Title: dS in N=2 super Liouville

Speakers: Beatrix Muehlmann

Series: Quantum Fields and Strings

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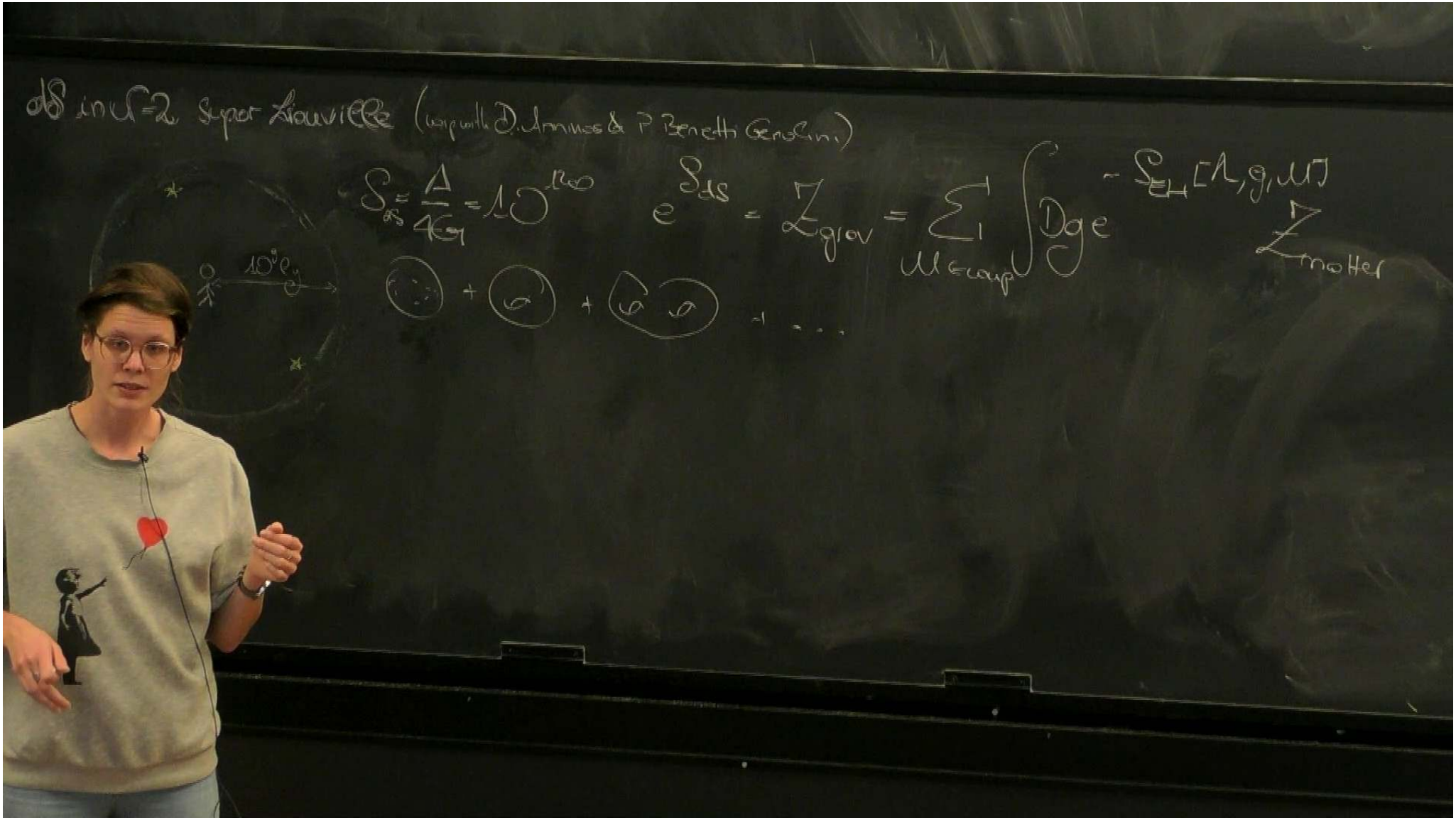
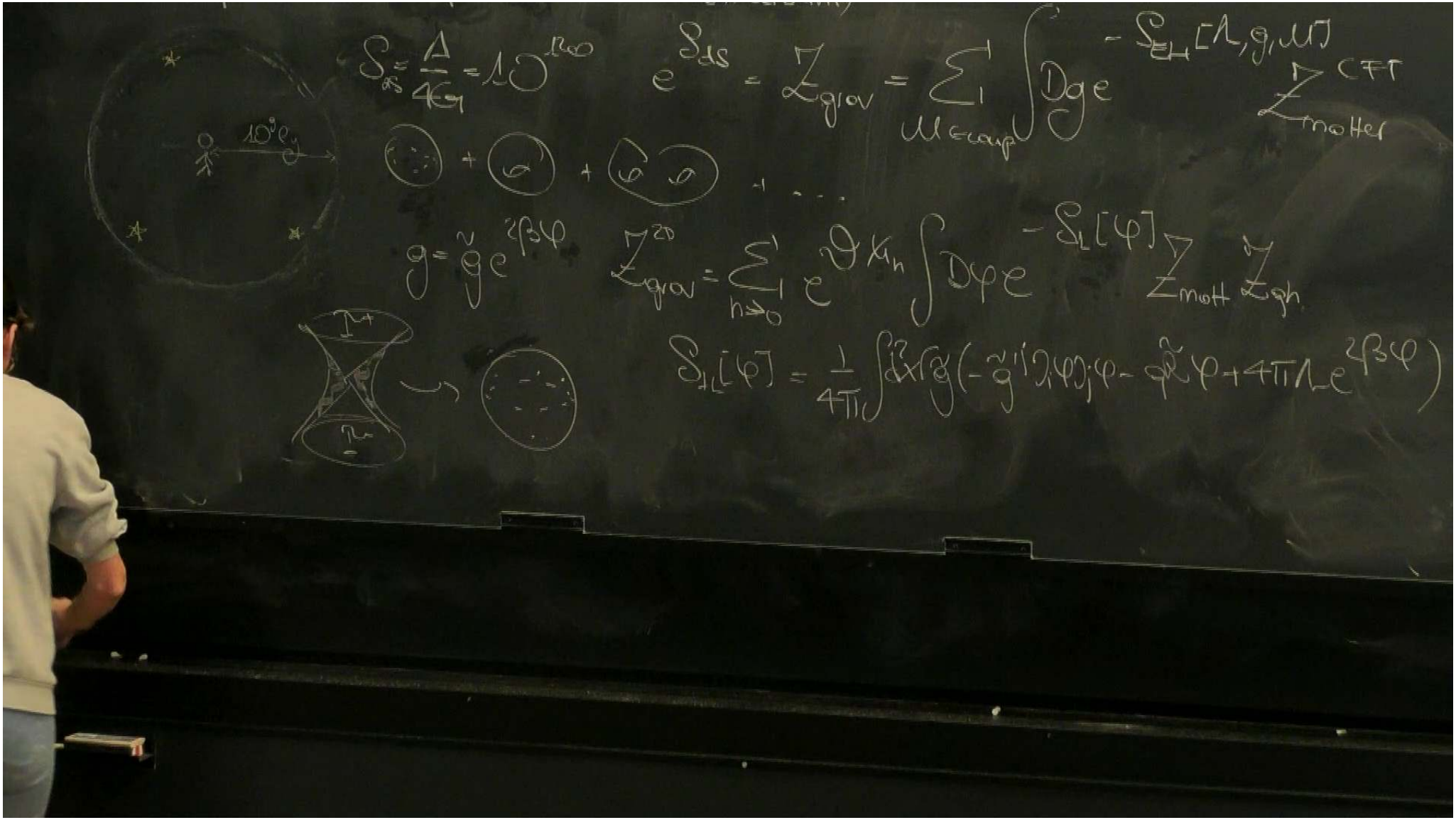
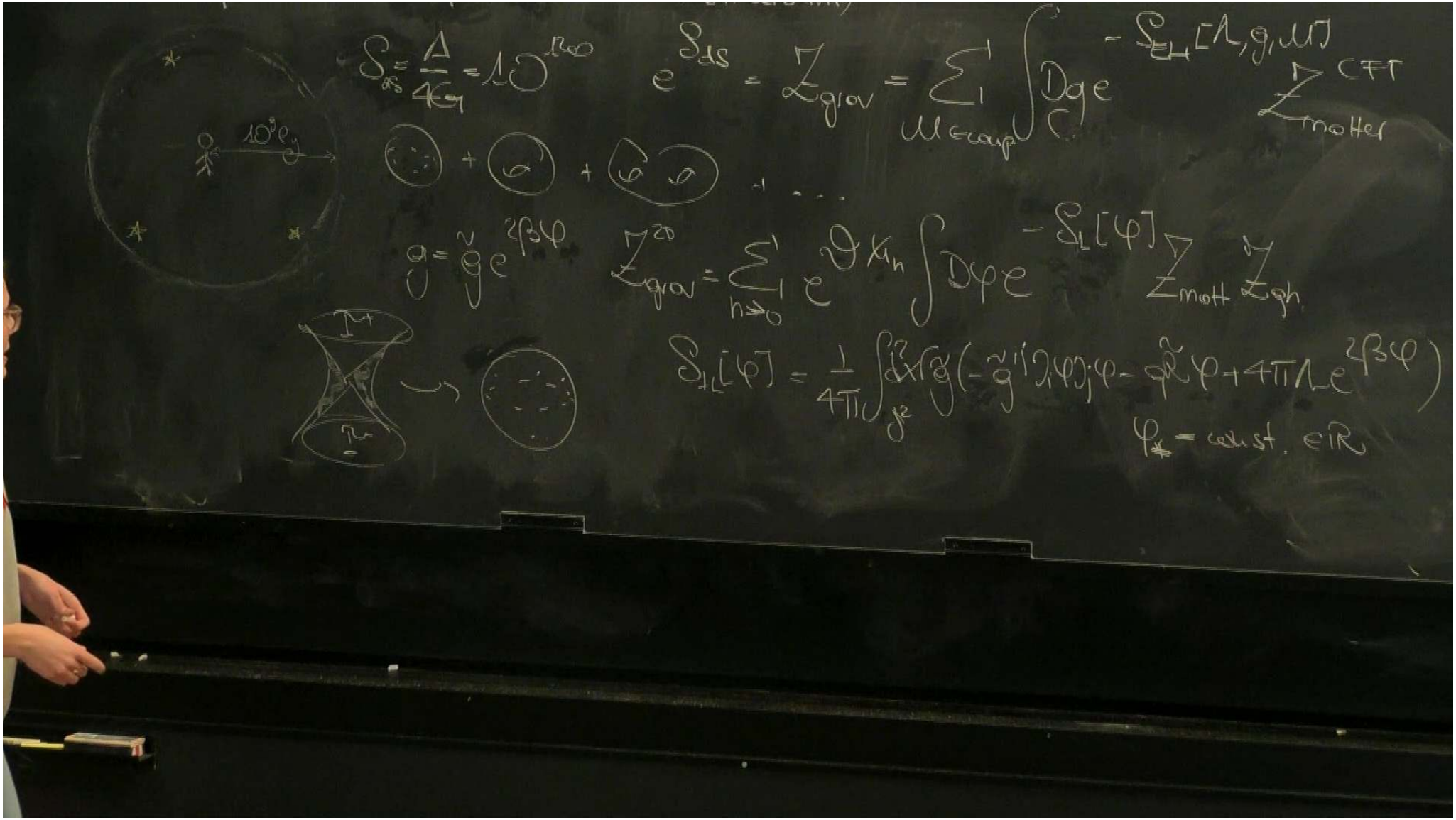
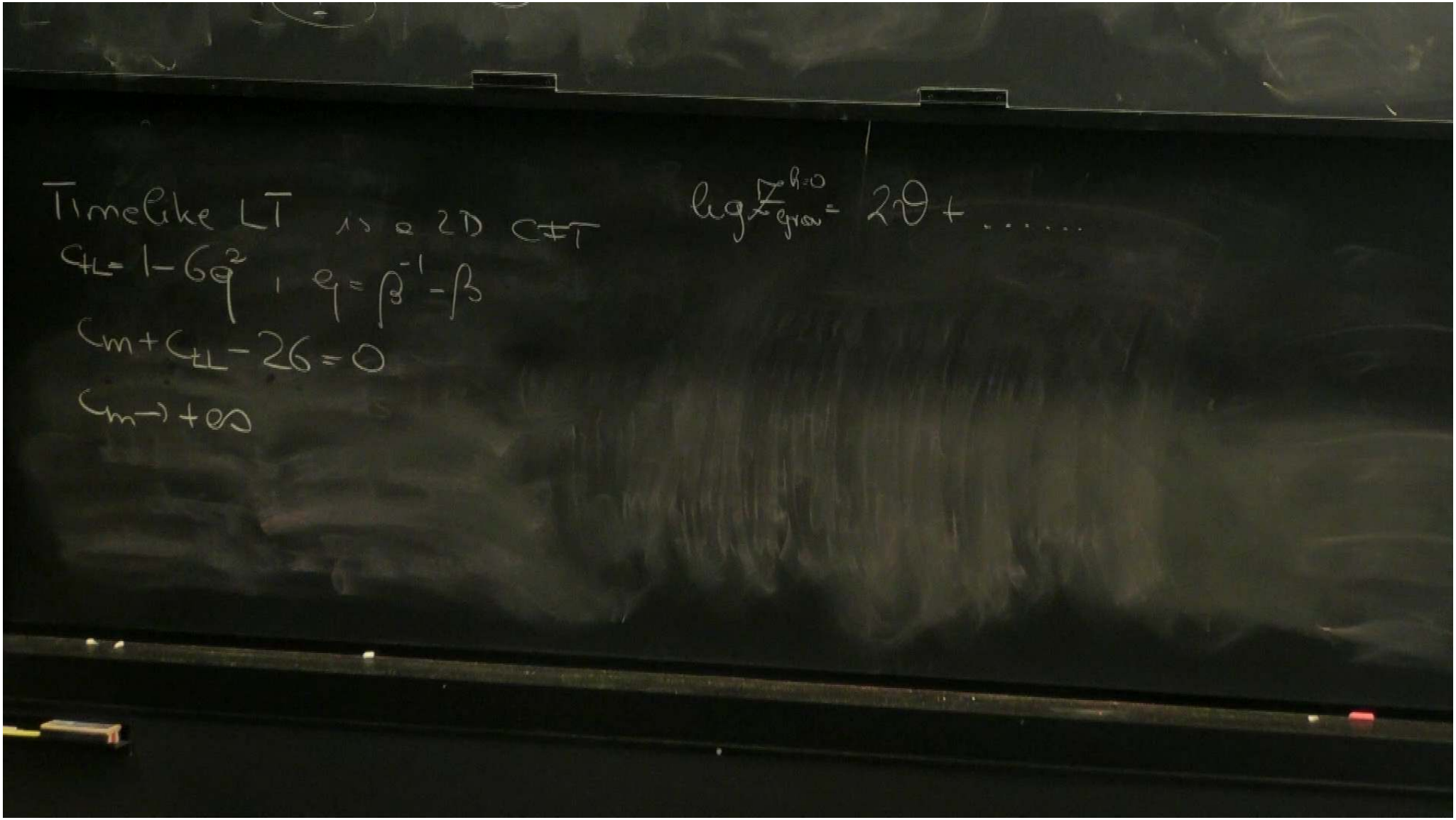
Abstract: In my talk I will discuss the Euclidean gravitational path integral of N=2 (timelike) Liouville theory on a two-sphere. We view N= 2 Liouville as a gauge fixed form of a 2d supergravity theory coupled to an N=2 superconformal field theory. N=2 super Liouville admits a positive cosmological constant. I will discuss and contrast the results of supersymmetric localization and the explicit higher-loop evaluation of the path integral around it's dS_2 saddle.

