Title: Bounds on gravitational brane couplings in AdS3â€‹ black hole microstates

Speakers: Dominik Neuenfeld

Series: Quantum Gravity

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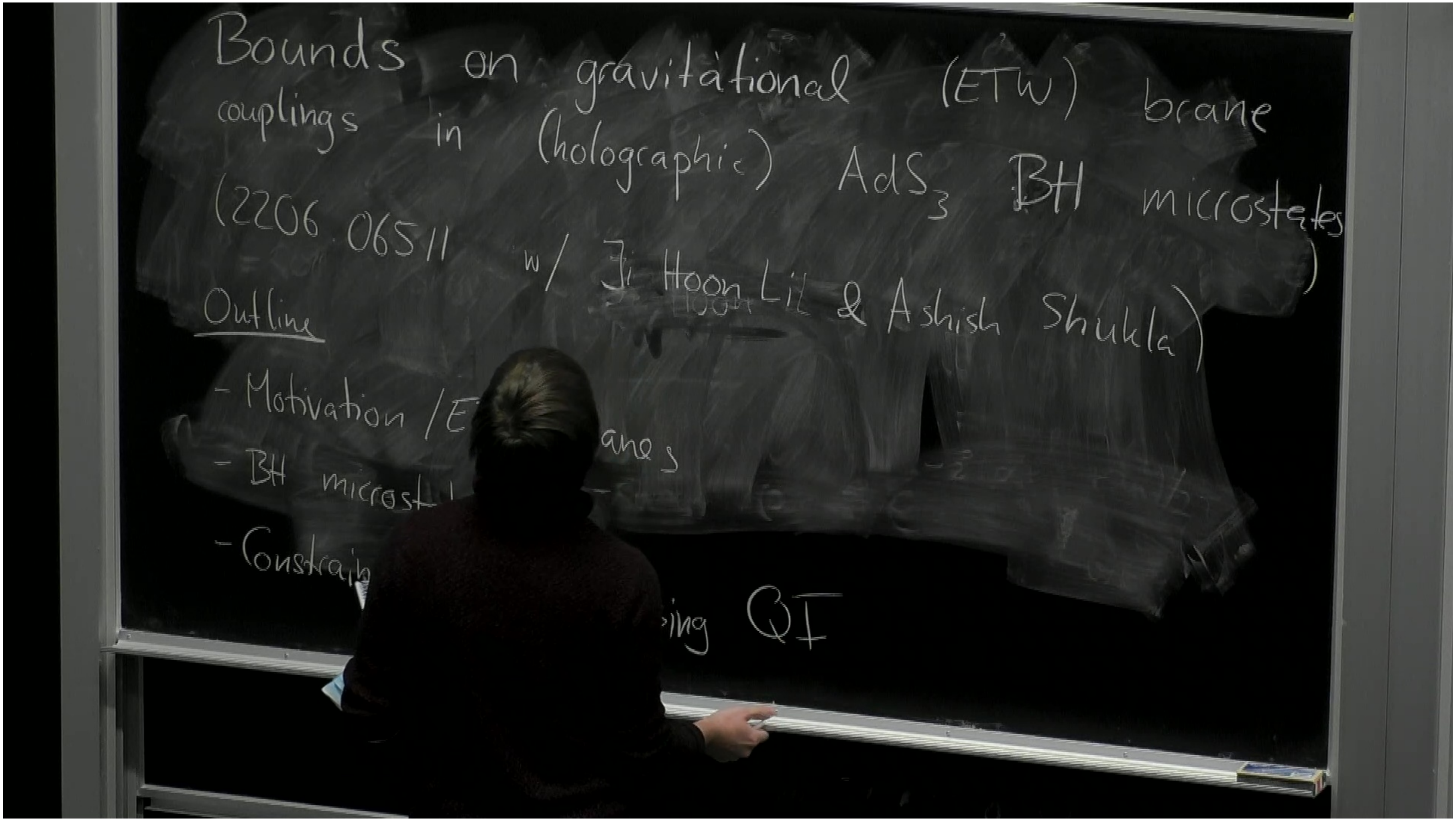
Abstract: I will discuss information theoretic properties of planar black hole microstates in 2 + 1 dimensional asymptotically anti-de Sitter spacetime, modeled by black holes with an end-of-the-world brane behind the horizon. The von Neumann entropy of sufficiently large subregions in the dual CFT exhibits a time-dependent phase, which from a doubly-holographic perspective corresponds to the appearance of quantum extremal islands in the brane description. Considering the case where dilaton gravity is added to the brane, we show that tuning the associated couplings affects the propagation of information in the dual CFT state. By requiring that information theoretic bounds on the growth of entanglement entropy are satisfied in the dual CFT, we can place bounds on the allowed values of the couplings on the brane.

Zoom link:  https://pitp.zoom.us/j/96173295706?pwd=REdGajBXbTlPYVFhL0s1c3lINXY5Zz09


Bounds on gravitational (ETW) brane
couplings in (holographic) AdS3 BH microstates
(2206.06511 w/ Ji Hoon Lee & Ashish Shukla)
Outline
- Motivation / E
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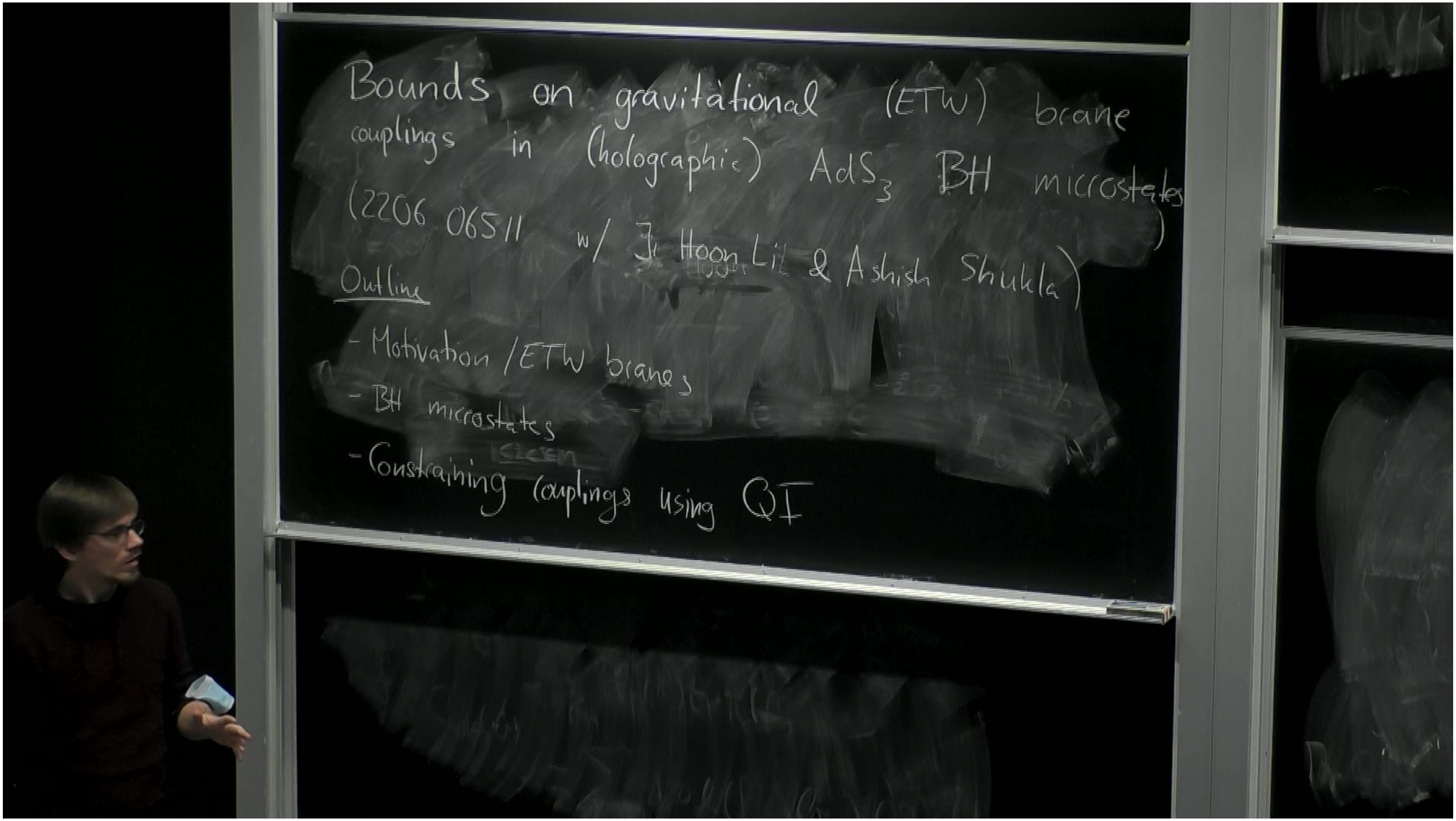
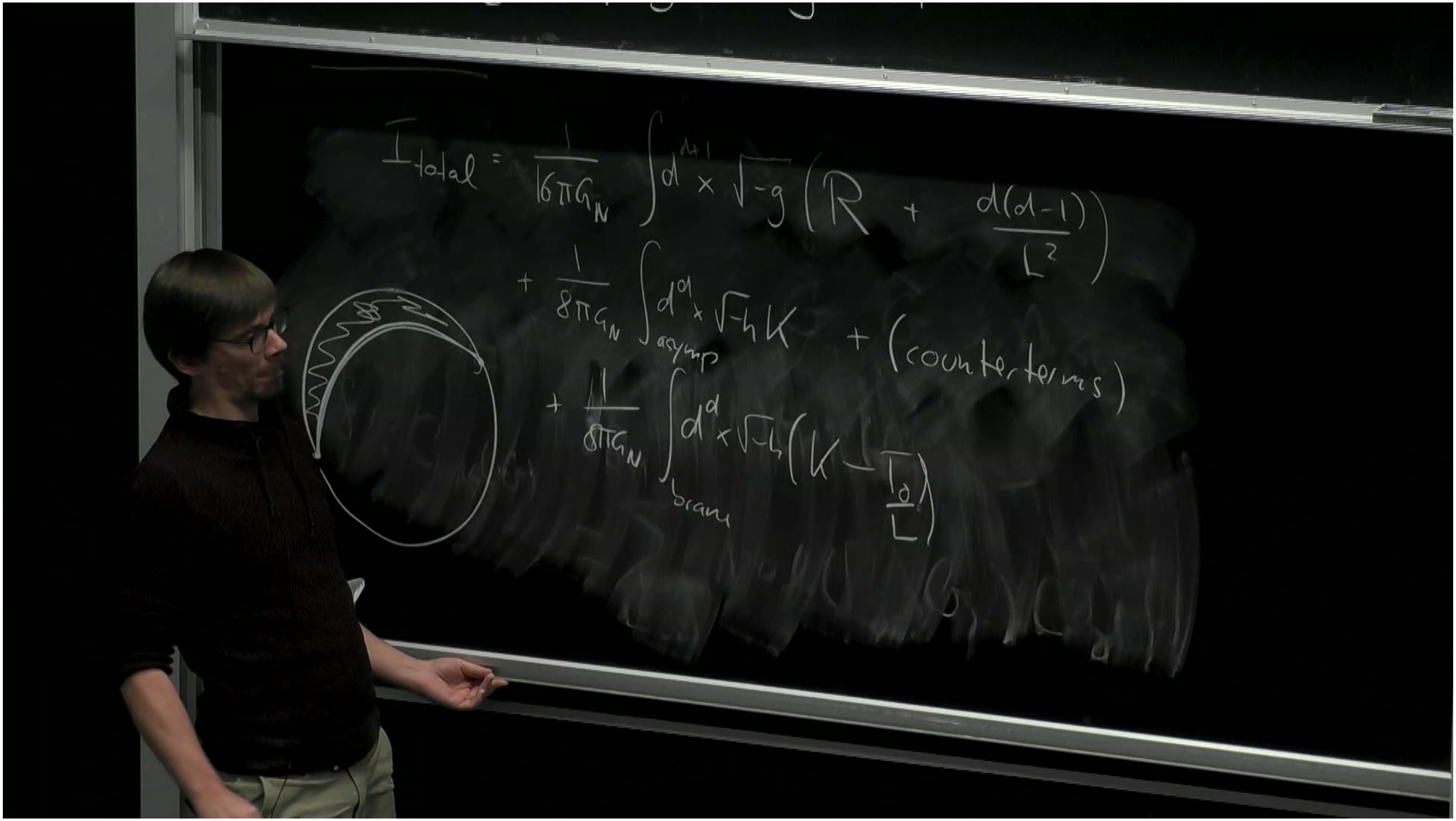
- BH microst
- Constrain
ing QF


