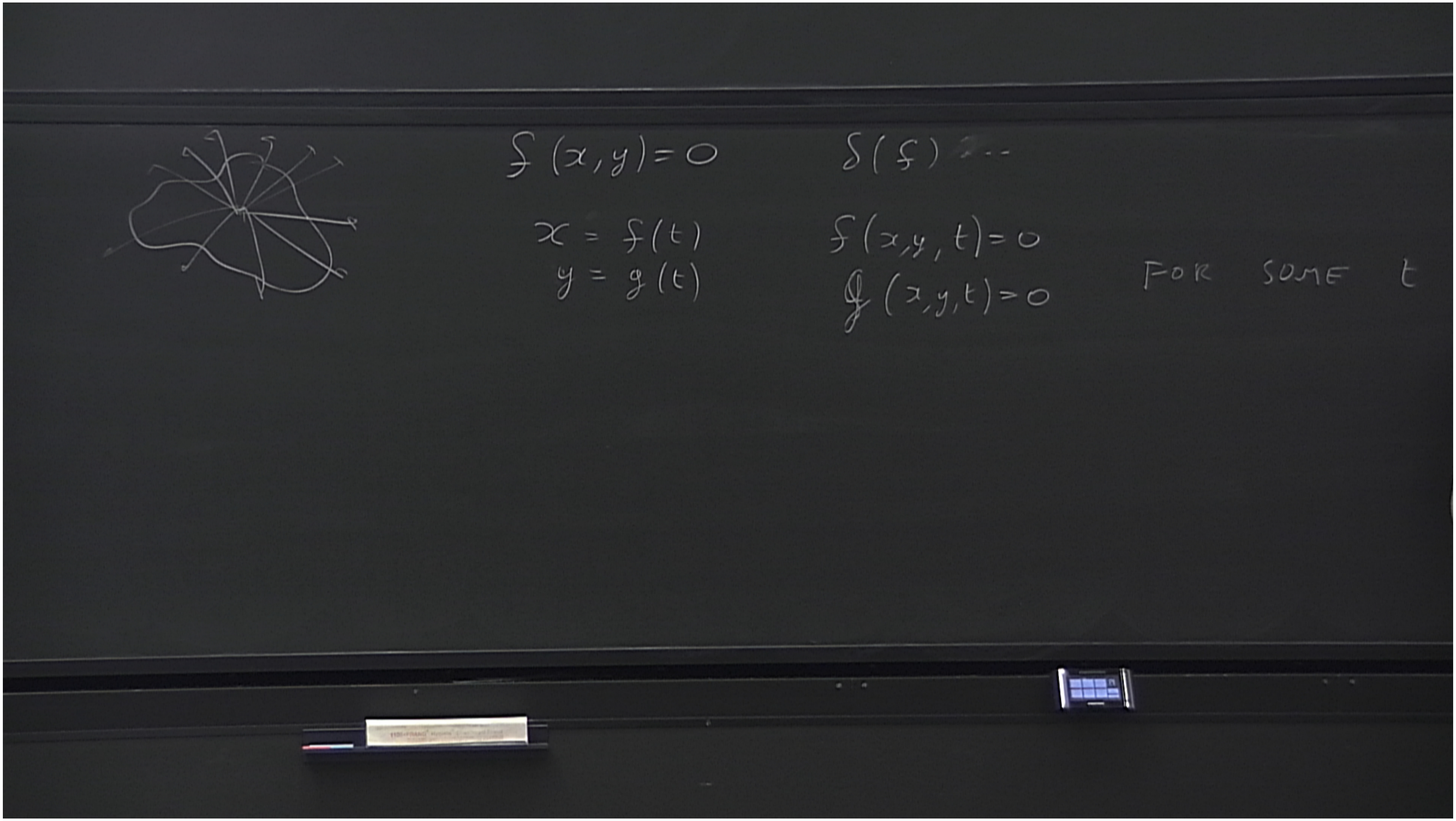
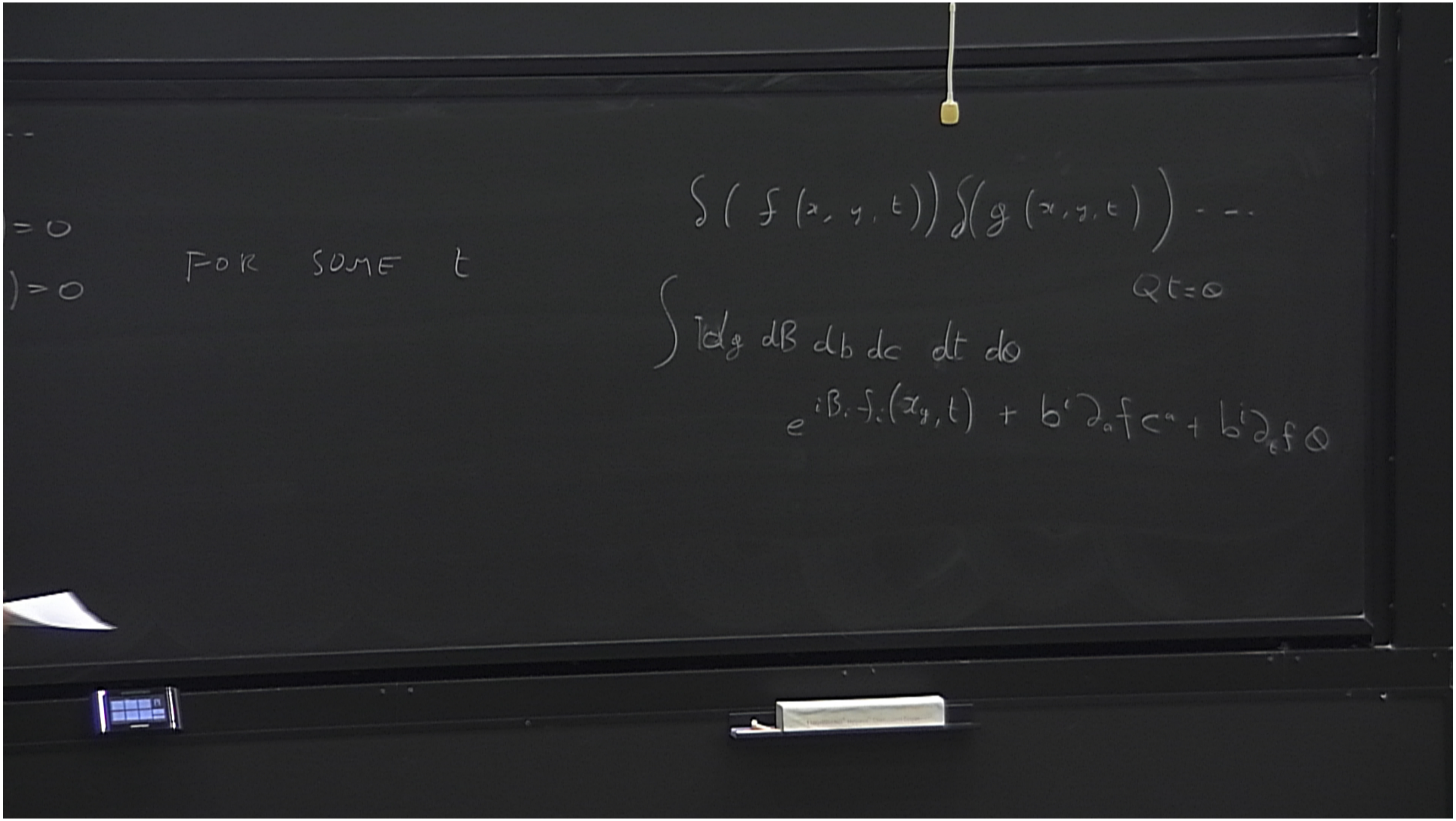
Title: 13/14 PSI - String Theory Review - Lecture 9

