Title: World Line Effective Theories and 2-D Partition Functions on the Plane with Compact Boundaries

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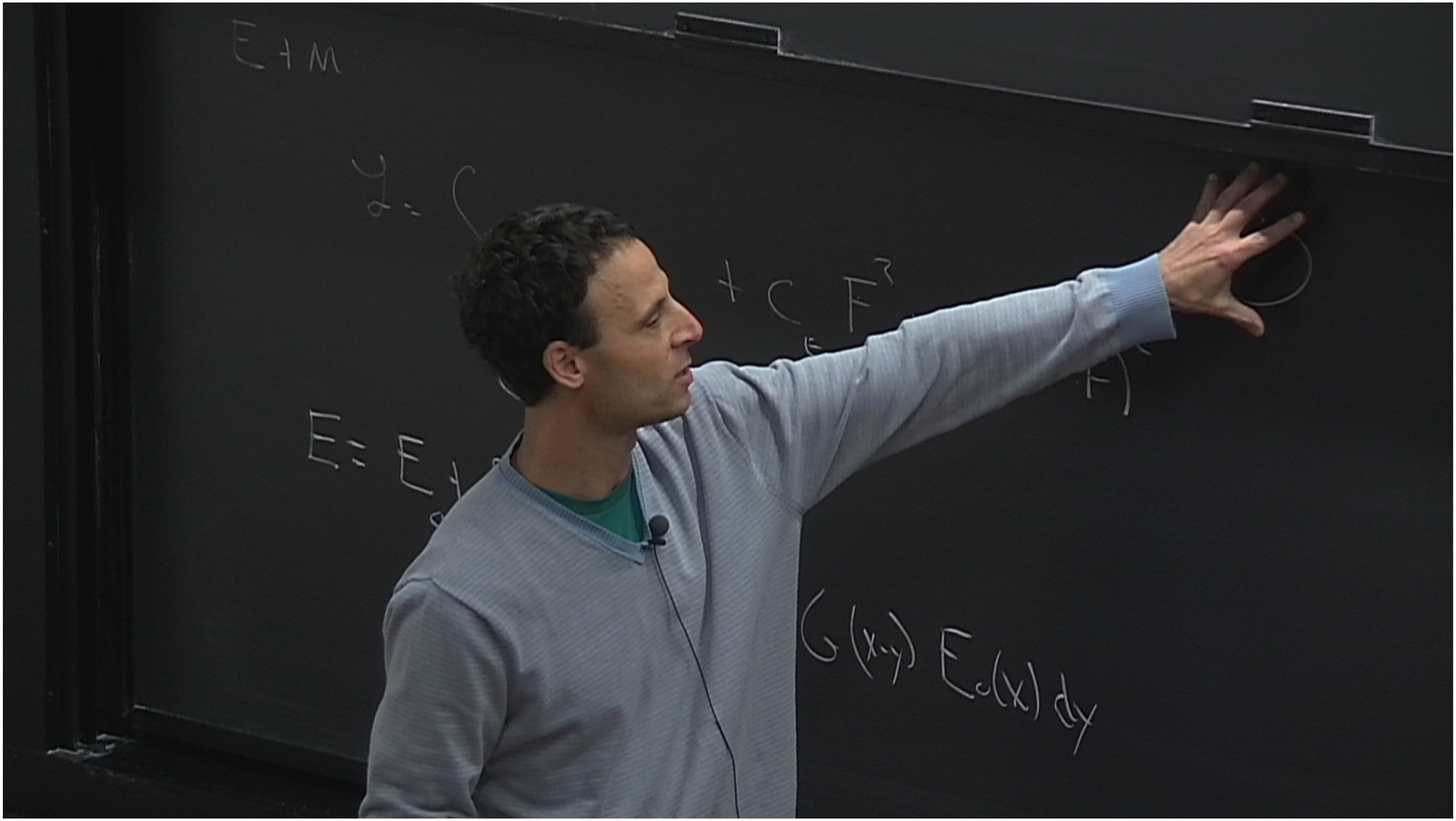
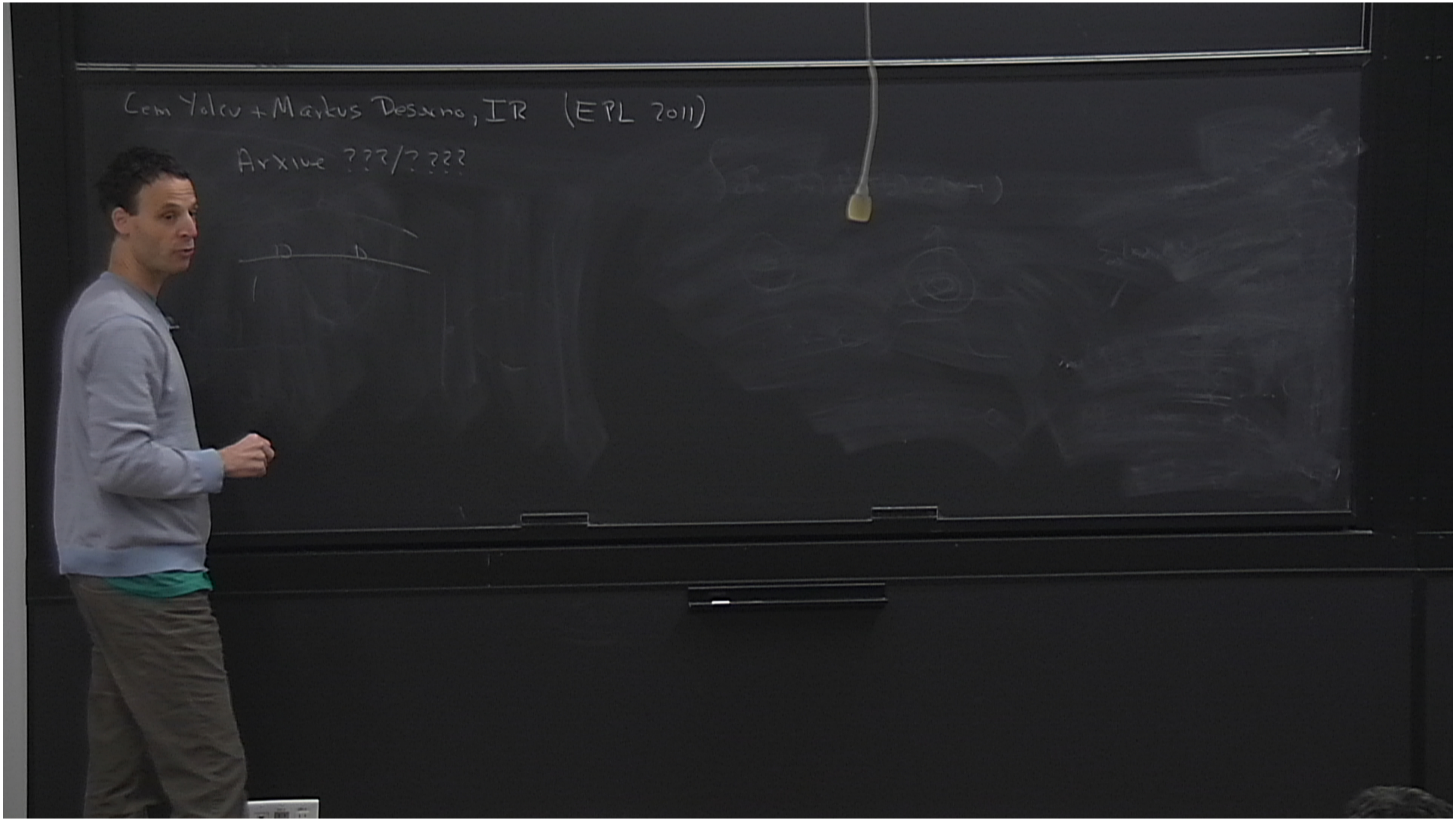
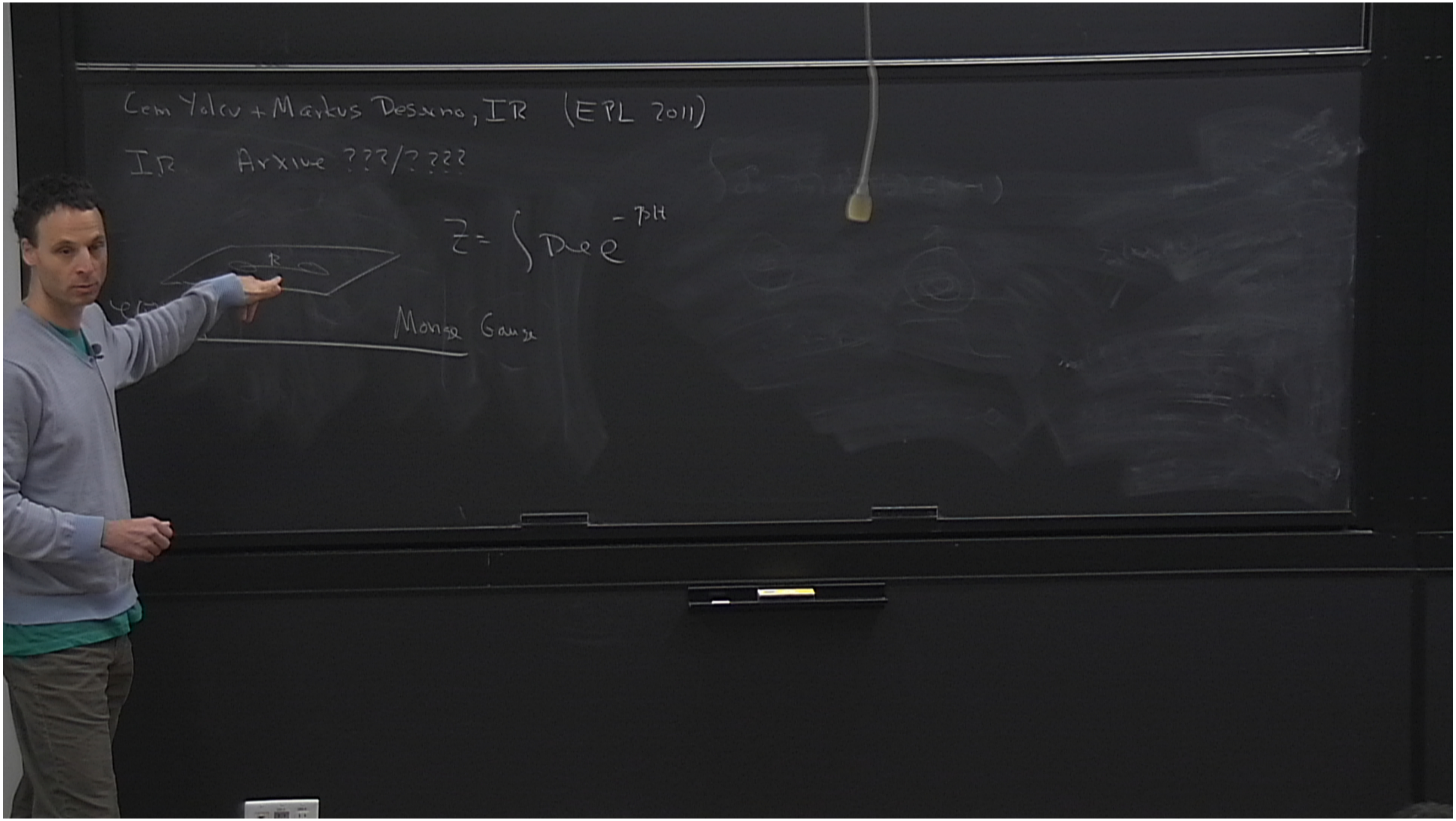
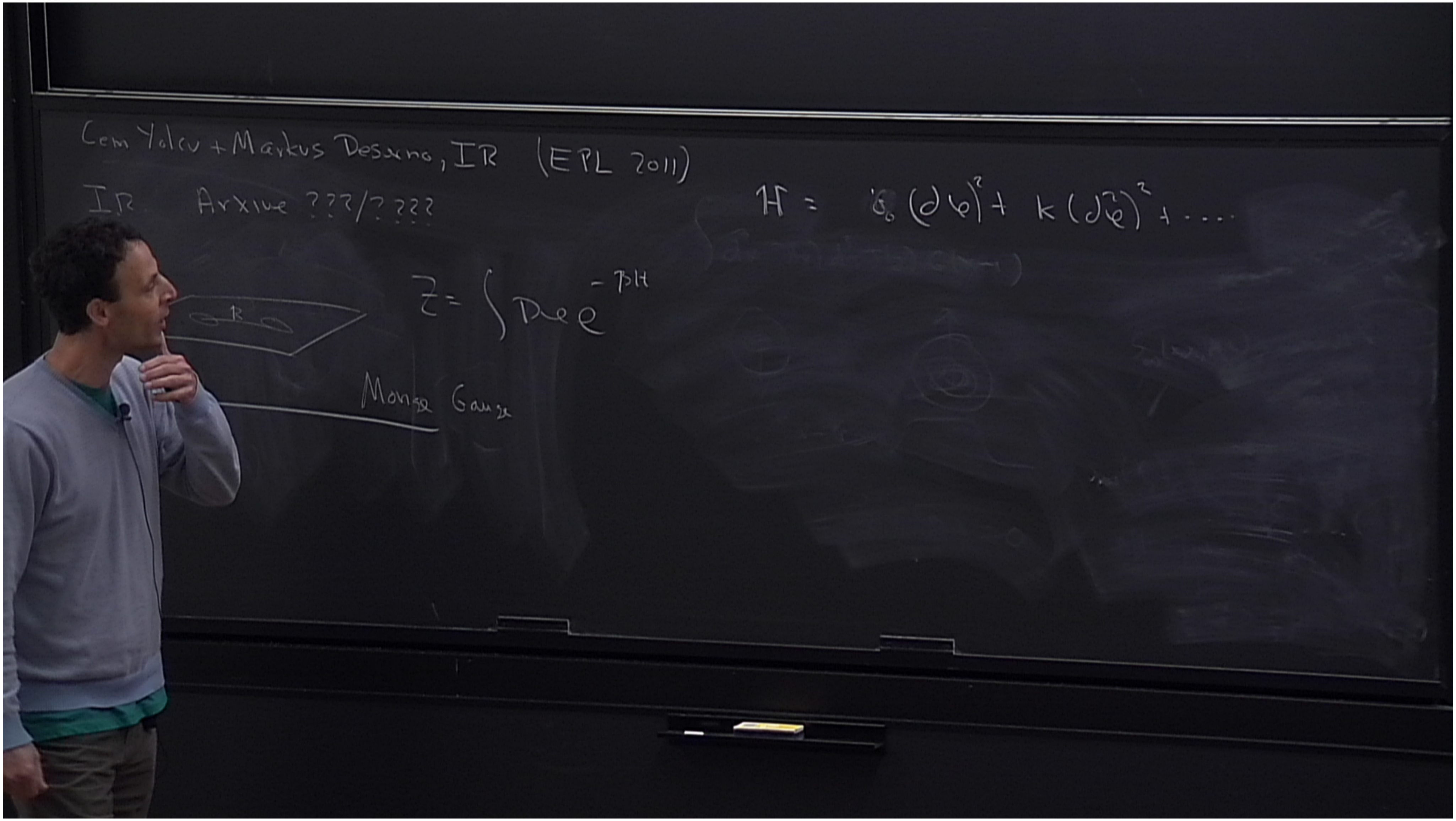
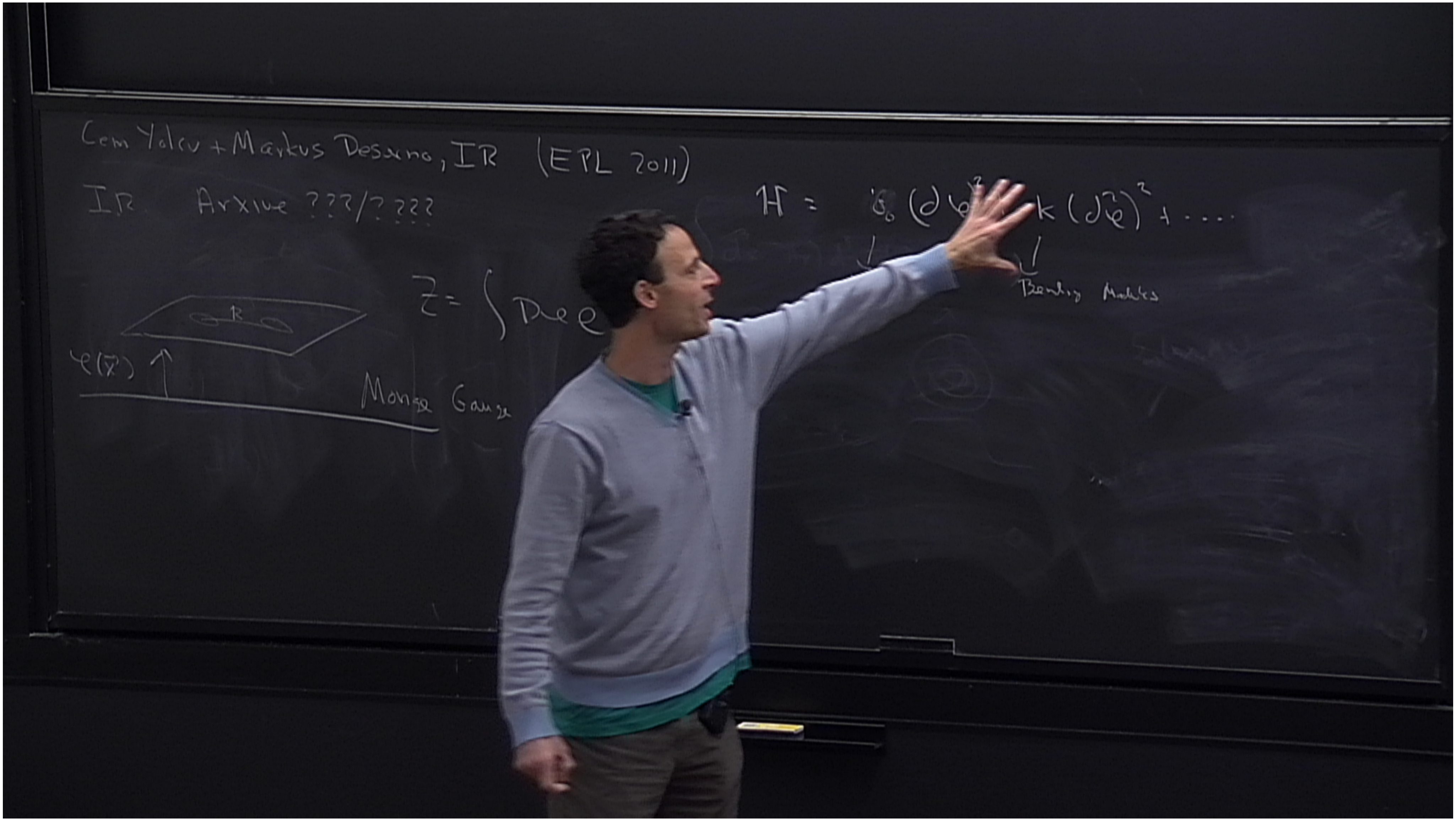
Abstract: In this talk I will describe how to calculate the exact partition function for free bosons on the plane with lacunae using world line effective field theory. It will be shown that the partition function for a plane with two spherical holes can be calculated by matching exactly for the infinite set of Wilson coefficients and then performing the ensuing Gaussian integration. This same partition function can also be calculated using conformal field theory technique and the equality of the two results will be shown. I will demonstrate that there is an exact correspondence between the Wilson coefficients (susceptabilities) in the effective field theory and the weights of the individual excitations of the closed string coherent state on the boundary. The partition function for the case of three holes, where CFT techniques necessitate a closed form for the map from the corresponding closed string pants diagram, is still calculable within the EFT. I will also show how conformal mappings can be used within the matching procedure to calculate the partition function for elliptically shaped boundaries. Finally I will show that the Wilson coefficients for the case of quartic and higher order kernels, where standard CFT techniques are no longer applicable, can also be completely determined.

