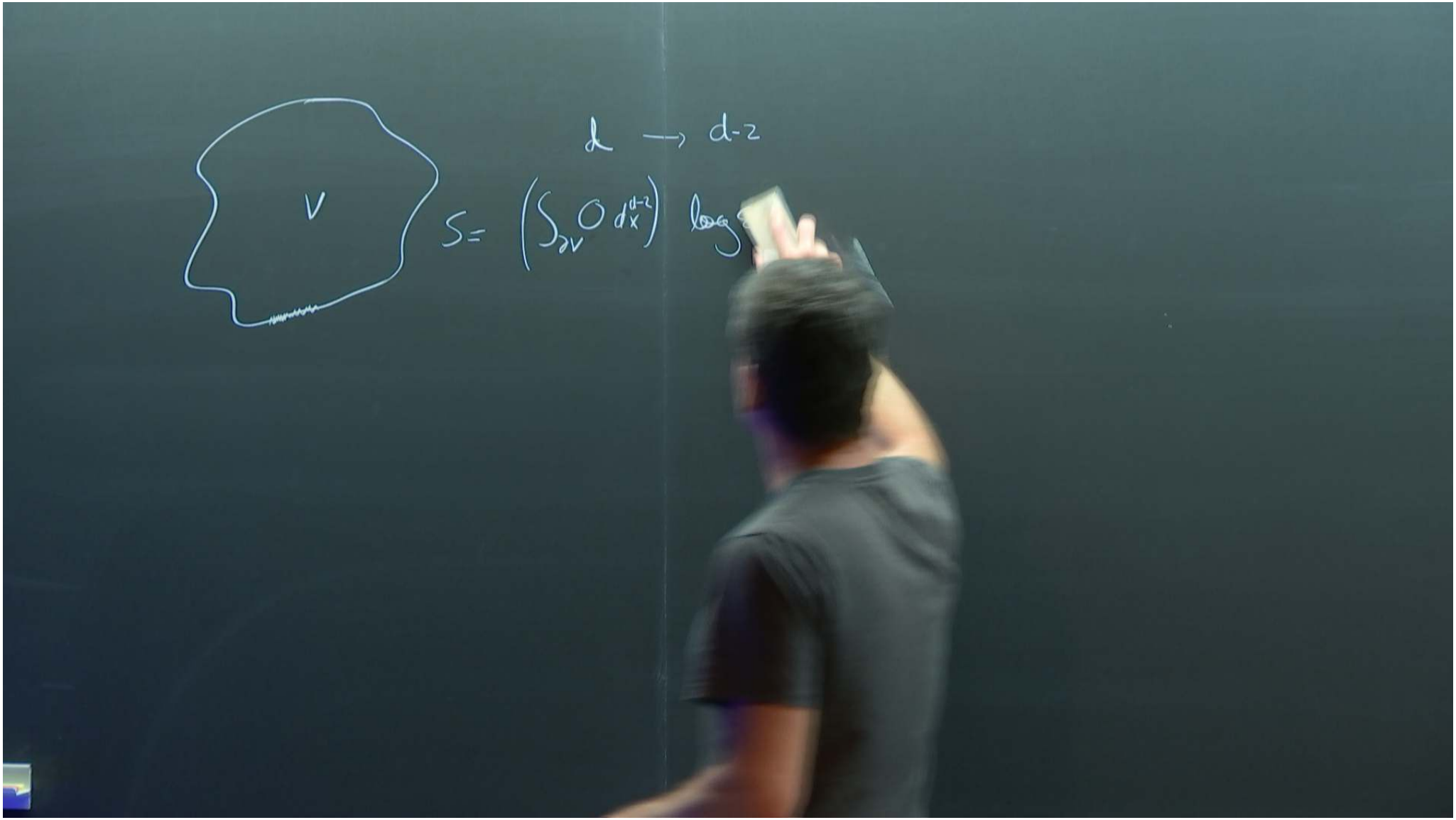
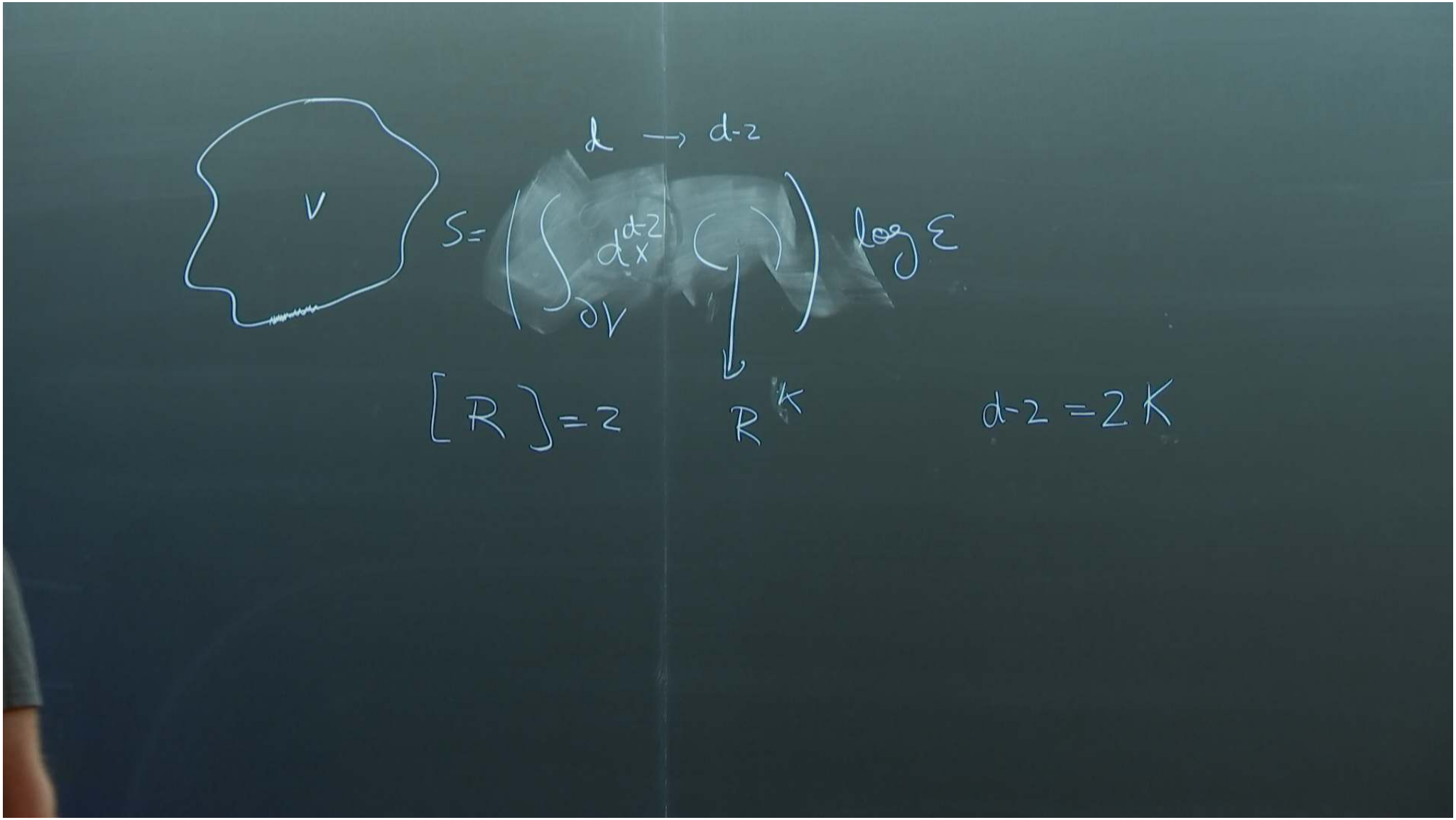
Title: Entanglement in QFT