Bounds on gravitational (ETW) brane
couplings in (holographic) $AdS_3$ BH microstates
(2206.06511 w/ Ji Hoon Lee & Ashish Shukla)
Outline
- Motivation / ETW branes
- BH microstates
- Constraining couplings using QI

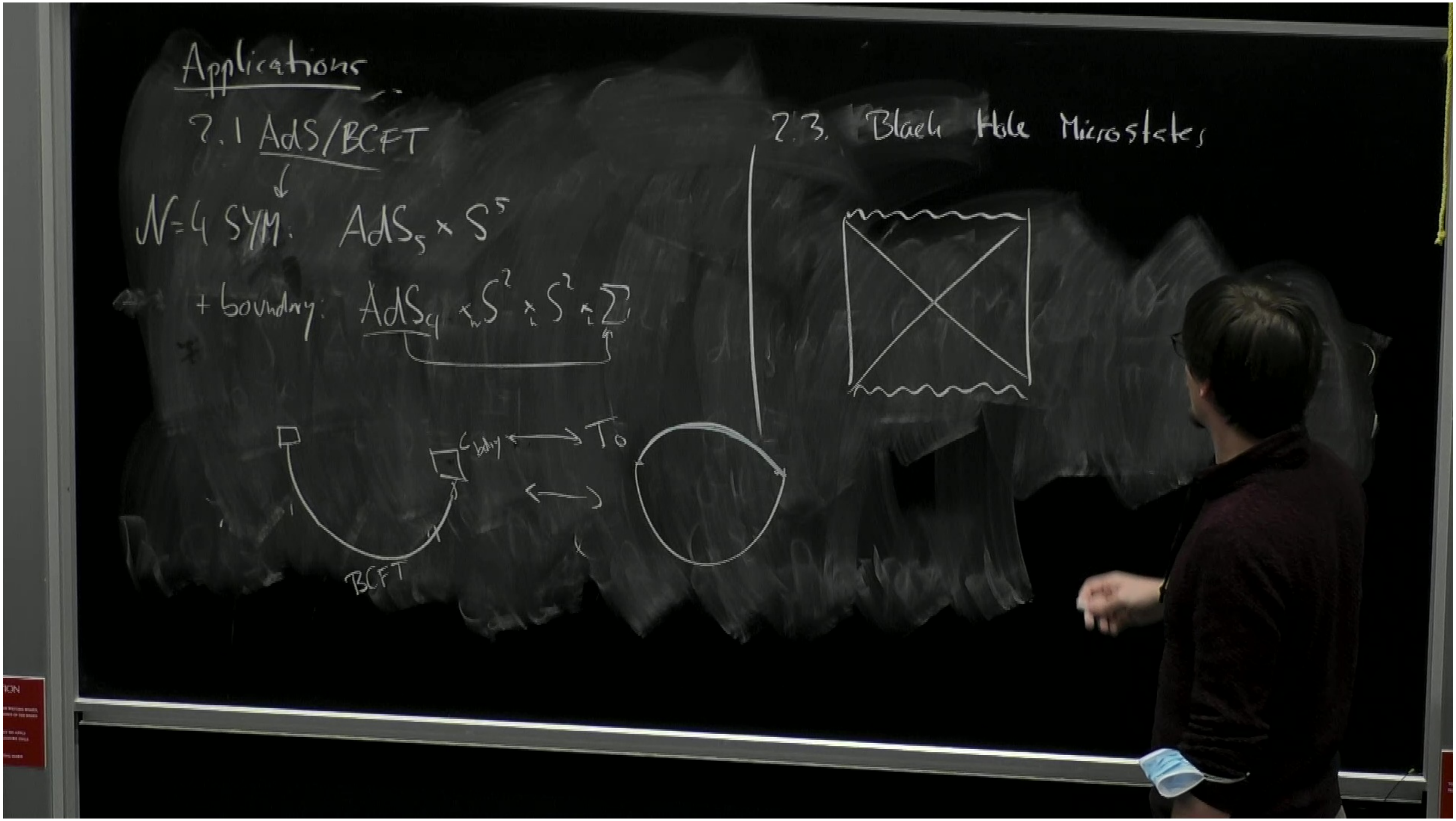

$I_{total} = \frac{1}{16\pi G_N}\int d^{d+1}x\,\sqrt{-g}\left(R + \frac{d(d-1)}{L^2}\right)$
$+ \frac{1}{8\pi G_N}\int_{asymp} d^d x\,\sqrt{-h}\,K + (\text{counterterms})$
$+ \frac{1}{8\pi G_N}\int_{brane} d^d x\,\sqrt{-h}\left(K - \frac{T_0}{L}\right)$