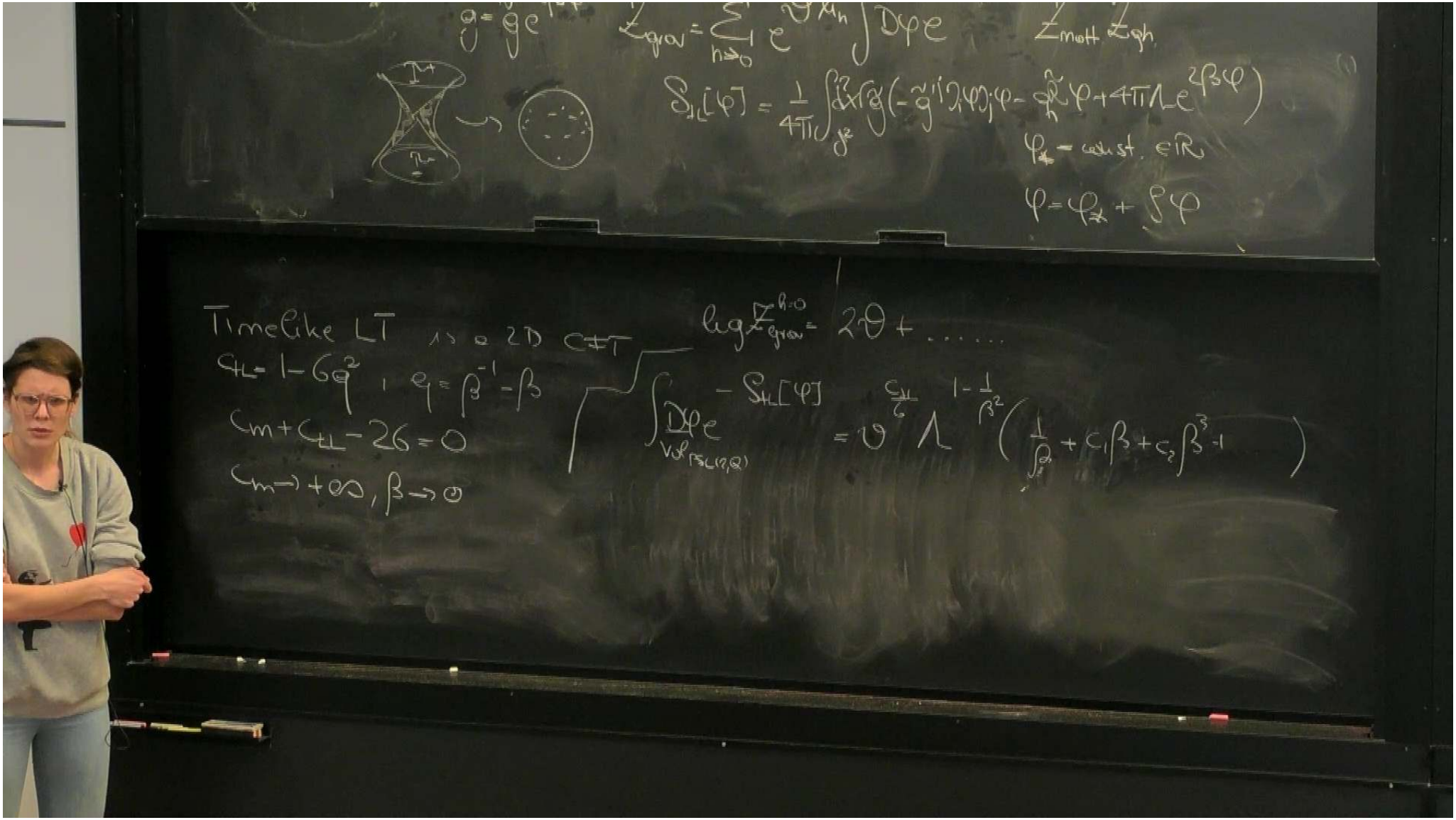
Zoom Link: https://pitp.zoom.us/j/91448729065?pwd=TmJSOGg4dkNxMVJsTWxRRHBYZnVoZz09

