Title: dS in N=2 super Liouville

Speakers: Beatrix Muehlmann

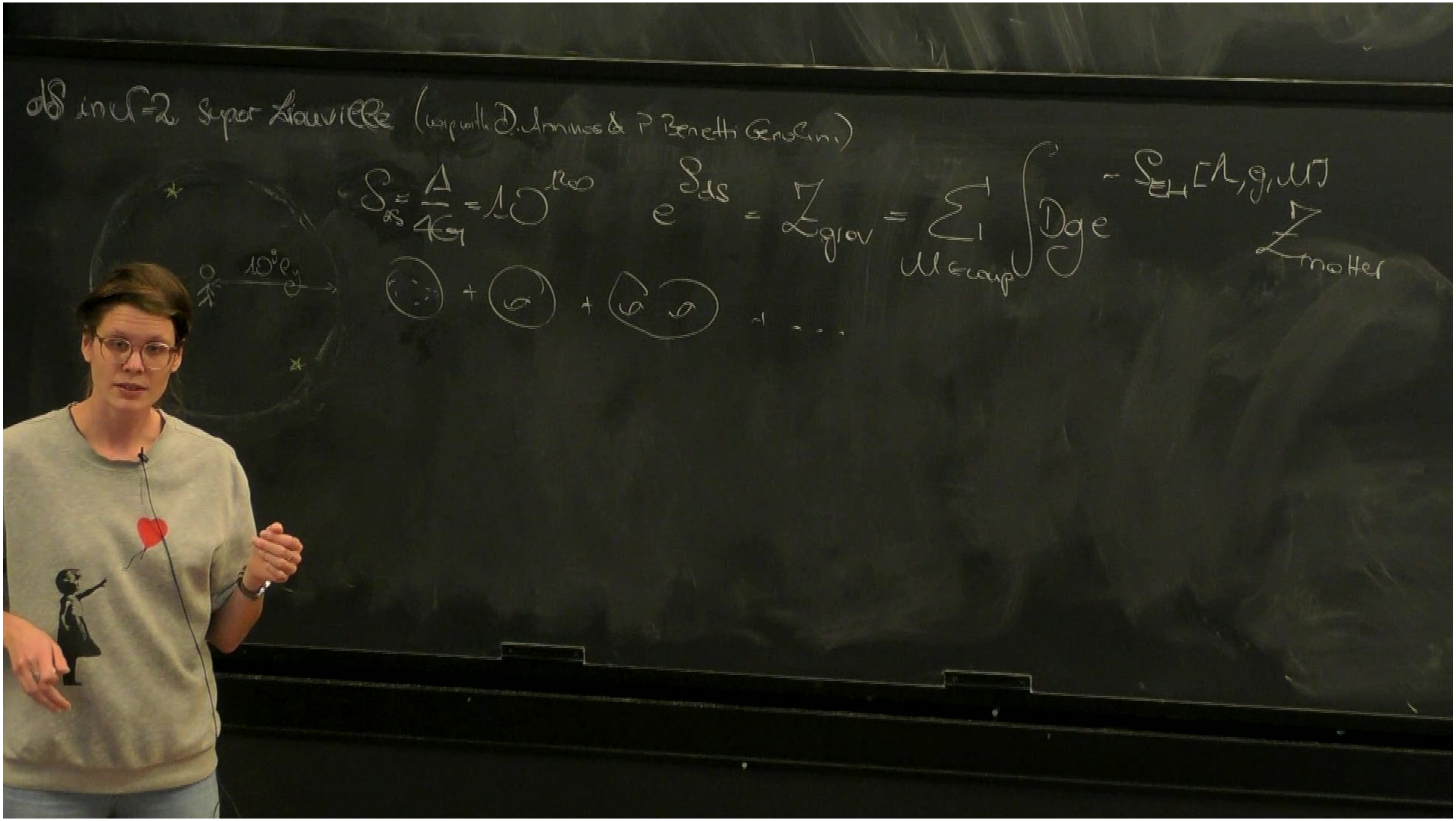
Series: Quantum Fields and Strings

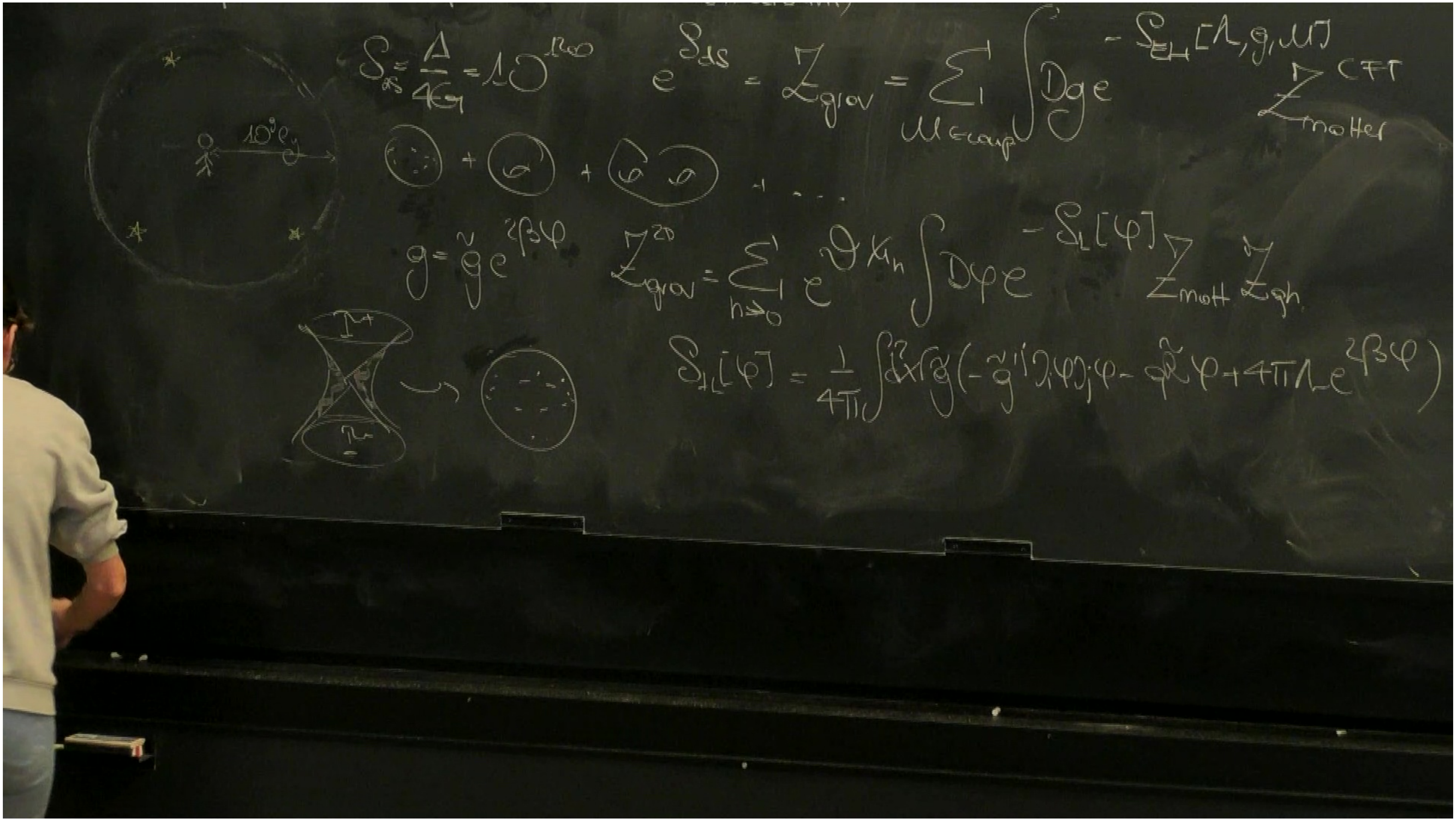
Date: November 15, 2022 - 2:00 PM

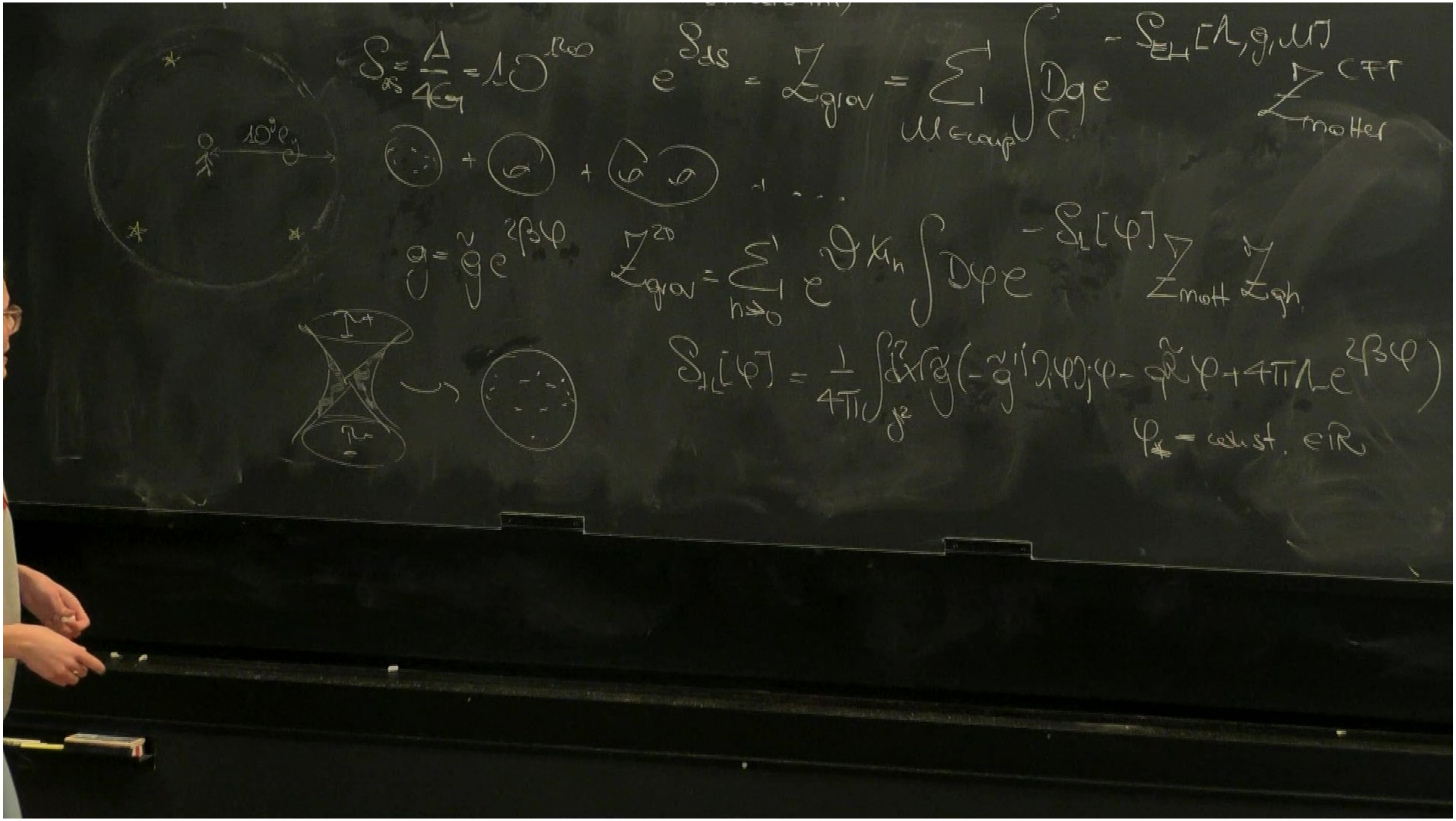
URL: https://pirsa.org/22110021

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 N=2 super Liouville (work with D. Anninos & P. Benetti Genolini)
$S_{dS} = \frac{A}{4G} = 10^{120}$
$e^{S_{dS}} = Z_{grav} = \sum_{M \in top} \int Dg \, e^{-S_{EH}[\Lambda, g, M]} Z_{matter}$