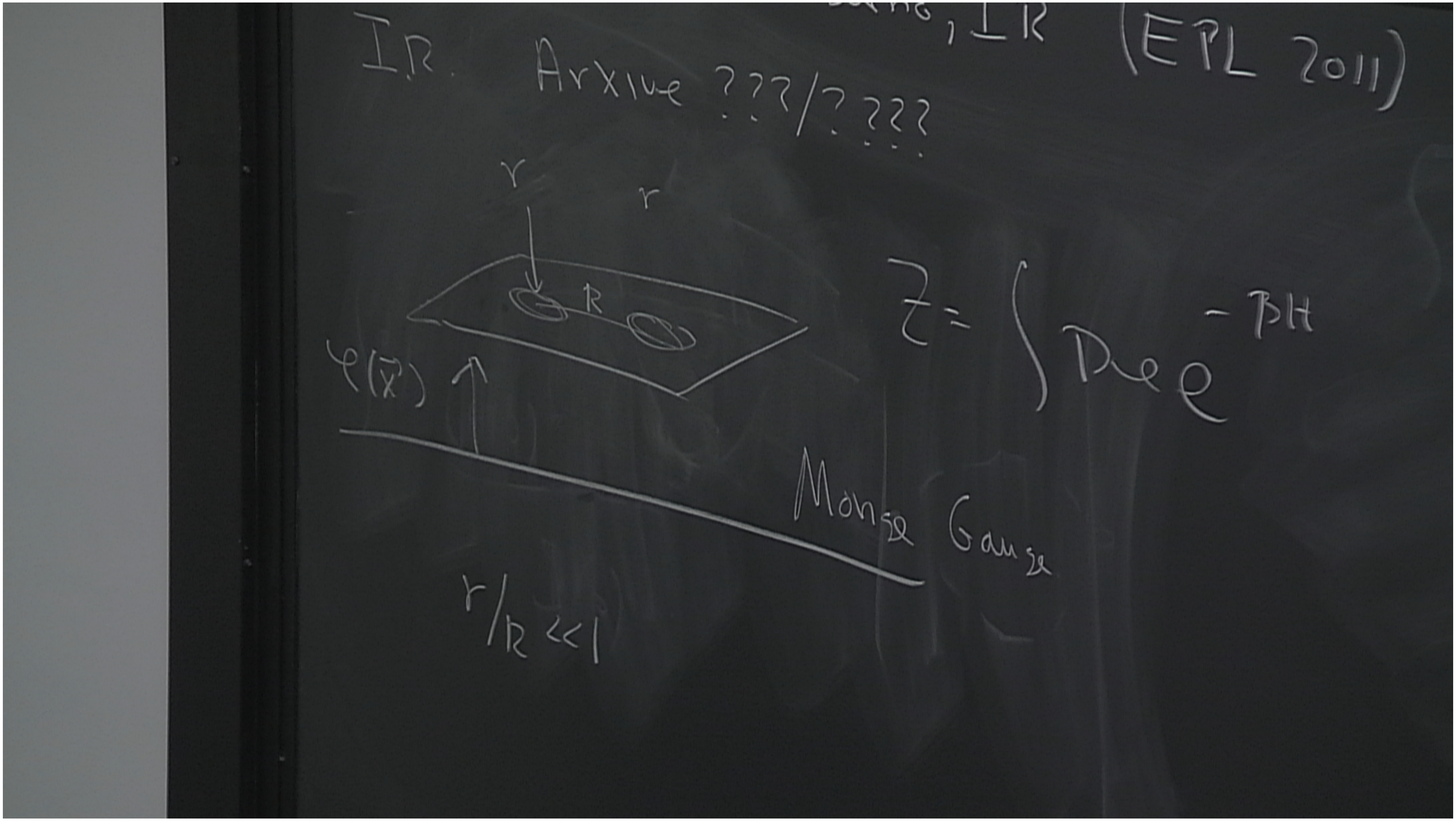

E + M
G (x-y) E0(x) dy


Cem Yolcu + Markus Deserno, IR (EPL 2011)
Arxive ???/????

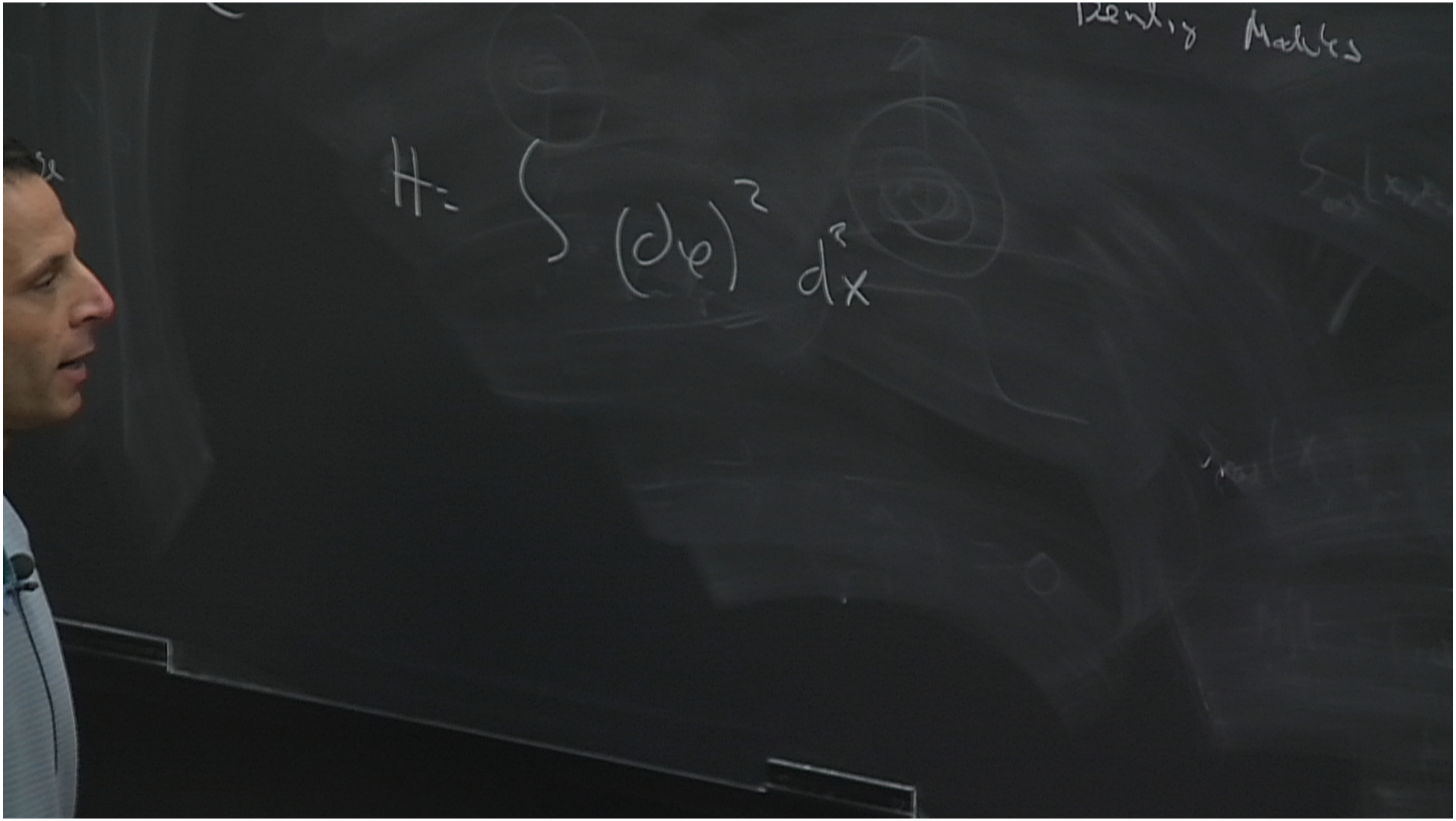

Cem Yolcu + Markus Deserno, IR (EPL 2011)
IR Arxive ???/????
R
Z = ∫ Dh e^{-βH}
Monge Gauge

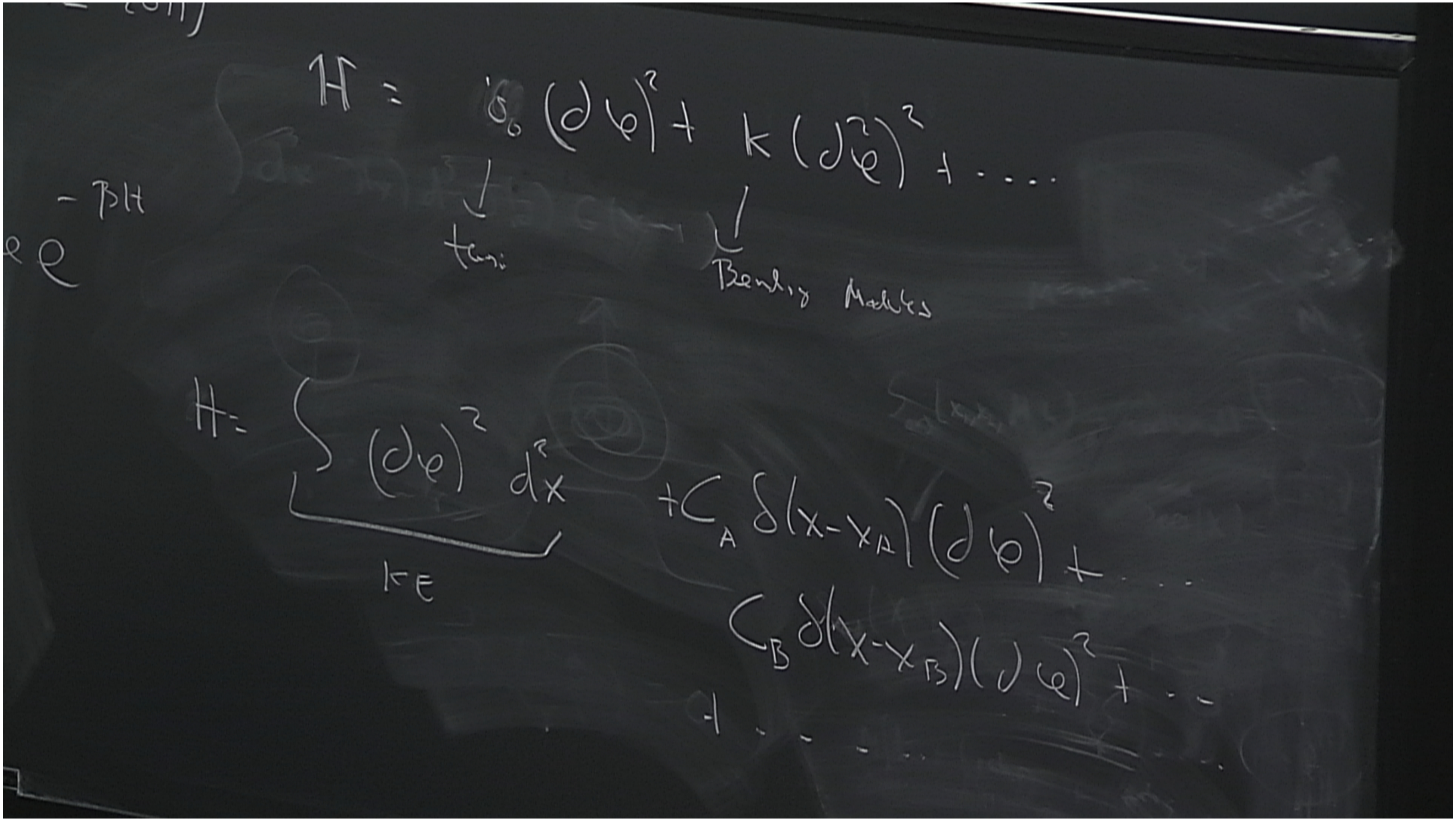

Cem Yolcu + Markus Deserno, IR (EPL 2011)
IR Arxive ???/????
Z = ∫Dφ e^-βH
Monge Gauge