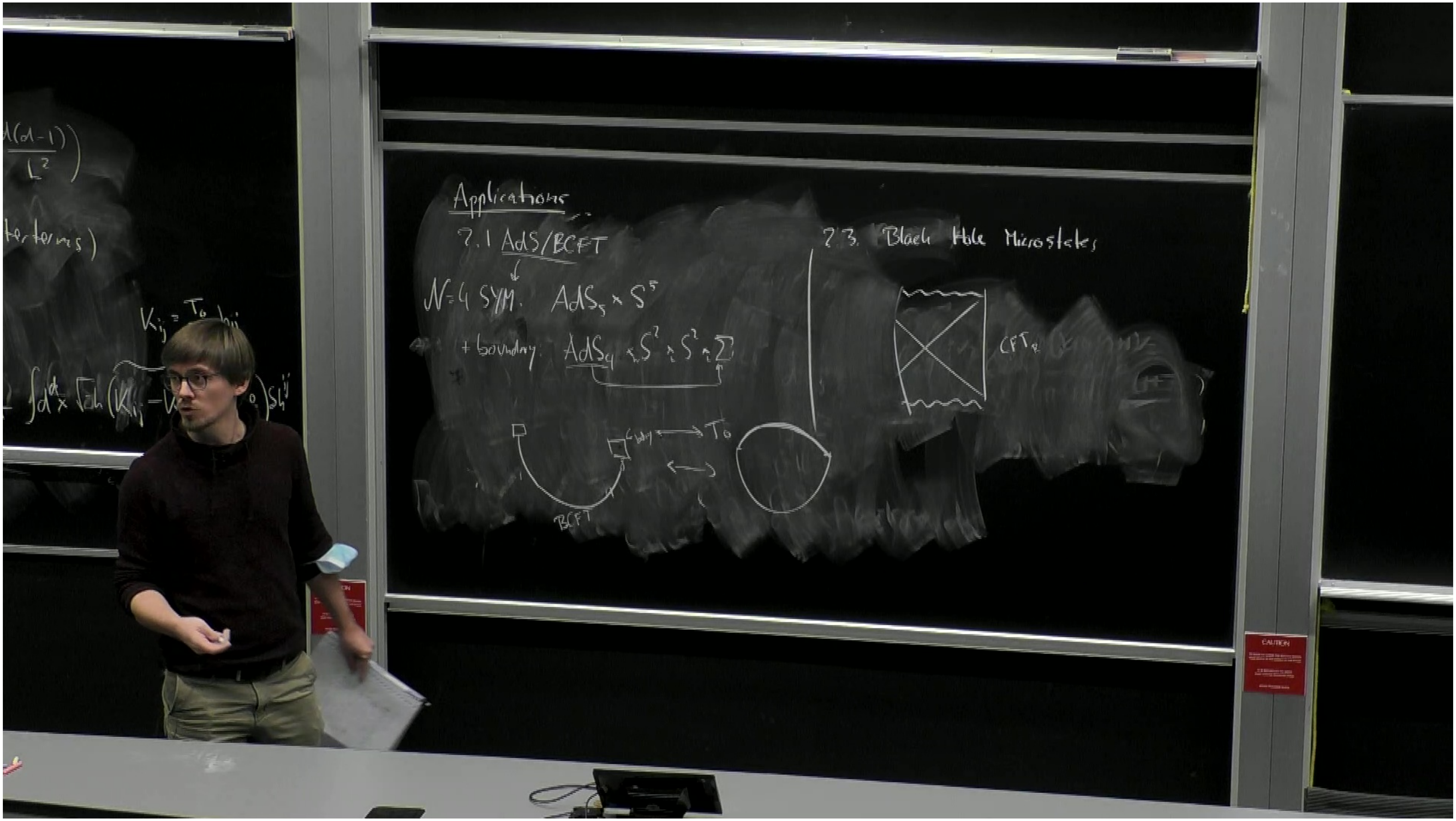
$$I_{total} = \frac{1}{16\pi G_N}\int d^{d+1}x\,\sqrt{-g}\left(R + \frac{d(d-1)}{L^2}\right)$$

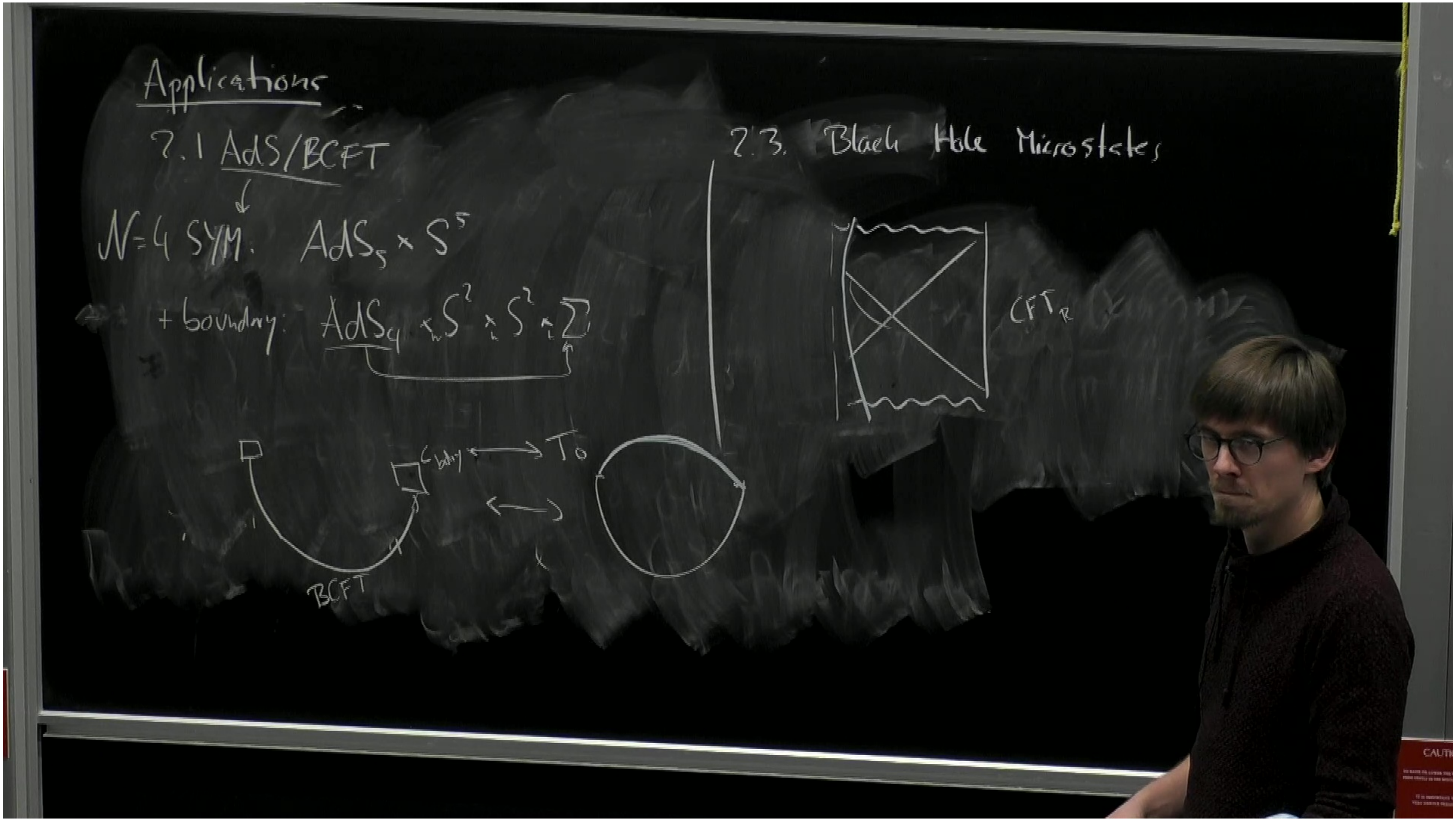
$$+ \frac{1}{8\pi G_N}\int_{asymp} d^d x\,\sqrt{-h}\,K \;+\; (\text{counterterms})$$

