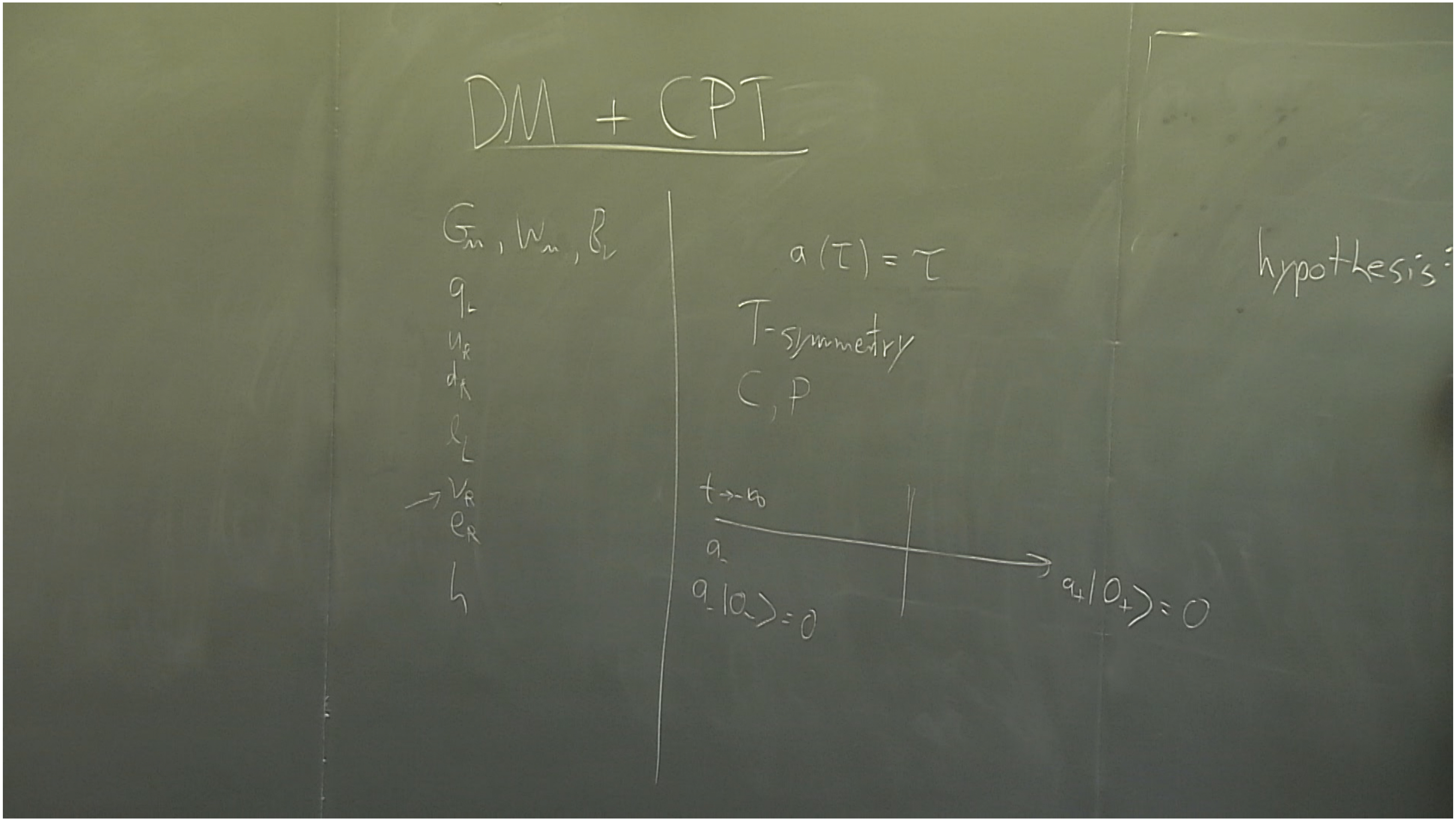
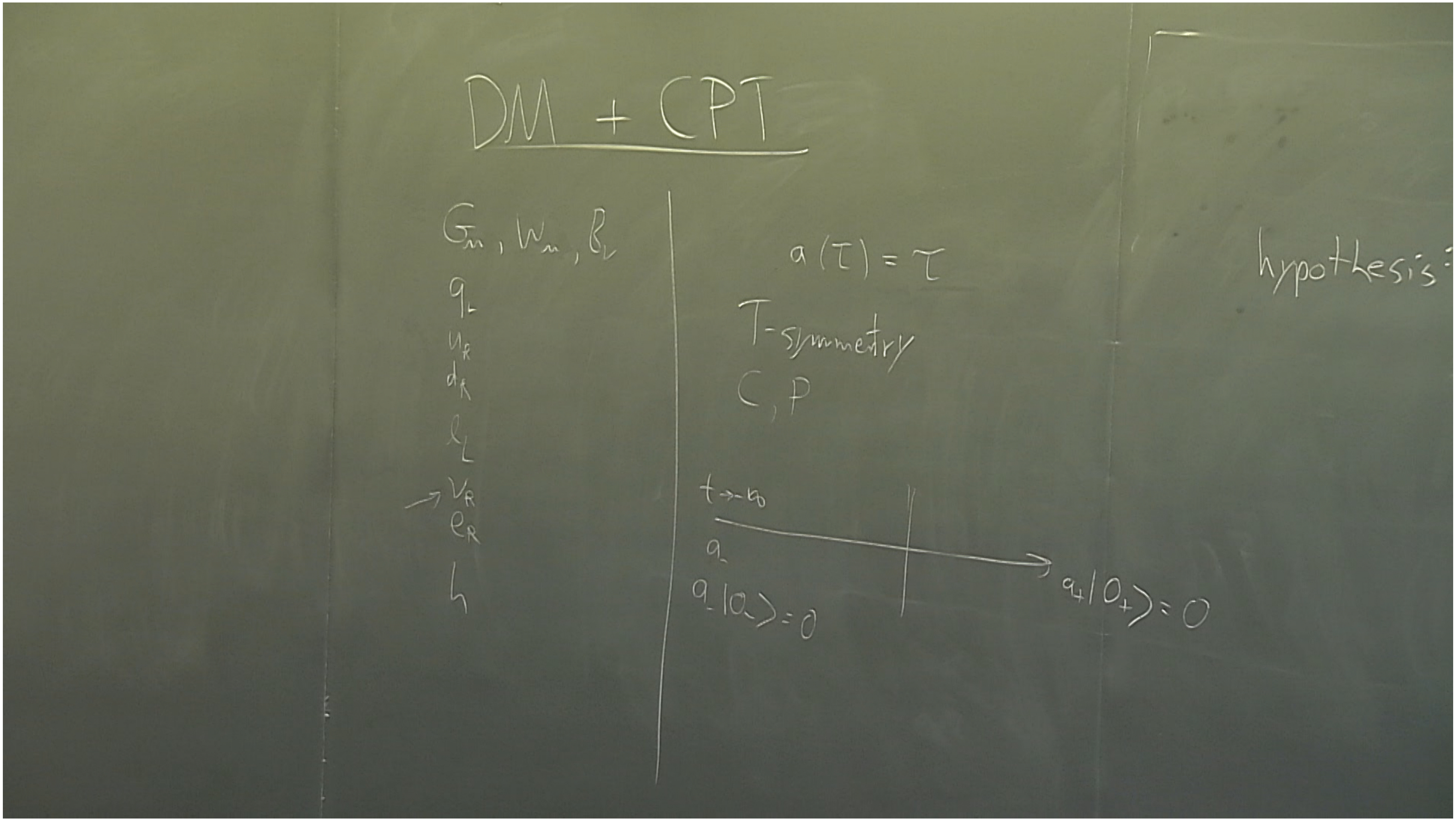
Title: Discussion Session 4

Date: Jun 27, 2017 04:00 PM

URL: http://pirsa.org/17060104

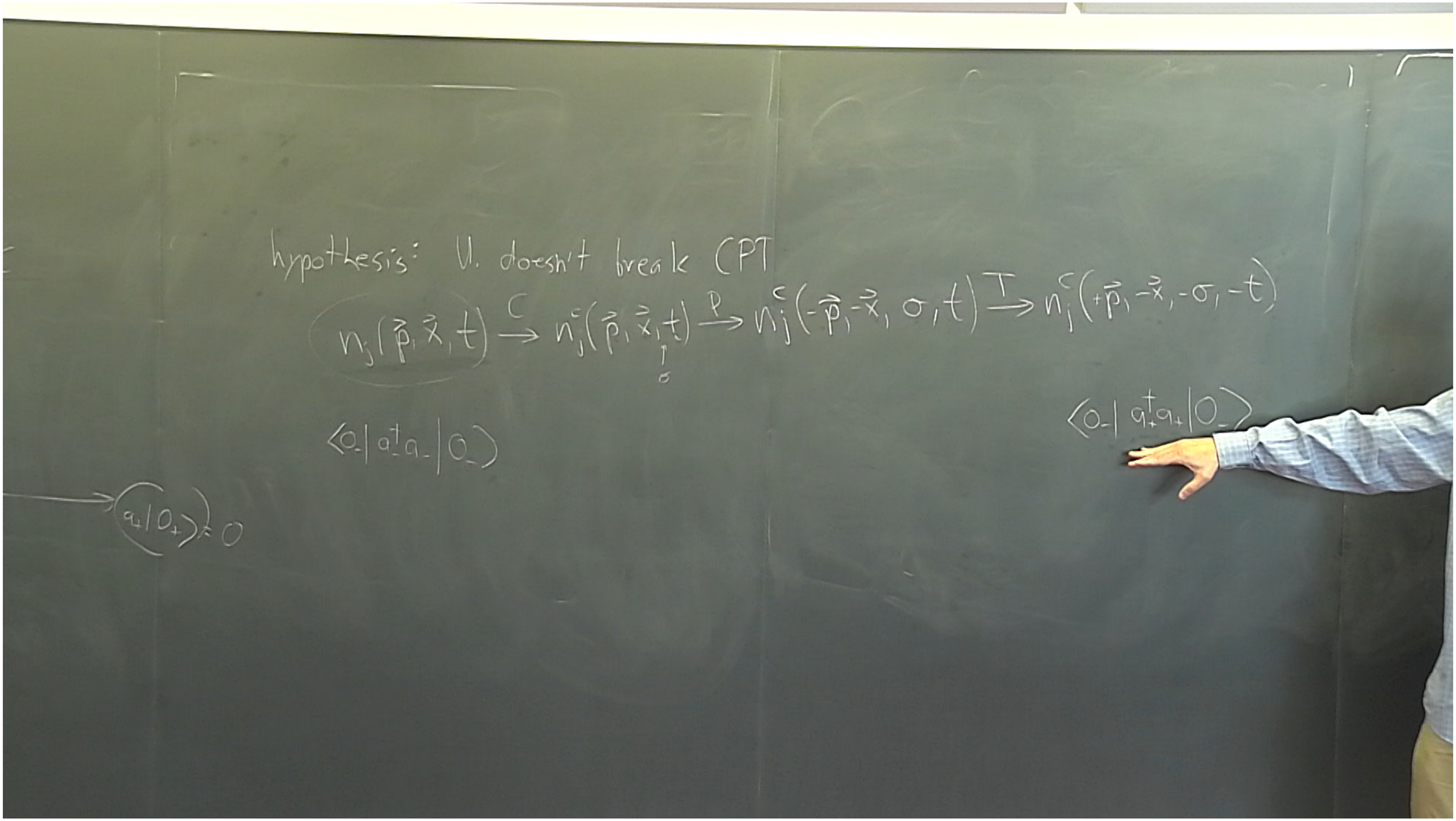
Abstract:

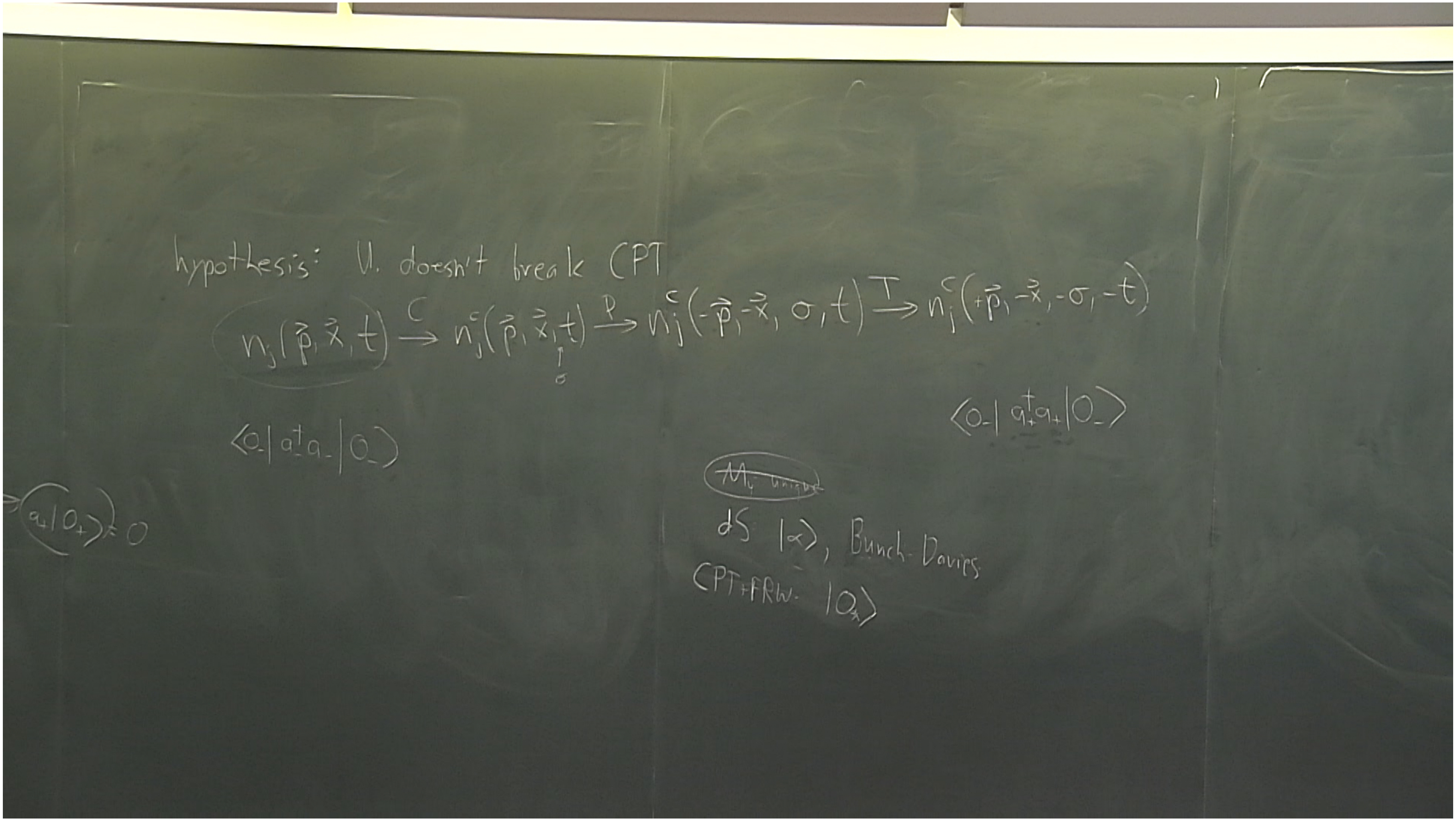

DM + CPT
G, W, B
q_L
u_R
d_R
ℓ_L
ν_R
e_R
h
a(τ) = τ
T-symmetry
C, P
t → -∞
a_-
a_-|0_-> = 0
a_+|0_+> = 0
hypothesis:


DM + CPT
G_μ, W_μ, B_ν
q_L
u_R
d_R
l_L
ν_R
e_R
h
a(τ) = τ
T-symmetry
C, P
t → -∞
a_-
a_-|0_-⟩ = 0
a_+|0_+⟩ = 0
hypothesis:


DM + CPT
a(τ) = τ
T-symmetry
C, P
hypothesis: U. doesn't


DM + CPT
G_μ, W_μ, B_μ
q_L
u_R
d_R
ℓ_L
ν_R
e_R
h
$a(\tau) = \tau$
T-symmetry
C, P
$t \to -\infty$
a_-
$a_- |0_-\rangle = 0$
hypothesis: U. doesn't


hypothesis: U. doesn't break CPT
$n_j(\vec{p}, \vec{x}, t) \xrightarrow{C} n_j^c(\vec{p}, \vec{x}, t) \xrightarrow{P} n_j^c(-\vec{p}, -\vec{x}, \sigma, t) \xrightarrow{T} n_j^c(+\vec{p}, -\vec{x}, -\sigma, -t)$
σ
$\langle 0_- | a_-^\dagger a_- | 0_- \rangle$
$\langle 0_- | a_+^\dagger a_+ | 0_- \rangle$
$a_+ | 0_+ \rangle = 0$


hypothesis: U. doesn't break CPT
$n_j(\vec{p}, \vec{x}, t) \xrightarrow{C} n_j^c(\vec{p}, \vec{x}, t) \xrightarrow{P} n_j^c(-\vec{p}, -\vec{x}, \sigma, t) \xrightarrow{T} n_j^c(+\vec{p}, -\vec{x}, -\sigma, -t)$
σ
$\langle 0_- | a_-^\dagger a_- | 0_- \rangle$
$\langle 0_- | a_+^\dagger a_+ | 0_- \rangle$
$a_+ | 0_+ \rangle = 0$
M_4 unique
dS $|\alpha\rangle$, Bunch-Davies
CPT+FRW: $|0_+\rangle$

$$e^\mu_a = \frac{1}{a}\delta^\mu_a \qquad N = a^{3/2} v$$

$$\Rightarrow n_j^c(+\vec{p}, -\vec{x}, -\sigma, -t)$$

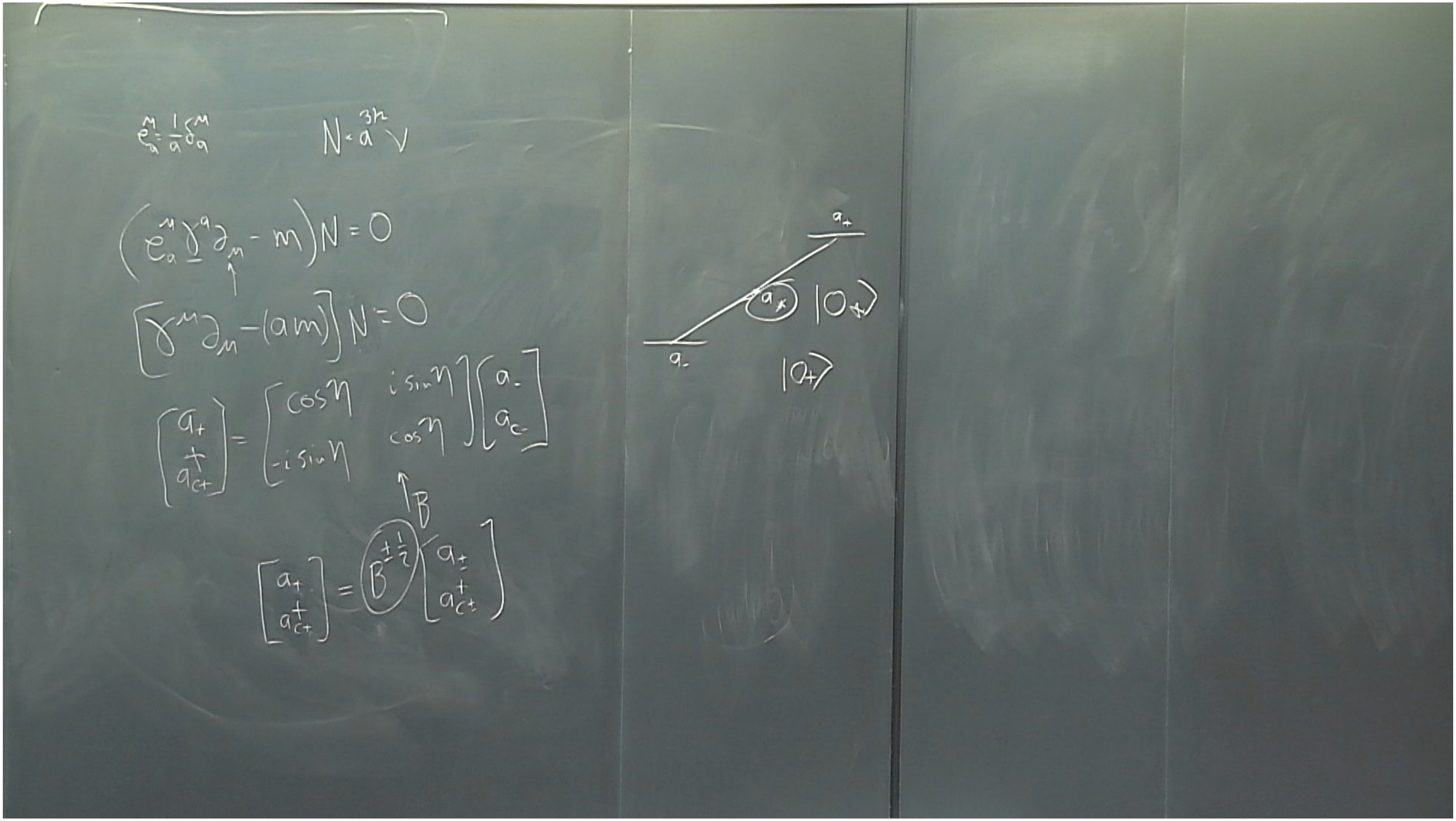
$$\left(e^\mu_a \gamma^a \partial_\mu - m\right) N = 0$$