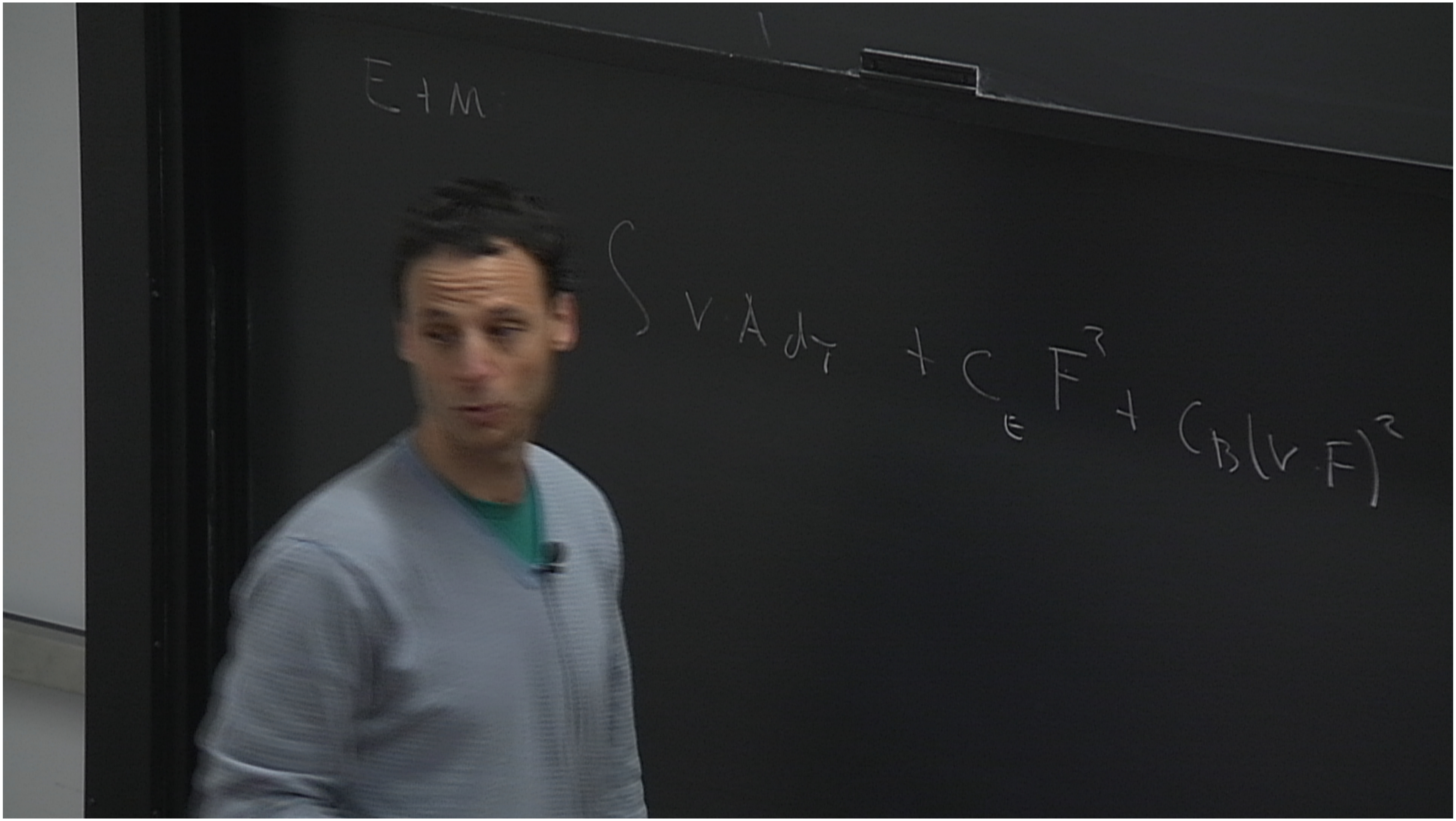

Cem Yolcu + Markus Deserno, IR (EPL 2011)
IR Arxive ???/????
Monge Gauge

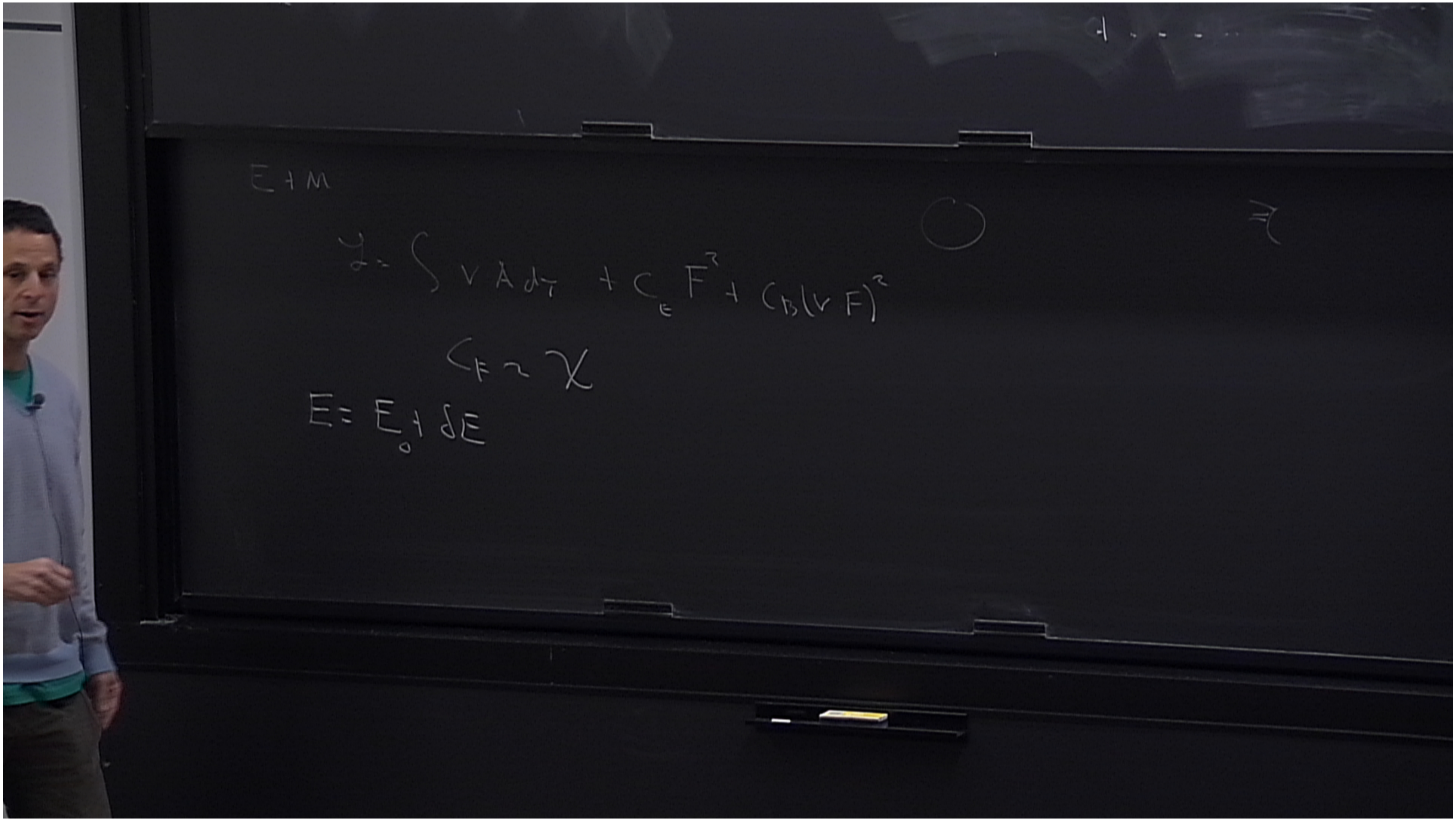


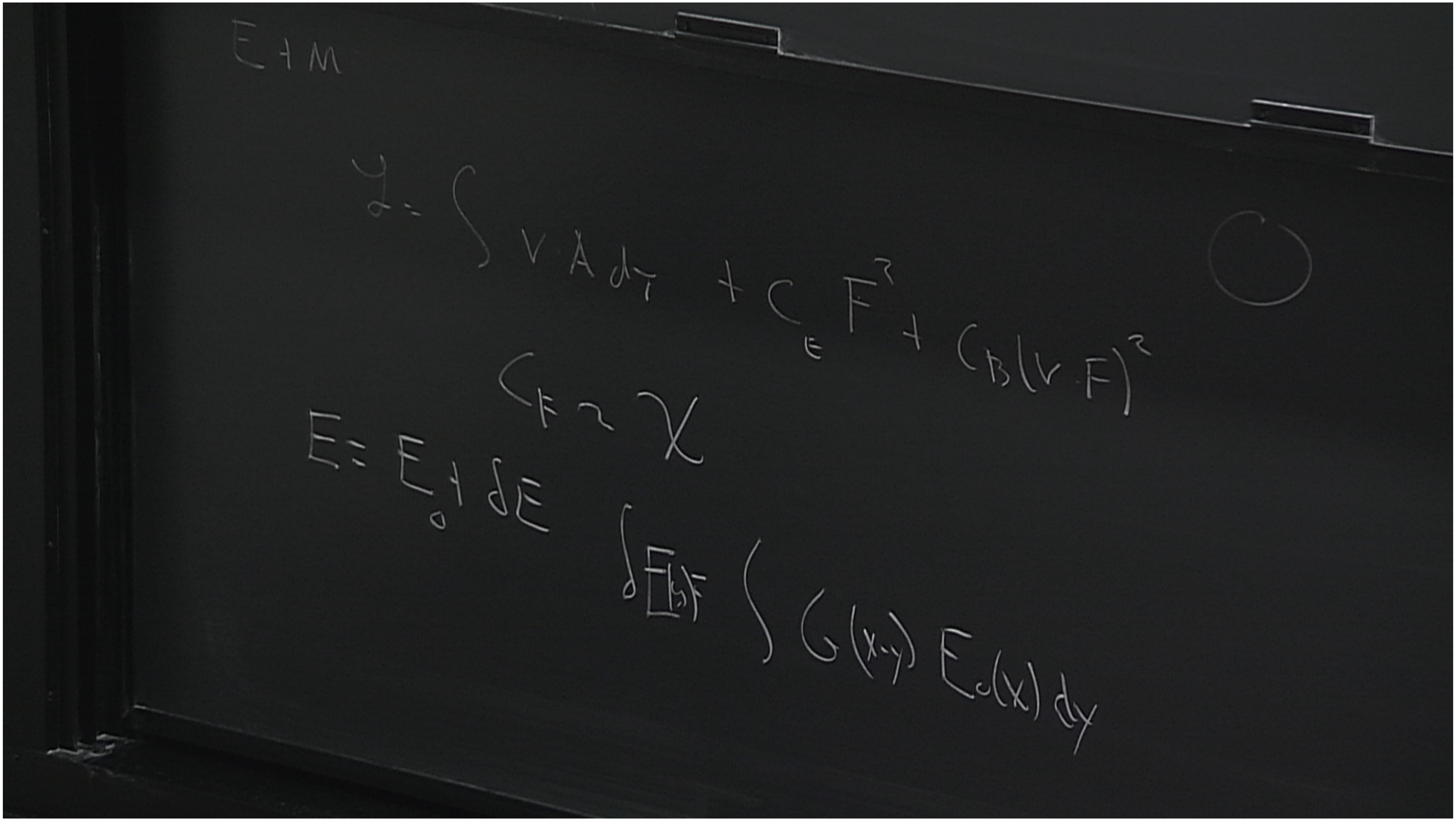
, IR (EPL 2011)
IR. Arxive ???/????
r
r
R
φ(x̄)
Z = ∫ Dφ e^{-βH}
Monge Gauge
r/R << 1