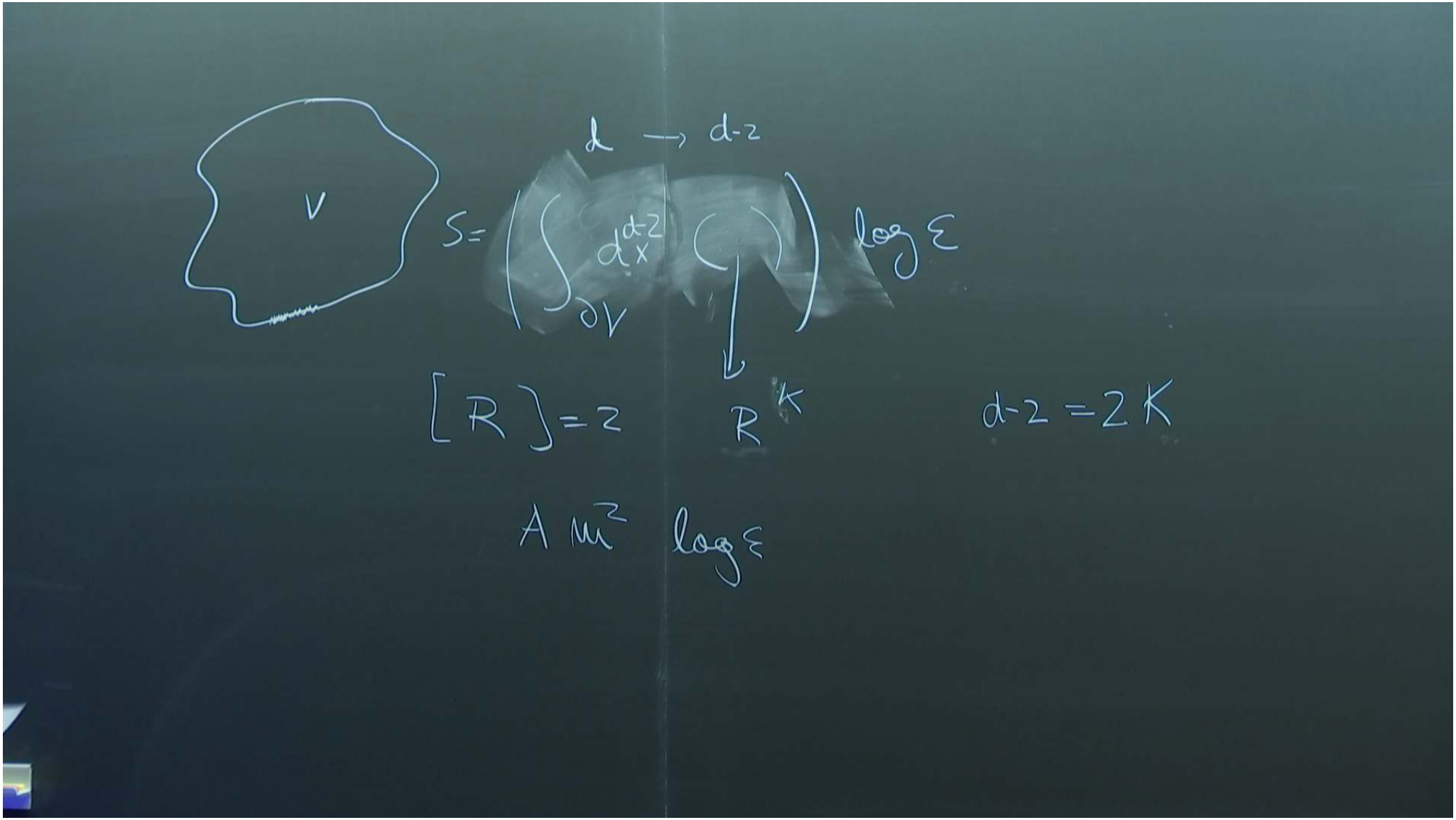
Date: Jul 21, 2016 11:00 AM

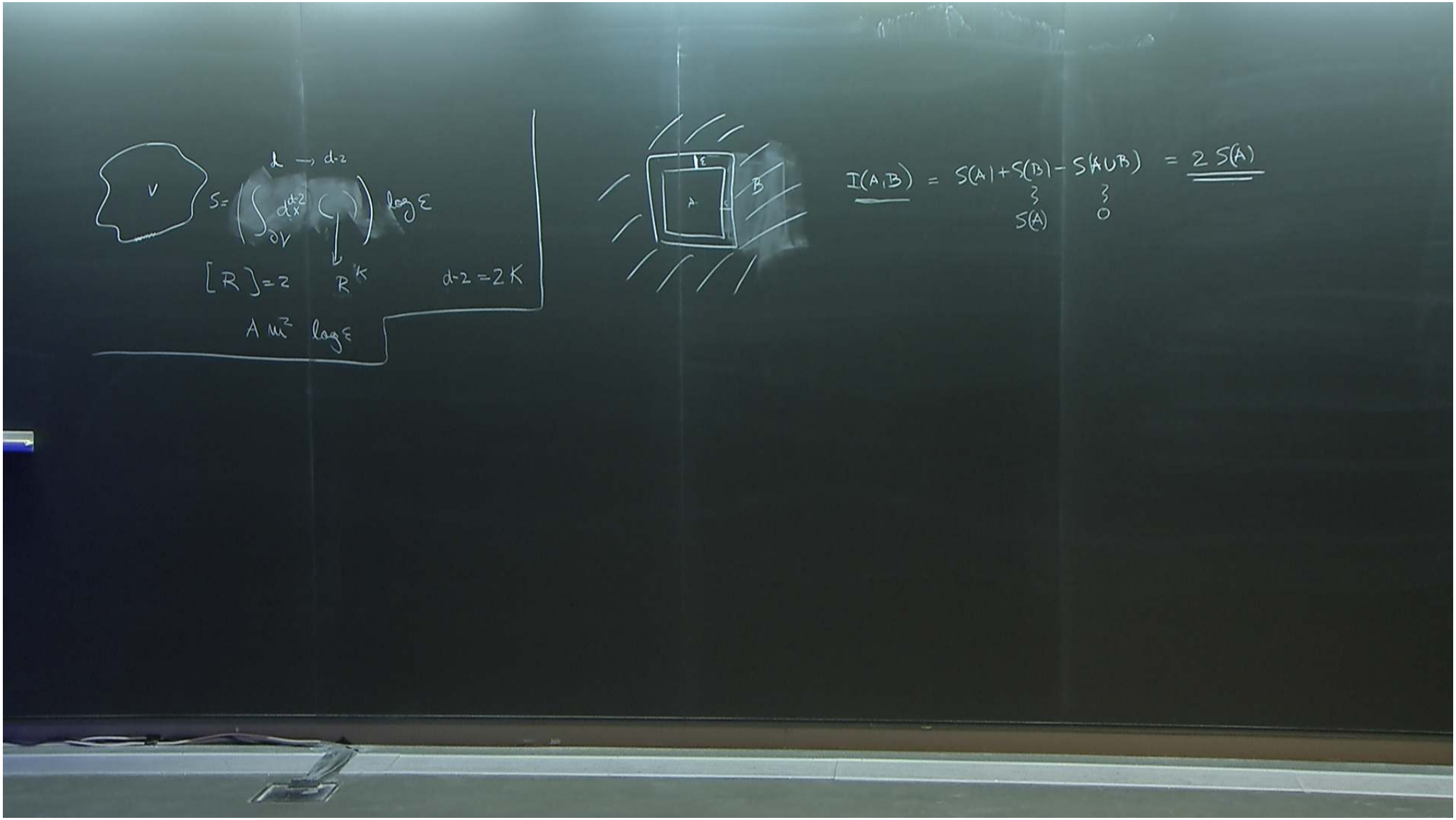
URL: http://pirsa.org/16070025

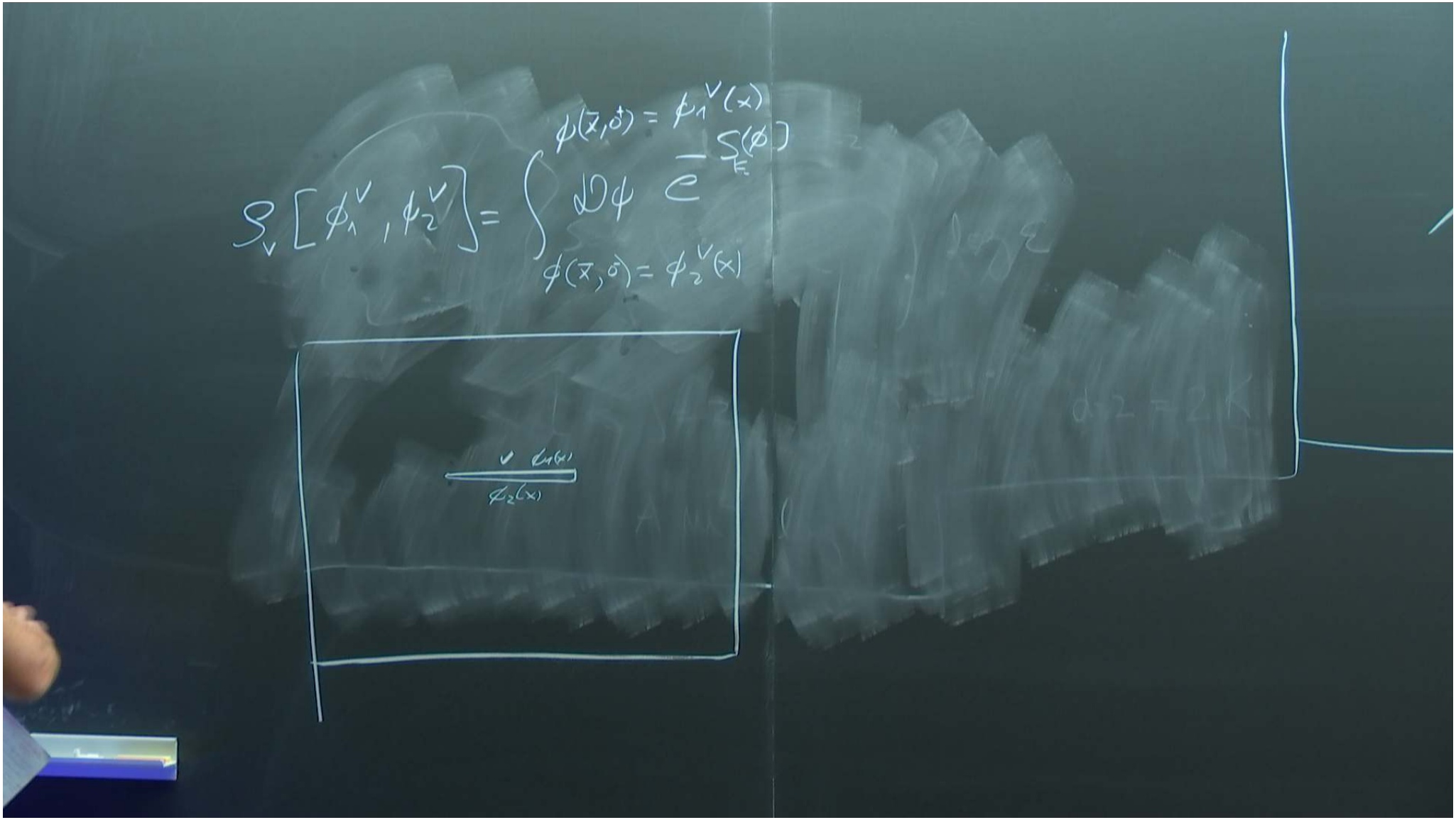
Abstract:

