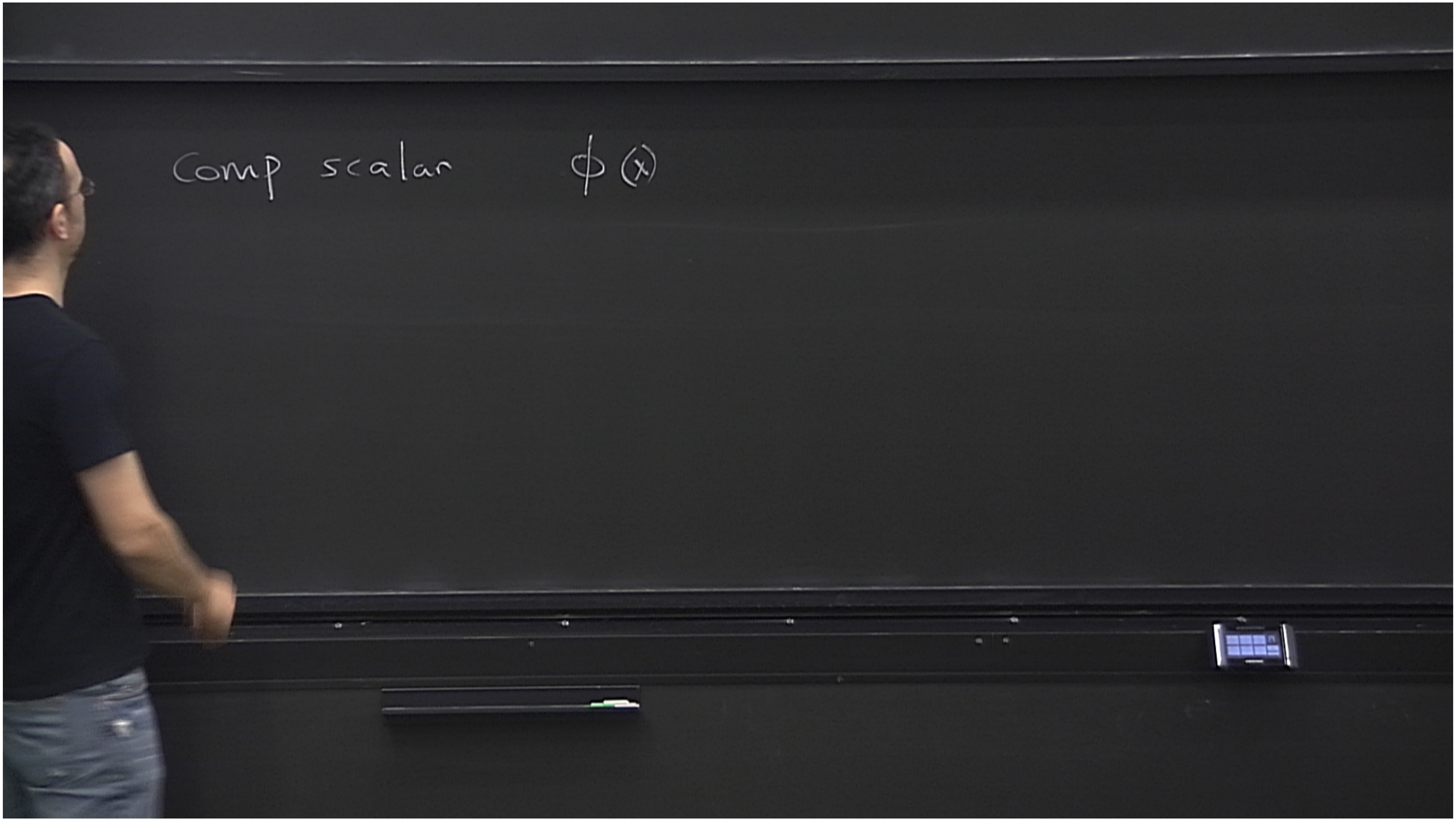
Title: 12/13 PSI - Beyond the Standard Model Lecture 1

Date: Feb 19, 2013 09:00 AM

URL: http://www.pirsa.org/13020089

Abstract:


Comp scalar $\phi(x)$

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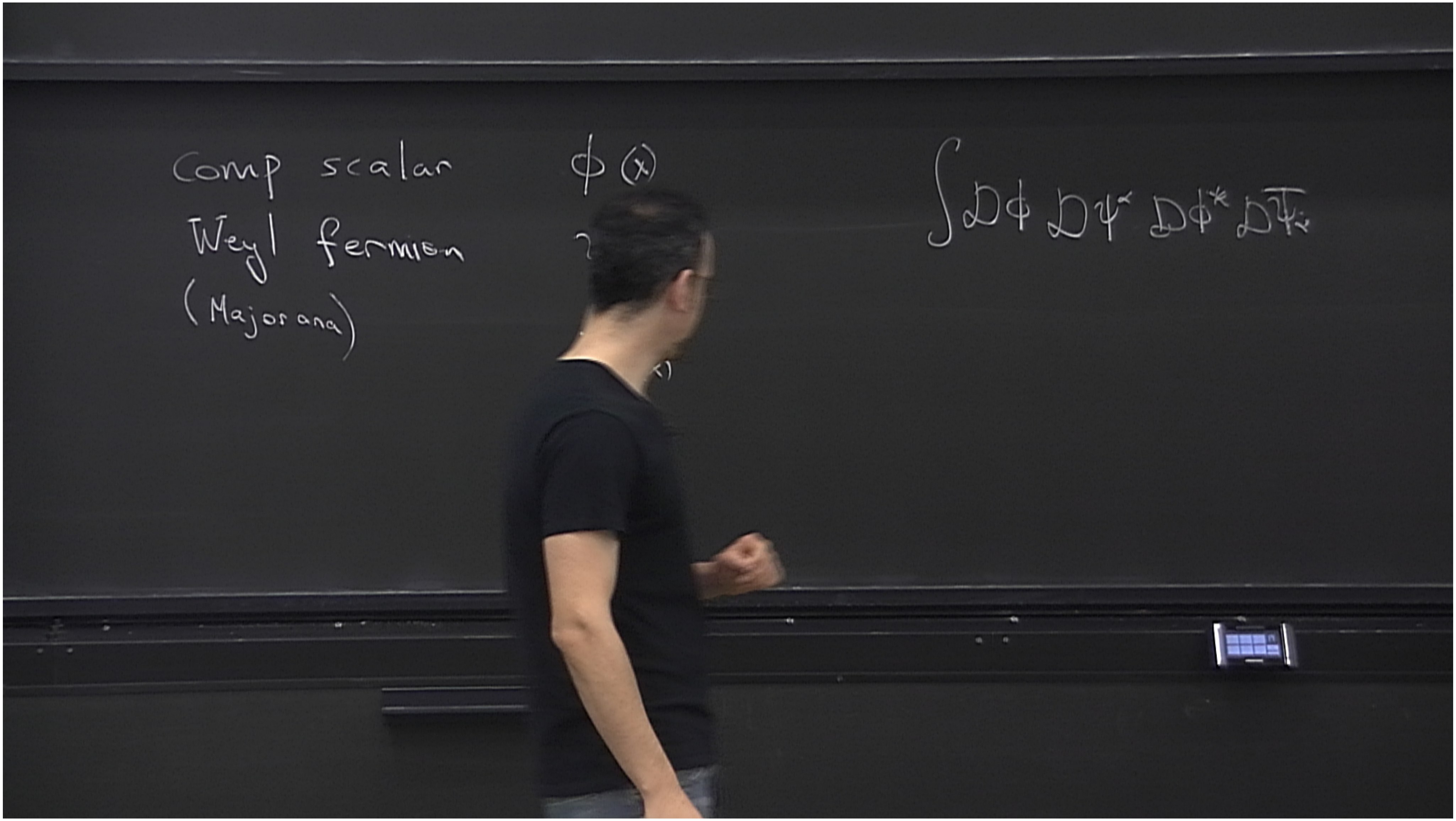
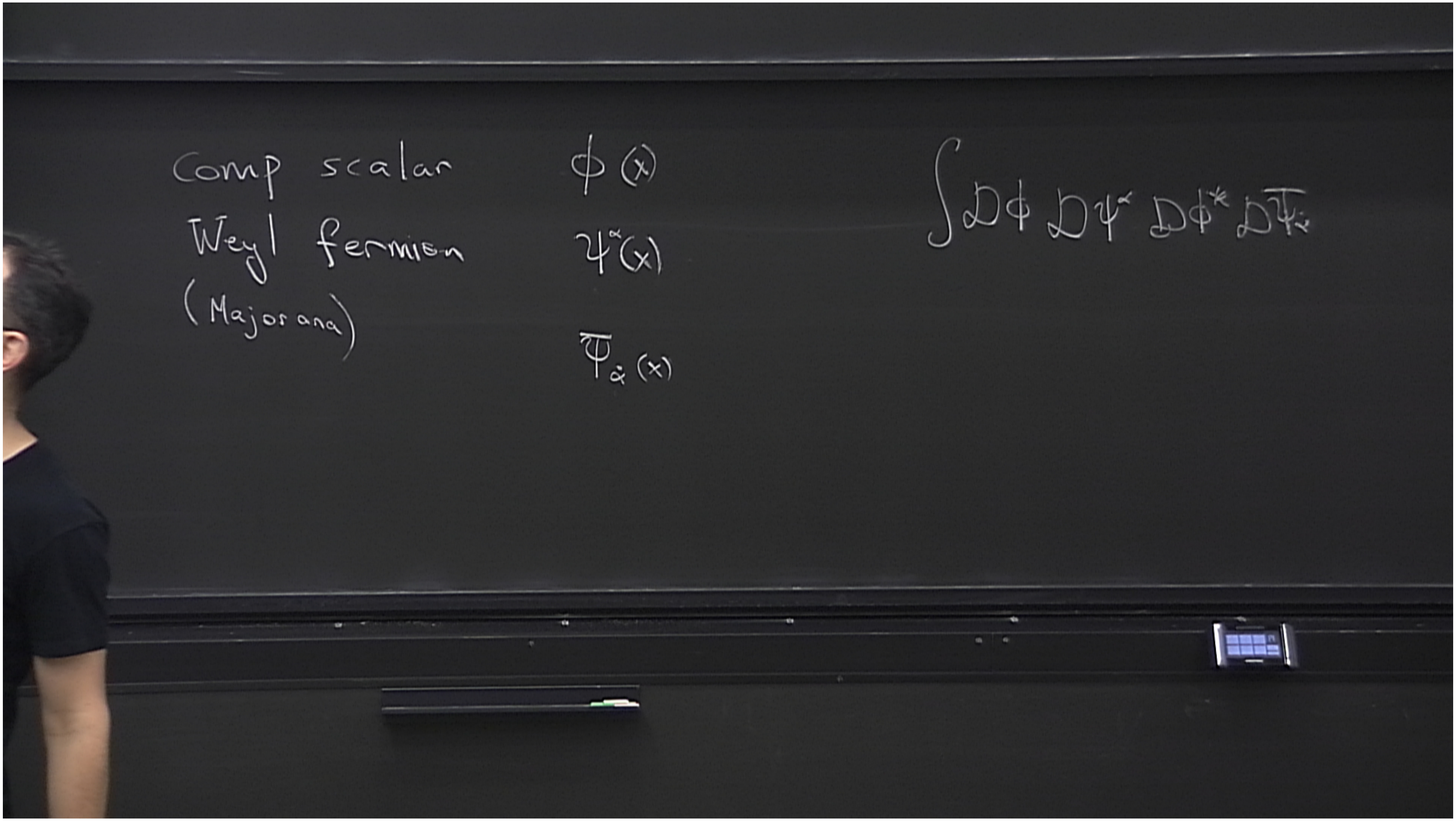
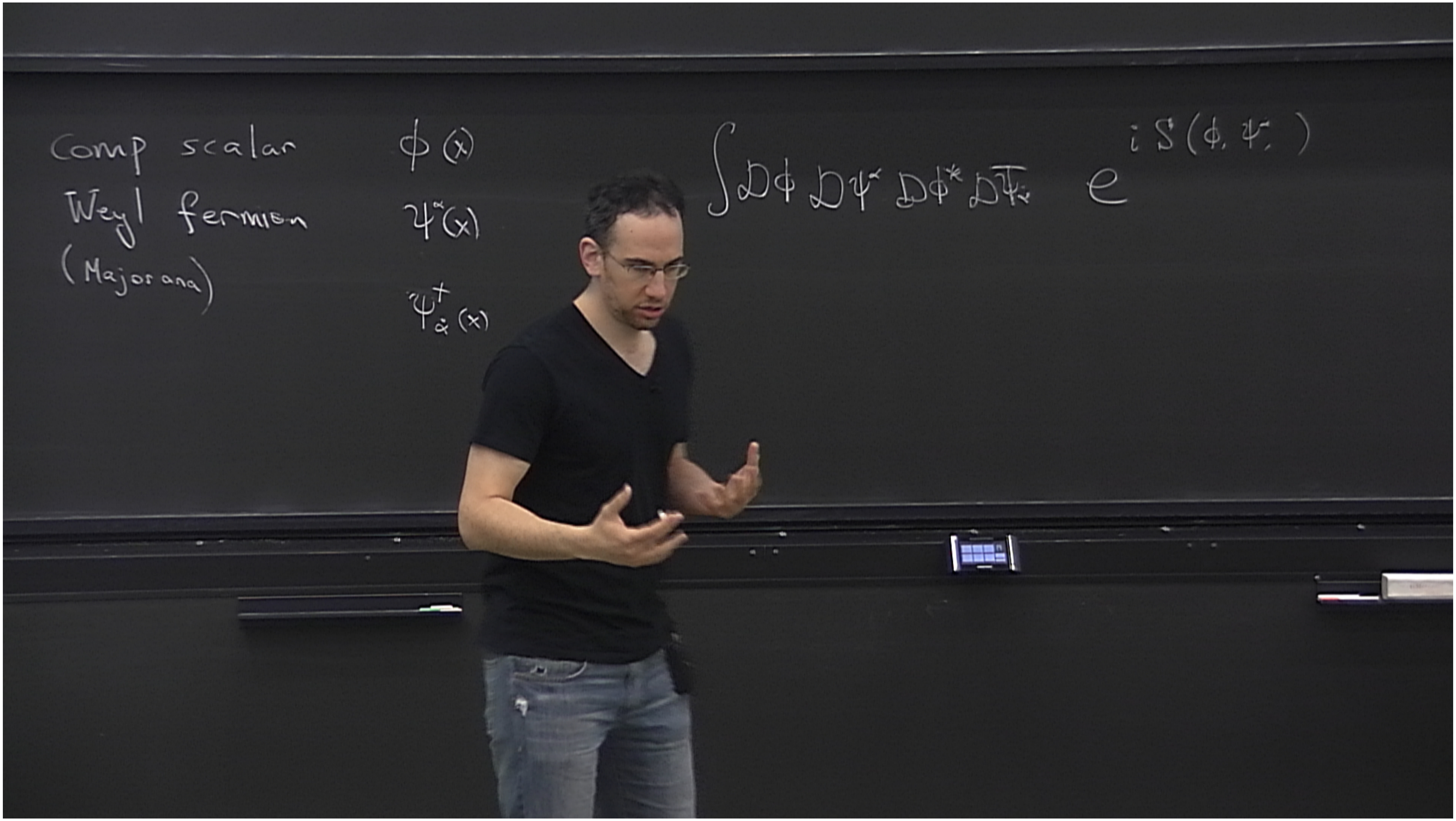
Weyl fermion $\psi^{\alpha}(x)$