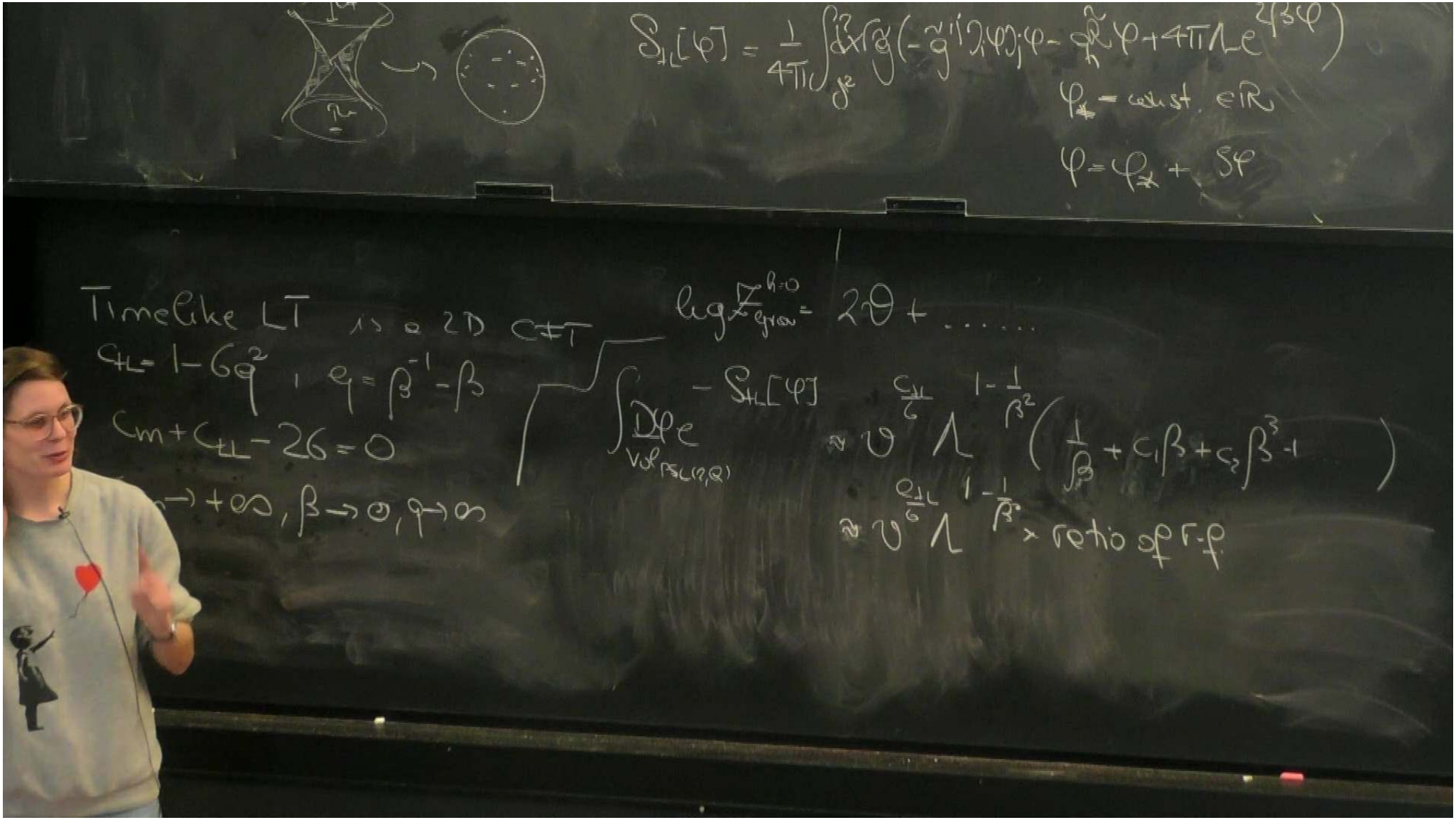

dS in d=2 Super Liouville (work with D. Ahmed & P Benetti Genolini)
$S_{BS} = \frac{A}{4G_N} = 10^{120}$
$e^{S_{dS}} = Z_{grav} = \sum_{M \in comp} \int Dg e^{-S_{EH}[\Lambda, g, M]}$
Z_{matter}
10^{10} ly

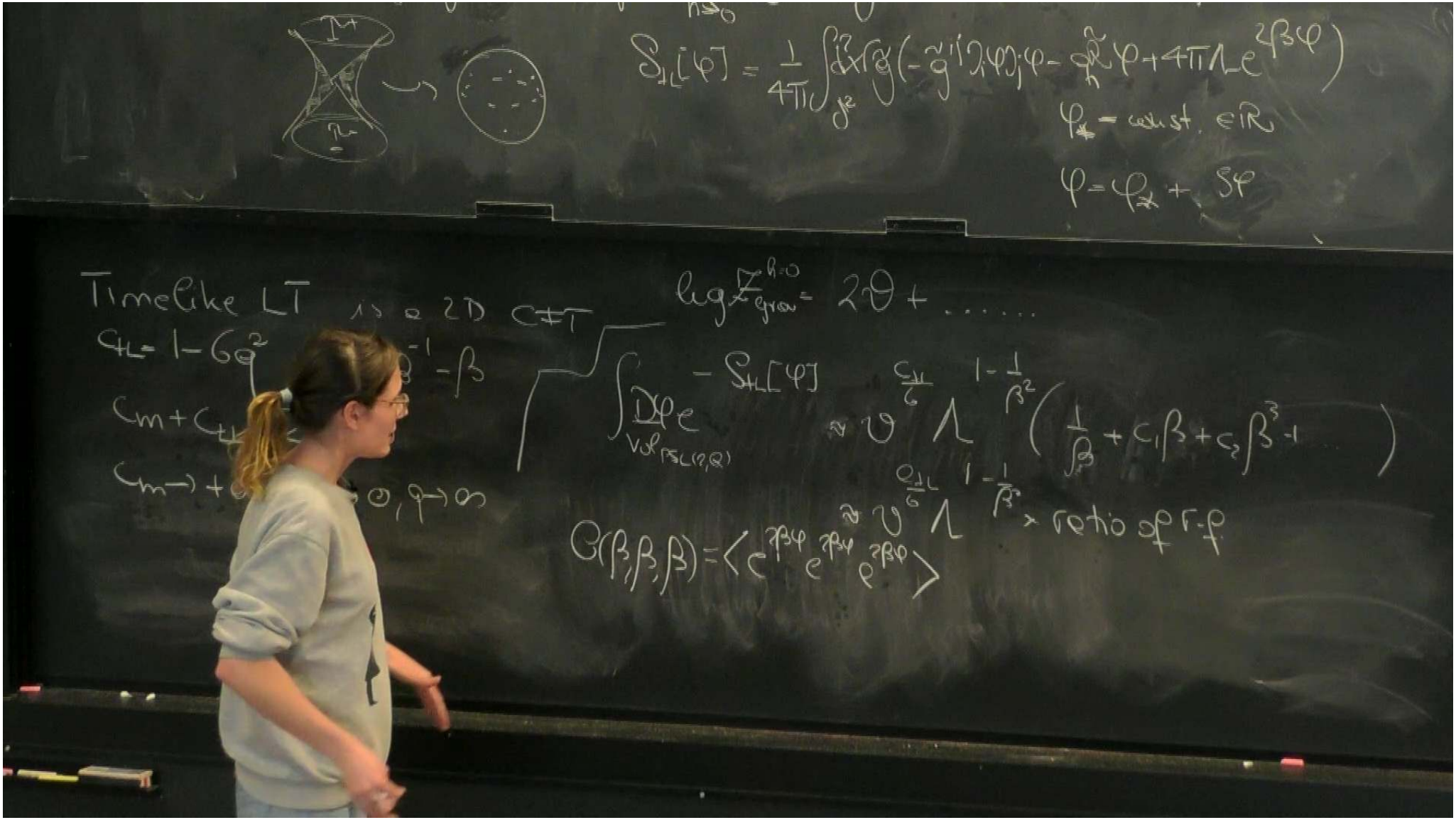

$S_{BH} = \frac{A}{4G_N} = 10^{100}$
$e^{S_{dS}} = Z_{grav} = \sum_{\mathcal{M}\in comp} \int Dg\, e^{-S_{EH}[\Lambda,g,\mathcal{M}]}$
Z_{CFT}
Z_{matter}
$10^{10^{29}}$
$g = \tilde{g} e^{2\beta\varphi}$
$Z_{grav}^{2D} = \sum_{h\geq 0} e^{\vartheta\chi_h} \int D\varphi\, e^{-S_L[\varphi]}$
Z_{matt} Z_{gh}
$S_L[\varphi] = \frac{1}{4\pi}\int d^2x \sqrt{g}\,(-\tilde{g}^{ij}\partial_i\varphi\partial_j\varphi - \tilde{R}\varphi + 4\pi\Lambda e^{2\beta\varphi})$