$S_{dS} = \frac{A}{4G_N} = 10^{120}$
$10^9 ly$
$e^{S_{dS}} = Z_{grav} = \sum_{M \in top}' \int Dg\, e^{-S_{EH}[\Lambda, g, M]}\, Z^{CFT}_{matter}$
$g = \tilde{g}\, e^{2\beta\varphi}$
$Z^{2D}_{grav} = \sum_{h \geq 0}' e^{\vartheta \chi_h} \int D\varphi\, e^{-S_L[\varphi]}\, \tilde{Z}_{matt}\, \tilde{Z}_{gh}$
$S_L[\varphi] = \frac{1}{4\pi} \int d^2x \sqrt{\tilde{g}} \left(-\tilde{g}^{ij} \partial_i\varphi \partial_j\varphi - q\tilde{R}\varphi + 4\pi\Lambda e^{2\beta\varphi}\right)$
$\mathcal{I}^+$
$\mathcal{I}^-$


$S_{dS} = \frac{A}{4G_N} = 10^{120}$
$e^{S_{dS}} = Z_{grav} = \sum'_{\mathcal{M} \in conf} \int Dg \, e^{-S_{EH}[\Lambda, g, \mathcal{M}]} Z^{CFT}_{matter}$
$10^9 ly$
$g = \tilde{g} e^{2\beta\varphi}$
$Z^{2D}_{grav} = \sum'_{h \geq 0} e^{\vartheta \chi_h} \int D\varphi \, e^{-S_L[\varphi]} Z_{matt} \tilde{Z}_{gh}$
$S_L[\varphi] = \frac{1}{4\pi} \int_{S^2} d^2x \sqrt{\tilde{g}} \left(-\tilde{g}^{ij} \partial_i\varphi \partial_j\varphi - \tilde{g}\tilde{R}\varphi + 4\pi\Lambda e^{2\beta\varphi} \right)$
$\varphi_* = const. \in \mathbb{R}$
$\mathcal{I}^+$
$\mathcal{I}^-$