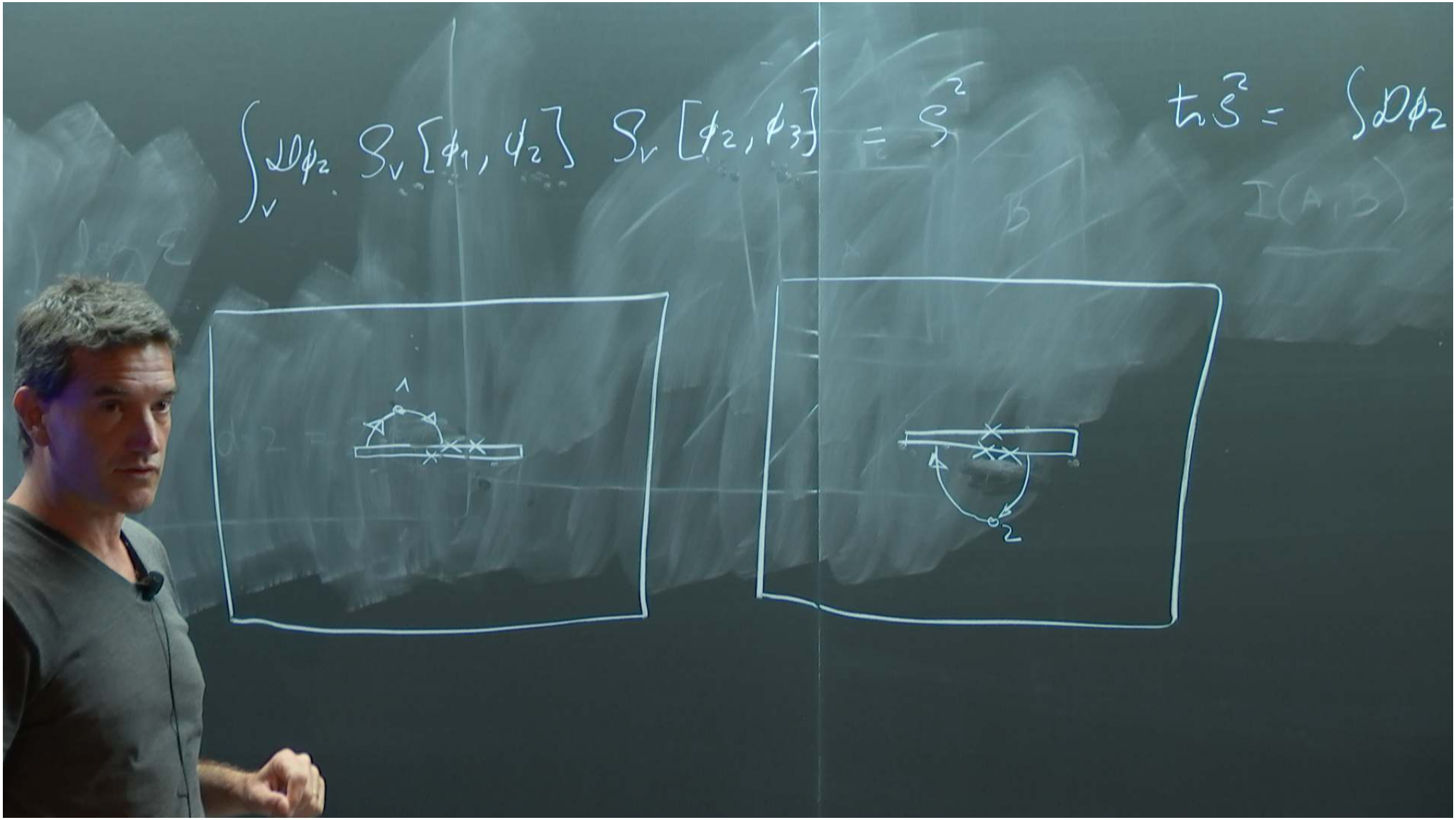

V
d → d-2


V
d → d-2
$S = \left(\int_{\partial V} d^{d-2}x \, (\;) \right) \log \varepsilon$
$[R] = 2$
R^K
$d-2 = 2K$


V
d → d-2
$S = \left(\int_{\partial V} d^{d-2}x \, (\;) \right) \log \varepsilon$
$[R] = 2$
R^K
$d-2 = 2K$
$A \, m^2 \log \varepsilon$

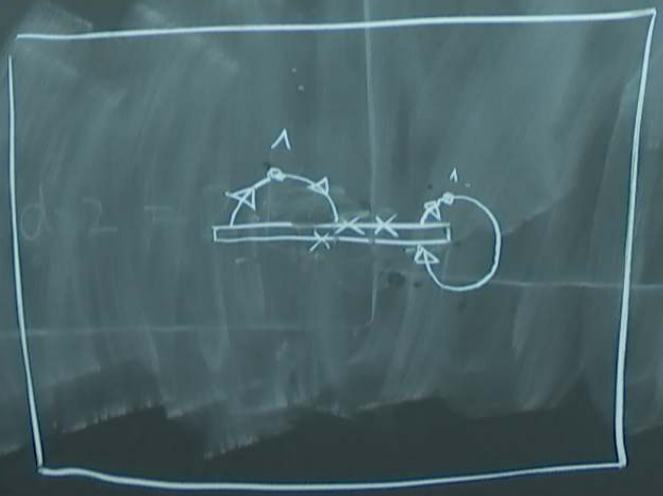

V
$S = \left(\int_{\partial V} d^{d-2}x \; (\;) \right) \log \varepsilon$
$d-2 \longrightarrow d-2$
$[R] = 2$
R^K
$d-2 = 2K$
$A \, m^2 \log \varepsilon$
ε
A
B
$I(A,B) = S(A) + S(B) - S(A \cup B) = 2\,S(A)$
$S(A)$
0

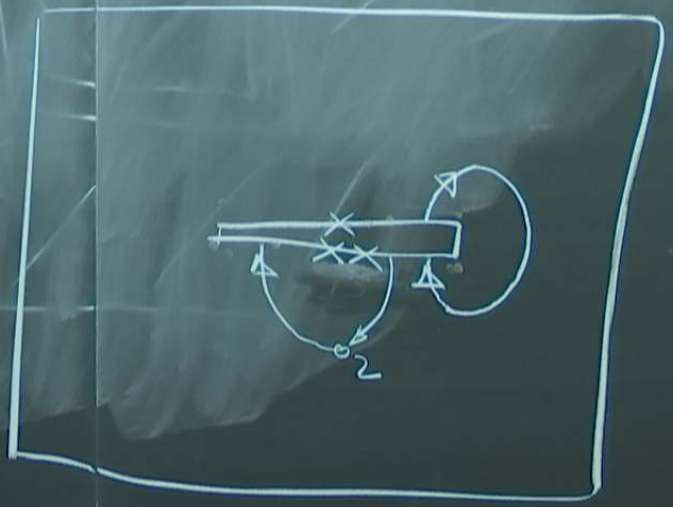

$S_V[\phi_1^V, \phi_2^V] = \int \mathcal{D}\phi \; e^{-S_E[\phi]}$
$\phi(\vec{x},0) = \phi_1^V(x)$
$\phi(\vec{x},0) = \phi_2^V(x)$
$\phi_1(x)$
$\phi_2(x)$


$\int_V \mathcal{D}\phi_2 \; S_V[\phi_1, \phi_2] \; S_V[\phi_2, \phi_3] = S^2$
$\int \mathcal{D}\phi_2$

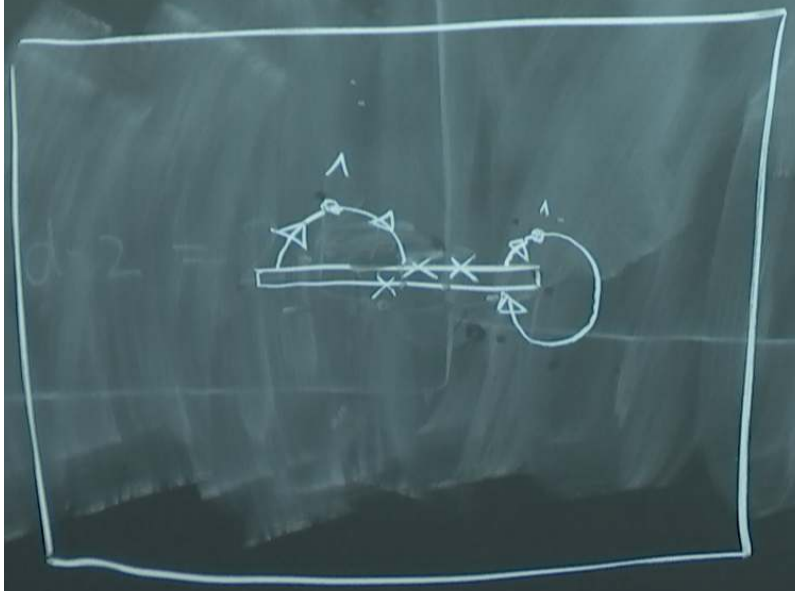
$$\int_V \mathcal{D}\phi_2 \; S_V[\phi_1, \phi_2] \; S_V[\phi_2, \phi_3] = S^2$$

