Title: The aAdS Geometry of Heavy CFT Correlators: Bananas to Doors toâ€¦ Wormholes?

Speakers: Jacob Abajian

Series: Quantum Fields and Strings

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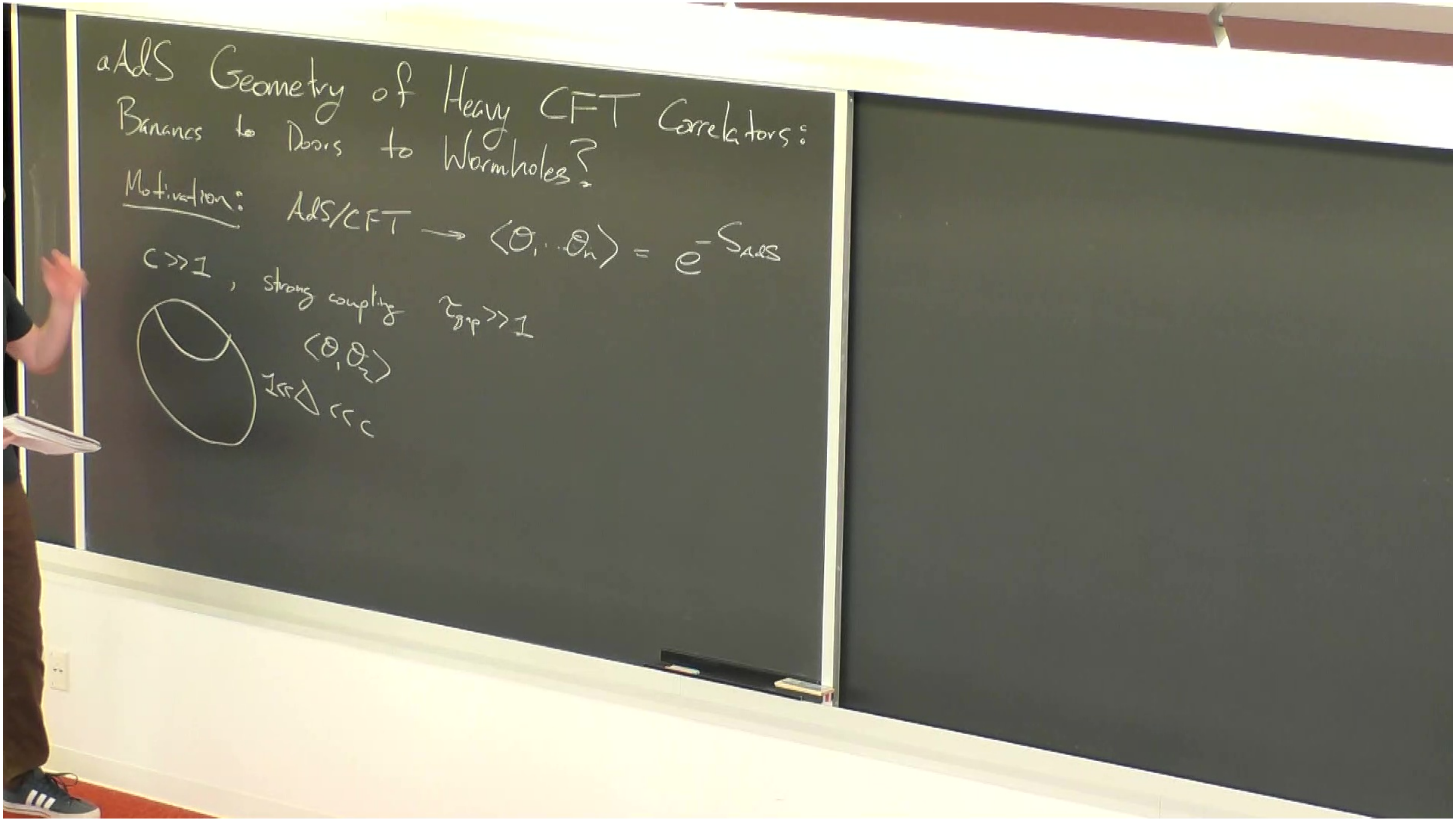
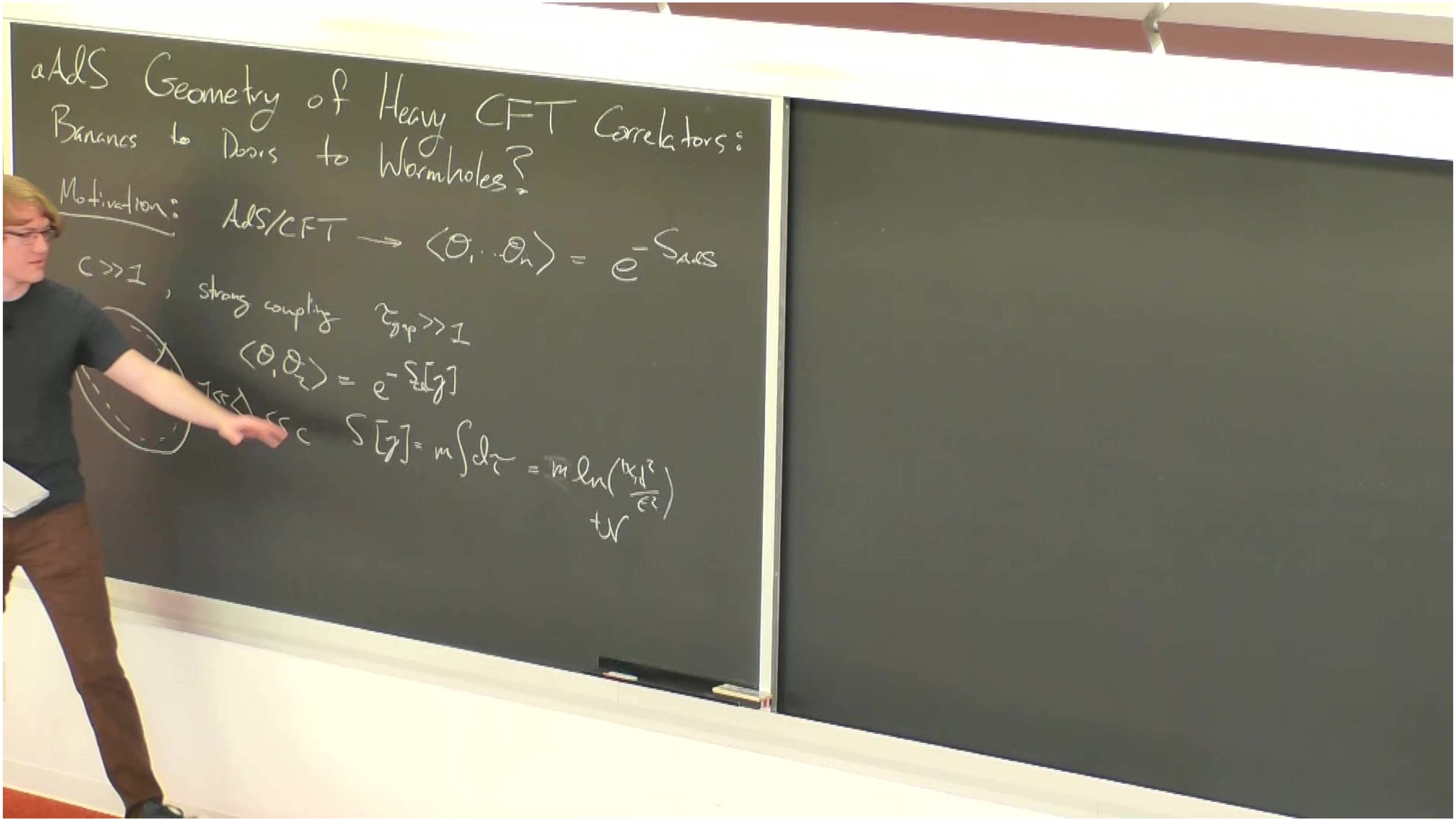
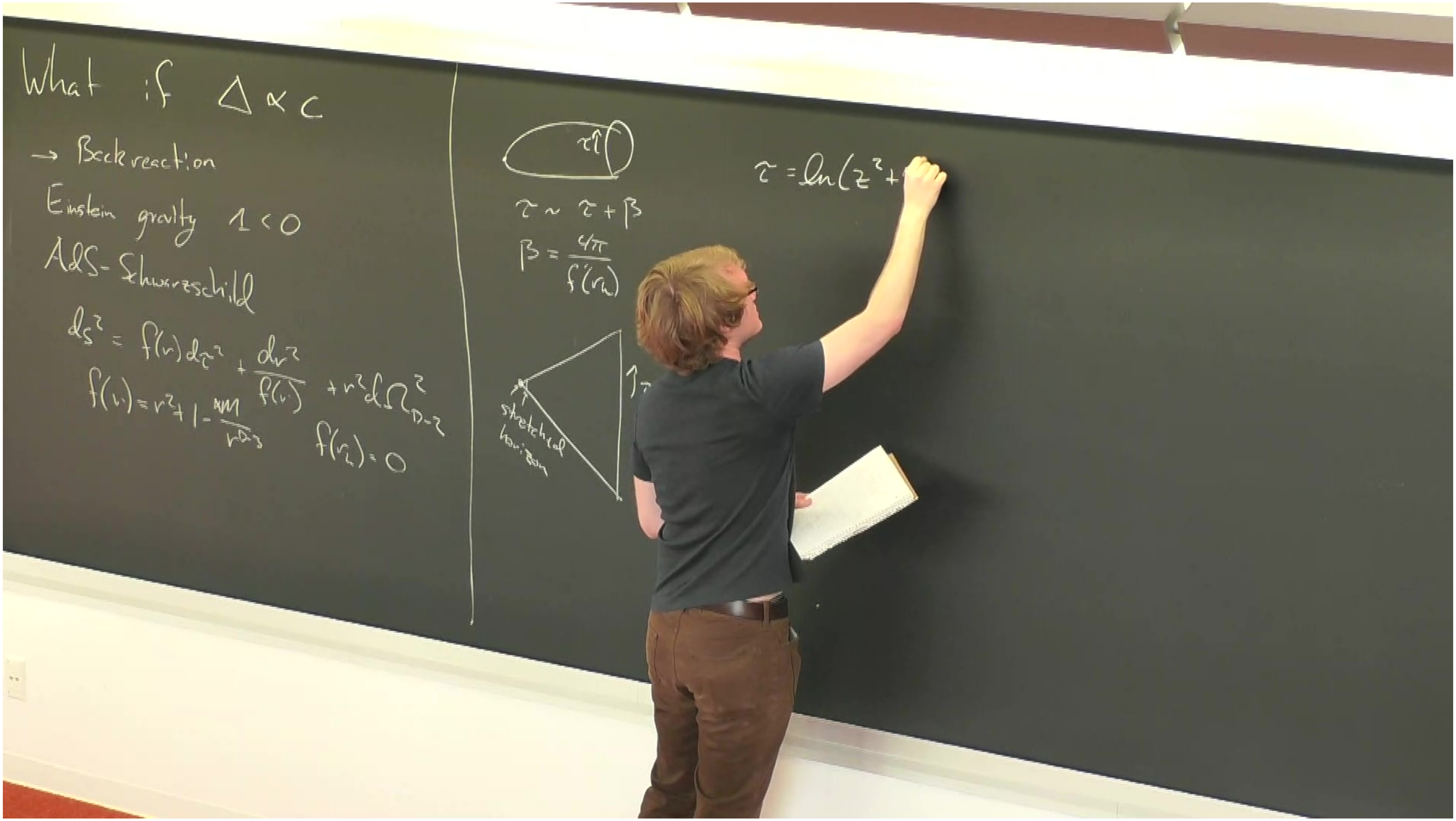
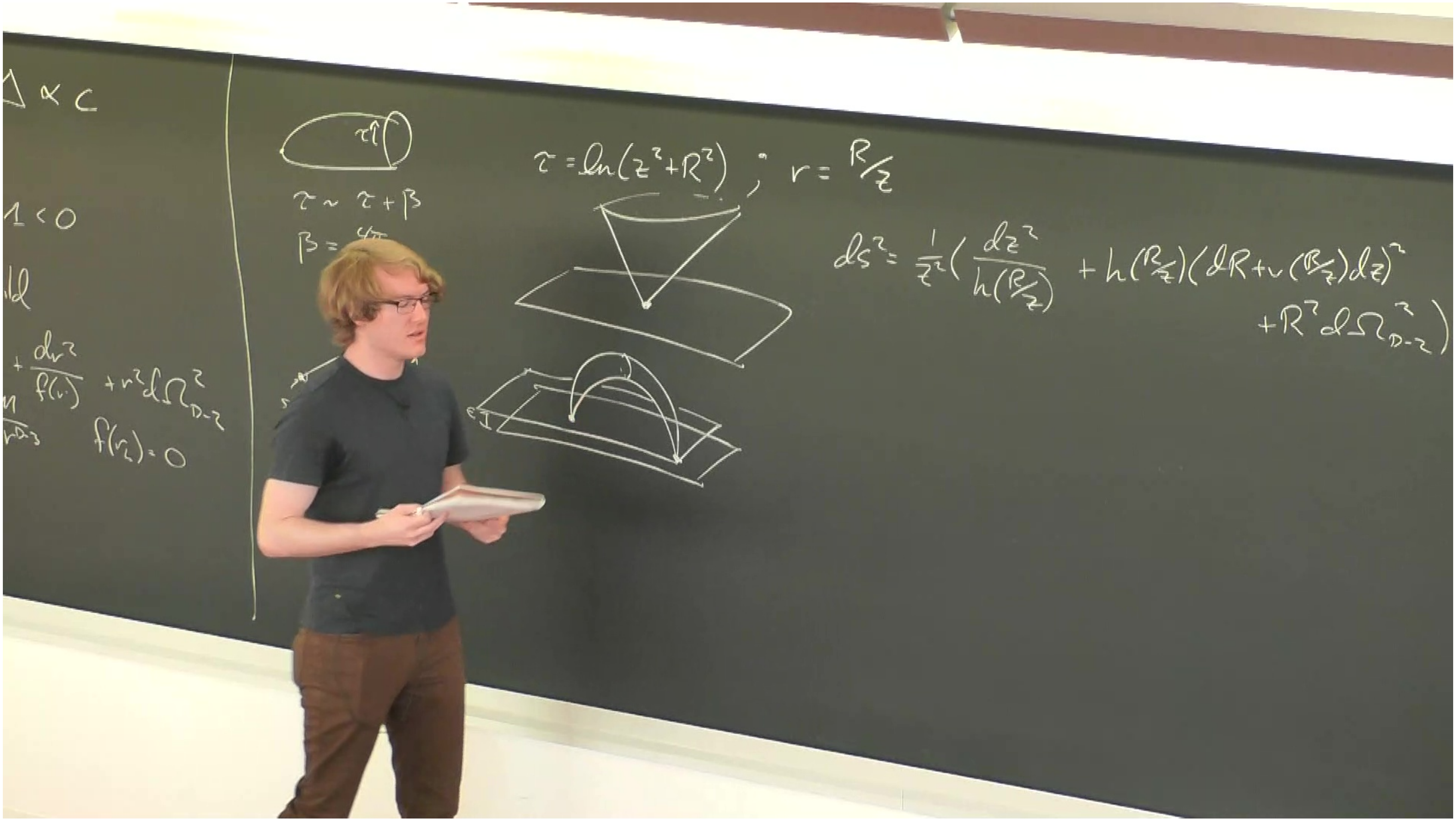
Abstract: We develop the bulk geometric description of correlation functions of operators whose scaling dimensions are of order the central charge in AdS/CFT. We follow a bottom-up approach, discussing solutions to Einstein gravity that are closely related to familiar black holes in AdS. In order to reproduce the correct dependence of a conformal correlation function on the location of operator insertions, we must introduce a novel Gibbons-Hawking-York boundary term associated with the stretched horizon of each black hole. We discuss the bulk dual of two point functions in CFT's living in arbitrary dimensions. Specializing to AdS3 allows us to discuss higher point functions, where we find that the dual geometries are sometimes multi-boundary wormholes, whose holographic interpretation has been the focus of much recent activity.

