Title: String Theory Lecture

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Collection: String Theory 2023/24

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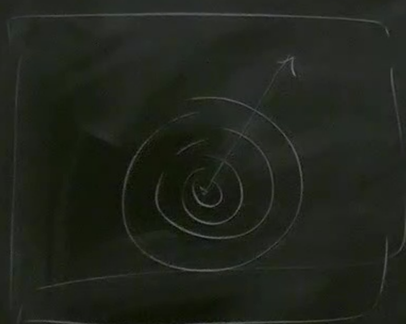
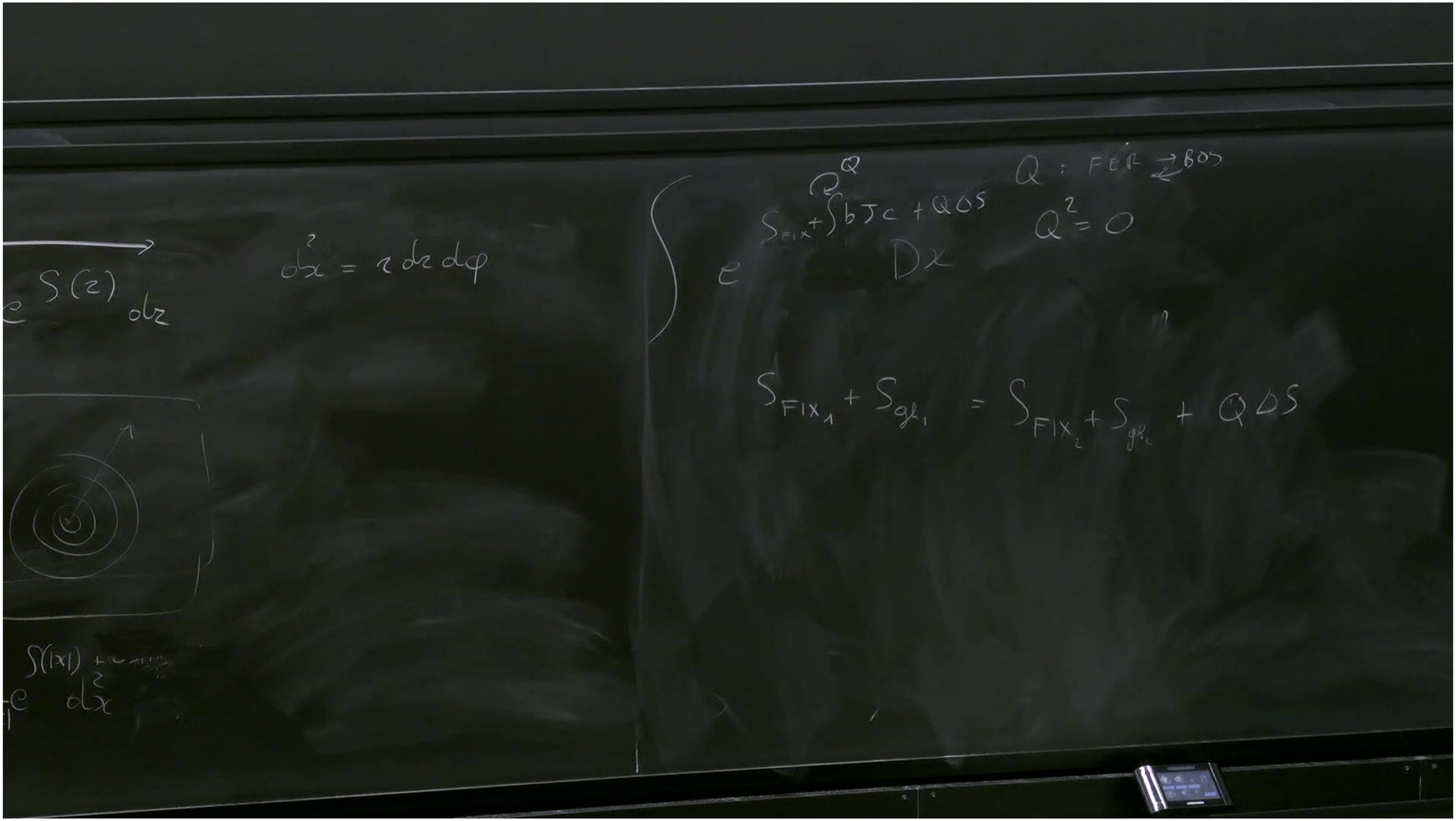
$$\int_0^\infty e^{S(r)}\,dr$$

$$d^2x = r\,dr\,d\varphi$$



$$\frac{1}{2\pi}\int_{\mathbb{R}^2}\frac{1}{|x|}e^{S(|x|)}\,d^2x$$

$$\int e^{S_{F,x}+\int_Q b\,J\,c}\,Dx$$


$d^2x = r\,dr\,d\varphi$
$e^{S(r)}\,dr$
$\int e^{S_{FIX} + \int b\,\delta c + Q\Delta S}\,Dx$
$Q : \text{FER} \rightleftarrows \text{BOS}$
$Q^2 = 0$
$S_{FIX_1} + S_{gh_1} = S_{FIX_2} + S_{gh_2} + Q\Delta S$