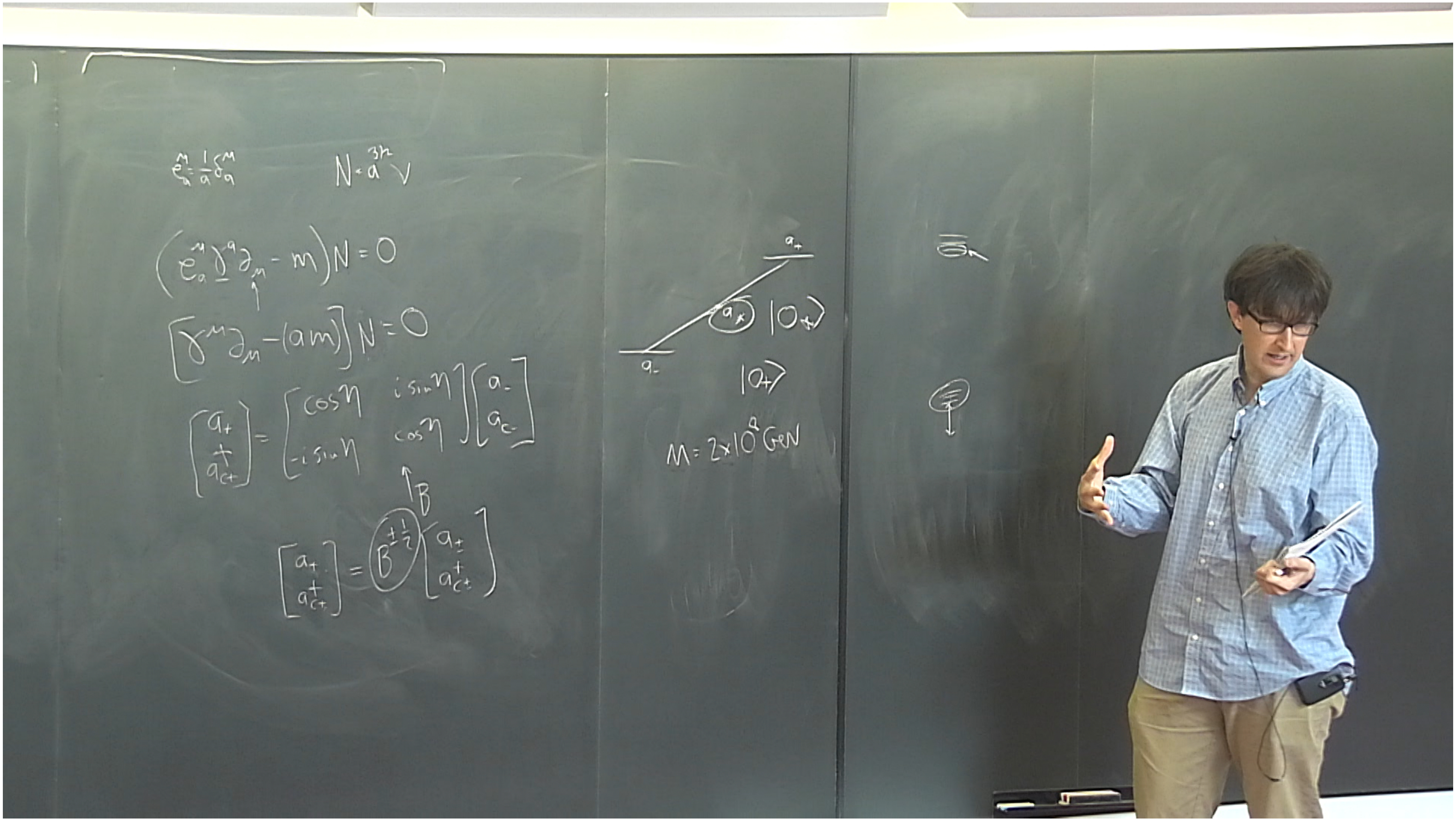
$$\left[\gamma^\mu \partial_\mu - (am)\right] N = 0$$

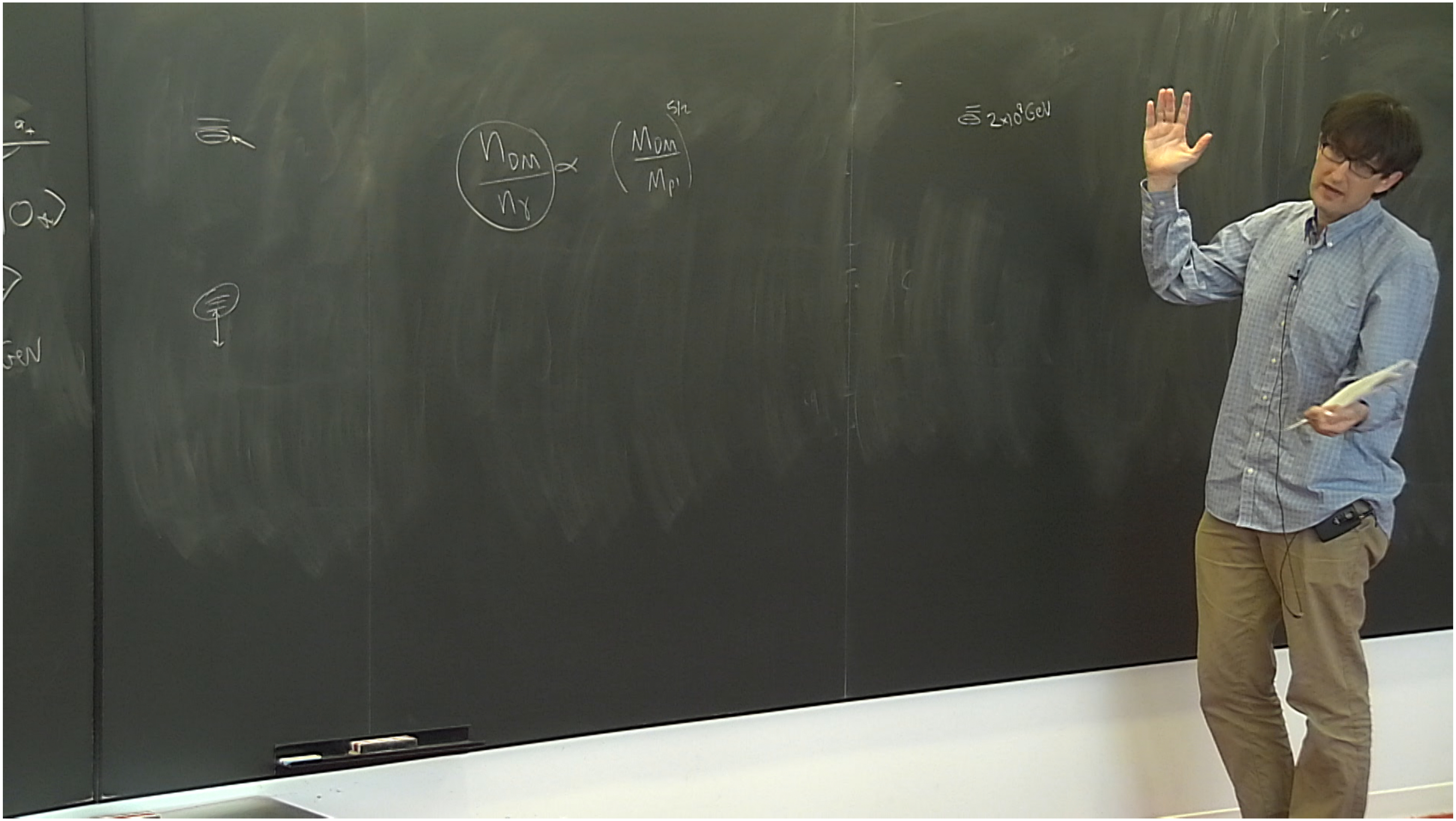
$$\langle 0_- | a_+^\dagger a_+ | 0_- \rangle$$

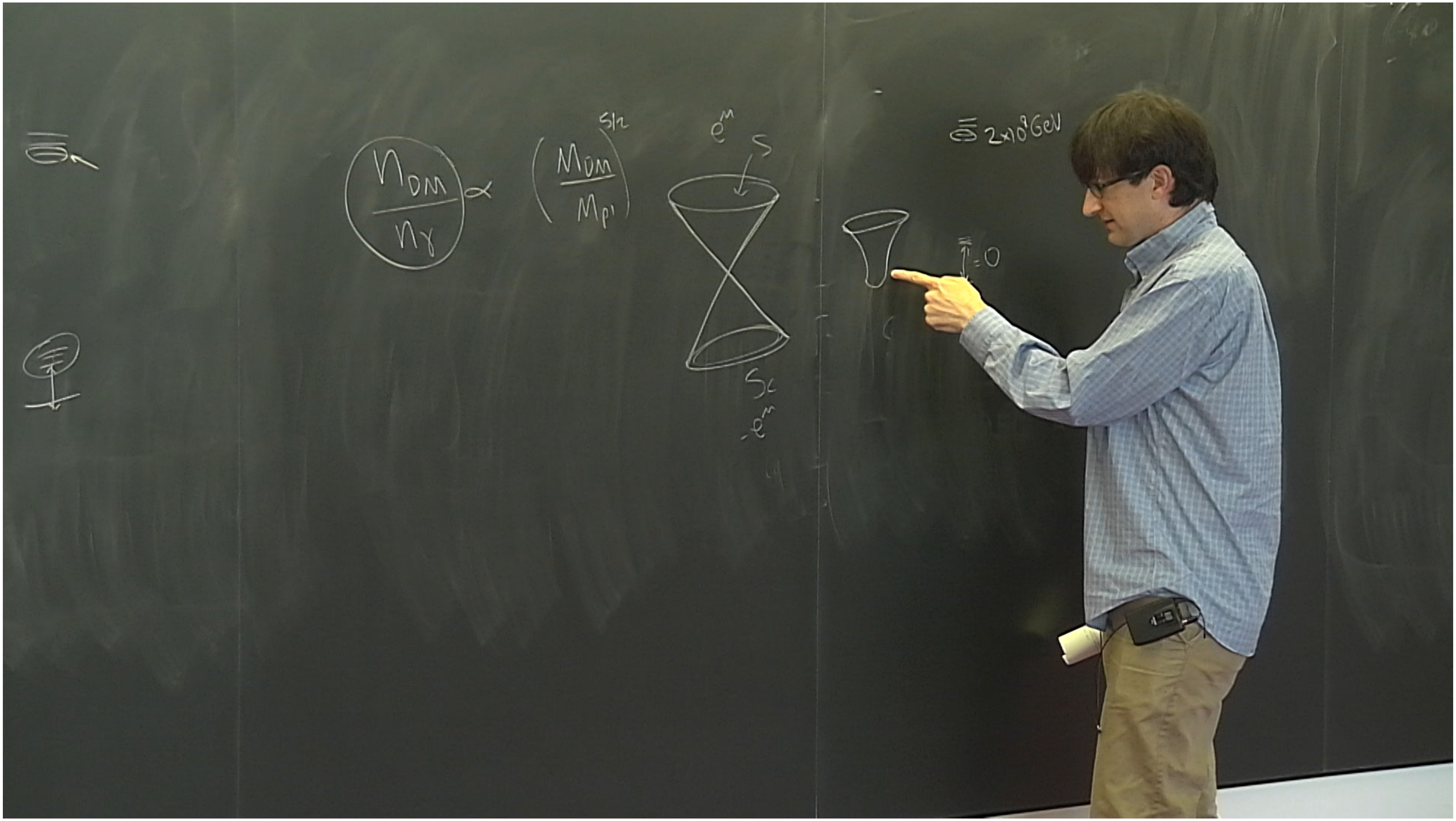
$$\begin{bmatrix} a_+ \\ a_{c+} \end{bmatrix} = \begin{bmatrix} \cos\eta & i\sin\eta \\ -i\sin\eta & \cos\eta \end{bmatrix} \begin{bmatrix} a_- \\ a_{c-} \end{bmatrix}$$