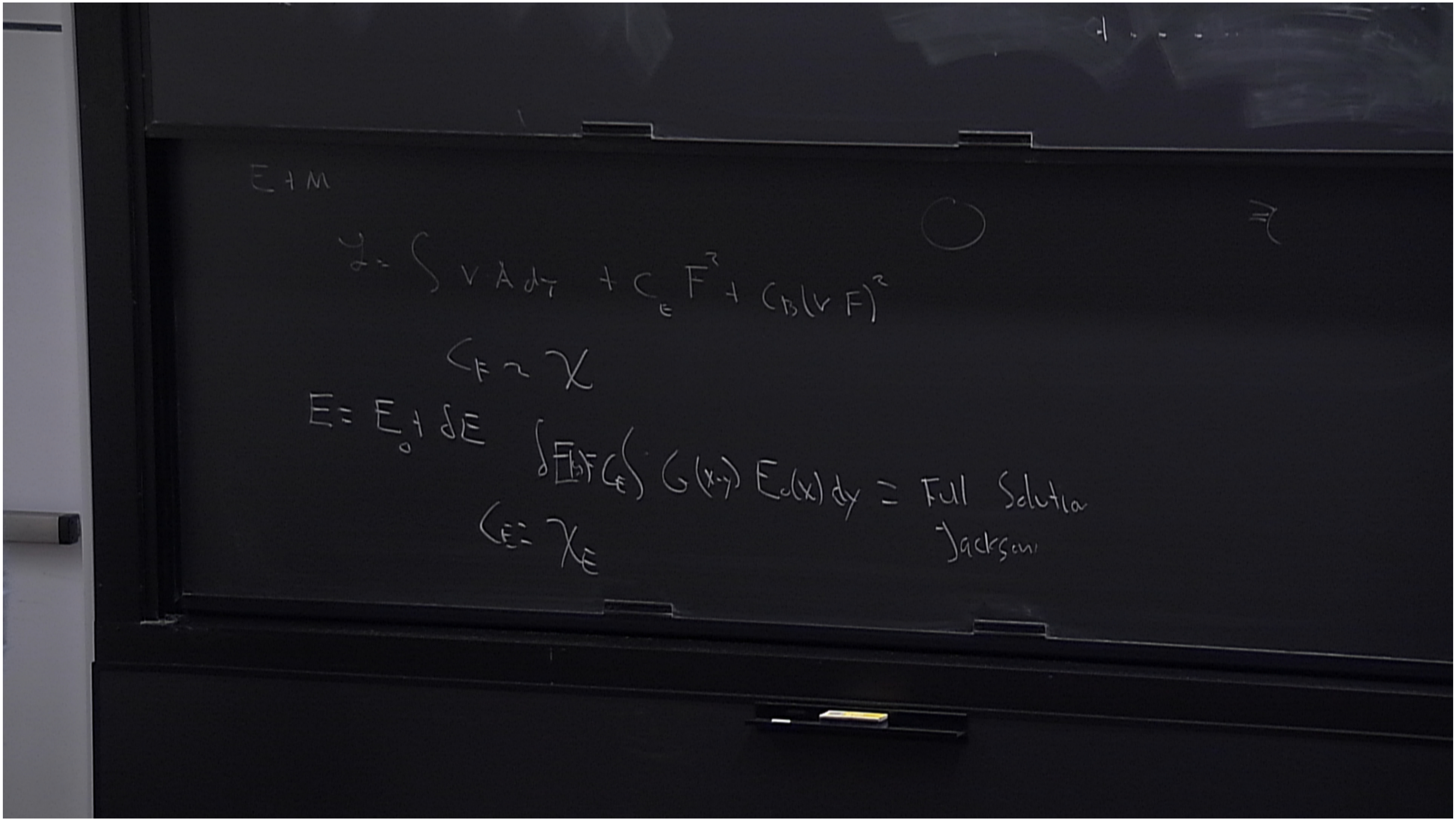

H = ∫ (∂φ)² d³x

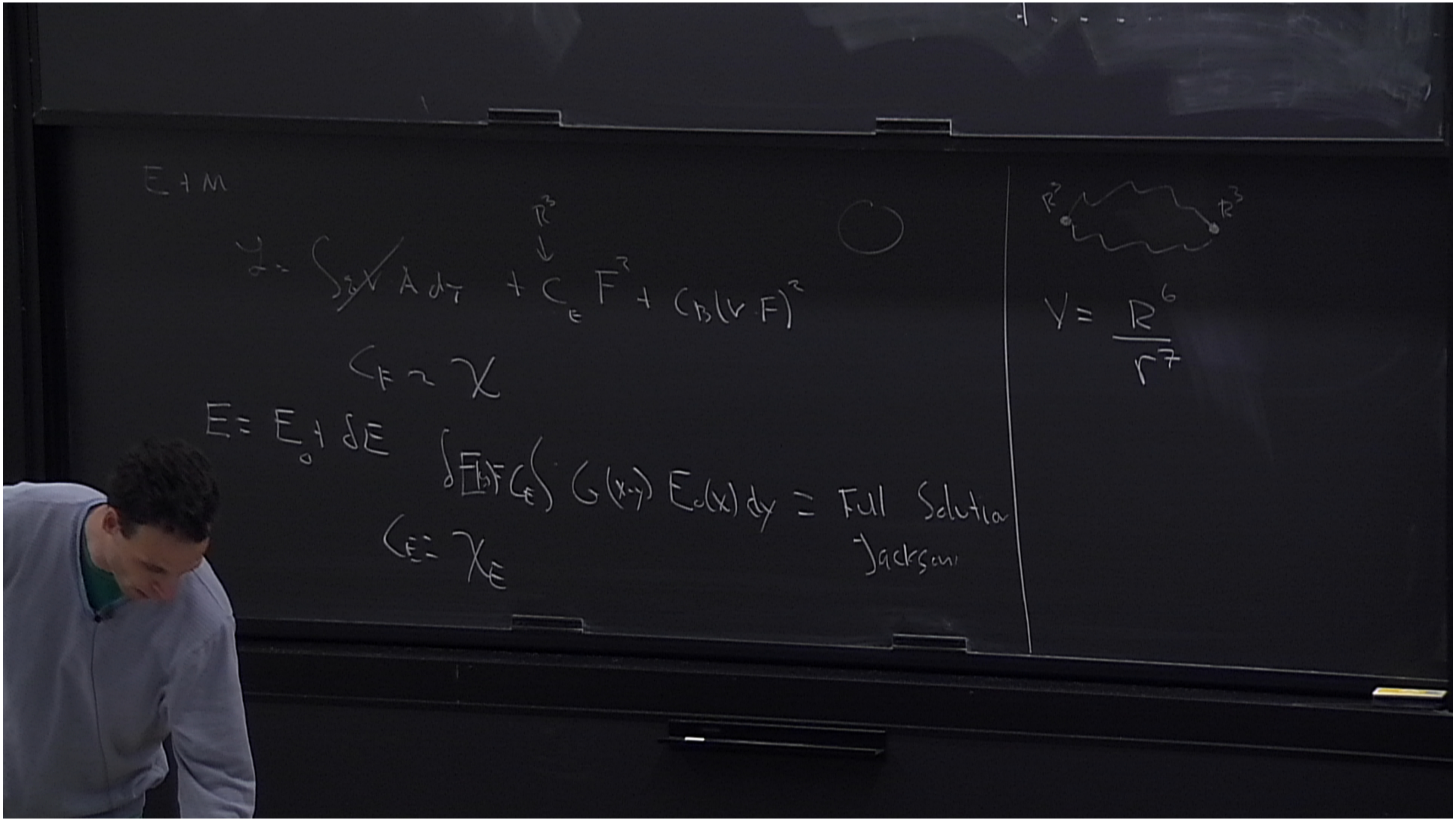

$H = \sigma_0 (\partial \varphi)^2 + k (\partial^2 \varphi)^2 + \dots$
tension
Bending Modulus
$e^{-\beta H}$
$H = \int (\partial \varphi)^2 d^2x$
KE
$+ C_A \delta(x - x_A)(\partial \varphi)^2 + \dots$
$C_B \delta(x - x_B)(\partial \varphi)^2 + \dots$

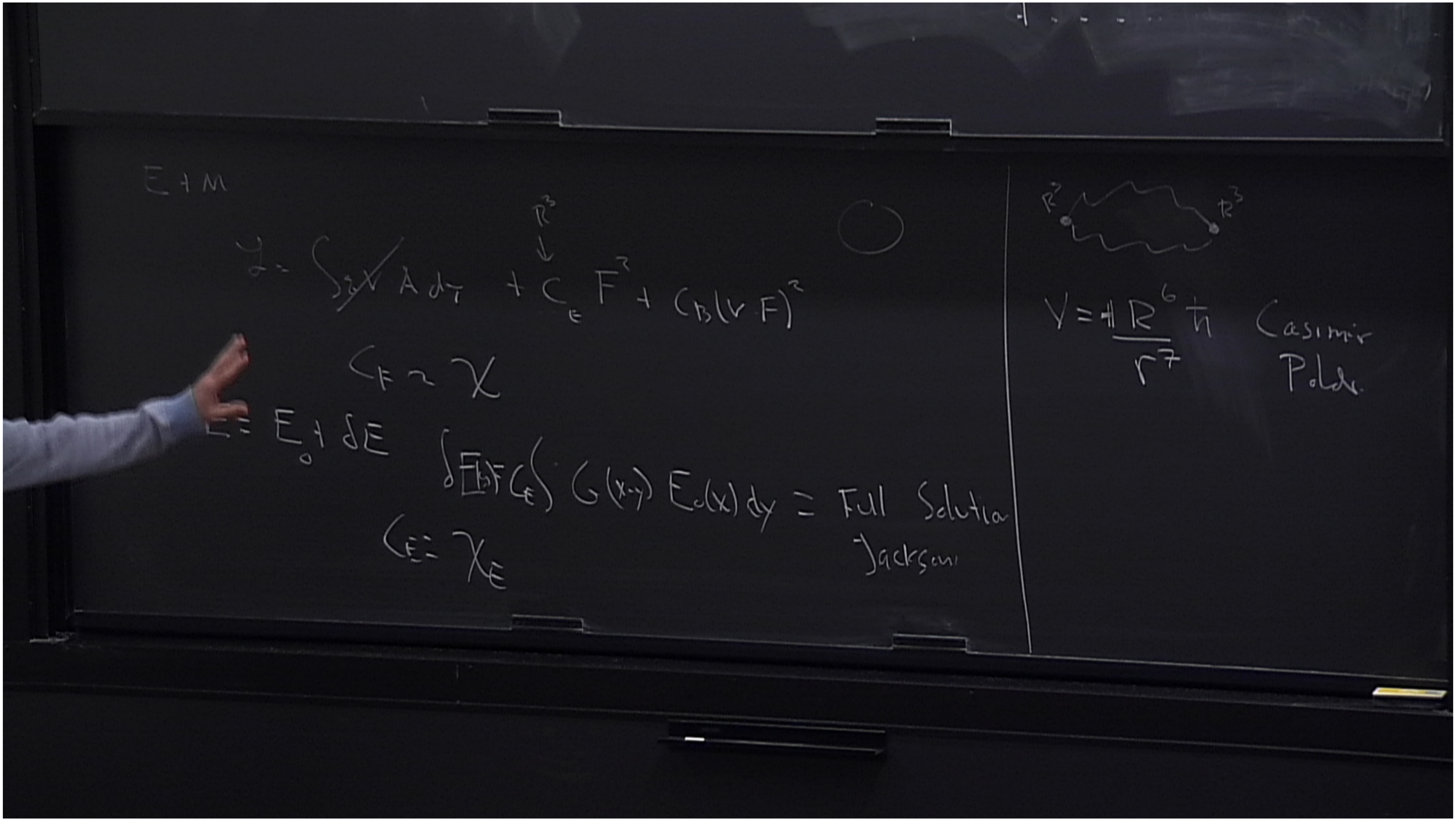

E + M
$\int v \cdot A \, d\tau + C_E F^2 + C_B (v \cdot F)^2$

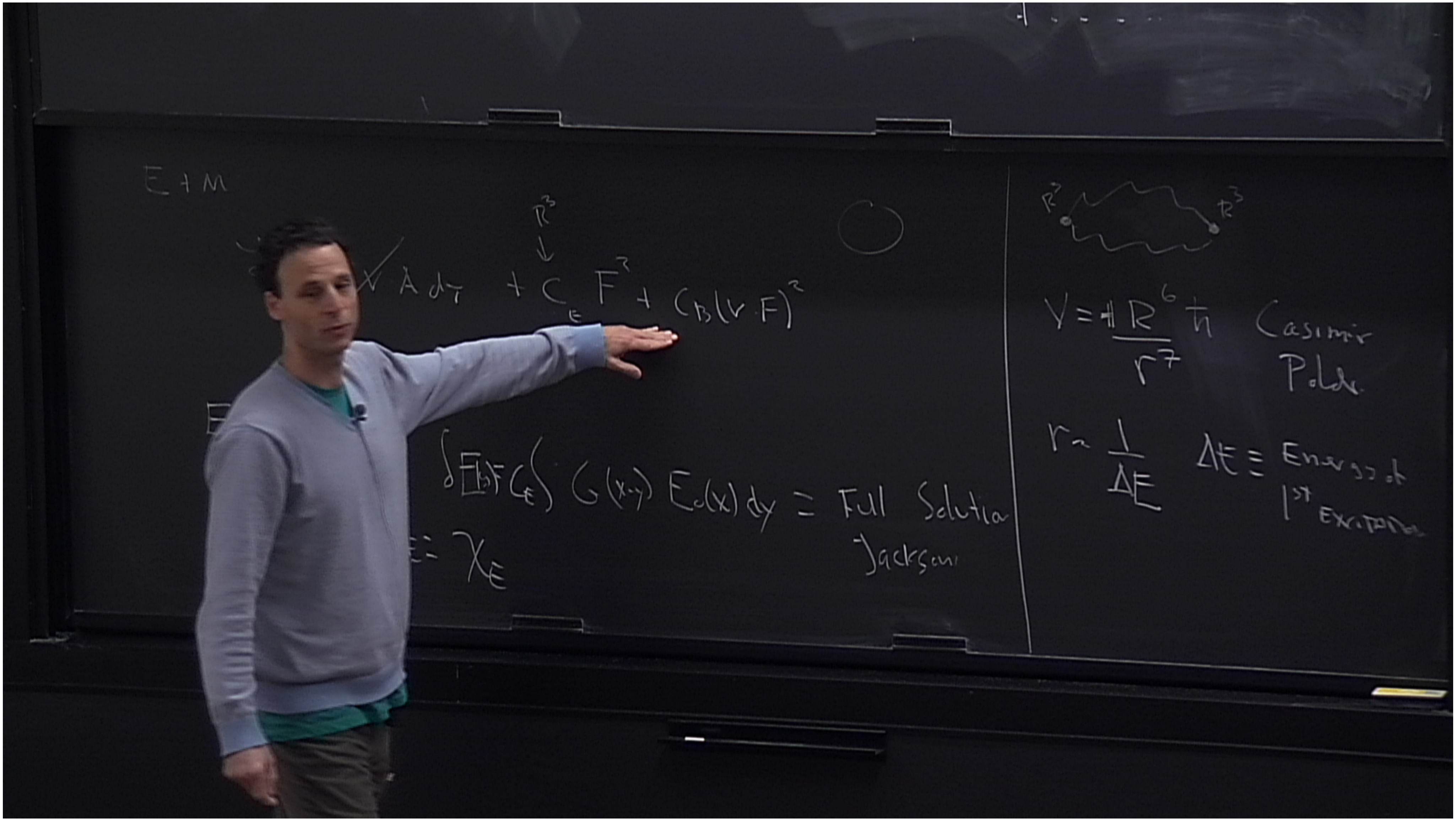

E+M
ℒ = ∫ v Ȧ dτ + C_E F² + C_B (∇F)²
C_E ~ χ
E = E_0 + δE

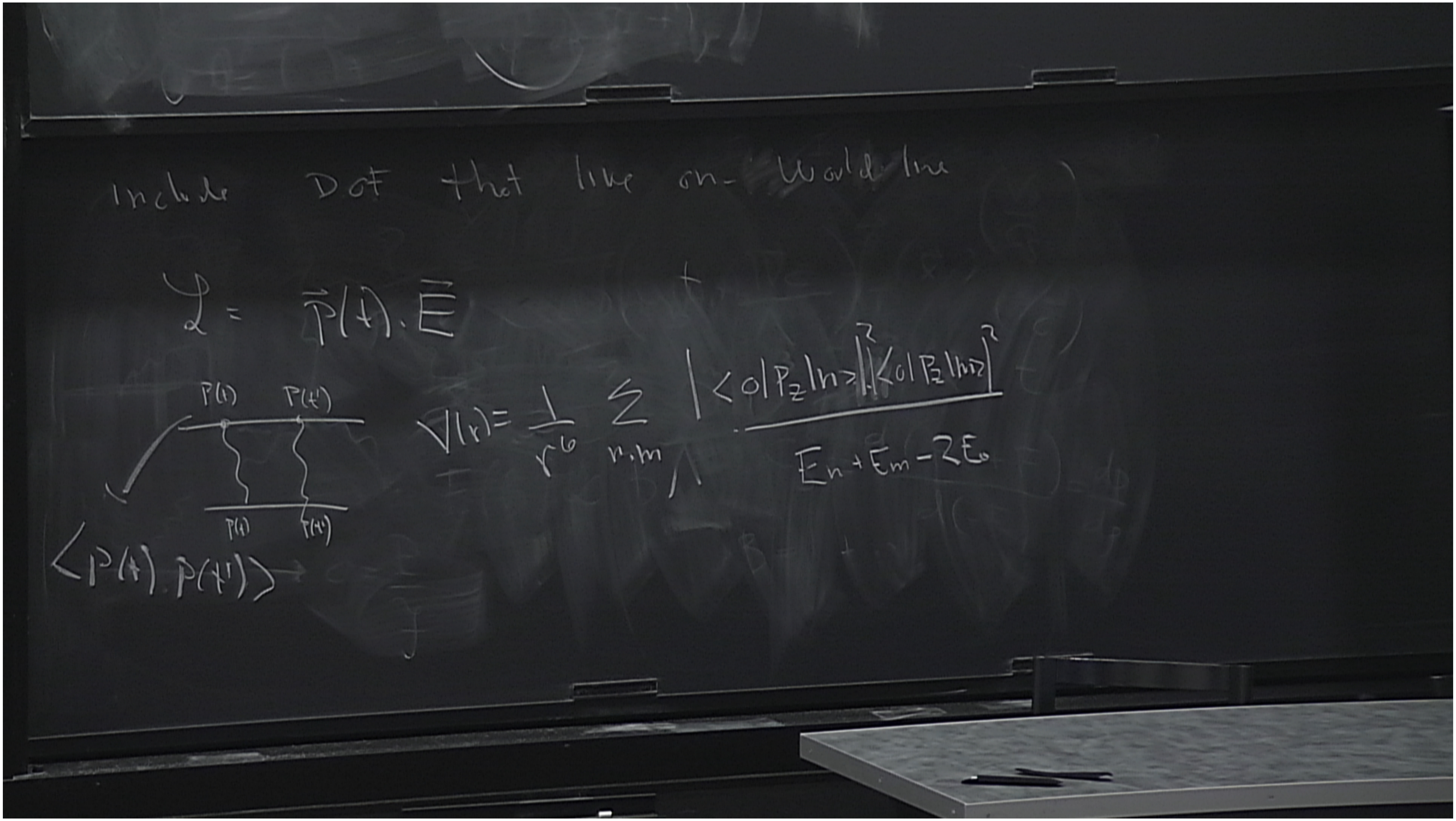

E + M
L = ∫ v·A dτ + C_E F² + C_B (v·F)²
C_F ~ χ
E = E_0 + δE
δE(y) F ∫ G(x-y) E_0(x) dy