$$f = f_{i_1 \dots i_n}(x^i)\, dx^{i_1} \dots dx^{i_n}$$

$$dx^i dx^j = -dx^j dx^i$$

$$dx^i = \frac{dx^i}{dy^j} dy^j$$

$$\int_{M_n} f = \int f_{i_1 \dots i_n} \det \frac{dx^{i_a}}{du_b}\, du_1 \dots du_n$$

$$f \to df$$

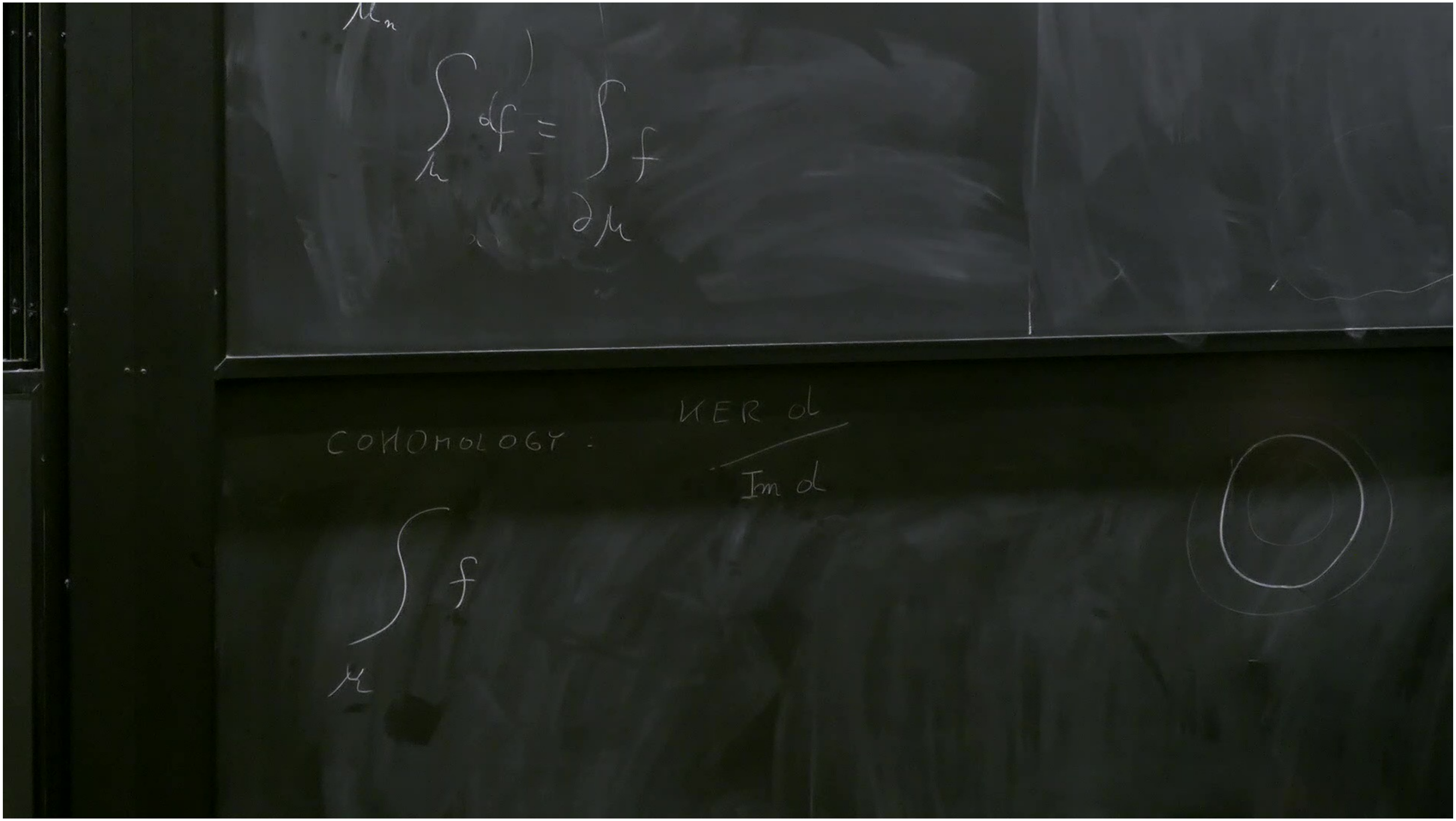
d LEIBNIZ

$d : x^i \to dx^i$

$dx^i \to 0$

$$\int_M df = \int_{\partial M} f$$

KER d


$\int_M df = \int_{\partial M} f$
COHOMOLOGY :
KER d
Im d
$\int_M f$

$\dots dx \dots dx^{n}$ $dx^i dx^j = -dx^j dx^i$ $dx^i = \frac{\partial x^i}{\partial y^j} dy^j$

$= \int f_{i_1 \dots i_n} \det \frac{\partial x^{i_a}}{\partial u_b} du_1 \dots du_n$