Zoom Link: TBD

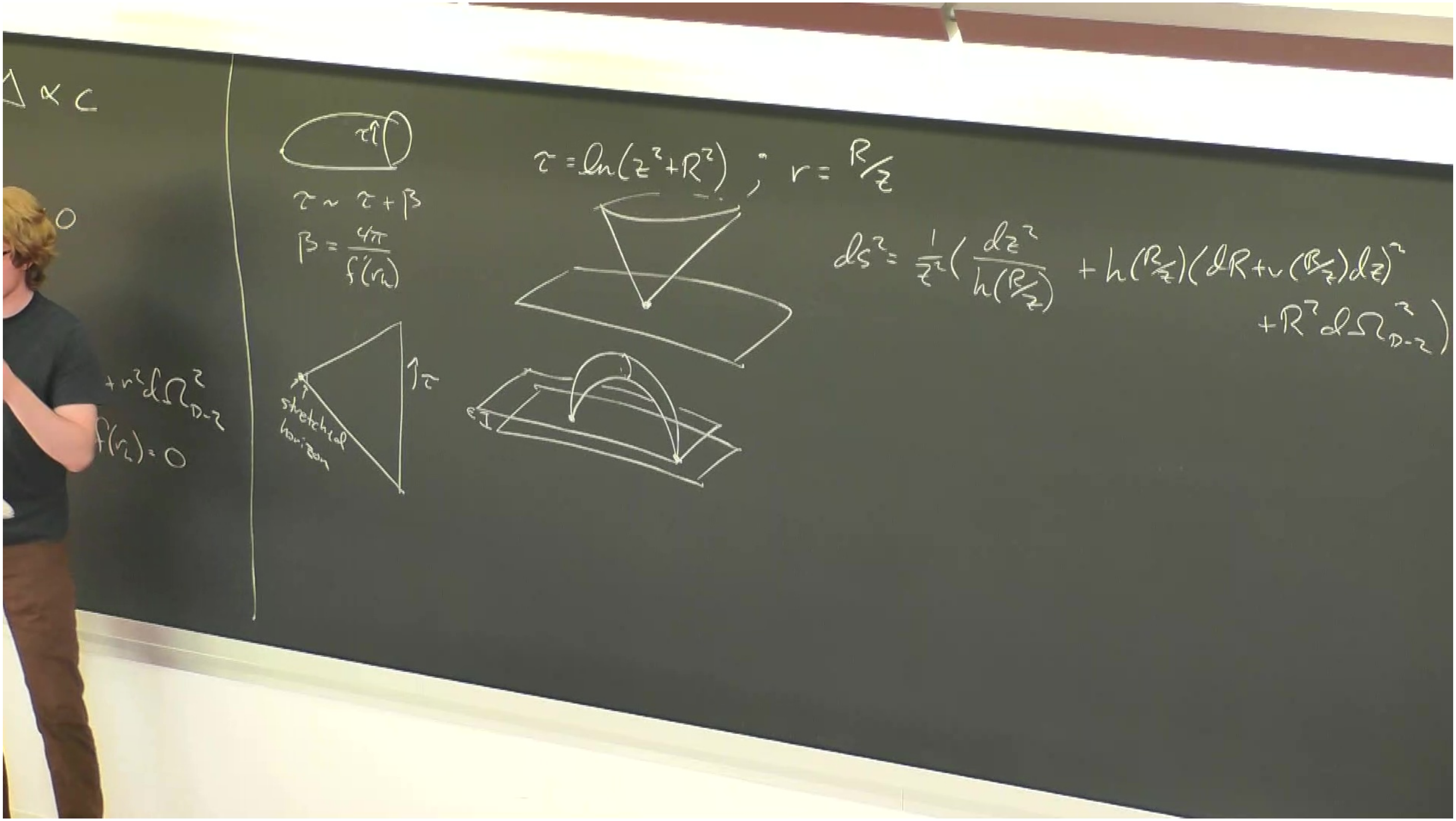

aAdS Geometry of Heavy CFT Correlators:
Bananas to Doors to Wormholes?
Motivation: AdS/CFT $\rightarrow$ $\langle \mathcal{O}_1 \cdots \mathcal{O}_n \rangle = e^{-S_{AdS}}$
$c \gg 1$, strong coupling $\tau_{gap} \gg 1$
$\langle \mathcal{O}_1 \mathcal{O}_2 \rangle$
$1 \ll \Delta \ll c$

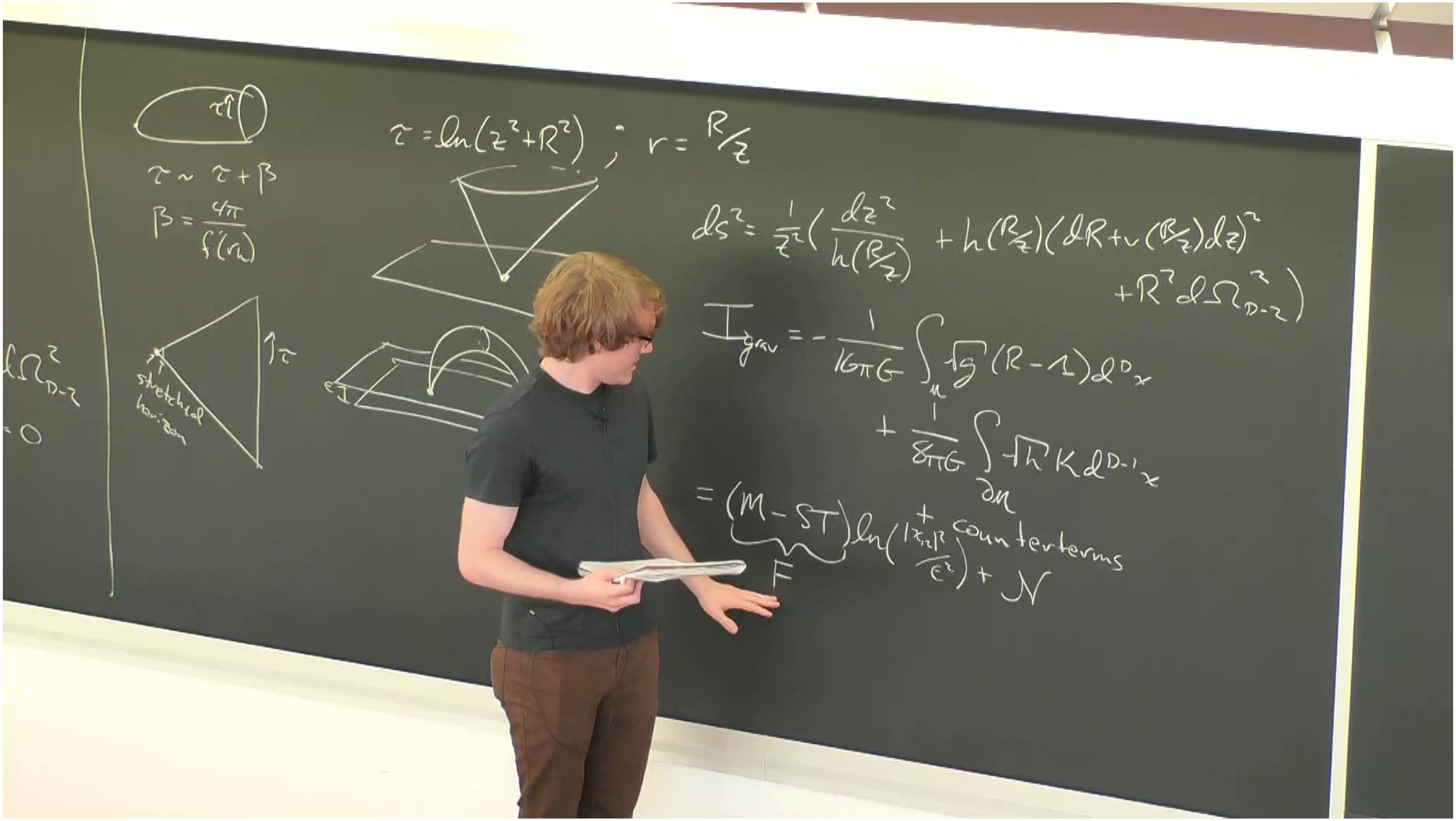

aAdS Geometry of Heavy CFT Correlators:
Bananas to Doors to Wormholes?
Motivation: AdS/CFT → ⟨O1 ⋯ On⟩ = e^(−S_AdS)
c >> 1 , strong coupling τ_gap >> 1
⟨O1 O2⟩ = e^(−S[γ])
1 << Δ << c S[γ] = m ∫dτ = m ln(|x12|²/ε²) + ⋯


What if Δ ∝ c
→ Backreaction
Einstein gravity Λ < 0
AdS-Schwarzschild
$ds^2 = f(r)d\tau^2 + \frac{dr^2}{f(r)} + r^2 d\Omega^2_{D-2}$
$f(r) = r^2 + 1 - \frac{4m}{r^{D-3}}$
$f(r_h) = 0$
$\tau \sim \tau + \beta$
$\beta = \frac{4\pi}{f'(r_h)}$
stretched horizon
$\tau = \ln(z^2 +$