-Davies


$e^\mu_a = \frac{1}{a}\delta^\mu_a$
$N = a^{3/2}\nu$
$(e^\mu_a \gamma^a \partial_\mu - m)N = 0$
$[\gamma^\mu \partial_\mu - (am)]N = 0$
$\begin{bmatrix} a_+ \\ a^\dagger_{c+} \end{bmatrix} = \begin{bmatrix} \cos\eta & i\sin\eta \\ -i\sin\eta & \cos\eta \end{bmatrix} \begin{bmatrix} a_- \\ a_{c-} \end{bmatrix}$
B
$\begin{bmatrix} a_+ \\ a^\dagger_{c+} \end{bmatrix} = B^{\pm\frac{1}{2}} \begin{bmatrix} a_\pm \\ a^\dagger_{c\pm} \end{bmatrix}$
a_+
a_*
$|0_*\rangle$
a_-
$|0_+\rangle$

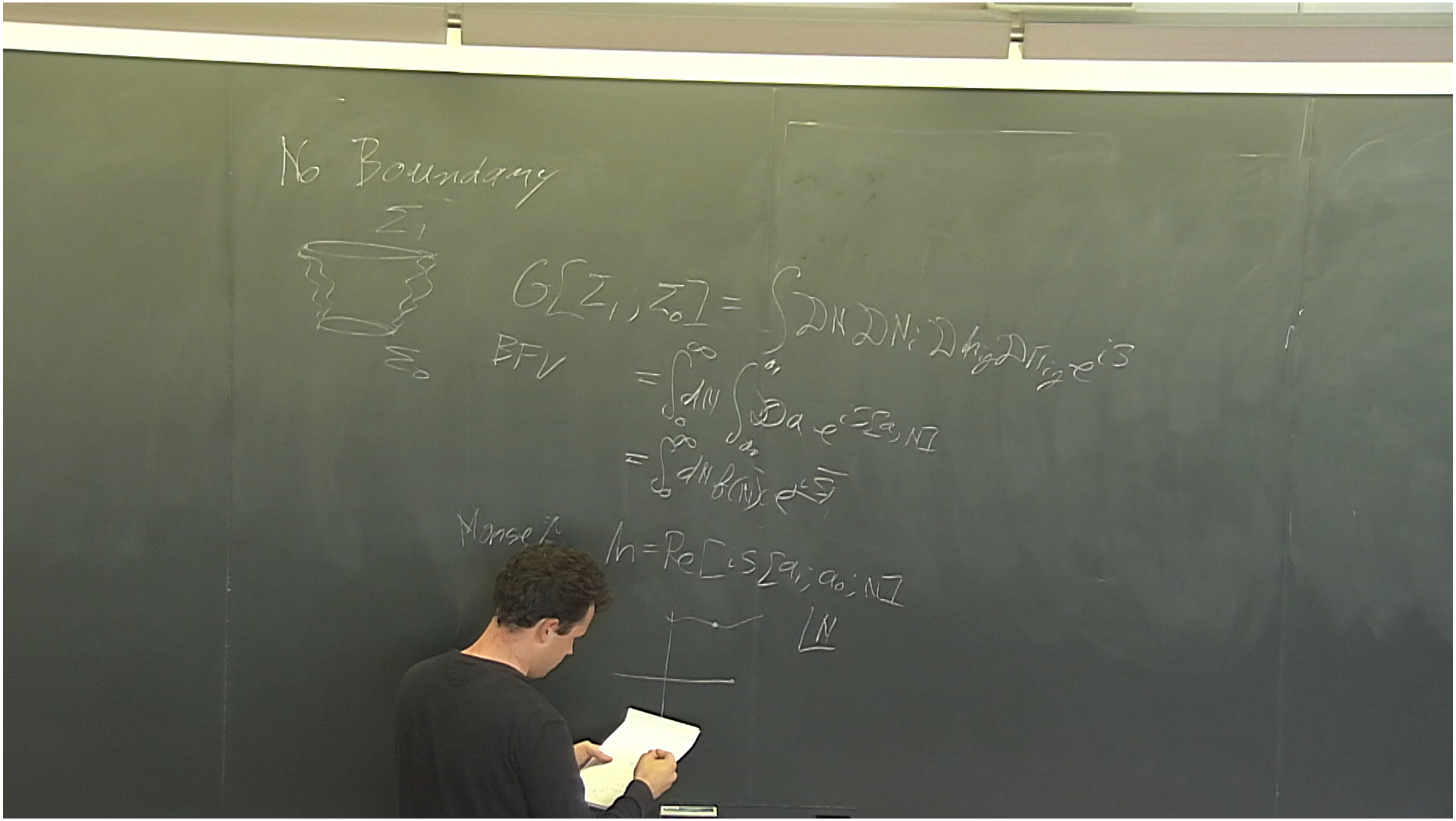

$e^\mu_a = \frac{1}{a}\delta^\mu_a$
$N = a^{3/2}\nu$
$(e^\mu_a \gamma^a \partial_\mu - m)N = 0$
$[\gamma^\mu \partial_\mu - (am)]N = 0$
$\begin{bmatrix} a_+ \\ a^\dagger_{c+} \end{bmatrix} = \begin{bmatrix} \cos\eta & i\sin\eta \\ -i\sin\eta & \cos\eta \end{bmatrix} \begin{bmatrix} a_- \\ a_{c-} \end{bmatrix}$
B
$\begin{bmatrix} a_+ \\ a^\dagger_{c+} \end{bmatrix} = B^{\pm\frac{1}{2}} \begin{bmatrix} a_\pm \\ a^\dagger_{c+} \end{bmatrix}$
a_+
a_*
$|0_*\rangle$
a_-
$|0_+\rangle$
$M = 2\times10^9$ GeV

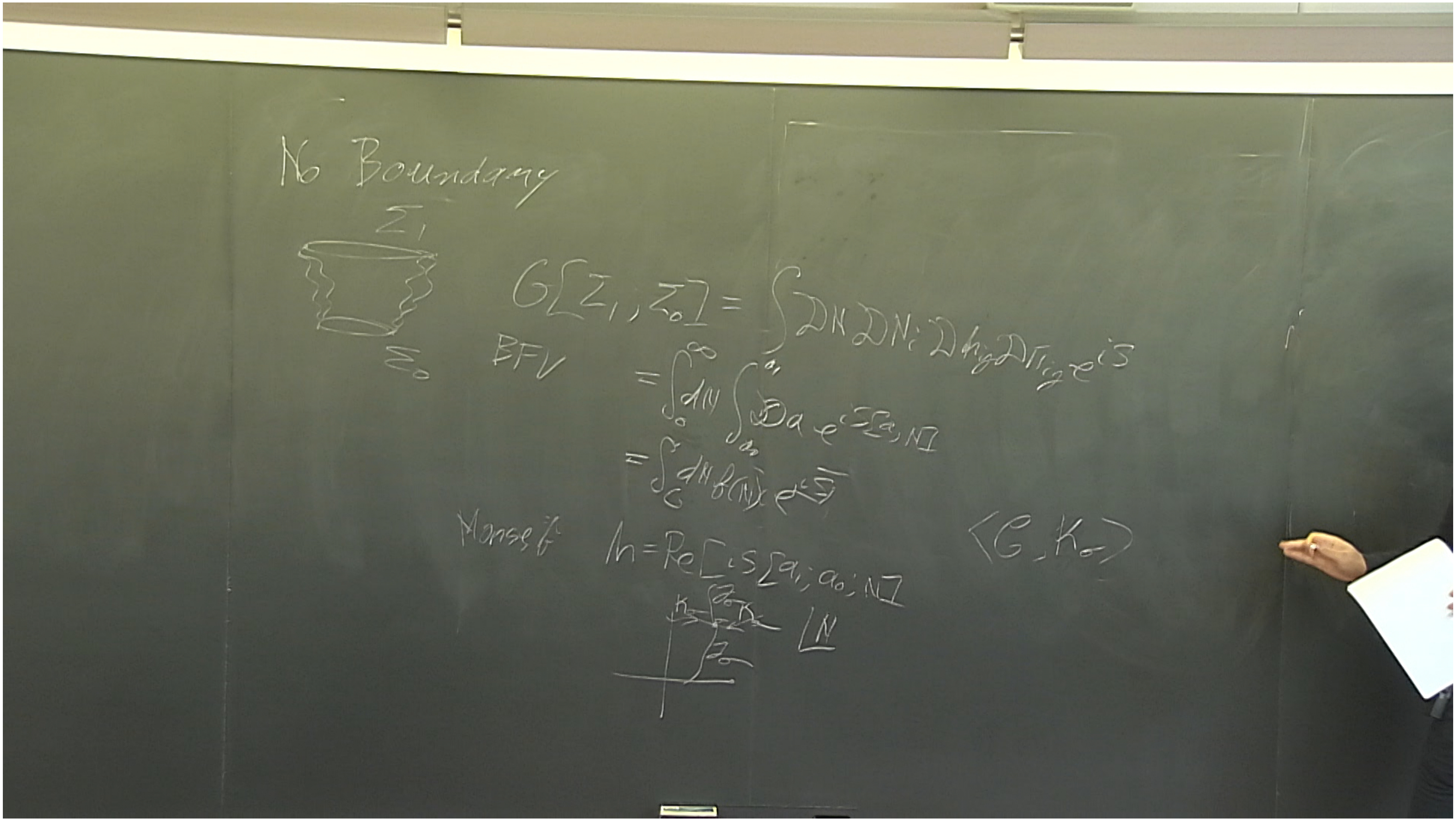

$\frac{n_{DM}}{n_\gamma} \propto \left(\frac{M_{DM}}{M_{Pl}}\right)^{5/2}$
$\simeq 2\times10^8$ GeV

