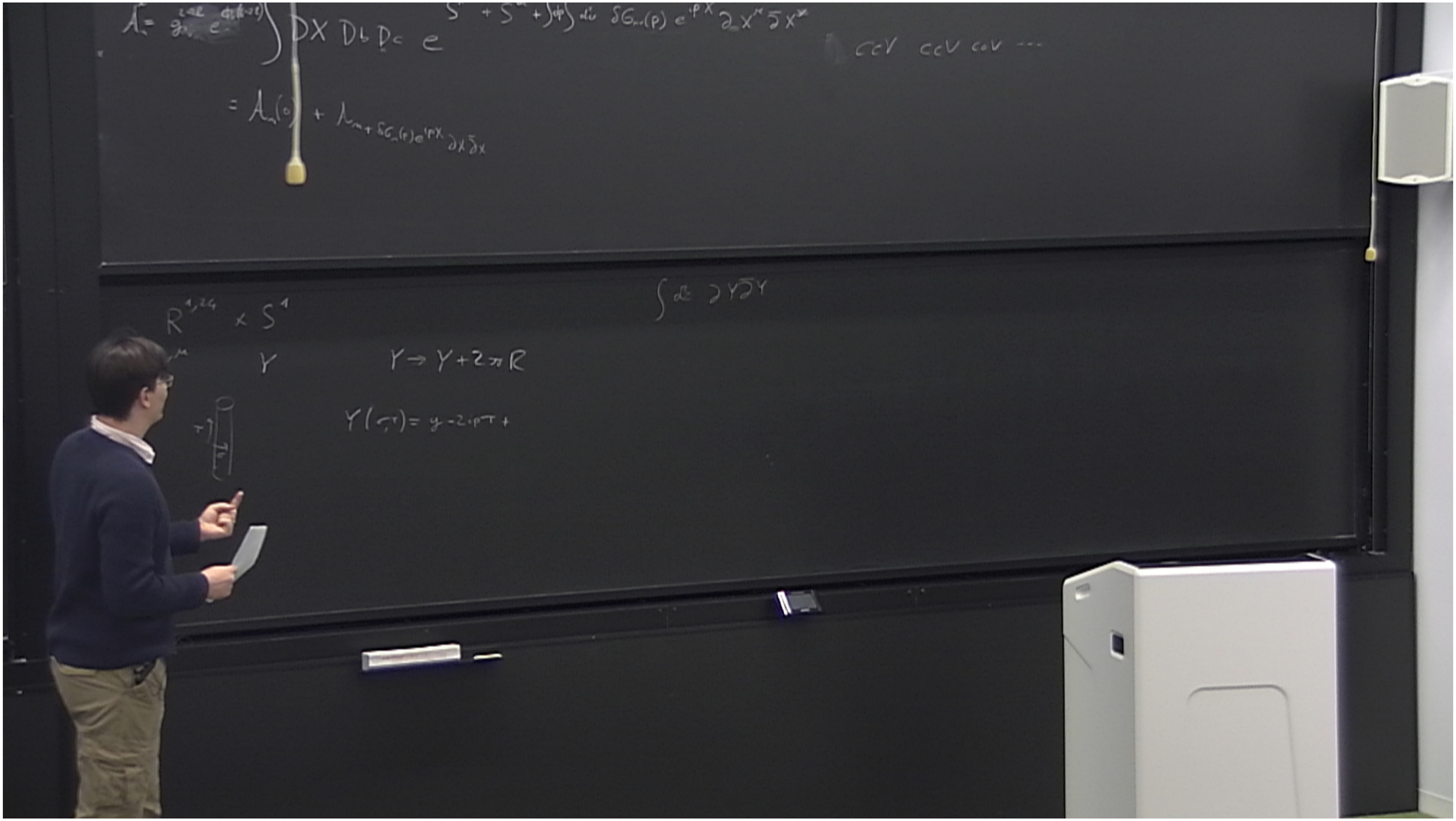

PARTICLE IN QED
TACHION
DILATON

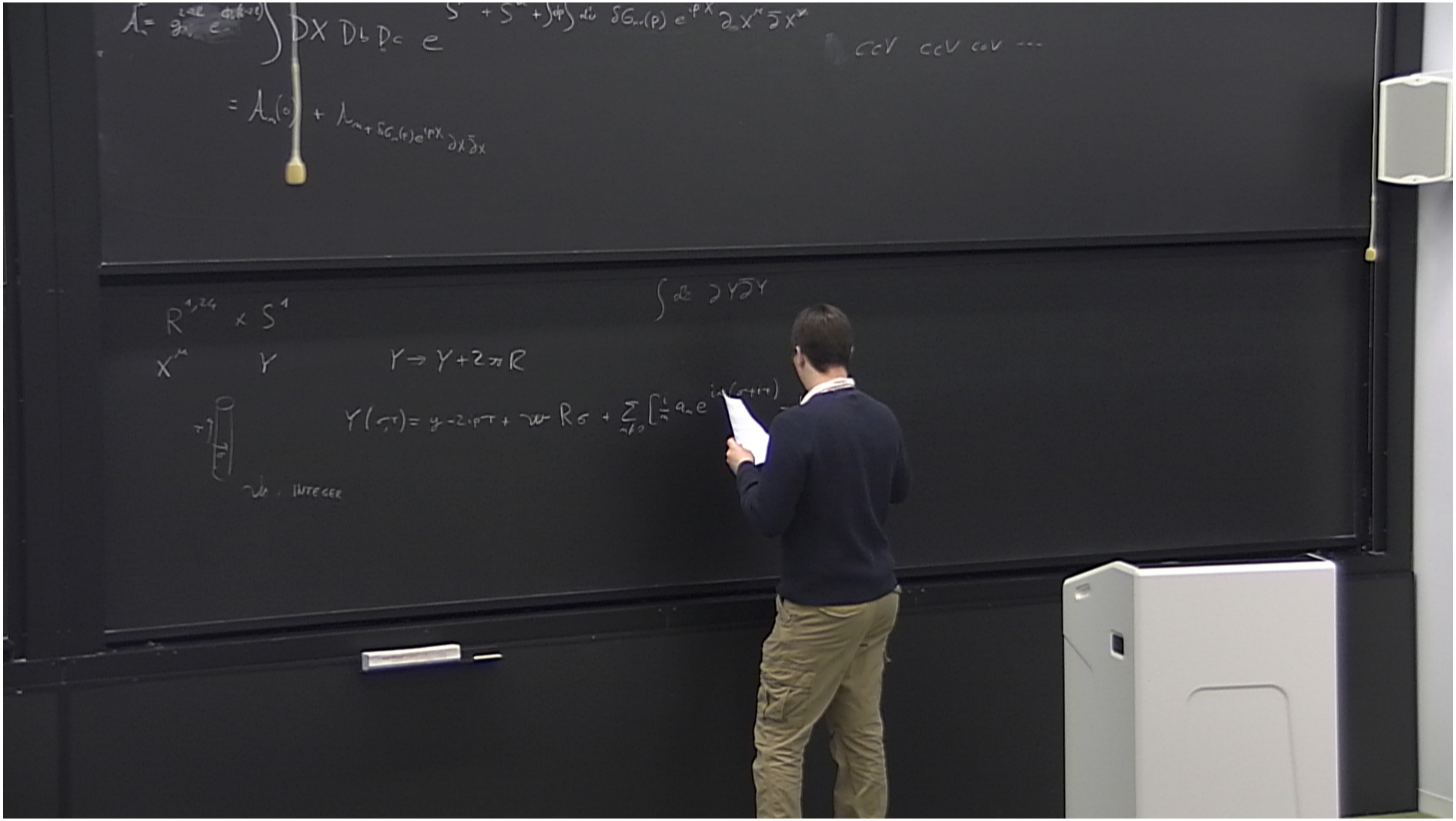

G_μν = η_μν + δG_μν
ccV ccV c∂V ...