Comp scalar
$\phi(x)$
Weyl fermion
(Majorana)
$\int \mathcal{D}\phi \, \mathcal{D}\psi^{\alpha} \, \mathcal{D}\phi^{*} \, \mathcal{D}\bar{\psi}_{\dot{\alpha}}$


Comp scalar $\phi(x)$
Weyl fermion $\psi^{\alpha}(x)$
(Majorana)
$\bar{\psi}_{\dot{\alpha}}(x)$
$\int \mathcal{D}\phi\, \mathcal{D}\psi^{\alpha}\, \mathcal{D}\phi^{*}\, \mathcal{D}\bar{\psi}_{\dot{\alpha}}$

$$\Psi = \begin{pmatrix} \cdot \\ \vdots \\ \cdot \end{pmatrix}$$

$$\bar{\Psi} = \Psi^{+} \gamma_0$$

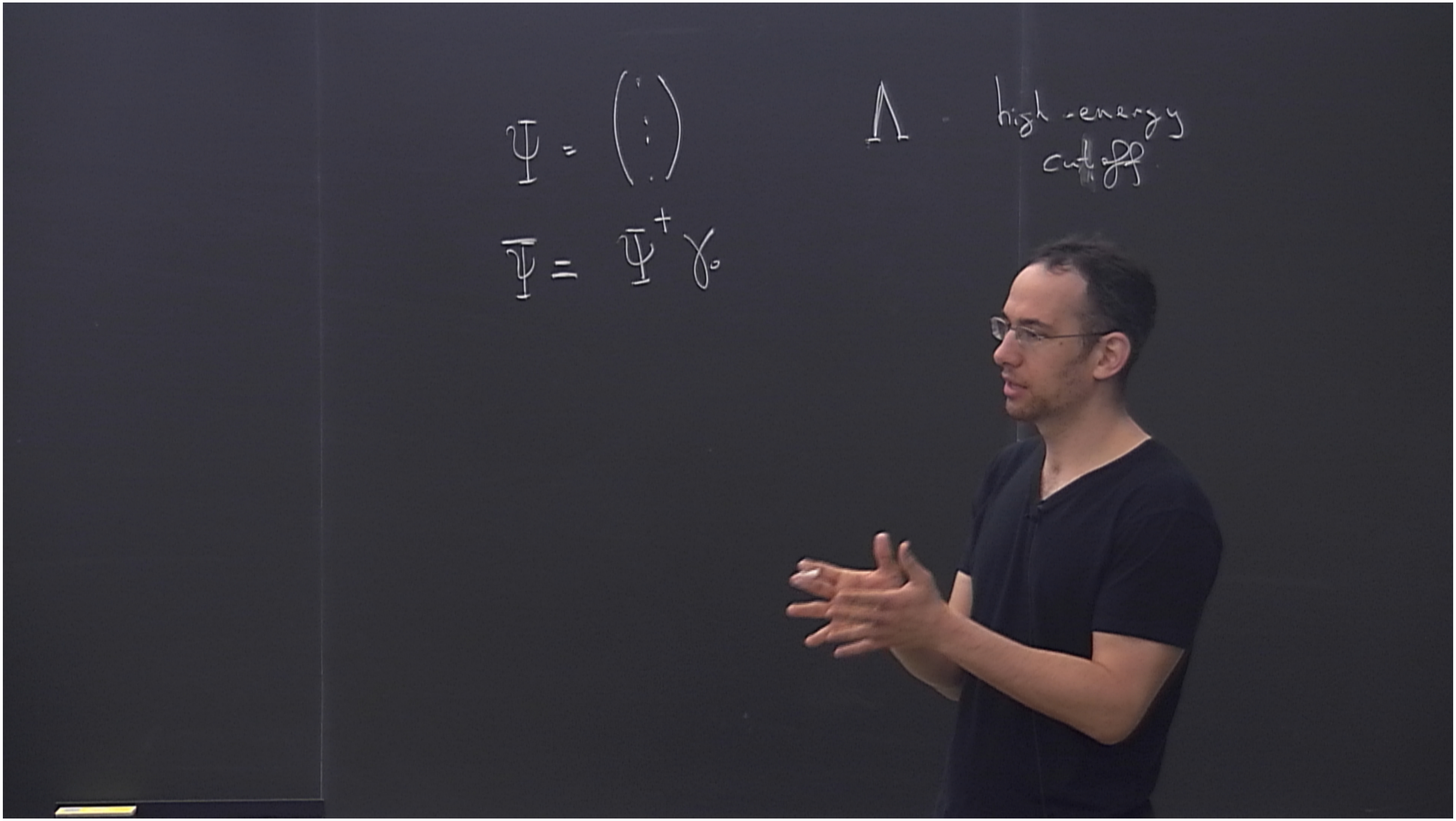

Comp scalar $\phi(x)$
Weyl fermion $\psi^{\alpha}(x)$
(Majorana)
$\psi^{\dagger}_{\dot\alpha}(x)$
$\int \mathcal{D}\phi \, \mathcal{D}\psi^{\alpha} \, \mathcal{D}\phi^{*} \, \mathcal{D}\bar\psi_{\dot\alpha} \; e^{iS(\phi, \psi, \;)}$