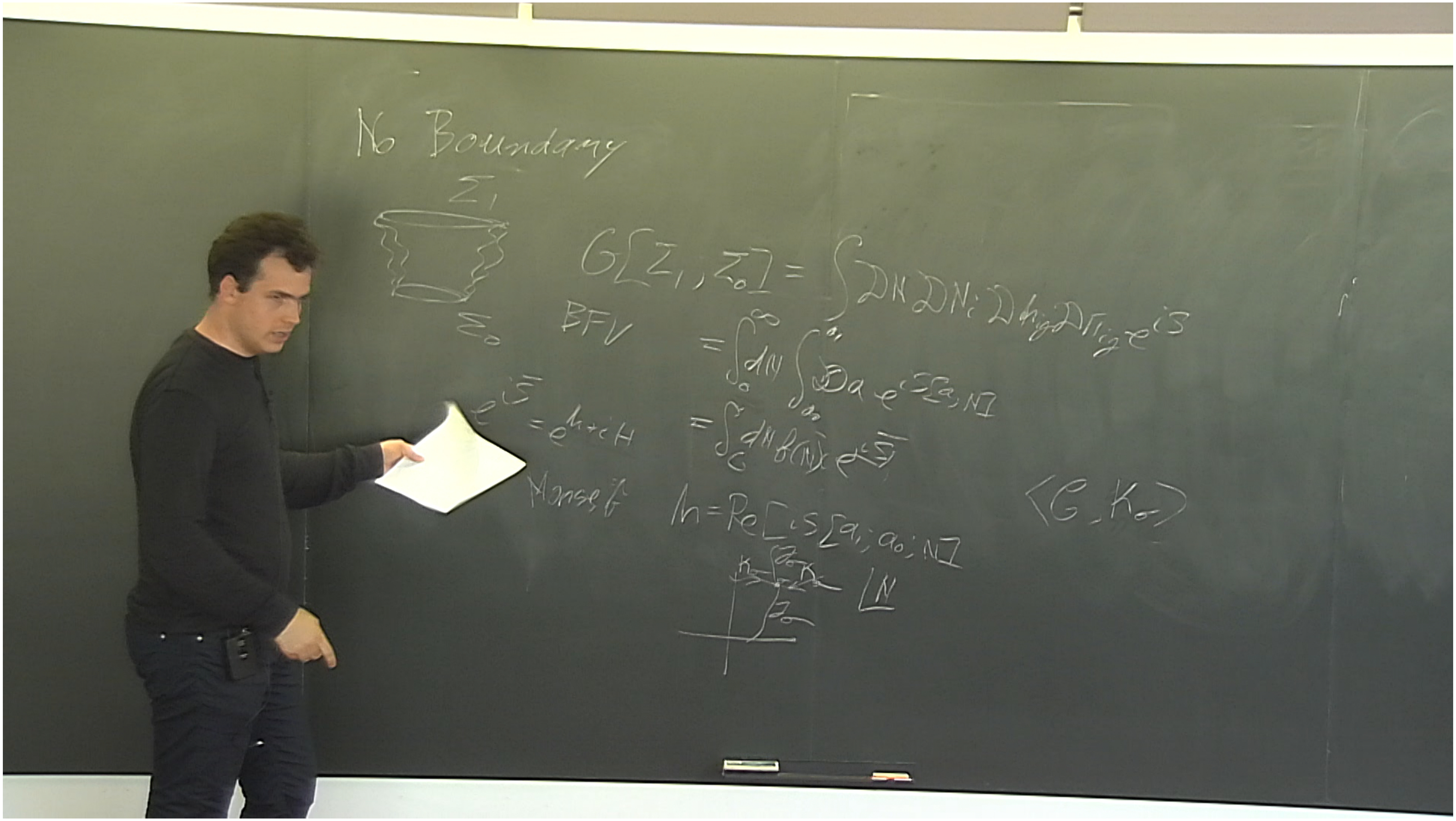


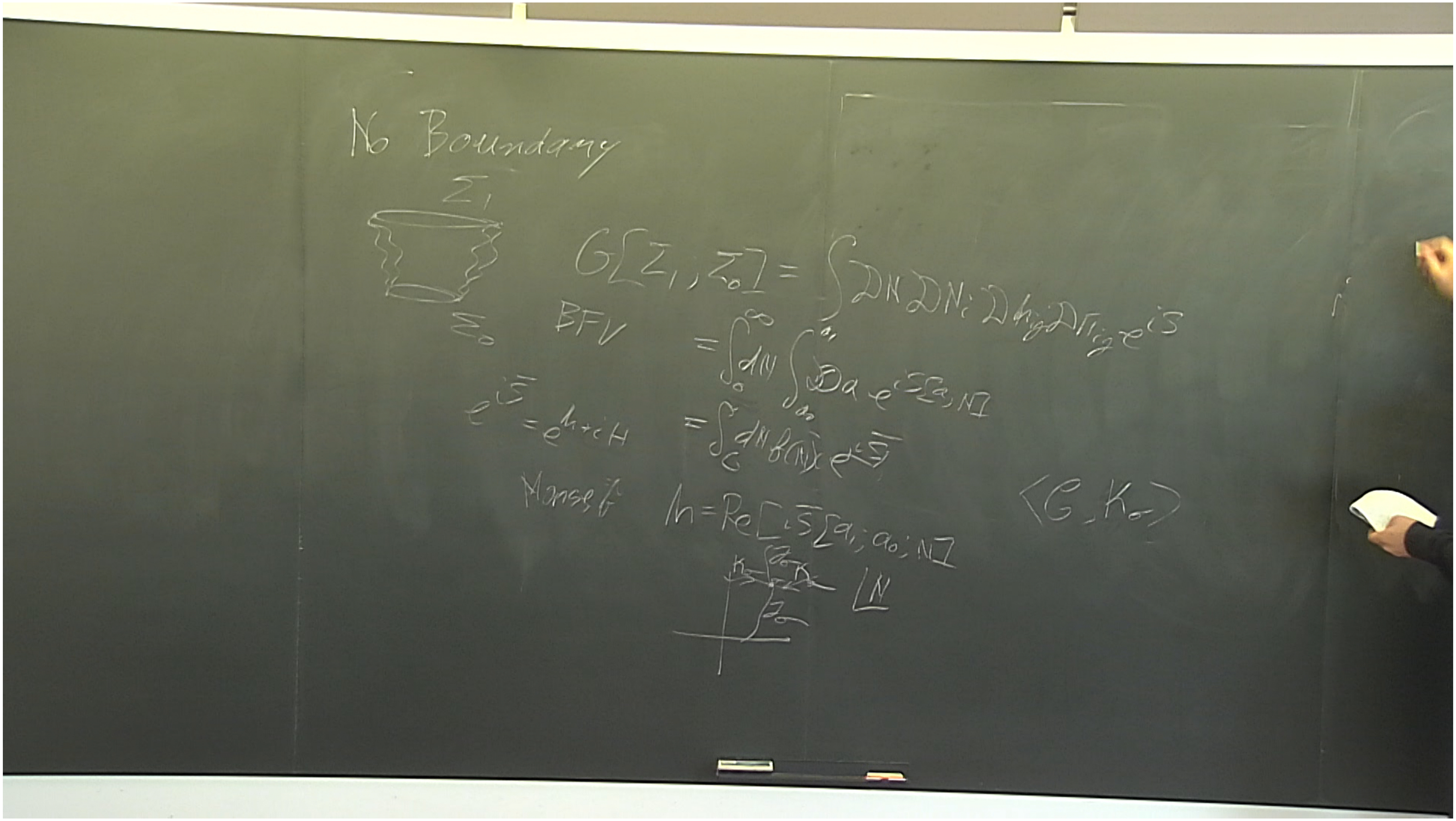
$\frac{n_{DM}}{n_\gamma} \propto \left(\frac{M_{DM}}{M_{pl}}\right)^{5/2}$
e^M
S
S_c
$-e^M$
$\approx 2\times10^9$ GeV