$f \to df$

d LEIBNIZ

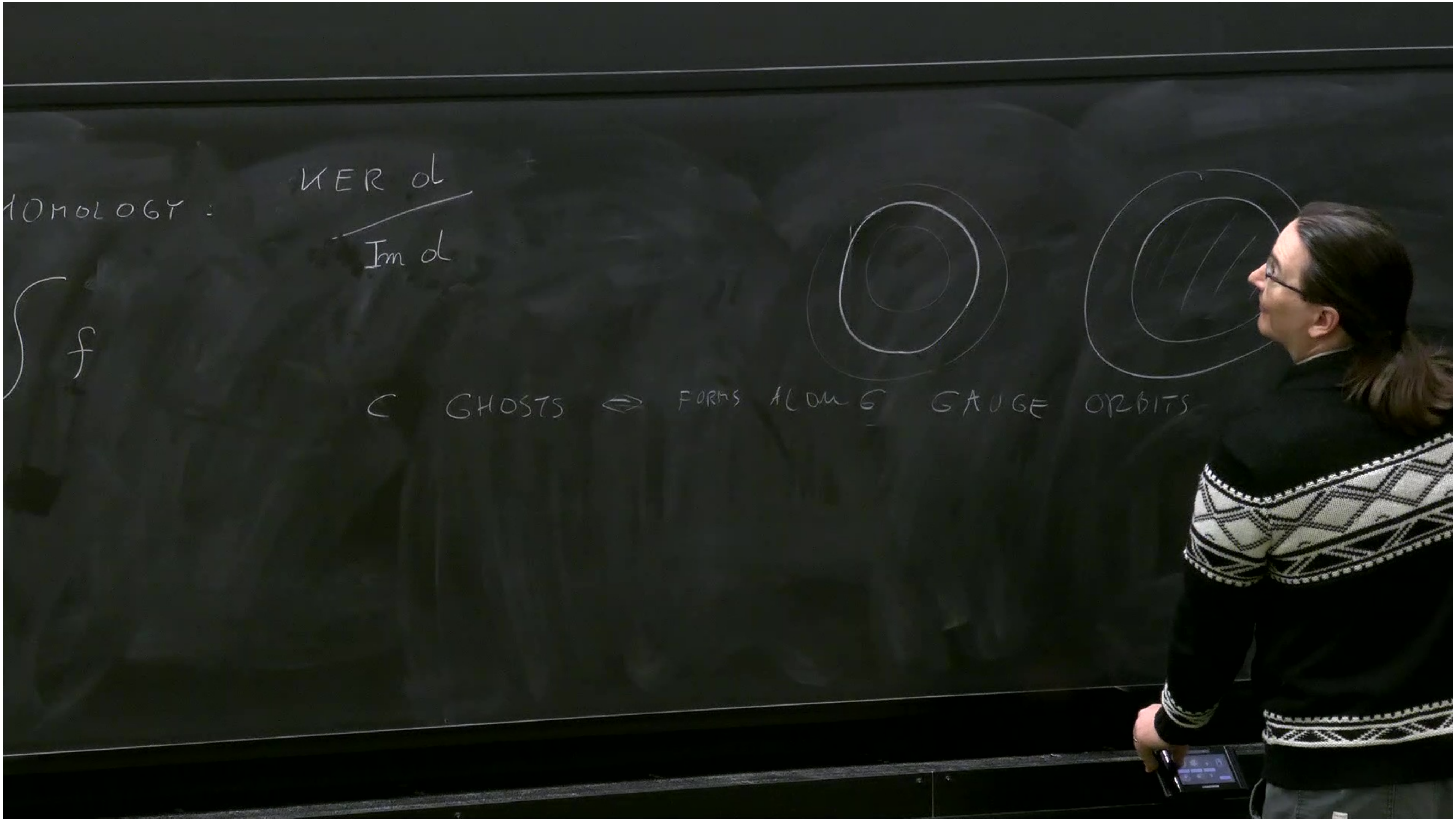
$d : x^i \to dx^i$

$dx^i \to 0$

$= \int_{\partial M} f$

$M \longrightarrow$ TOPOLOGY OF M

...OGY : $\frac{\mathrm{KER}\ d}{\mathrm{Im}\ d}$


OMOLOGY :
KER d
Im d
f
C GHOSTS ⇔ FORMS ALONG GAUGE ORBITS

$\delta(x)$ $\qquad \displaystyle\int_{I \ni 0} F(x)\,\delta(x) = F(0)$

$\delta(f(x))$ $\qquad \displaystyle\int F(x)\,\delta(f(x))\,dx = \sum_{f(x_*)=0} \frac{1}{|f'(x_*)|} F(x_*)$

$$\int F(x)\,|f'(x)|\,\delta(f(x))\,dx = \sum_{f(x_*)=0} \frac{f'}{|f'|}(x_*)\,F(x_*)$$

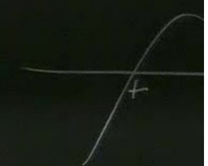
$$\int e^{\overbrace{iBf(x) + bf'c}^{Q(bf(x)) + Q(bB)} + iB^2}\, db\,dc\,dx\,dB = \qquad \delta(f)\,df$$