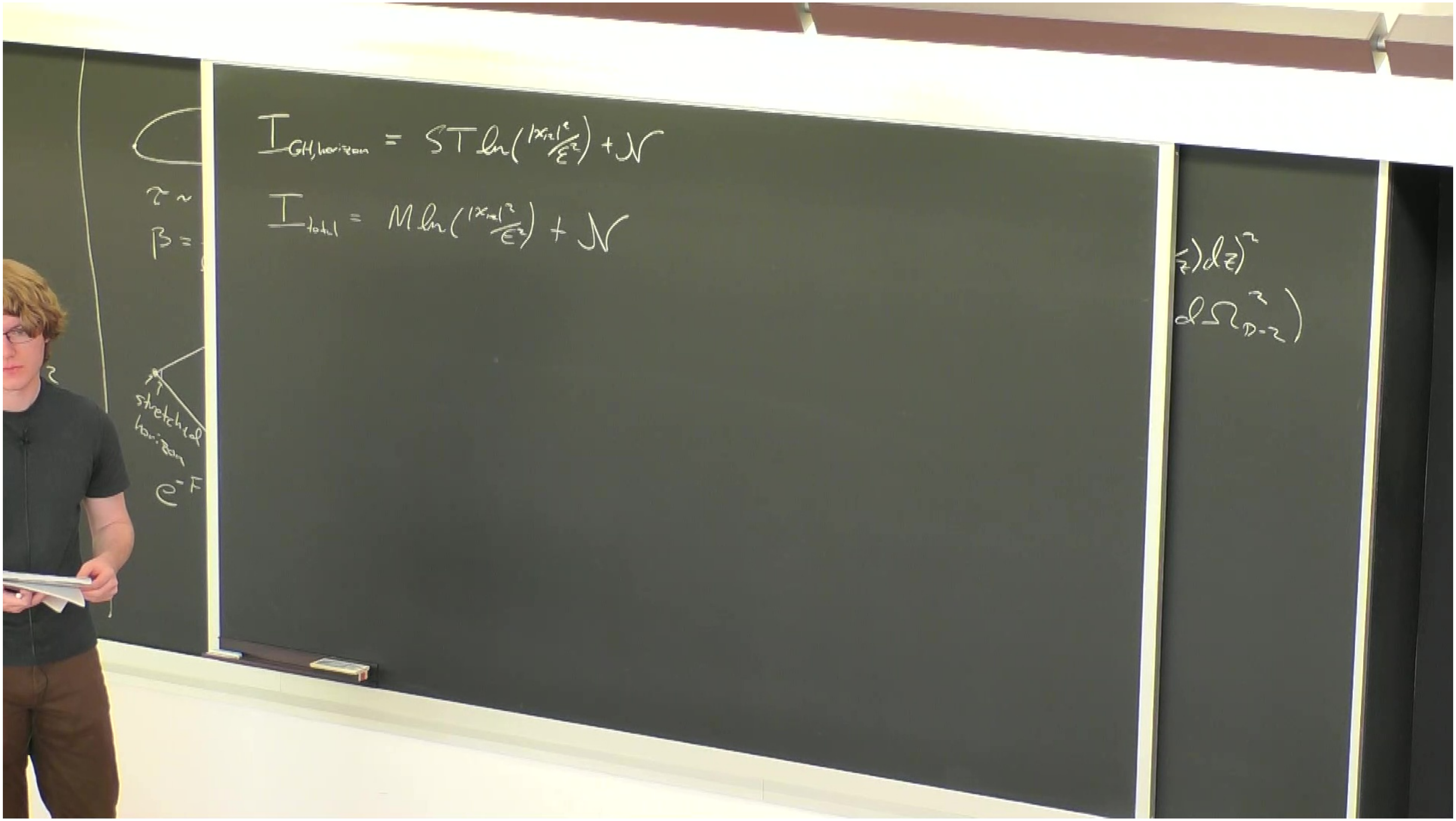


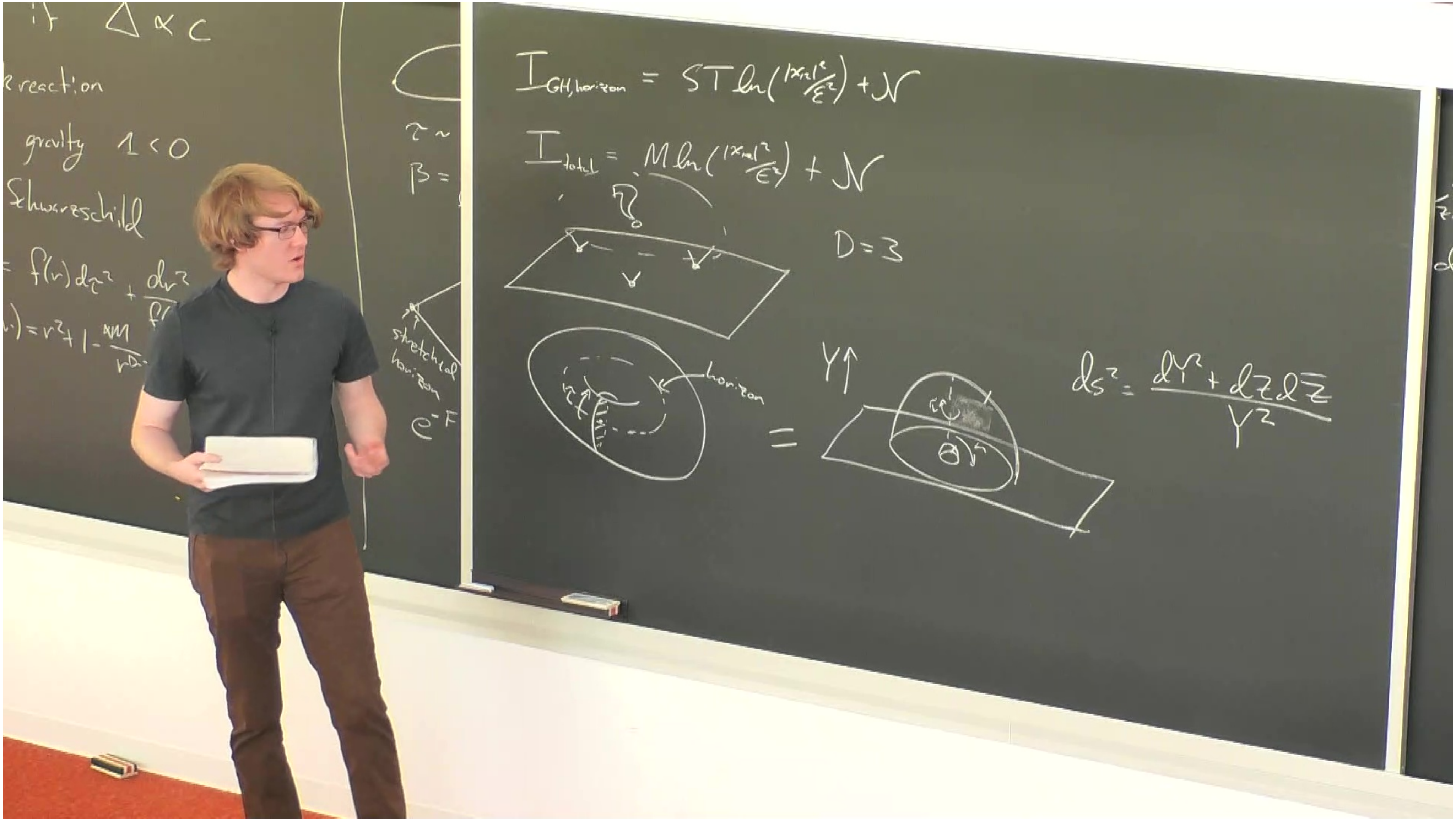
τ ~ τ + β
τ = ln(z² + R²) ; r = R/z
ds² = 1/z² (dz²/h(R/z) + h(R/z)(dR + v(R/z)dz)² + R² dΩ²_{D-2})
f(r_h) = 0


$\Delta \propto c$
$\tau \sim \tau + \beta$
$\beta = \frac{4\pi}{f'(r_h)}$
$+ r^2 d\Omega_{D-2}^2$
$f(r_h) = 0$
stretched horizon
$\tau = \ln(z^2 + R^2)$; $r = R/z$
$ds^2 = \frac{1}{z^2}\left(\frac{dz^2}{h(R/z)} + h(R/z)(dR + v(R/z)dz)^2 + R^2 d\Omega_{D-2}^2 \right)$