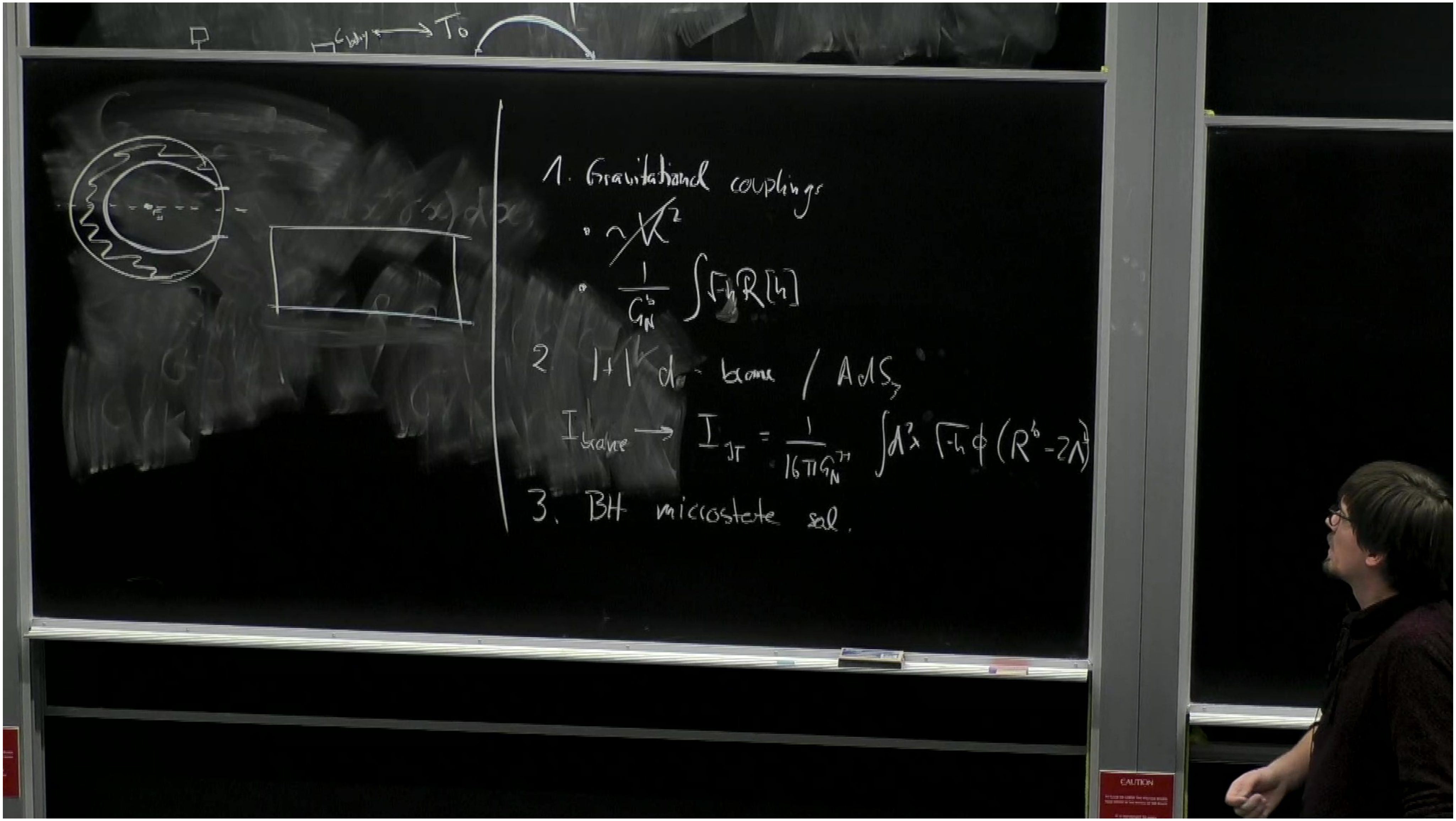
$$+ \frac{1}{8\pi G_N}\int_{brane} d^d x\,\sqrt{-h}\left(K - \frac{T_0}{L}\right)$$

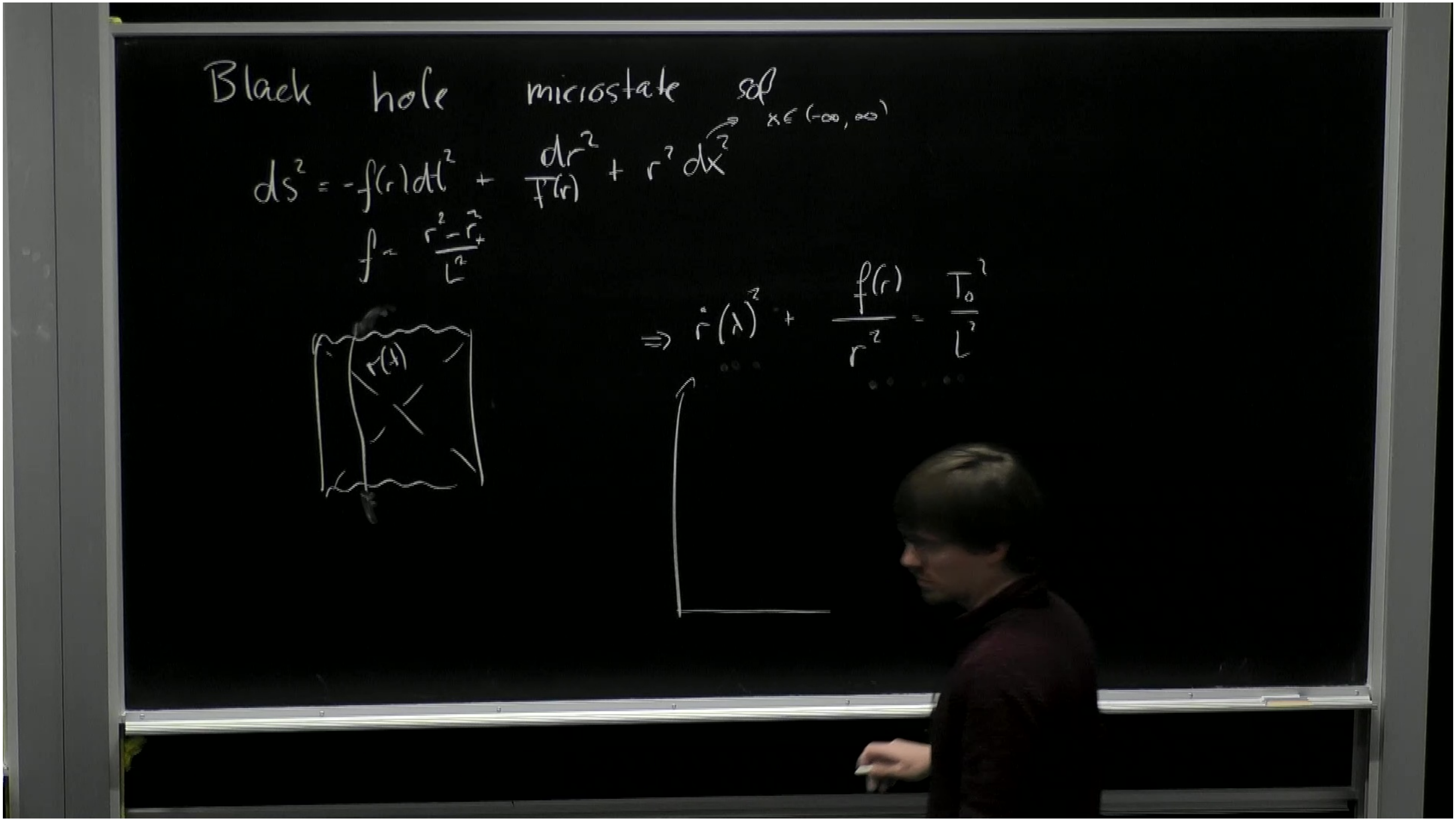
$$\delta I_{total} = \int d^{d+1}\,(E.O.M.)_{\mu\nu}\,\delta g^{\mu\nu} + \int d^d x\,\sqrt{-h}\,\overbrace{\left(K_{ij} - K h_{ij} + \frac{T_0}{L}\right)}^{K_{ij} = \frac{T_0}{L} h_{ij}}\delta h^{ij}$$