$Q:$ $x \to c$

$b \to iB$

$$\frac{\mathrm{KER}\,Q}{\mathrm{IM}\,Q}$$

$\delta(x)$ $\qquad \int F(x)\,\delta(x) = F(0)$

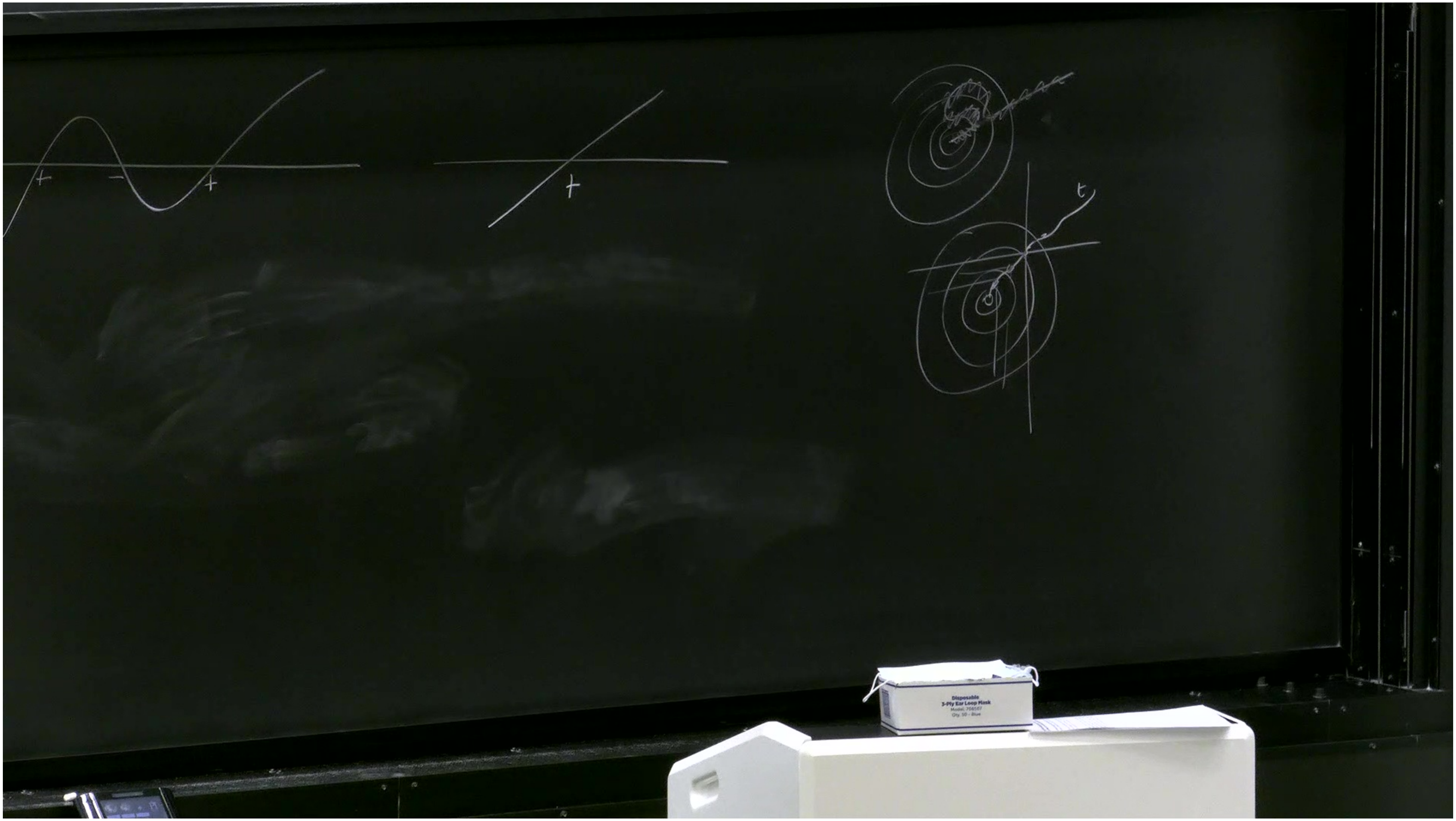


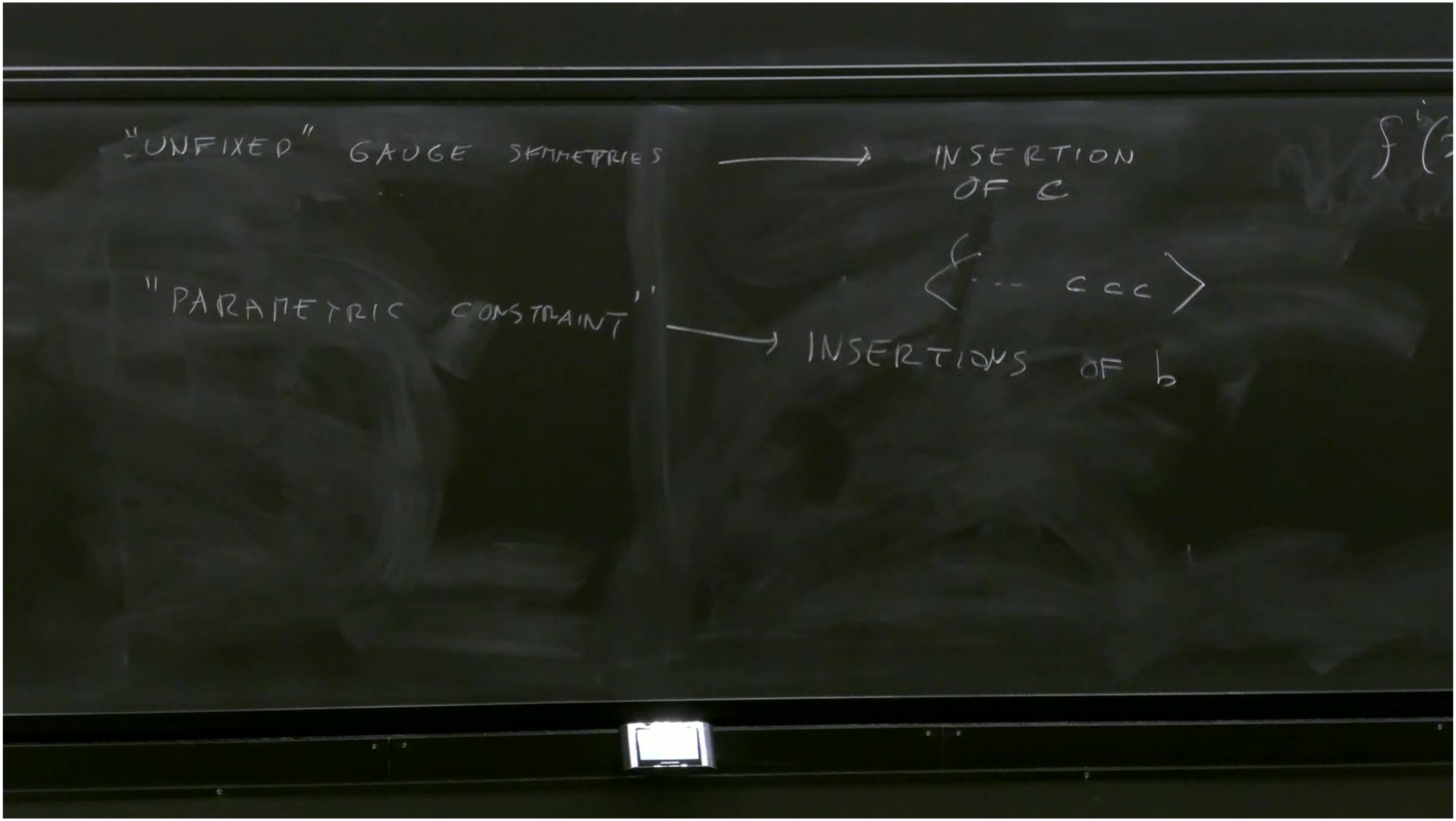
$I \geq 0$

$\delta(f(x))$ $\qquad \int F(x)\,\delta(f(x))\,dx = \sum_{f(x_*)=0} \frac{1}{|f'(x_*)|} F(x_*)$

$$\int e^{\overbrace{iBf(x) + bf'c}^{Q(bf(x)) + Q(bB)} + iB^2}\, db\, dc\, dx\, dB = \qquad \int F(x)\,|f'(x)|\,\delta(f(x))\,dx = \sum_{f(x_*)=0} \frac{f'}{|f'|}(x_*)\,F(x_*)$$

$\delta(f)\,df$




"UNFIXED" GAUGE SYMMETRIES → INSERTION OF c
⟨... ccc⟩
"PARAMETRIC CONSTRAINT" → INSERTIONS OF b

$$h_{ab} = h_{ab}(\tau)$$

"UNFIXED" GAUGE SYMMETRIES

$$\int_\Sigma \partial_\tau h_{ab}\, b^{ab}$$

$$f(x,t) = 0 \qquad \boxed{\partial_t f(x,t)\, b}$$

"PARAMETRIC CONSTRAINT"