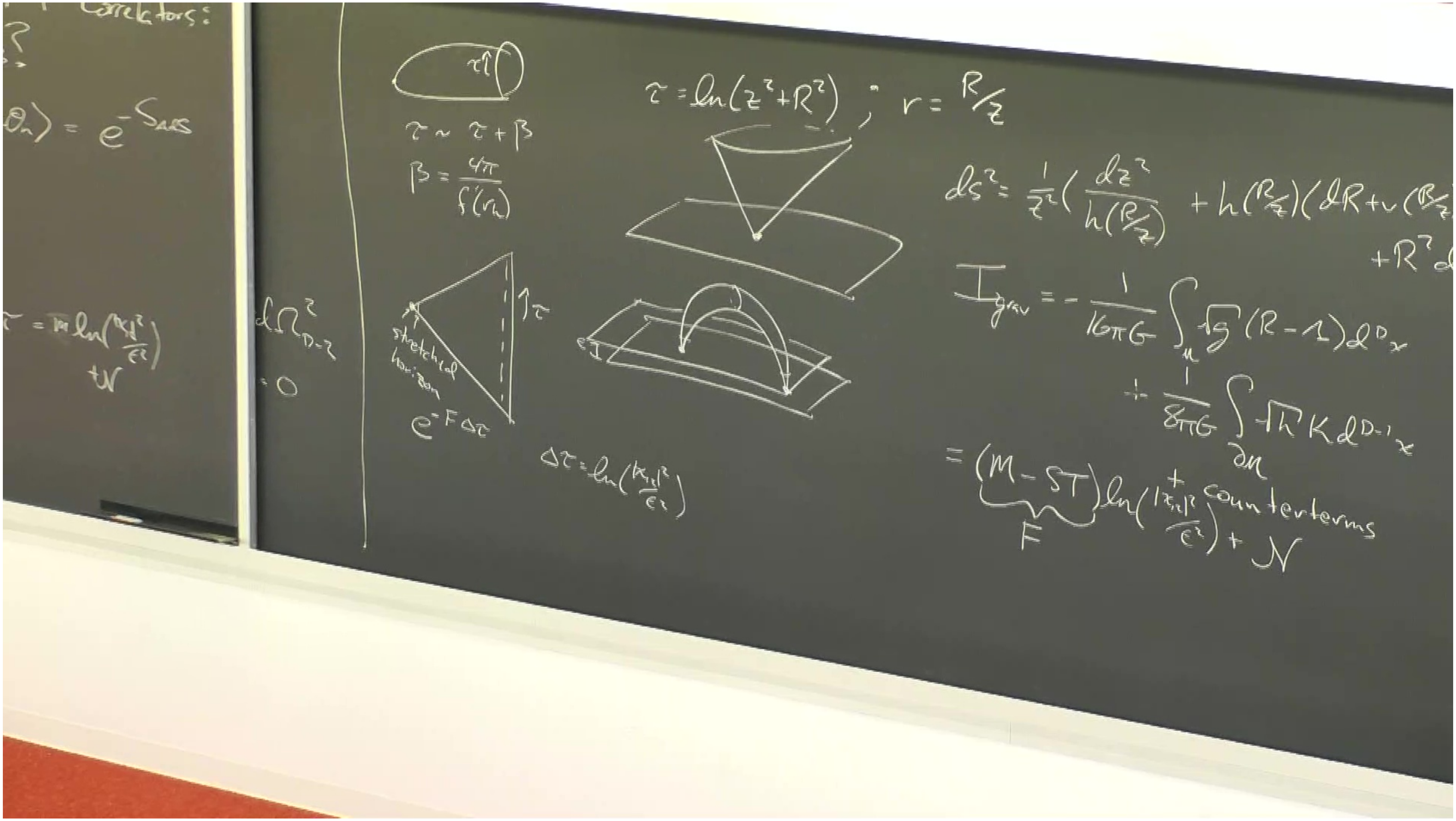


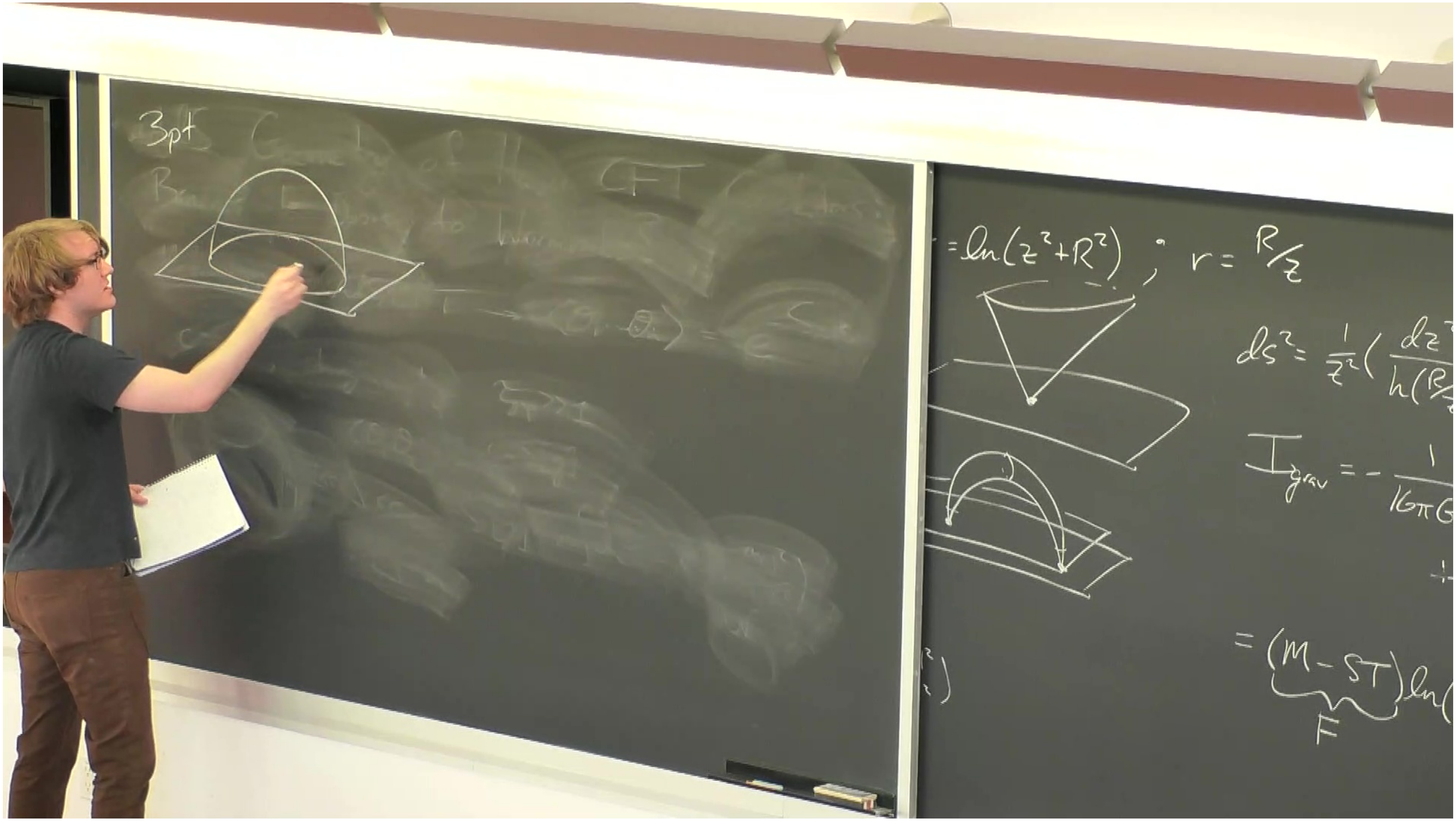
$d\Omega^2_{D-2}$
$= 0$
$\tau \sim \tau + \beta$
$\beta = \frac{4\pi}{f'(r_h)}$
stretched horizon
τ
ϵ
$\tau = \ln(z^2 + R^2)\ ;\ r = R/z$
$ds^2 = \frac{1}{z^2}\left(\frac{dz^2}{h(R/z)} + h(R/z)\left(dR + v(R/z)\,dz\right)^2 + R^2 d\Omega^2_{D-2} \right)$
$I_{grav} = -\frac{1}{16\pi G}\int_{M} \sqrt{g}\,(R - \Lambda)\,d^D x + \frac{1}{8\pi G}\int_{\partial M} \sqrt{h}\,K\,d^{D-1}x$
$+$ counterterms
$= \underbrace{(M - ST)}_{F} \ln\left(\frac{|x_{12}|^2}{\epsilon^2}\right) + \mathcal{N}$

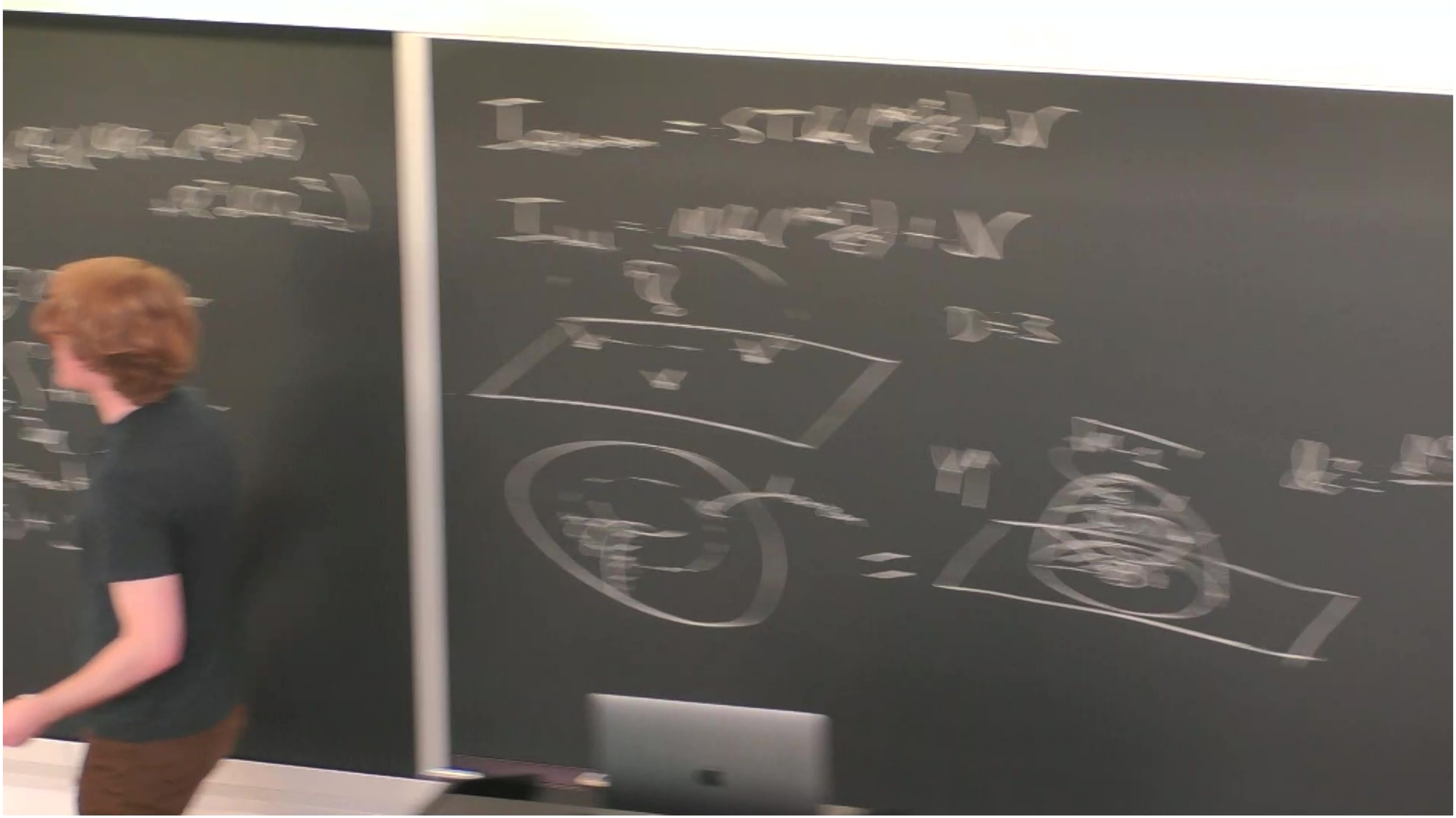

$I_{GH,\,horizon} = S T \ln\left(\frac{|x_{12}|^2}{\epsilon^2}\right) + \mathcal{N}$
$I_{total} = M \ln\left(\frac{|x_{12}|^2}{\epsilon^2}\right) + \mathcal{N}$
stretched horizon
e^{-F}
$d\Omega_{D-2}^2)$