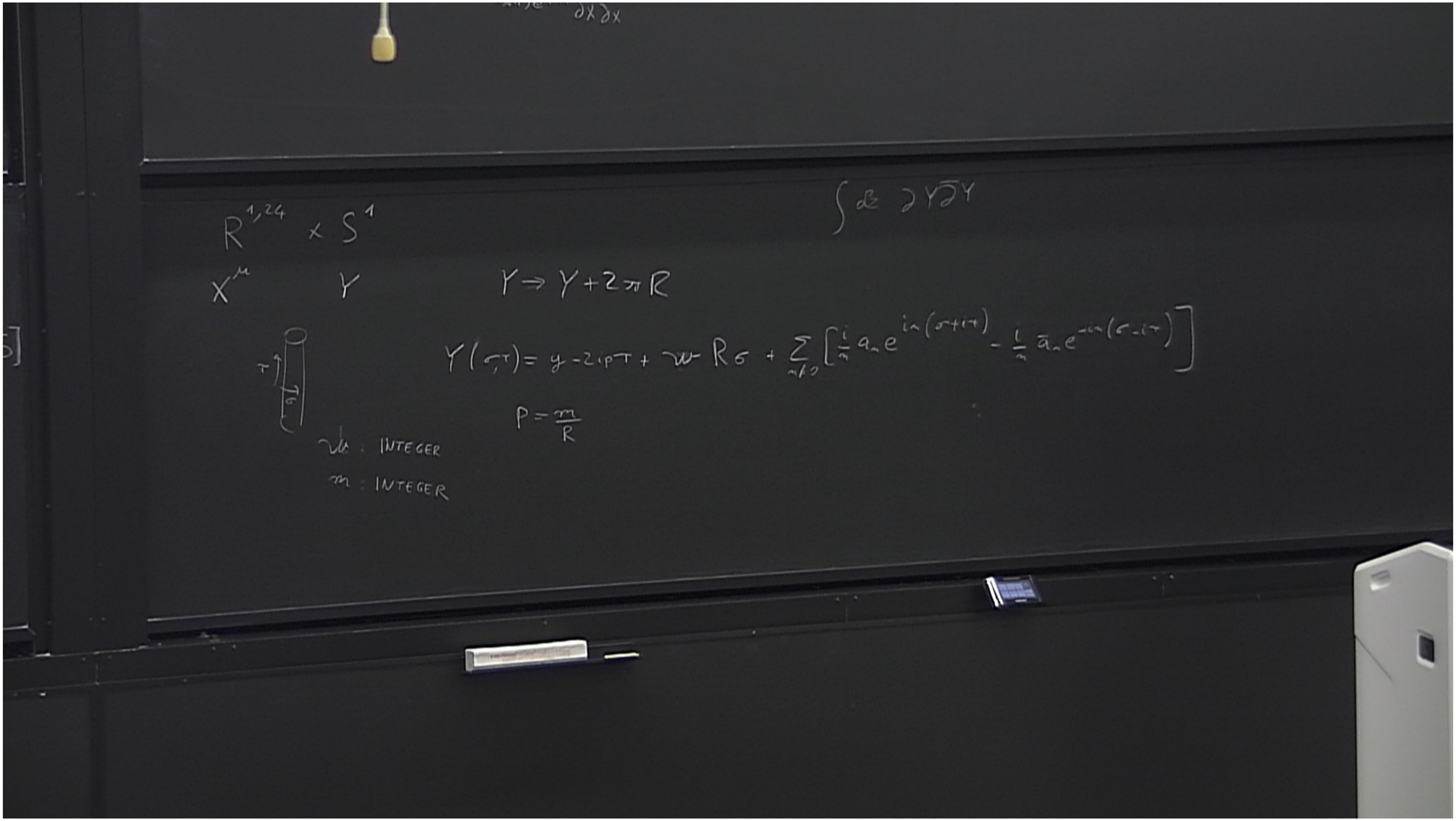


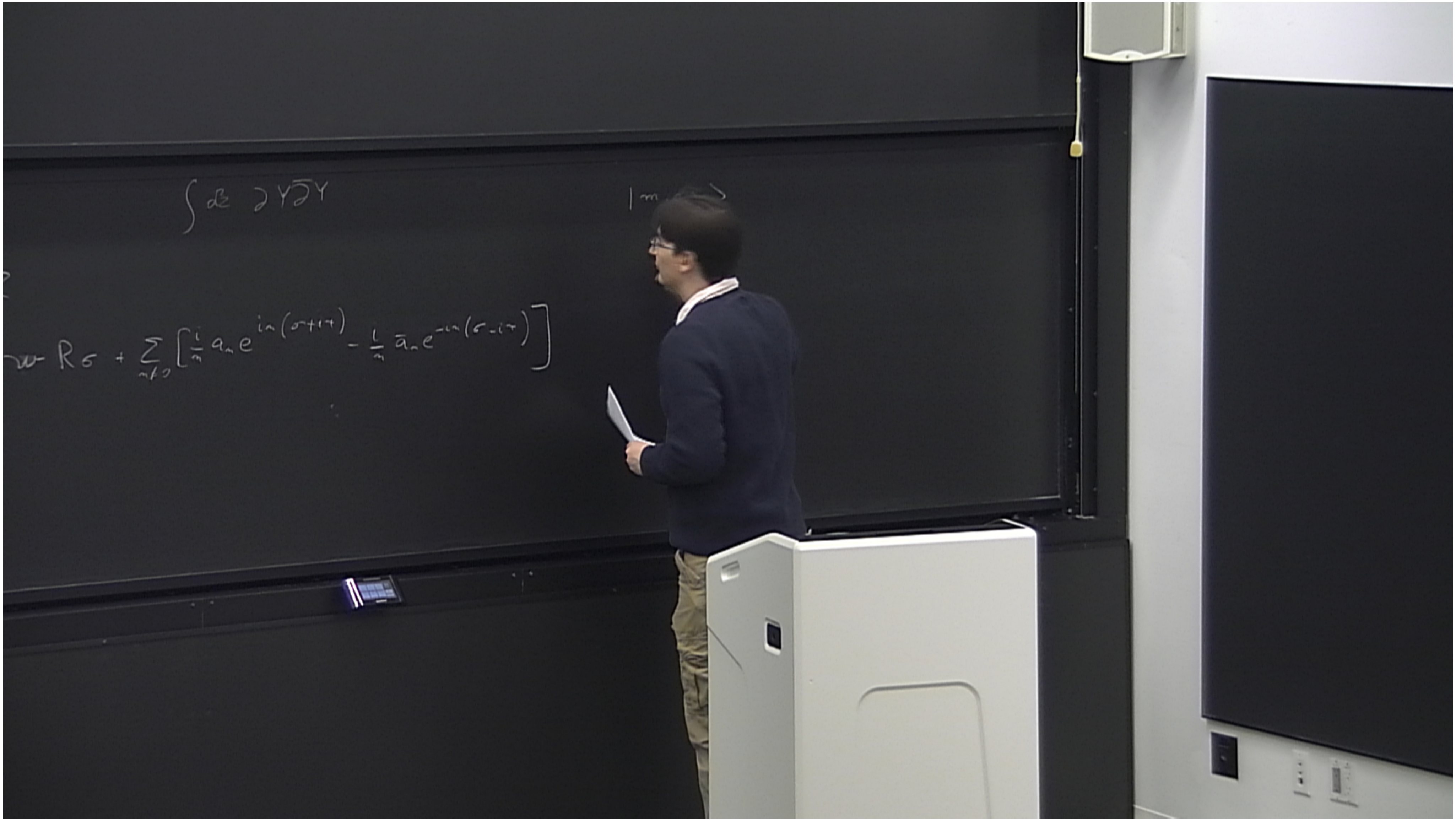

R^{1,24} × S^1
X^μ
Y
Y → Y + 2πR