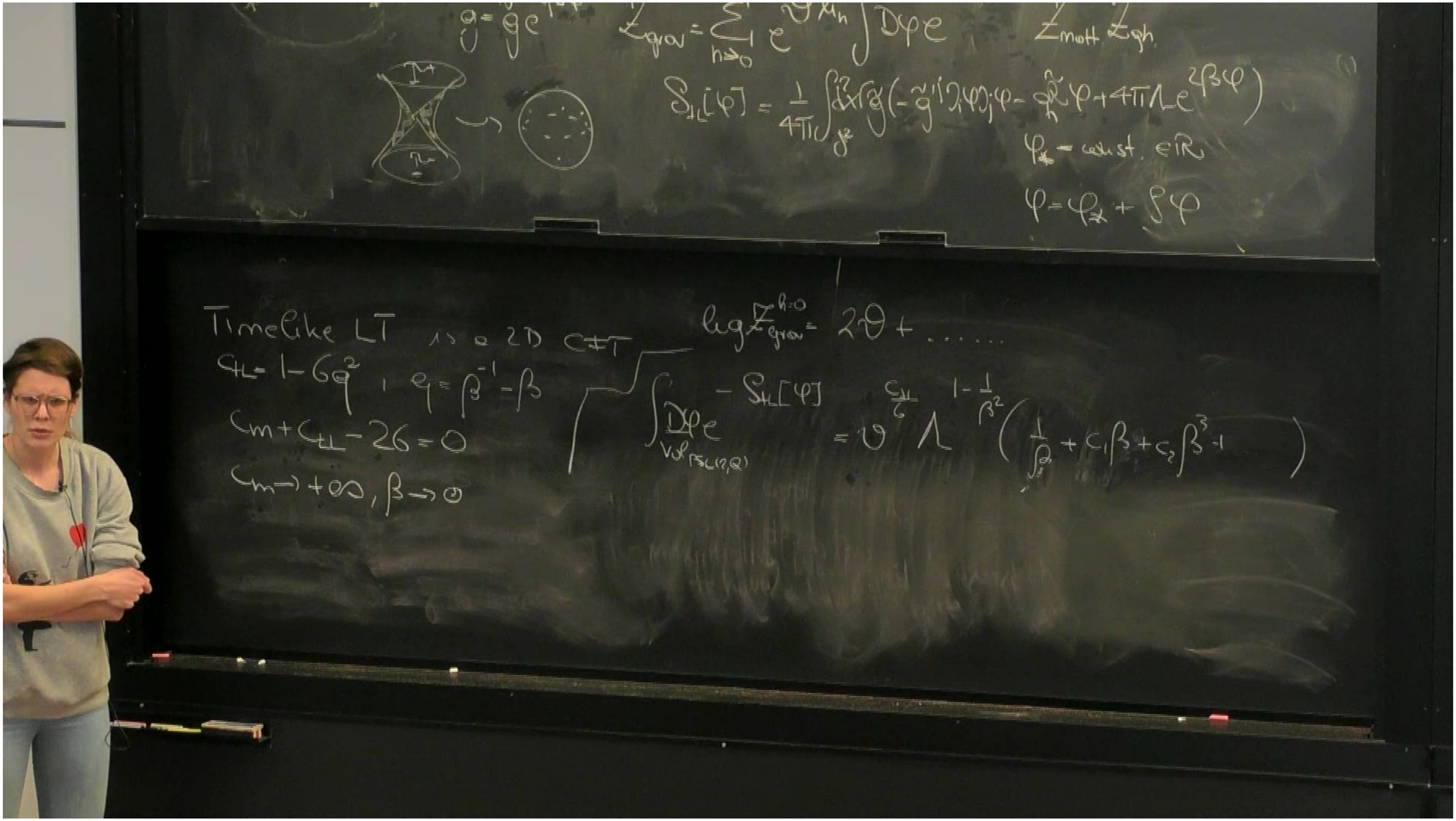
Timelike LT is a 2D CFT

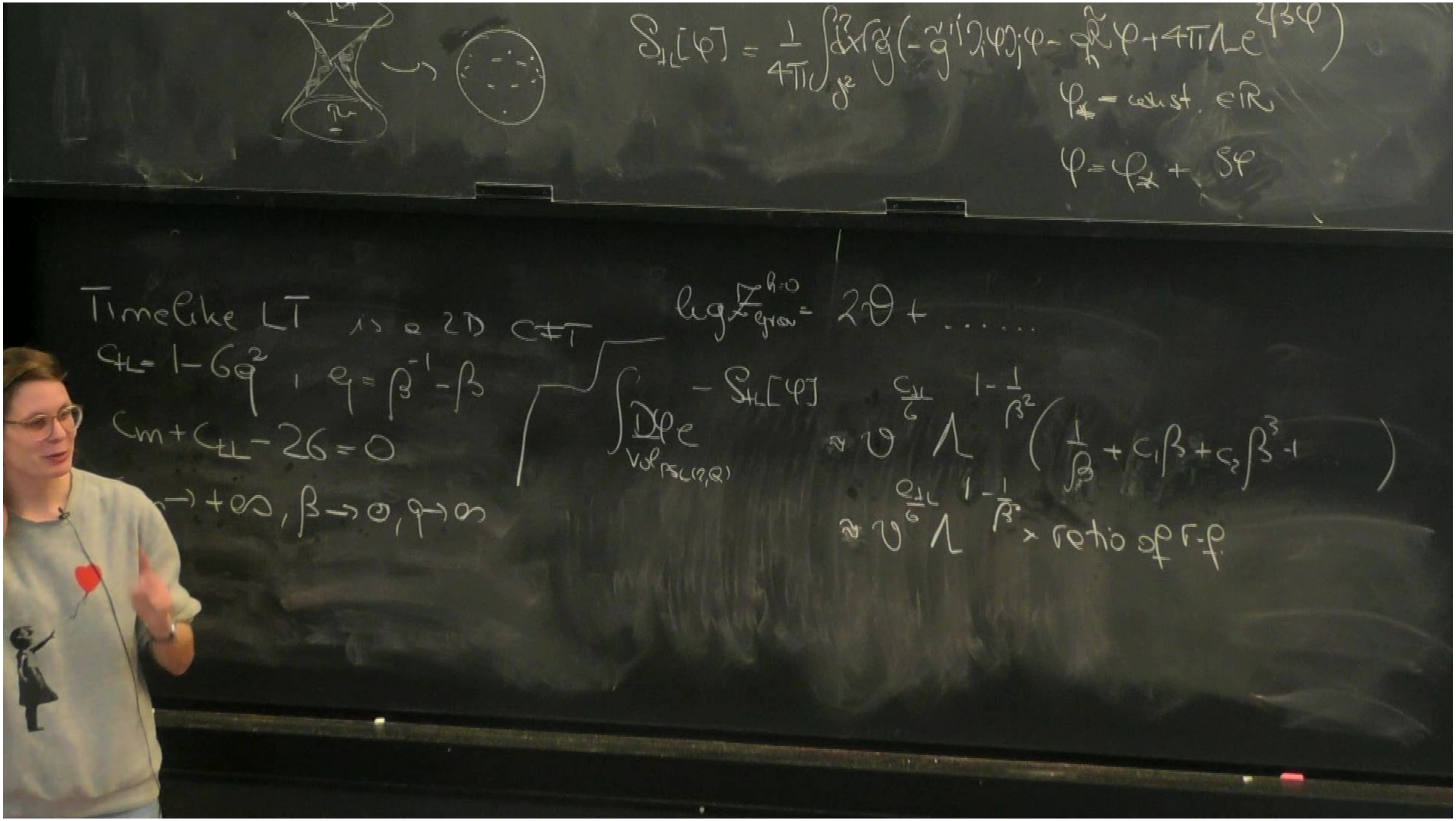
$c_{TL} = 1 - 6q^2 \,,\quad q = \beta^{-1} - \beta$