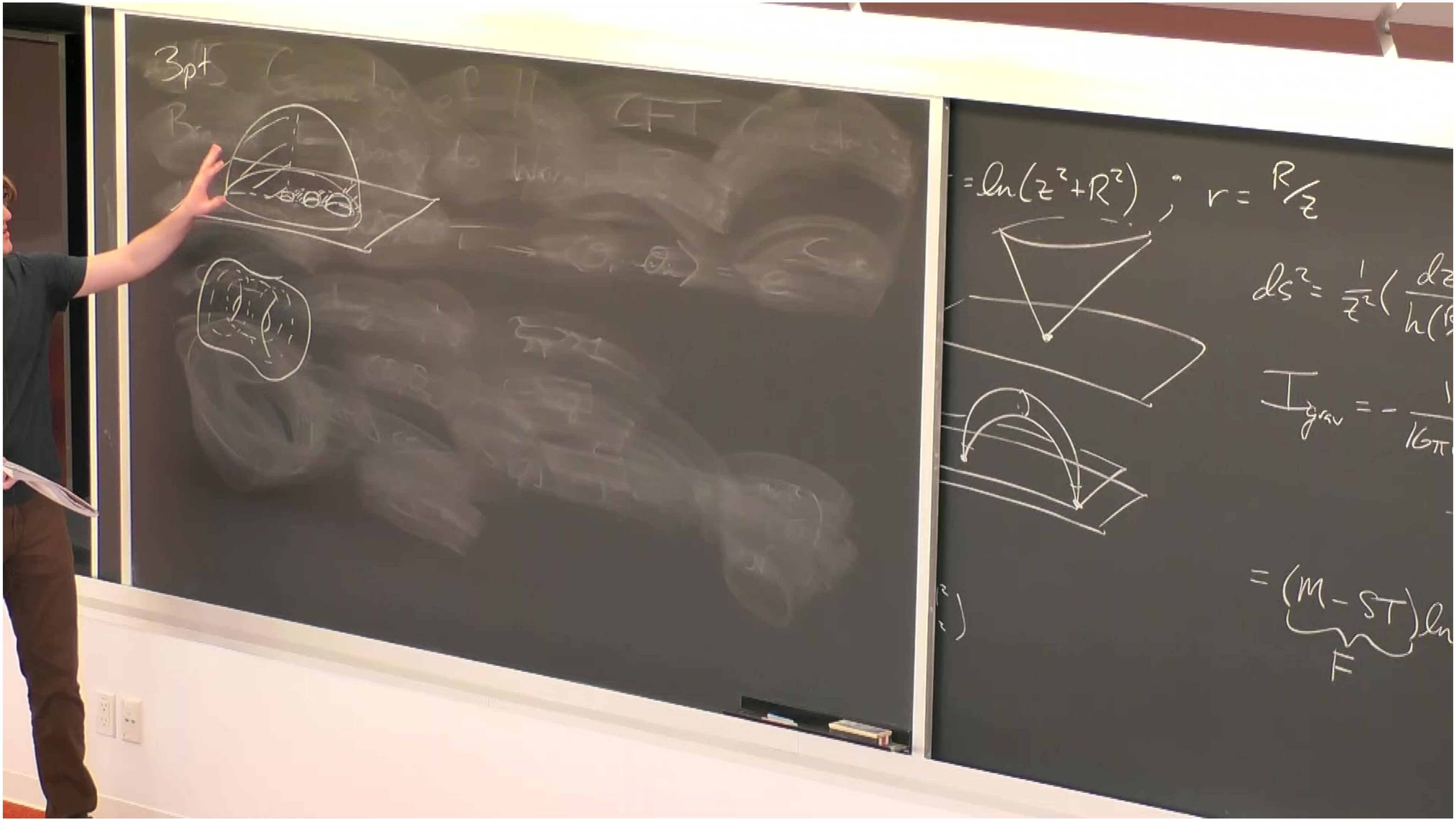


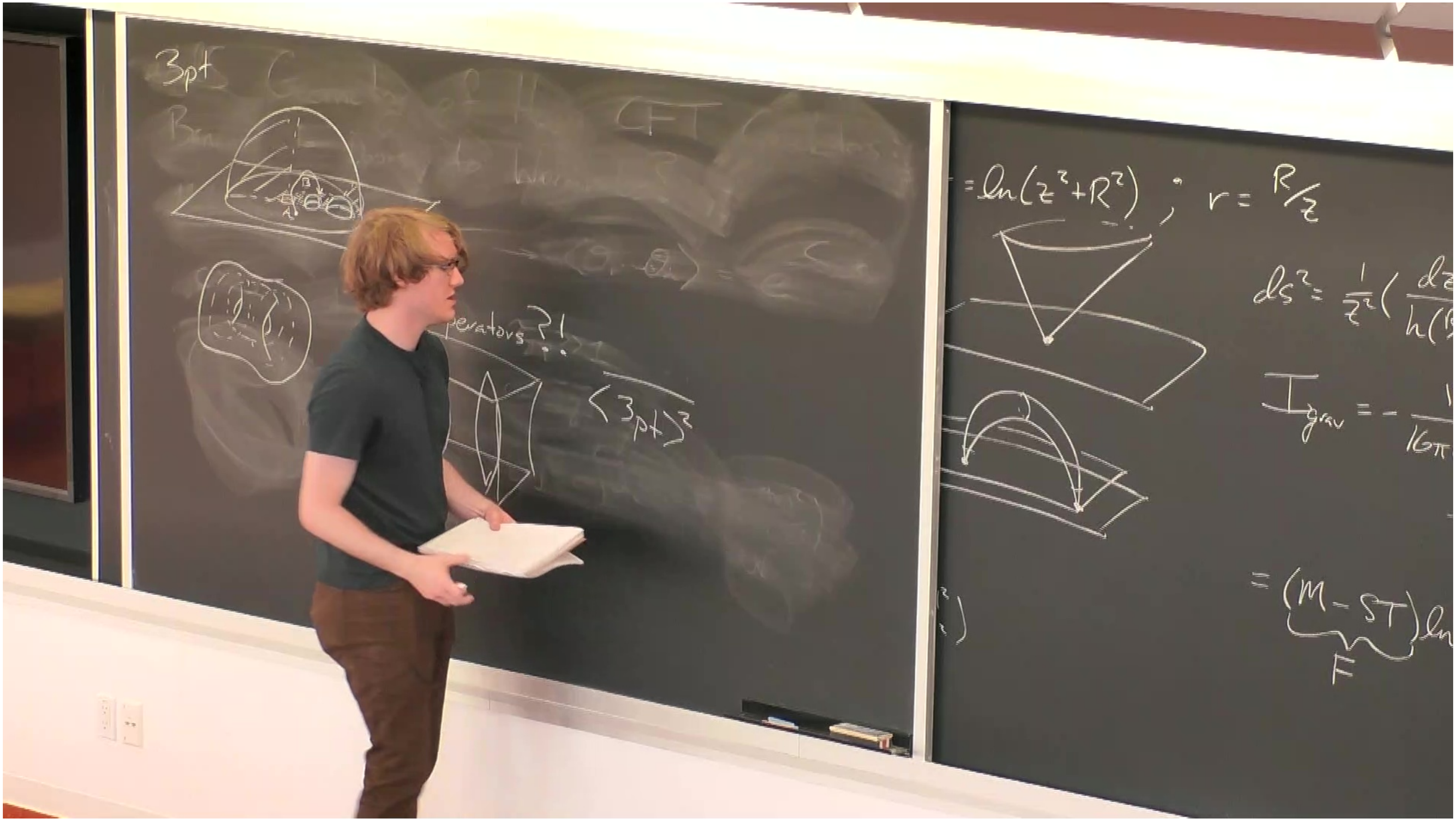
if Δ ∝ C
reaction
gravity Λ < 0
Schwarzschild
I_GH,horizon = ST ln(|x12|²/ε²) + N
I_total = M ln(|x12|²/ε²) + N
D = 3
horizon
stretched horizon
ds² = (dY² + dz dz̄)/Y²