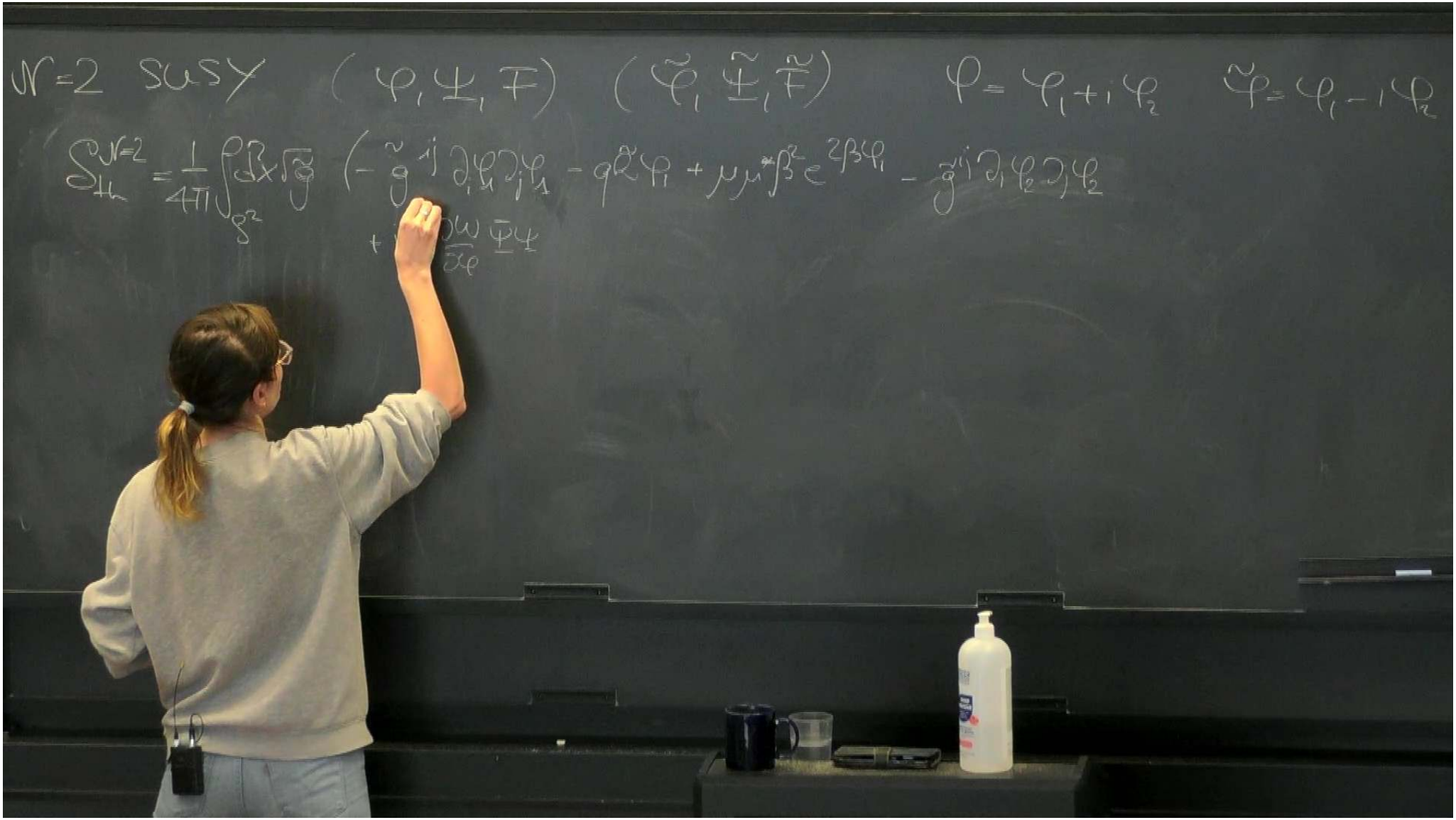

$S_{BH} = \frac{A}{4G_N} = 10^{100}$
$e^{S_{dS}} = Z_{grav} = \sum_{\mathcal{M}\in comp} \int Dg\, e^{-S_{EH}[\Lambda,g,\mathcal{M}]}$
Z_{mother}^{CFT}
$g = \tilde{g} e^{2\beta\varphi}$
$Z_{grav}^{2D} = \sum_{h=0}^{\infty} e^{\vartheta\chi_h} \int D\varphi\, e^{-S_L[\varphi]}$
Z_{matt} Z_{gh}
$S_L[\varphi] = \frac{1}{4\pi} \int_{S^2} d^2x \sqrt{g} \left(-\tilde{g}^{ij}\partial_i\varphi\partial_j\varphi - \frac{1}{8}\mathcal{R}\varphi + 4\pi\Lambda e^{2\beta\varphi} \right)$
$\varphi_* = const. \in \mathbb{R}$

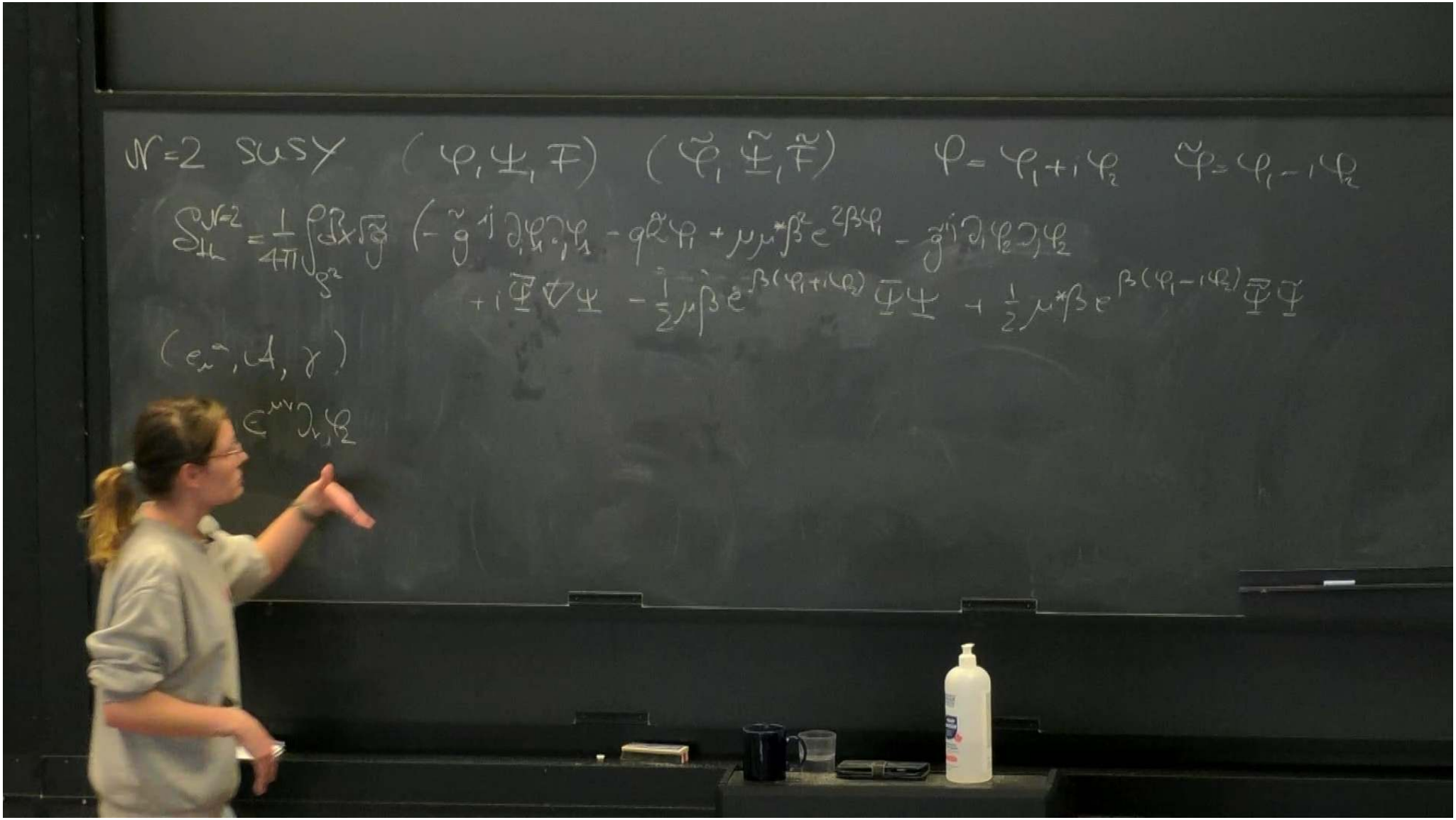

Timelike LT is a 2D CFT
$c_L = 1 - 6q^2 \; ; \; q = \beta^{-1} - \beta$
$c_m + c_L - 26 = 0$
$c_m \to +\infty$
$\log Z^{h=0}_{grav} = 2\theta + \ldots\ldots$