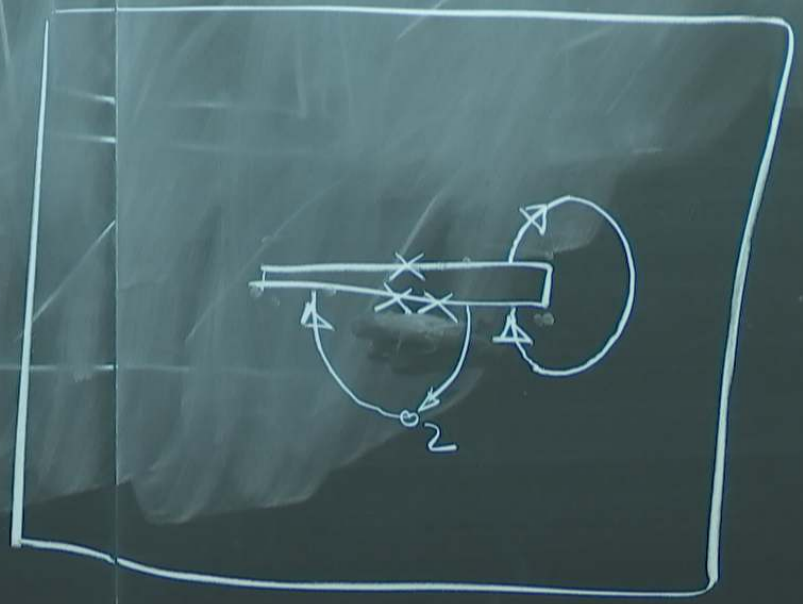
$$\text{tr}\, S^2 = \int \mathcal{D}\phi_2$$



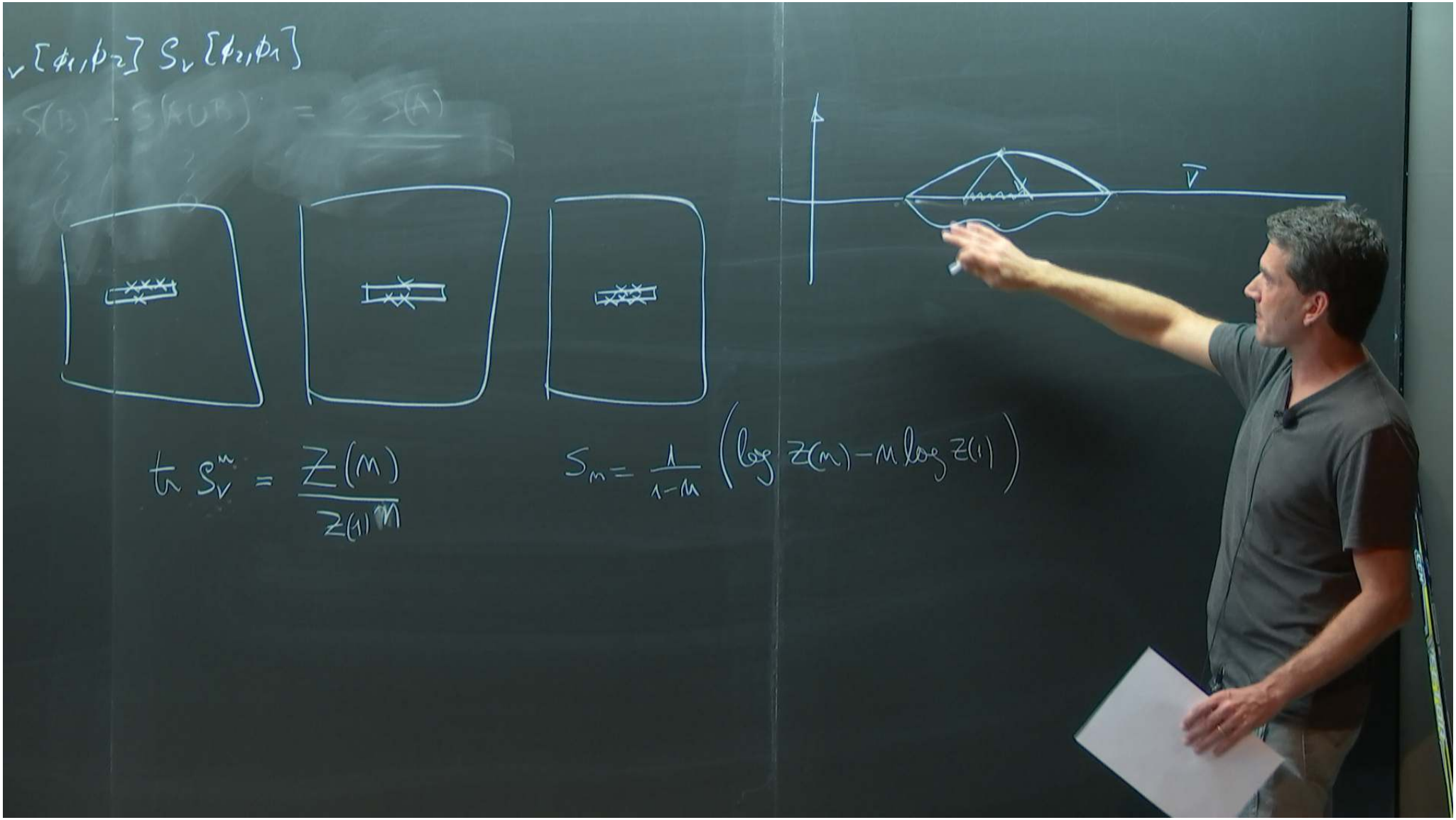


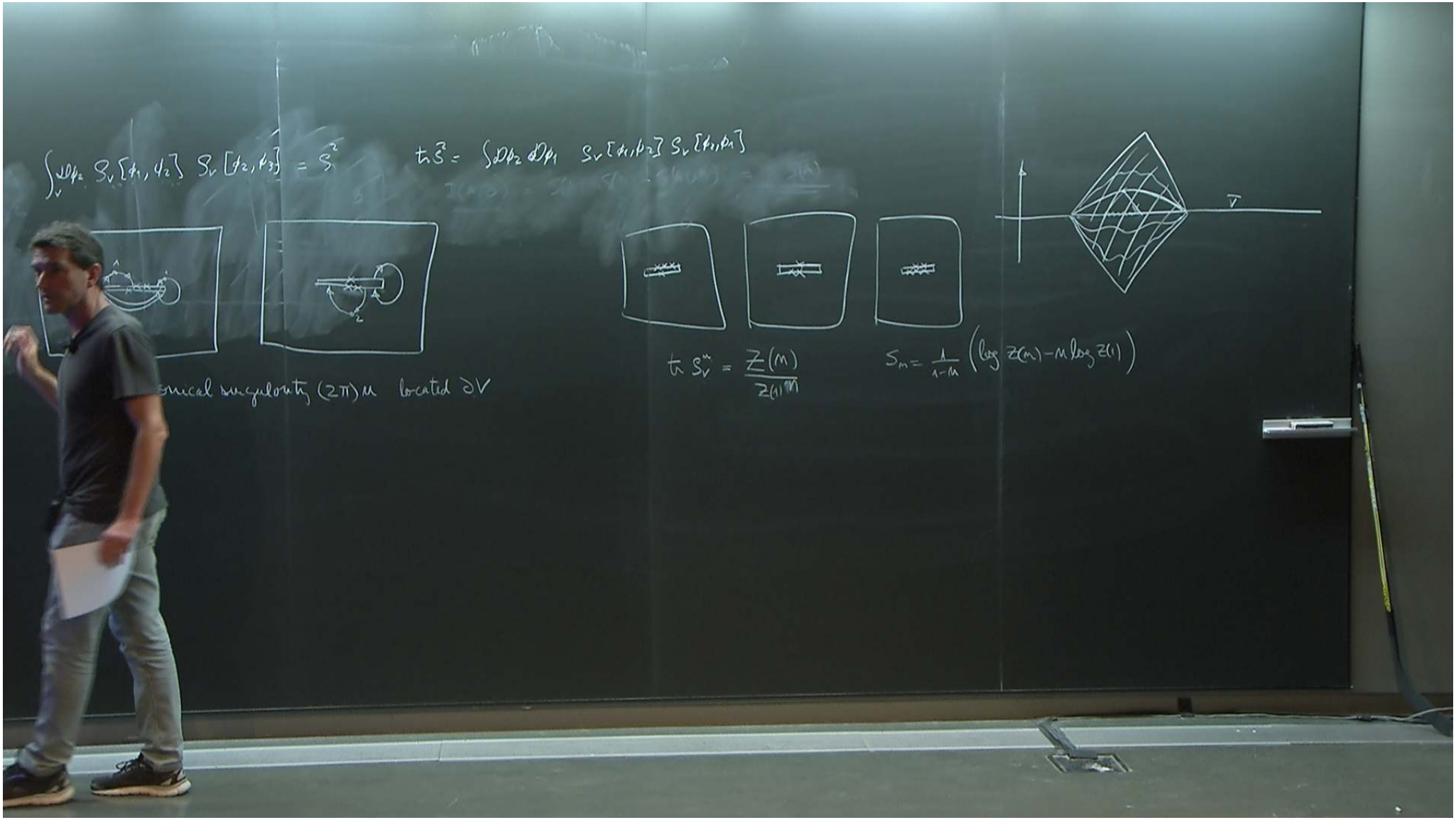
$\int_V \mathcal{D}\phi_2 \; S_V[\phi_1, \phi_2]$





conical singularity $(2\pi)n$ located ∂V


$\mathrm{tr}\, \rho_V^n = \frac{Z(n)}{Z(1)^n}$
$S_n = \frac{1}{1-n}\left(\log Z(n) - n \log Z(1)\right)$
$\bar{V}$