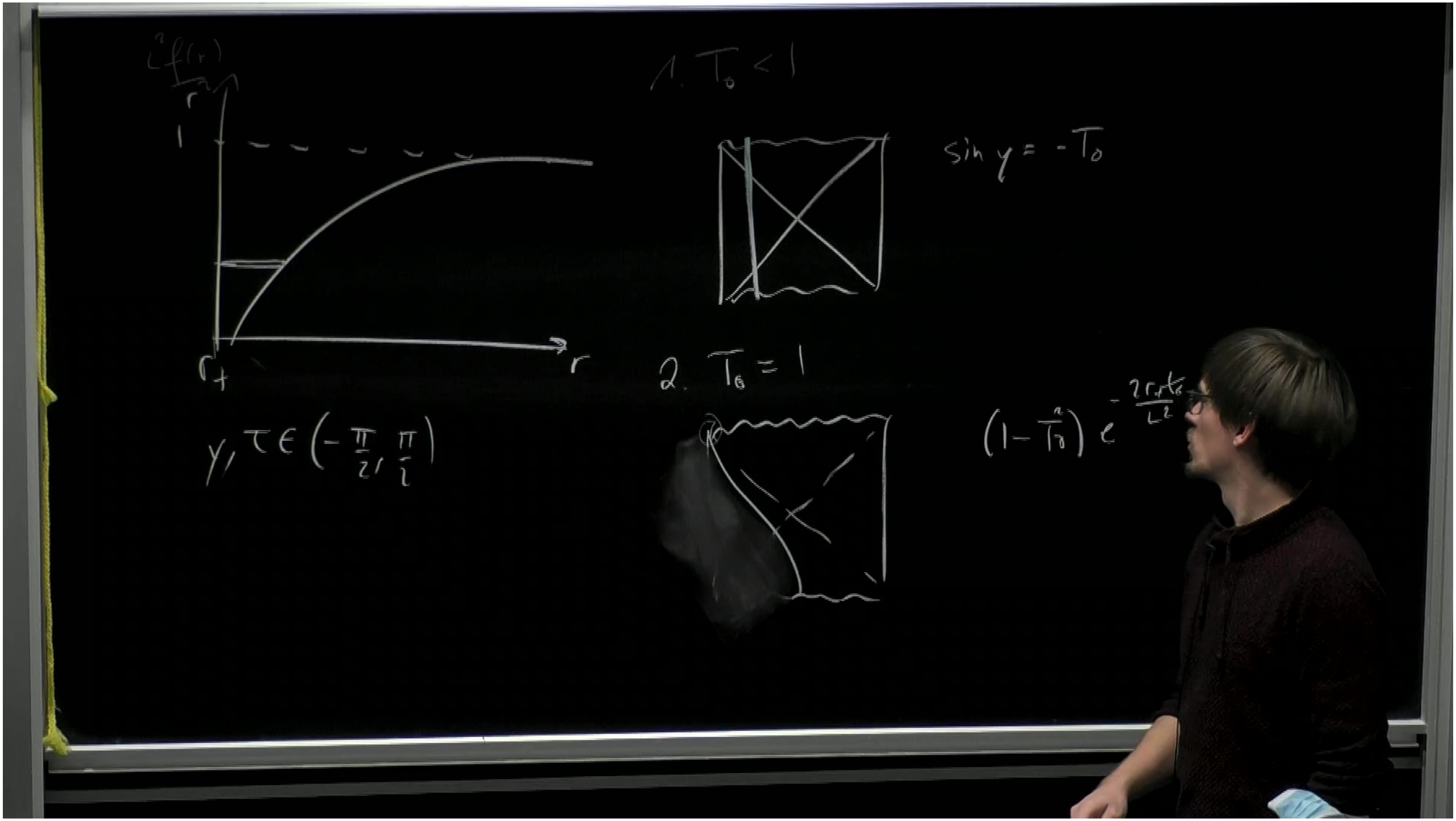

Applications
2.1 AdS/BCFT
N=4 SYM: AdS5 × S5
+ boundary: AdS4 × S2 × S2 × Σ
bdry
T0
BCFT
2.3. Black Hole Microstates


Applications
7.1 AdS/BCFT
$\mathcal{N}=4$ SYM. $AdS_5 \times S^5$
+ boundary. $AdS_4 \times S^2 \times S^2 \times \Sigma$
BCFT
$T_0$
7.3. Black Hole Microstates
$CFT_2$
$K_{ij} = T_0 h_{ij}$

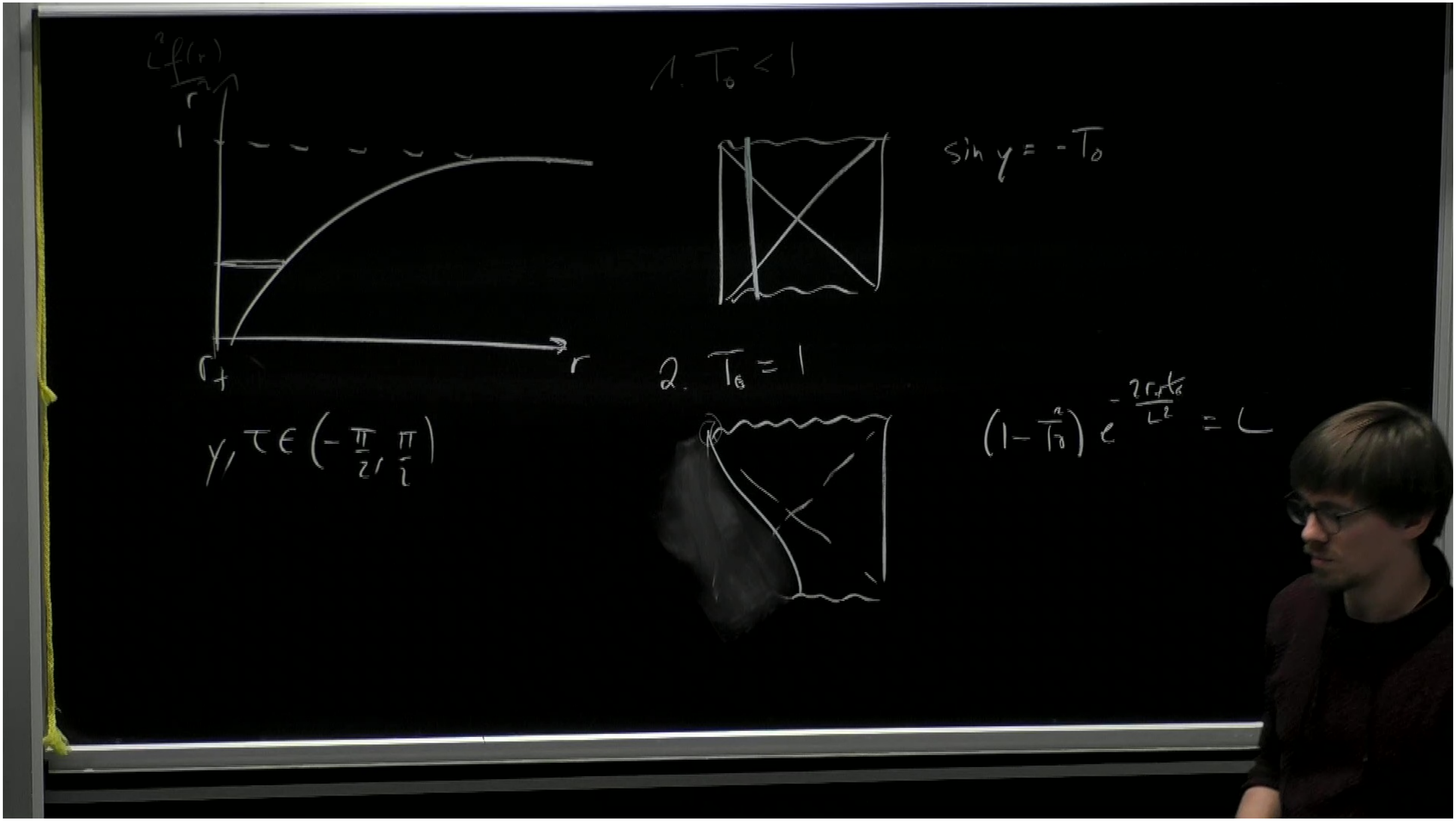

Applications
2.1 AdS/BCFT
N=4 SYM: AdS5 × S5
+ boundary: AdS4 × S2 × S2 × Σ
bdry ⟷ T0
BCFT
2.3. Black Hole Microstates
CFTR


1. Gravitational couplings
• ∼ ~~K²~~
• 1/G_N^b ∫√-h R[h]
2 1+1 d - brane / AdS_3
I_brane → I_JT = 1/(16π G_N^{2+1}) ∫d²x √-h φ (R^b - 2Λ)
3. BH microstate sol.