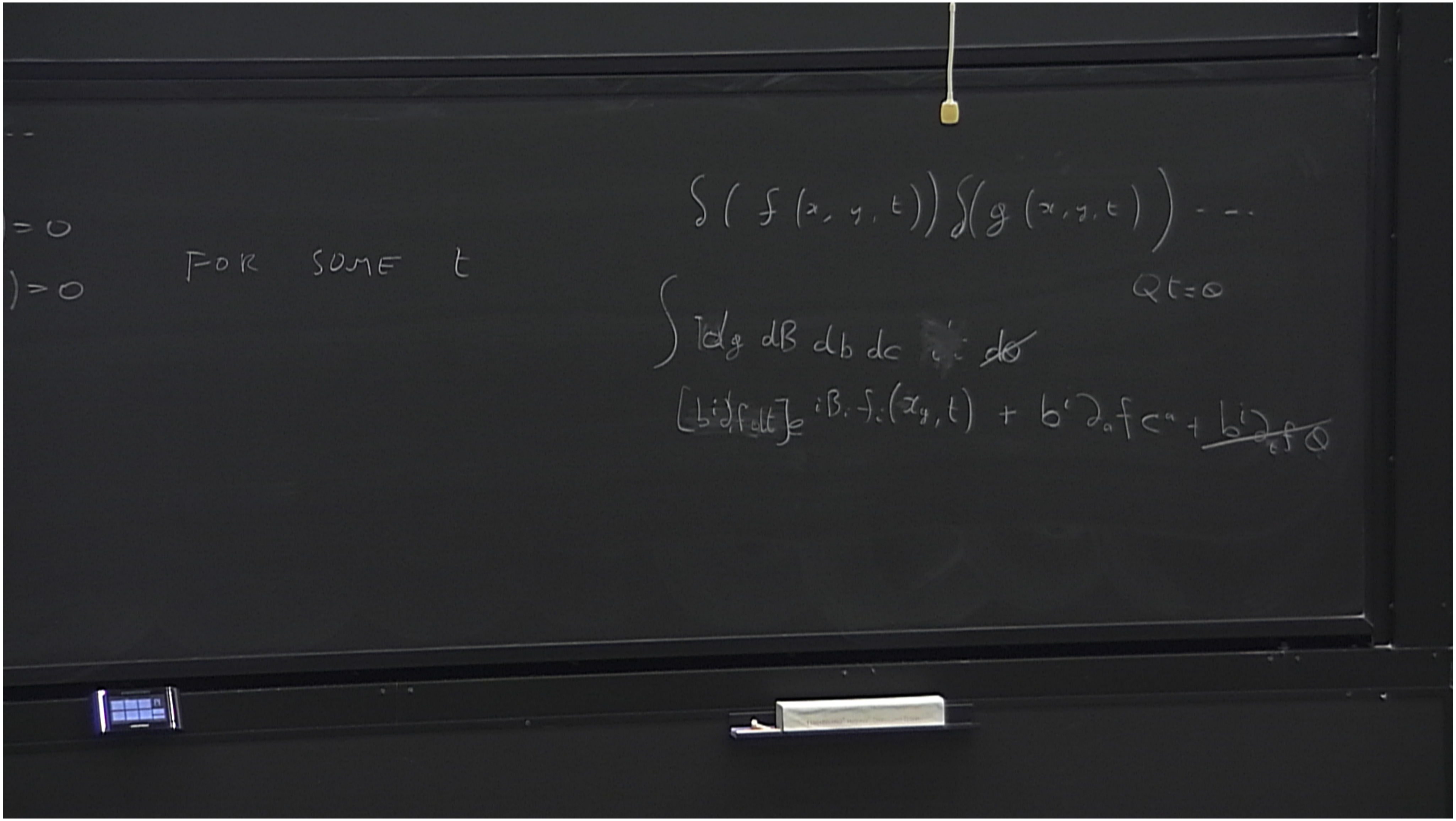
Date: Feb 07, 2014 10:15 AM

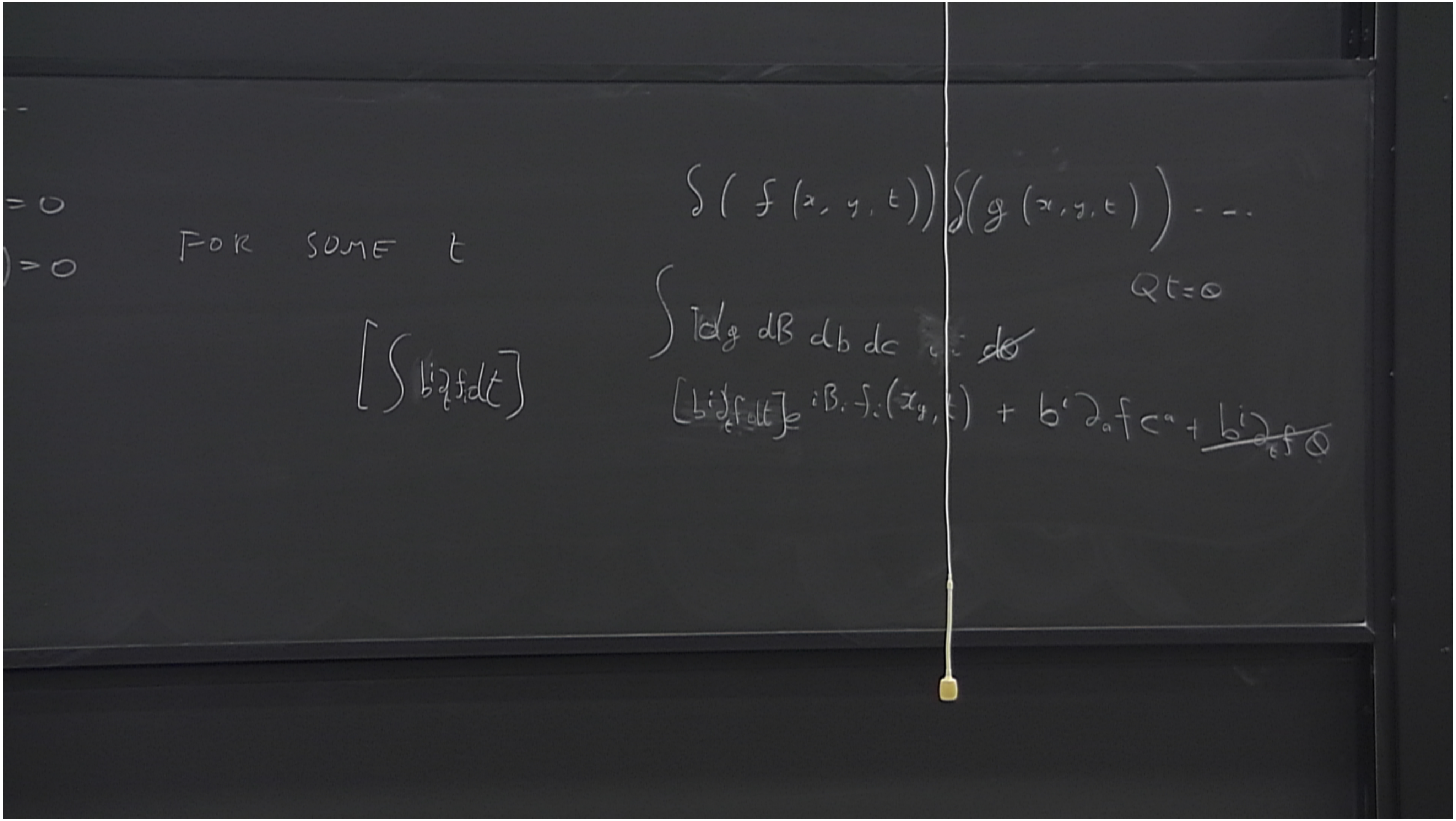
URL: http://pirsa.org/14020027

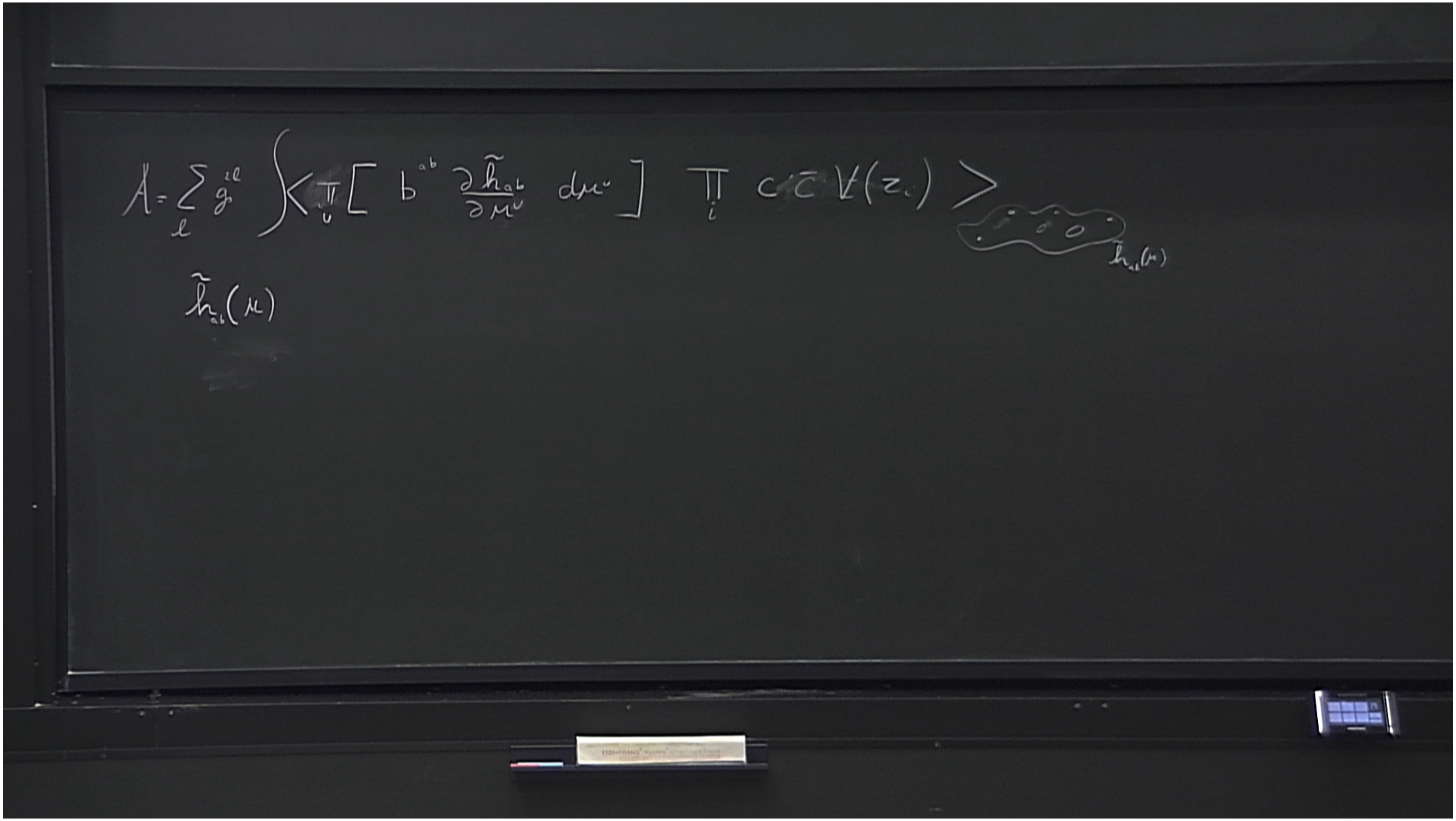
Abstract:

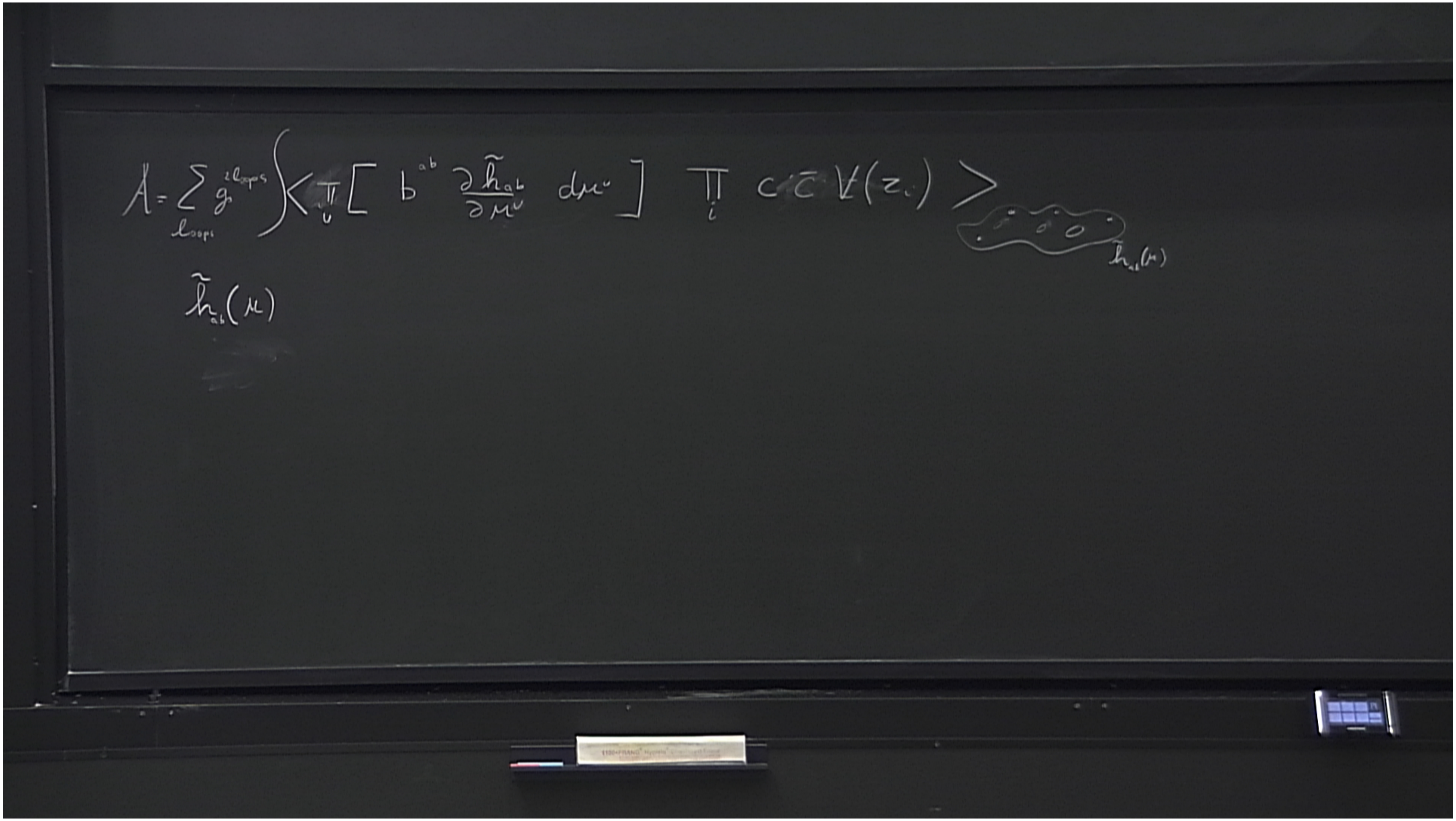

f(x,y)=0
δ(f) ...
x = f(t)
y = g(t)
f(x,y,t)=0
g(x,y,t)=0
FOR SOME t

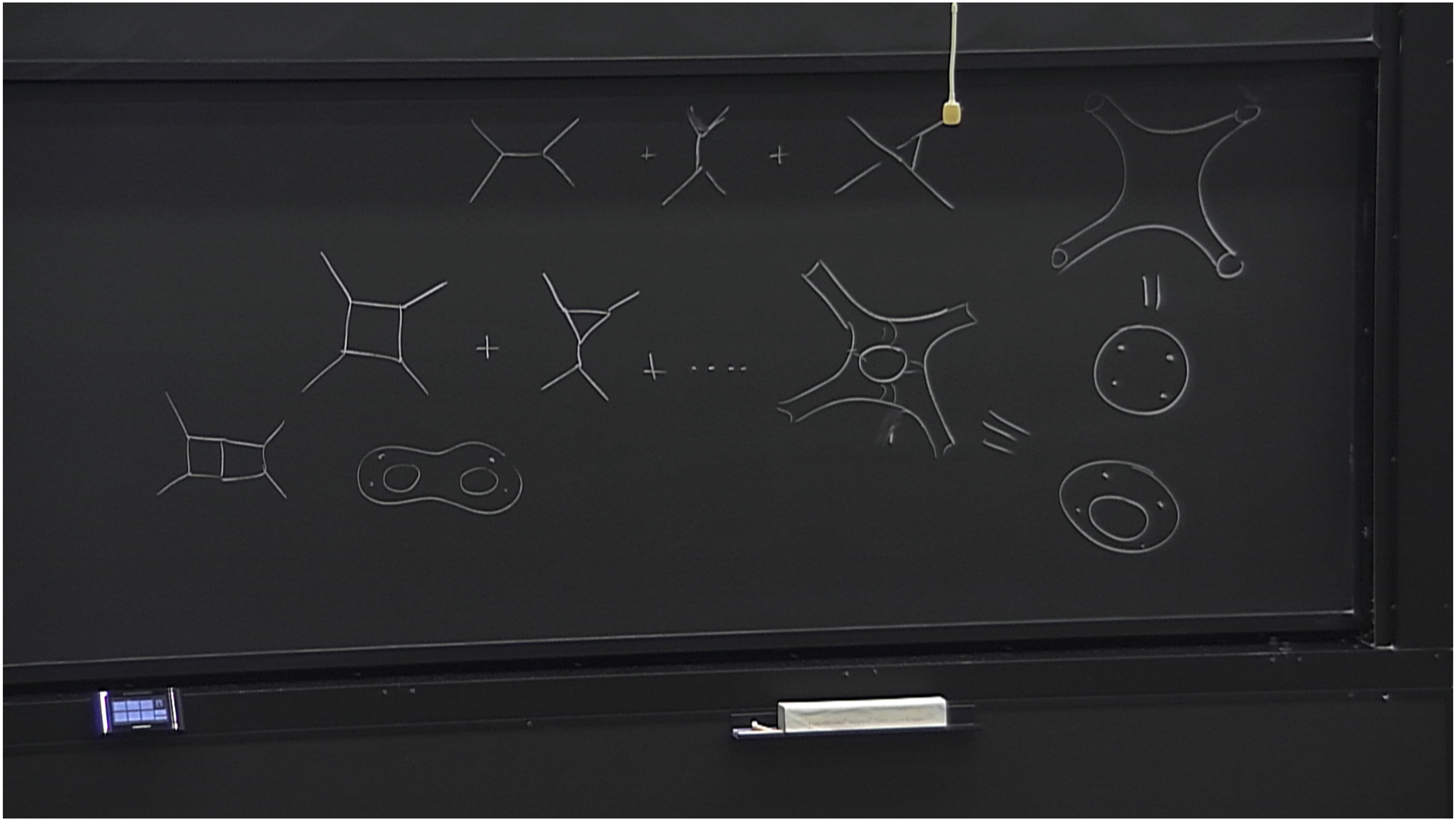

= 0
FOR SOME t
) = 0
δ(f(x, y, t)) δ(g(x, y, t)) ...
Qt = 0
∫ dg dB db dc dt dθ
e^{iB_i f_i(x_y, t) + b^i ∂_a f c^a + b^i ∂_t f θ}


FOR SOME t
Qt=0


= 0
) = 0
FOR SOME t
δ( f (x, y, t)) δ(g (x, y, t)) . . .
Qt = 0


$A = \sum_{l} g^{2l} \int \langle \prod_{i} [ b^{ab} \frac{\partial \tilde{h}_{ab}}{\partial \mu^{i}} d\mu^{i} ] \prod_{i} c \bar{c} V(z_i) \rangle$
$\tilde{h}_{ab}(\mu)$
$\tilde{h}_{ab}(\mu)$


$A = \sum_{\text{loops}} g^{2\,\text{loops}} \int \langle \prod_i \left[ b^{ab} \frac{\partial \tilde{h}_{ab}}{\partial \mu^i} d\mu^i \right] \prod_i c\bar{c}\, V(z_i) \rangle$
$\tilde{h}_{ab}(\mu)$
$\tilde{h}_{ab}(\mu)$

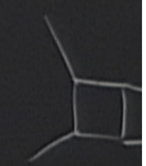


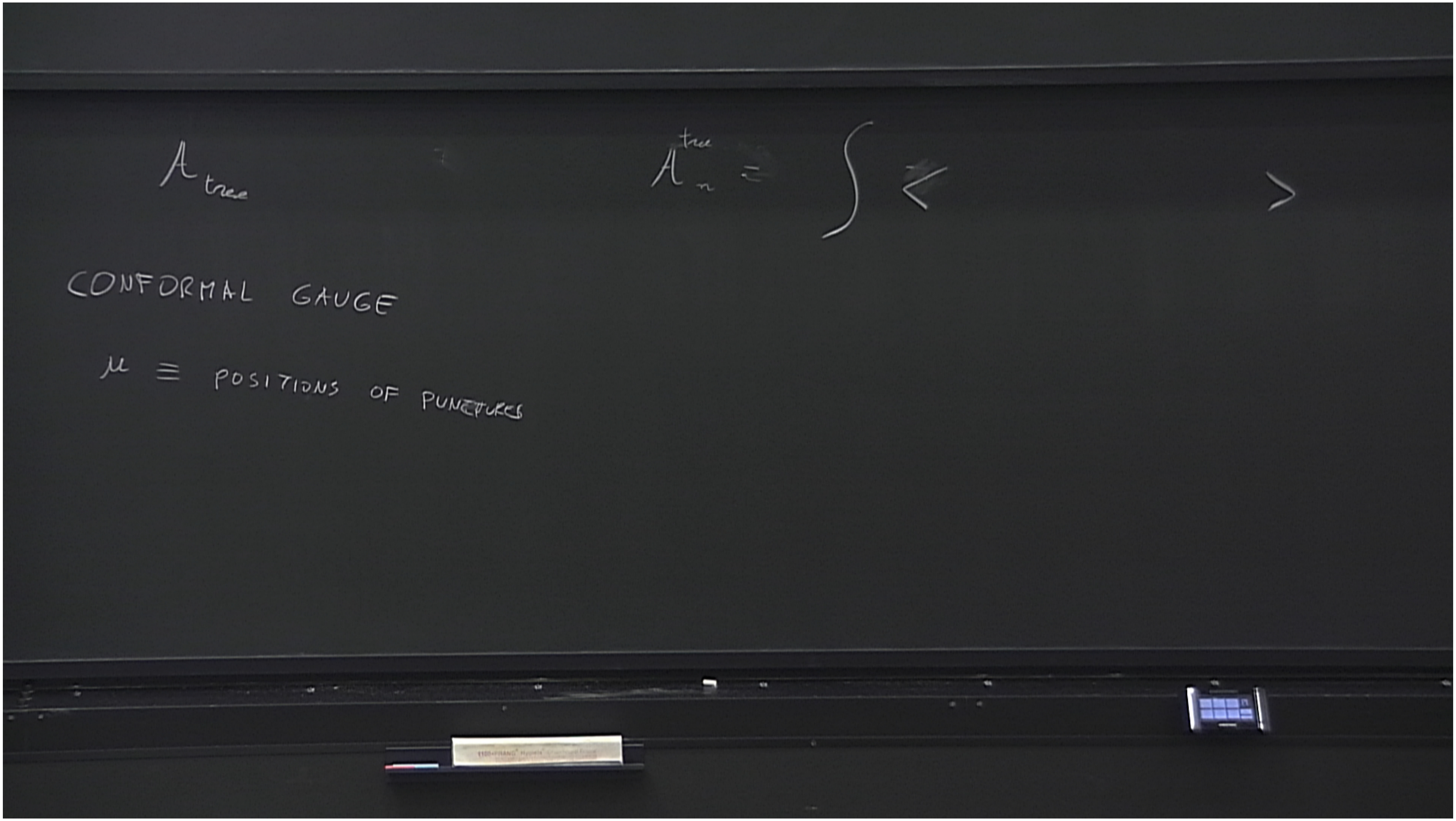
$$A = \sum_{\text{loops}} g^{2\,\text{loops}} \int \left\langle \prod_{\nu=1}^{\#[\mu]} \left[ b^{ab} \frac{\partial \tilde{h}_{ab}}{\partial \mu^{\nu}} \, d\mu^{\nu} \right] \prod_i c \bar{c} V(z_i) \right\rangle$$