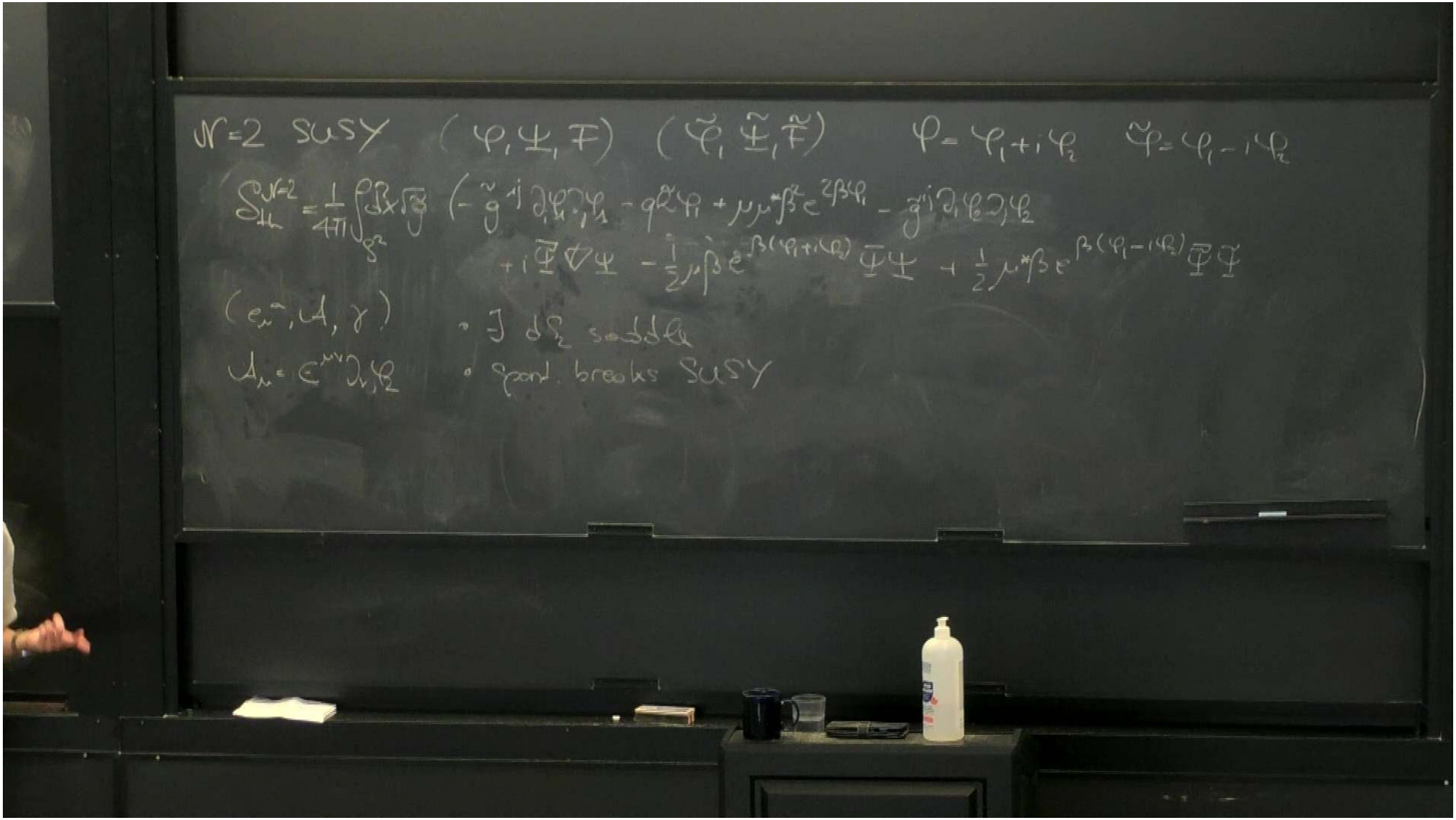

Timelike LT in 2D QFT
$c_L = 1 - 6q^2 \; , \; q = \beta^{-1} - \beta$
$c_m + c_{tL} - 26 = 0$
$c_m \to +\infty \, , \, \beta \to 0$
$\varphi = \varphi_* + \delta\varphi$
$\varphi_* = \text{const.} \in \mathbb{R}$