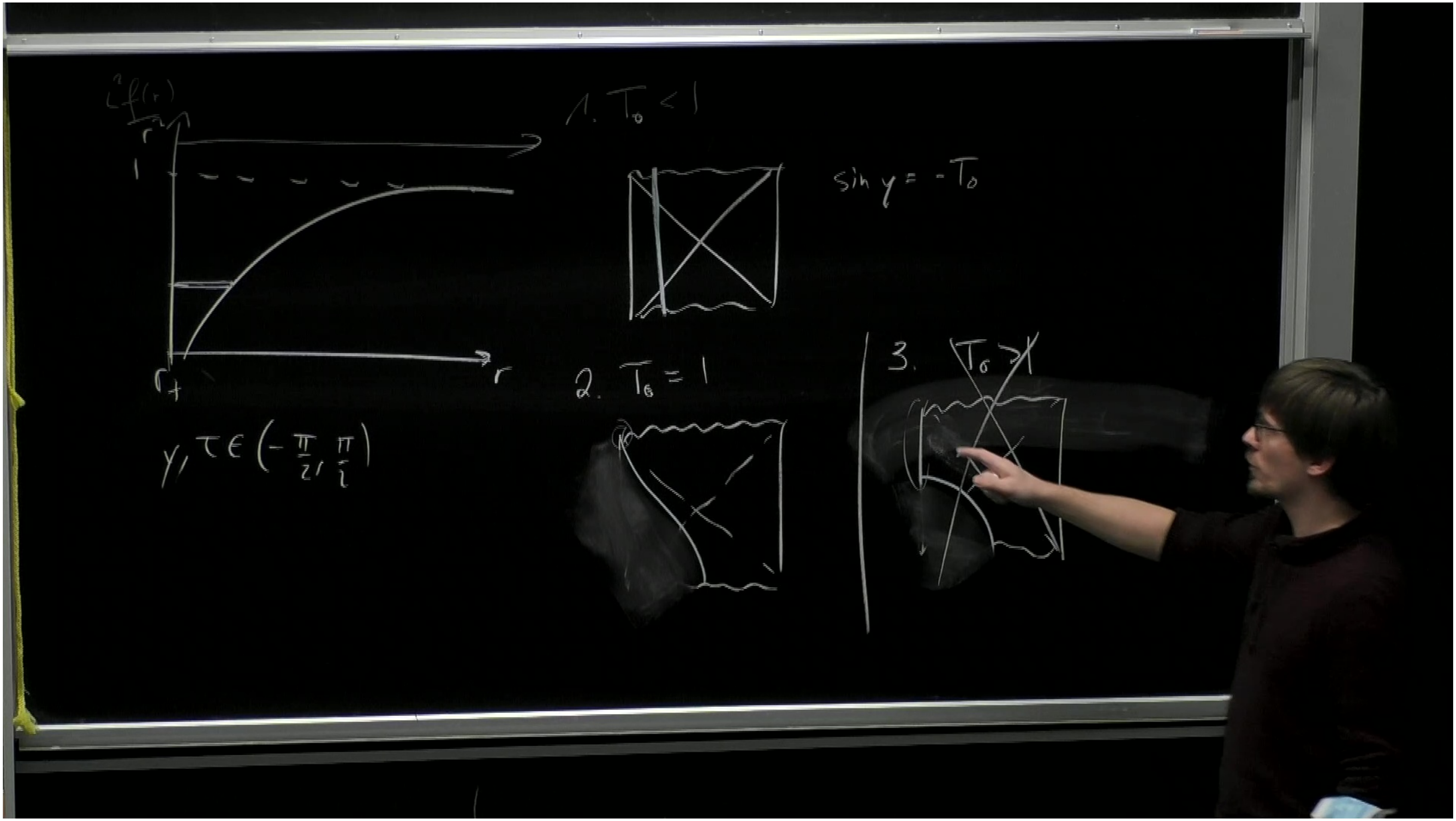

Black hole microstate sol
x ∈ (-∞, ∞)
$ds^2 = -f(r)dt^2 + \frac{dr^2}{f(r)} + r^2 dx^2$
$f = \frac{r^2 - r_+^2}{L^2}$
$r(\lambda)$
$\Rightarrow \dot{r}(\lambda)^2 + \frac{f(r)}{r^2} = \frac{T_0^2}{L^2}$

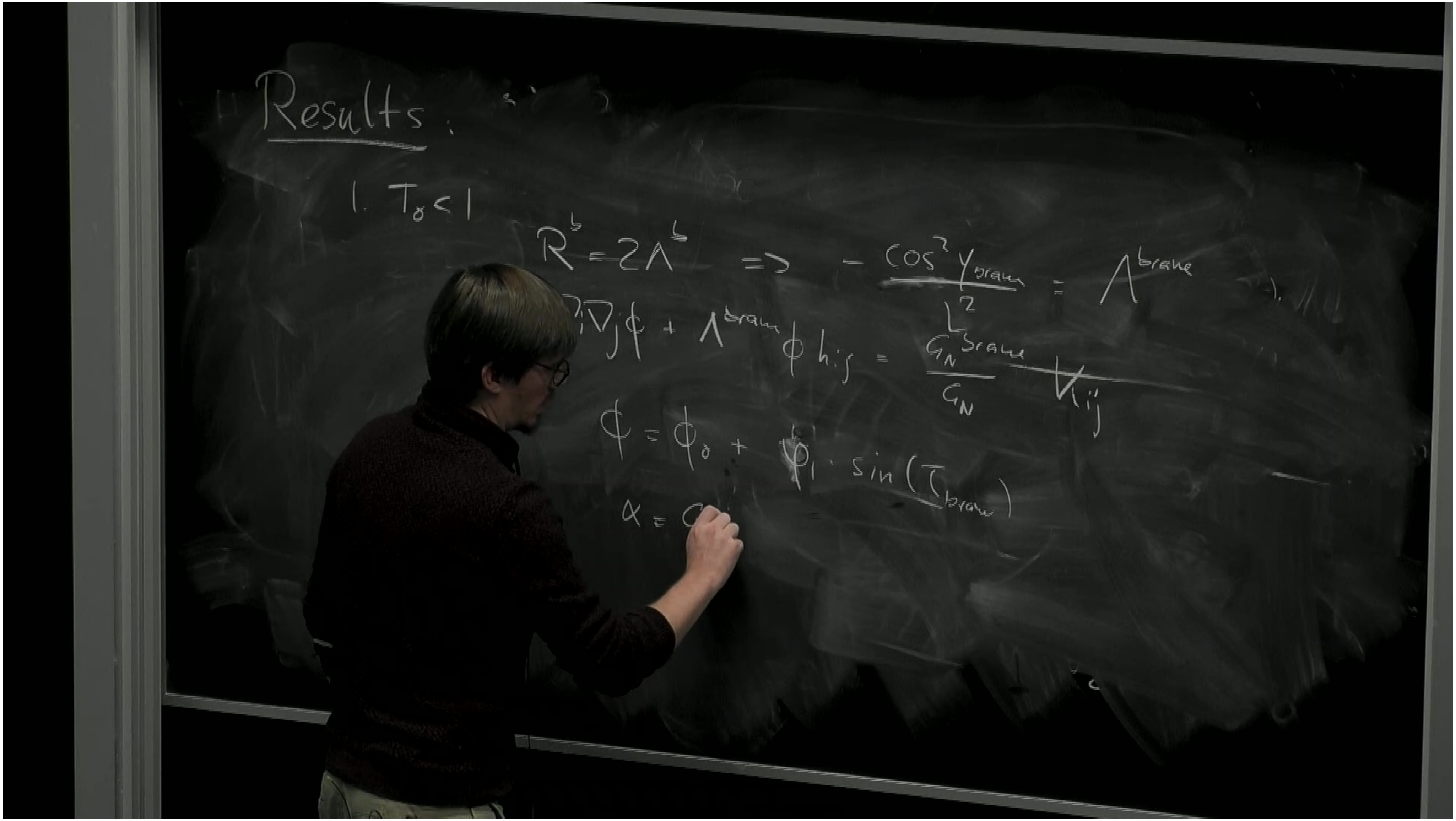


f(r)
r
1
r+
r
y, τ ∈ (−π/2, π/2)
1. T0 < 1
sin y = −T0
2. T0 = 1



1. T0 < 1
sin y = - T0
2. T0 = 1
y, τ ∈ (-π/2, π/2)


1. $T_0 < 1$
$\sin y = -T_0$
2. $T_0 = 1$
3. $T_0 > 1$
$y, \tau \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$


Results:
1. T_γ < 1
R^b = 2Λ^b => − cos² y_brane / L² = Λ^brane
∇_i∇_j φ + Λ^brane φ h_ij = (G_N^brane / G_N) T_ij
φ = φ_0 + φ_1 · sin(τ_brane)
α =

## Results:

1. $T_\gamma < 1$

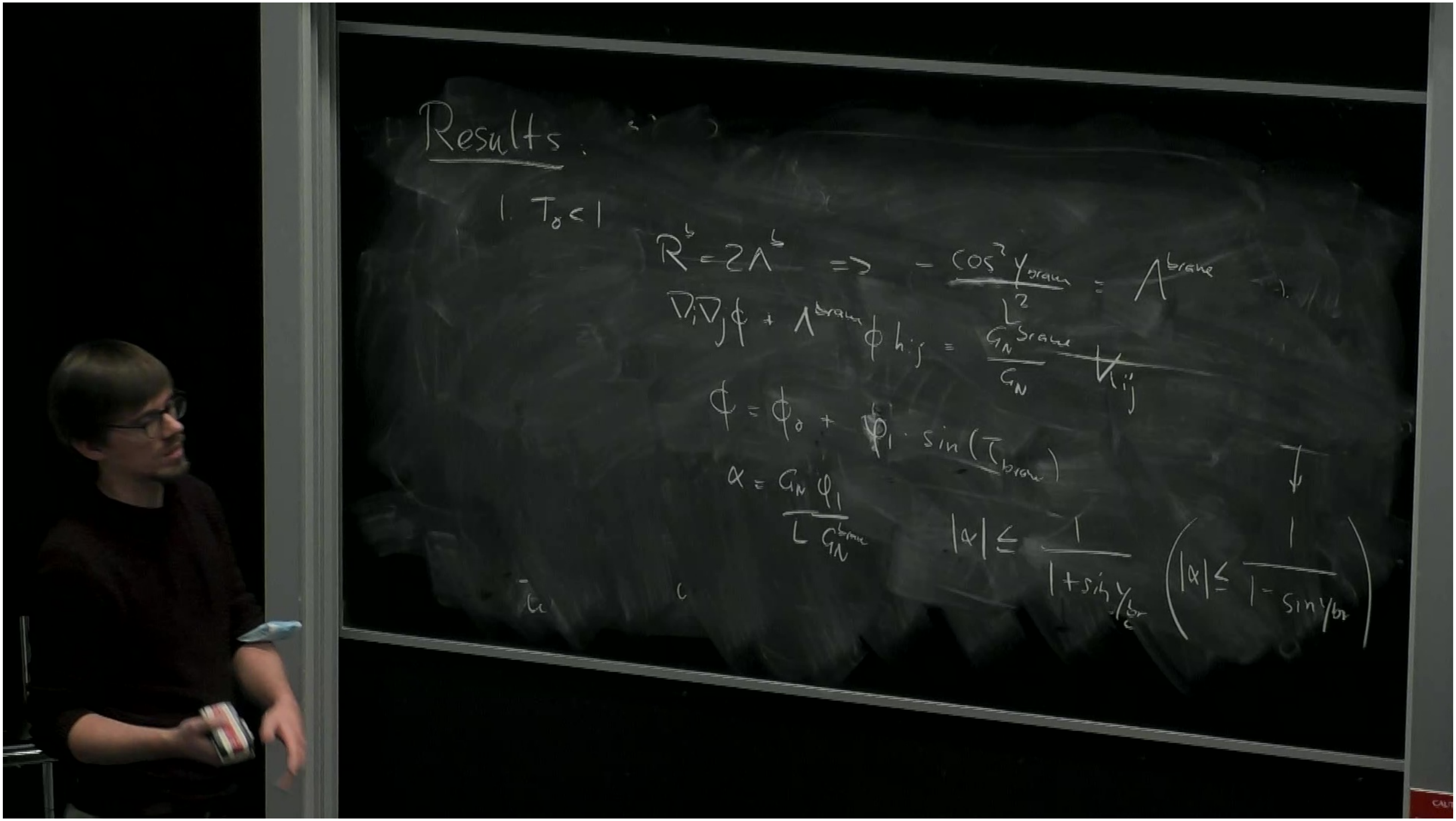
$$R^b = 2\Lambda^b \Rightarrow -\frac{\cos^2 y_{brane}}{L^2} = \Lambda^{brane}$$