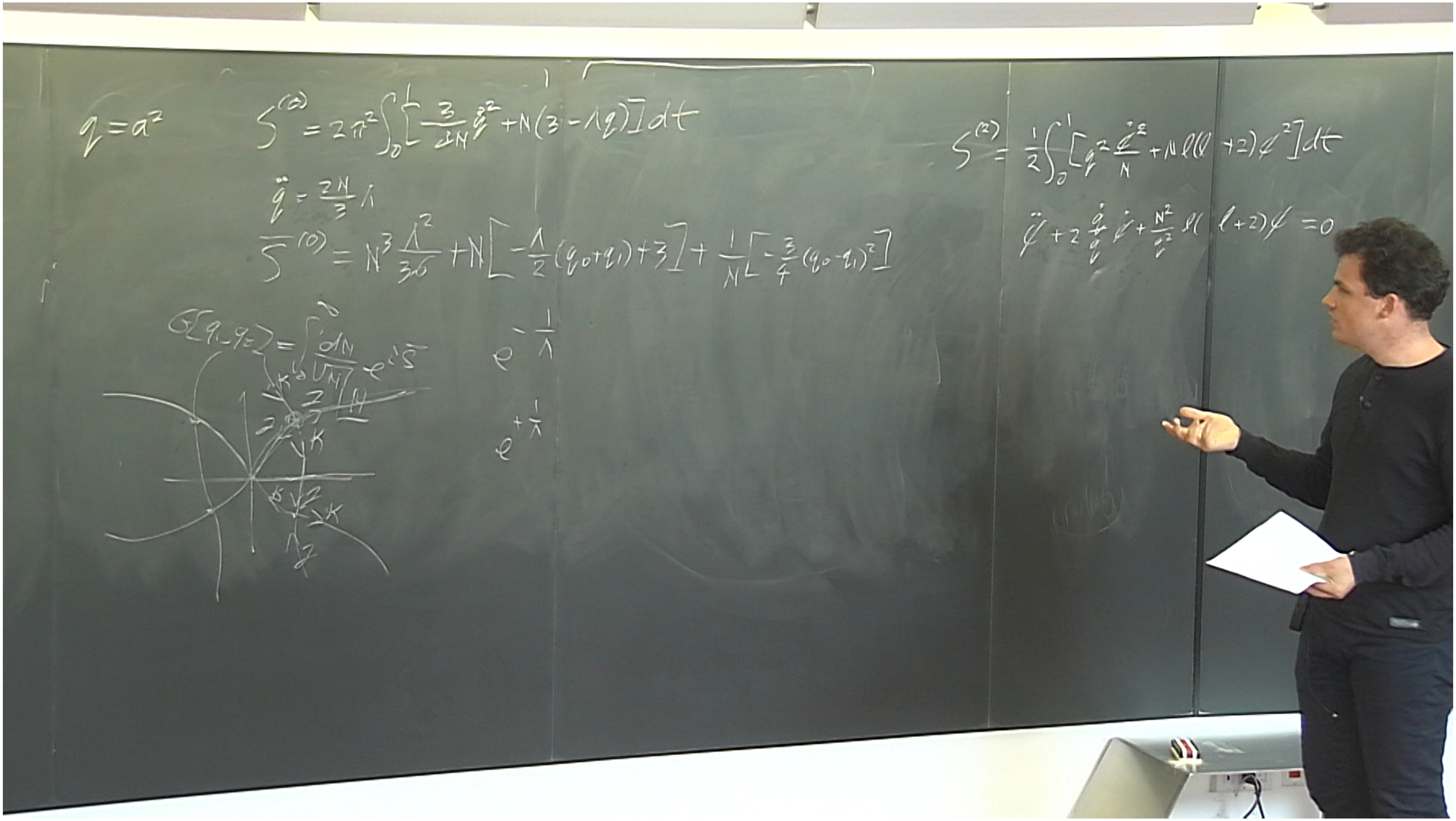
PERIMETER INSTITUTE FOR THEORETICAL PHYSICS


No Boundary
BFV
Morse

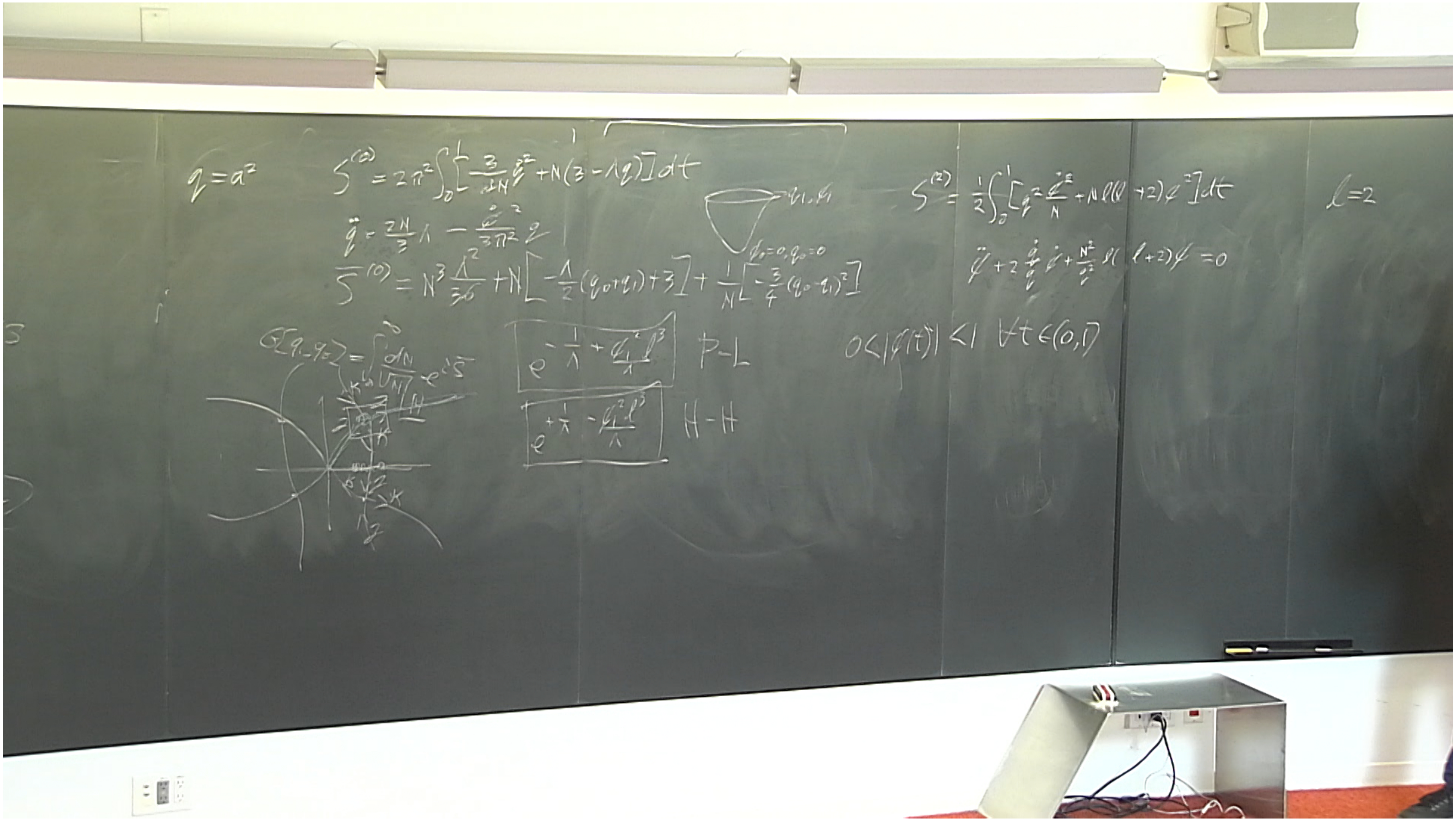

No Boundary
Σ_1
Σ_0
G[Σ_1, Σ_0] = ∫ DN DN_i Dh_ij Dπ_ij e^{iS}
BFV
Morse fn
⟨C, K_σ⟩