$\int_V dA_2\, S_V[A_1, A_2]\, S_V[A_2, A_3] = S^2$
$\mathrm{tr}\, S^2 = \int DA_2\, DA_1\, S_V[A_1, A_2]\, S_V[A_2, A_1]$
$\mathrm{tr}\, S_V^n = \frac{Z(n)}{Z(1)^n}$
$S_n = \frac{1}{1-n}\left(\log Z(n) - n \log Z(1)\right)$
V

$\mathcal{H}_A \otimes \mathcal{H}_B$

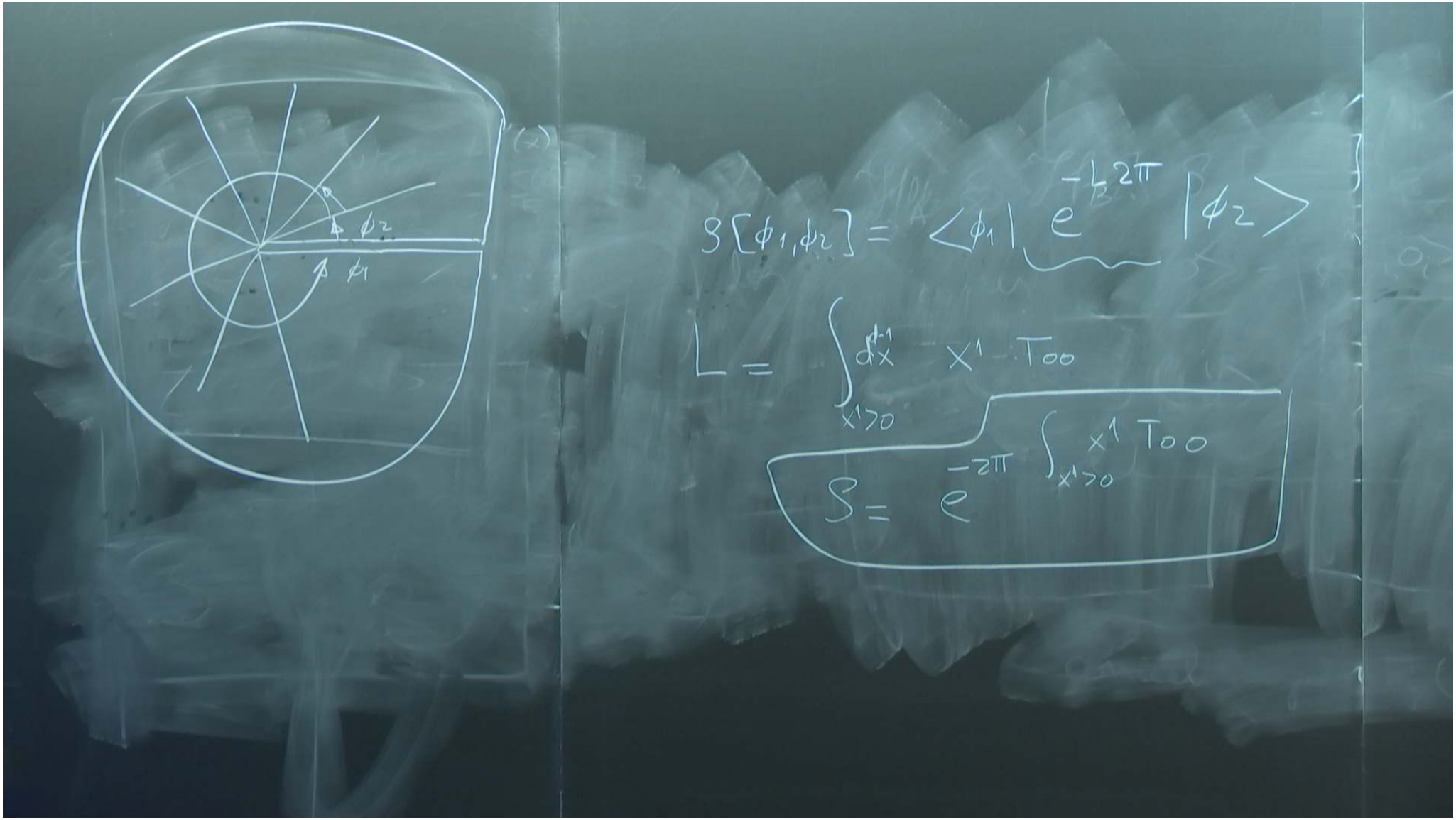
n copies $|0\rangle = \bigotimes^n |0_i\rangle$

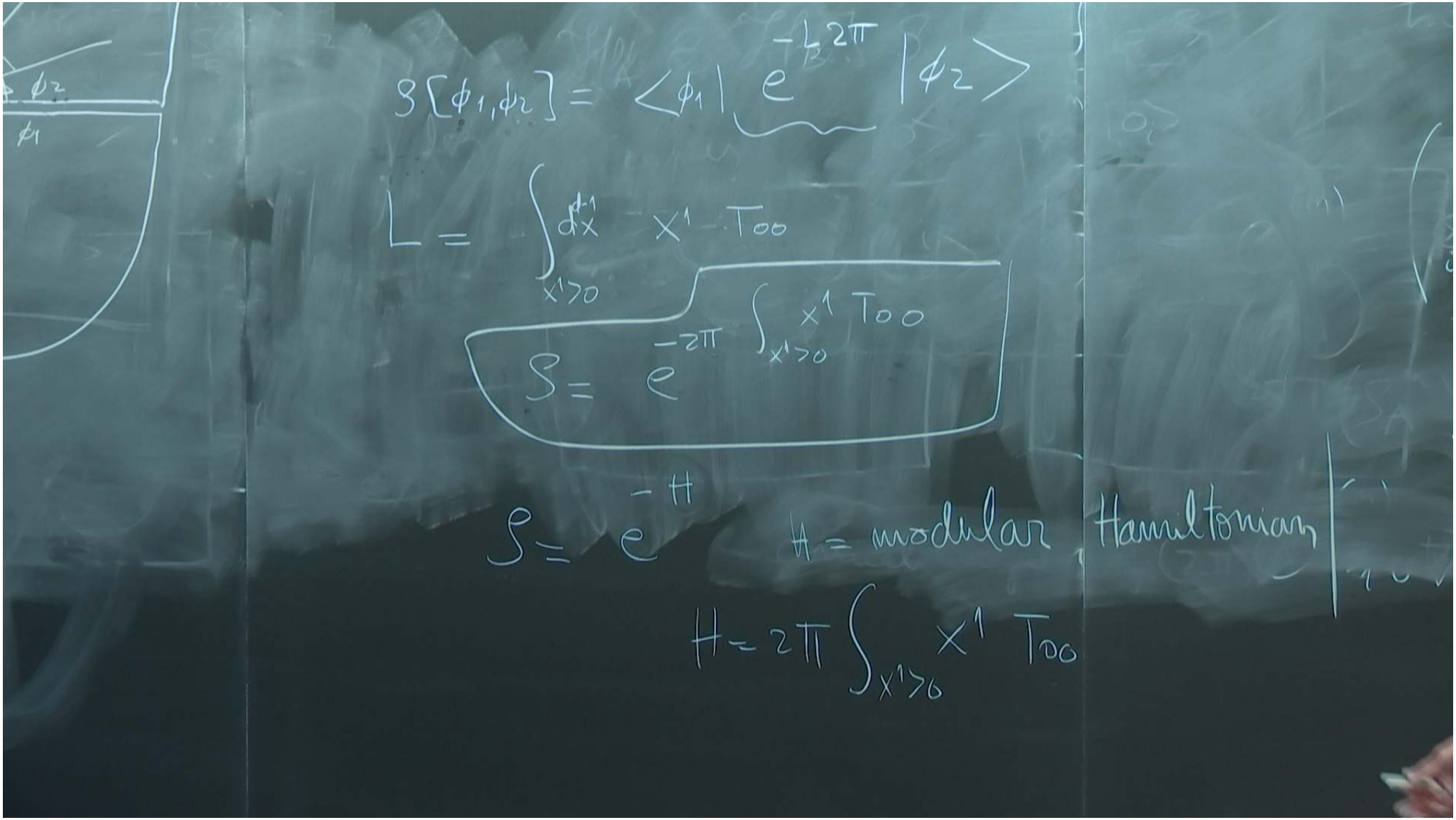
$\left\{ |e_a^i\rangle \otimes |f_b^i\rangle \right\}$