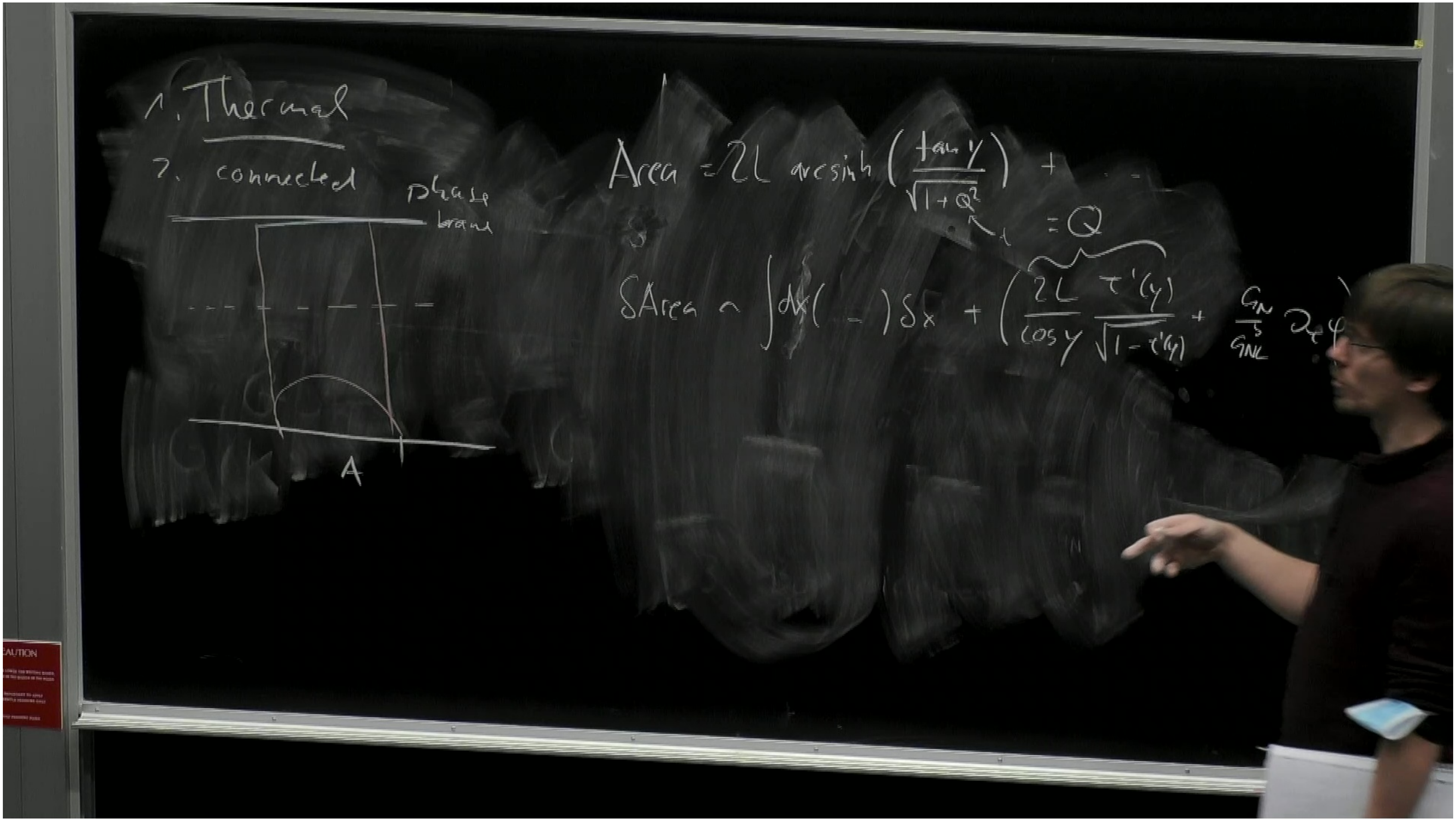
$$\nabla_i \nabla_j \phi + \Lambda^{brane} \phi h_{ij} = \frac{G_N^{brane}}{G_N} T_{ij}$$

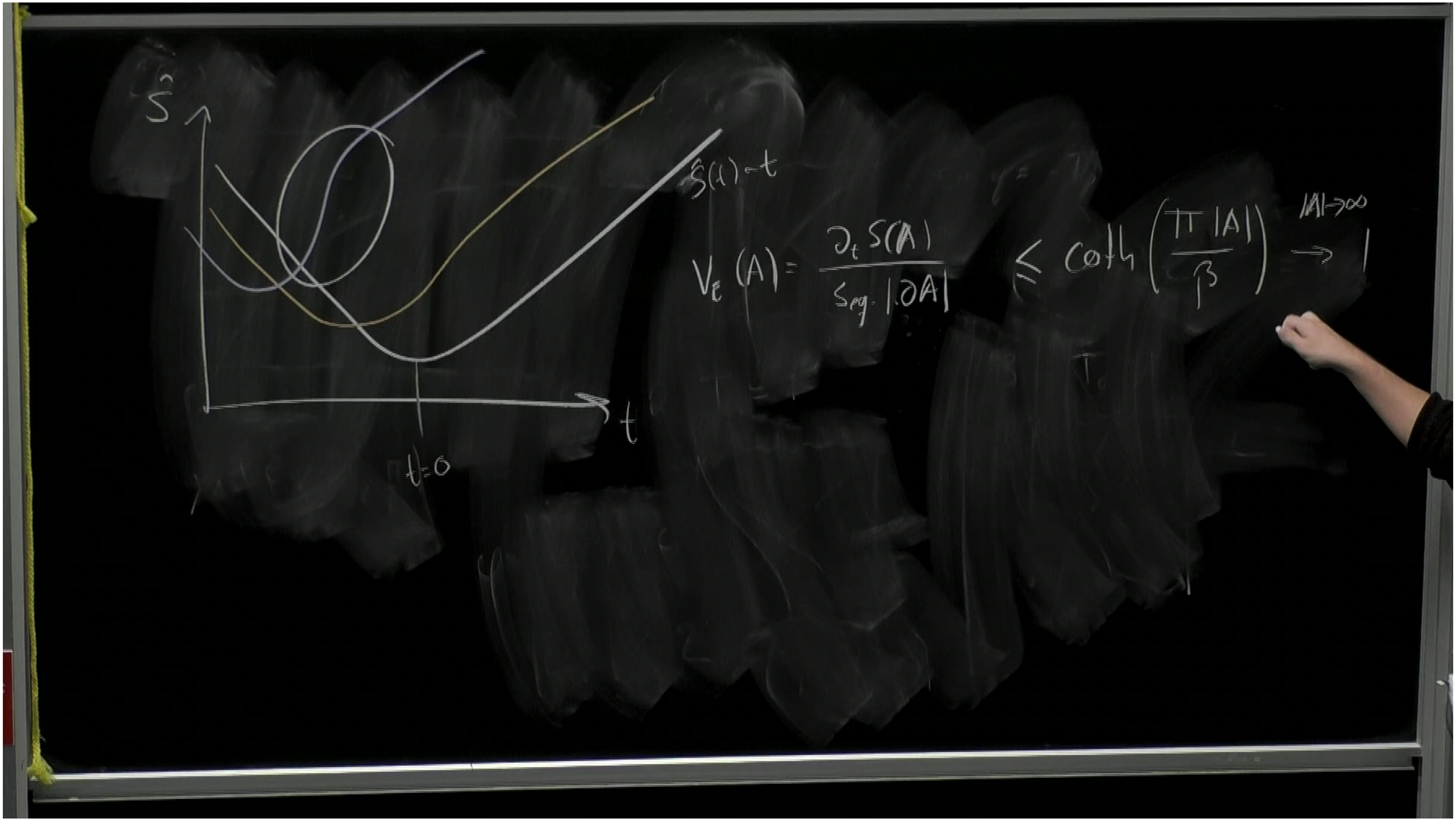
$$\phi = \phi_0 + \phi_1 \cdot \sin(\tau_{brane})$$

