

Title: String Theory Review-13

Date: Feb 11, 2015 10:15 AM

URL: <http://pirsa.org/15020023>

Abstract:

$$\frac{1}{p^2 + m^2} \rightarrow \int d\tau e^{-\tau m^2 - \tau p^2} \rightarrow \int d\tau DX e^{-\dots} \rightarrow \int De DX e^{\int_0^1 e^{-\tau^2} (x^2 + m^2) d\tau}$$

$$\tau = \int_0^1 e d\tau$$

$$\frac{p_\mu \gamma^\mu}{p^2}$$

$$DX e^{\int e^{-1} x^2 + m^2 e dx}$$

$$\psi^{\mu}$$

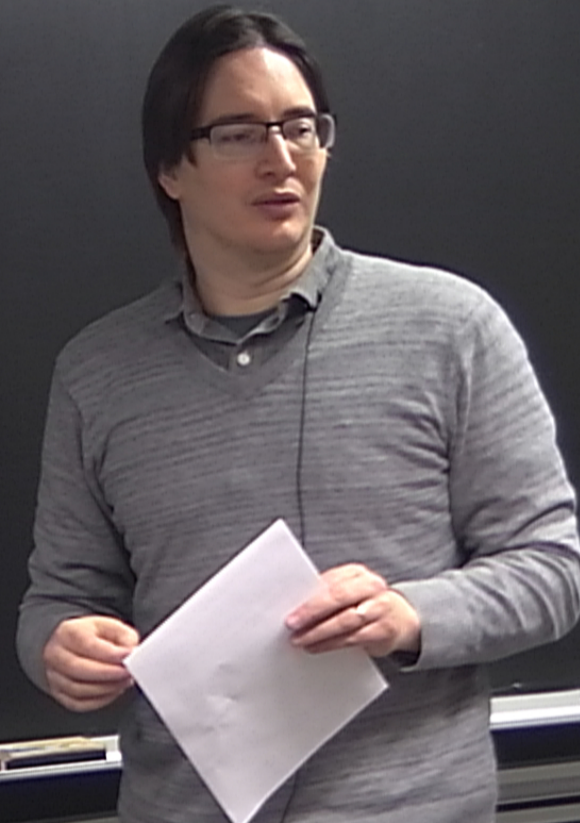
$$\{\psi^{\mu}, \psi^{\nu}\} = 2\eta^{\mu\nu}$$