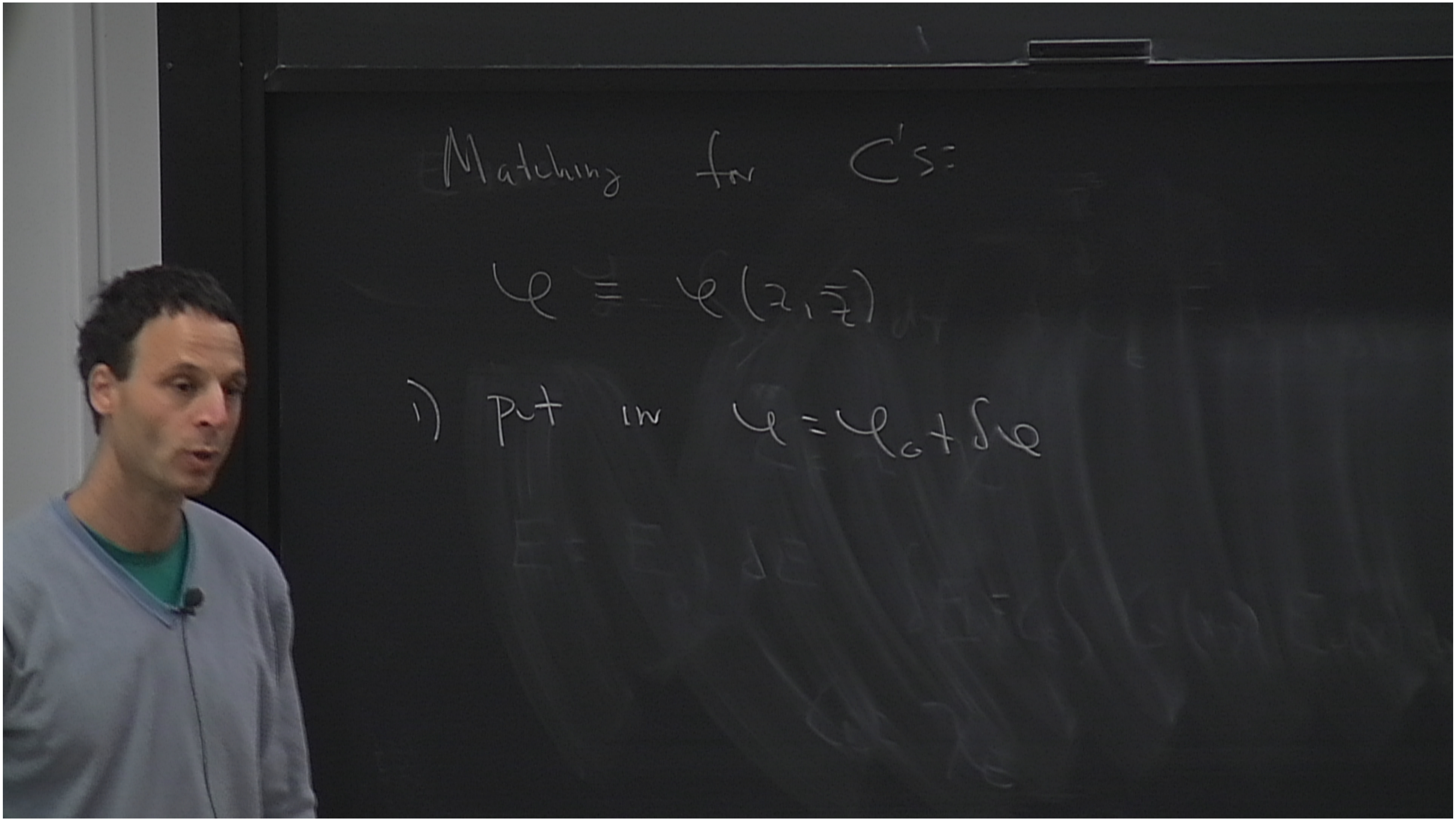

E+M
= Full Solution
Jackson

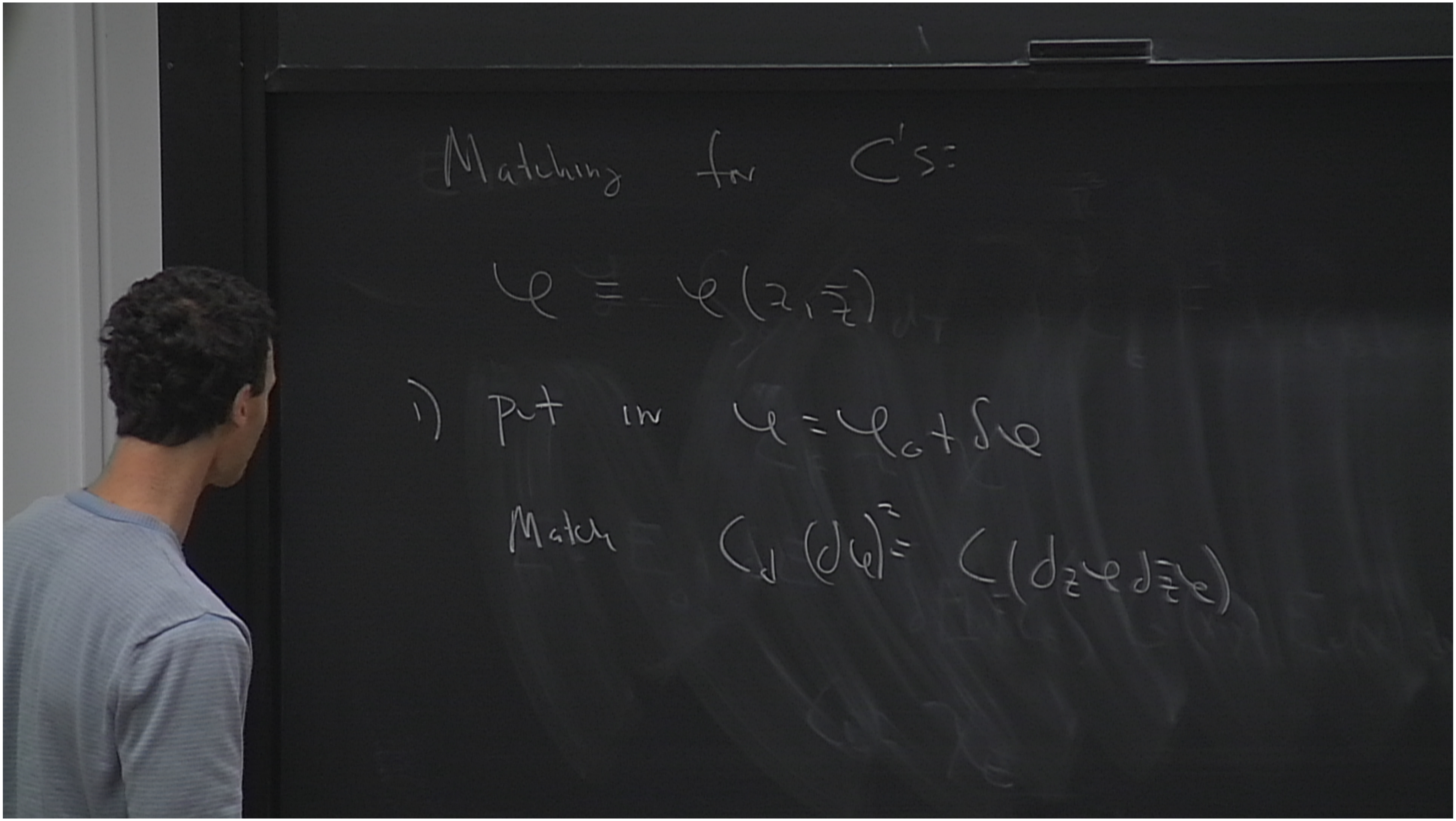

E + M
Full Solution
Jackson

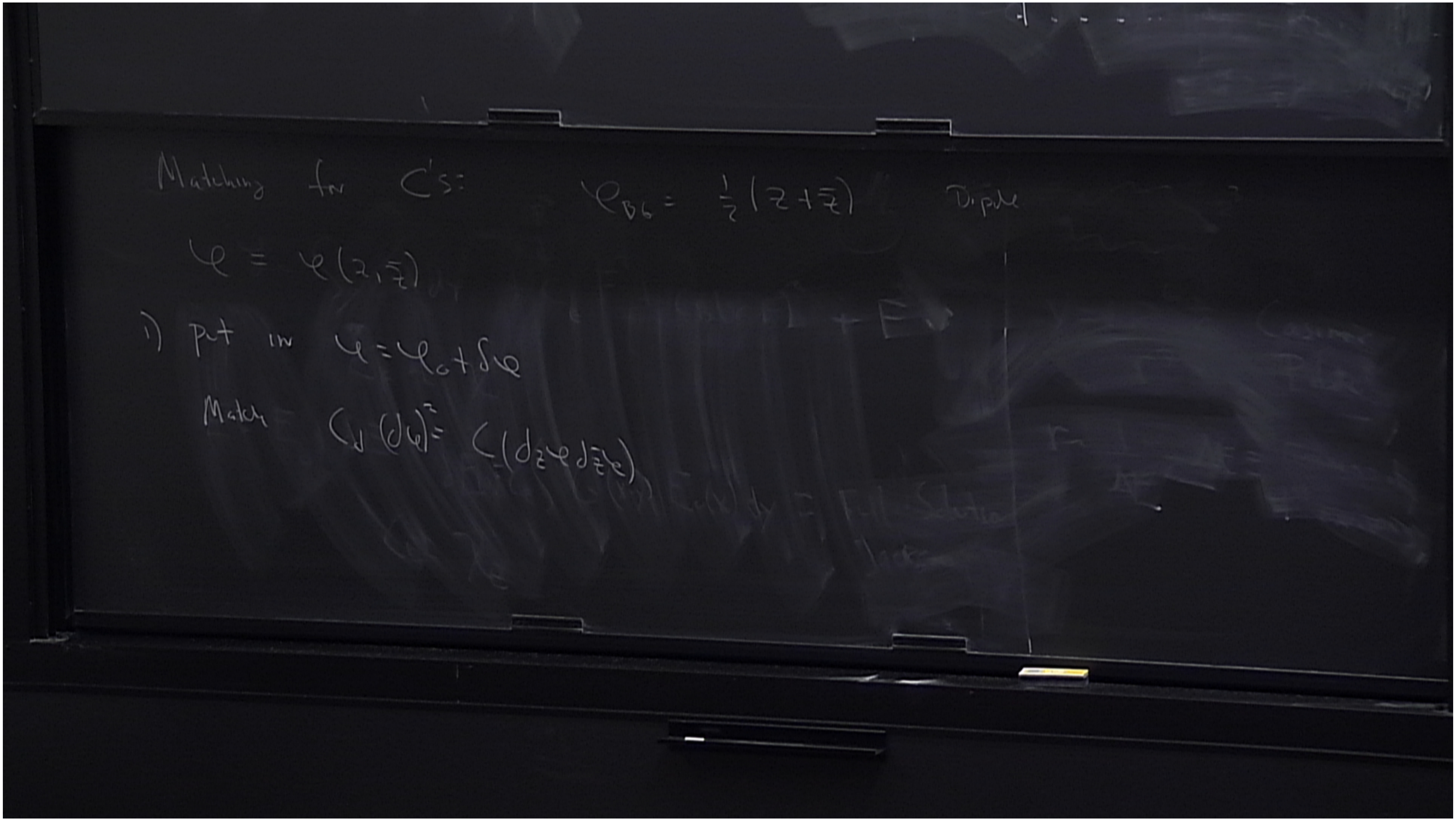

E+M
= Full Solution
Jackson
Casimir
Polder

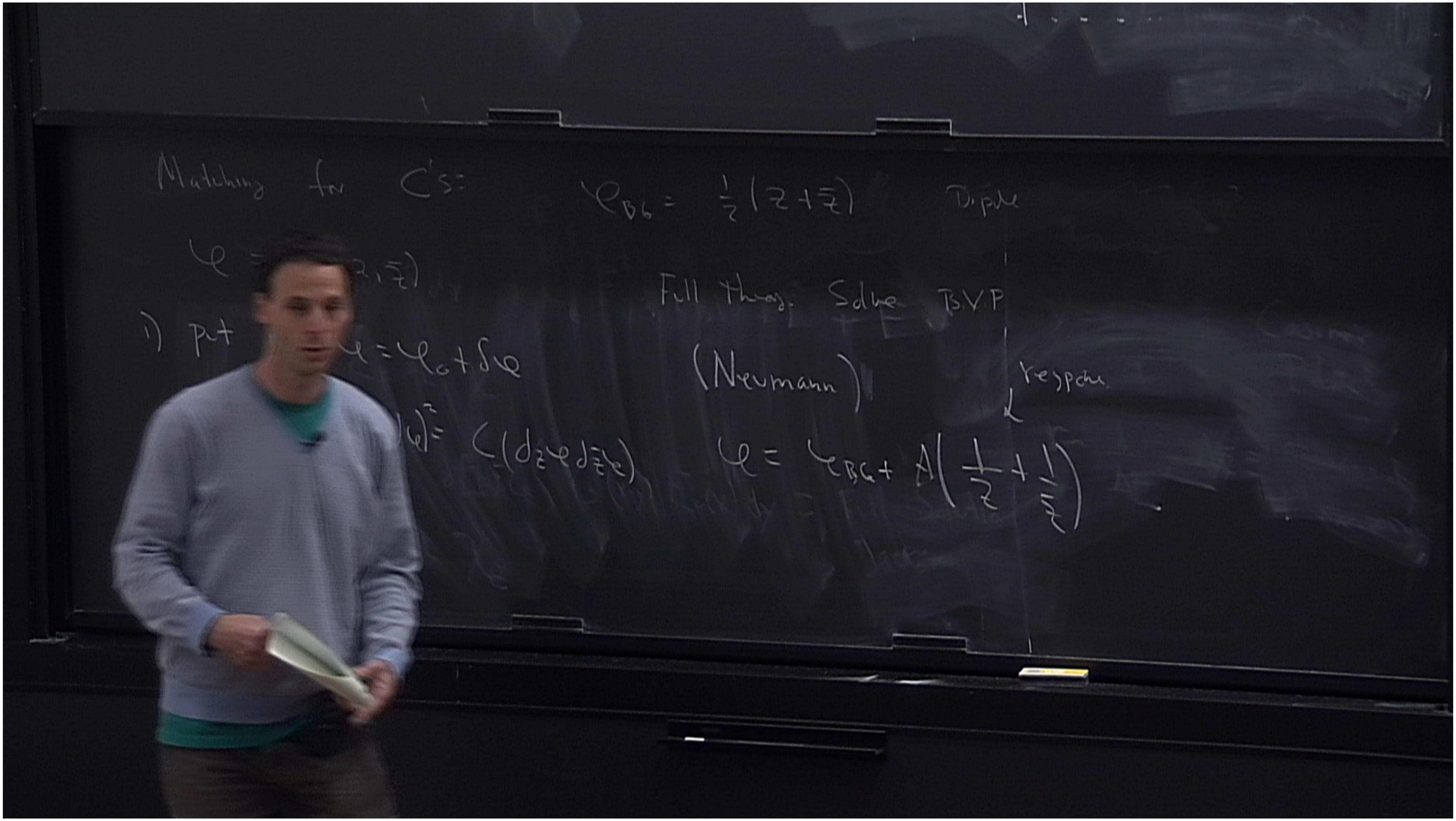

E+M
Full Solution
Jackson
Casimir Polder
Energy of
1st Excitation

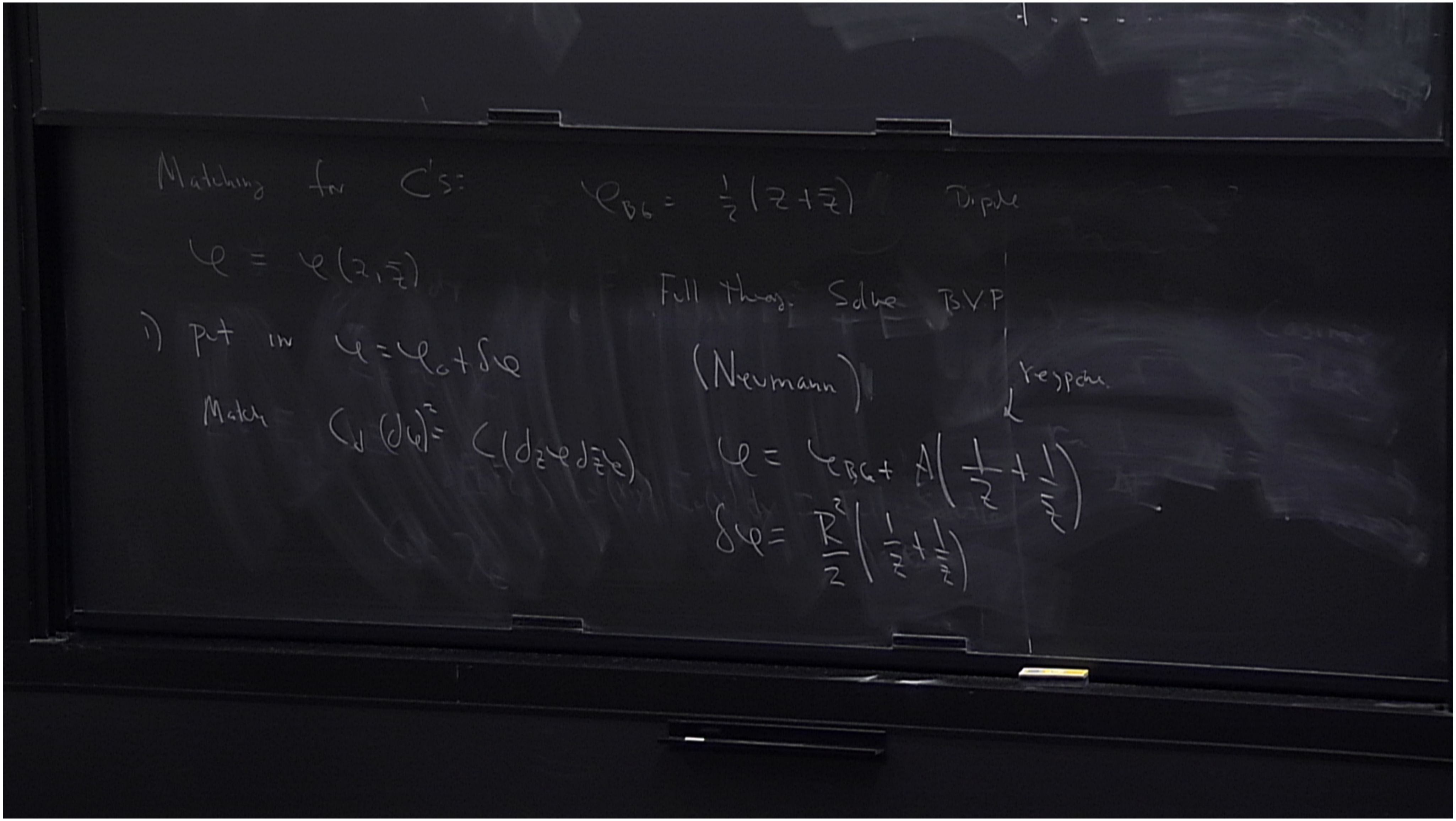

Include DoF that live on World line
L = p(t) · E
p(t) p(t')