$\tilde{h}_{ab}(\mu)$

$\tilde{h}_{ab}(\mu)$

$\#\mu = 2[3\ell - 3 + \text{nc OF POINTS}]$




$A_{tree}$
$A_n^{tree} = \int \langle \quad \rangle$
CONFORMAL GAUGE
$\mu \equiv$ POSITIONS OF PUNCTURES

$$A_n^{\text{tree}} = \int \left\langle c\bar{c}V_1(z_1)\, c\bar{c}V_2(z_2)\, c\bar{c}V_3(z_3) \prod_{k=4}^{n} V_k(z_k)\, dz_k\, d\bar{z}_k \right\rangle_{\text{SPHERE}}$$

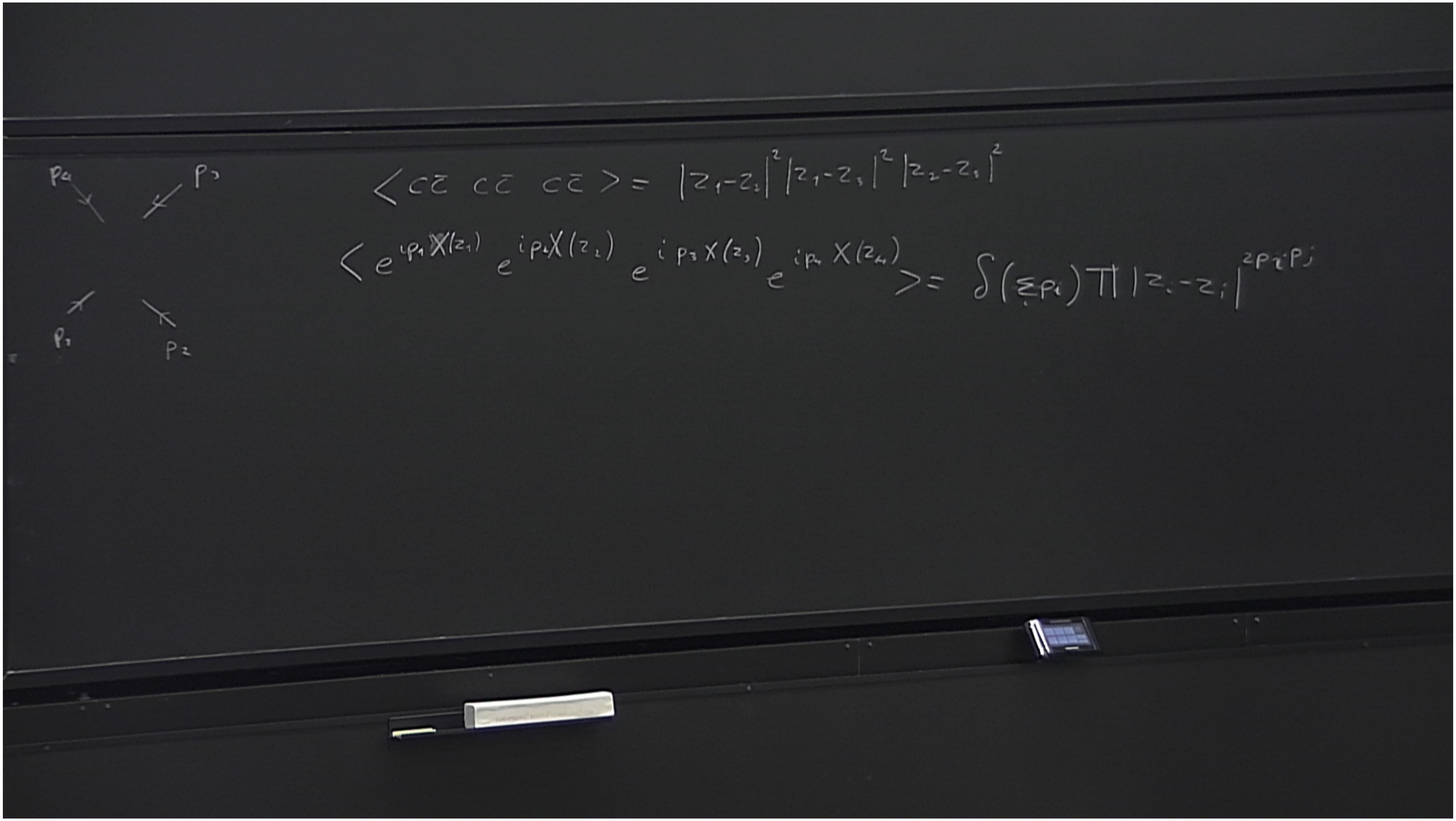
$$O_{\Delta,\bar\Delta}(z,\bar z) = \left(\frac{\partial \tilde z}{\partial z}\right)^{\Delta}\left(\frac{\partial \bar{\tilde z}}{\partial \bar z}\right)^{\bar\Delta} O(\tilde z, \bar{\tilde z}) \qquad \left[ O(z)\, dz^{\Delta}\, d\bar z^{\bar\Delta} \right]$$

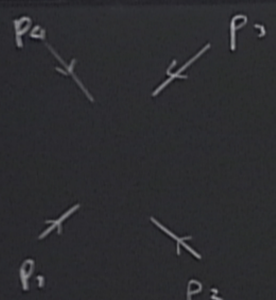
$A_{tree}$ =

$$A_n^{tree} = \int \langle c\bar c V_1(z_1)\; c\bar c V_2(z_2) \cdots c\bar c V_3(z_n)$$

CONFORMAL GAUGE

$\mu \equiv$ POSITIONS OF PUNCTURES


p4
p3
p1
p2
$\langle c\bar{c}\ c\bar{c}\ c\bar{c} \rangle = |z_1 - z_2|^2 |z_1 - z_3|^2 |z_2 - z_3|^2$
$\langle e^{ip_1 X(z_1)} e^{ip_2 X(z_2)} e^{ip_3 X(z_3)} e^{ip_4 X(z_4)} \rangle = \delta(\sum_i p_i) \prod |z_i - z_j|^{2p_i \cdot p_j}$




$$\langle c\bar{c}\; c\bar{c}\; c\bar{c} \rangle = |z_1 - z_2|^2 |z_1 - z_3|^2 |z_2 - z_3|^2$$

$$\langle e^{ip_1 X(z_1)}\, e^{ip_2 X(z_2)}\, e^{ip_3 X(z_3)}\, e^{ip_4 X(z_4)} \rangle = \delta\left(\textstyle\sum p_i\right) \prod |z_i - z_j|^{2p_i \cdot p_j}$$

$$A_4^{tree} = \prod_{1 \le i < j \le 3} |z_i - z_j|^{2 + 2p_i \cdot p_j} \int d^2 z \prod_{1 \le i \le 3} |z - z_i|^{2p_4 \cdot p_i}$$

$$\int d^2z \, \frac{1}{|z|^\alpha} = \int \frac{r\,dr}{r^\alpha} \qquad \alpha - 1 < 1$$

$$\sum p_i = 0 \qquad p_i^2 = 2$$

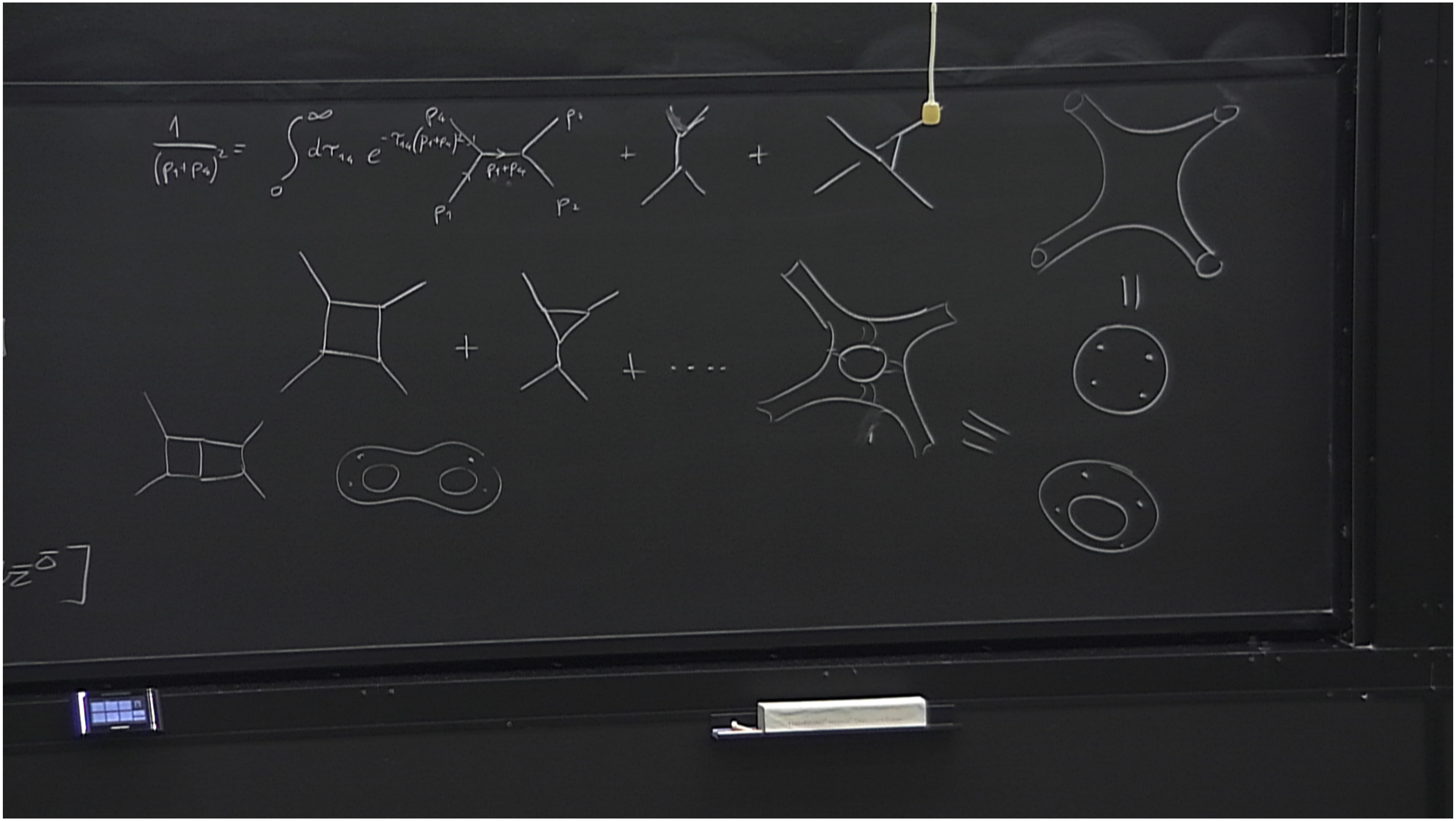
$$\ldots z_2 - z_3|^2$$

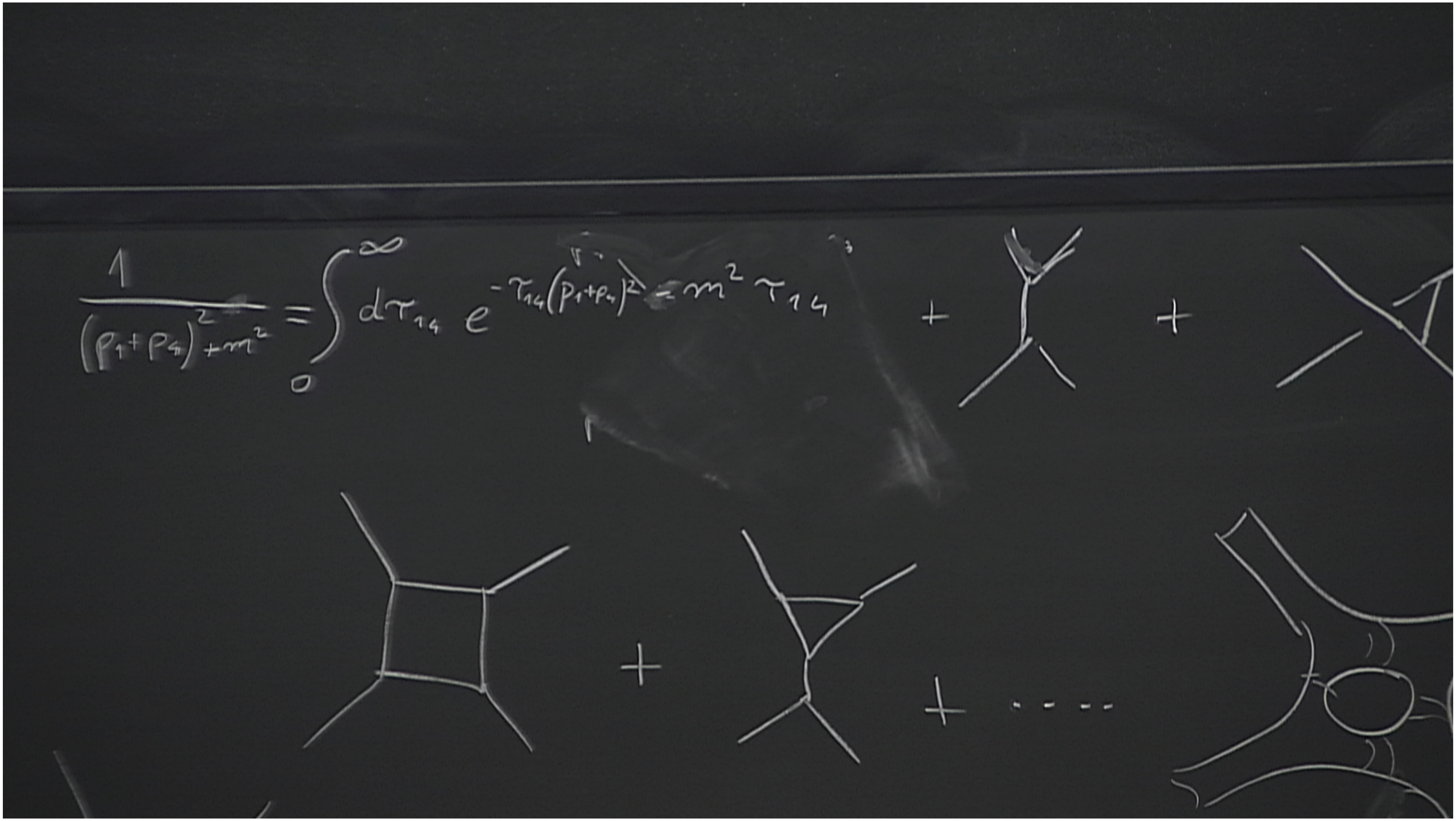
$$\sim |z|^{2p_4\cdot\sum p_i} = |z|^{-2p_4^2} = |z|^{-4}$$