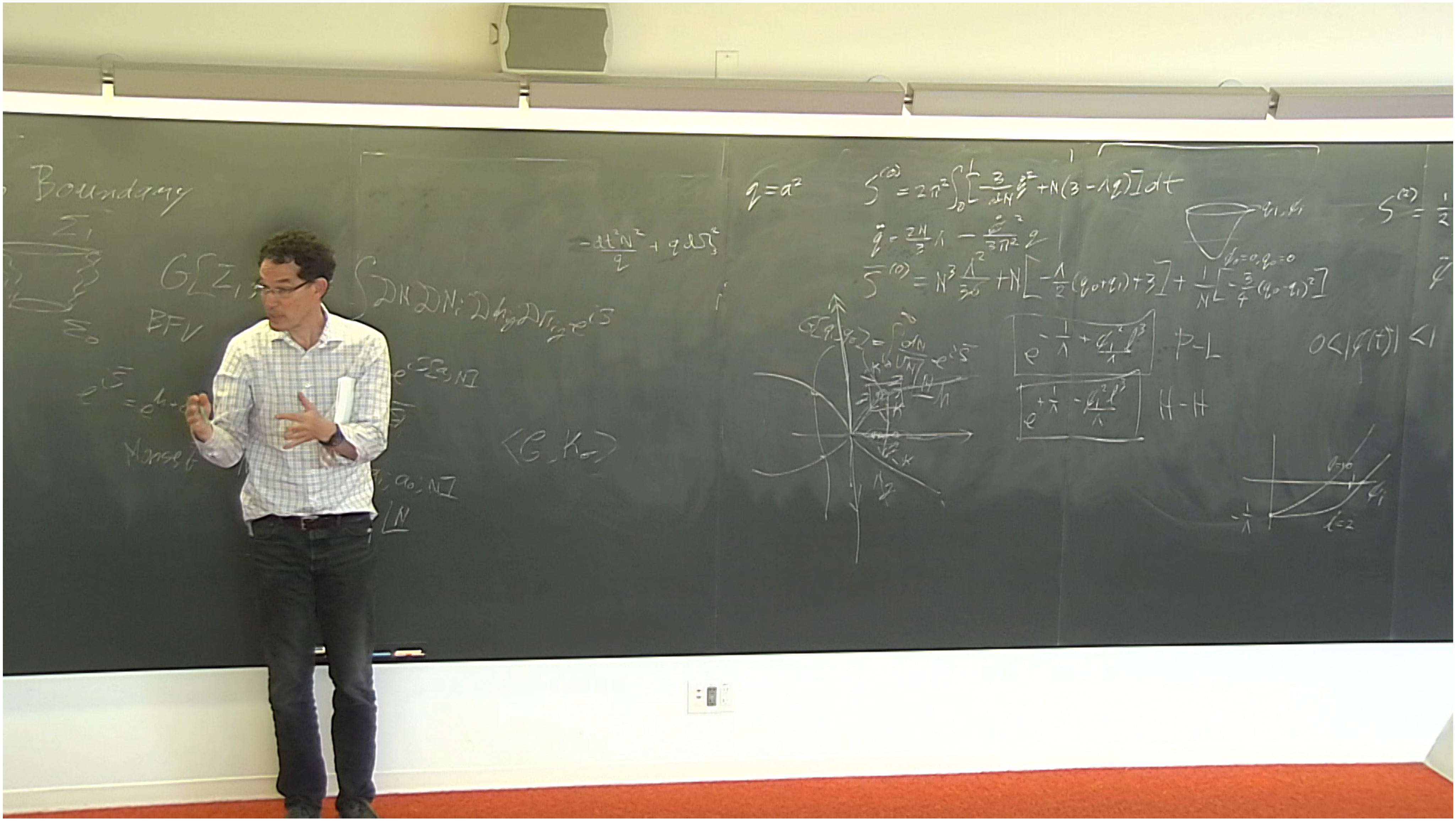

No Boundary
BFV

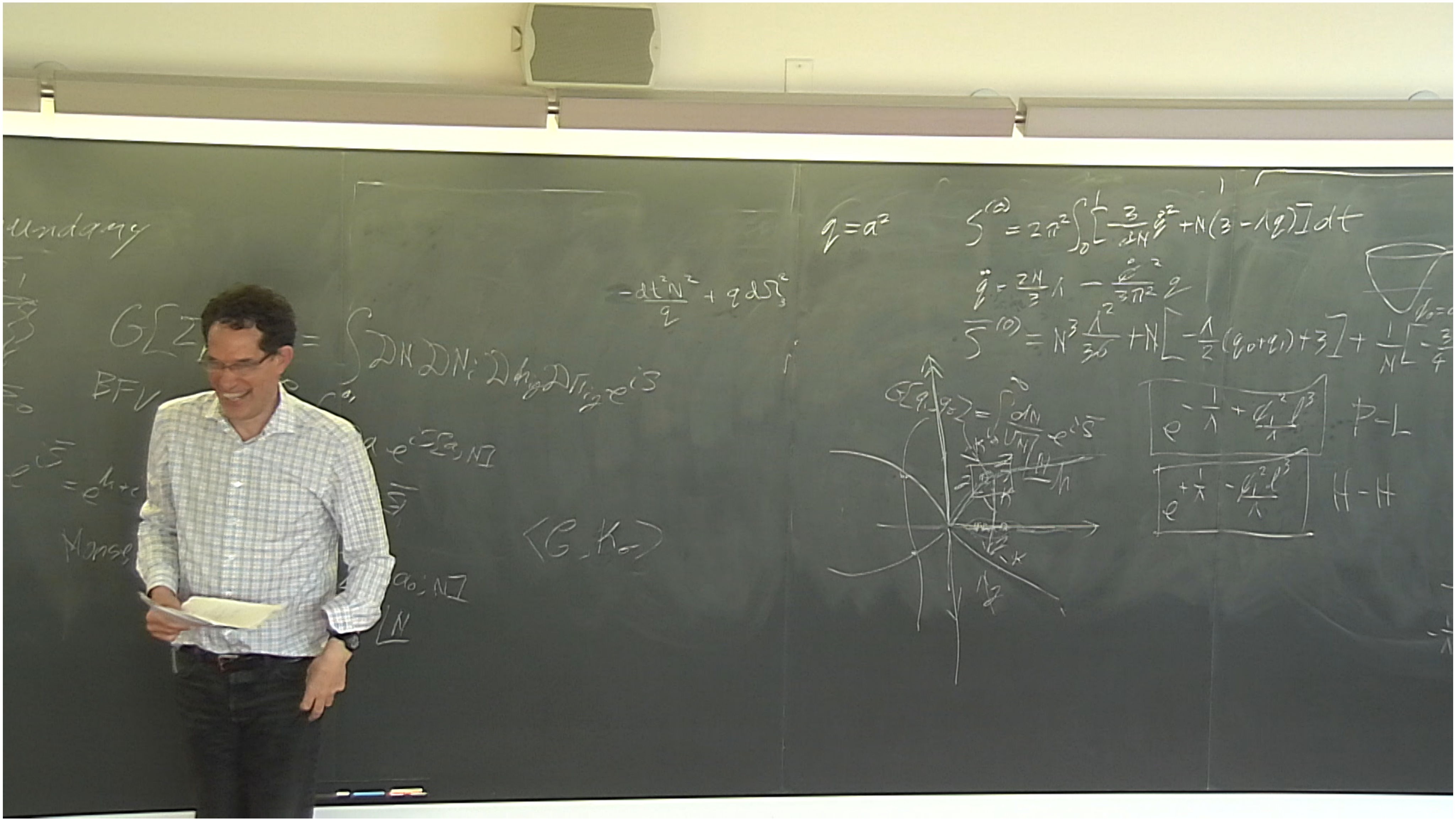

No Boundary
Σ1
Σ0
G[Σ1, Σ0] = ∫ DN DNi Dhij DΠij e^{iS}
BFV
= ∫_0^∞ dN ∫_{a0}^{a1} Da e^{iS[a, N]}
e^{iS} = e^{h+iH}
= ∫_C dN f(N) e^{iS}
Morse f
h = Re[iS[a1; a0; N]]
⟨C, Kσ⟩

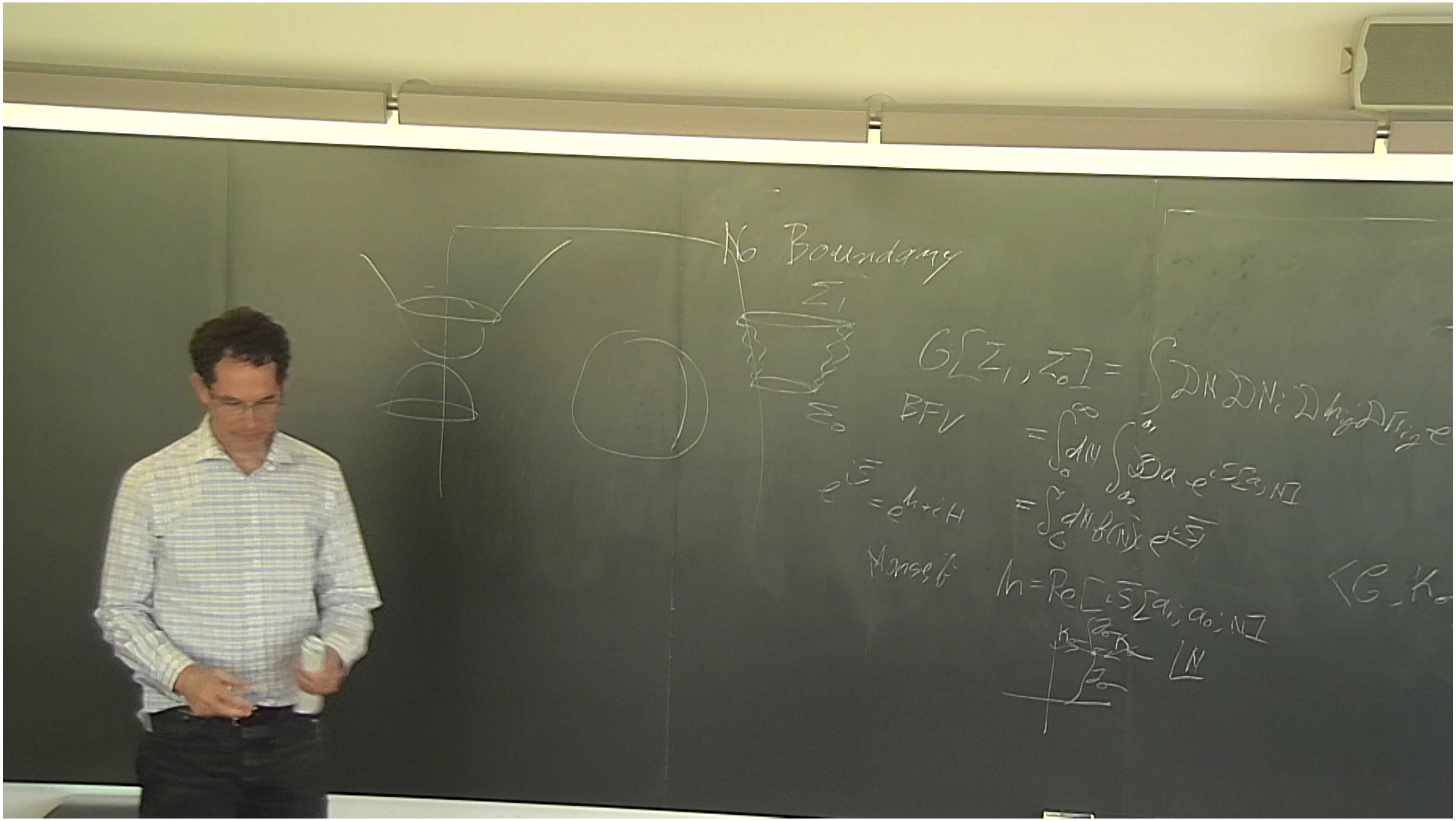


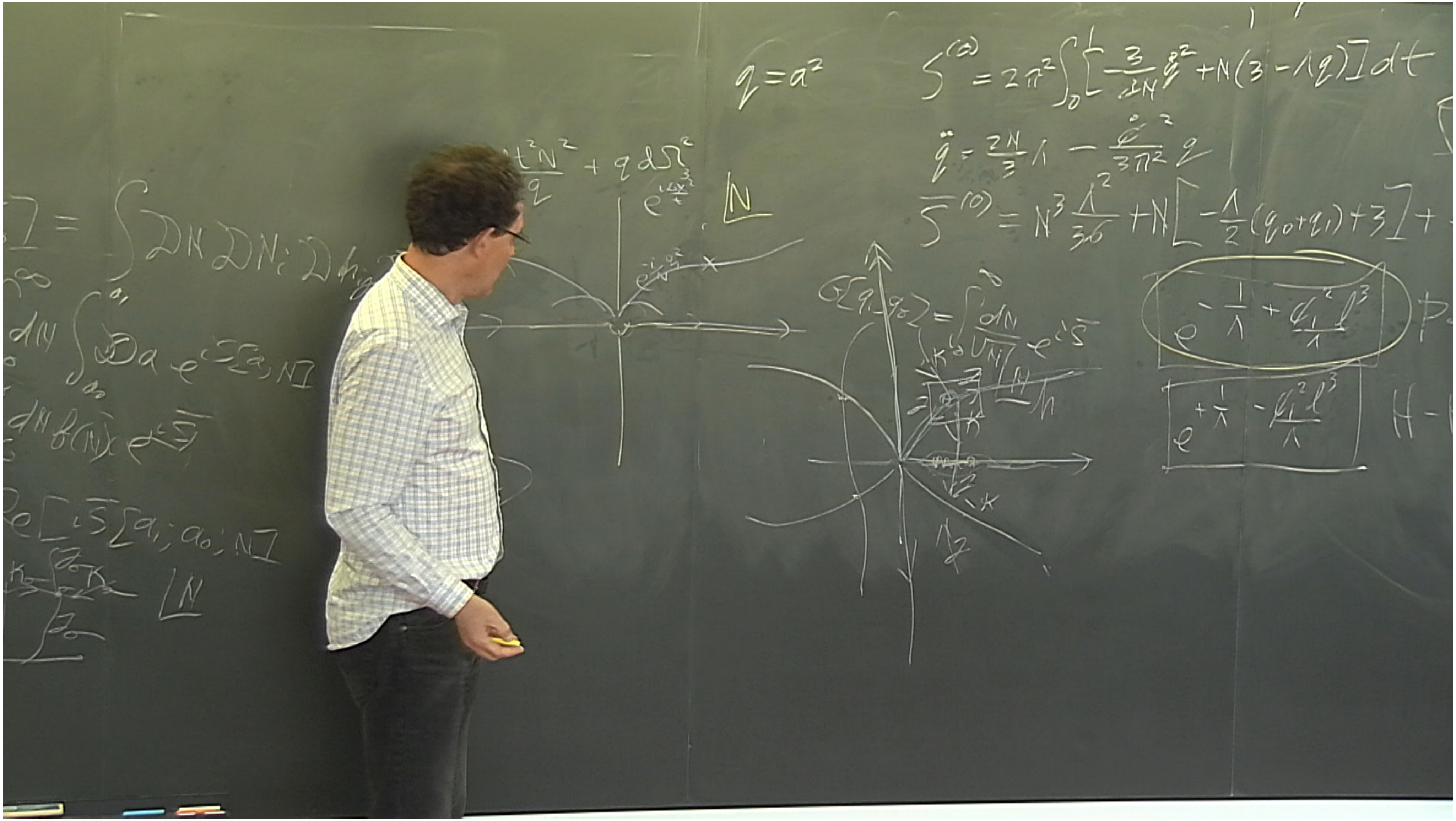
$q = a^2$
$S^{(0)} = 2\pi^2 \int_0^1 \left[-\frac{3}{4N} \dot{q}^2 + N(3 - \Lambda q) \right] dt$
$\ddot{q} = \frac{2N}{3} \Lambda$
$S^{(0)} = N^3 \frac{\Lambda^2}{36} + N\left[-\frac{\Lambda}{2}(q_0 + q_1) + 3 \right] + \frac{1}{N}\left[-\frac{3}{4}(q_0 - q_1)^2 \right]$
$G[q_0, q_1] = \int_0^\infty \frac{dN}{\sqrt{N}} e^{iS}$
$e^{-\frac{1}{\Lambda}}$
$e^{+\frac{1}{\Lambda}}$
$S^{(2)} = \frac{1}{2} \int_0^1 \left[q^2 \frac{\dot{\phi}^2}{N} + N \ell(\ell+2) \phi^2 \right] dt$
$\ddot{\phi} + 2\frac{\dot{q}}{q}\dot{\phi} + \frac{N^2}{q^2}\ell(\ell+2)\phi = 0$