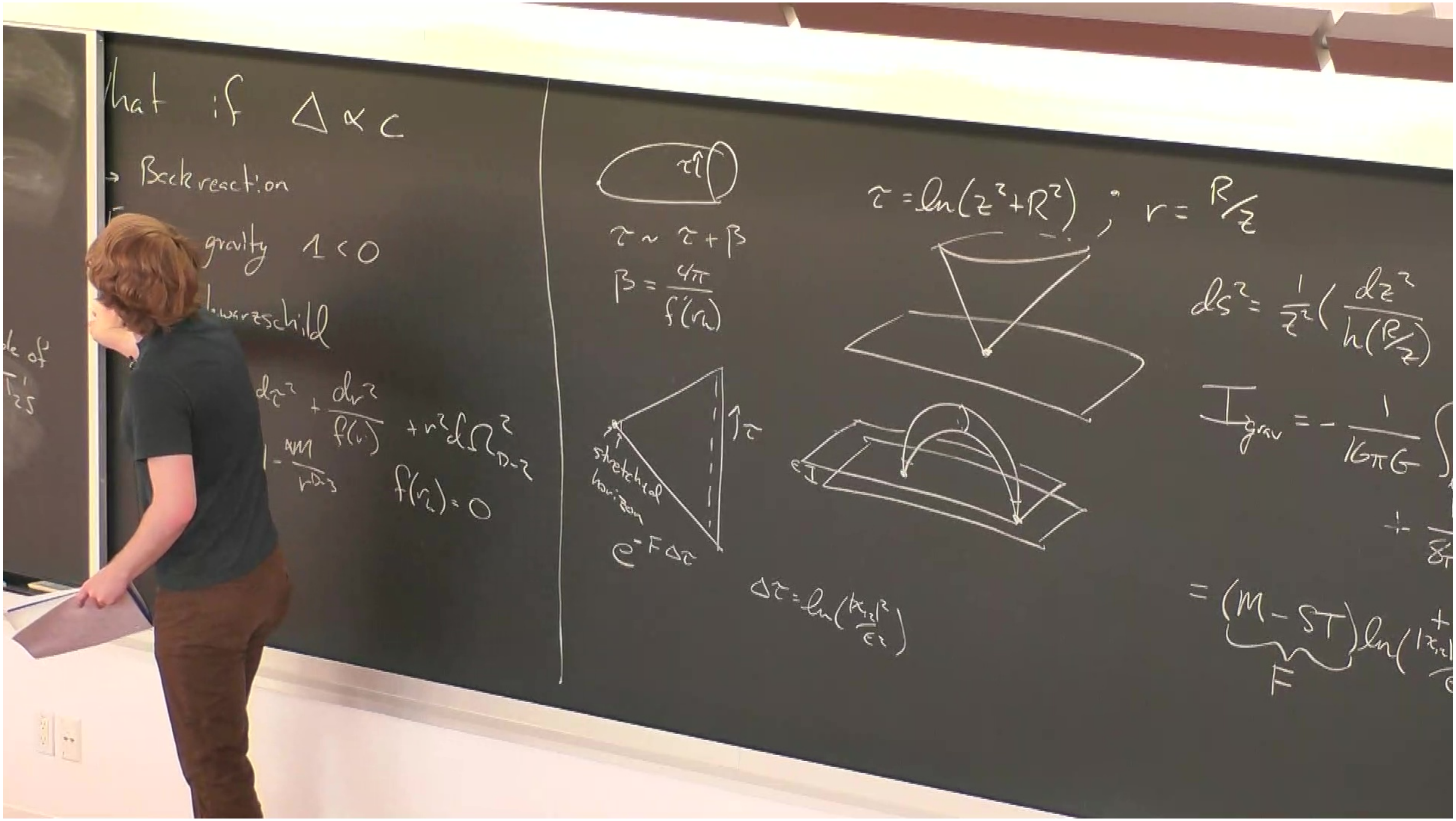

Correlators:
τ = ln(z² + R²) ; r = R/z
τ ~ τ + β
β = 4π / f′(r_h)
ds² = 1/z² (dz²/h(R/z) + h(R/z)(dR + v(R/z)
+ R² d
I_grav = − 1/16πG ∫_M √g (R − Λ) d^D x
+ 1/8πG ∫_∂M √h K d^(D−1) x
+ counterterms
= (M − ST) ln(|x_12|²/ε²) + N
F
stretched horizon
e^(−F Δτ)
Δτ = ln(|x_12|²/ε²)
dΩ²_(D−2)
= 0
⟨O_n⟩ = e^(−S_AdS)
τ = m ln(|x_12|²/ε²) + N

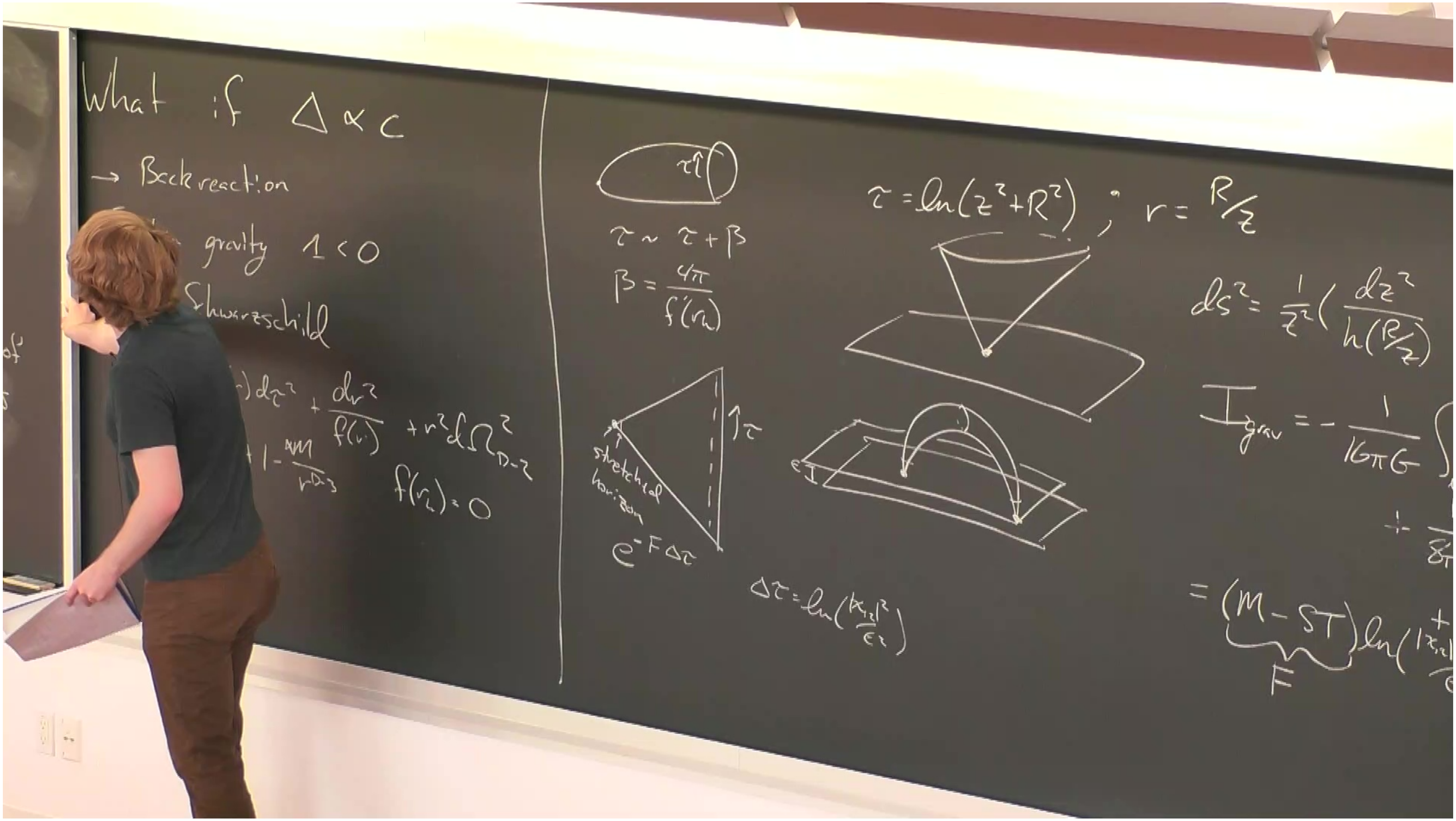

3pt
CFT
= ln(z²+R²) ; r = R/z
ds² = 1/z² (dz²/h(R/z
I_grav = - 1/16πG
= (M - ST) ln(
F