Comp scalar $\phi(x)$

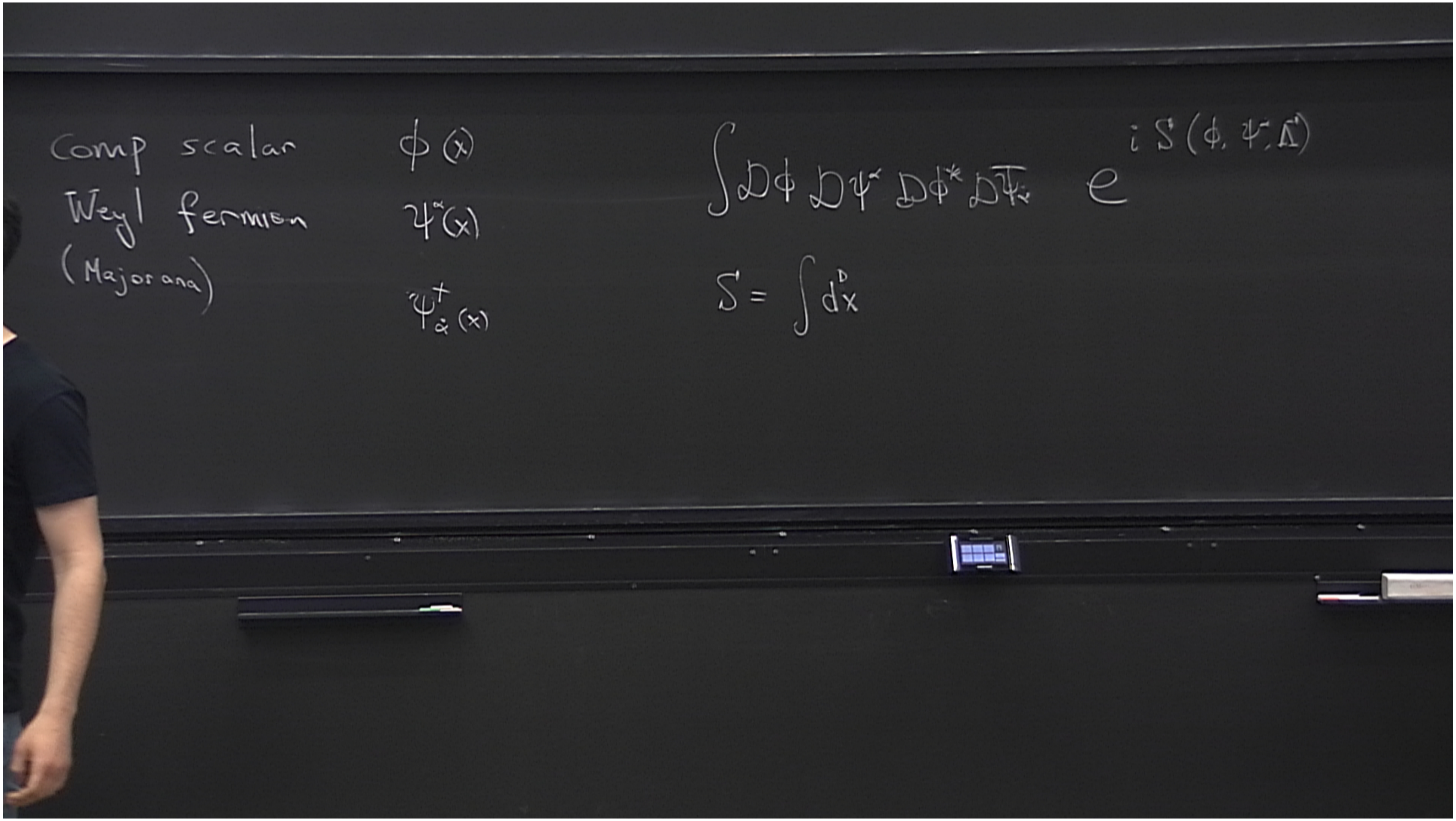
Weyl fermion $\psi^{\alpha}(x)$

(Majorana) $\psi^{\dagger}_{\dot{\alpha}}(x)$

$$\int \mathcal{D}\phi \, \mathcal{D}\psi^{\alpha} \, \mathcal{D}\phi^{*} \, \mathcal{D}\bar{\psi}_{\dot{\alpha}} \; e^{iS(\phi, \psi^{\alpha}, \bar{\psi})}$$



$\Psi = \begin{pmatrix} \vdots \end{pmatrix}$
$\bar{\Psi} = \Psi^{\dagger} \gamma_0$
Λ : high-energy cutoff


Comp scalar $\phi(x)$
Weyl fermion $\psi^{\alpha}(x)$
(Majorana) $\psi^{\dagger}_{\dot\alpha}(x)$
$\int \mathcal{D}\phi\, \mathcal{D}\psi^{\alpha}\, \mathcal{D}\phi^{*}\, \mathcal{D}\bar{\Psi}_{\dot\alpha}\; e^{iS(\phi,\psi^{\alpha},\Lambda)}$
$S = \int d^{D}x$

Comp scalar $\phi(x)$

Weyl fermion $\psi^\alpha(x)$

(Majorana) $\psi^\dagger_{\dot\alpha}(x)$

$$\int \mathcal{D}\phi\, \mathcal{D}\psi^\alpha\, \mathcal{D}\phi^*\, \mathcal{D}\bar\Psi_{\dot\alpha}\; e^{iS(\phi,\psi;\Lambda)}$$

$$S = \int d^Dx\, \mathcal{L}(\phi, \psi; \Lambda)$$

$$\mathcal{L} = \partial_t \phi^* \partial_t \phi - \vec{\nabla} \phi^* \cdot \vec{\nabla} \phi$$

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$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi}$$

$$+ \; i \, \psi^\dagger_{\dot{\alpha}} \, \partial_\mu \psi^\alpha$$

$$c = 1$$

$$\hbar = 1$$

$$\eta_{\mu\nu} = \begin{pmatrix} 1 & & & \\ & -1 & & \\ & & -1 & \\ & & & -1 \end{pmatrix}$$

$$\Psi = \begin{pmatrix} \vdots \end{pmatrix}$$

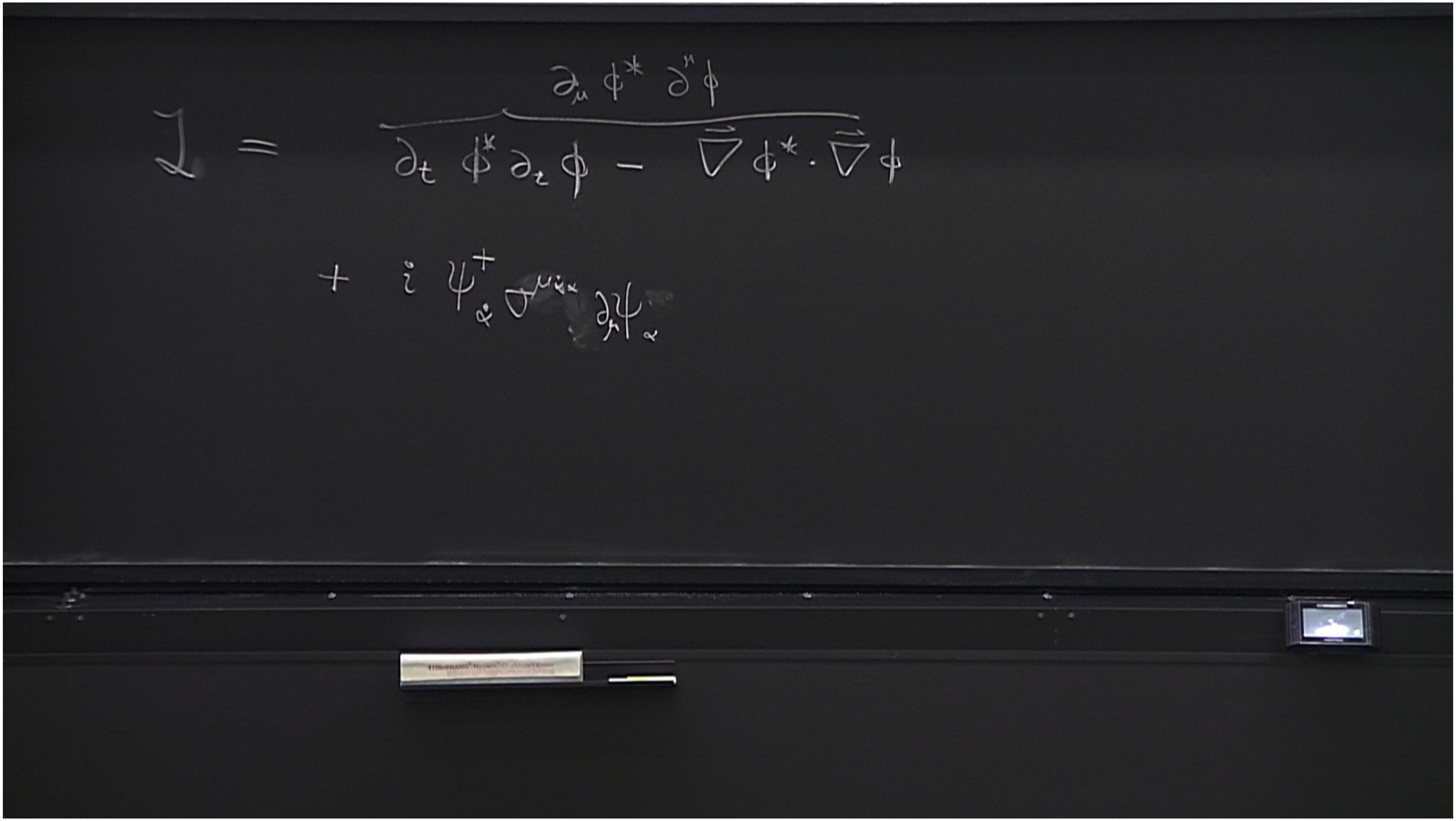
$$\bar{\Psi} = \Psi^{\dagger} \gamma_0$$

Λ - high-energy cutoff

$$D = 4$$

$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla} \phi^* \cdot \vec{\nabla} \phi}^{\partial_\mu \phi^* \partial^\mu \phi}$$

$$+ \; i \, \psi^\dagger_{\dot\alpha} \; \partial_\mu \psi^\alpha$$


$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi}$
$+ \; i \, \psi^\dagger_{\dot\alpha} \bar\sigma^{\mu \dot\alpha \alpha} \partial_\mu \psi_\alpha$