$$DX e^{\int e^{-1} \dot{x}^2 + m^2 e dx}$$

$$\psi^\mu$$

$$\{\psi^\mu, \psi^\nu\} = 2\eta^{\mu\nu}$$

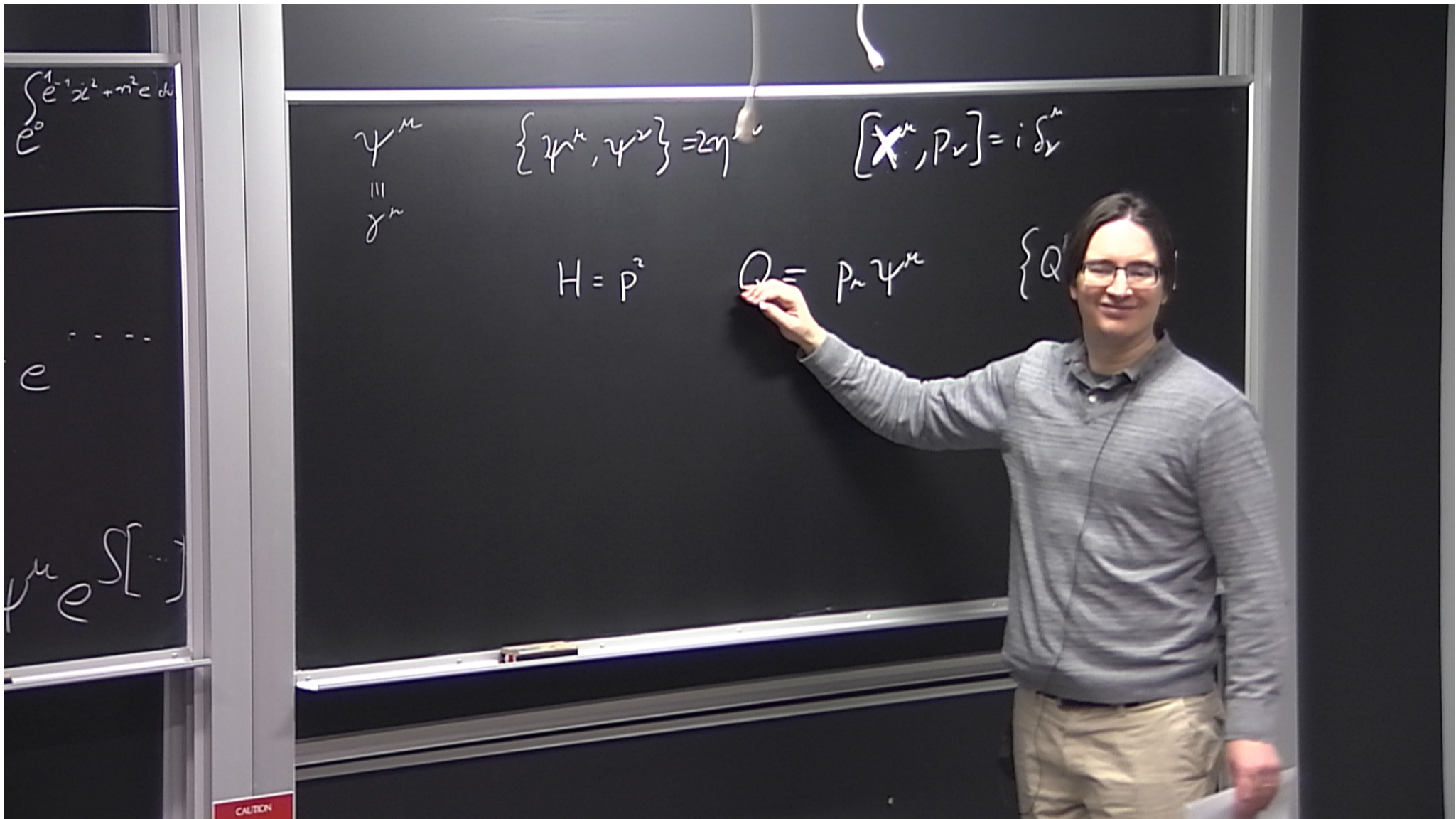


$$\frac{1}{p^2+m^2} \rightarrow \int d\tau e^{-\tau m^2 - \tau p^2} \rightarrow \int d\tau DX e^{-\dots} \rightarrow \int \frac{De DX}{\text{Diff}} e^{\int_0^1 e^{-\tau} x^L + m^2 e d\tau}$$

$$\frac{p_\mu \gamma^\mu}{p^2} \rightarrow \int d\tau d\zeta e^{-\tau p^2 - \zeta p_\mu \gamma^\mu} \Rightarrow \int d\tau d\zeta DX^\mu DY^\mu e^{-\dots}$$