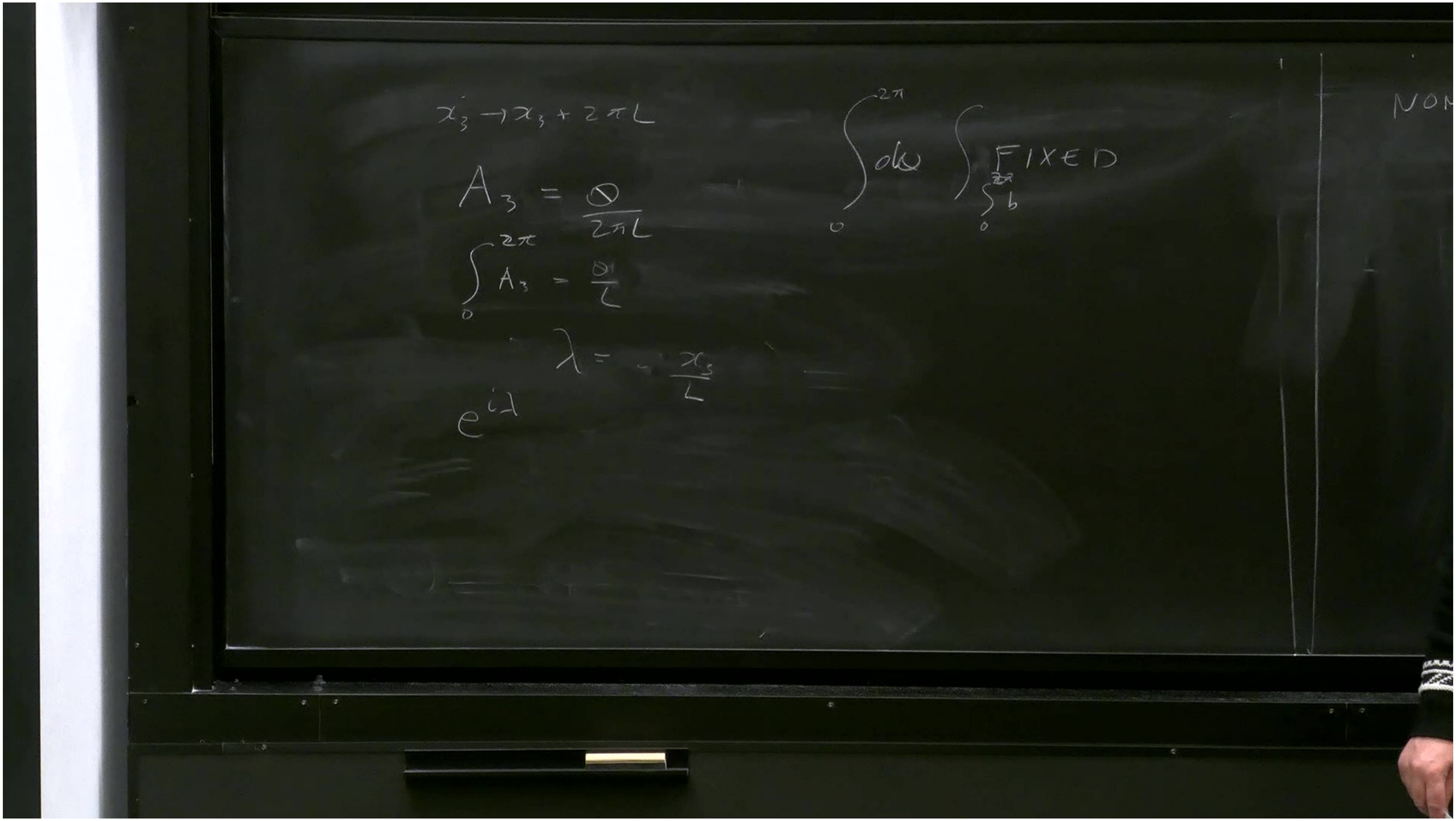
$x_3 \to x_3 + 2\pi L$

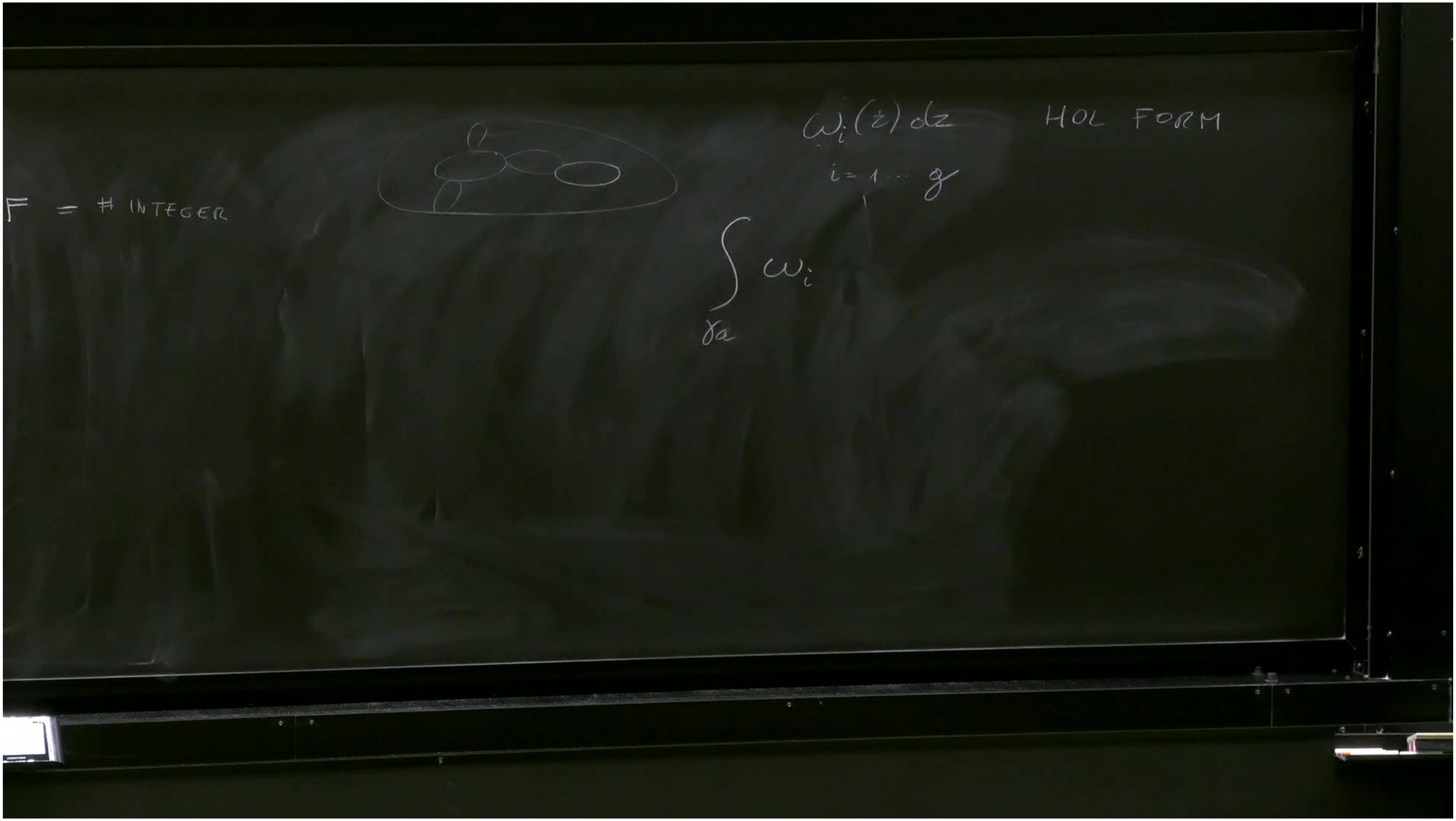
$$A_3 = \frac{\theta}{2\pi L}$$