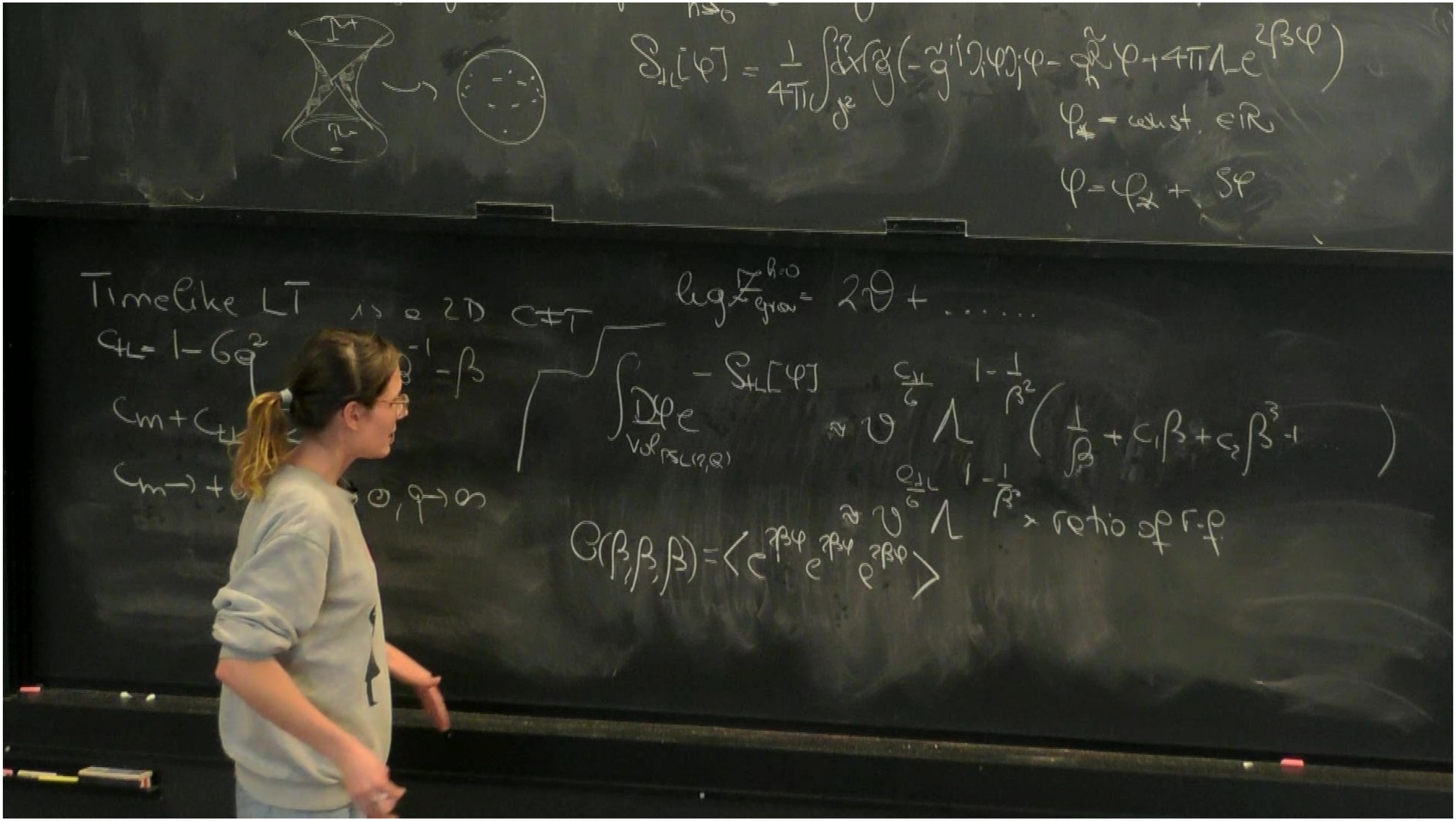
$c_m + c_{TL} - 26 = 0$

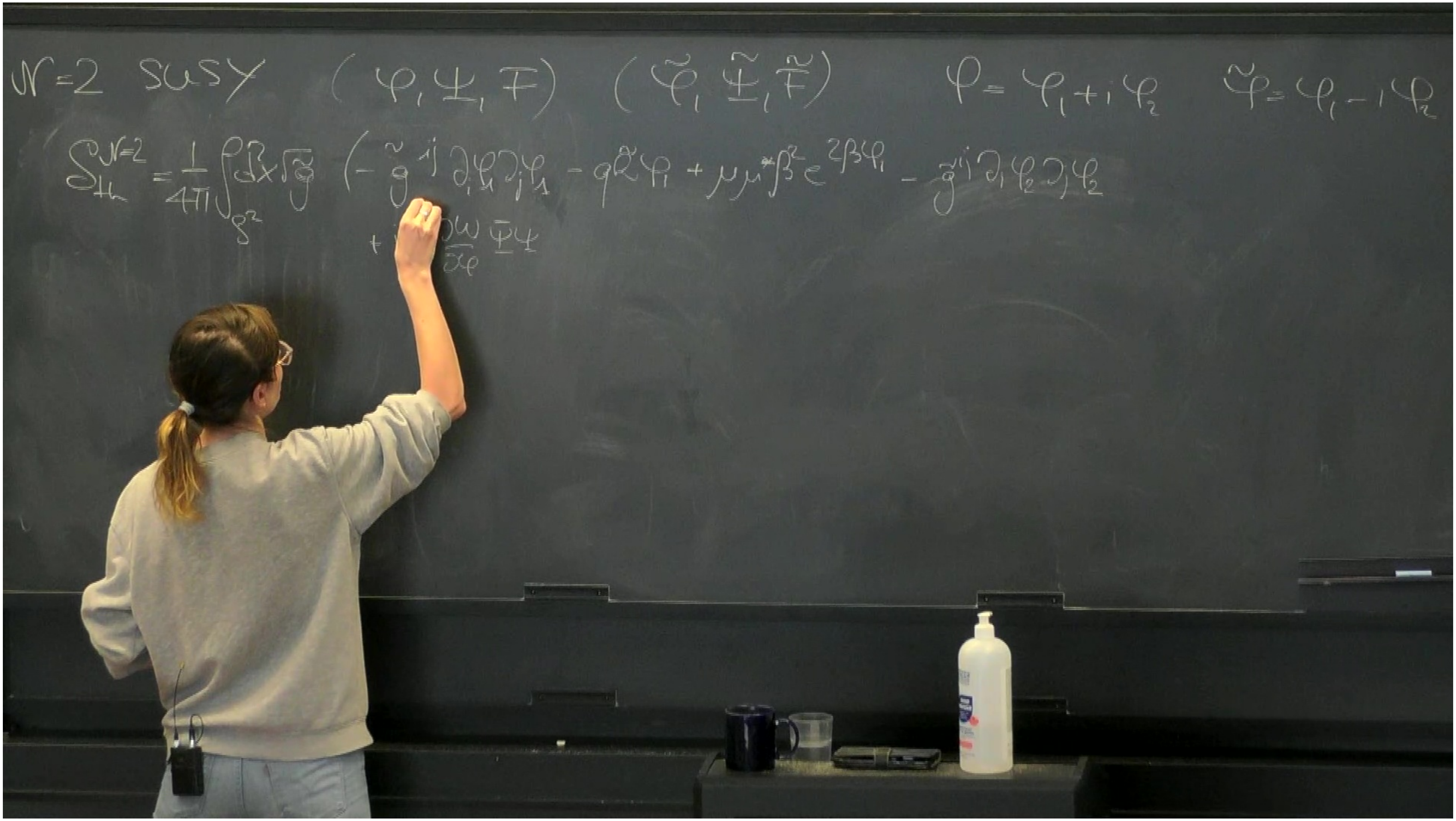
$c_m \to +\infty$

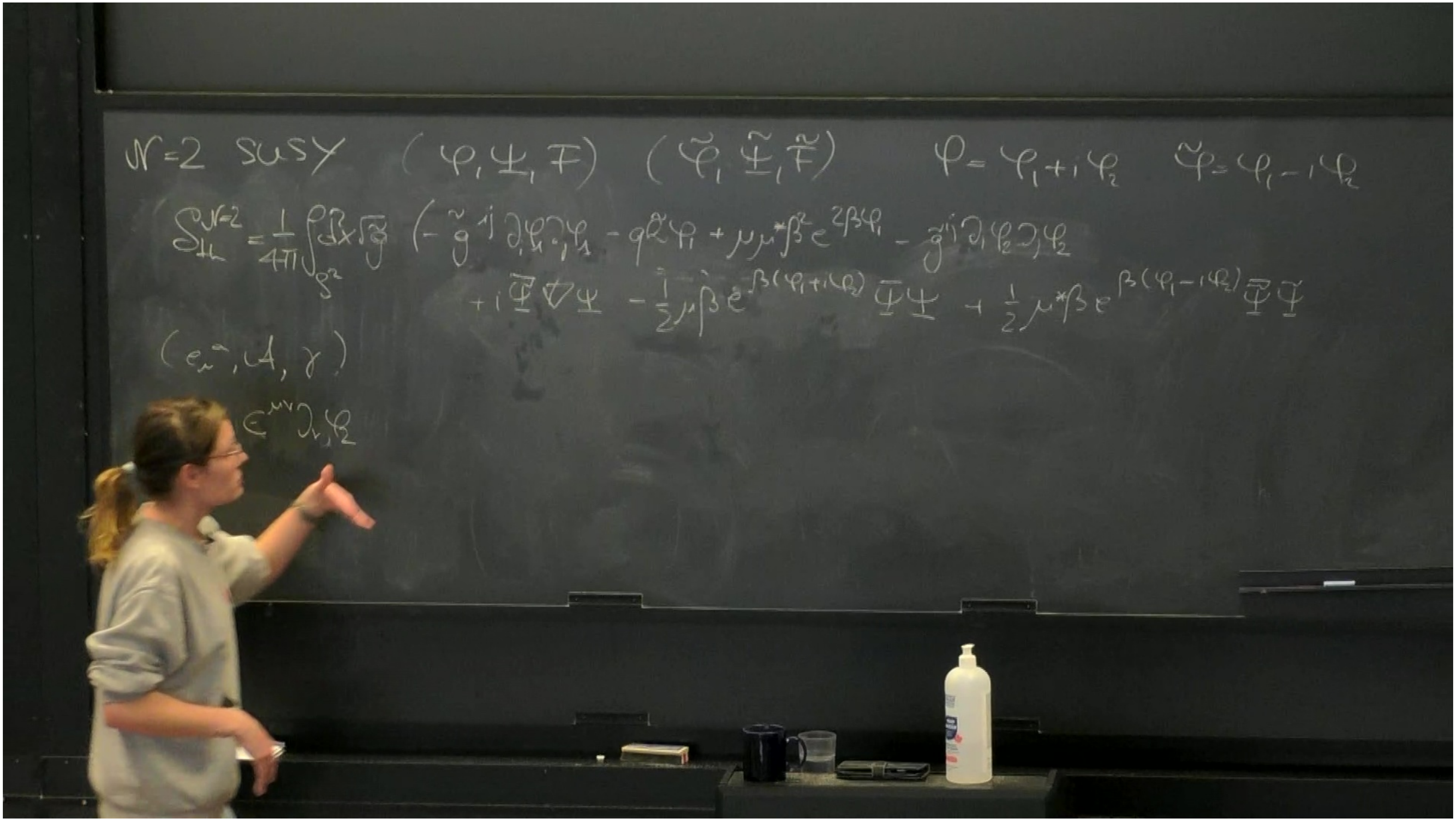
$\log Z_{grav}^{h=0} = 2\vartheta + \ldots\ldots$


$Z_{grav} = \sum_{h \geq 0} e^{\vartheta \chi_h} \int D\varphi\, e$
$Z_{matt}\, Z_{gh}$
$S_{tL}[\varphi] = \frac{1}{4\pi} \int_{\Sigma} d^2x \sqrt{\tilde g}\,(-\tilde g^{ij} \partial_i \varphi \partial_j \varphi - q \tilde R \varphi + 4\pi \Lambda e^{2\beta\varphi})$
$\varphi_* =$ const. $\in \mathbb{R}$
$\varphi = \varphi_* + \delta\varphi$
Timelike LT is a 2D CFT
$c_{tL} = 1 - 6q^2$, $q = \beta^{-1} - \beta$
$c_m + c_{tL} - 26 = 0$
$c_m \to +\infty$, $\beta \to 0$
$\log Z_{grav}^{h=0} = 2\vartheta + \ldots\ldots$
$\int \frac{D\varphi\, e^{-S_{tL}[\varphi]}}{\mathrm{Vol}_{PSL(2,\mathbb{C})}} = \vartheta^{\frac{c_{tL}}{6}} \Lambda^{1 - \frac{1}{\beta^2}} \left(\frac{1}{\beta^3} + c_1 \beta + c_2 \beta^3 + \ldots \right)$