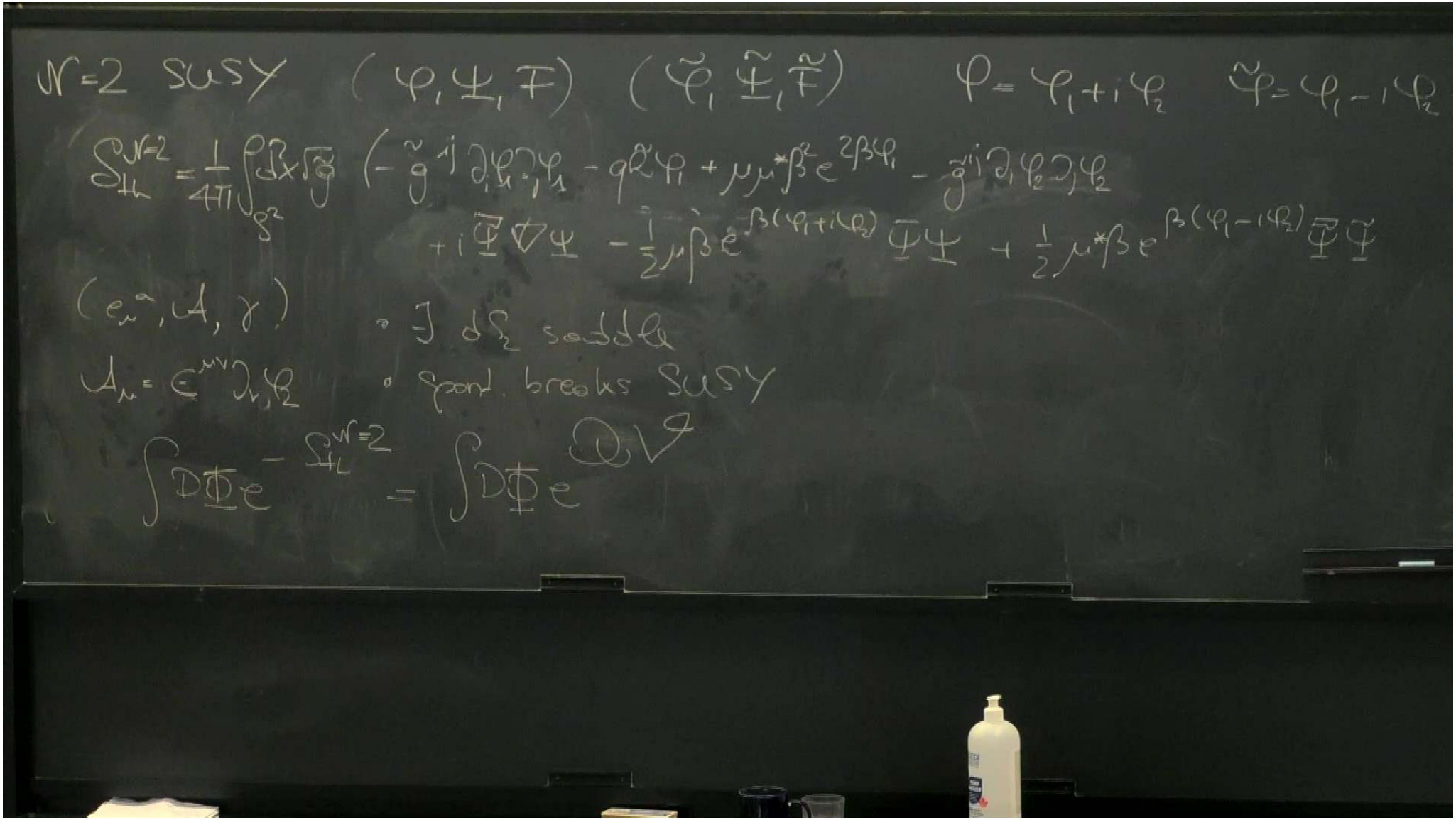

$S_L[\varphi] = \frac{1}{4\pi l} \int_{\mathcal{M}^2} d^2x \sqrt{g} \left(-\tilde{g}^{ij} \partial_i \varphi \partial_j \varphi - \frac{1}{8} \tilde{R} \varphi + 4\pi \Lambda e^{2\beta\varphi} \right)$
φ_{cl} = const. $\in \mathbb{R}$
$\varphi = \varphi_{cl} + \delta\varphi$
Timelike LT is a 2D CFT
$c_L = 1 - 6q^2 \; , \; q = \beta^{-1} - \beta$
$c_m + c_L - 26 = 0$
$\log Z^{h=0}_{grav} = 2\theta + \ldots\ldots$
$\int \frac{D\varphi e^{-S_L[\varphi]}}{Vol_{PSL(2,\mathbb{R})}}$
$\sim \upsilon^{\frac{c_L}{2}} \Lambda^{1-\frac{1}{\beta^2}} \left(\frac{1}{\beta} + c_1 \beta + c_2 \beta^3 - 1 \right)$
$\sim \upsilon^{\frac{c_L}{6}} \Lambda^{1-\frac{1}{\beta^2}}$ × ratio of r.p.

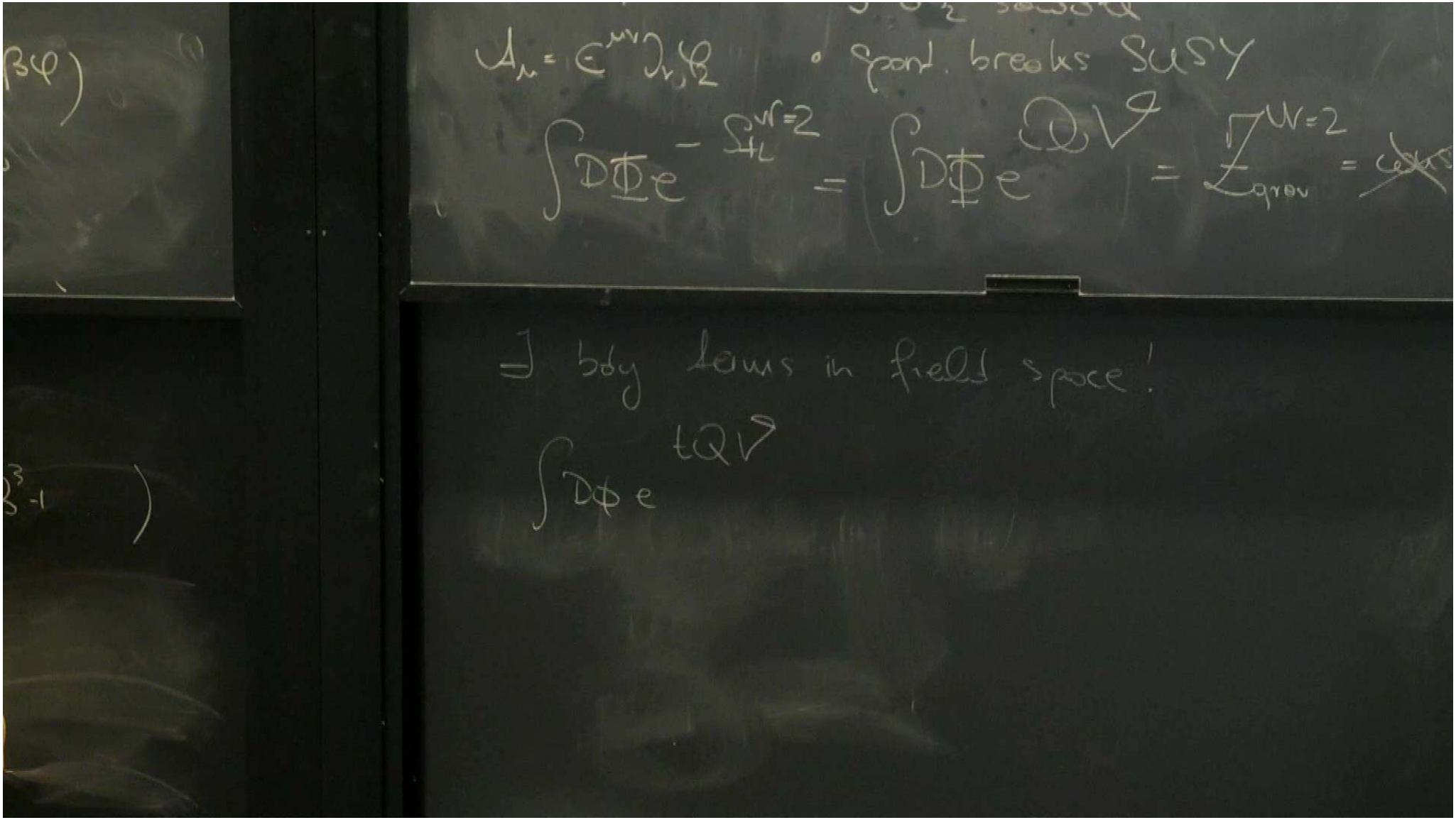

TimeLike LT
$S_L[\varphi] = \frac{1}{4\pi}\int_{\Sigma^2} d^2x \sqrt{g}\,(-g^{ij}\partial_i\varphi\partial_j\varphi - QR^{(2)}\varphi + 4\pi\mu_L e^{2\beta\varphi})$
$\varphi_* = \text{const.} \in \mathbb{R}$
$\varphi = \varphi_* + \delta\varphi$
$\log Z^{h=0}_{\text{grav}} = 2\vartheta + \dots$
$\int \frac{\mathcal{D}\varphi\, e^{-S_L[\varphi]}}{\text{Vol}\,[SL(2,\mathbb{R})]} \sim \vartheta^{\frac{c_L}{6}} \Lambda^{1-\frac{1}{\beta^2}} \left(\frac{1}{\beta} + c_1\beta + c_2\beta^3 - 1\right)$
$G(\beta_1,\beta_2,\beta_3) = \langle e^{2\beta\varphi} e^{2\beta\varphi} e^{2\beta\varphi} \rangle \sim \vartheta^{\frac{c_L}{6}} \Lambda^{1-\frac{1}{\beta^2}} \times \text{ratio of } \Gamma\text{-f.}$