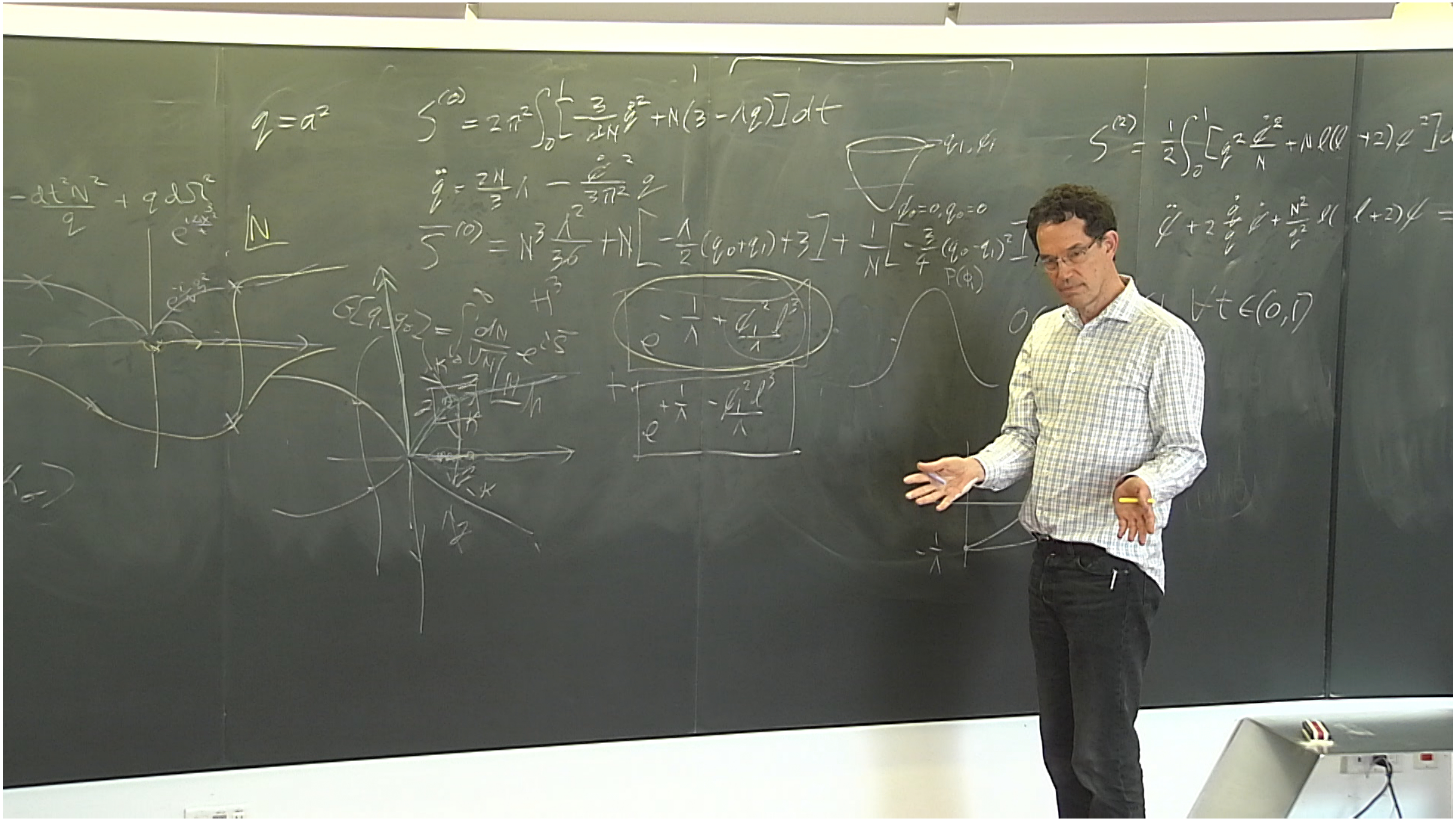

q = a^2
S^(0) = 2π^2 ∫_0^1 [-3/(4N) q̇^2 + N(3 - Λq)] dt
q̈ = 2N/3 Λ
S̄^(0) = N^3 Λ^2/36 + N[-Λ/2 (q_0 + q_1) + 3] + 1/N [-3/4 (q_0 - q_1)^2]
q_0 = 0, q_0 = 0
G[q_0, q_1] = ∫ dN/√N e^(iS)
P-L
H-H
S^(2) = 1/2 ∫_0^1 [q φ̇^2/N + N l(l+2) φ^2] dt
l = 2
φ̈ + 2 q̇/q φ̇ + N^2/q^2 l(l+2) φ = 0
0 < |φ(t)| < 1 ∀ t ∈ (0,1)



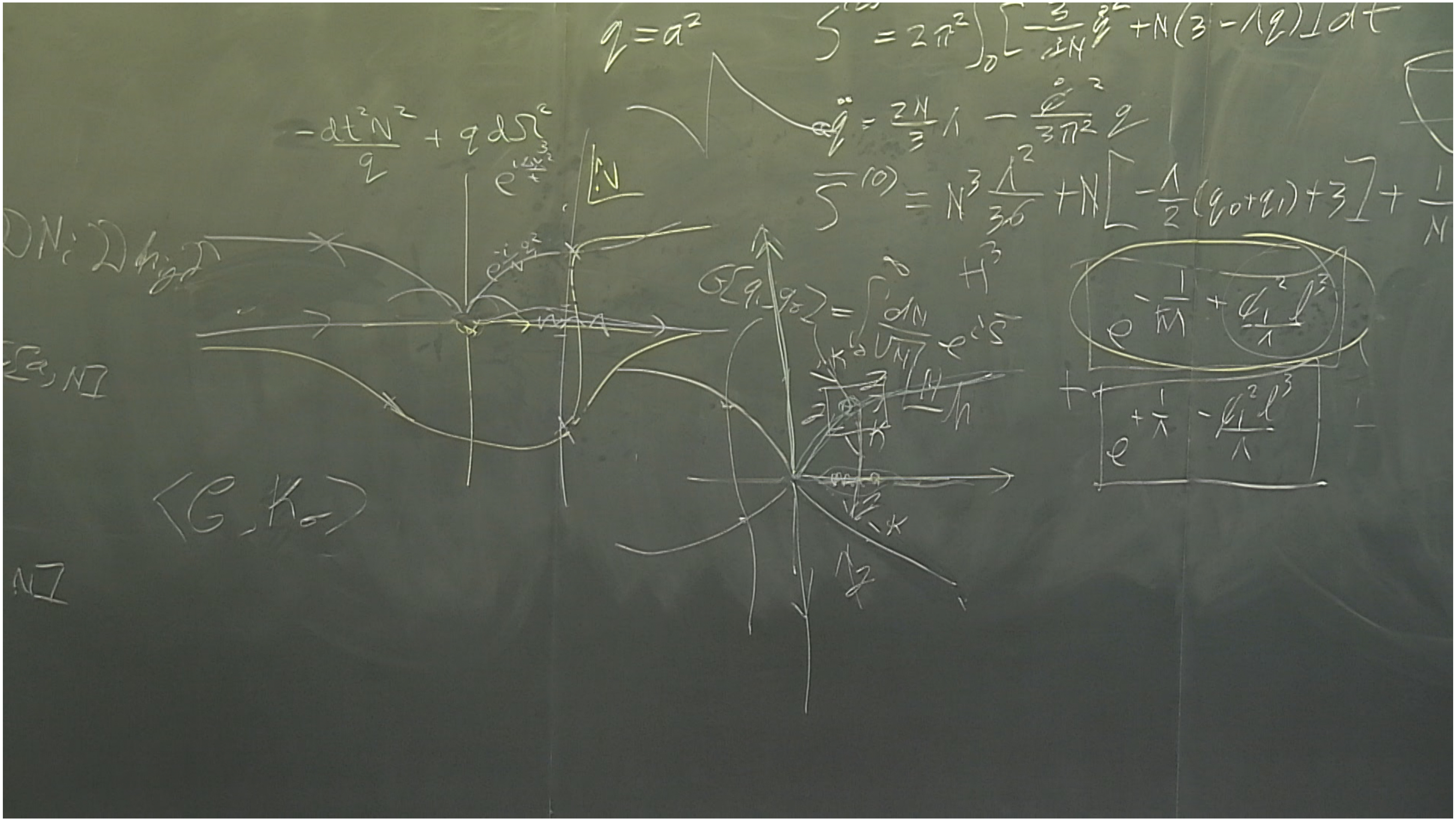








q = a²
P(φ)
∀ t ∈ (0,1)


q = a²
H³