$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi}$$

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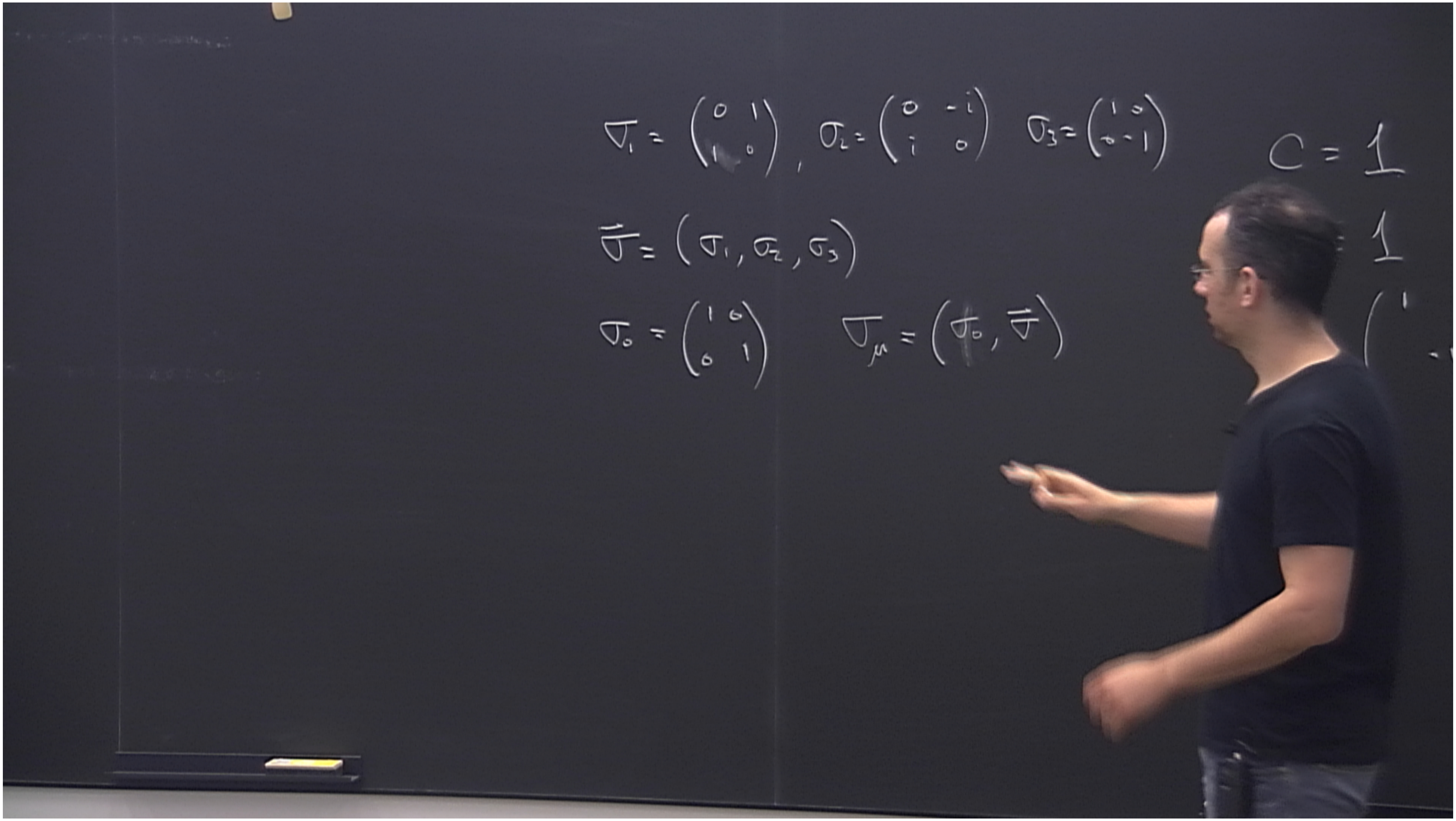
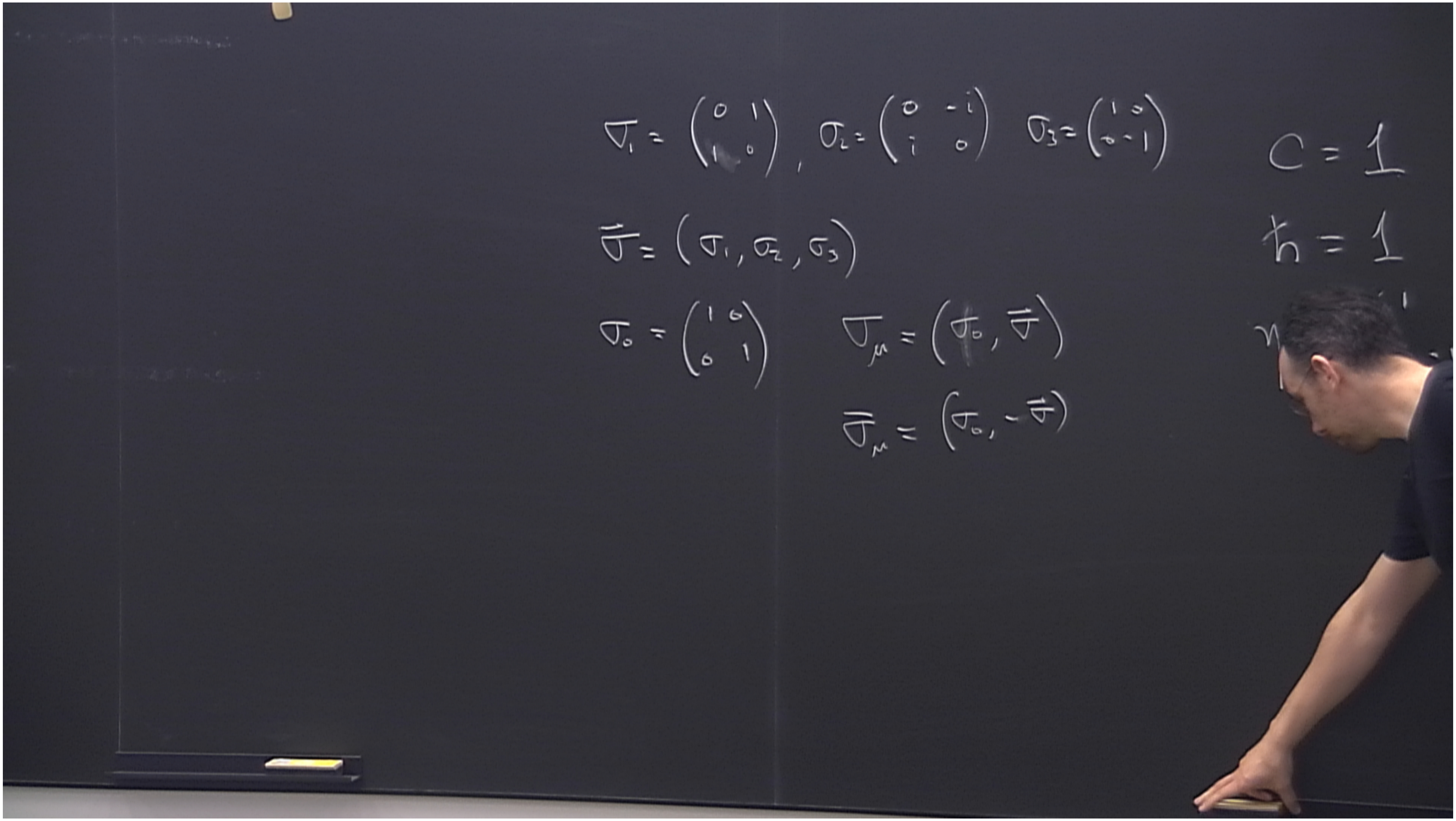


$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$, $\sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$ $\sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
$c = 1$
$\vec{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$
$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ $\sigma_\mu = (\sigma_0, \vec{\sigma})$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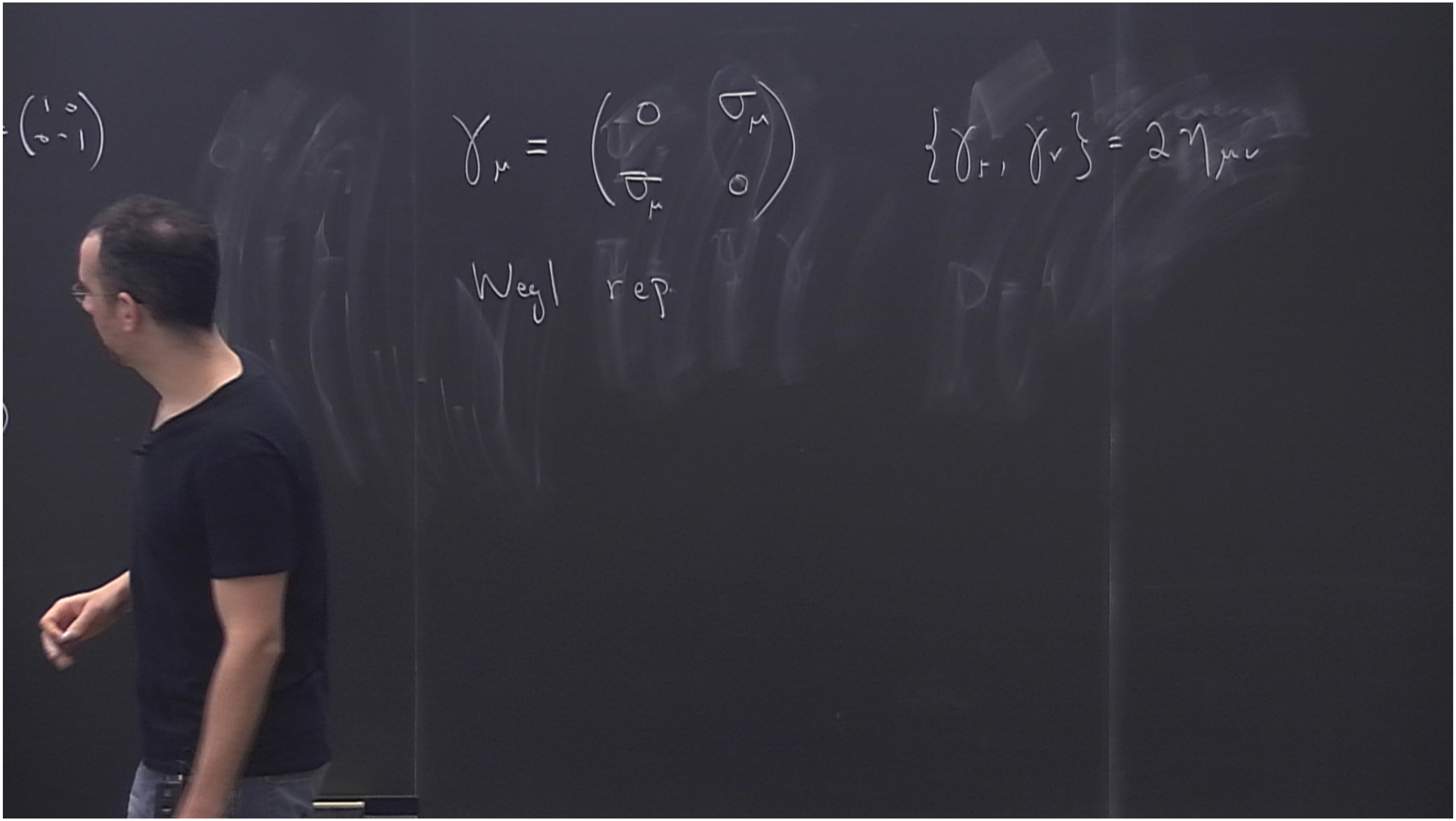
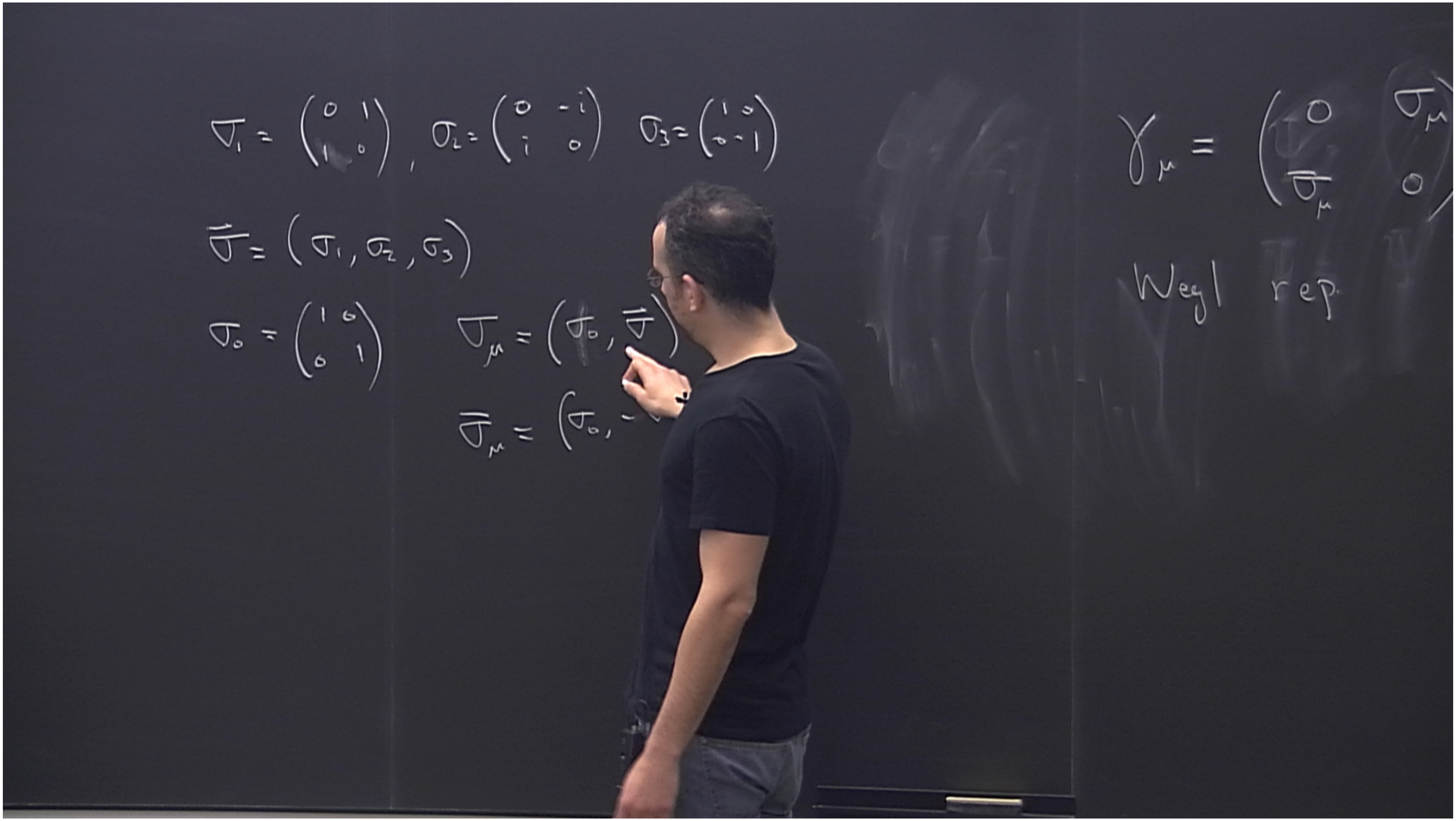
$\vec{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$
$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
$\sigma_\mu = (\sigma_0, \vec{\sigma})$
$\bar{\sigma}_\mu = (\sigma_0, -\vec{\sigma})$
$c = 1$
$\hbar = 1$