ccV ccV ccV ...

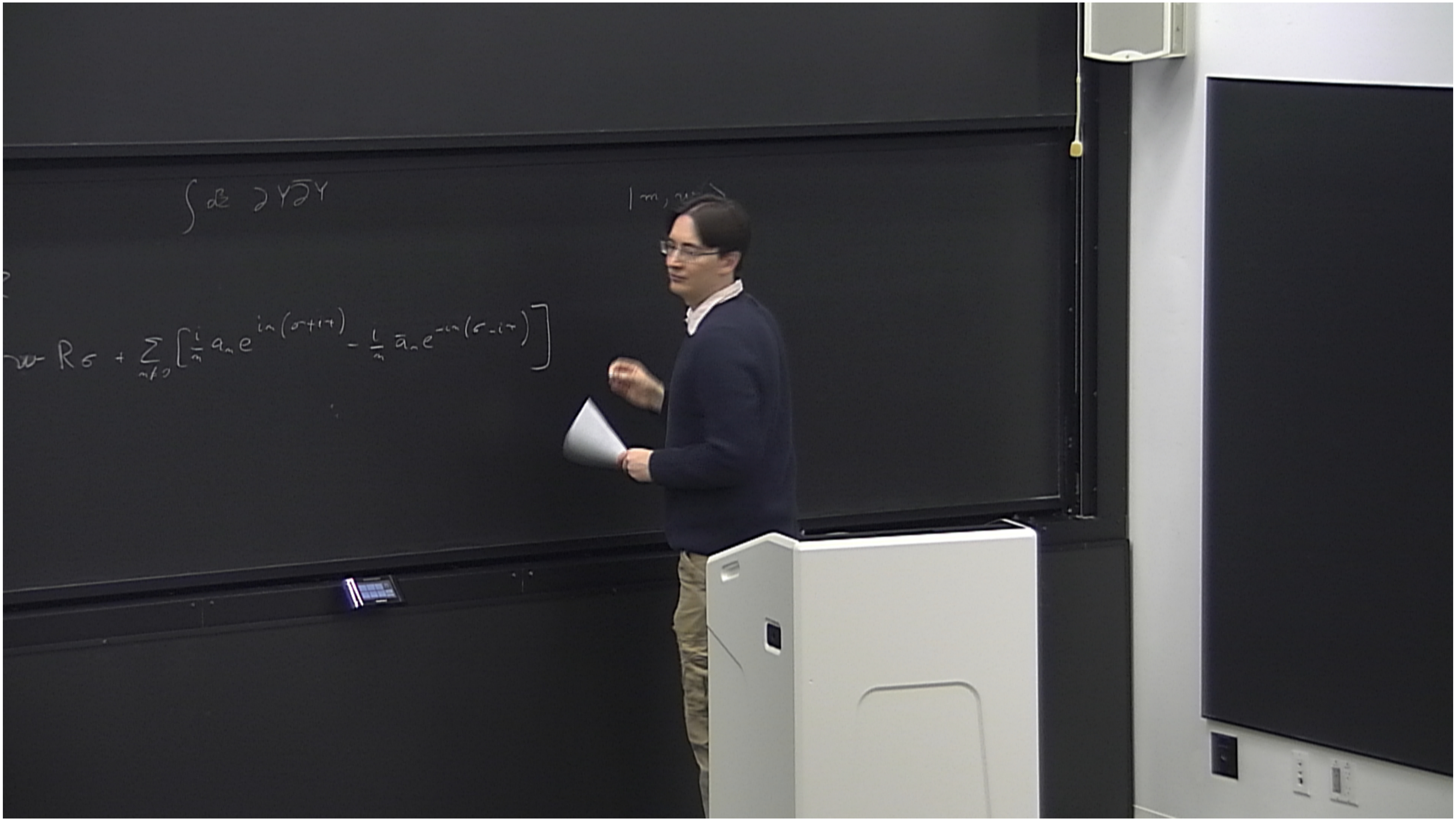

R^{1,24} × S^1
Y
Y → Y + 2πR
Y'
∫d²z ∂Y∂̄Y
ccV ccV ccV ...