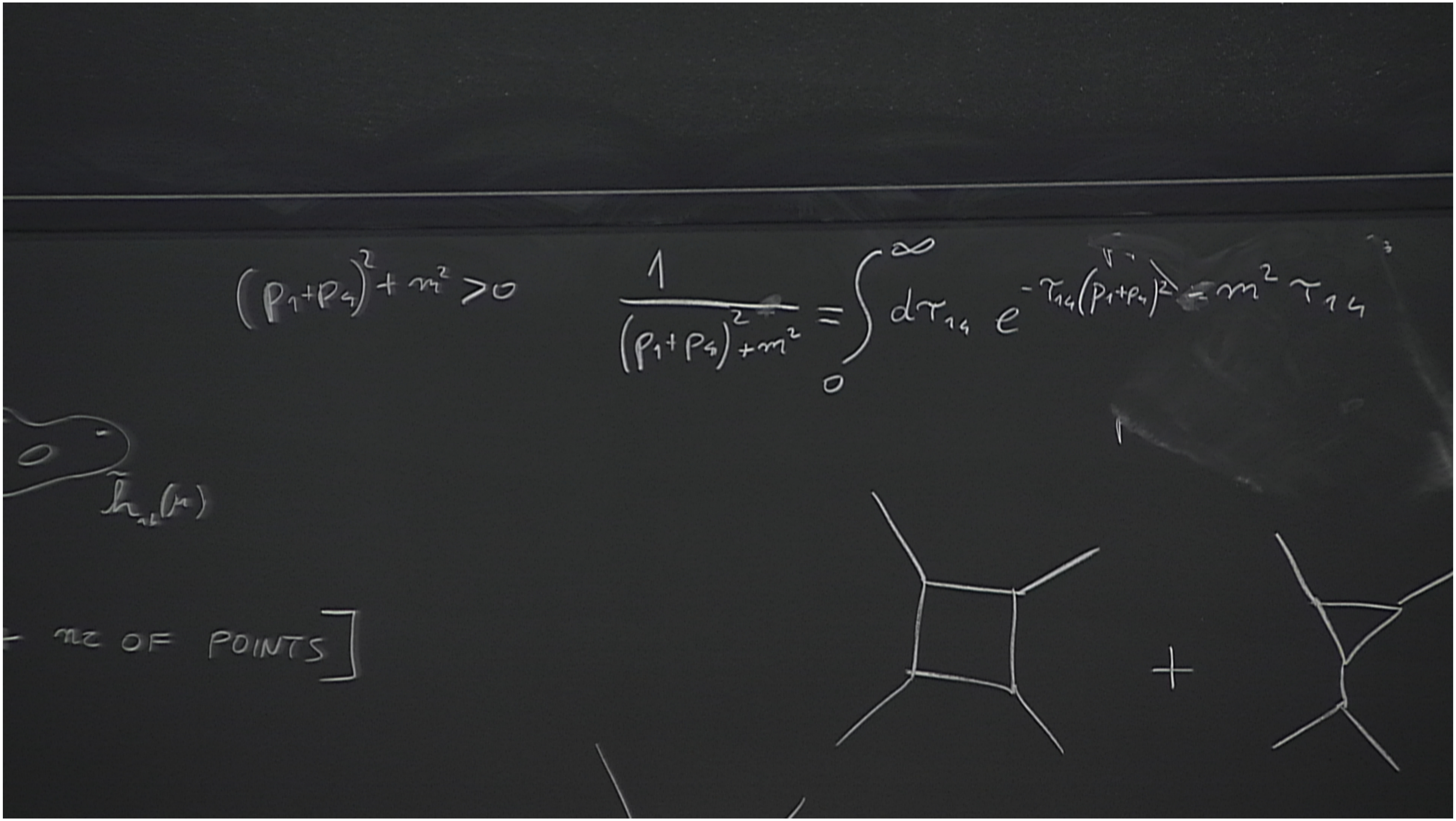
$$2p_4\cdot p_i \geq -2 \qquad (p_4 + p_i)^2 \geq 2$$

$$= \delta\left(\sum p_i\right) \prod |z_i - z_j|^{2p_i\cdot p_j}$$

$$\prod_{i \leq 3} |z - z_i|^{2p_4\cdot p_i}$$


$\frac{1}{(p_1+p_4)^2} = \int_0^\infty d\tau_{14}\, e^{-\tau_{14}(p_1+p_4)^2}$
$p_4$
$p_1$
$p_2$
$p_1+p_4$


$\frac{1}{(p_1+p_4)^2+m^2} = \int_0^\infty d\tau_{14}\, e^{-\tau_{14}(p_1+p_4)^2 - m^2\tau_{14}}$
+
+
+
+ ....


$(p_1+p_4)^2 + m^2 > 0$
$\frac{1}{(p_1+p_4)^2+m^2} = \int_0^\infty d\tau_{14}\, e^{-\tau_{14}(p_1+p_4)^2 - m^2\tau_{14}}$
nr OF POINTS]

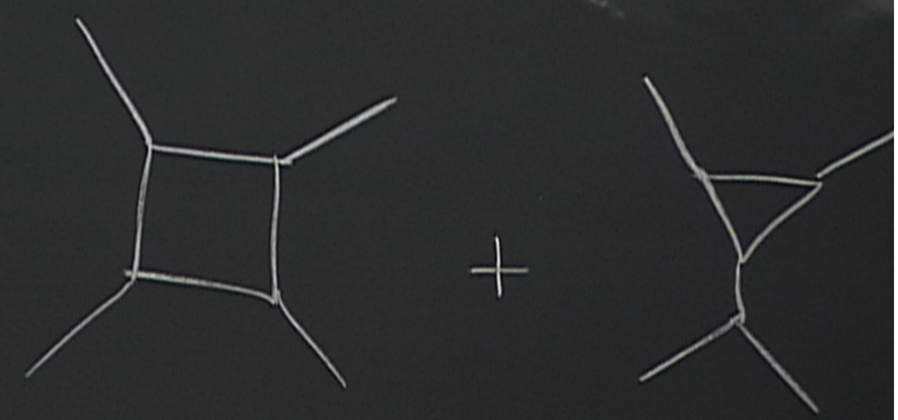
$(p_1+p_4)^2+m^2>0$

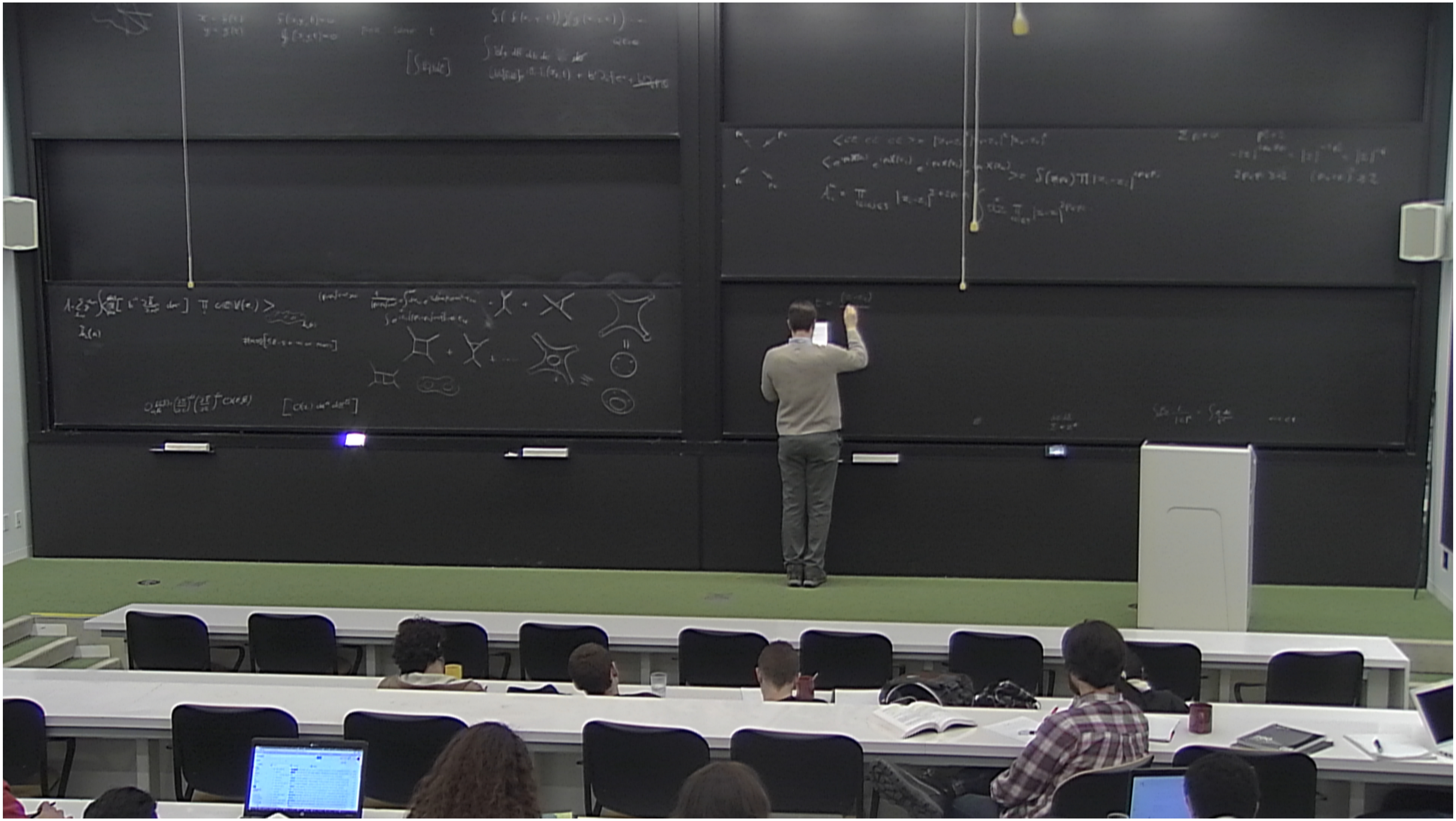
$$\frac{1}{(p_1+p_4)^2+m^2}=\int_0^\infty d\tau_{14}\, e^{-\tau_{14}(p_1+p_4)^2-m^2\tau_{14}}$$

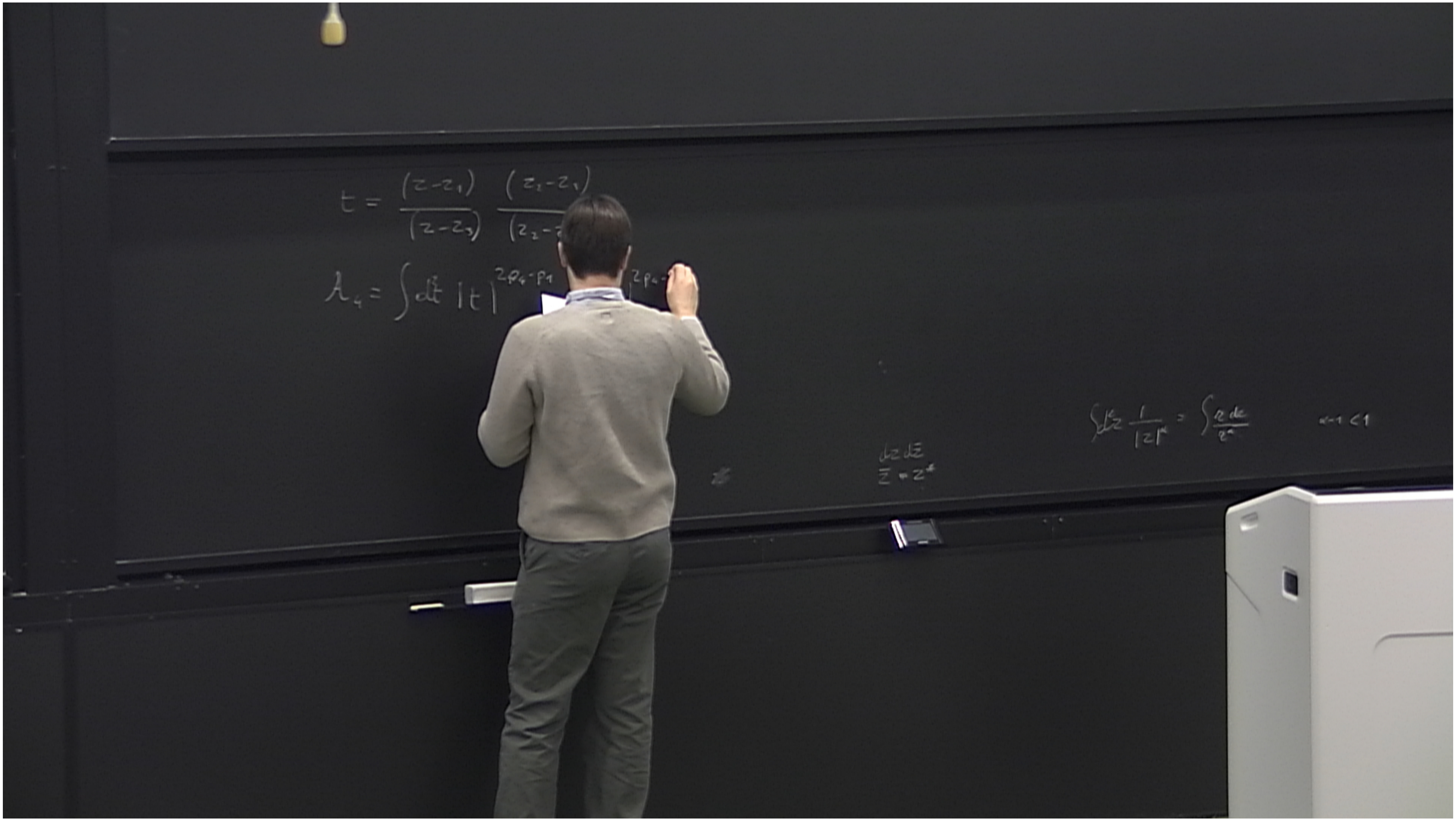
$$\int e^{it_{14}\left[(p_1+p_4)^2+m^2\right]-\epsilon t_{14}}$$