$$\downarrow$$

$$\int \frac{De DX DX^\mu DY^\mu}{S_{\text{Diff}}} e^{S[\dots]}$$



$$\psi^{\mu} \\ \equiv \\ \gamma^{\mu}$$

$$\{\psi^{\mu}, \psi^{\nu}\} = 2\eta^{\mu\nu}$$

$$[X^{\mu}, P_{\nu}] = i\delta_{\nu}^{\mu}$$

$$H = p^2$$

$$Q = p_n \psi^{\mu}$$

$$\{Q^{\mu}\}$$

$$\int_{e^0}^1 e^{-x^2 + n^2} dx$$

$$e^{-\dots}$$

$$\psi^{\mu} e^{-S[\dots]}$$

CAUTION

$$\int_0^1 e^{-x^2 + nx^2} dx$$

$$e^{-x^2}$$

$$\psi^\mu e^{-S[\psi]}$$

$$\psi^\mu$$

$$\equiv$$

$$\gamma^\mu$$

$$\{\psi^\mu, \psi^\nu\} = 2\eta^{\mu\nu}$$

$$[X^\mu, P_\nu] = i\delta^\mu_\nu$$

$$H = P^2$$

$$Q = P_\mu \psi^\mu$$

$$\{Q, Q\} = 2H$$

$$G = e^{-\tau H - \beta Q}$$

$$\partial_\tau G + H G = 0$$

$$(\partial_\beta + \beta \partial_\tau) G + Q G = 0$$

$$G = e^{-\tau H} (1 - \beta Q)$$

CAUTION

$$\int_0^1 e^{-x^2 + nx^2} dx$$

$$e^{-x^2}$$

$$\mu e^{-S[\cdot]}$$

$$\psi^\mu$$

$$\equiv$$

$$z^\mu$$

$$\{\psi^\mu, \psi^\nu\} = 2\eta^{\mu\nu}$$

$$[X^\mu, P_\nu] = i\delta^\mu_\nu$$

$$H = P^2$$

$$Q = p_\mu \psi^\mu$$

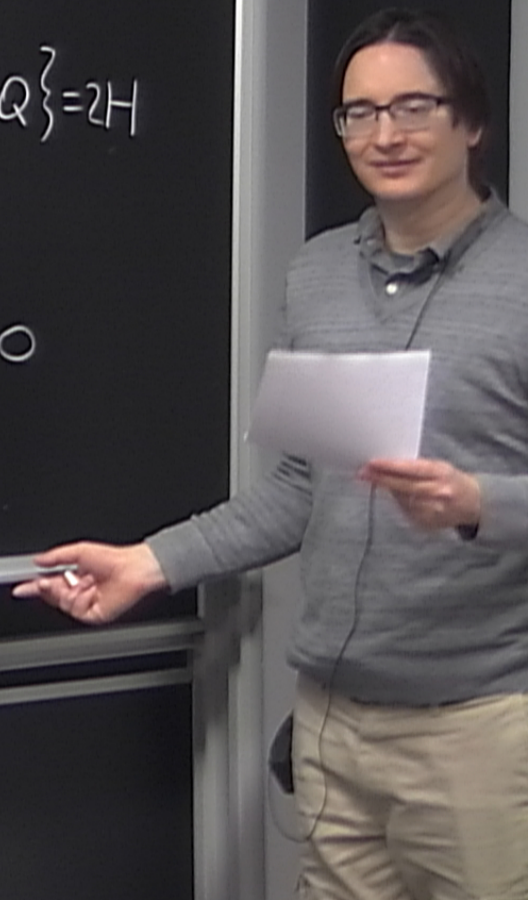
$$\{Q, Q\} = 2H$$

$$G = e^{-\tau H - \zeta Q}$$

$$\partial_\tau G + H G = 0$$

$$(\partial_\zeta + \zeta \partial_\tau) G + Q G = 0$$

$$G = e^{-\tau H} (1 - \zeta Q)$$



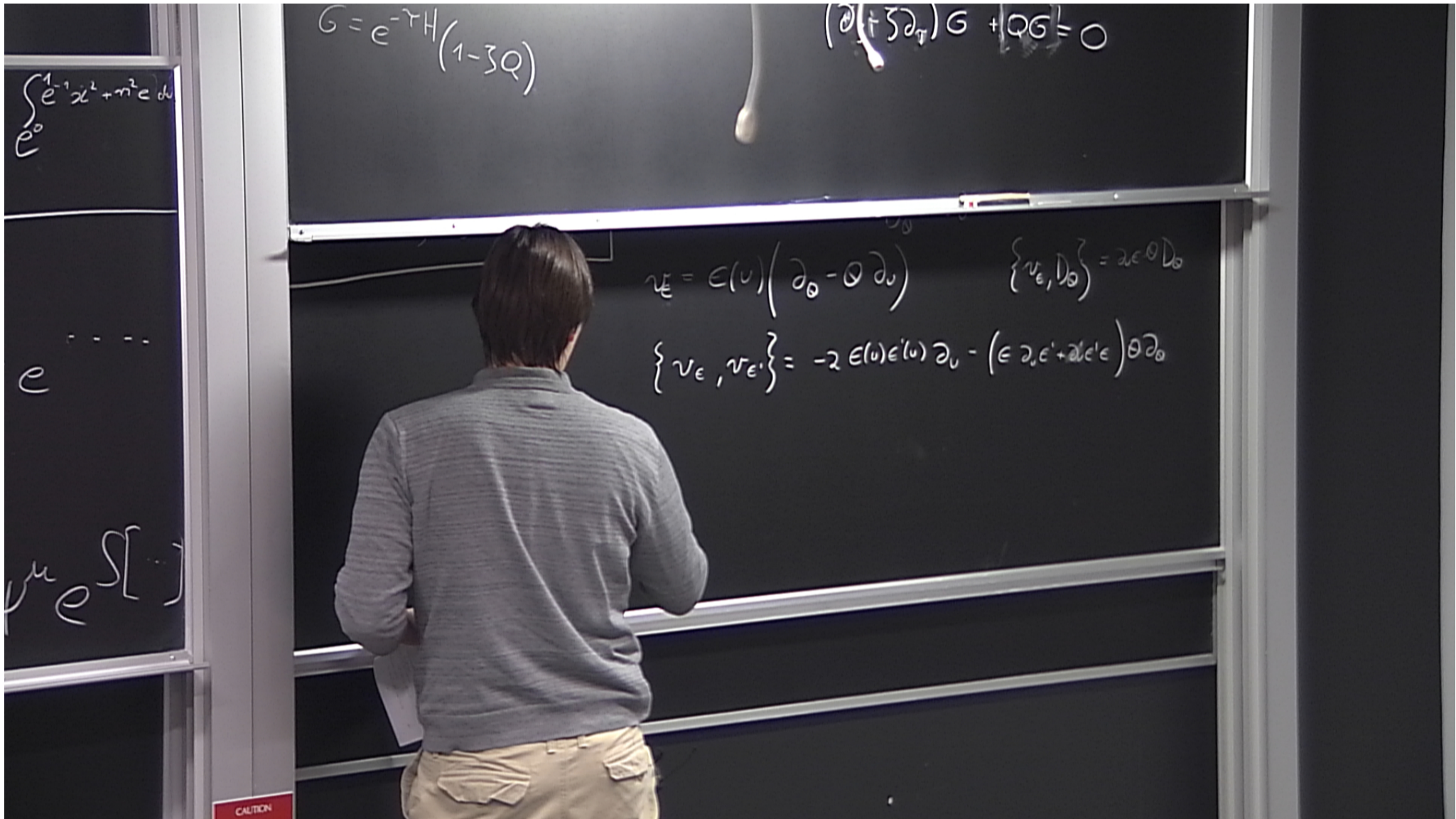
$$\frac{1}{p^2 + m^2} \rightarrow \int d\tau e^{-\tau m^2 - \tau p^2} \rightarrow \int d\tau DX e^{-\tau p^2} \rightarrow \int \frac{De DX}{\text{Diff}} e^{-\tau p^2} \int_0^1 e^{-\tau(x^2 + m^2)} d\tau$$