$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$
rep


$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$
$\{\gamma_\mu, \gamma_\nu\} = 2\eta_{\mu\nu}$
Weyl rep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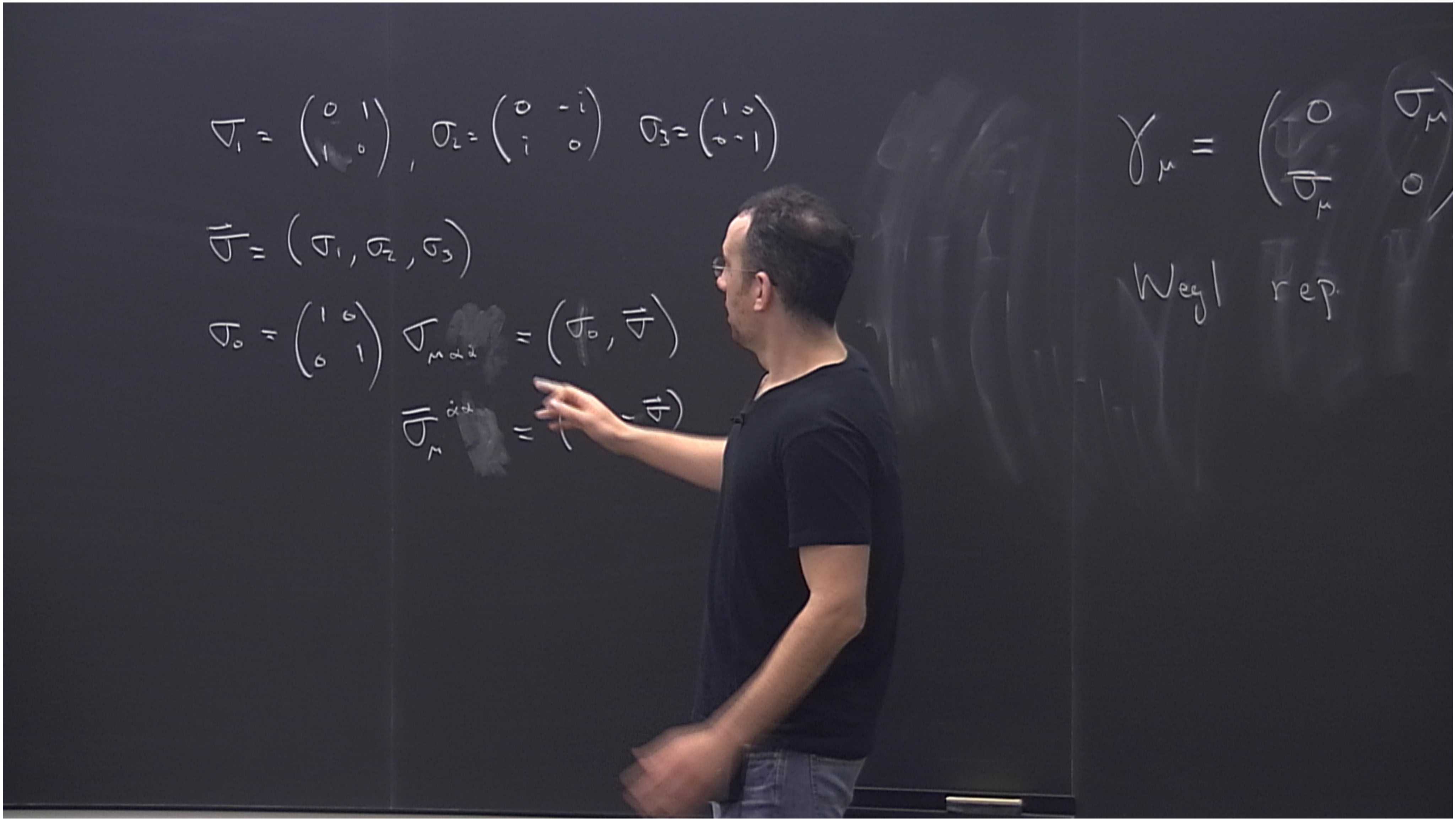
$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
$\sigma_\mu = (\sigma_0, \vec{\sigma})$
$\bar{\sigma}_\mu = (\sigma_0, -$
$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$
Weyl rep.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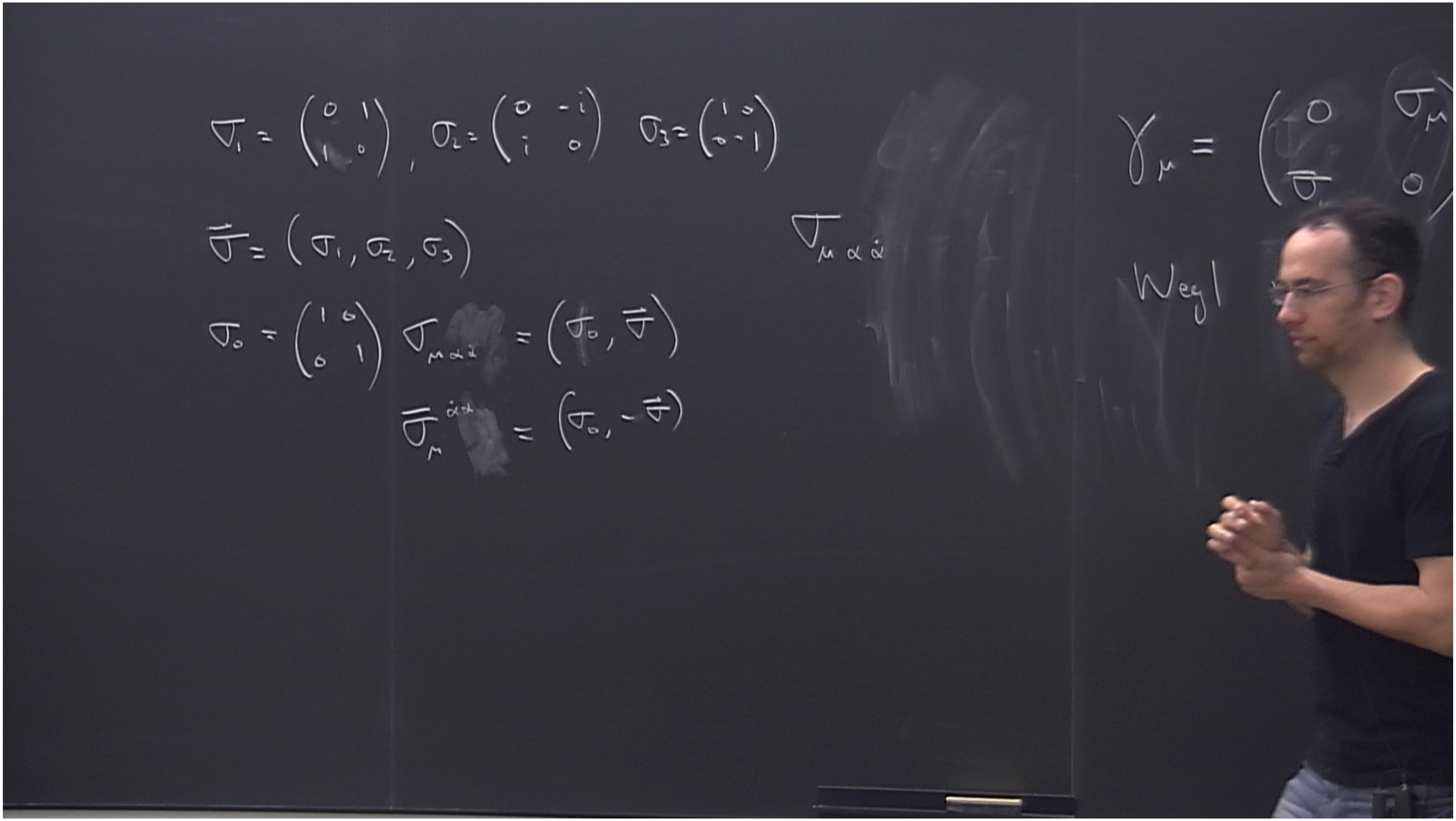
$\vec{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$
$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad \sigma_{\mu\alpha\dot\alpha} = (\sigma_0, \vec{\sigma})$
$\bar{\sigma}_\mu^{\dot\alpha\alpha} = (\quad -\vec{\sigma})$
$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$
Weyl rep.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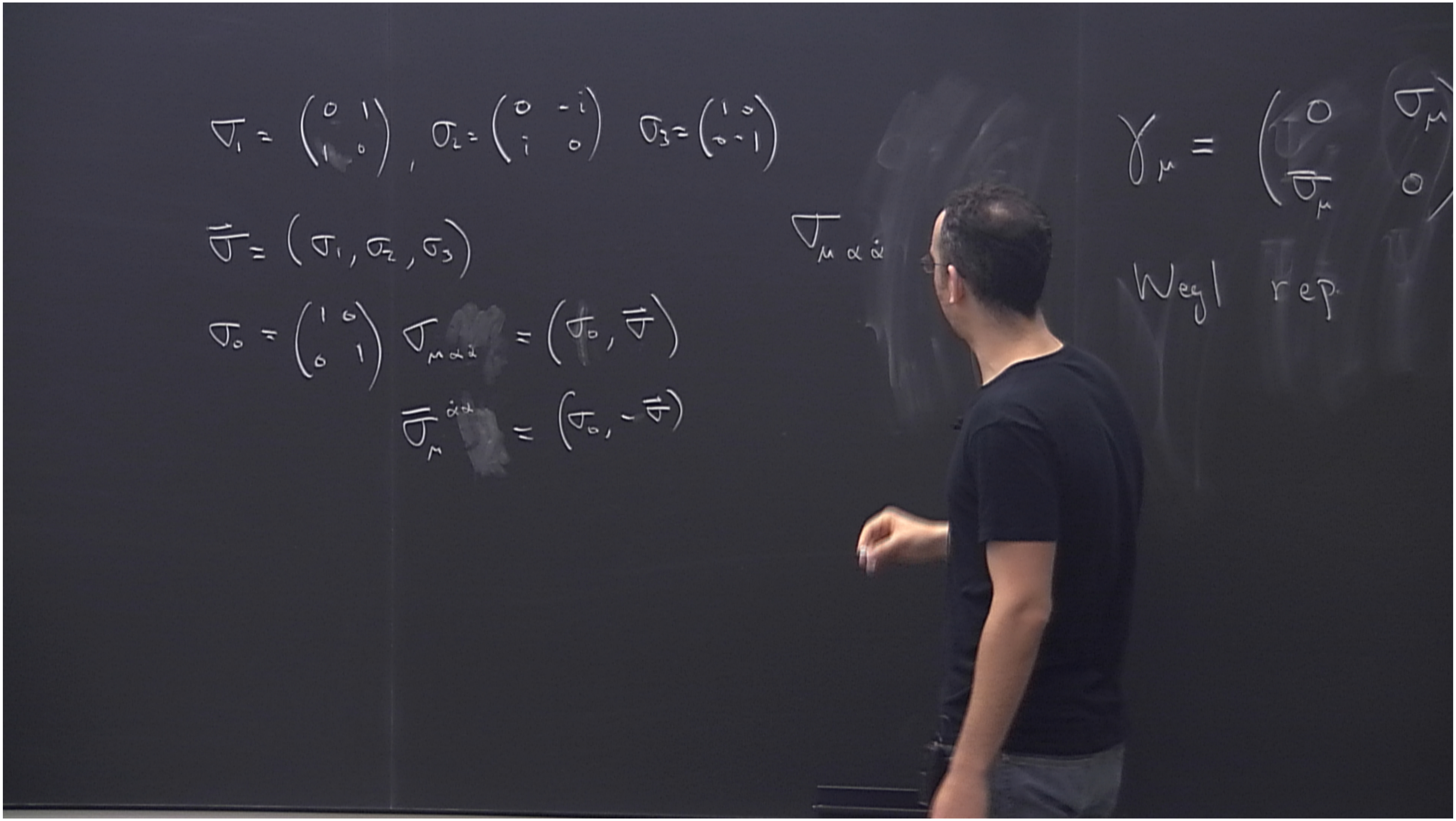
$\bar{\sigma}_\mu^{\dot{\alpha}\alpha} = (\sigma_0, -\vec{\sigma})$
$\sigma_{\mu\alpha\dot{\alpha}}$
$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma} & 0 \end{pmatrix}$
Weyl