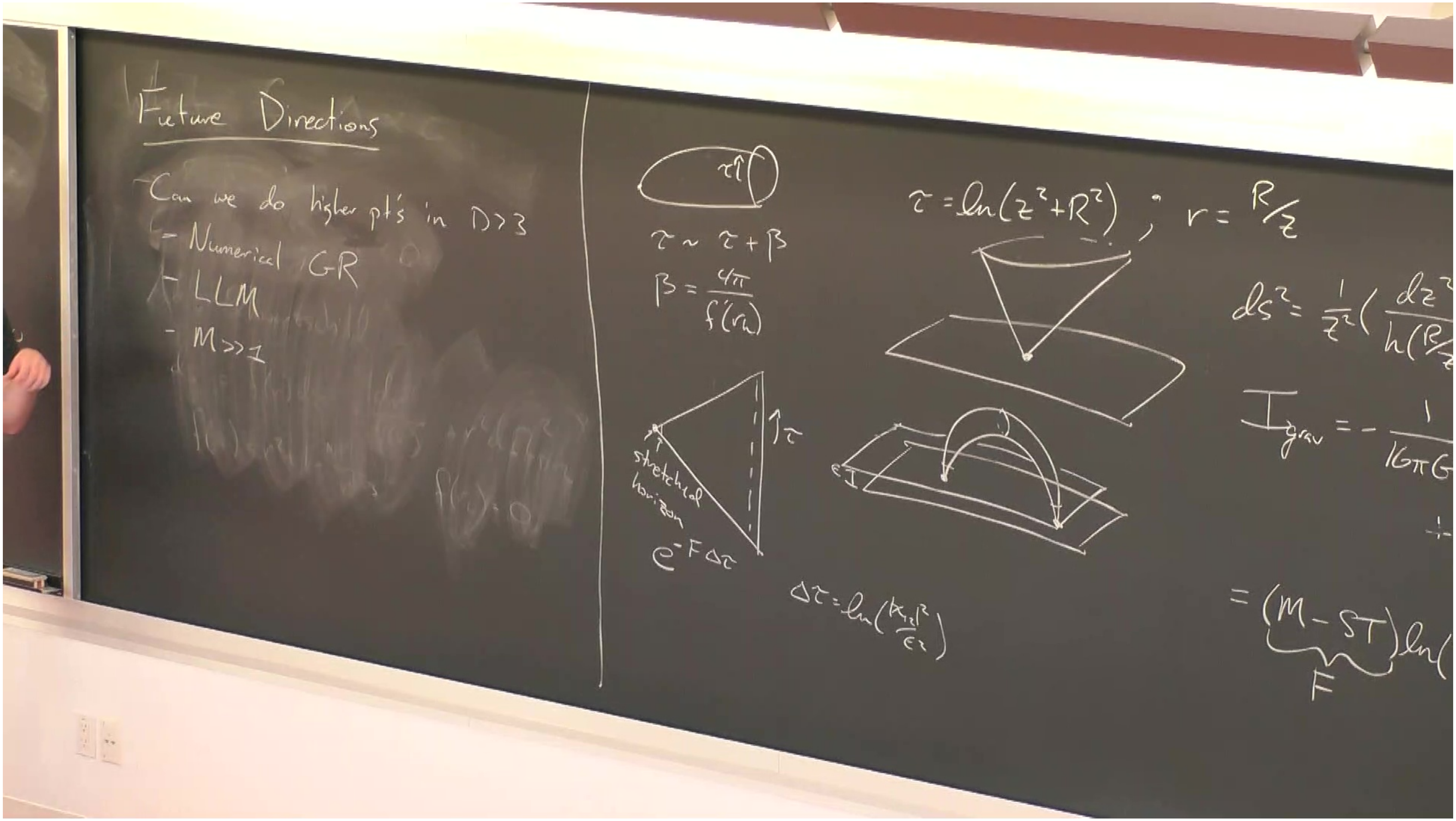


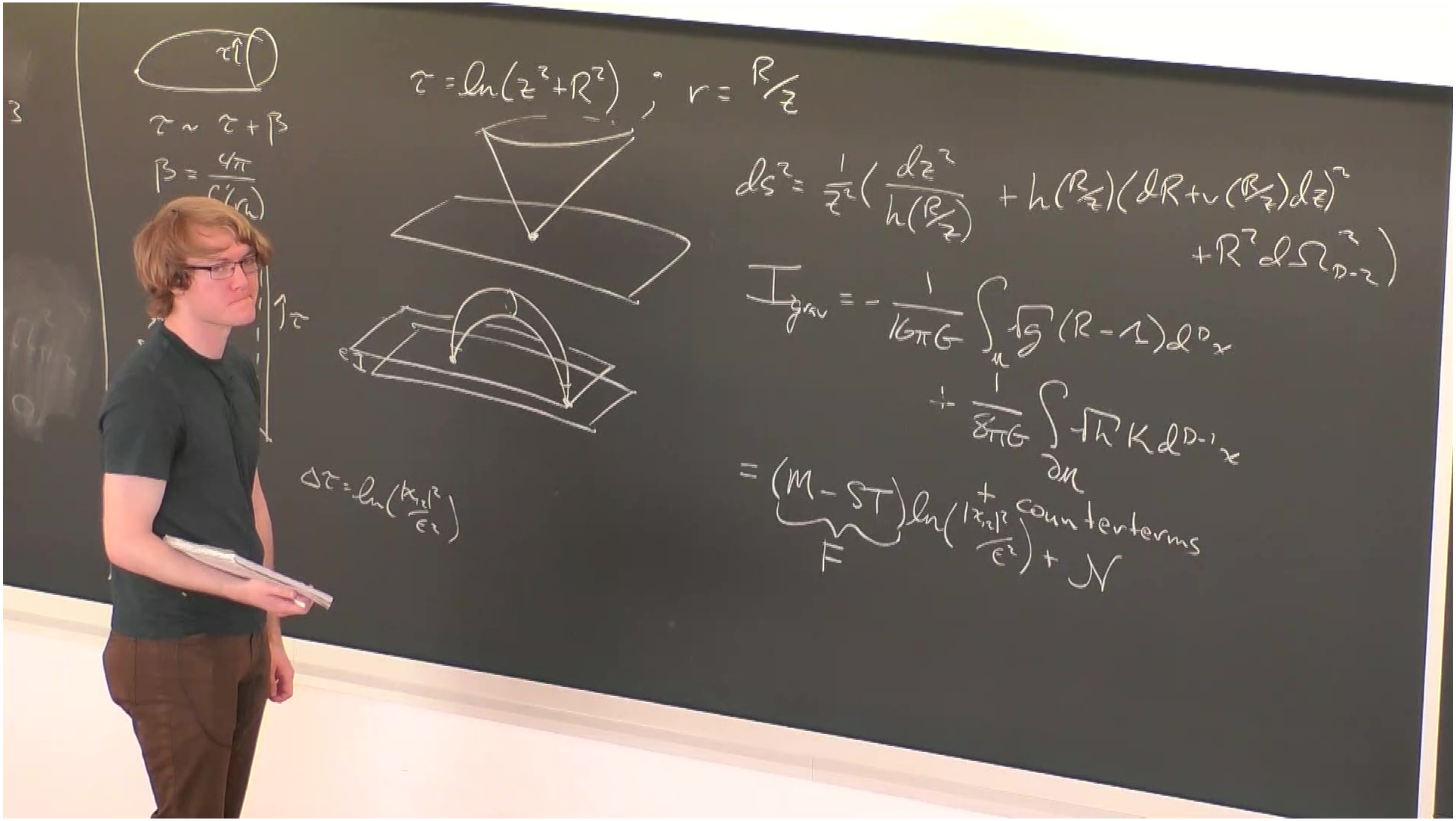

3pt
CFT
= ln(z²+R²) ; r = R/z
ds² = 1/z² (dz
I_grav = - 1/16π
= (M - ST) ln
F


3pt
CFT
operators ?!
⟨3pt⟩²
= ln(z² + R²) ; r = R/z
ds² = 1/z² (dz
I_grav = -
16π
= (M - ST) ln
F


hat if Δ ∝ c
Backreaction
gravity
warzschild
f(r_h) = 0
τ ∼ τ + β
β = 4π / f′(r_h)
stretched horizon
e^{-FΔτ}
Δτ = ln(|x_12|^2 / ε^2)
τ = ln(z^2 + R^2) ; r = R/z
ds^2 = 1/z^2 (dz^2 / h(R/z)
I_grav = − 1/16πG
= (M − ST) ln(
F


What if Δ ∝ c
→ Backreaction
gravity 1 < 0
Schwarzschild
f(r_h) = 0
τ ~ τ + β
β = 4π / f'(r_h)
stretched horizon
e^{-FΔτ}
Δτ = ln(|x_12|^2 / ε^2)
τ = ln(z^2 + R^2) ; r = R/z
ds^2 = 1/z^2 (dz^2 / h(R/z)
I_grav = - 1/16πG
= (M - ST) ln(
F


Future Directions
- Can we do higher pt's in D>3
- Numerical GR
- LLM
- M>>1
τ ~ τ + β
β = 4π / f'(r_h)
stretched horizon
e^{-FΔτ}
Δτ = ln(|x_{12}|^2 / ε^2)
τ = ln(z^2+R^2) ; r = R/z
ds^2 = 1/z^2 (dz^2 / h(R/z
I_grav = - 1 / 16πG
= (M - ST) ln(
F


τ ~ τ + β
β = 4π / f'(r_h)
τ = ln(z² + R²) ; r = R/z
ds² = 1/z² (dz²/h(R/z) + h(R/z)(dR + v(R/z)dz)² + R² dΩ²_{D-2})
I_grav = − 1/(16πG) ∫_M √g (R − Λ) d^D x + 1/(8πG) ∫_∂M √h K d^{D-1} x
= (M − ST) ln(|x₁₂|²/ε²) + N + counterterms
F
Δτ = ln(|x₁₂|²/ε²)
ε