$\tilde{h}_{n_L}(\mu)$

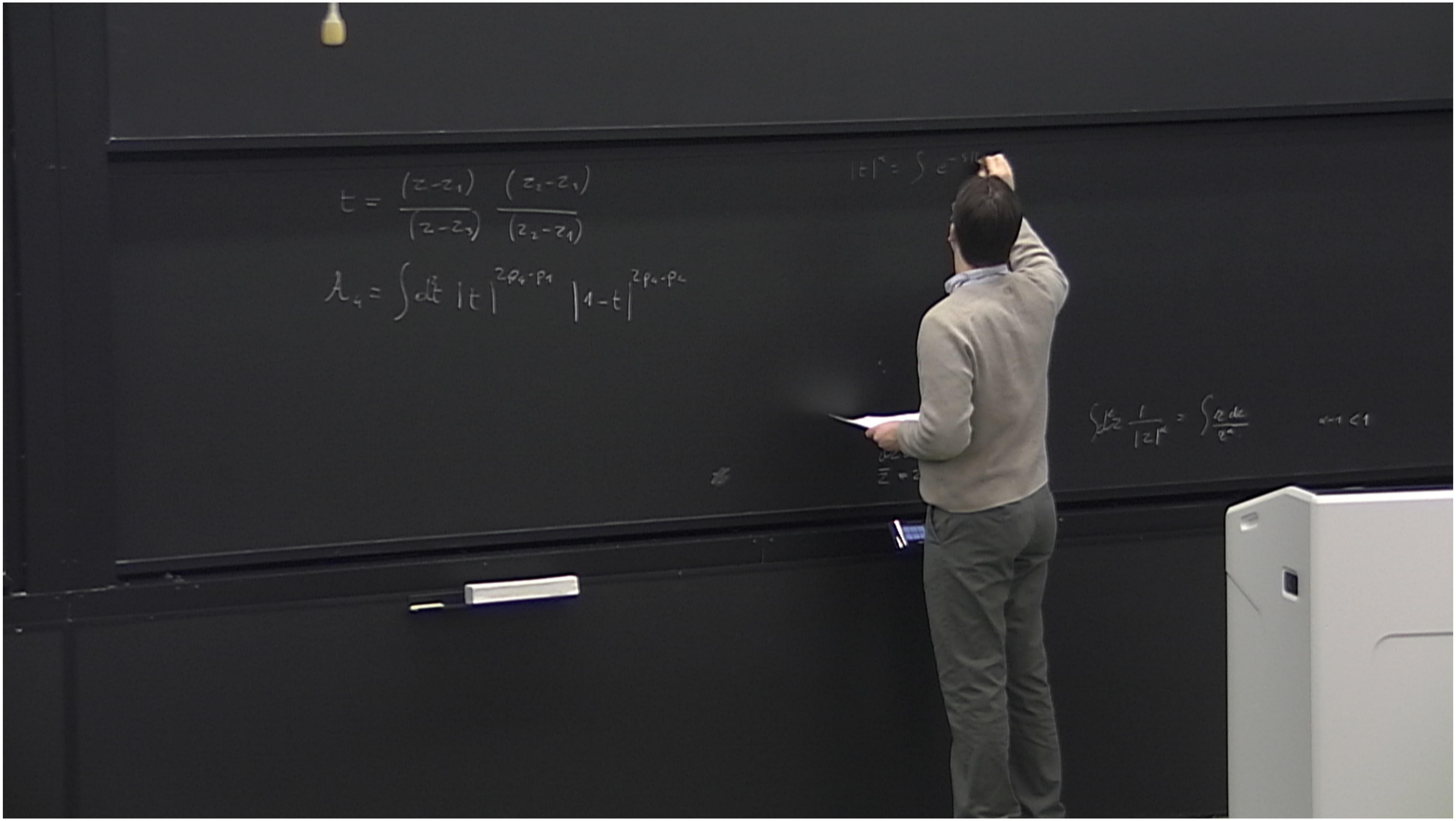
– nr OF POINTS]



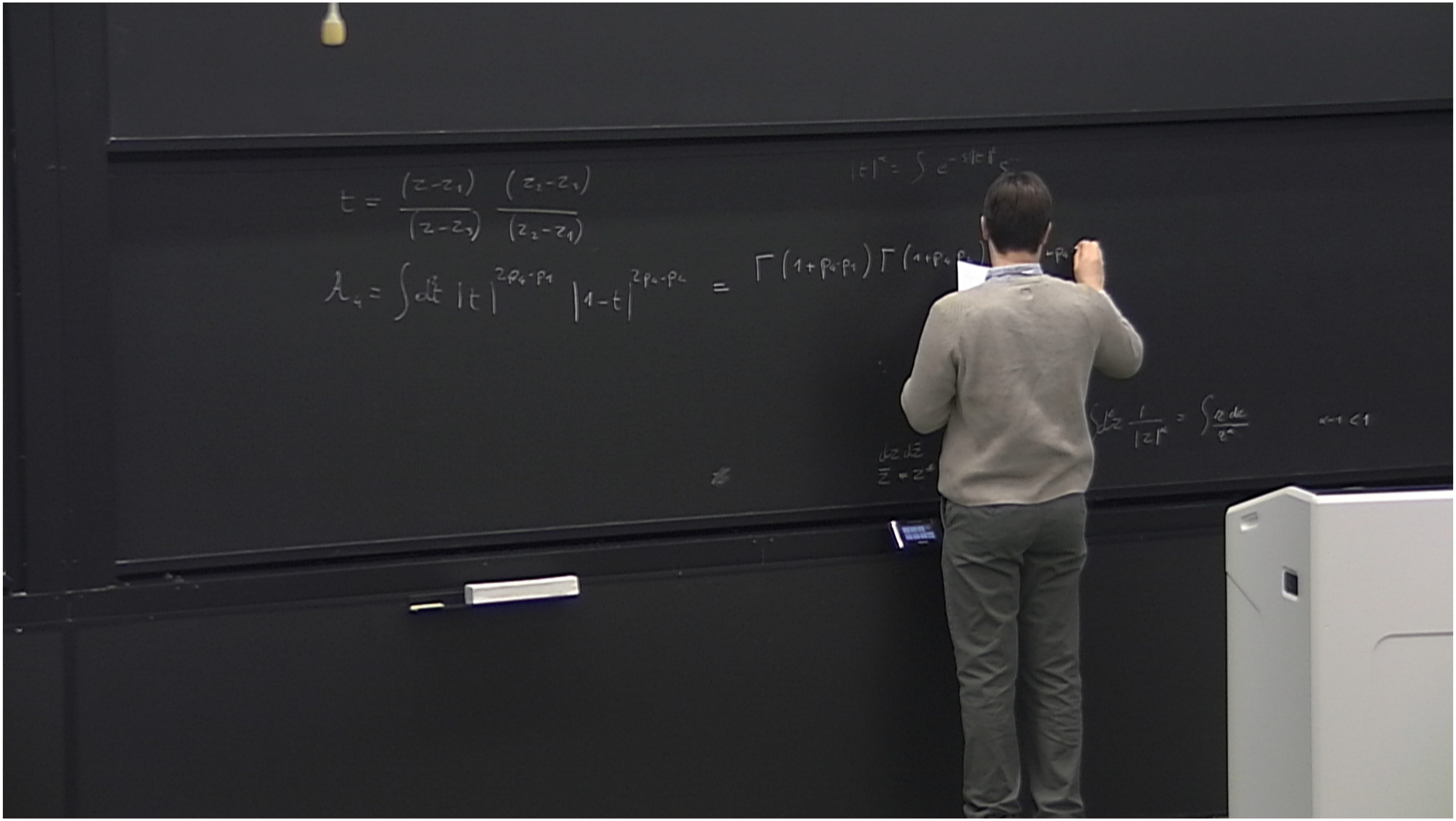


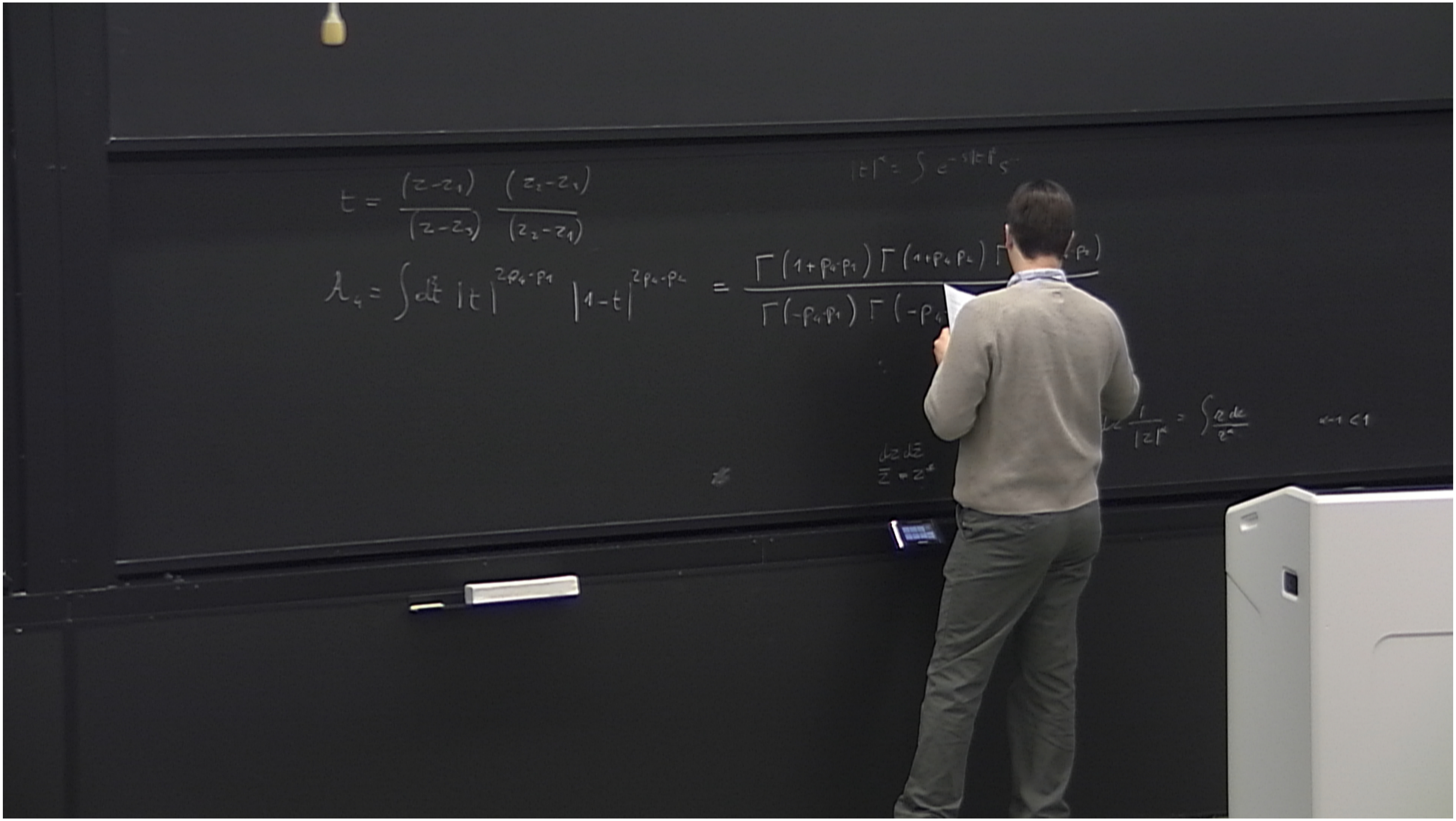


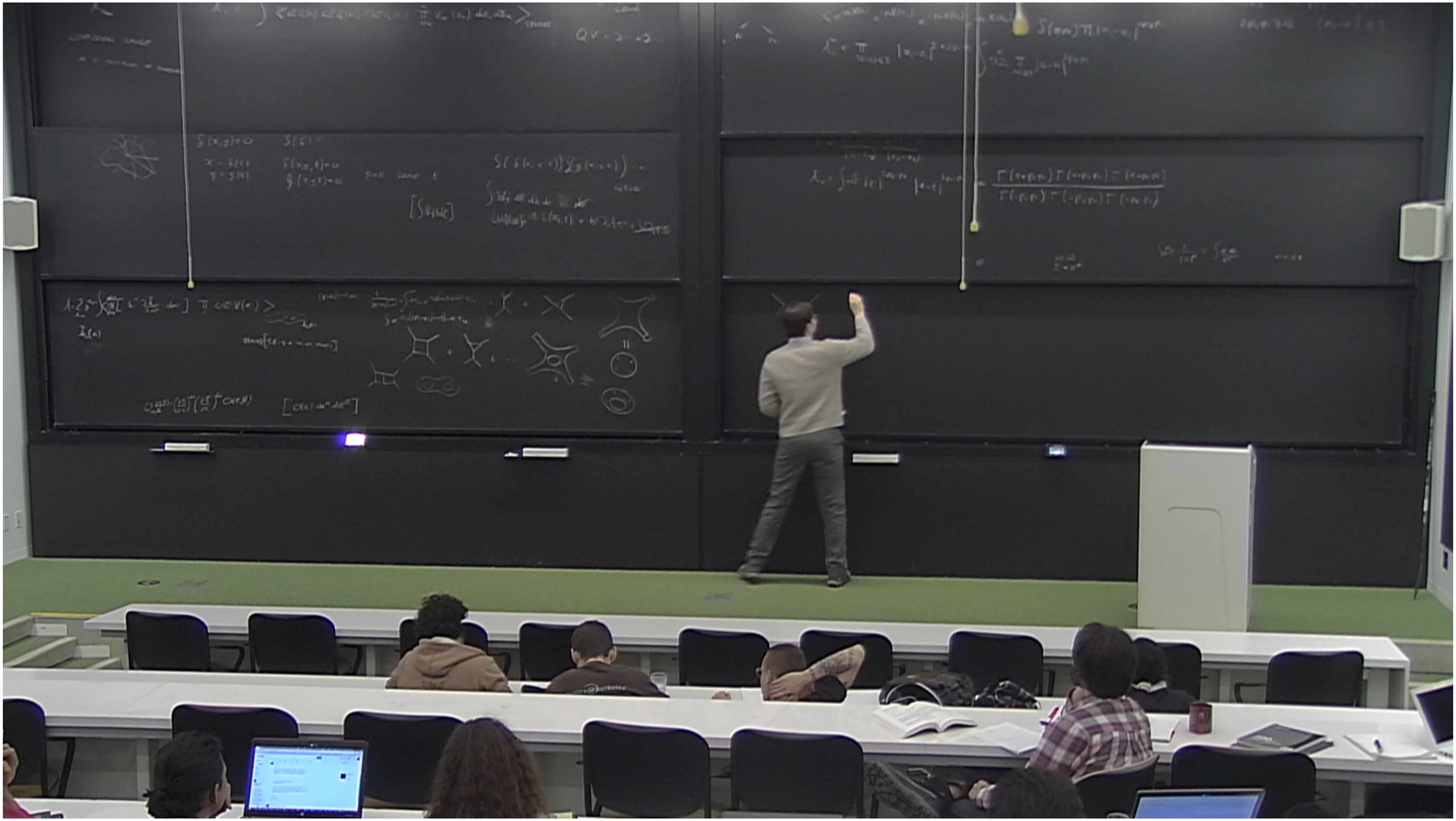
$t = \frac{(z-z_1)}{(z-z_3)} \frac{(z_2-z_3)}{(z_2-z}$
$\lambda_4 = \int dt\, |t|^{2p_4-p_1}$