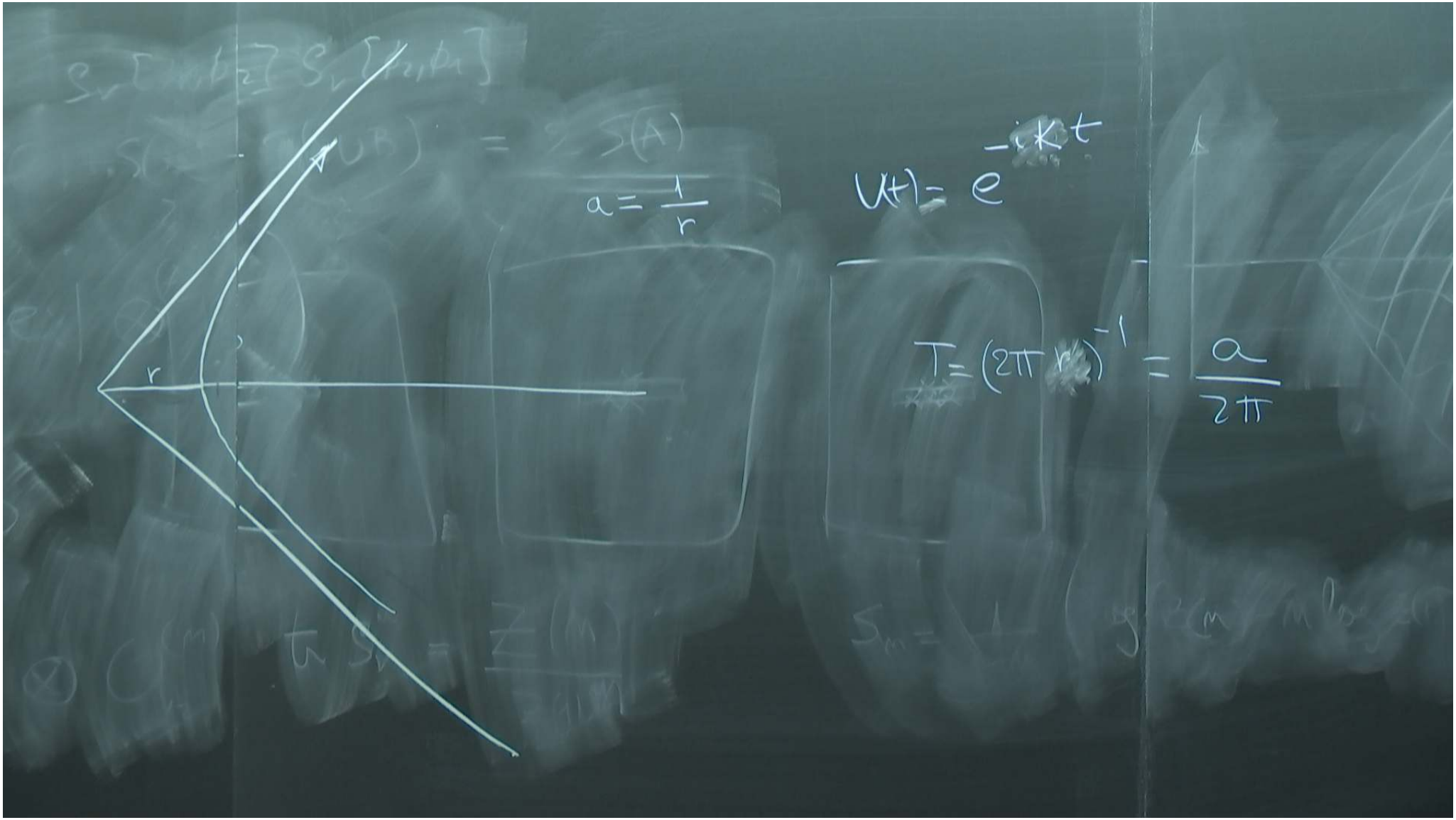
$\rightarrow \mathcal{O}_A^{(n)} = \left(\bigotimes_i \sum_a |e_a^{i+1}\rangle\langle e_a^i| \otimes 1_B \right)$

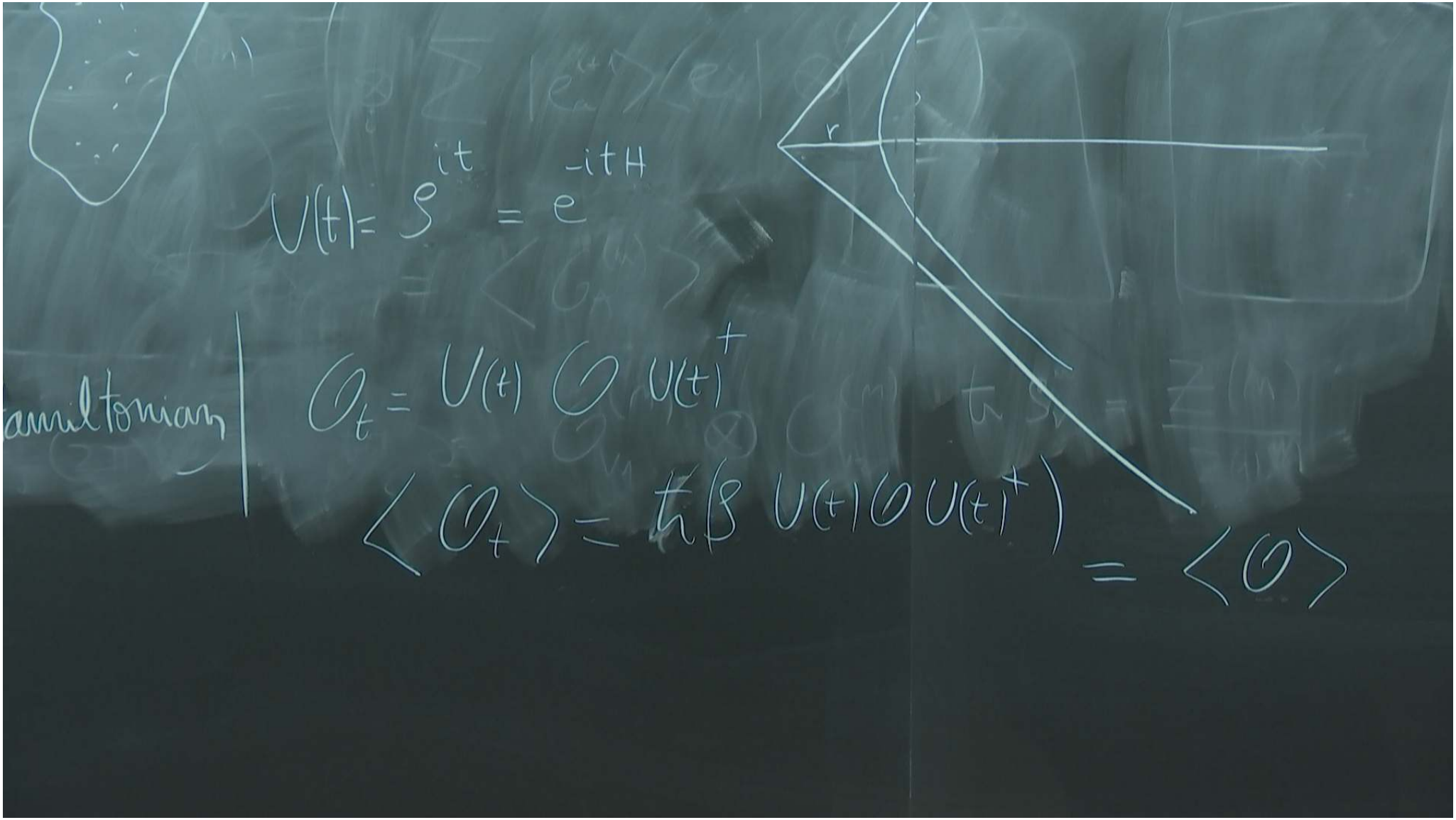
$\mathrm{tr}(S_A^n) = \langle G_A^{(n)} \rangle$

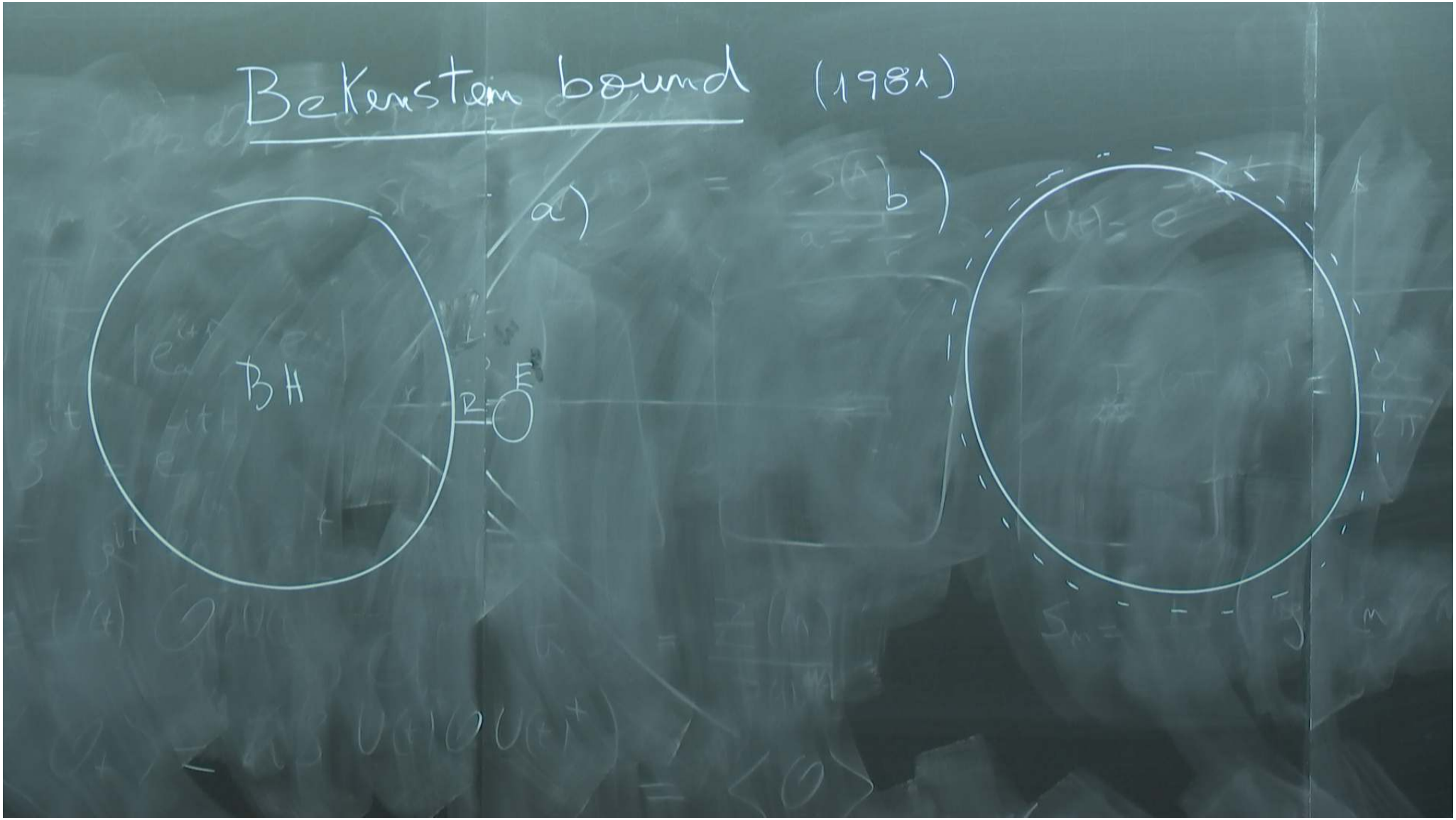
$G^{(n)}_{V_1 \cup V_2} = G^{(n)}_{V_1} \otimes G^{(n)}_{V_2}$