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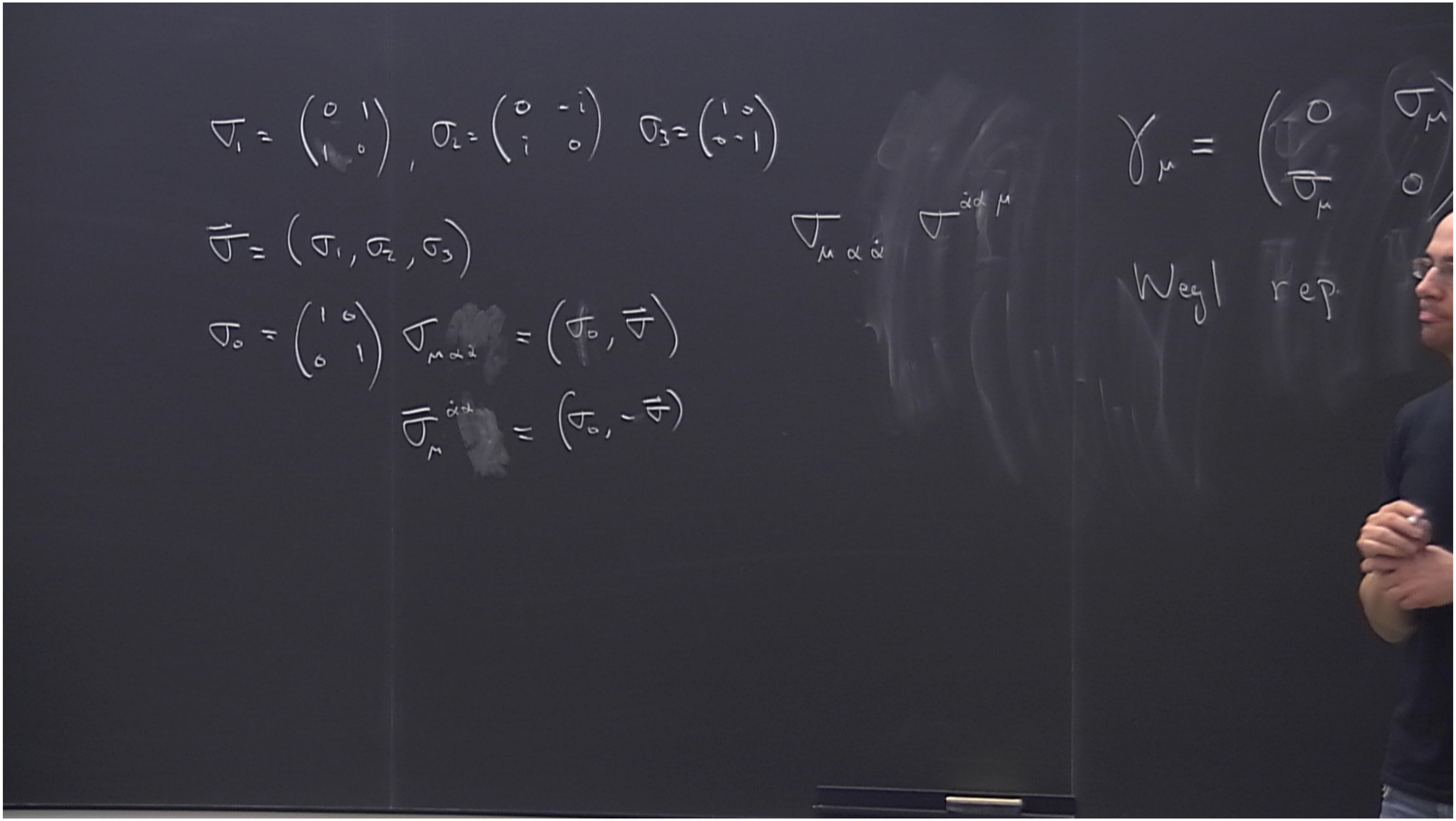
$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$
Weyl rep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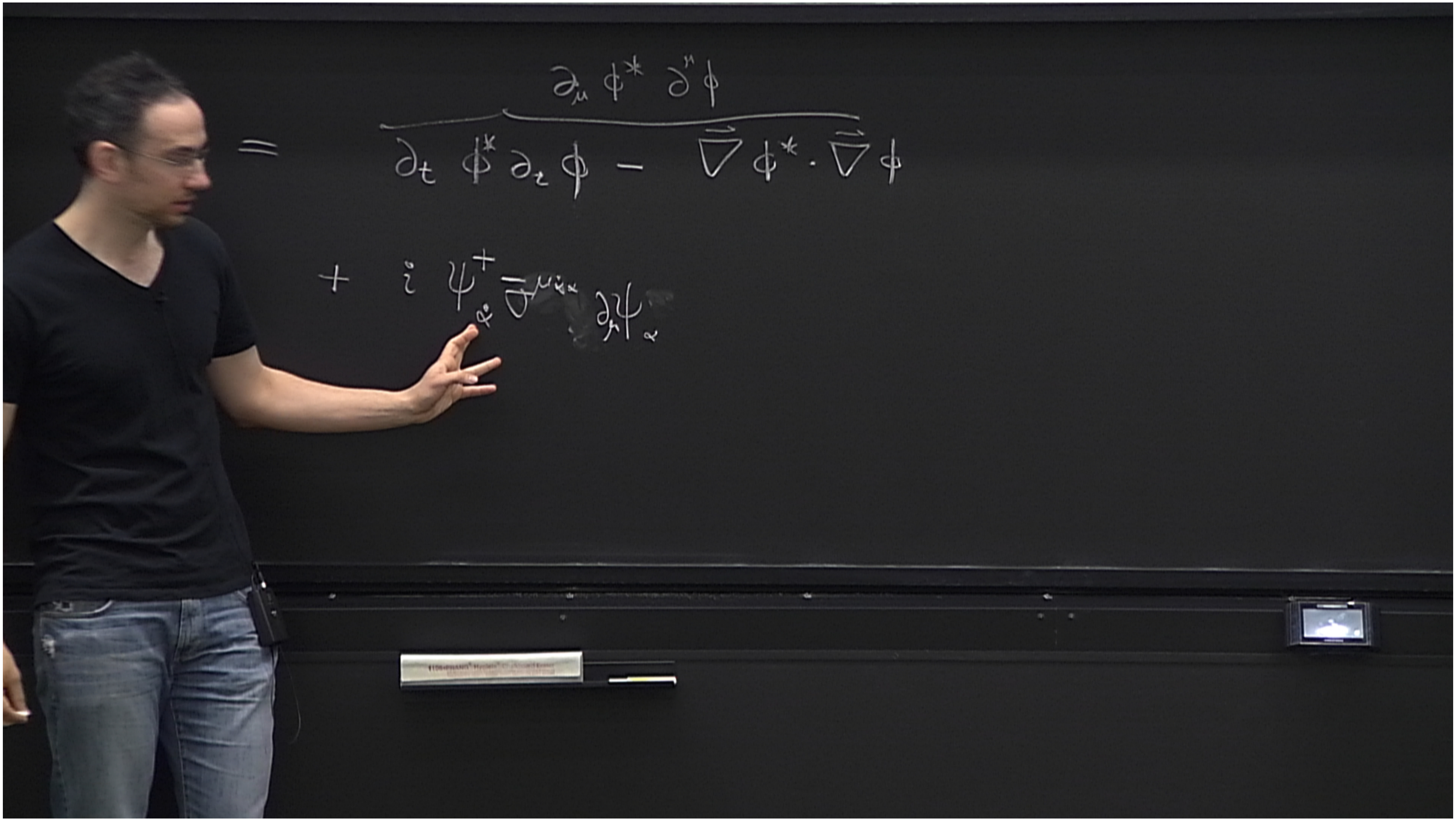
$\sigma_{\mu\alpha\dot\alpha} \quad \bar\sigma^{\dot\alpha\alpha\mu}$
$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar\sigma_\mu & 0 \end{pmatrix}$
Weyl rep.


$\partial_\mu \phi^* \partial^\mu \phi$
$= \partial_t \phi^* \partial_t \phi - \vec{\nabla} \phi^* \cdot \vec{\nabla} \phi$
$+ \; i \, \psi^\dagger_{\dot\alpha} \bar\sigma^{\mu \dot\alpha \alpha} \partial_\mu \psi_\alpha$

$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla} \phi^* \cdot \vec{\nabla} \phi}^{\partial_\mu \phi^* \partial^\mu \phi}$$

$$+ \; i \, \psi^\dagger_{\dot\alpha} \, \bar\sigma^{\mu \dot\alpha \alpha} \, \partial_\mu \psi_\alpha$$

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$$\bar{\sigma}_\mu^{\dot{\alpha} \alpha} = (\sigma_0, -\vec{\sigma})$$

$$\sigma_{\mu \alpha \dot{\alpha}} \, \bar{\sigma}^{\dot{\alpha} \alpha}_{\nu} = \eta_{\mu\nu}$$

$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

Weyl rep.

$$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

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$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

Weyl rep.