V(r) = 1/r^6 Σ n,m |<0|Pz|n>|² |<0|Pz|m>|² / (En + Em − 2E0)
<p(t) · p(t')>

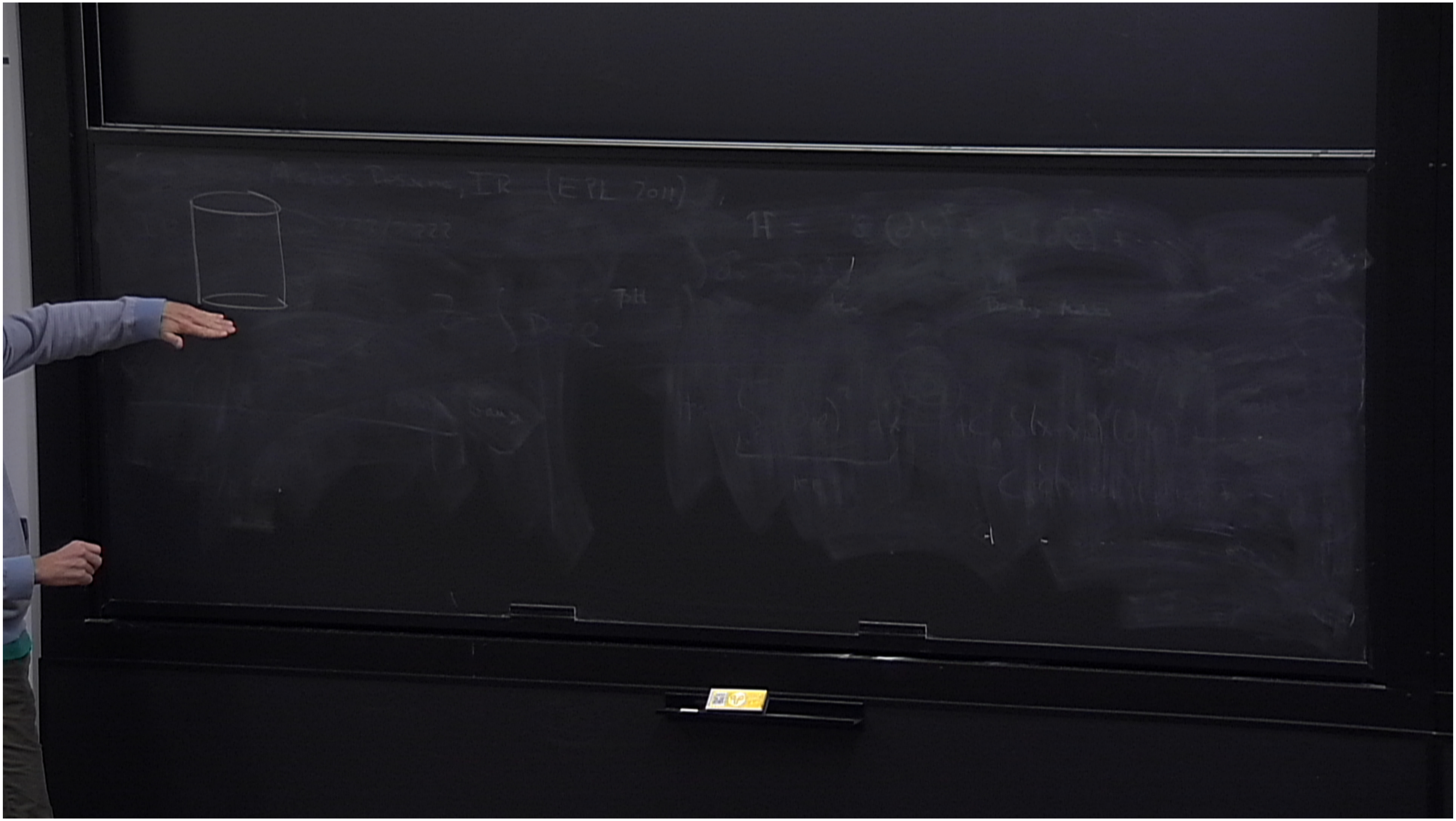

Matching for C's:
φ ≡ φ(z, z̄)
1) put in φ = φ0 + δφ

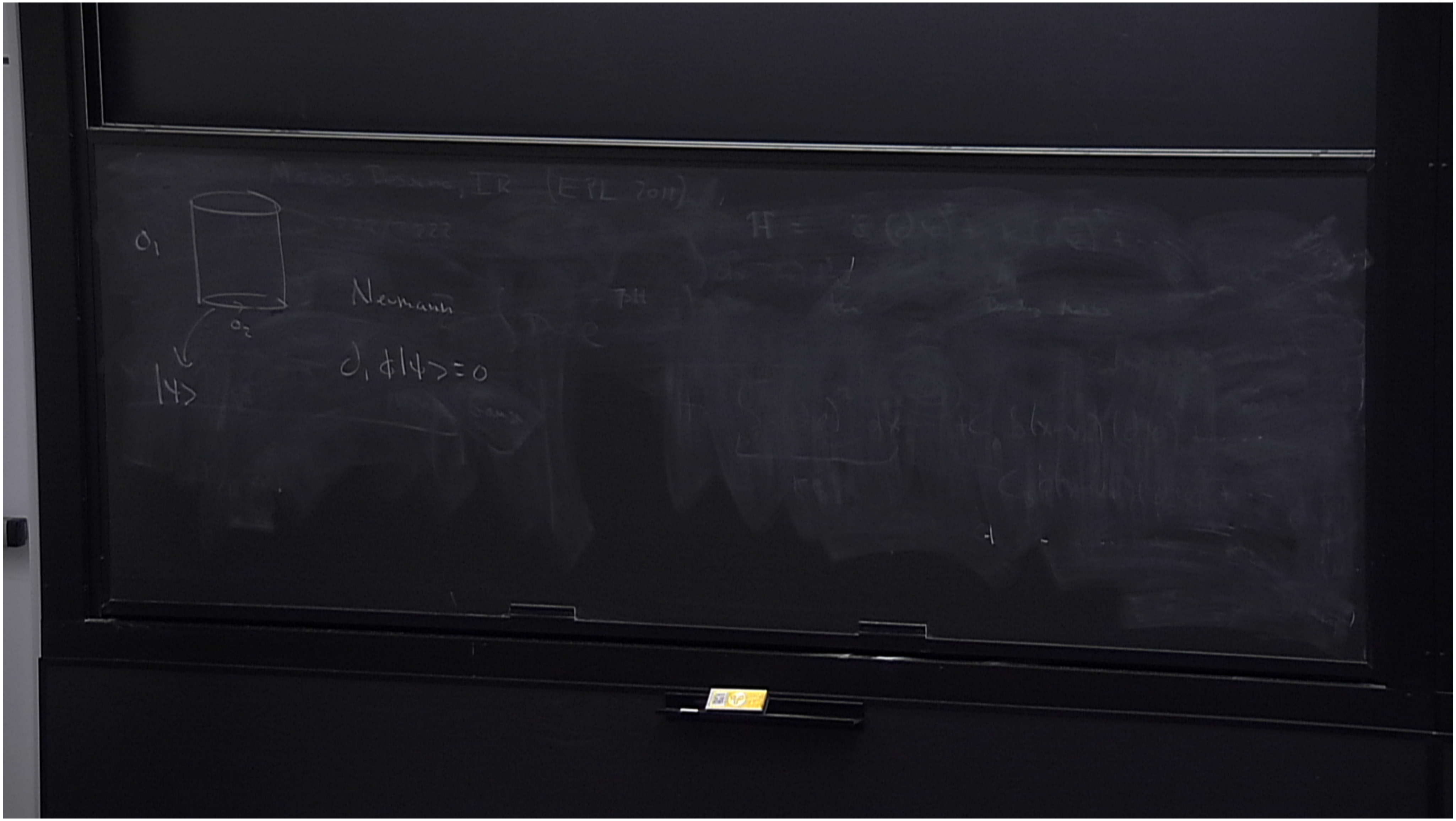

Matching for C's:
φ = φ(z, z̄)
1) put in φ = φ₀ + δφ
Match C_d (∂φ)² = C(∂_z φ ∂_z̄ φ)

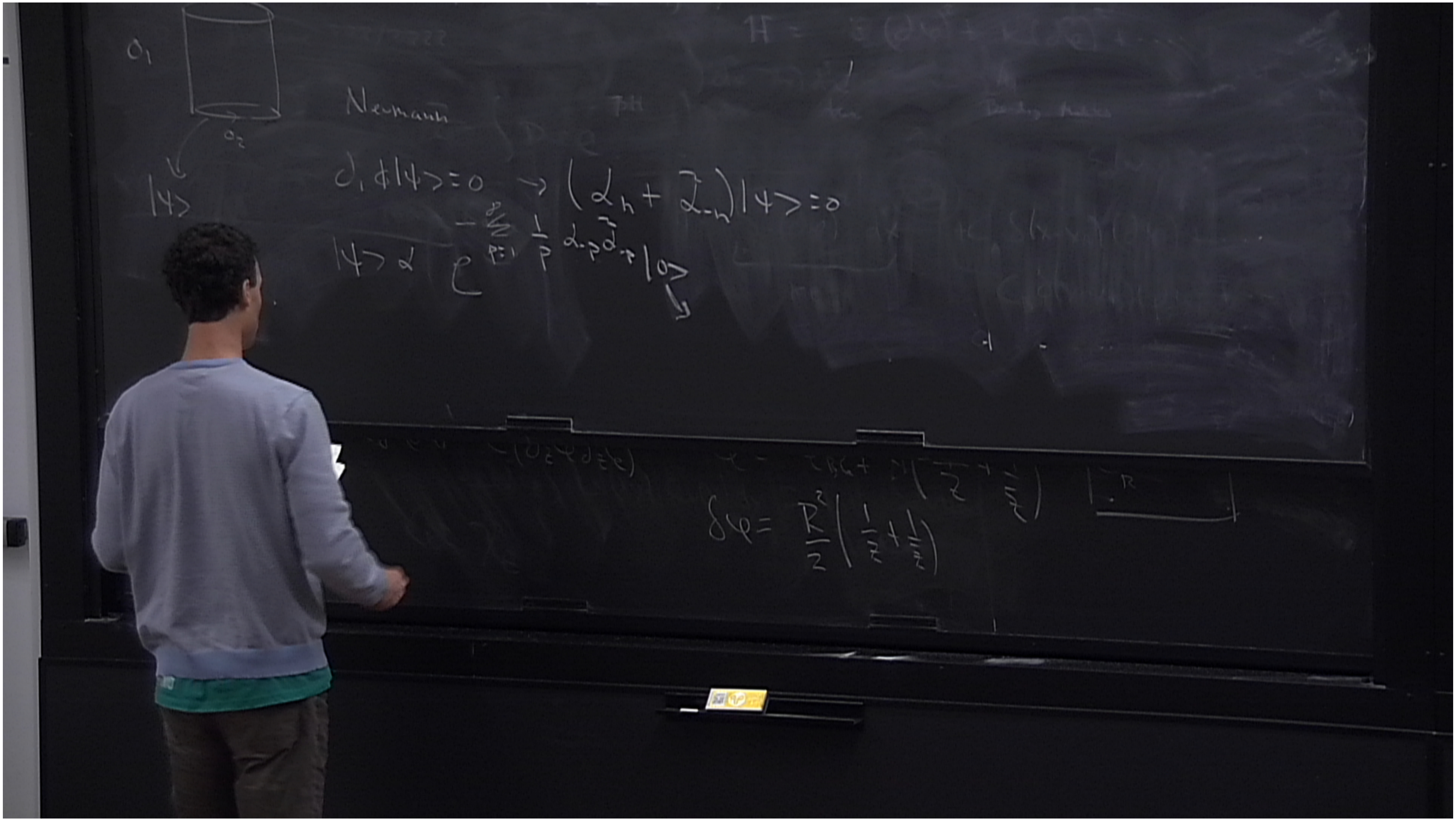

Matching for C's:
φ_DG = ½ (z + z̄)
Dipole
φ = φ(z, z̄)
1) put in φ = φ_0 + δφ
Match C_d (∂φ)² = C (∂_z φ ∂_z̄ φ)