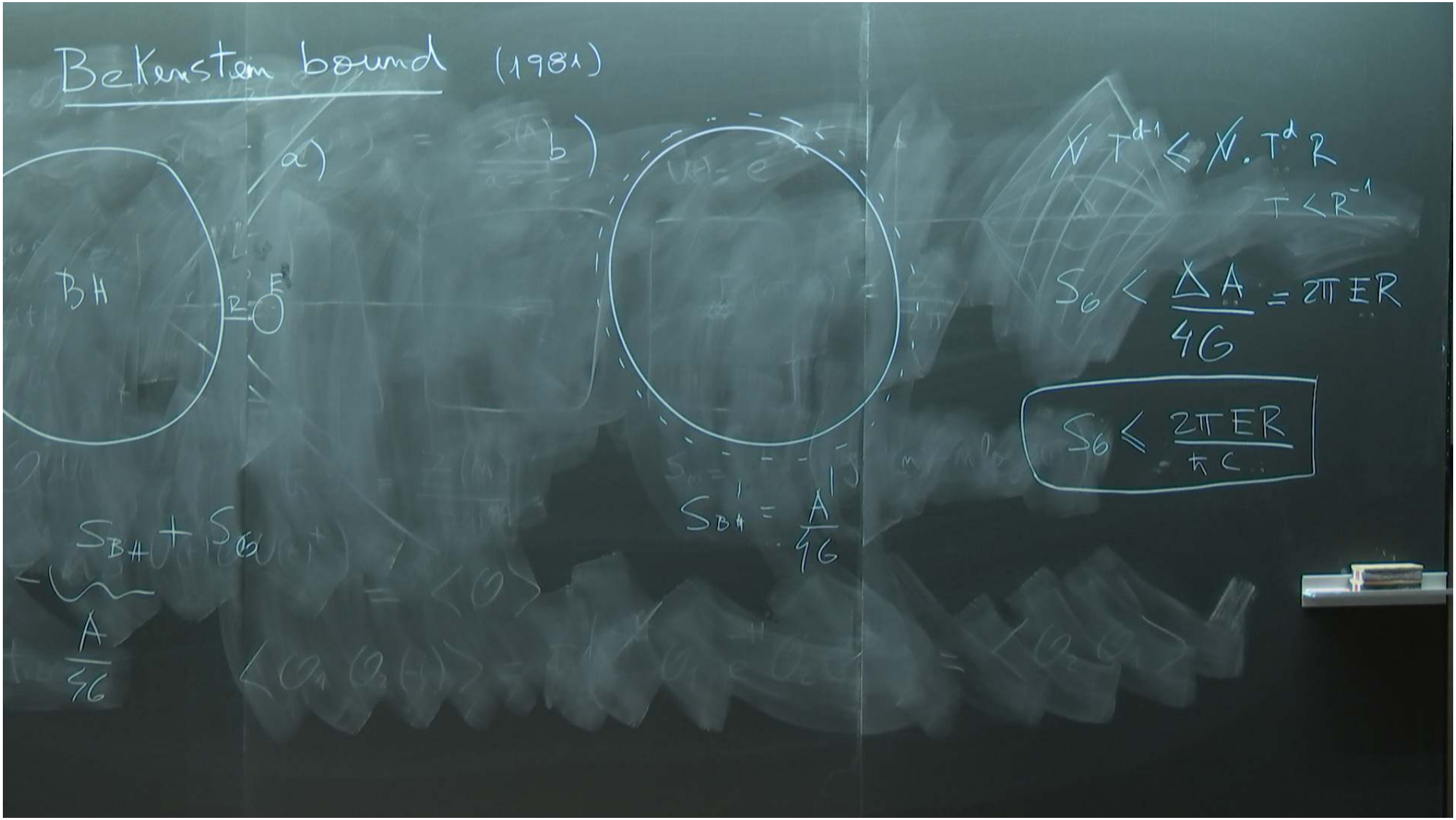

ϕ_2
ϕ_1
$S[\phi_1,\phi_2] = \langle\phi_1| e^{-\frac{i}{\hbar}2\pi} |\phi_2\rangle$
$L = \int_{x^1>0} dx^{d-1}\, x^1\, T_{00}$
$S = e^{-2\pi \int_{x^1>0}^{x^1} T_{00}}$

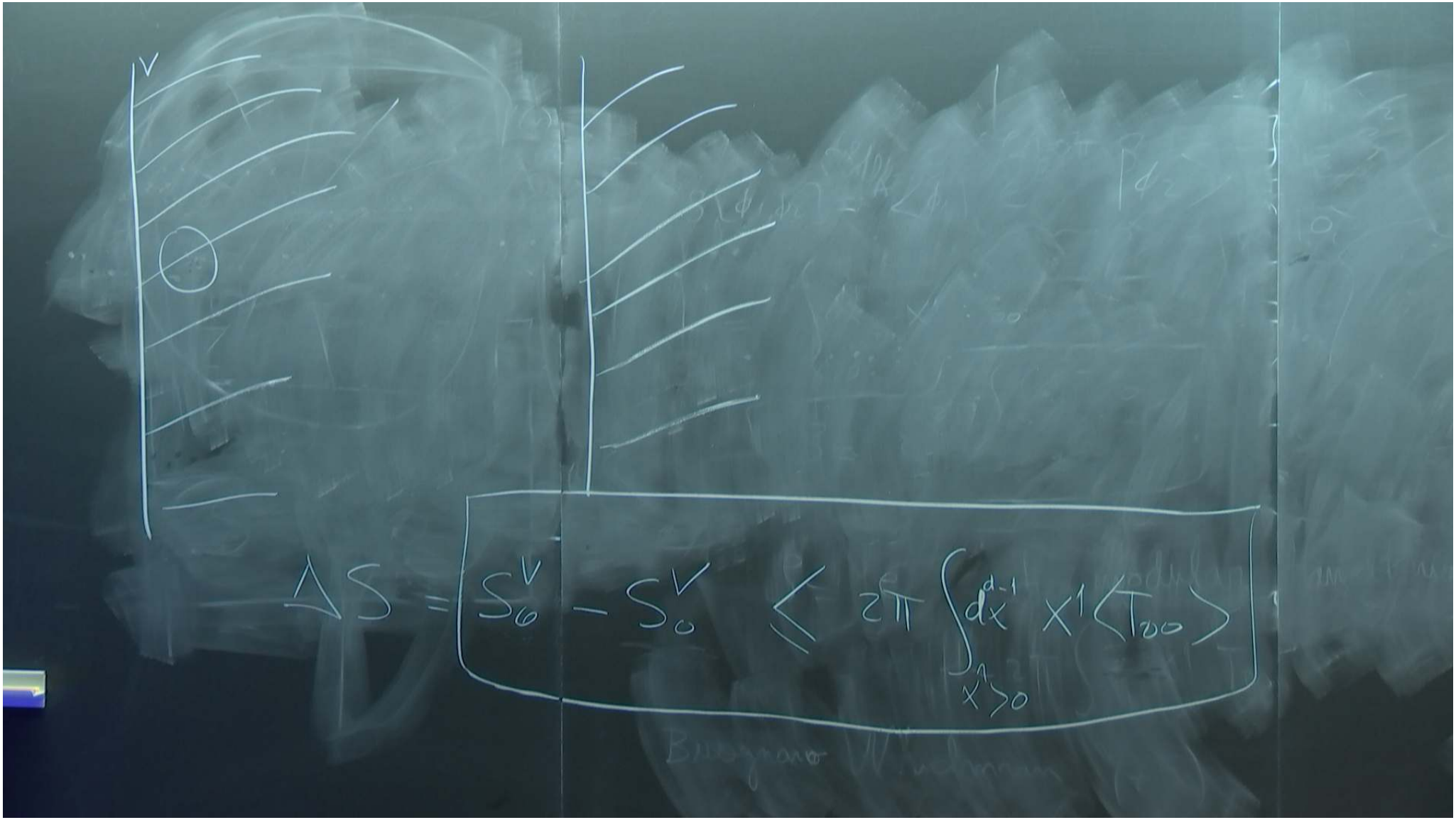

ϕ_2
ϕ_1
$S[\phi_1,\phi_2] = \langle\phi_1| e^{-\frac{1}{2}2\pi} |\phi_2\rangle$
$L = \int_{x^1>0} dx^{d-1}\, x^1\, T_{00}$
$S = e^{-2\pi \int_{x^1>0} x^1 T_{00}}$
$\rho = e^{-H}$
H = modular Hamiltonian
$H = 2\pi \int_{x^1>0} x^1\, T_{00}$