$S_{tL}[\varphi] = \frac{1}{4\pi} \int_{S^2} d^2x \sqrt{\tilde{g}} \left(-\tilde{g}^{ij} \partial_i\varphi \partial_j\varphi - q \tilde{R} \varphi + 4\pi \Lambda e^{2\beta\varphi} \right)$
$\varphi_* = \text{const.} \in \mathbb{R}$
$\varphi = \varphi_* + \delta\varphi$
Timelike LT is a 2D CFT
$c_{tL} = 1 - 6q^2$, $q = \beta^{-1} - \beta$
$c_m + c_{tL} - 26 = 0$
$+\infty$, $\beta \to 0$, $q \to \infty$
$\log Z^{h=0}_{grav} = 2\vartheta + \ldots\ldots$
$\int \frac{D\varphi}{\mathrm{Vol}_{PSL(2,\mathbb{C})}} e^{-S_{tL}[\varphi]}$
$\approx \vartheta^{\frac{c_{tL}}{6}} \Lambda^{1-\frac{1}{\beta^2}} \left(\frac{1}{\beta} + c_1\beta + c_2\beta^3 + \ldots \right)$
$\approx \vartheta^{\frac{c_{tL}}{6}} \Lambda^{1-\frac{1}{\beta^2}} \times$ ratio of Γ-f.