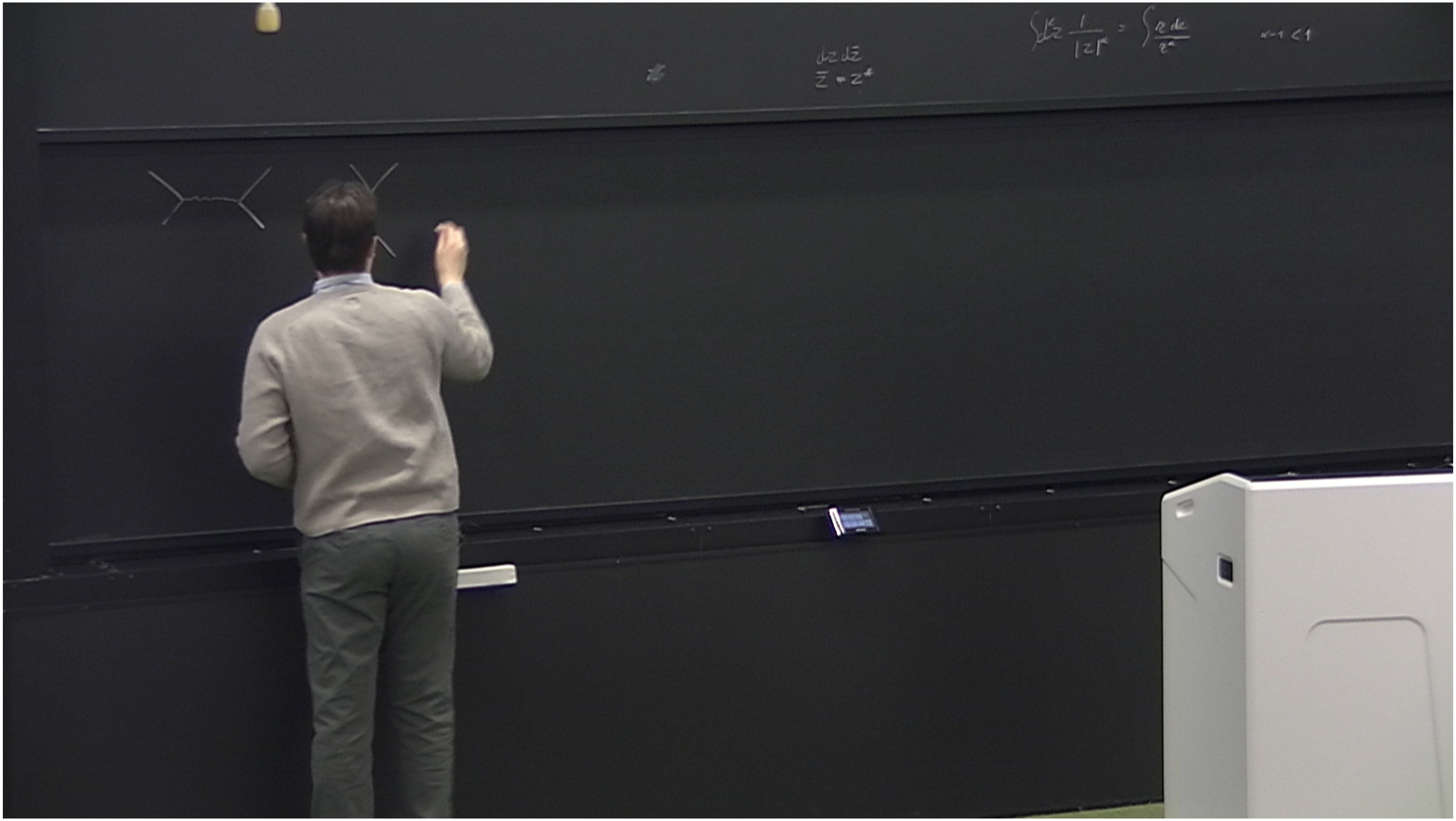


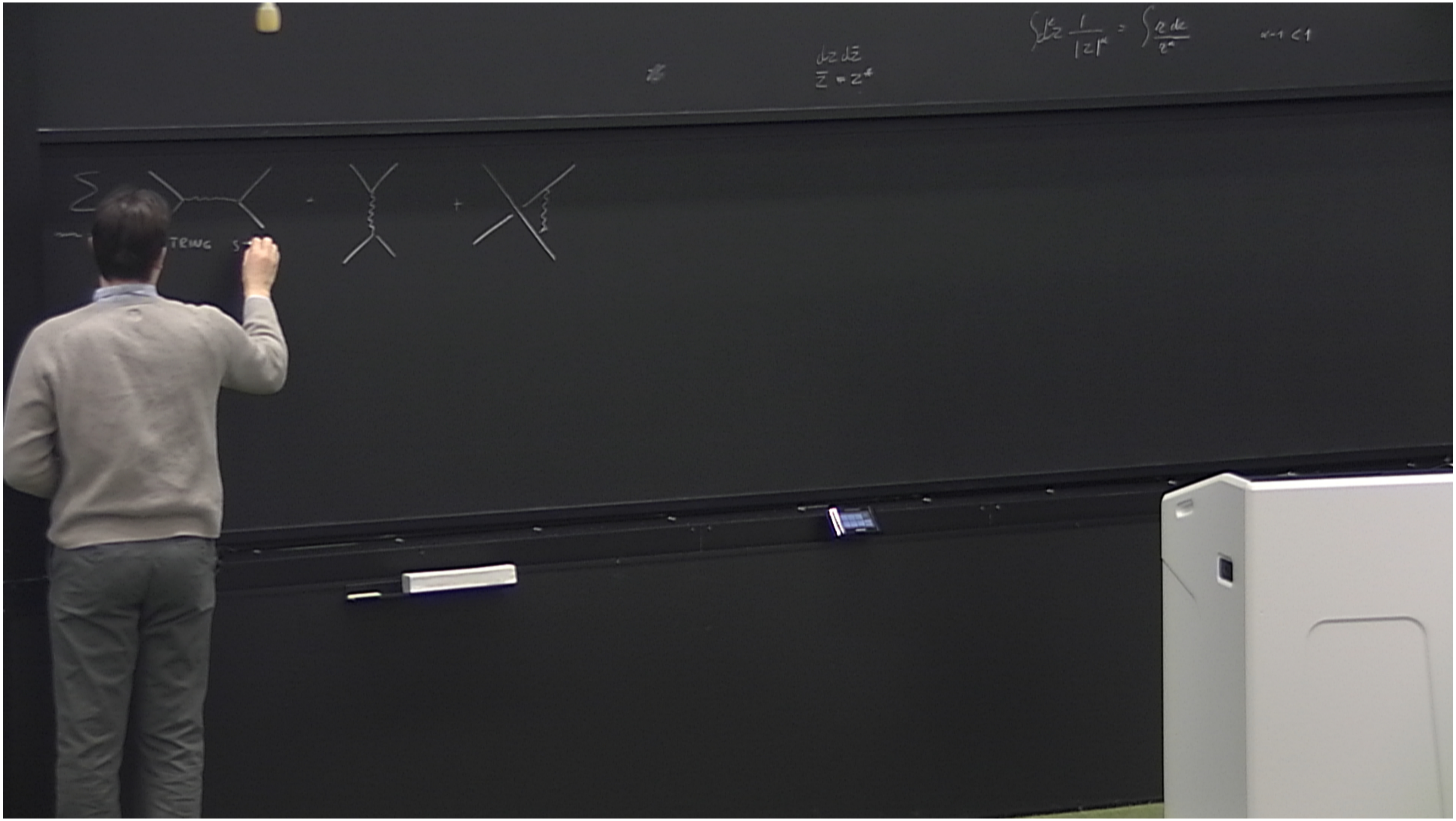
$t = \frac{(z-z_1)}{(z-z_3)} \frac{(z_2-z_3)}{(z_2-z_1)}$
$\lambda_4 = \int d^2t\, |t|^{2p_4-p_1} |1-t|^{2p_4-p_2}$

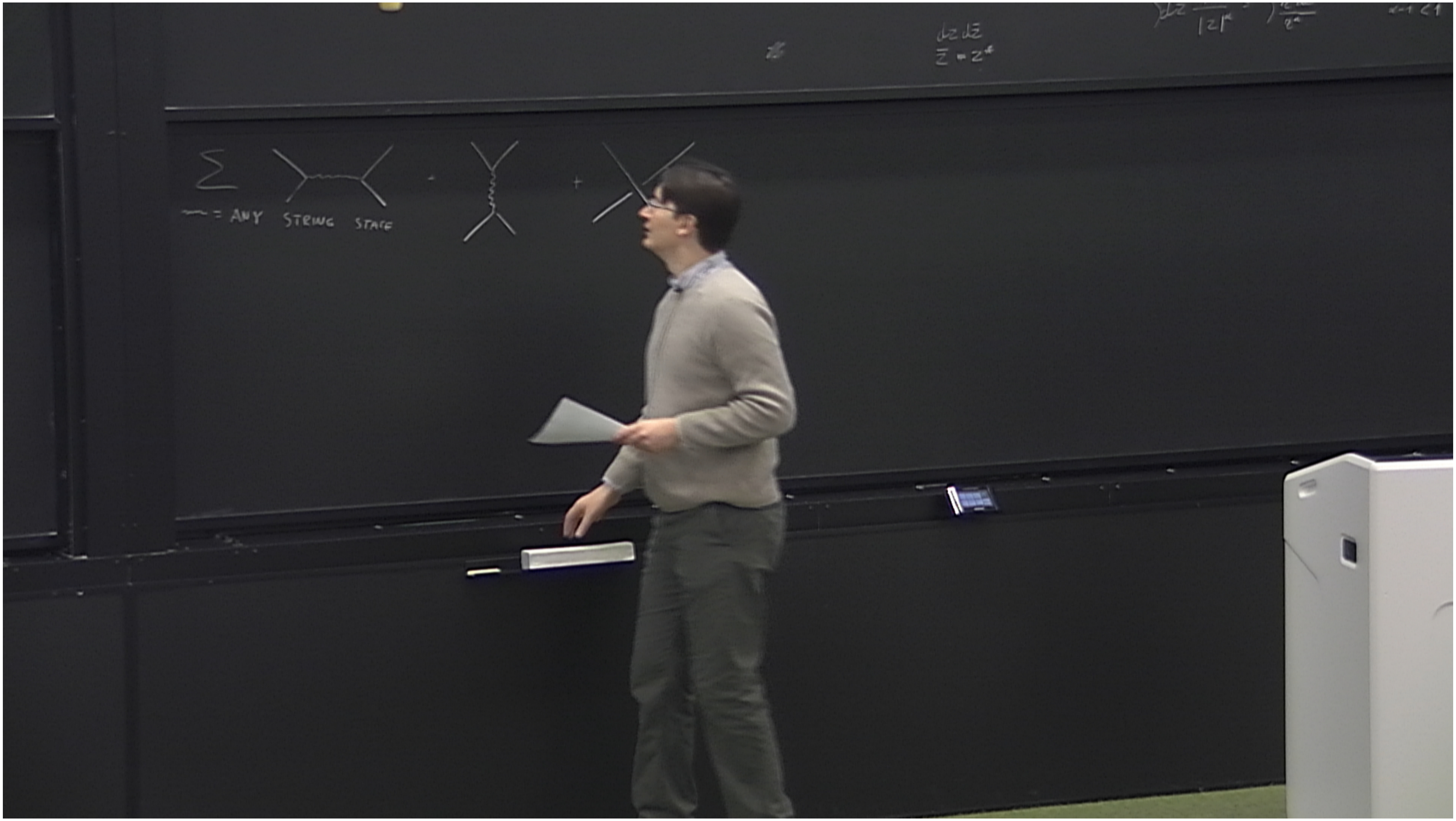


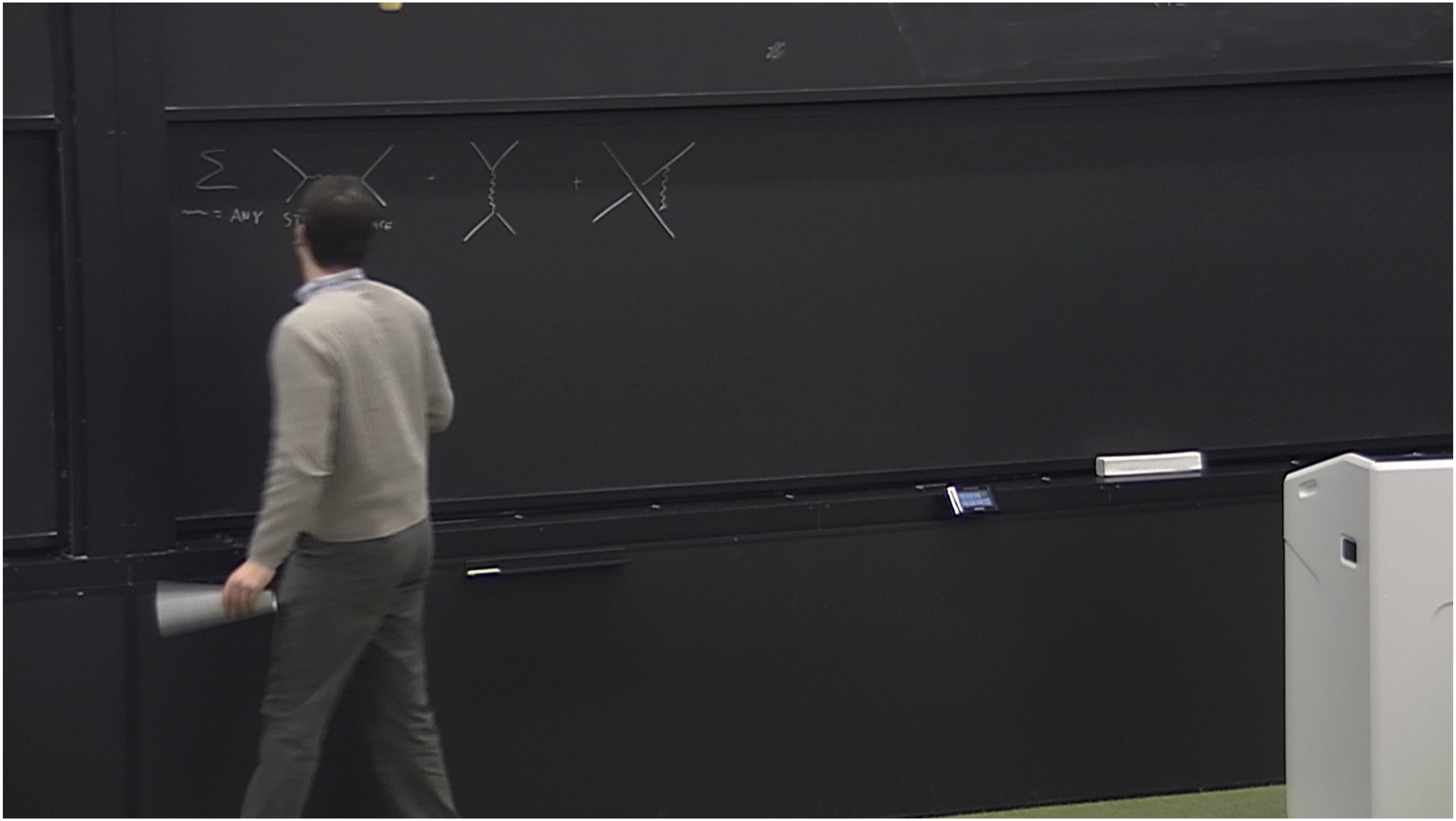

t = (z−z_1)/(z−z_3) (z_2−z_3)/(z_2−z_1)
λ_4 = ∫d²t |t|^{2p_4·p_1} |1−t|^{2p_4·p_2} =