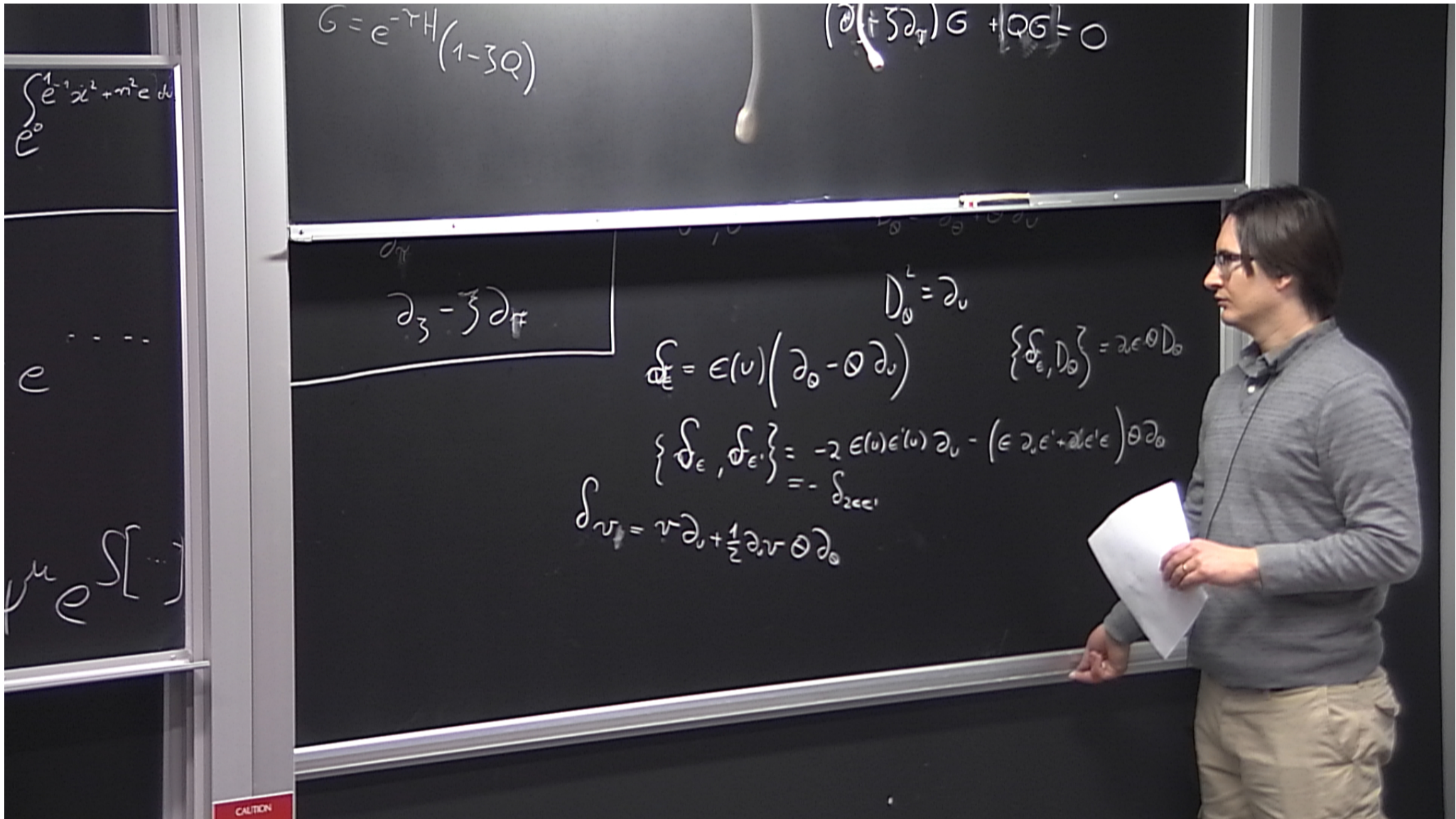
$\tau = \int_0^1 e d\tau$

$$\frac{p_\mu \gamma^\mu}{p^2} \rightarrow \int d\tau d\zeta e^{-\tau p^2 - \zeta p_\mu \gamma^\mu} \Rightarrow \int d\tau d\zeta DX^\mu D\psi^\mu e^{-\tau p^2 - \zeta p_\mu \gamma^\mu}$$

↓

$$\int \frac{De DX^\mu D\psi^\mu}{S_{\text{Diff}}} e^{-\tau p^2 - \zeta p_\mu \gamma^\mu} S[\dots]$$





$$G = e^{-2H} (1 - 3Q)$$

$$(\partial_t + 3\partial_r)G + QG = 0$$

$$\int_0^1 e^{-1} x^2 + n^2 e dx$$

e

$$\mu e^S [\dots]$$

$$\partial_3 - \xi \partial_r$$

$$D_0^L = \partial_0$$

$$\mathcal{D}_\xi = \epsilon(\nu) (\partial_0 - \theta \partial_\nu)$$

$$\{\mathcal{D}_\xi, D_0\} = 2\epsilon \theta D_0$$

$$\{\mathcal{D}_\xi, \mathcal{D}_{\xi'}\} = -2\epsilon(\nu)\epsilon'(\nu)\partial_\nu - (\epsilon \partial_\nu \epsilon' + \partial_\nu \epsilon \epsilon') \theta \partial_0$$

$$= -\delta_{2\epsilon\epsilon'}$$

$$\delta_{\nu_1} = r \partial_\nu + \frac{1}{2} \partial_\nu r \theta \partial_0$$

CAUTION

$$\int \frac{Dx}{S_{\text{Diff}}} DX^\mu D\psi^\mu e^{S[\cdot]}$$

$$y^\mu(t, \theta) = x^\mu + \theta \psi^\mu$$

$$\delta_\epsilon x^\mu = \epsilon(t) \psi^\mu \quad \delta_\epsilon \psi^\mu = -\epsilon \partial_\nu x^\mu$$

$$\partial_3 - \bar{\partial}$$

CAUTION
TO AVOID GLASS BREAKAGE AND PERSONAL INJURY, DO NOT TOUCH THE BOARD SURFACE.
IF GLASS BREAKS, DO NOT TOUCH THE GLASS.
PLEASE REPORT ANY DAMAGE TO THE FACILITY MANAGER.