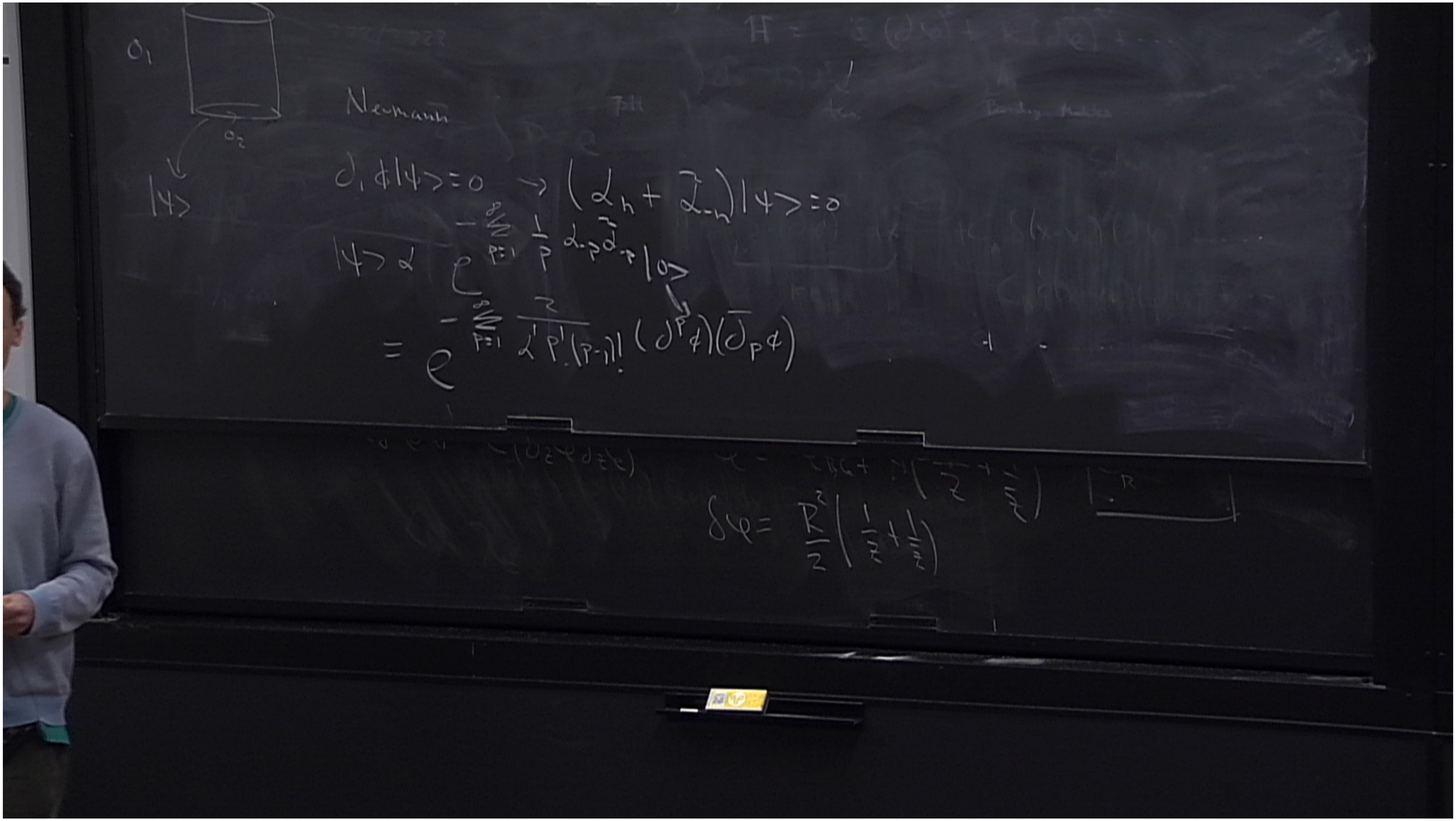

Matching for C's:
φ_BG = 1/2 (z + z̄)
Dipole
Full thing: Solve B.V.P
(Neumann)
response
φ = φ_BG + A(1/z + 1/z̄)
1) put
φ = φ_0 + δφ


Matching for C's:
$\varphi_{BG} = \frac{1}{2}(z+\bar{z})$
Dipole
$\varphi = \varphi(z,\bar{z})$
Full theory: Solve BVP
1) put in $\varphi = \varphi_0 + \delta\varphi$
(Neumann)
response
Match $C_d\,(\partial\varphi)^2 = C(\partial_z\varphi\,\partial_{\bar{z}}\varphi)$
$\varphi = \varphi_{BG} + A\left(\frac{1}{z} + \frac{1}{\bar{z}}\right)$
$\delta\varphi = \frac{R^2}{2}\left(\frac{1}{z} + \frac{1}{\bar{z}}\right)$


(EPL 2011)