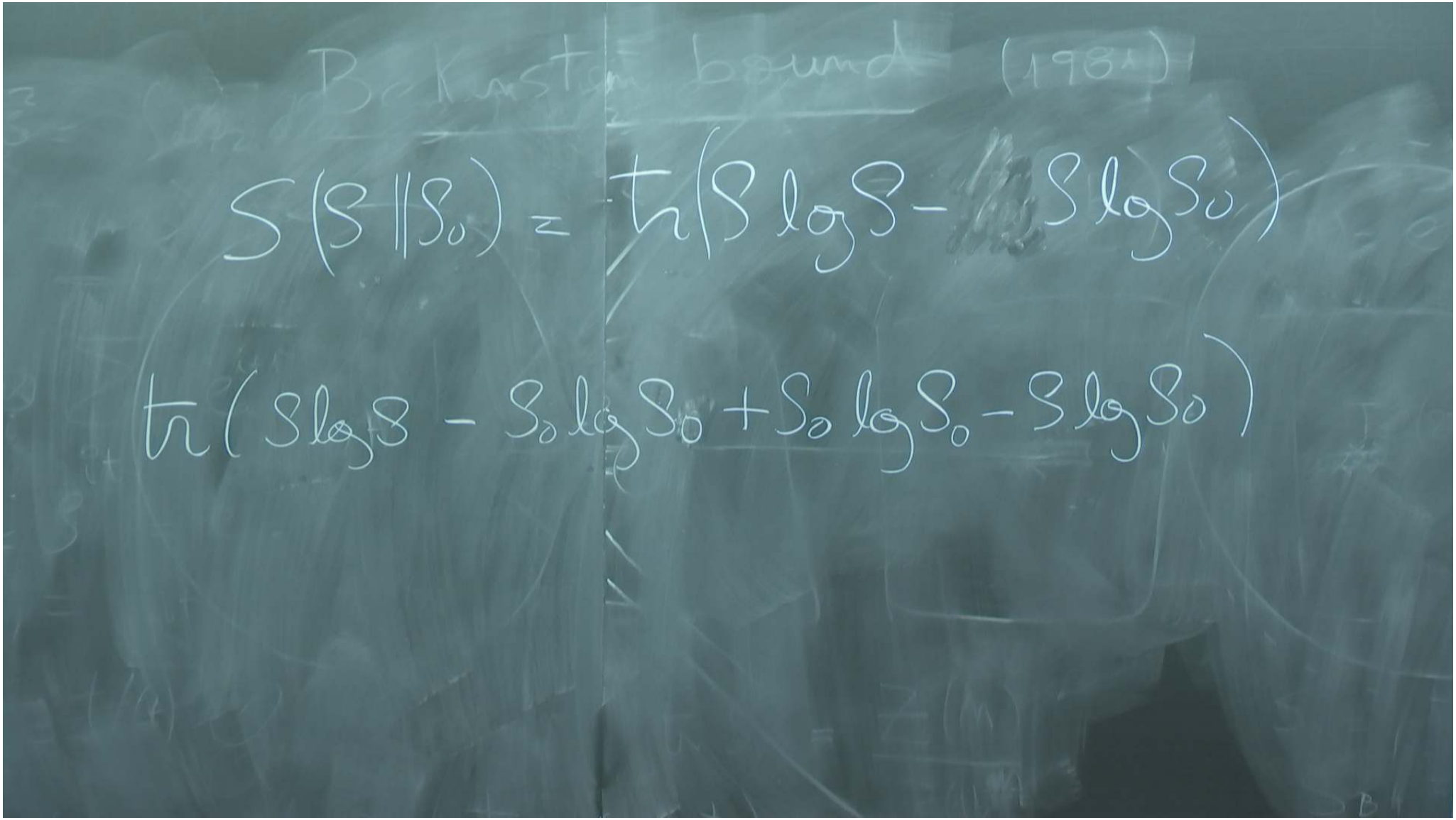

r
$a = \frac{1}{r}$
$U(t) = e^{-ikt}$
$T = (2\pi r)^{-1} = \frac{a}{2\pi}$

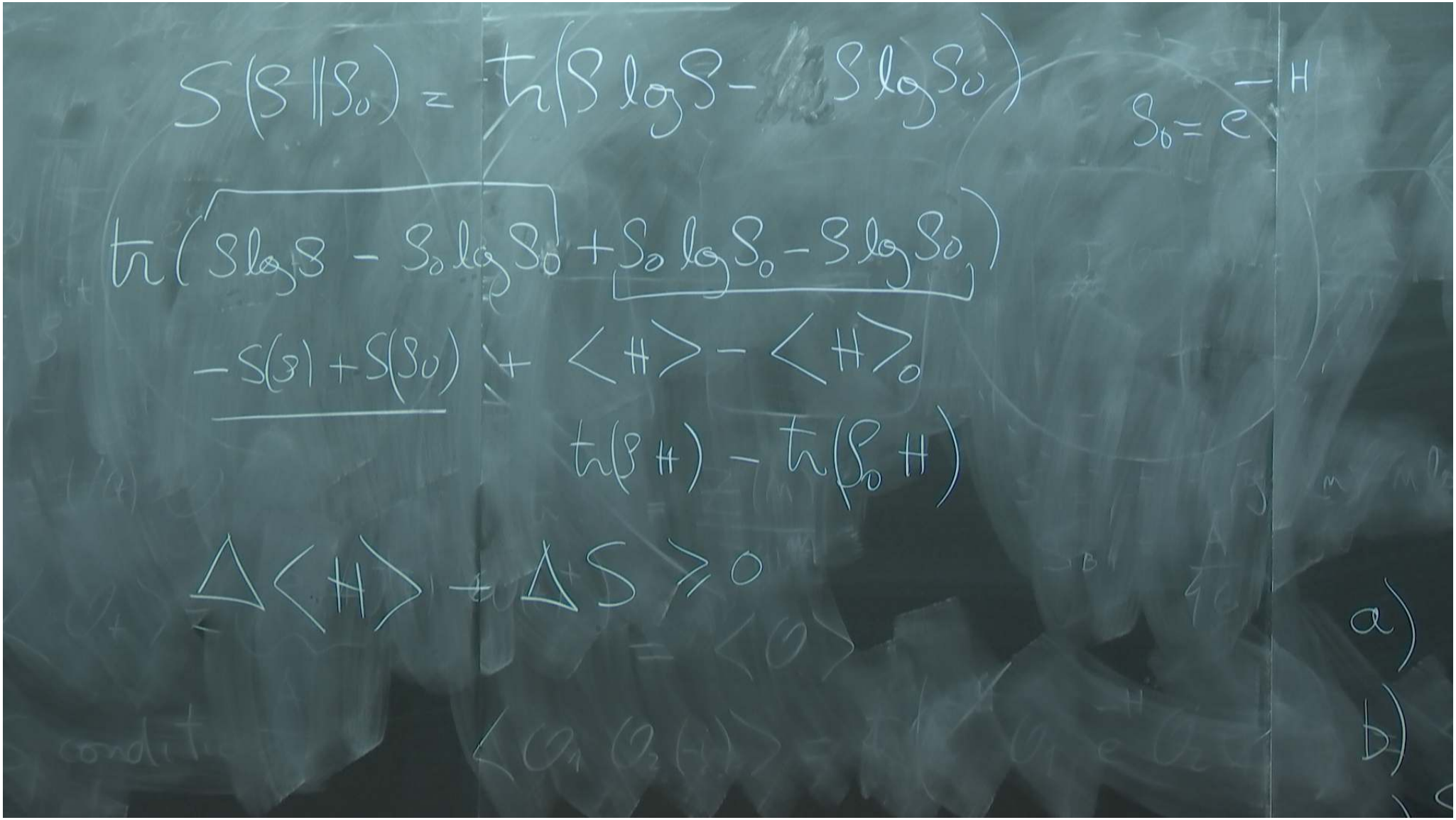

$U(t) = e^{itH}$
$\mathcal{O}_t = U(t)\,\mathcal{O}\,U(t)^\dagger$
$\langle \mathcal{O}_t \rangle = \mathrm{tr}(\beta\, U(t)\,\mathcal{O}\,U(t)^\dagger) = \langle \mathcal{O} \rangle$
r


Bekenstein bound (1981)
a)
b)
BH
R
E


Bekenstein bound (1981)
a)
b)
BH
R
E
$S_{BH} + S_{G} \geq \langle O \rangle$
$\frac{A}{4G}$
$\langle O_1 O_2 \rangle$
$S_{BH}' = \frac{A'}{4G}$
$N T^{d-1} \leq N \cdot T^d R$
$T < R^{-1}$
$S_G < \frac{\Delta A}{4G} = 2\pi E R$
$S_G \leq \frac{2\pi E R}{\hbar c}$


V
$\Delta S = S_6^V - S_0^V \leq 2\pi \int_{x^1>0} dx^{d-1} x^1 \langle T_{00} \rangle$


Bekenstein bound (1981)
$S(\rho\|\rho_0) = \mathrm{tr}(\rho\log\rho - \rho\log\rho_0)$
$\mathrm{tr}(\rho\log\rho - \rho_0\log\rho_0 + \rho_0\log\rho_0 - \rho\log\rho_0)$


$S(\rho\|\rho_0) = \mathrm{tr}(\rho\log\rho - \rho\log\rho_0)$
$\rho_0 = e^{-H}$
$\mathrm{tr}(\rho\log\rho - \rho_0\log\rho_0 + \rho_0\log\rho_0 - \rho\log\rho_0)$
$-S(\rho) + S(\rho_0) \leq \langle H\rangle - \langle H\rangle_0$
$\mathrm{tr}(\rho H) - \mathrm{tr}(\rho_0 H)$
$\Delta\langle H\rangle + \Delta S \geq 0$
a)
b)