CAUTION
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$$x = \partial_u z$$

$$S_z = \int e^{-1} \dot{x}^2 du$$

$$\delta_\epsilon S_z = \int du \ 2e^{-1} \dot{x} (\partial_u \epsilon \gamma + \epsilon \hat{\partial}_u \gamma) + \delta_\epsilon e^{-1} \dot{x}^2$$

$$S_\gamma = \int e^{-1} \gamma \dot{\gamma} du$$

$$\delta_\epsilon S_\gamma = \int du \ 2e^{-1} \dot{\gamma} (-\epsilon \hat{\partial}_u \gamma - \frac{1}{2} \partial_u \epsilon \gamma)$$

$$S_x = \int du \ \dot{x} \chi \gamma$$

$$- \epsilon \dot{x} \gamma \partial_u e^{-1} + \delta_\epsilon e^{-1} \gamma \dot{\gamma}$$

$$\delta_\epsilon S_x = \int du \ \dot{x} \delta_\epsilon \chi \gamma + \epsilon \chi \gamma \dot{\gamma} + \epsilon \dot{x}^2 \chi$$

$$\delta_\epsilon \chi = \partial_u \epsilon e^{-1} - \epsilon \partial_u e^{-1}$$

$$\delta_\epsilon e^{-1} = -\epsilon \chi$$

$$S_{\dot{x}} = \int e^{-1} \dot{x}^2 du$$

$$S_{\dot{\gamma}} = \int e^{-1} \dot{\gamma} \dot{\gamma} du$$

$$S_{\dot{\chi}} = \int du \dot{\chi} \chi \dot{\gamma}$$

$$\delta_{\epsilon} S_{\dot{x}} = \int du 2 e^{-1} \dot{x} (\partial_u \epsilon \dot{\gamma} + \epsilon \hat{\partial}_u \dot{\gamma}) + \delta_{\epsilon} e^{-1} \dot{x}^2$$

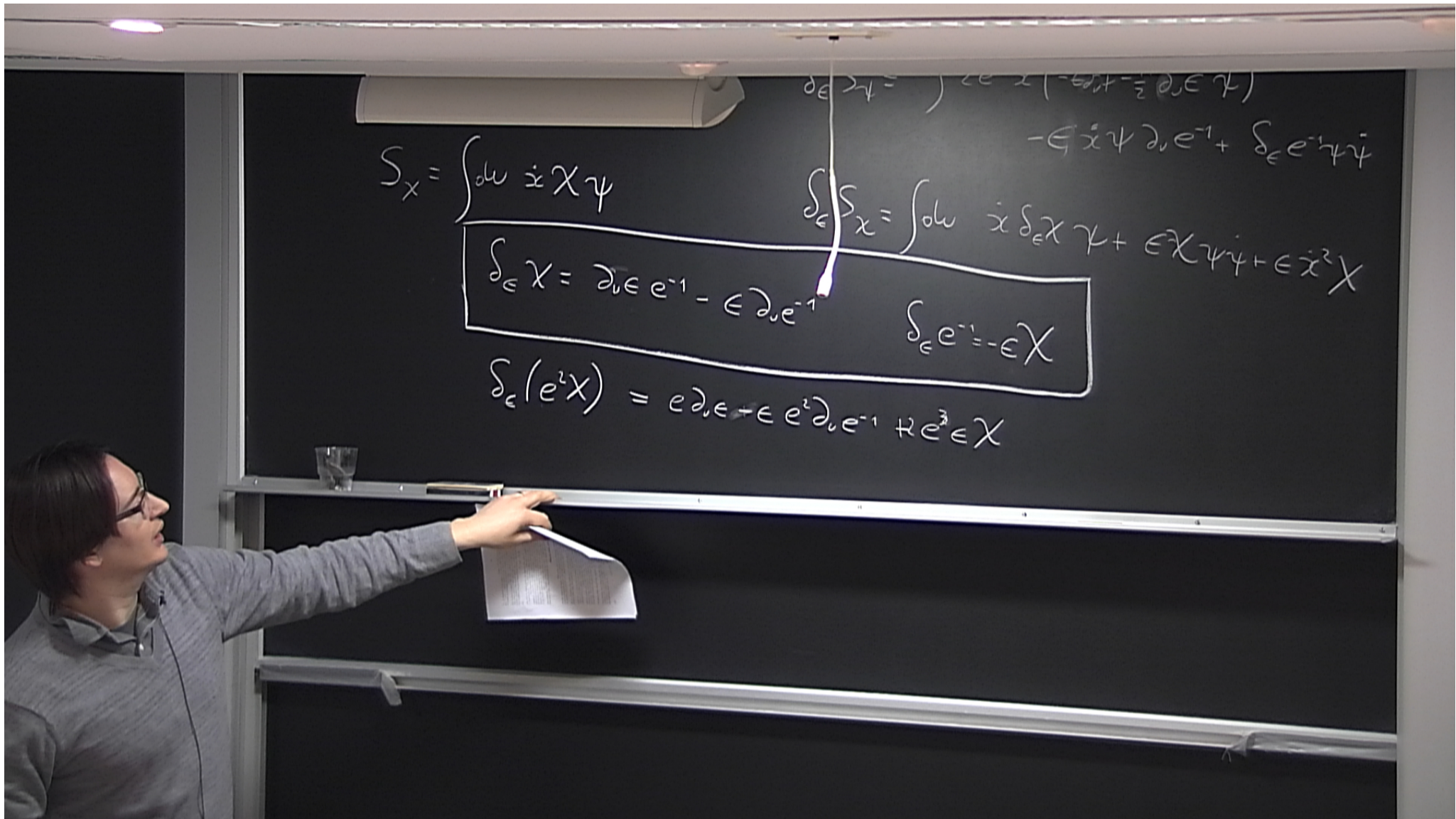
$$\delta_{\epsilon} S_{\dot{\gamma}} = \int 2 e^{-1} \dot{\gamma} (-\hat{\partial}_u \epsilon + \frac{1}{2} \partial_u \epsilon \dot{\gamma})$$