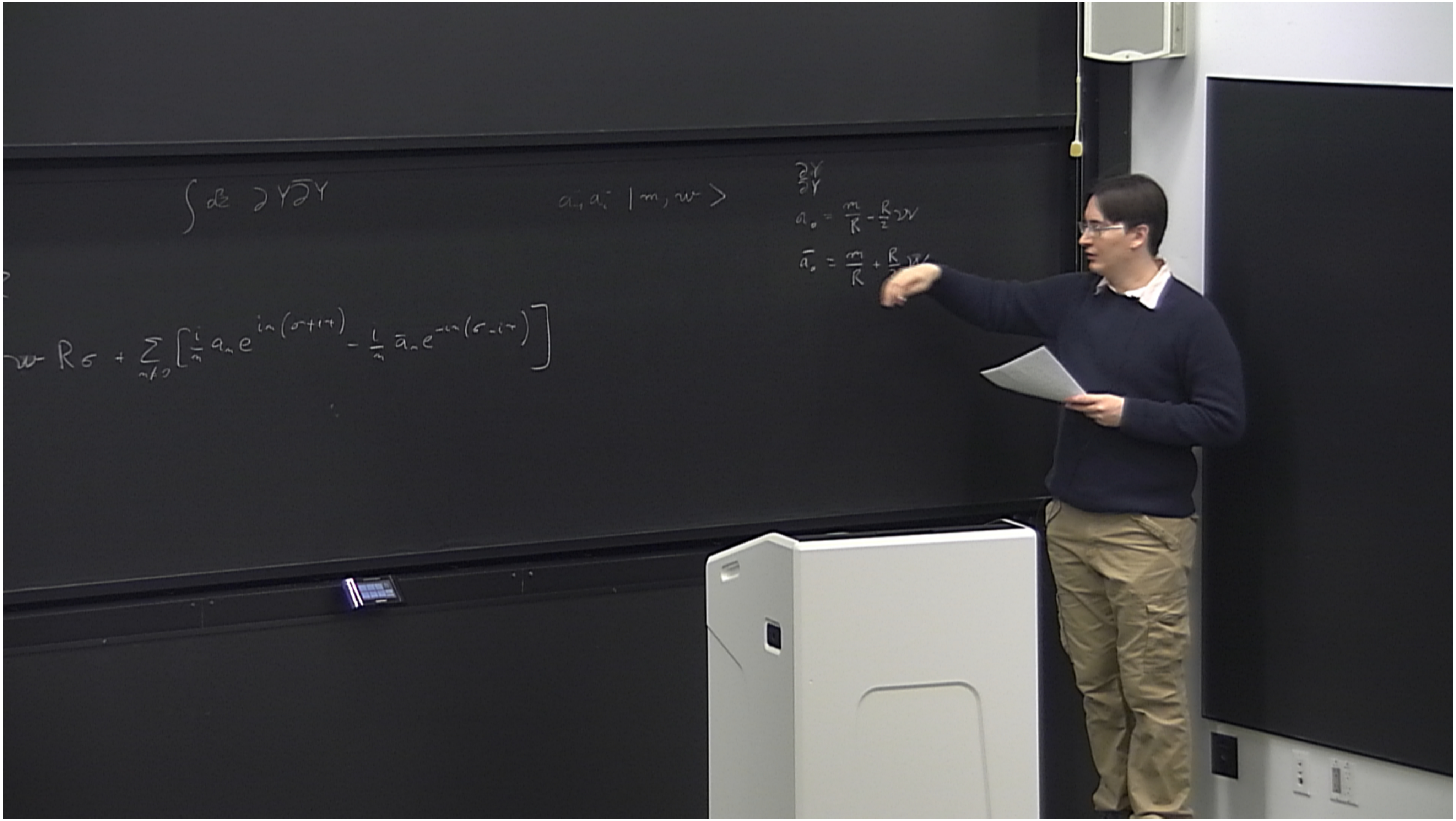

ccV ccV ccV ---
R^{1,24} × S^1
Y → Y + 2πR

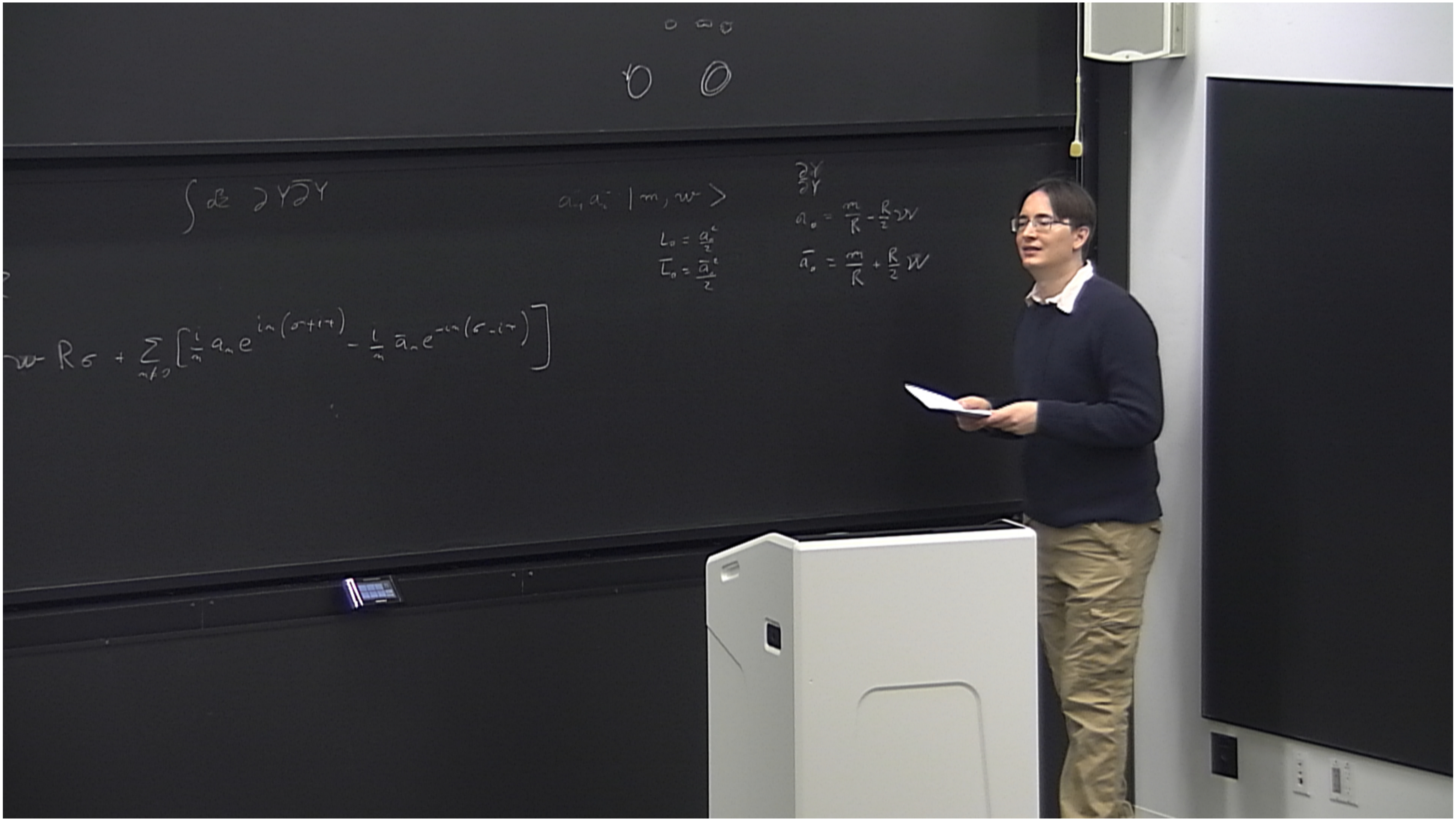

CCV CCV COV ...
$R^{1,24} \times S^1$
X^μ Y
$Y \to Y + 2\pi R$
INTEGER