$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

$$\{\gamma_\mu, \gamma_\nu\} = 2\eta_{\mu\nu}$$

$$\sigma_{\mu\alpha\dot{\alpha}}\,\bar{\sigma}^{\dot{\alpha}\alpha}_{\nu} = \eta_{\mu\nu}$$

Weyl rep.

$$\{\sigma_{\mu\alpha\dot{\alpha}}, \bar{\sigma}^{\dot{\alpha}\beta}_{\nu}\} = 2\eta_{\mu\nu}\,\delta_\alpha{}^\beta$$

$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

$$\{\gamma_\mu, \gamma_\nu\} = 2\eta_{\mu\nu}$$

$$\sigma_{\mu\alpha\dot{\alpha}} \bar{\sigma}^{\dot{\alpha}\alpha}_\nu = \eta_{\mu\nu}$$

Weyl rep.

$$\{\sigma_{\mu\alpha\dot{\alpha}}, \bar{\sigma}^{\dot{\alpha}\beta}_\nu\} = 2\eta_{\mu\nu}\delta_\alpha{}^\beta$$

$$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

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$$\bar{\sigma}_\mu^{\dot{\alpha}\alpha} = (\sigma_0, -\vec{\sigma})$$

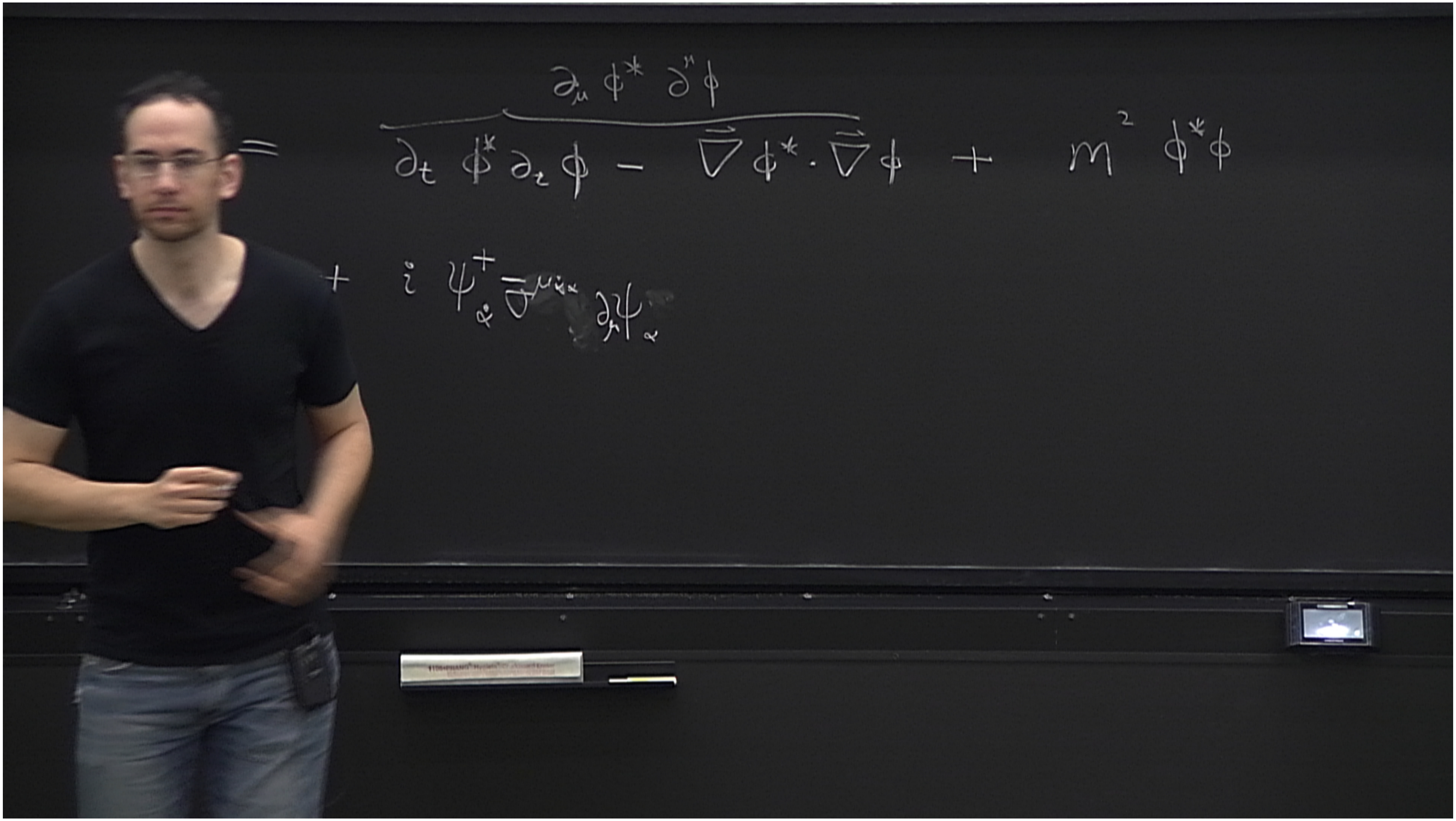
$$\sigma_{\mu\alpha\dot{\alpha}} \, \bar{\sigma}^{\dot{\alpha}\alpha}_{\nu} = \eta_{\mu\nu}$$

$$\epsilon_{\alpha\dot{\alpha}} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

$$\epsilon^{\dot{\alpha}\alpha} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

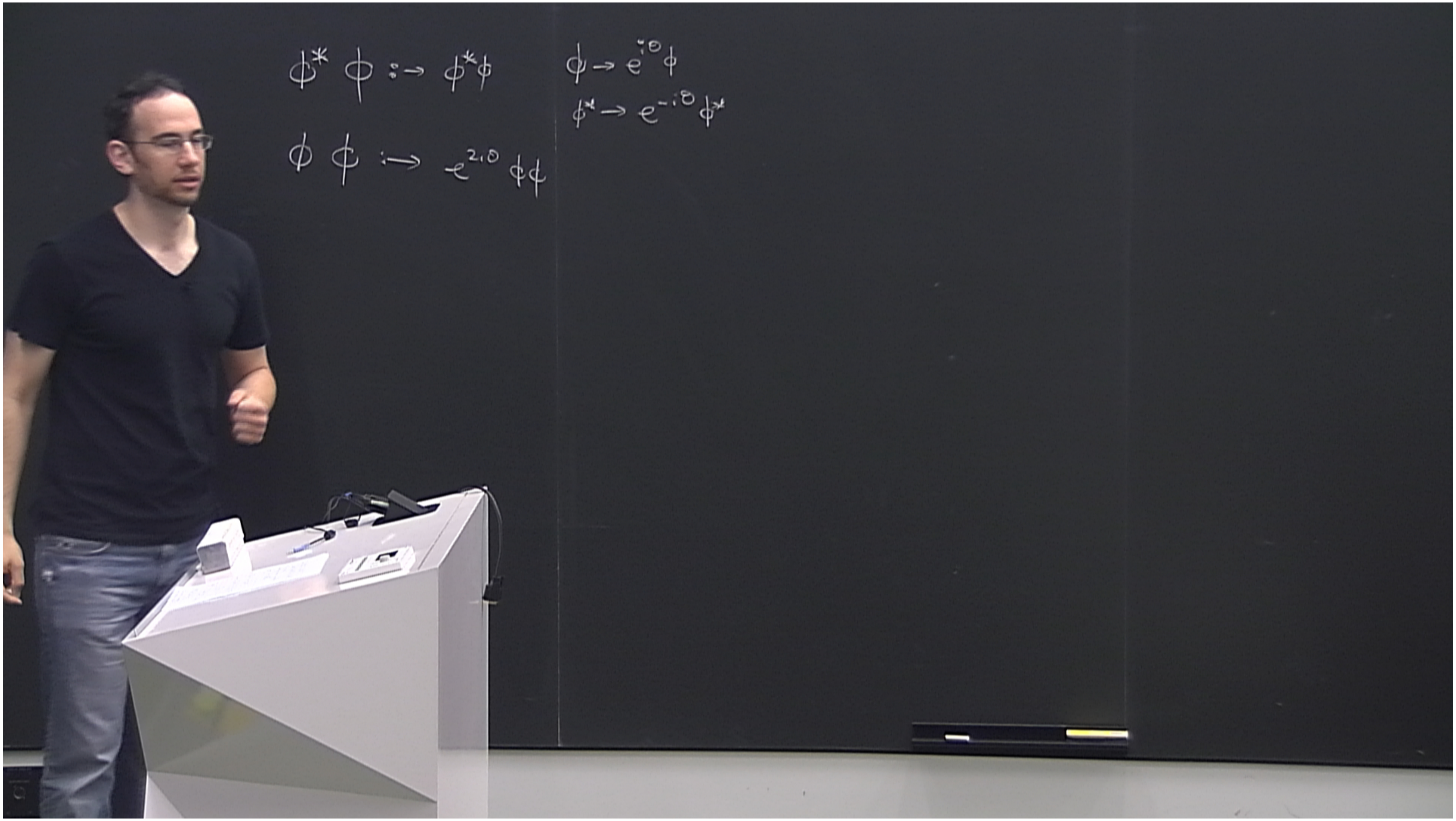
$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

Weyl rep.


$\partial_\mu \phi^* \partial^\mu \phi$
$= \partial_t \phi^* \partial_t \phi - \vec{\nabla} \phi^* \cdot \vec{\nabla} \phi + m^2 \phi^* \phi$
$+ i \psi^\dagger_{\dot\alpha} \bar{\sigma}^{\mu \dot\alpha \alpha} \partial_\mu \psi_\alpha$

$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi} + m^2 \phi^*(x)\phi(x)$$

$$+ i \psi^\dagger_{\dot\alpha} \bar\sigma^{\mu\dot\alpha\alpha} \partial_\mu \psi_\alpha$$


$\phi^* \phi \mapsto \phi^* \phi$
$\phi \rightarrow e^{i\theta} \phi$
$\phi^* \rightarrow e^{-i\theta} \phi^*$
$\phi \phi \mapsto e^{2i\theta} \phi \phi$

$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

$\vec{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$

$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad \sigma_{\mu\alpha\dot{\alpha}} = (\sigma_0, \vec{\sigma})$