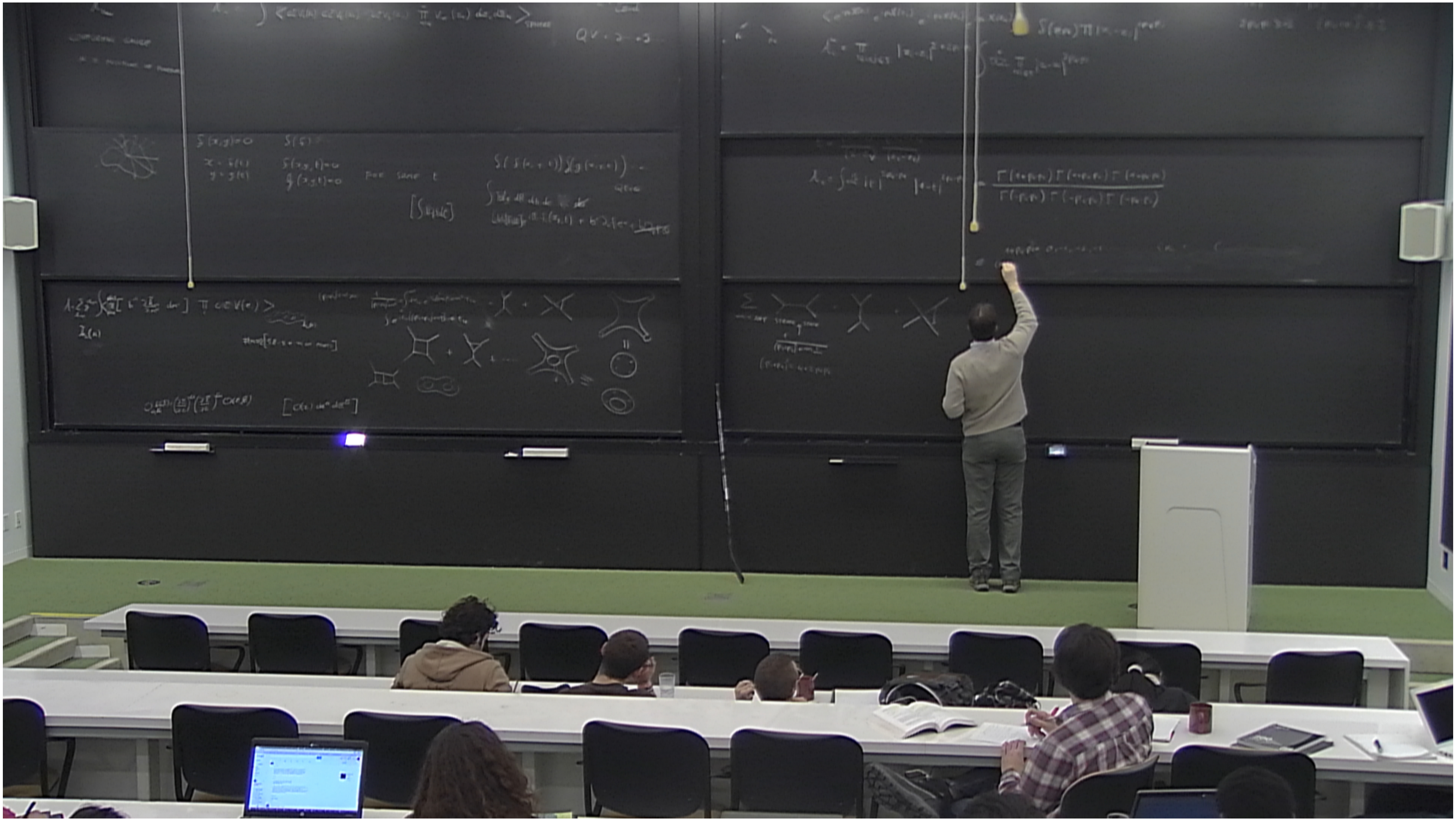


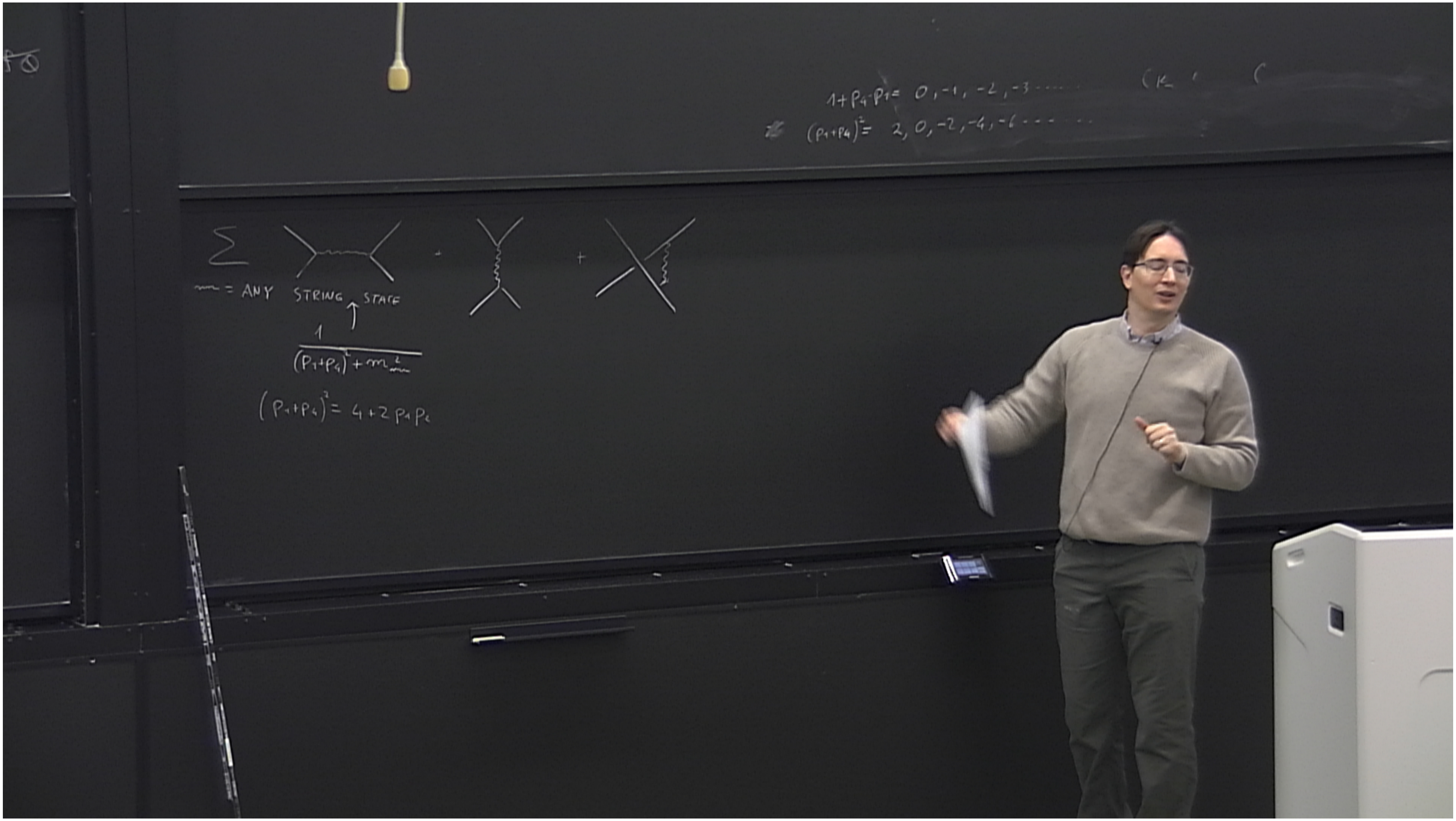




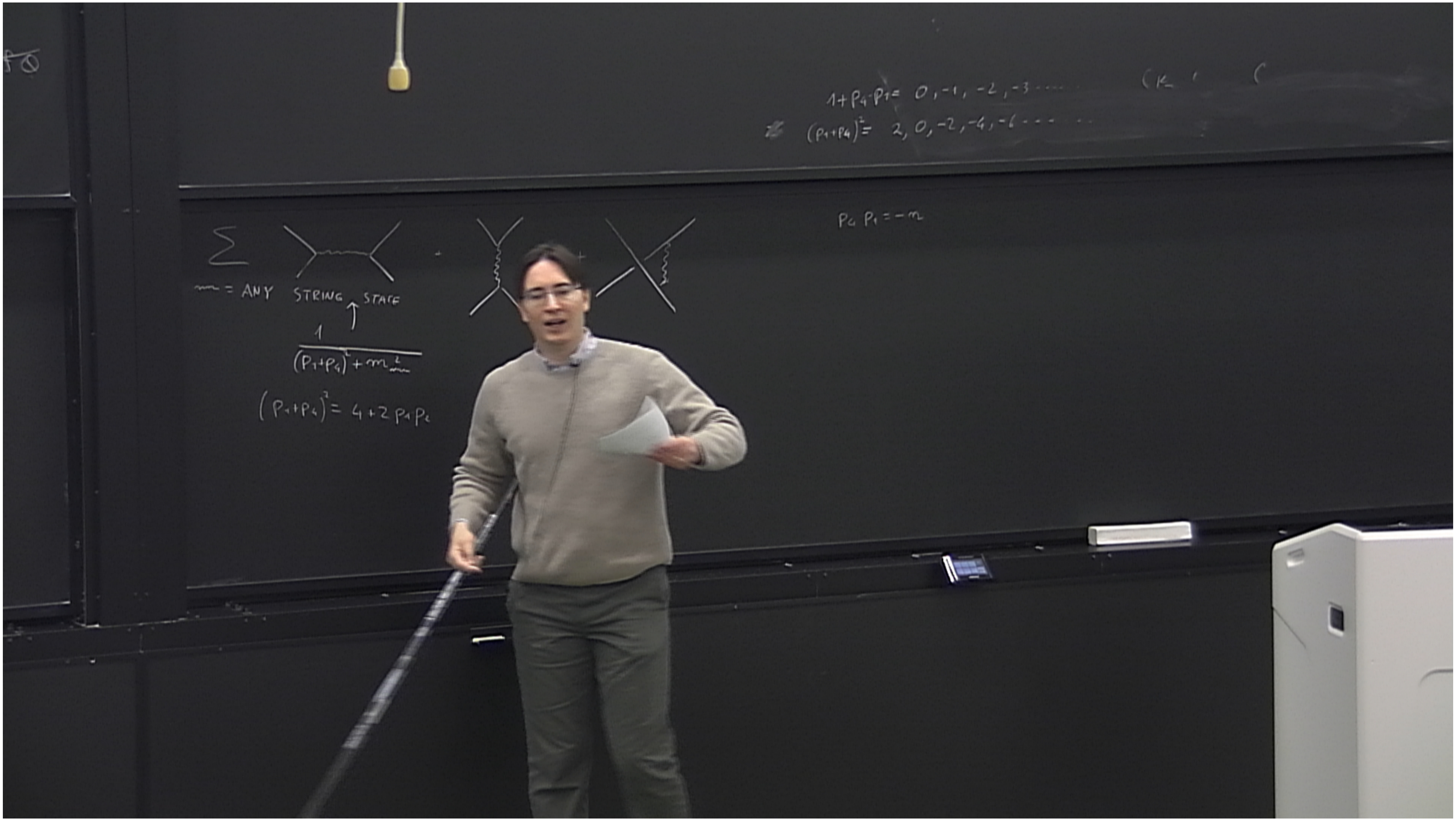

= ANY STRING STATE


= ANY

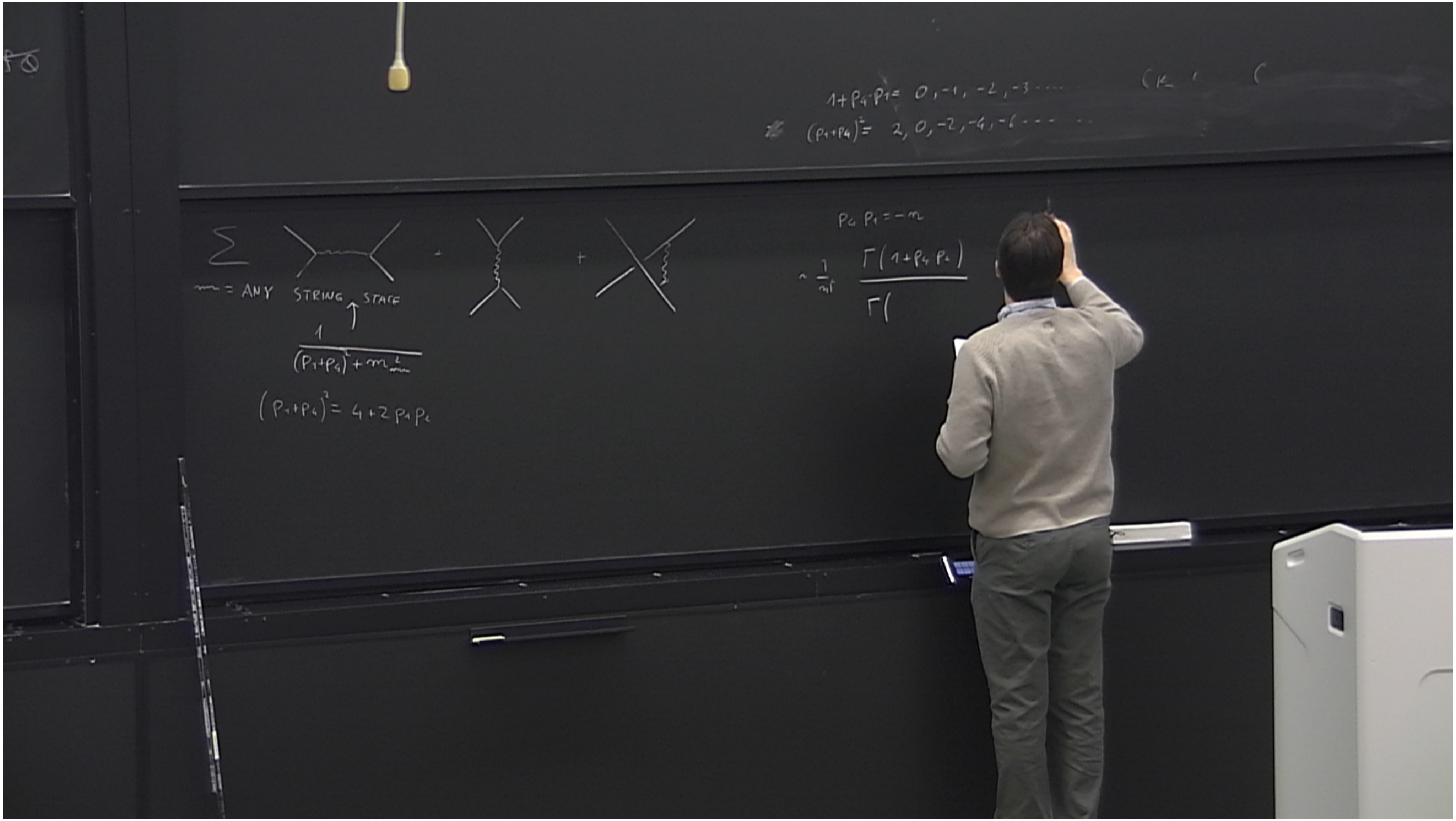


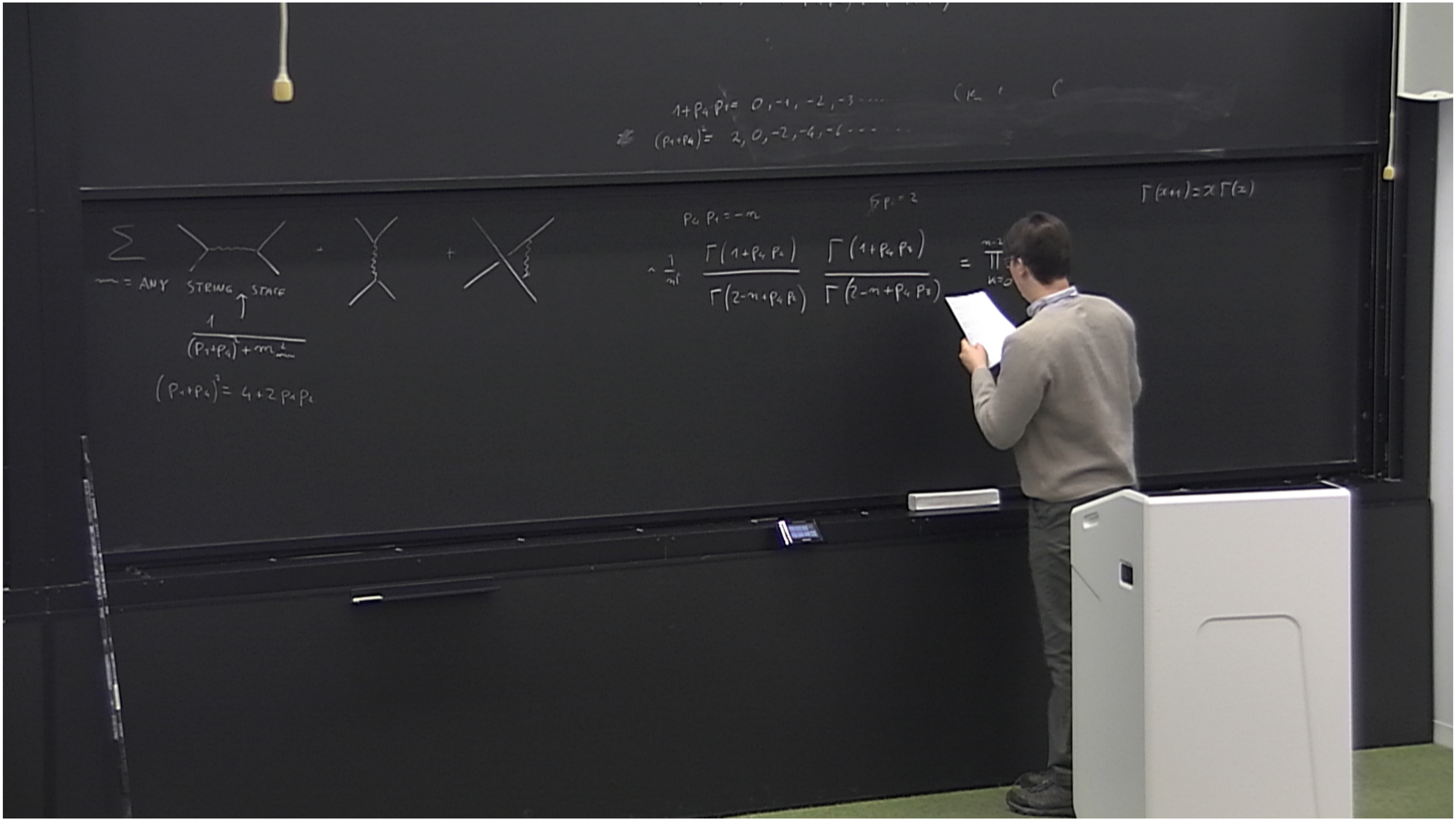


1+p4·p1= 0, -1, -2, -3 ....
(p1+p4)^2= 2, 0, -2, -4, -6 .......
= ANY STRING STATE
1 / (p1+p4)^2 + m^2
(p1+p4)^2 = 4+2 p1 p4

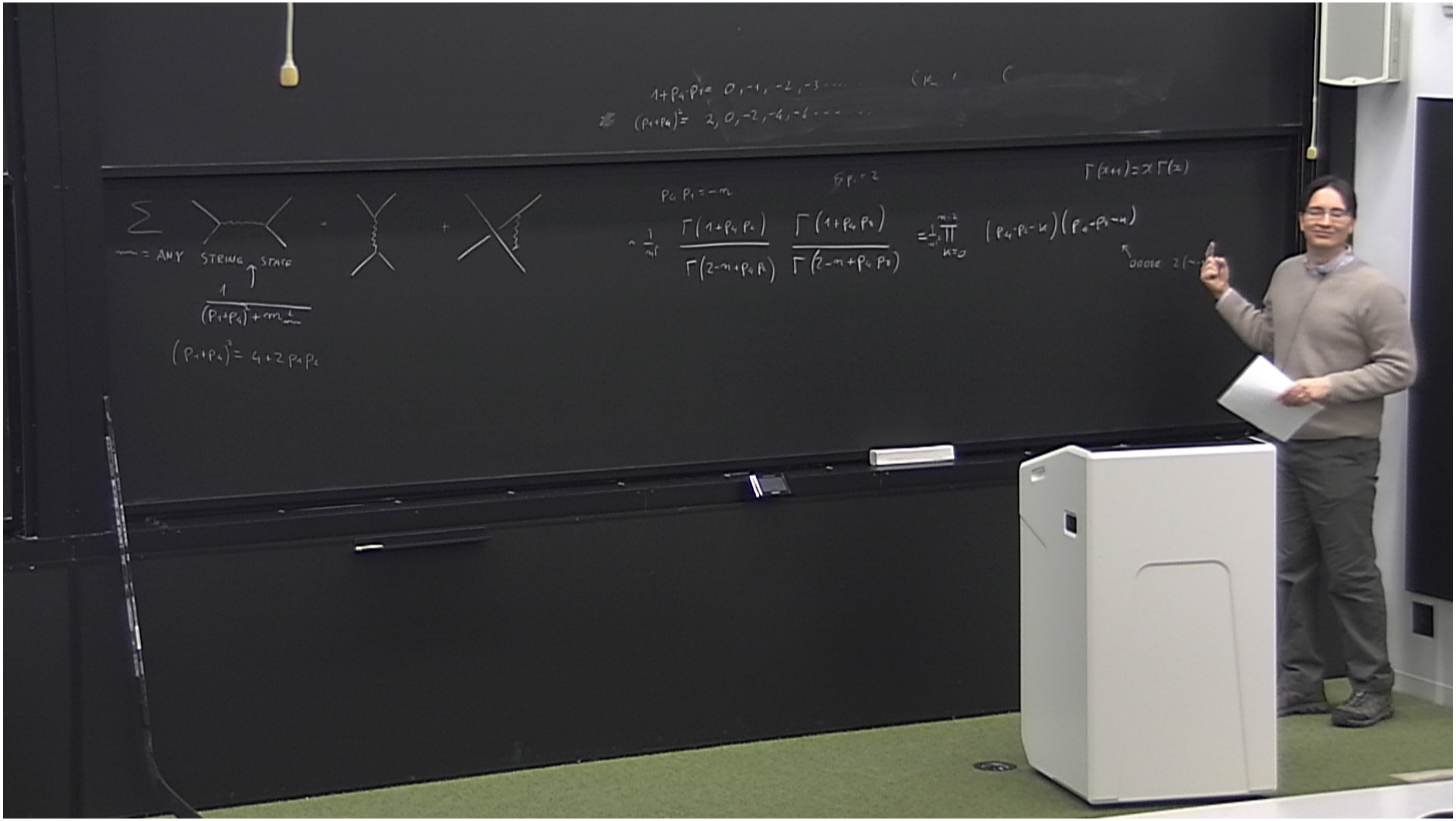


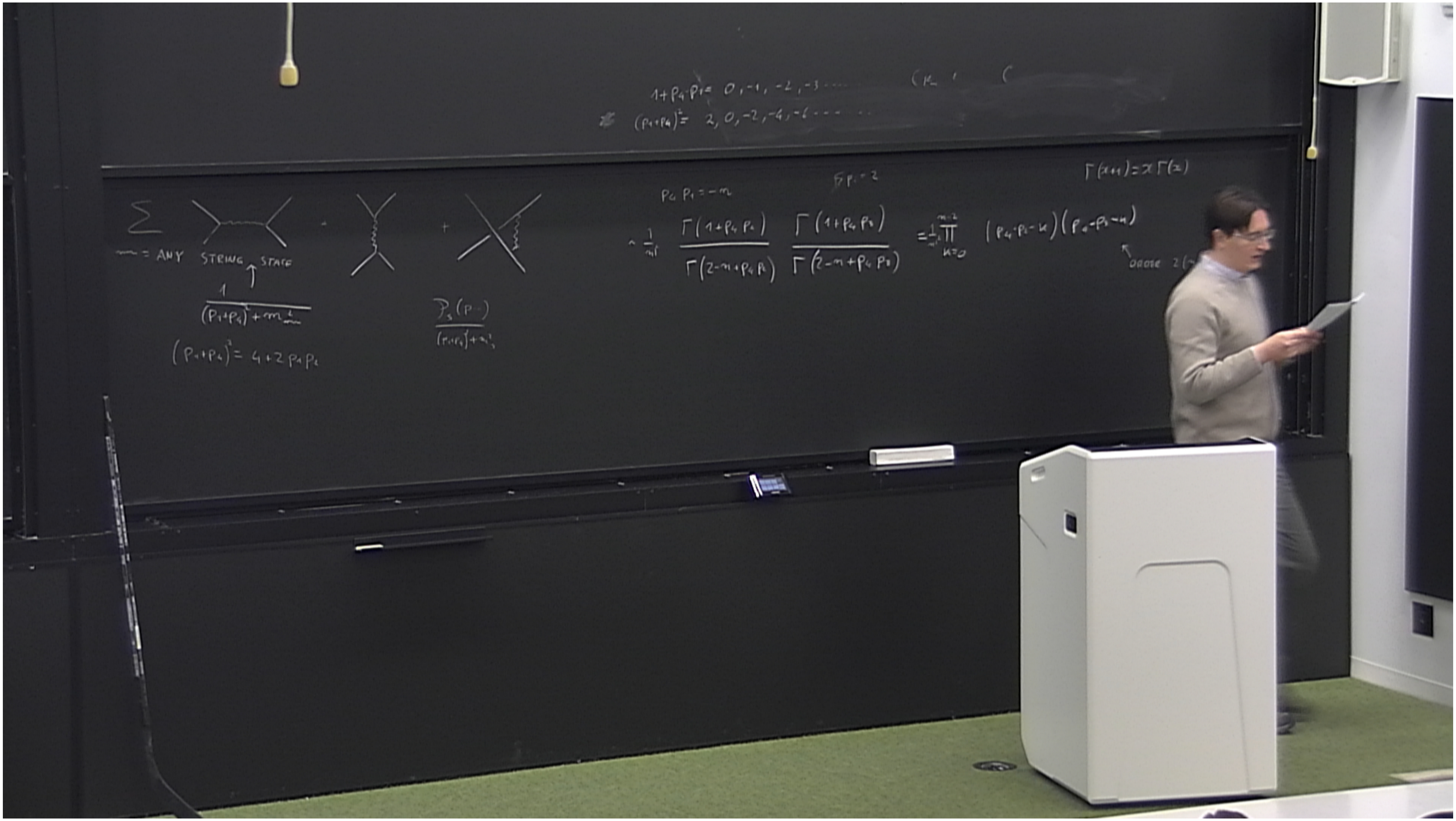
1+p4·p1= 0, -1, -2, -3 ....