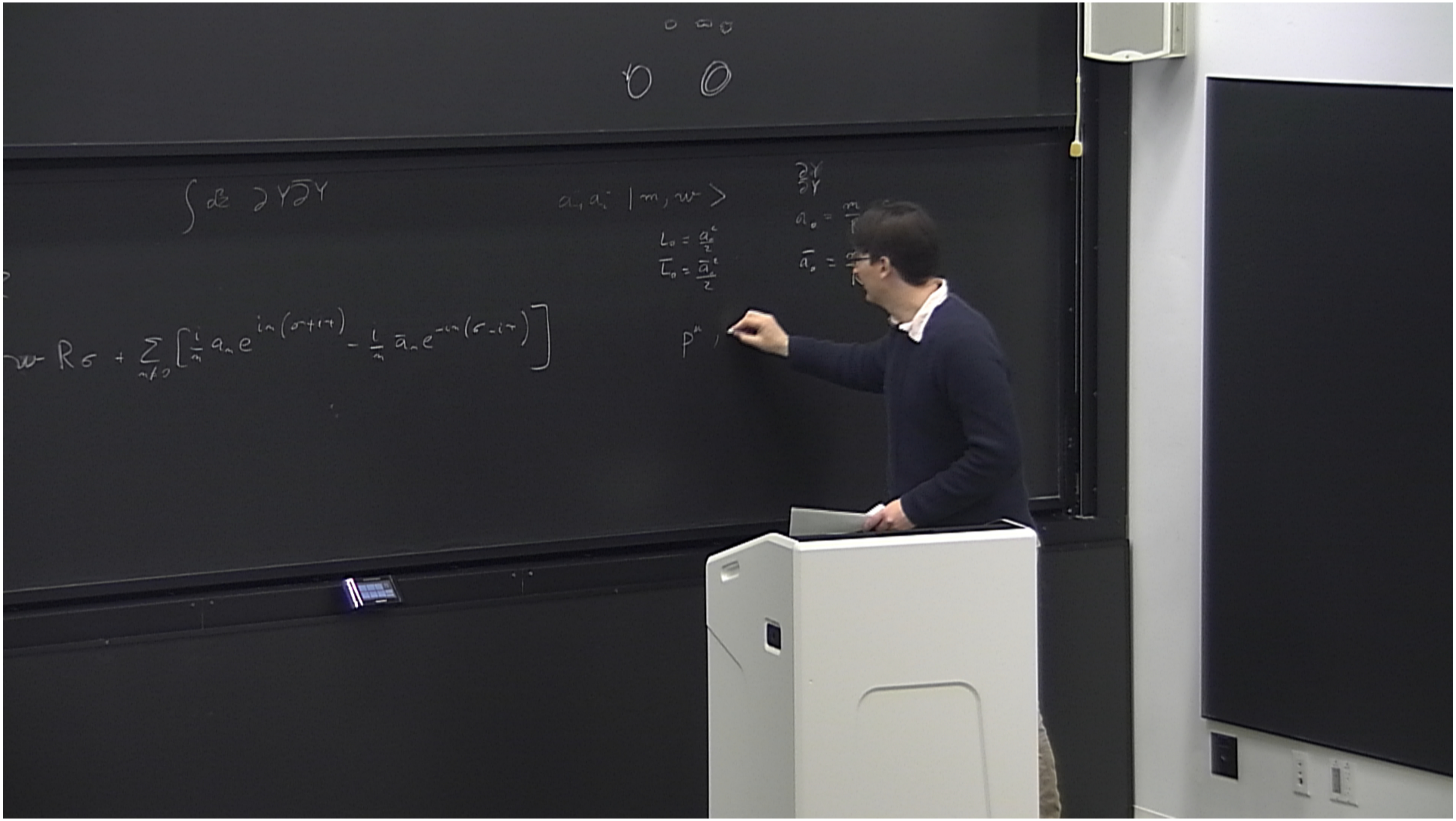

∫d²z ∂Y∂̄Y
R^{1,24} × S^1
X^μ Y
Y → Y + 2πR
Y(σ,τ) = y − 2ipτ + w Rσ + Σ_{n≠0} [i/n a_n e^{in(σ+iτ)} − i/n ā_n e^{−in(σ−iτ)}]
p = m/R
w : INTEGER
m : INTEGER