S_tL[φ] = 1/4π ∫ d²x √g (− g̃^ij ∂_iφ ∂_jφ − q R̃ φ + 4πΛ e^{2βφ})
φ* = const. ∈ ℝ
φ = φ* + δφ
Timelike LT is a 2D CFT
c_tL = 1 − 6q²
−β
c_m + c_tL
log Z_grav^{h=0} = 2ϑ + ...
∫ Dφ e^{−S_tL[φ]} / Vol_PSL(2,ℂ) ≈ ϑ^{c_tL/6} Λ^{1 − 1/β²} (1/β + c₁β + c₂β³ + ...)
≈ ϑ^{c_tL/6} Λ^{1 − 1/β²} × ratio of Γ-f.
C(β,β,β) = ⟨e^{2βφ} e^{2βφ} e^{2βφ}⟩


N=2 SUSY (φ, Ψ, F) (φ̃, Ψ̃, F̃) φ = φ1 + i φ2 φ̃ = φ1 − i φ2



$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$
$S_{Lh}^{\mathcal{N}=2} = \frac{1}{4\pi}\int_{S^2} d^2x \sqrt{\tilde{g}} \left(-\tilde{g}^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q\tilde{R}\varphi_1 + \mu\mu^*\beta^2 e^{2\beta\varphi_1} - \tilde{g}^{ij}\partial_i\varphi_2\partial_j\varphi_2\right.$
$+ i\bar{\Psi}\nabla\Psi - \frac{1}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar{\Psi}\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\tilde{\Psi}}\tilde{\Psi}$
(e_μ^a, A, γ)
$\epsilon^{\mu\nu}\partial_\nu\varphi_2$

$\mathcal{N}=2$ SUSY (φ, Ψ, F) $(\tilde{\varphi}, \tilde{\Psi}, \tilde{F})$ $\varphi = \varphi_1 + i\varphi_2$ $\tilde{\varphi} = \varphi_1 - i\varphi_2$

$$S_{th}^{\mathcal{N}=2} = \frac{1}{4\pi}\int_{S^2} d^2x\sqrt{\tilde{g}}\,\Big(-\tilde{g}^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q\tilde{R}\varphi_1 + \mu\mu^*\beta^2 e^{2\beta\varphi_1} - \tilde{g}^{ij}\partial_i\varphi_2\partial_j\varphi_2$$
$$+ i\bar{\Psi}\nabla\Psi - \frac{1}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar{\Psi}\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\tilde{\Psi}}\tilde{\Psi}$$

(e_μ^a, A, γ)

$A_\mu = \epsilon^{\mu\nu}\partial_\nu\varphi_2$

- $\exists$ $d\varphi_2$ saddle
- spont. breaks SUSY

$\mathcal{N}=2$ SUSY $\quad (\varphi, \Psi, F) \quad (\tilde\varphi, \tilde\Psi, \tilde F) \qquad \varphi = \varphi_1 + i\varphi_2 \quad \tilde\varphi = \varphi_1 - i\varphi_2$

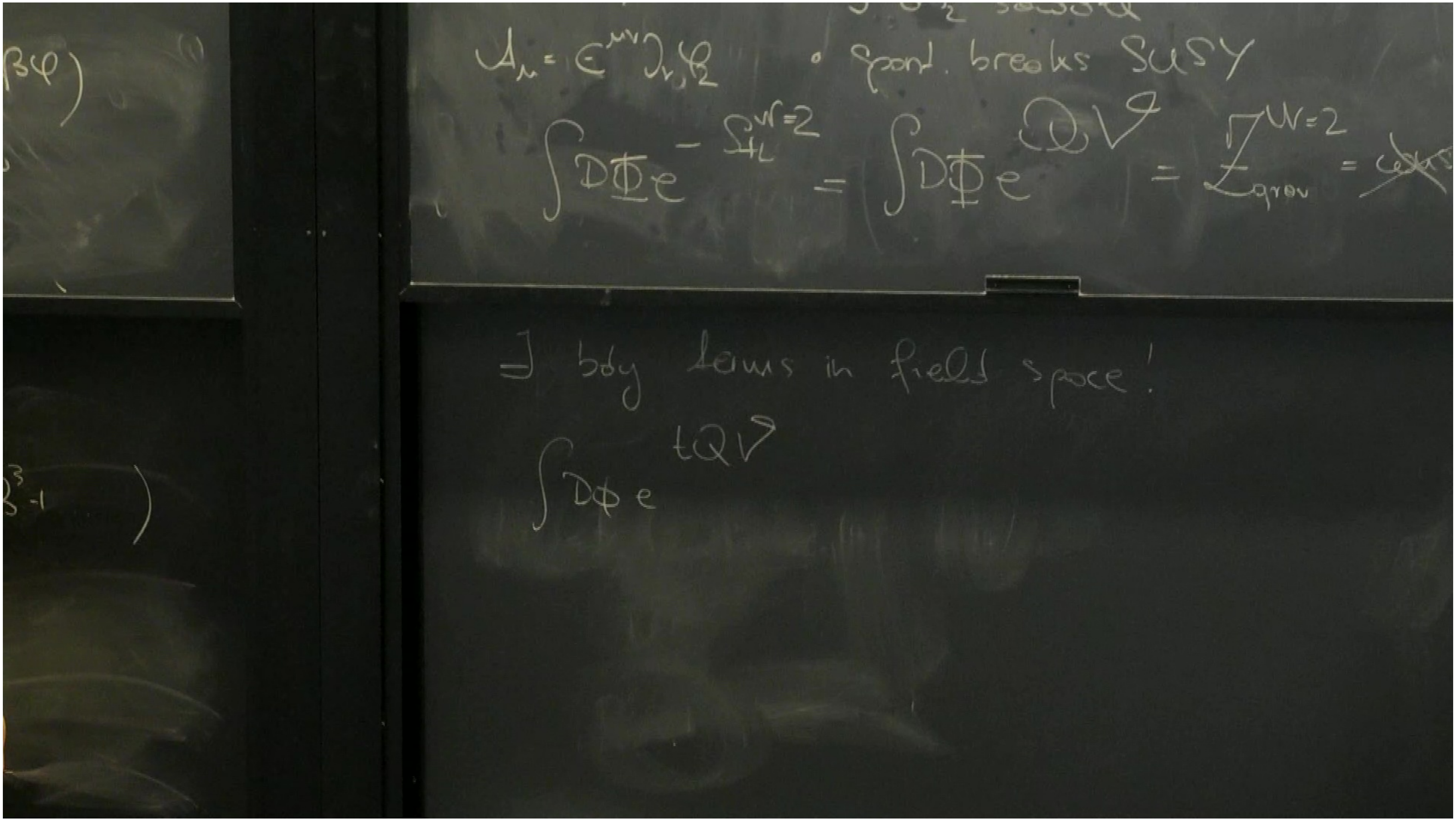
$$S_{th}^{\mathcal{N}=2} = \frac{1}{4\pi}\int_{S^2} d^2x \sqrt{\tilde g}\,\Big(-\tilde g^{ij}\partial_i\varphi_1\partial_j\varphi_1 - q\tilde R\varphi_1 + \mu\mu^*\beta^2 e^{2\beta\varphi_1} - \tilde g^{ij}\partial_i\varphi_2\partial_j\varphi_2$$
$$+ i\bar\Psi\nabla\Psi - \frac{1}{2}\mu\beta e^{\beta(\varphi_1+i\varphi_2)}\bar\Psi\Psi + \frac{1}{2}\mu^*\beta e^{\beta(\varphi_1-i\varphi_2)}\bar{\tilde\Psi}\tilde\Psi$$