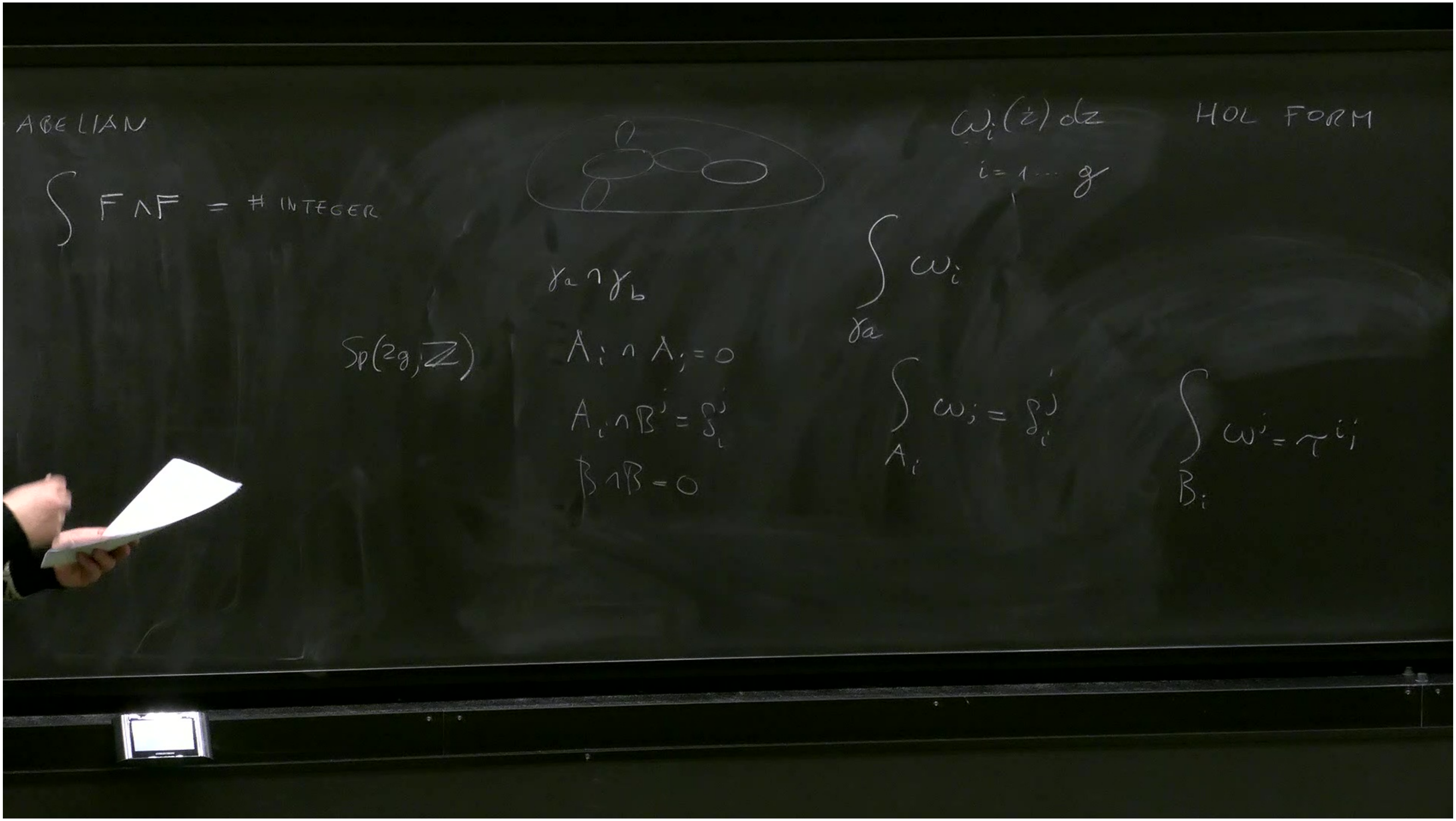
$$\int_0^{2\pi} d\omega \int \text{FIXED} \quad \int_0^{2\pi} b$$