$$- \epsilon \dot{\chi} \dot{\gamma} \partial_u e^{-1} + \delta_{\epsilon} e^{-1} \dot{\gamma} \dot{\gamma}$$

$$\delta_{\epsilon} S_{\dot{\chi}} = \int du \dot{\chi} \delta_{\epsilon} \chi \dot{\gamma} + \epsilon \chi \dot{\gamma} \dot{\gamma} + \epsilon \dot{\chi}^2 \chi$$

$$\delta_{\epsilon} \chi = \partial_u \epsilon e^{-1} - \epsilon \partial_u e^{-1}$$

$$\delta_{\epsilon} e^{-1} = -\epsilon \chi$$



$$S_X = \int dt \dot{x} X \psi$$

$$\delta_\epsilon S_X = \int dt \dot{x} \delta_\epsilon X \psi + \epsilon X \psi \dot{\psi} + \epsilon \dot{x}^2 X$$

$$\delta_\epsilon X = \partial_t \epsilon e^{-1} - \epsilon \partial_t e^{-1} \quad \delta_\epsilon e^{-1} = -\epsilon X$$

$$\delta_\epsilon (e^2 X) = e \partial_t \epsilon + \epsilon e^2 \partial_t e^{-1} + \epsilon e^3 \epsilon X$$

$$S_X = \int dt \dot{x} \chi \psi$$

$$\delta_\epsilon S_X = \int dt \dot{x} \delta_\epsilon \chi \psi + \epsilon \dot{x} \chi \psi + \epsilon \dot{x}^2 \chi$$

$$\delta_\epsilon \chi = \partial_t \epsilon e^{-1} - \epsilon \partial_t e^{-1} \quad \delta_\epsilon e^{-1} = -\epsilon \dot{\chi}$$

$$\delta_\epsilon (e^2 \dot{\chi}) = e \partial_t \epsilon - \epsilon e^2 \partial_t e^{-1} + \epsilon e^3 \dot{\chi} \\ = \partial_t (\epsilon e) + \epsilon (e^2 \dot{\chi})$$