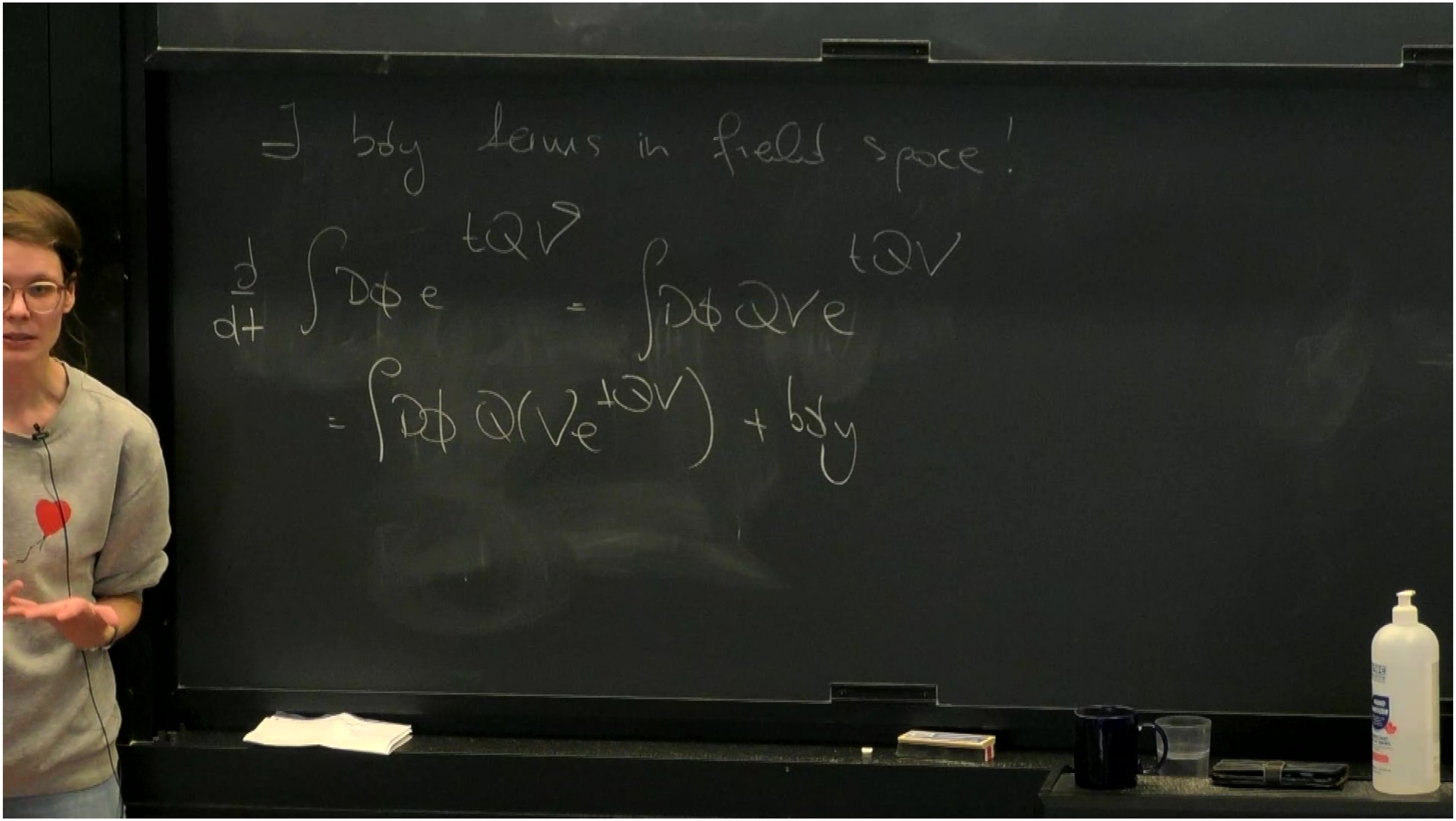
(e_μ^a, A, γ)

$A_\mu = \epsilon^{\mu\nu}\partial_\nu\varphi_2$

- $\exists\ dS_2$ saddle
- spont. breaks SUSY

$$\int D\Phi\, e^{-S_{th}^{\mathcal{N}=2}} = \int D\Phi\, e^{QV}$$


$A_\mu = \epsilon^{\mu\nu}\partial_\nu \varphi_2$
spont. breaks SUSY
$\int D\Phi\, e^{-S_{4L}^{N=2}} = \int D\Phi\, e^{QV} = Z_{grav}^{N=2}$
∃ bdy terms in field space!
$\int D\phi\, e^{tQV}$


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