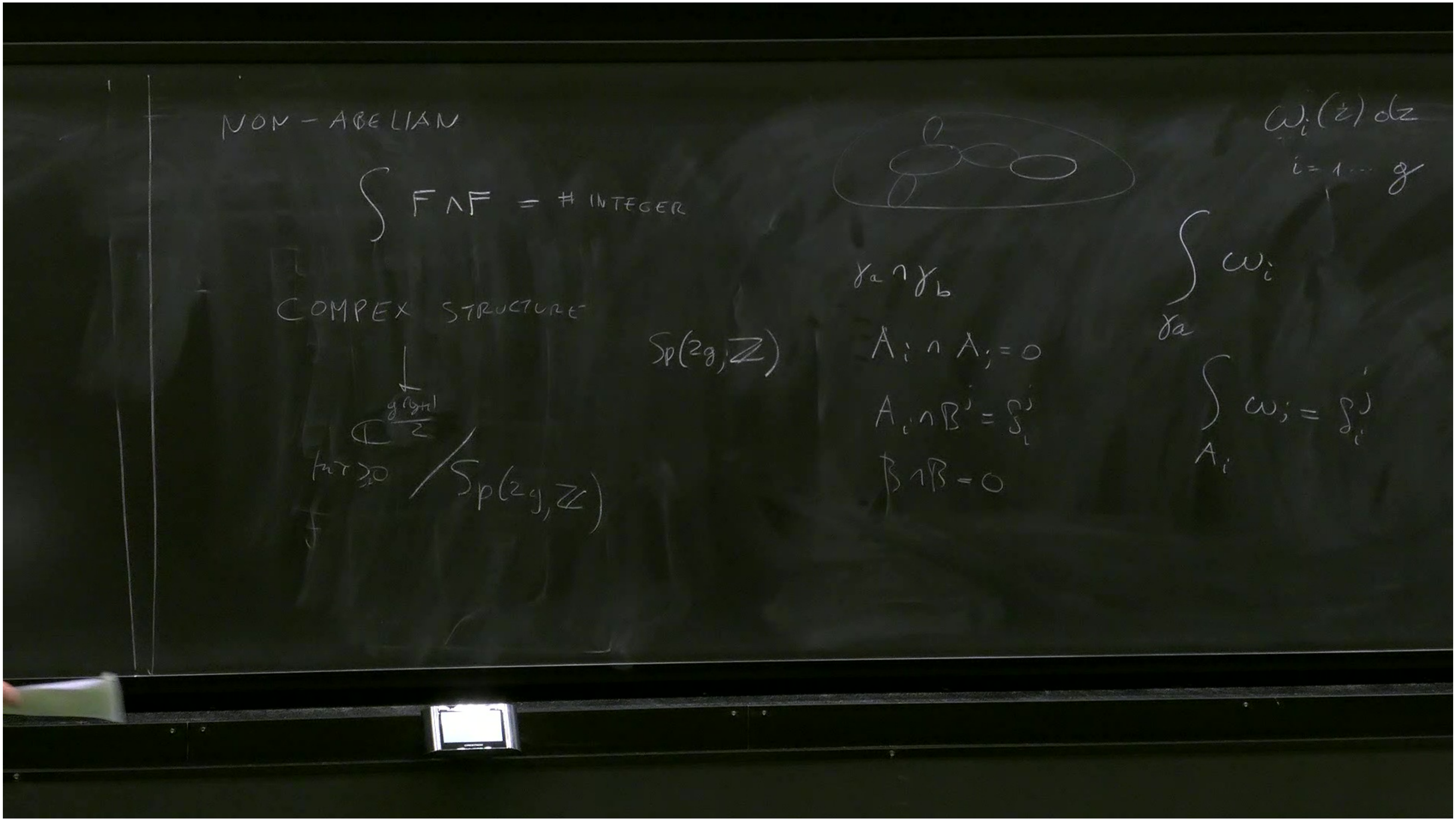
$$\lambda = \frac{x_3}{L}$$

$$e^{i\lambda}$$


x3 → x3 + 2πL
A3 = θ / 2πL
∫ A3 = θ / L
λ = x3 / L
e^{iλ}
∫ dw ∫ FIXED
∫ b


F = # INTEGER
$\omega_i(z)\,dz$
HOL FORM
$i = 1 \dots g$
$\int_{\gamma_a} \omega_i$


ABELIAN
$\int F \wedge F = \#$ INTEGER
$\omega_i(z)\,dz$
HOL FORM
$i = 1 \dots g$
$\int_{\gamma_a} \omega_i$
$\gamma_a \cap \gamma_b$
$Sp(2g,\mathbb{Z})$
$A_i \cap A_j = 0$
$A_i \cap B^j = \delta_i^j$
$B \cap B = 0$
$\int_{A_i} \omega_j = \delta_i^j$
$\int_{B_i} \omega^j = \tau^{ij}$


NON-ABELIAN
$\int F \wedge F = $ # INTEGER
COMPEX STRUCTURE
$\mathbb{C}^{\frac{g(g+1)}{2}}$
$\mathrm{Im}\,\tau \geq 0$
$/ Sp(2g, \mathbb{Z})$
$Sp(2g, \mathbb{Z})$
$\gamma_a \cap \gamma_b$
$A_i \cap A_j = 0$
$A_i \cap B^j = \delta_i^j$
$B \cap B = 0$
$\omega_i(z)\,dz$
$i = 1 \dots g$
$\int_{\gamma_a} \omega_i$
$\int_{A_i} \omega_j = \delta_i^j$