$$X^{\mu} \psi^{\mu} + \epsilon \dot{x}^{\mu} X^{\mu}$$

$$\frac{1}{p^2} \rightarrow \int dx^{\mu} dx^{\nu} \dots - 3P$$

$$\rightarrow \int dx^{\mu} dx^{\nu} D X^{\mu} D \psi^{\mu} e$$

$$\downarrow$$

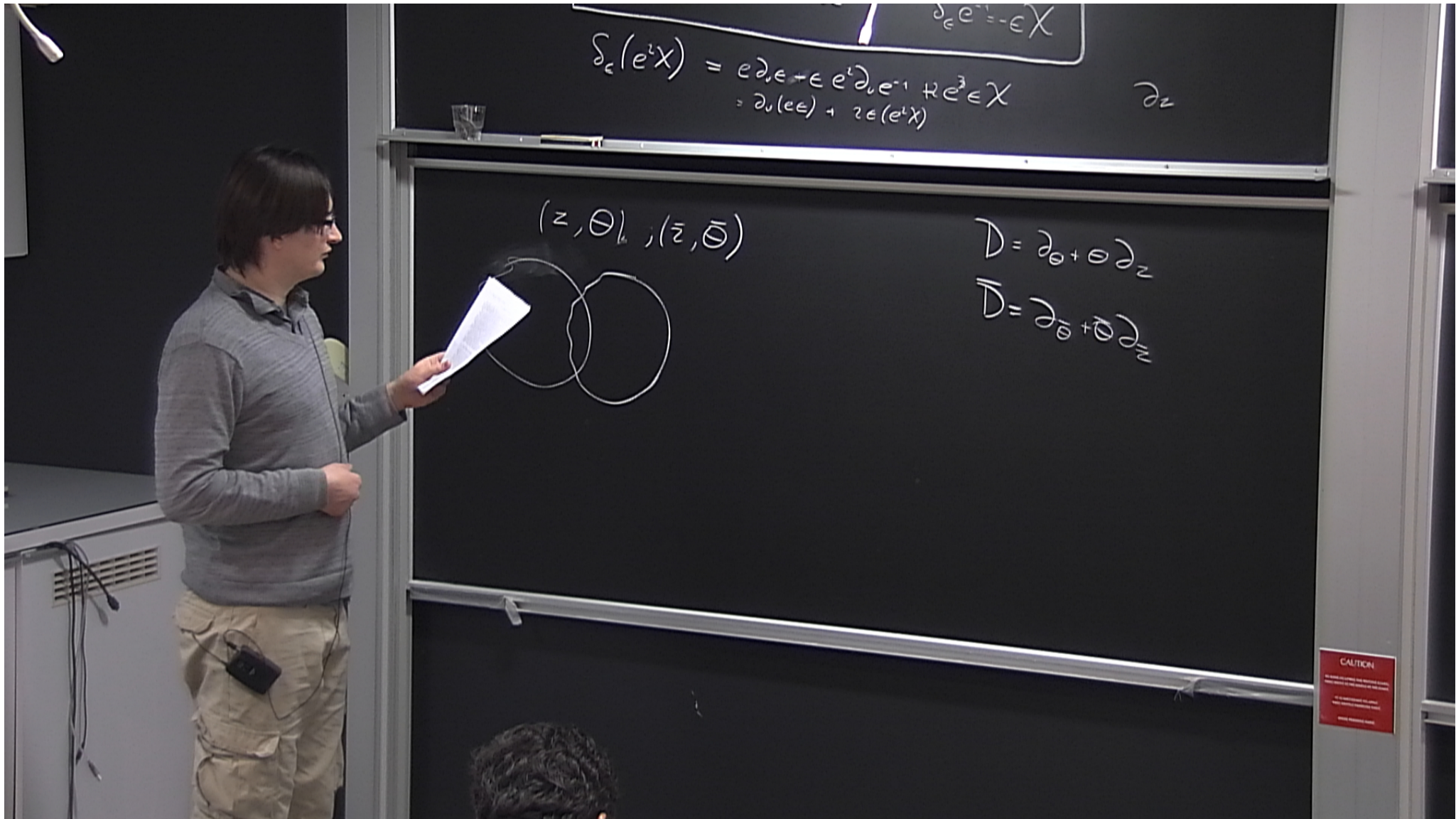
$$\int \frac{D e D X^{\mu} D \psi^{\mu}}{S_{\text{diff}}} e$$

$$y^{\mu}(u, \theta) = x^{\mu} + \theta \psi^{\mu}$$

$$\delta_{\epsilon} x^{\mu} = \epsilon(u) \psi^{\mu} \quad \delta_{\epsilon} \psi^{\mu} = -\epsilon \partial_{\sigma} x^{\mu}$$

$$G = e^{-\gamma H} (1 - \dots)$$

$$\partial_s - \dot{\gamma}$$

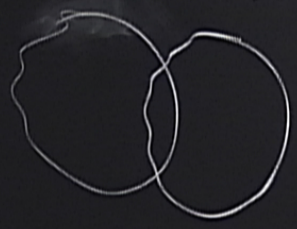


$$\partial_{\epsilon} e^{\epsilon X} = -\epsilon X$$

$$\delta_{\epsilon}(e^{\epsilon X}) = e \partial_{\epsilon} e^{\epsilon X} + e^{\epsilon X} \partial_{\epsilon} e^{-1} + e^{\epsilon X} \epsilon X$$