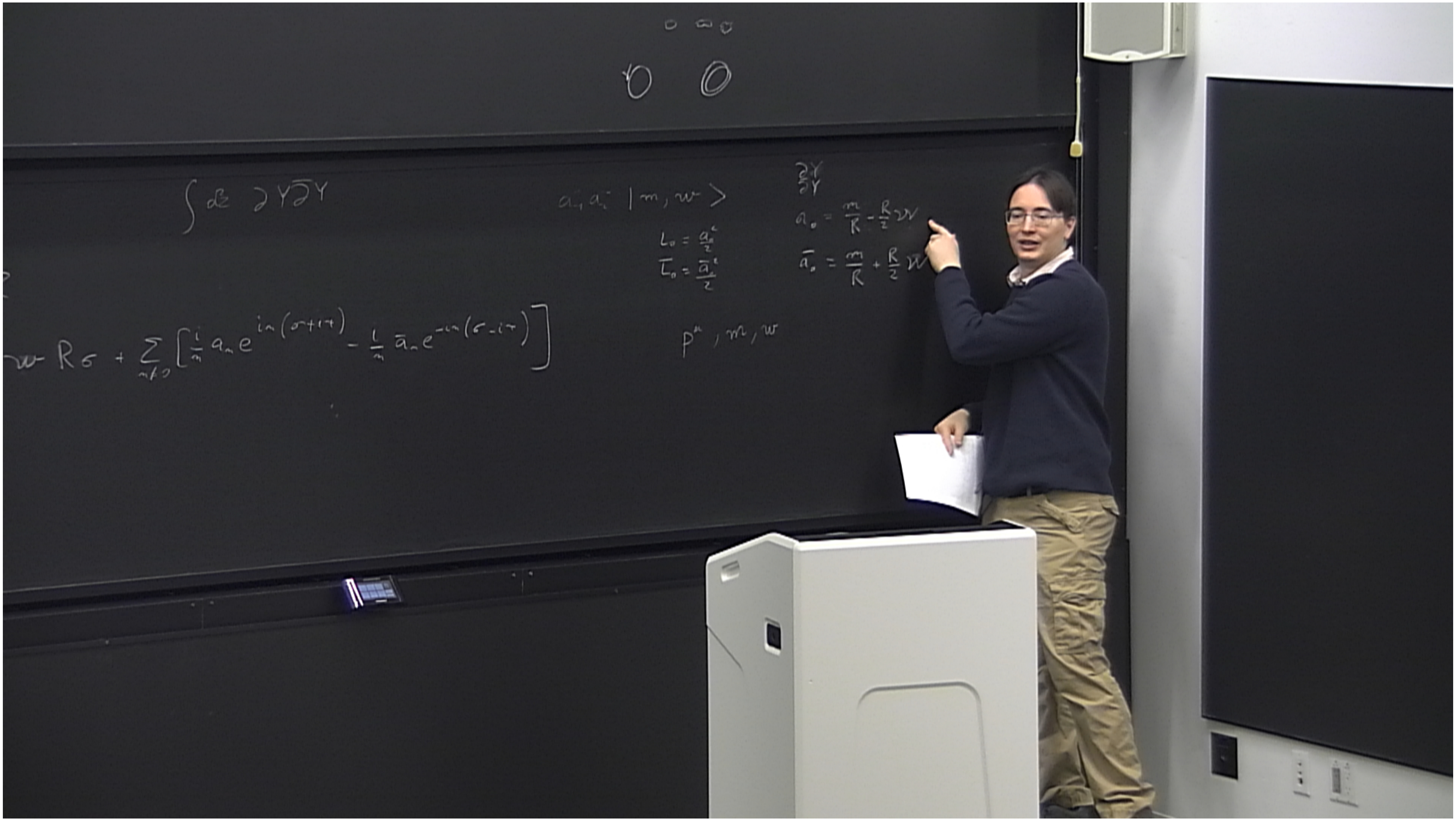


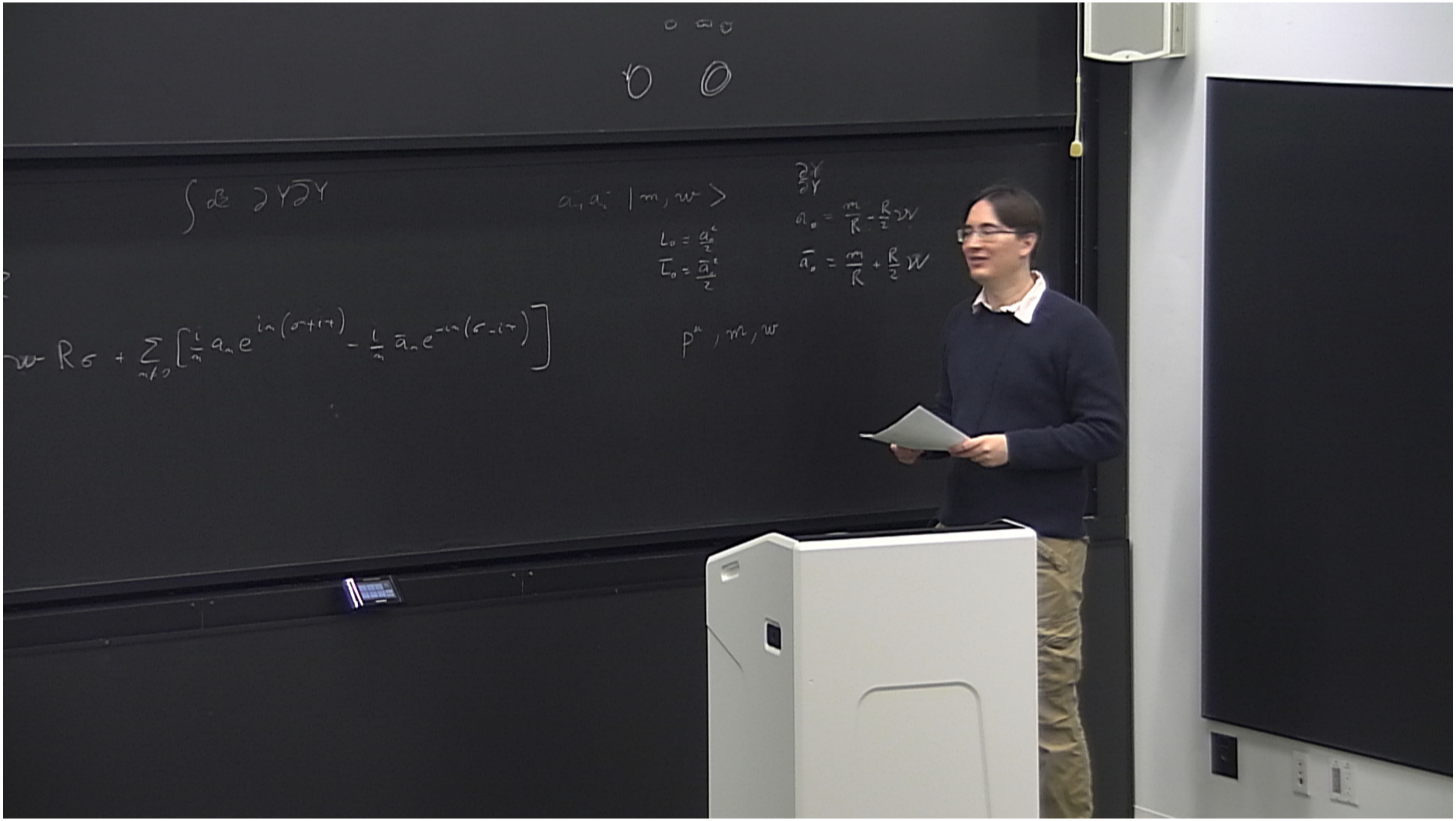


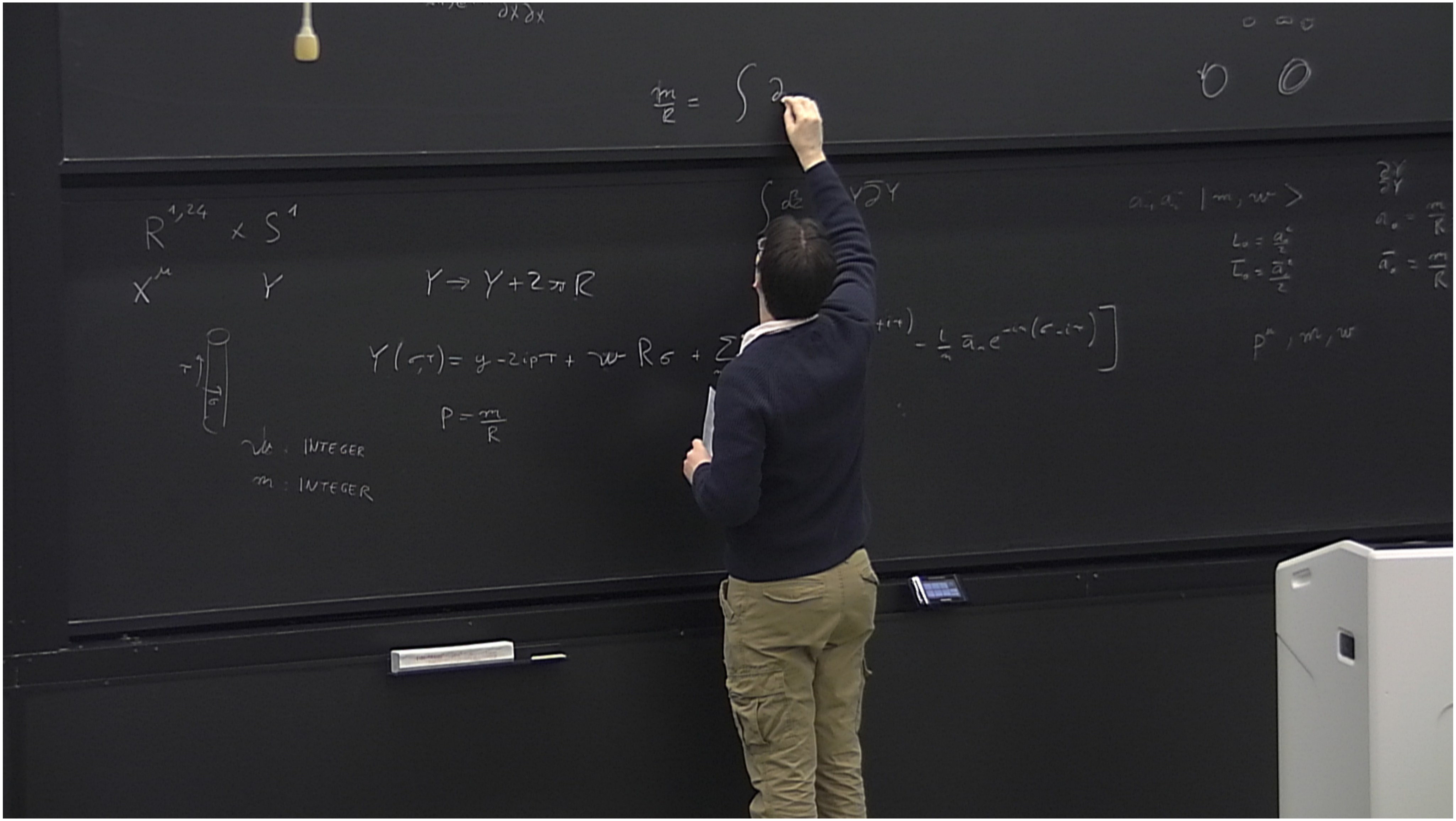


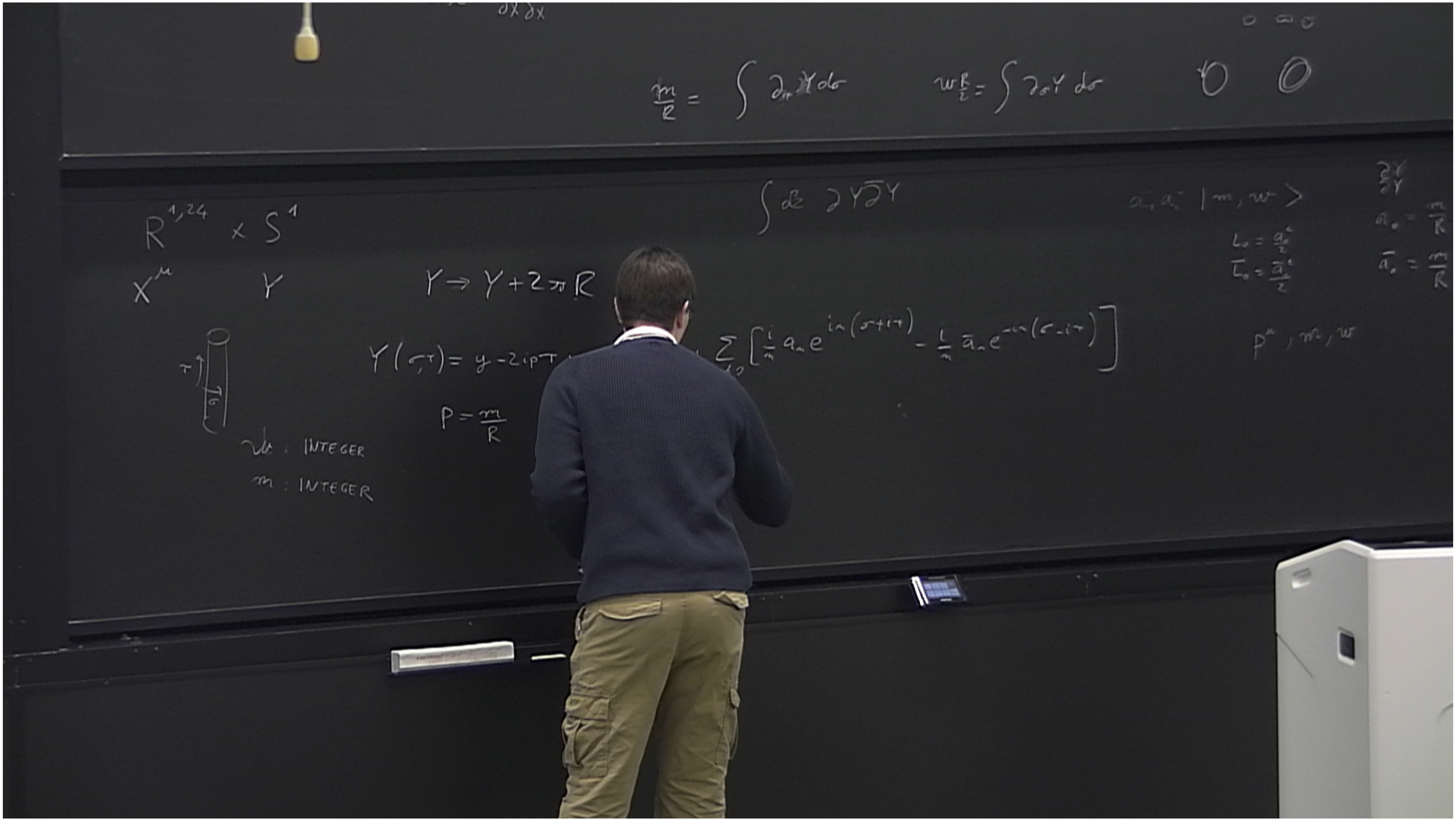