$$\alpha = \frac{G_N \phi_1}{L\, G_N^{brane}}$$

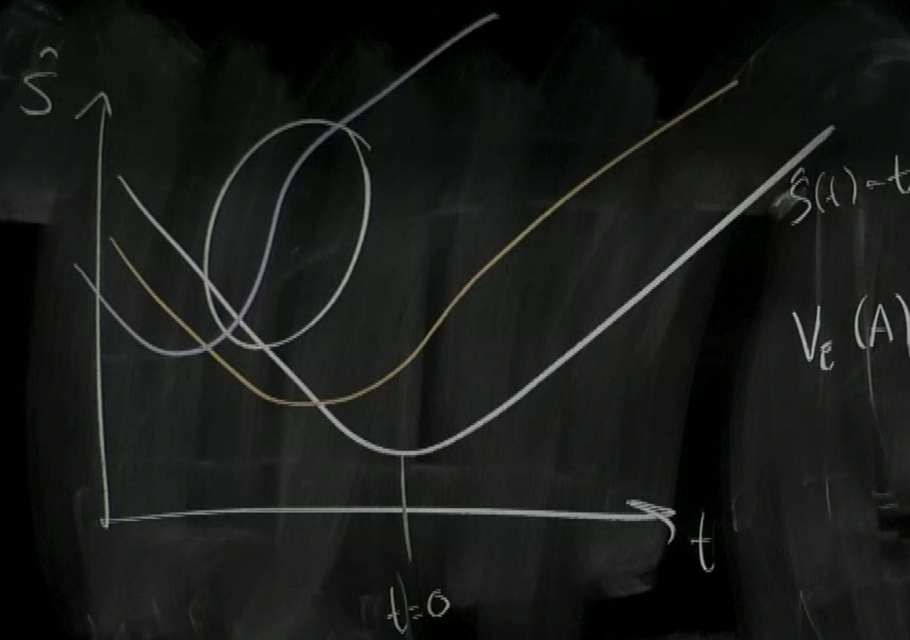
$$|\alpha| \le \frac{1}{1+\sin y_{br}} \qquad \left( |\alpha| \le \frac{1}{1-\sin y_{br}} \right)$$


Results:
1. Tγ < 1
Rᵇ = 2Λᵇ => − cos² y_brane / L² = Λ^brane
∇i∇j φ + Λ^brane φ hij = G_N^brane / G_N Kij
φ = φ0 + φ1 · sin(τ_brane)
α = G_N φ1 / L G_N^brane
|α| ≤ 1 / 1 + sin y_br
(|α| ≤ 1 / 1 − sin y_br)


1. Thermal
2. connected phase
brane
A
Area = 2L arcsinh ( tan y / √(1+Q²) ) + ...
= Q
δArea ~ ∫dx( _ ) δx + ( 2L/cos y · τ'(y)/√(1 − τ'(y)) + G_N/G_NL ∂_τ φ )



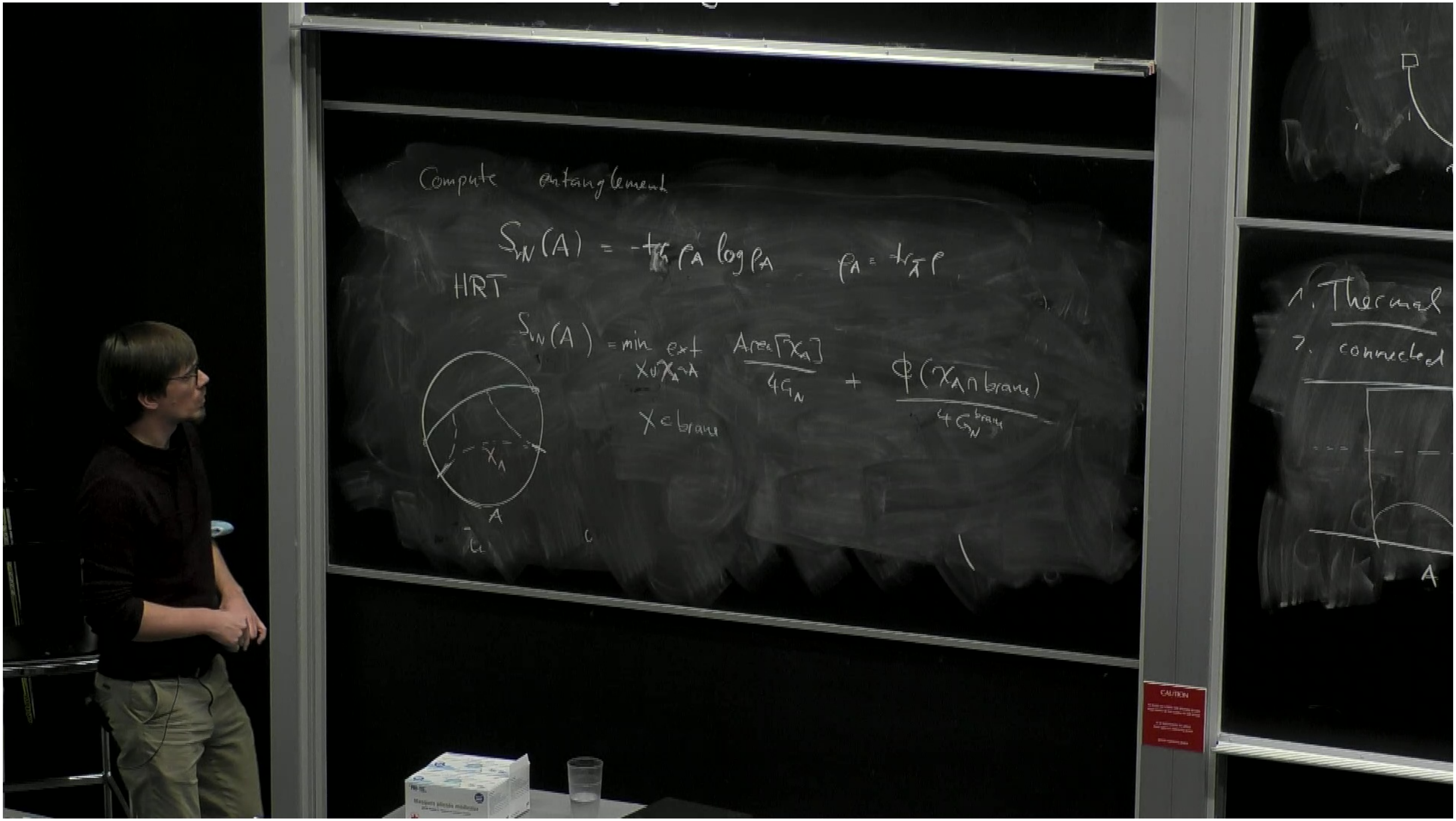
Ŝ
t
t=0
Ŝ(t) ~ t
V_E(A) = ∂_t S(A) / (s_eq |∂A|) ≤ coth(π|A| / β) → 1
|A|→∞




$$V_E(A) = \frac{\partial_t S(A)}{s_{eq}\,|\partial A|} \leq \coth\left(\frac{\pi |A|}{\beta}\right) \xrightarrow{|A|\to\infty} 1$$

$$|\alpha| < \frac{1}{1+\sin y_{br}}$$

$$V_E \sim 1 - \frac{1}{2}\left(1+\alpha+\alpha \sin y_{br}\right)\left(1-\alpha-\alpha \sin y_{br}\right)\left(\frac{\pi}{2}-\tau\right)^2 + \dots$$


Compute entanglement
S_vN(A) = -tr ρ_A log ρ_A
ρ_A = tr_Ā ρ
HRT
S_vN(A) = min ext Area[X_A] / 4G_N + Φ(X_A ∩ brane) / 4G_N^brane
X ∪ X_A ~ A
X ⊂ brane
X_A
A
1. Thermal
2. connected
A