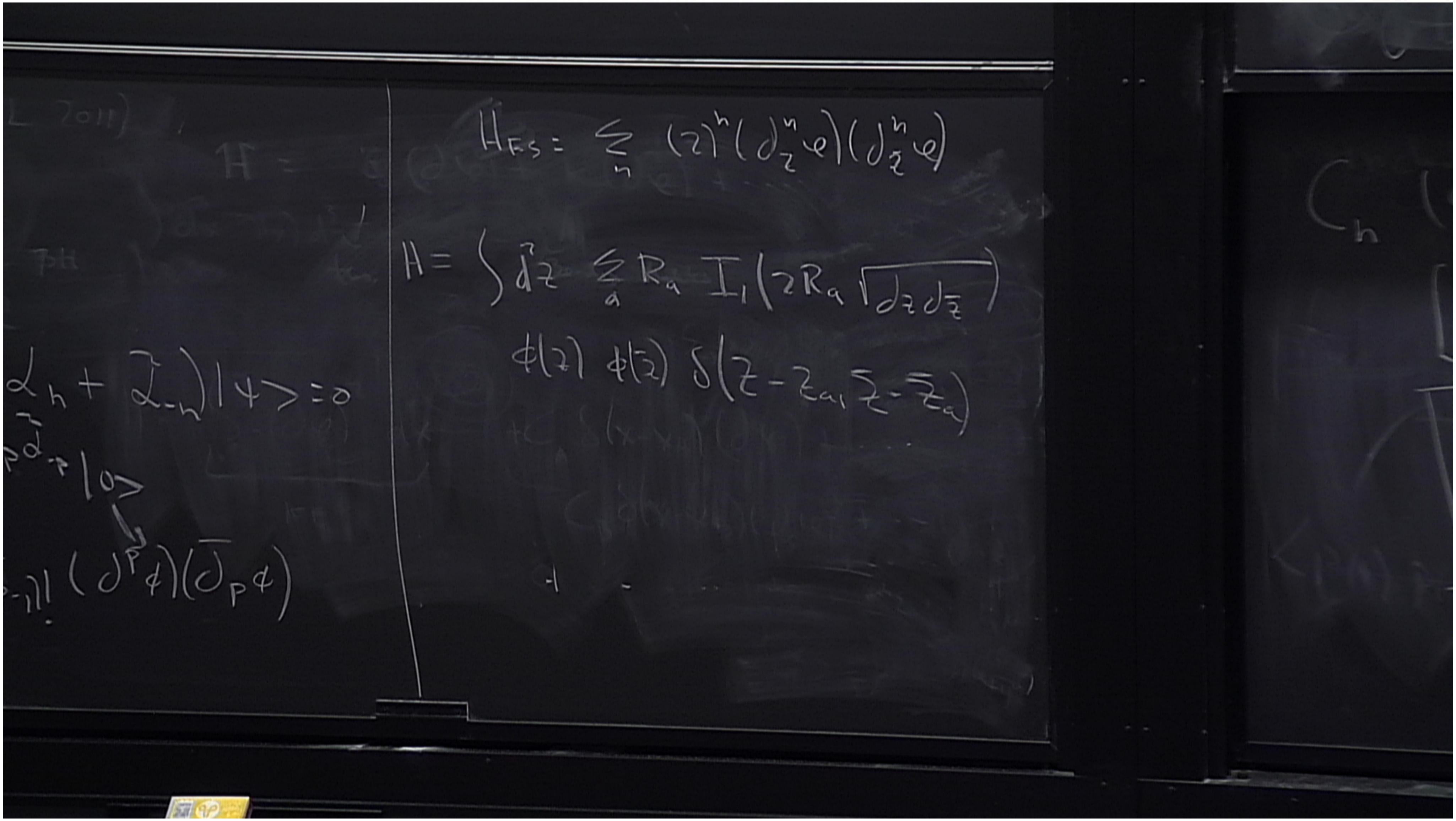

O1
O2
|ψ>
Neumann
∂1 φ|ψ>=0

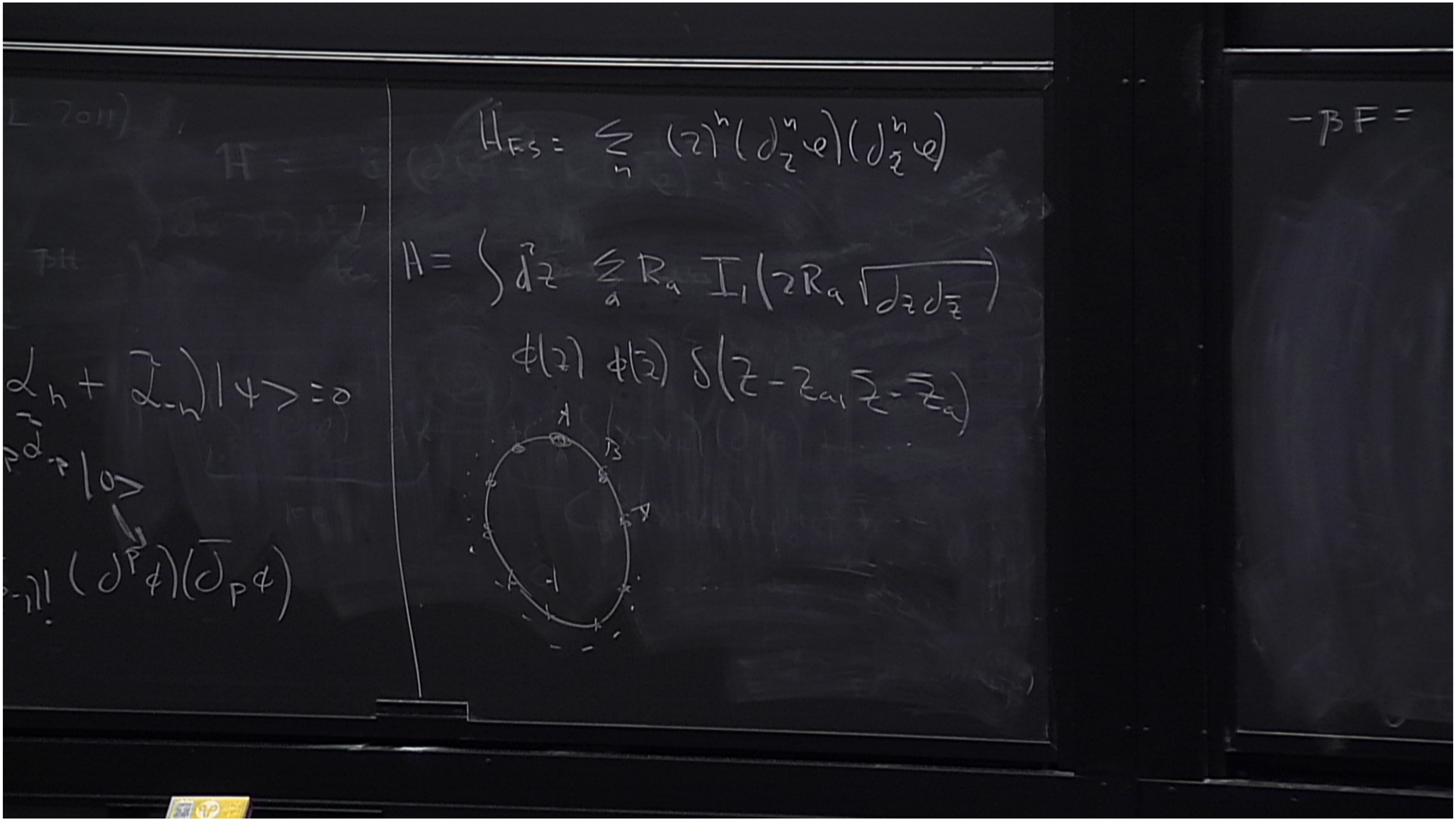

Neumann

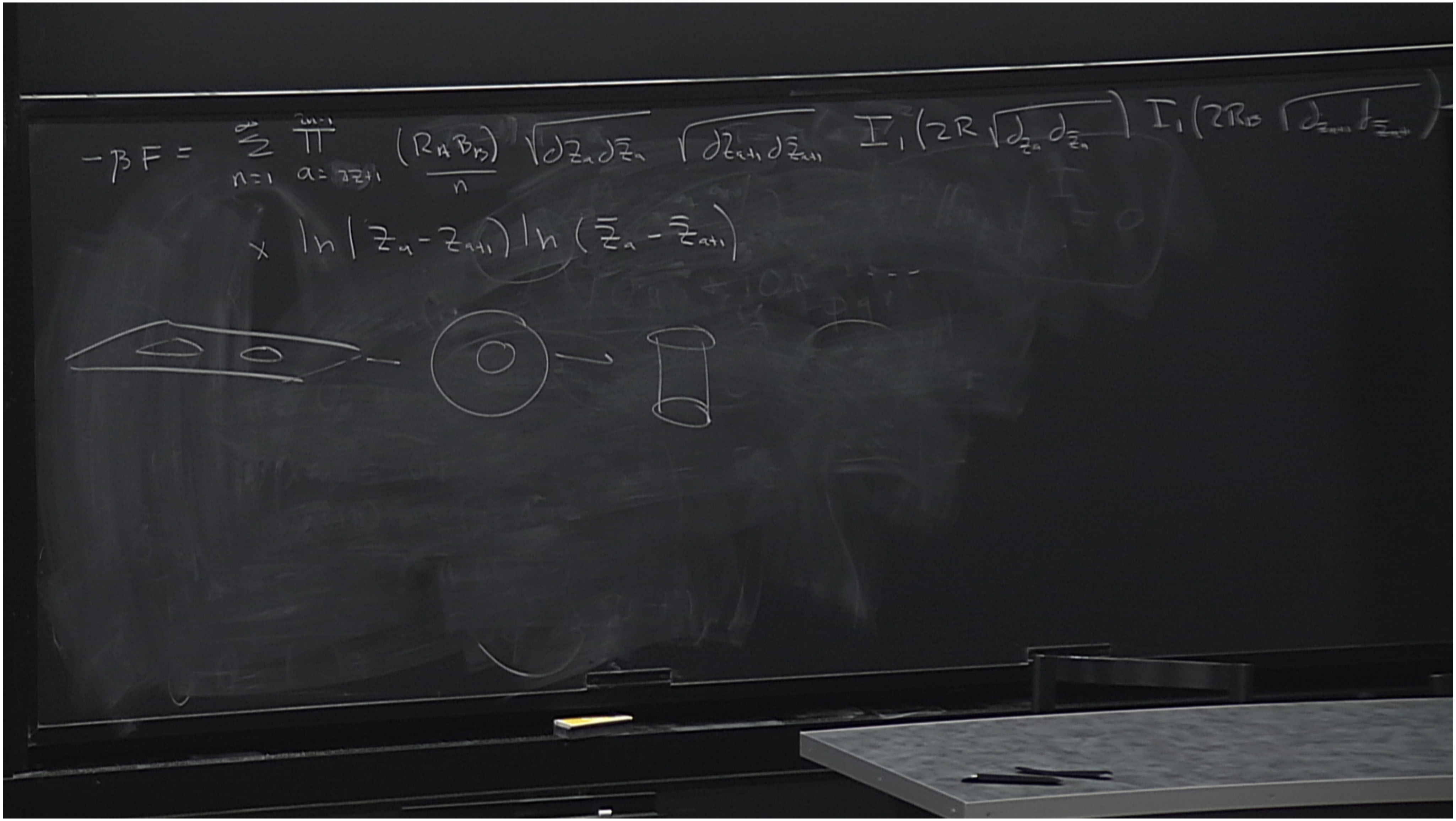

Neumann
∂₁φ|ψ> = 0 → (α_n + α̃_{-n})|ψ> = 0
|ψ>

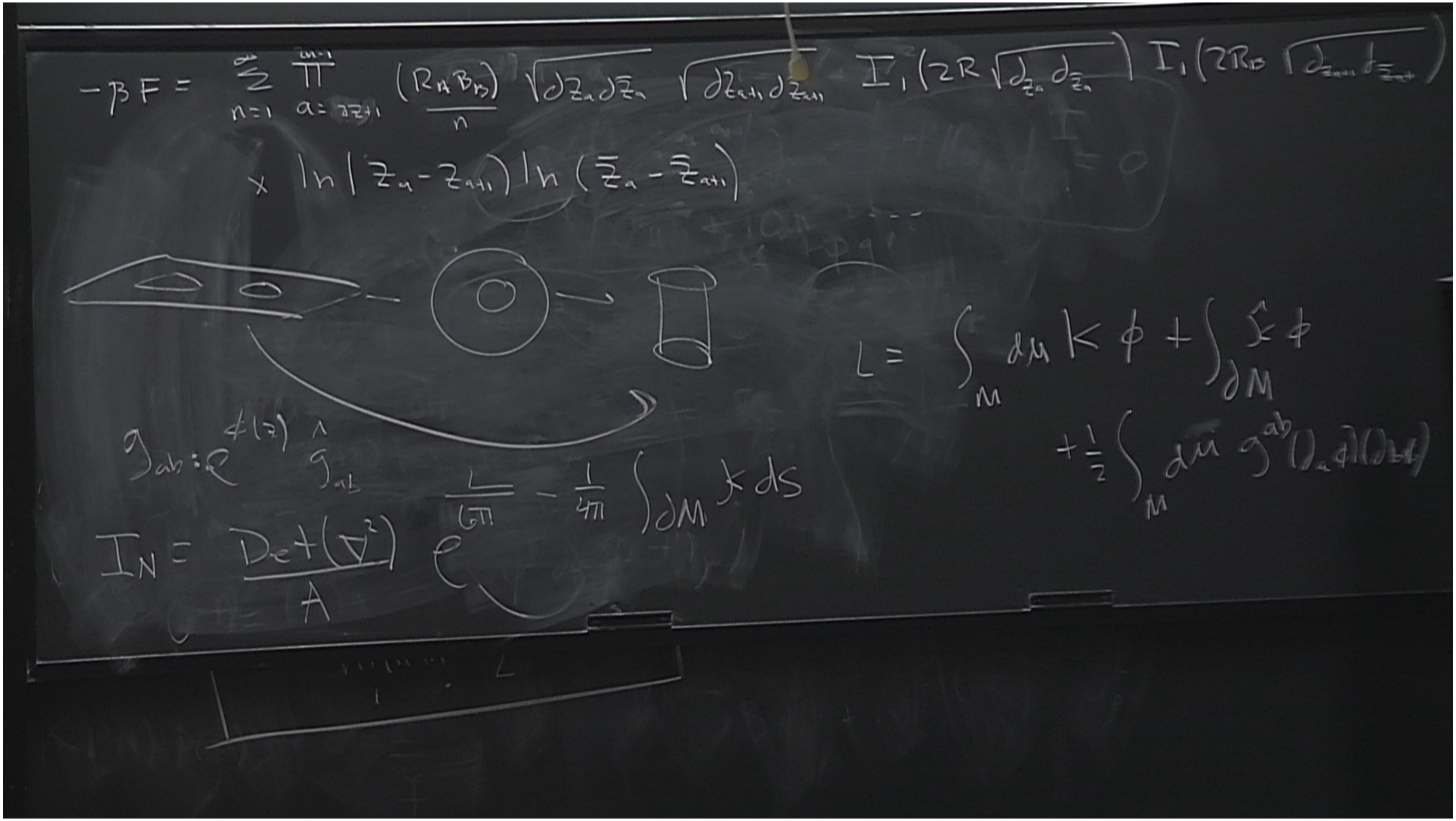
$$\beta F = \sum_{n=1} \prod_{a=2Z+1} \left(\frac{R_A B_B}{n}\right) \sqrt{\partial z_a \partial \bar{z}_a} \sqrt{\partial z_{a+1} \partial \bar{z}_{a+1}} \; I_1\left(2R\sqrt{\partial_{z_a} \partial_{\bar{z}_a}}\right) I_1\left(2R_B \sqrt{\partial_{z \ldots}}\right.$$

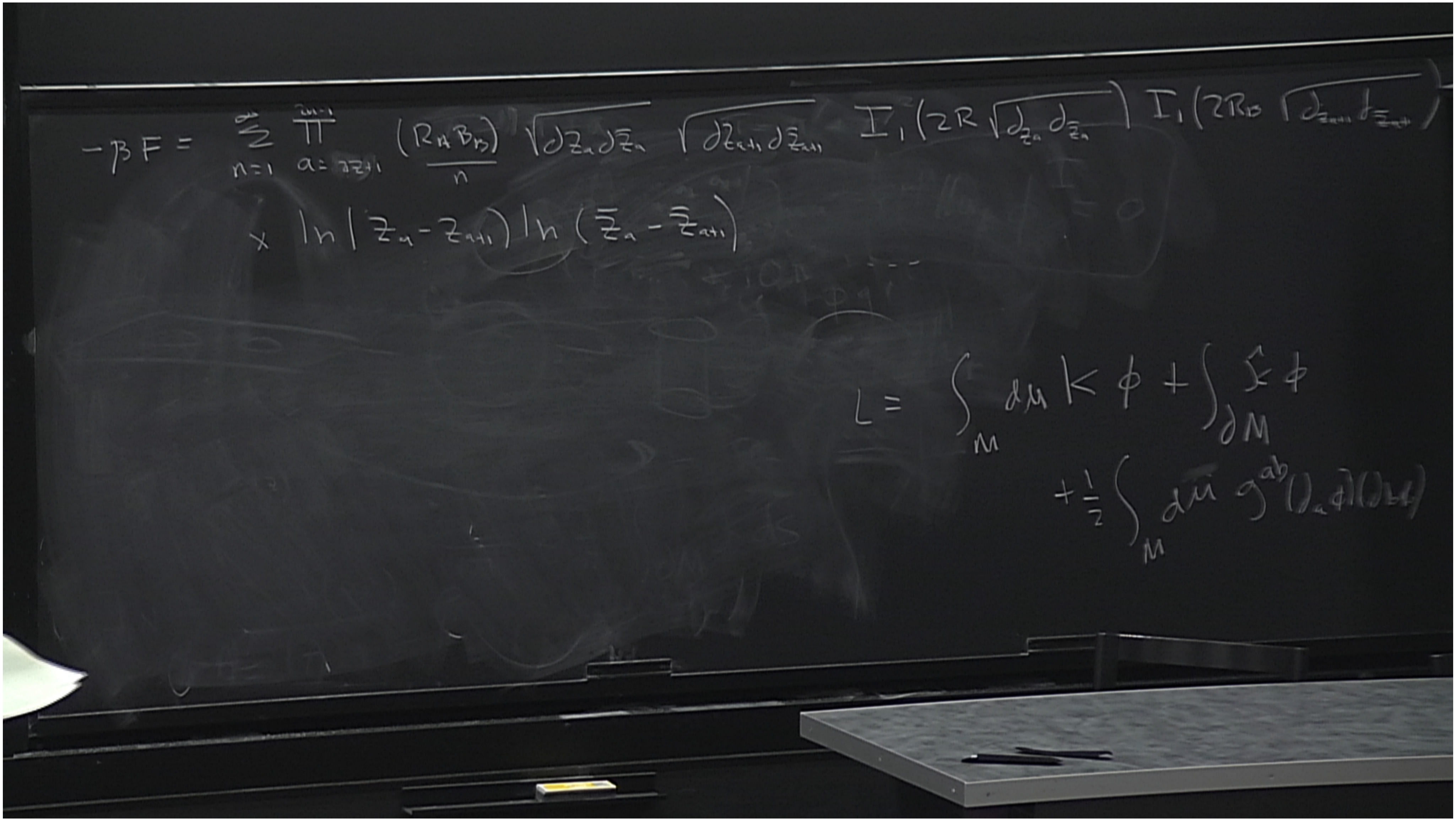
$$\times \ln(z_a - z_{a+1}) \ln(\bar{z}_a - \bar{z}_{a+1})$$

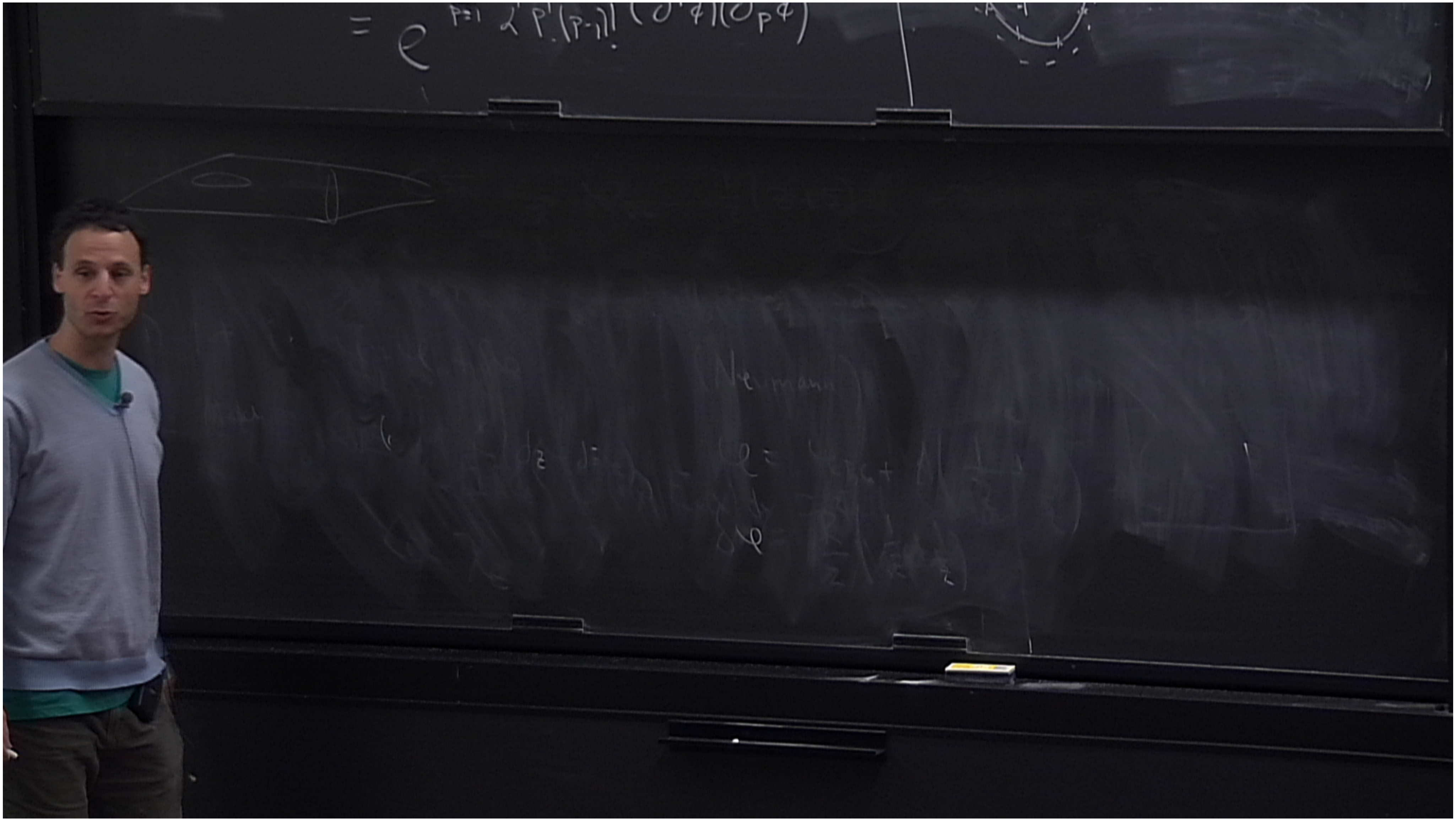

$H_{FS} = \sum_n (2)^n (\partial_z^n \varphi)(\partial_{\bar z}^n \varphi)$
$H = \int d^2z \sum_a R_a I_1 (2R_a \sqrt{\partial_z \partial_{\bar z}})$
$\phi(z)\, \phi(\bar z)\, \delta(z - z_a, \bar z - \bar z_a)$
$(\alpha_n + \tilde\alpha_{-n})|\psi\rangle = 0$
$(\partial^p \phi)(\bar\partial_p \phi)$


$H_{FS} = \sum_n (2)^n (\partial_z^n \varphi)(\partial_{\bar z}^n \varphi)$
$H = \int d^2 z \sum_a R_a I_1(2R_a \sqrt{\partial_z \partial_{\bar z}})$
$\phi(z)\, \phi(\bar z)\, \delta(z - z_a, \bar z - \bar z_a)$
$(\alpha_n + \bar\alpha_{-n})|\psi\rangle = 0$
$-\beta F =$


$-\beta F = \sum_{n=1}^{\infty} \prod_{a=2\mathbb{Z}+1}^{2n-1} \frac{(R_A B_B)}{n} \sqrt{\partial z_a \partial \bar{z}_a} \sqrt{\partial z_{a+1} \partial \bar{z}_{a+1}}\, I_1\left(2R\sqrt{\partial_{z_a} \partial_{\bar{z}_a}}\right) I_1\left(2R_B \sqrt{\partial_{z_{a+1}} \partial_{\bar{z}_{a+1}}}\right)$
$\times \ln(z_a - z_{a+1}) \ln(\bar{z}_a - \bar{z}_{a+1})$


-βF =
I_N = Det(∇²) / A
L =
ds


$-\beta F = \sum_{n=1}^{\infty} \prod_{a=2l+1}^{2m-1} \frac{(R_A B_B)}{n} \sqrt{\partial z_a \partial \bar{z}_a} \sqrt{\partial z_{a+1} \partial \bar{z}_{a+1}} \, I_1 (2R \sqrt{\partial_{z_a} \partial_{\bar{z}_a}}) \, I_1 (2R_B \sqrt{\partial_{z_{a+1}} \partial_{\bar{z}_{a+1}}})$
$\times \ln(z_a - z_{a+1}) \ln(\bar{z}_a - \bar{z}_{a+1})$
$L = \int_M d\mu \, K \phi + \int_{\partial M} \hat{k} \phi$
$+ \frac{1}{2} \int_M d\mu \, g^{ab} (\partial_a \phi)(\partial_b \phi)$


Neumann