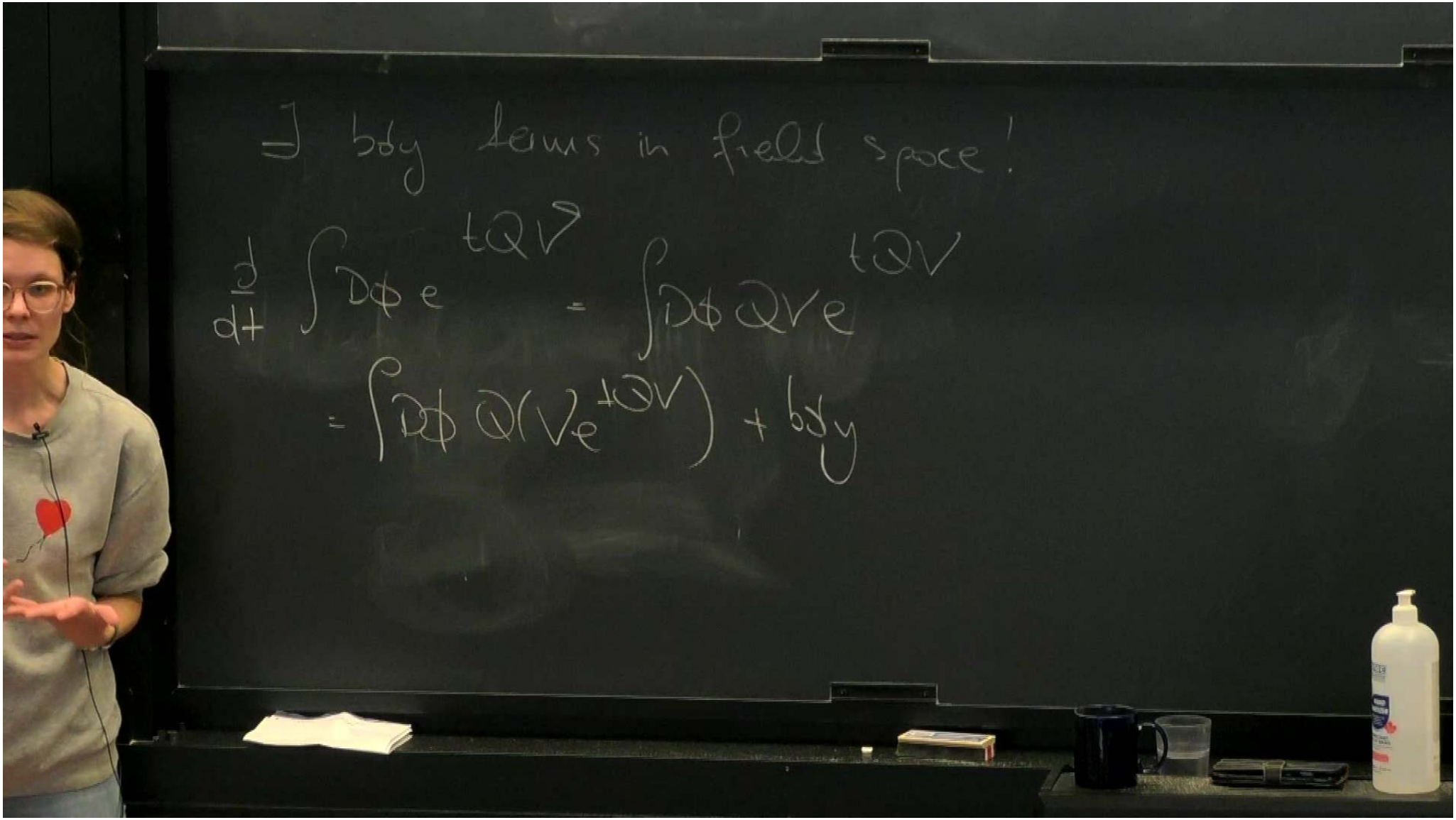

$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$
$S_{\text{top}}^{\mathcal{N}=2} = \frac{1}{4\pi} \int_{\Sigma^2} d^2x \sqrt{g} \left(- \tilde{g}^{ij} \partial_i \varphi_1 \partial_j \varphi_1 - q \tilde{R} \varphi_1 + \mu_{\mu} \beta^2 e^{2\beta\varphi_1} - \tilde{g}^{ij} \partial_i \varphi_2 \partial_j \varphi_2 \right.$
$+ \frac{\partial W}{\partial \varphi} \bar{\Psi} \Psi$


$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$
$S^{\mathcal{N}=2}_{UV} = \frac{1}{4\pi}\int_{S^2} d^2x \sqrt{g}\,(-\tilde{g}^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q^2\varphi_1 + \mu\mu^*\beta^2 e^{2\beta\varphi_1} - g^{ij}\partial_i\varphi_2\partial_j\varphi_2$
$+ i\bar{\Psi}\not{\nabla}\Psi - \frac{1}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar{\Psi}\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\Psi}\Psi$
$(e^a_\mu, \omega_\mu, \chi)$
$\epsilon^{\mu\nu}\partial_\mu\varphi_2$


$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$
$S_{UV}^{\mathcal{N}=2} = \frac{1}{4\pi} \int_{S^2} d^2x \sqrt{g}$ $(-\tilde{g}^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q^2\varphi_1 + \mu\mu^* \beta^2 e^{2\beta\varphi_1} - \tilde{g}^{ij}\partial_i\varphi_2\partial_j\varphi_2$
$+ i\bar{\Psi}\not{\nabla}\Psi - \frac{i}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar{\Psi}\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\Psi}\Psi$
(e_μ^a, A, γ) • $\int d^2\xi$ saddle
$A_\mu = \epsilon^{\mu\nu}\partial_\nu\varphi_2$ • spont. breaks SUSY


$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$
$S_{YM}^{\mathcal{N}=2} = \frac{1}{4\pi}\int_{S^2} d^2x \sqrt{g}\,(-\tilde{g}^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q^2\varphi_1 + \mu\mu^*\beta^2 e^{2\beta\varphi_1} - \tilde{g}^{ij}\partial_i\varphi_2\partial_j\varphi_2$
$+ i\bar{\Psi}\nabla\Psi - \frac{1}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar{\Psi}\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\Psi}\Psi$
(e_μ^a, A, χ)
$A_\mu = \epsilon^{\mu\nu}\partial_\nu\varphi_2$
• $\int d\xi_2$ saddle
• spont. breaks SUSY
$\int D\Phi e^{-S_{YM}^{\mathcal{N}=2}} = \int D\Phi e^{QV}$


$A_\mu = \epsilon^{\mu\nu}\lambda_1\psi_2$ spont. breaks SUSY
$\int D\Phi e^{-S_L^{vr=2}} = \int D\Phi e^{tQV} = Z_{qrav}^{N=2}$
$\exists$ bdy terms in field space!
$\int D\phi e^{tQV}$


∃ bdy terms in field space!
$\frac{d}{dt}\int D\phi\, e^{tQV} = \int D\phi\, Q V e^{tQV}$
$= \int D\phi\, Q(V e^{tQV}) + bdy$