$$= \partial_{\epsilon}(e \epsilon) + \epsilon e^{\epsilon X}$$

$(z, \theta), (\bar{z}, \bar{\theta})$



$$D = \partial_{\theta} + \theta \partial_z$$

$$\bar{D} = \partial_{\bar{\theta}} + \bar{\theta} \partial_{\bar{z}}$$

X^{μ}

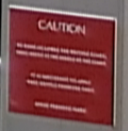
ψ^{μ}

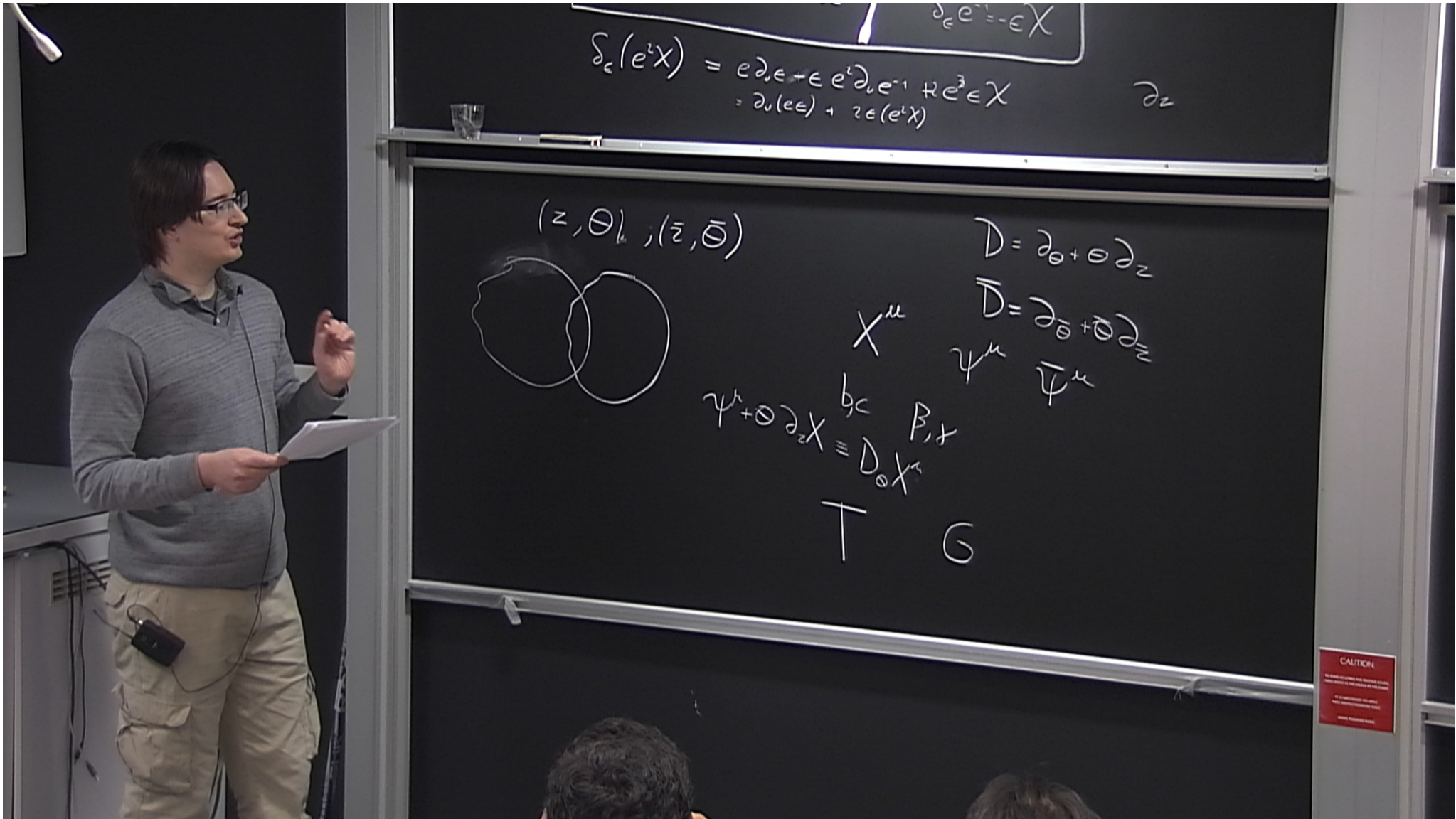
$\bar{\psi}^{\mu}$

$$\psi^{\mu} + \theta \partial_z X^{\mu} \equiv D_{\theta} X^{\mu}$$

T

G





$$\partial_\epsilon e^i = -\epsilon^i X$$

$$\begin{aligned} \delta_\epsilon(e^i X) &= e^i \partial_\epsilon X + \epsilon^i \partial_\epsilon e^i + \epsilon^i X \\ &= \partial_\epsilon(e^i X) + \epsilon^i X \end{aligned} \quad \partial_z$$

$(z, \theta), (\bar{z}, \bar{\theta})$



$$D = \partial_\theta + \theta \partial_z$$

$$\bar{D} = \partial_{\bar{\theta}} + \bar{\theta} \partial_{\bar{z}}$$

X^μ

$\psi^\mu \quad \bar{\psi}^\mu$

$$\psi^\mu + \theta \partial_z X^\mu \equiv D_\theta X^\mu$$

T G

CAUTION
Do not touch the equipment unless
you are instructed to do so by the lecturer.

$$\delta_2 X^{\gamma} + \epsilon X^{\gamma} + \epsilon^2 X^{\gamma} + \epsilon^3 X^{\gamma}$$

$$\epsilon X$$

$$= \partial_{\bar{0}} + \theta \partial_z$$

$$= \partial_{\bar{0}} + \theta \partial_z$$

$$\Psi^{\mu}$$

$$\frac{1}{p^2} \rightarrow \int d^4x \delta^4(x) \delta^4(x) = \delta^4(x)$$

$$\rightarrow \int d^4x \delta^4(x) D^{\mu} X^{\nu} D^{\mu} \Psi^{\alpha} e$$

$$\downarrow$$

$$\int \frac{D^{\mu} X^{\nu} D^{\mu} X^{\alpha} D^{\mu} \Psi^{\beta} e}{S_{\text{Diff}}}$$

(z, θ)	\bar{z}
$X^{\mu}(z, \bar{z})$	
$\psi(z)$	$\frac{1}{b} \bar{z}$
b, c	32×2
β, γ	

$$G = e^{-TH - 3Q}$$

$$G = e^{-TH(1-3Q)}$$