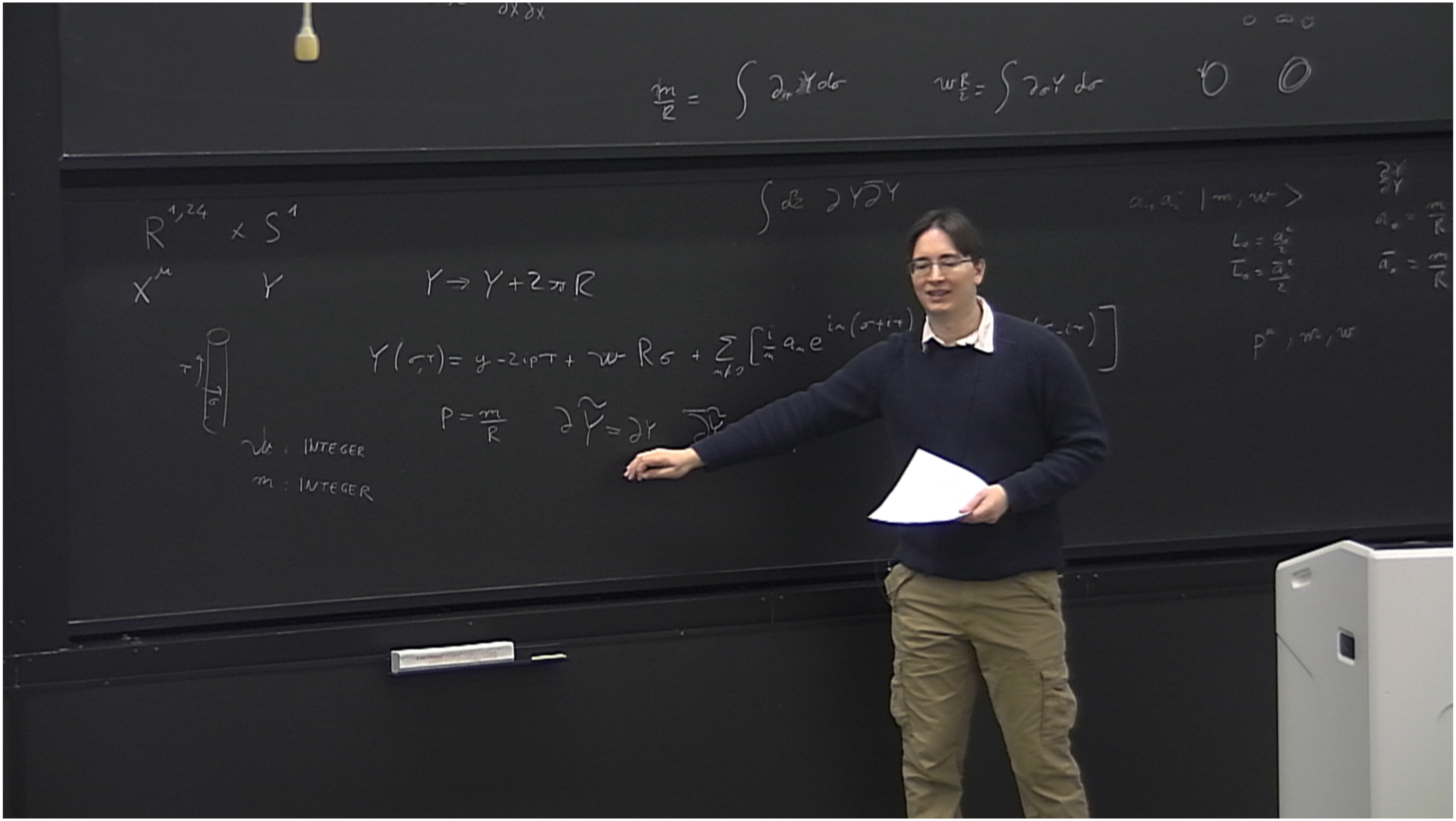







R^{1,24} × S^1
X^μ
Y
Y → Y + 2πR
P = m/R
w : INTEGER
m : INTEGER
p^μ, m, w




$\frac{m}{R} = \int \partial_\tau Y d\sigma$
$w\frac{R}{2} = \int \partial_\sigma Y d\sigma$
$\int dz\, \partial Y \bar{\partial} Y$
$R^{1,24} \times S^1$
X^μ
Y
$Y \to Y + 2\pi R$
p^μ, m, w
$P = \frac{m}{R}$
w : INTEGER
m : INTEGER