(p1+p4)2= 2, 0, -2, -4, -6 .....
p4 p1 = -m
= ANY STRING STATE
(p1+p4)2 = 4+2 p1p4

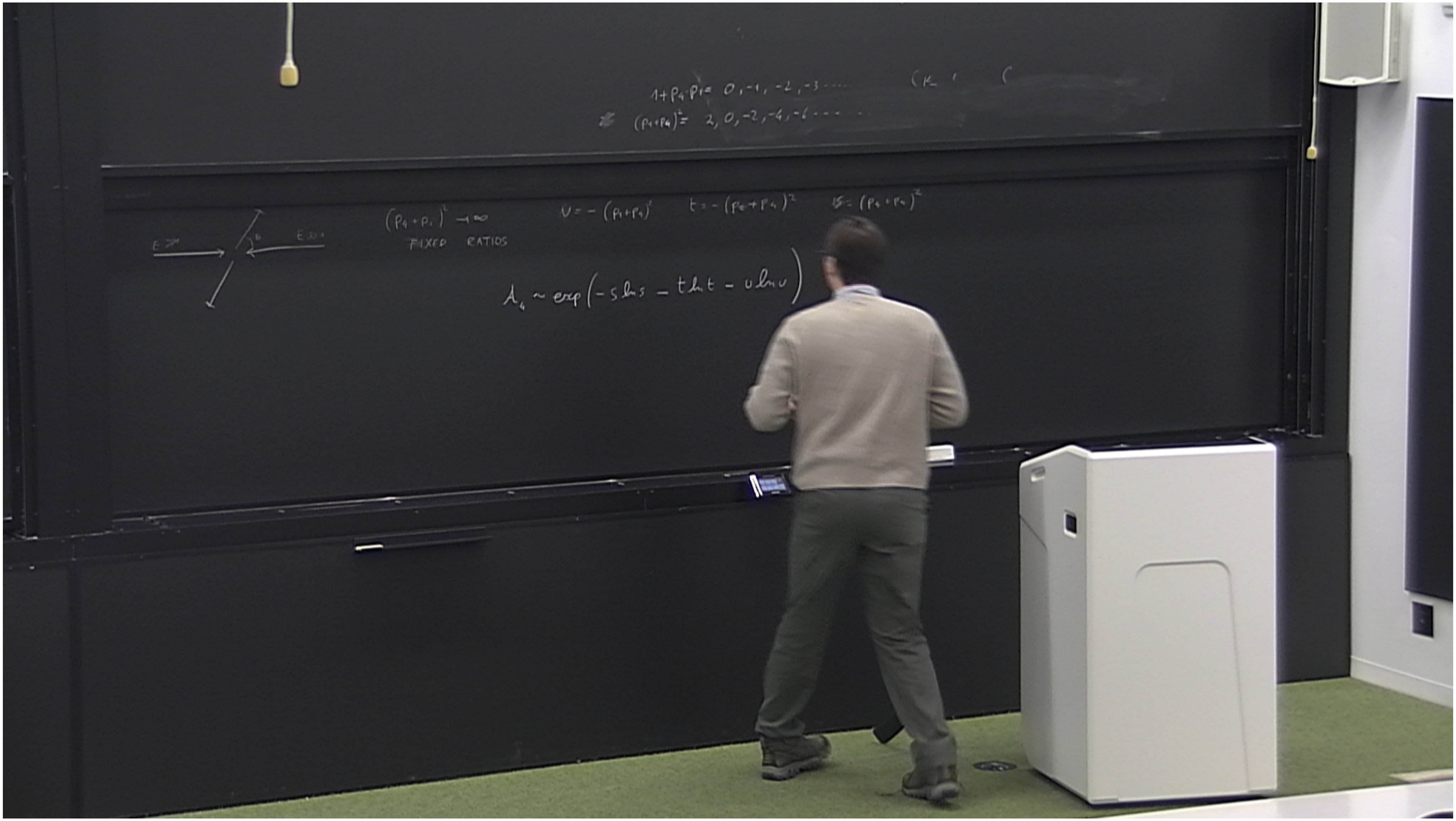

1+p4·p1= 0, -1, -2, -3 ....
(p1+p4)²= 2, 0, -2, -4, -6 - - - ..
ANY STRING STATE
(p1+p4)² + m²
(p1+p4)²= 4+2 p1 p2
Γ(1+p4 p2)
Γ(



ANY STRING STATE







$1 + p_4 \cdot p_1 = 0, -1, -2, -3 \cdots$
$(p_1+p_4)^2 = 2, 0, -2, -4, -6 \cdots$
$(p_4+p_1)^2 \to \infty$
FIXED RATIOS
$u = -(p_1+p_3)^2$
$t = -(p_2+p_4)^2$
$s = (p_4+p_1)^2$
$A_4 \sim \exp(-s \ln s - t \ln t - u \ln u)$