$\bar{\sigma}_\mu^{\dot{\alpha}\alpha} = (\sigma_0, -\vec{\sigma})$

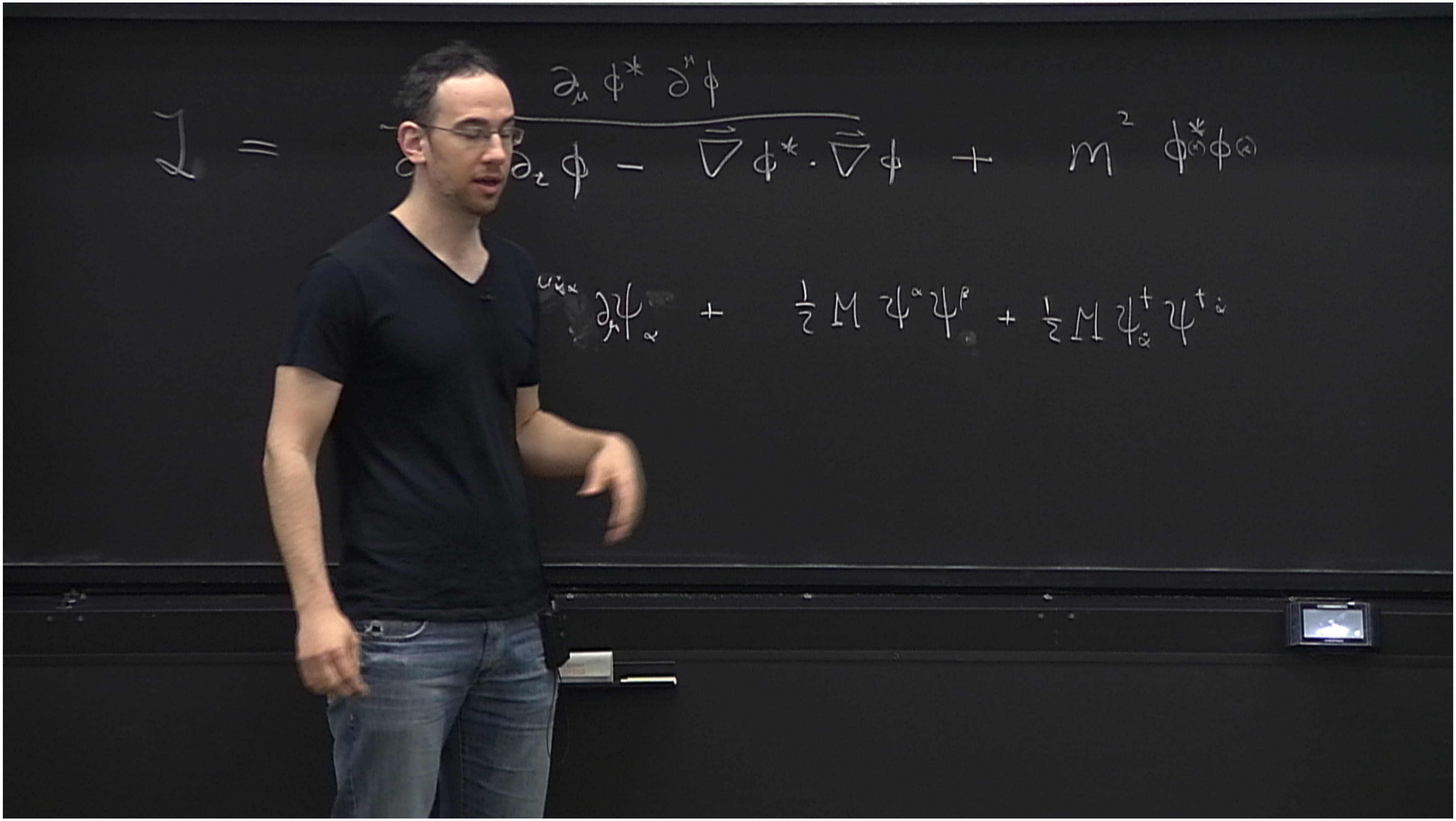
$\sigma_{\mu\alpha\dot{\alpha}} \bar{\sigma}^{\dot{\alpha}\alpha}_\nu = \eta_{\mu\nu}$

$\epsilon_{\dot{\alpha}\dot{\alpha}} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$

$\epsilon^{\dot{\alpha}\alpha} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$

$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$

Weyl rep.


$\partial_\mu \phi^* \partial^\mu \phi$
$\mathcal{L} =$
$\partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi + m^2 \phi^* \phi$
$+ \frac{1}{2} M \psi^\alpha \psi^\beta + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger \dot\alpha}$

$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi} + m^2 \phi^*(x)\phi(x)$$

$$+ i \psi^\dagger_{\dot\alpha} \bar{\sigma}^{\mu\dot\alpha\alpha} \partial_\mu \psi_\alpha + \frac{1}{2} M \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger\dot\alpha}$$

$$\sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$\vec{\sigma} = (\sigma_1, \sigma_2, \sigma_3)$$

$$\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad \sigma_{\mu \alpha \dot\alpha} = (\sigma_0, \vec{\sigma})$$

$$\bar{\sigma}_\mu^{\dot\alpha \alpha} = (\sigma_0, -\vec{\sigma})$$

$$\sigma_{\mu \alpha \dot\alpha} \bar{\sigma}^{\dot\alpha \alpha}{}_\nu = \eta_{\mu\nu}$$

$$\epsilon_{\alpha\beta} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

$$\epsilon^{\dot\alpha \dot\beta} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

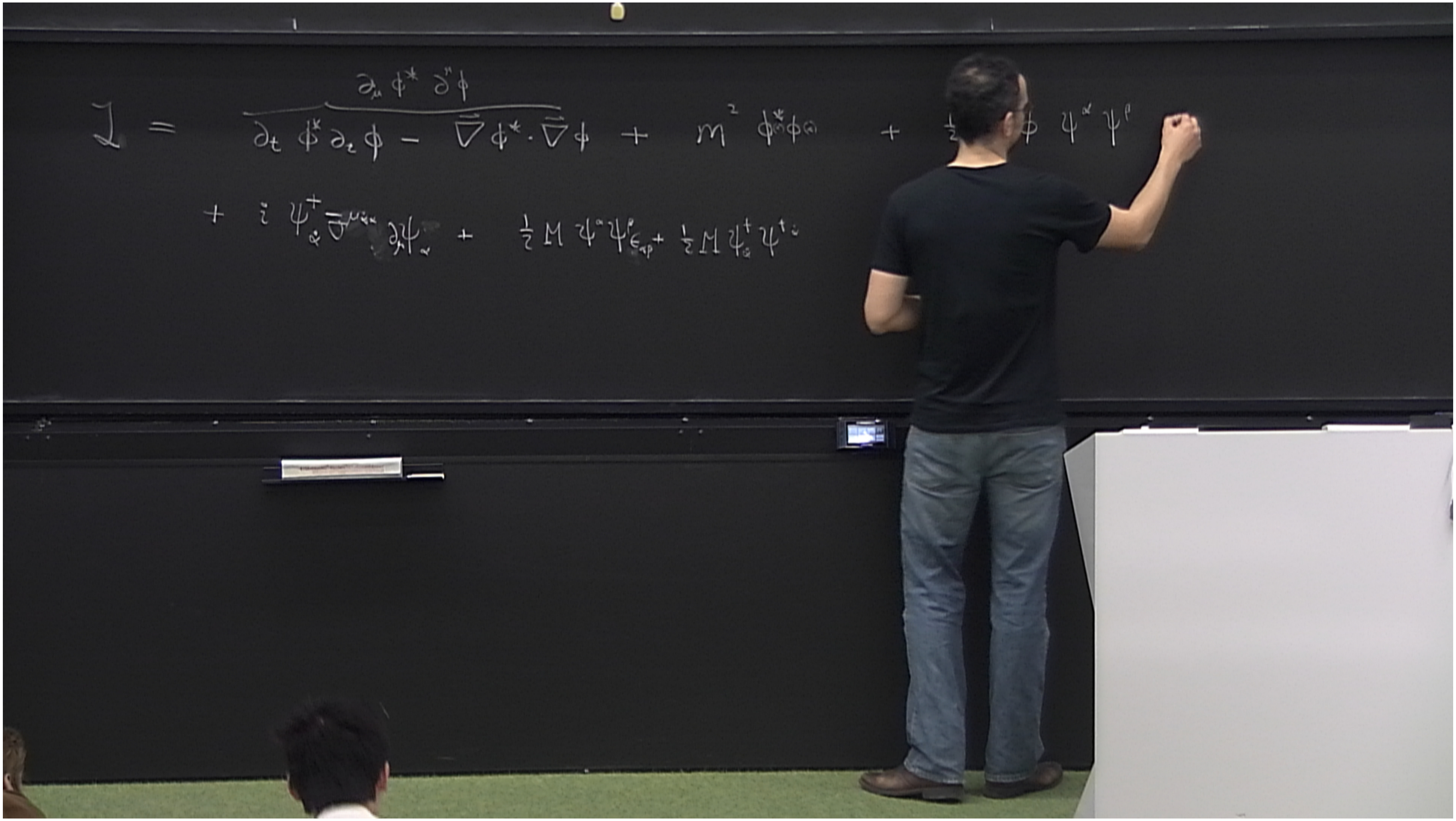
$$\gamma_\mu = \begin{pmatrix} 0 & \sigma_\mu \\ \bar{\sigma}_\mu & 0 \end{pmatrix}$$

Weyl rep.

$\partial^\mu \phi$

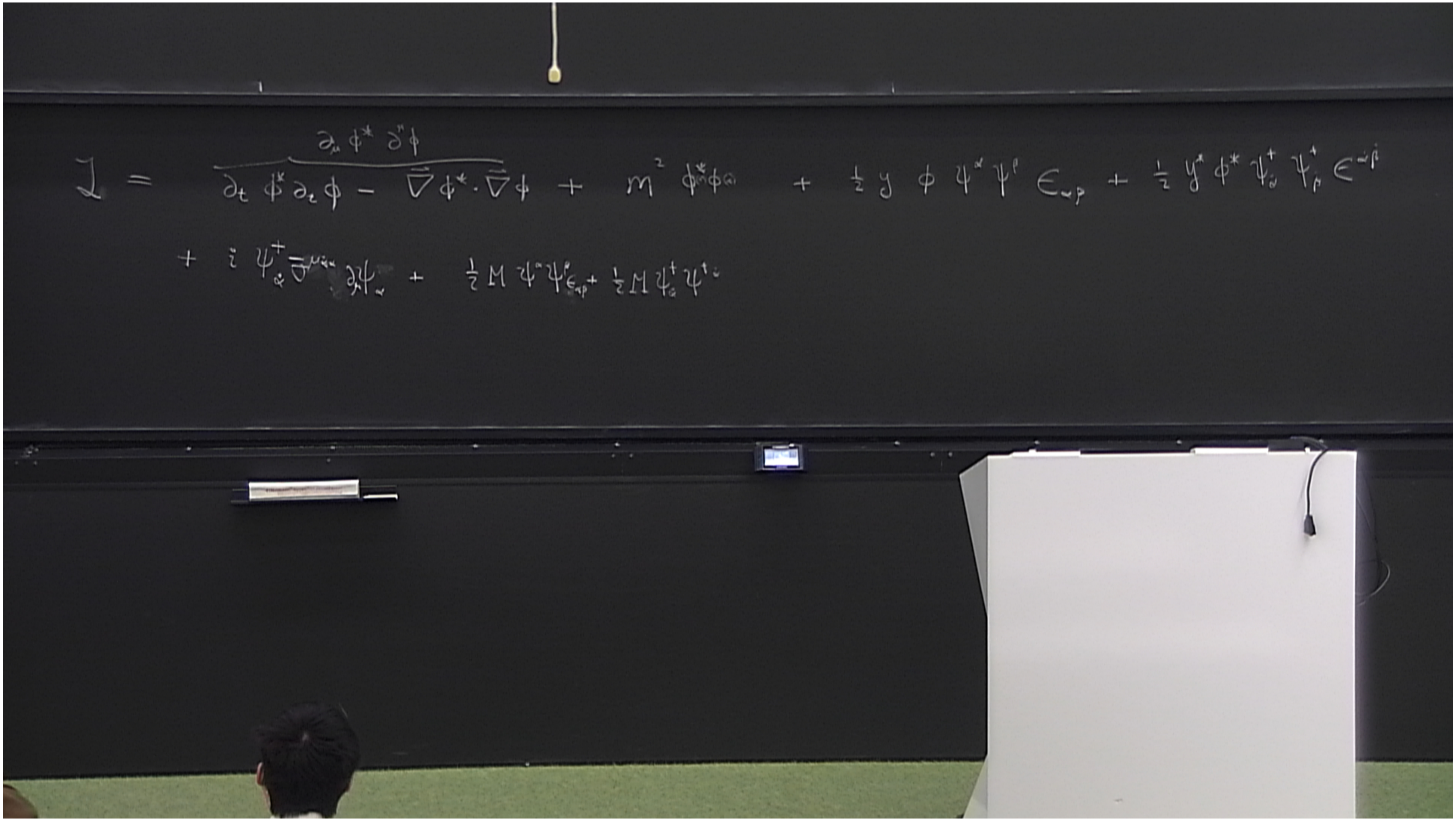
$\vec{\nabla}\phi^* \cdot \vec{\nabla}\phi \; + \; m^2 \, \phi^*(x)\phi(x) \; + \; \frac{1}{2} y \, \phi \, \psi^\alpha \psi^\beta$

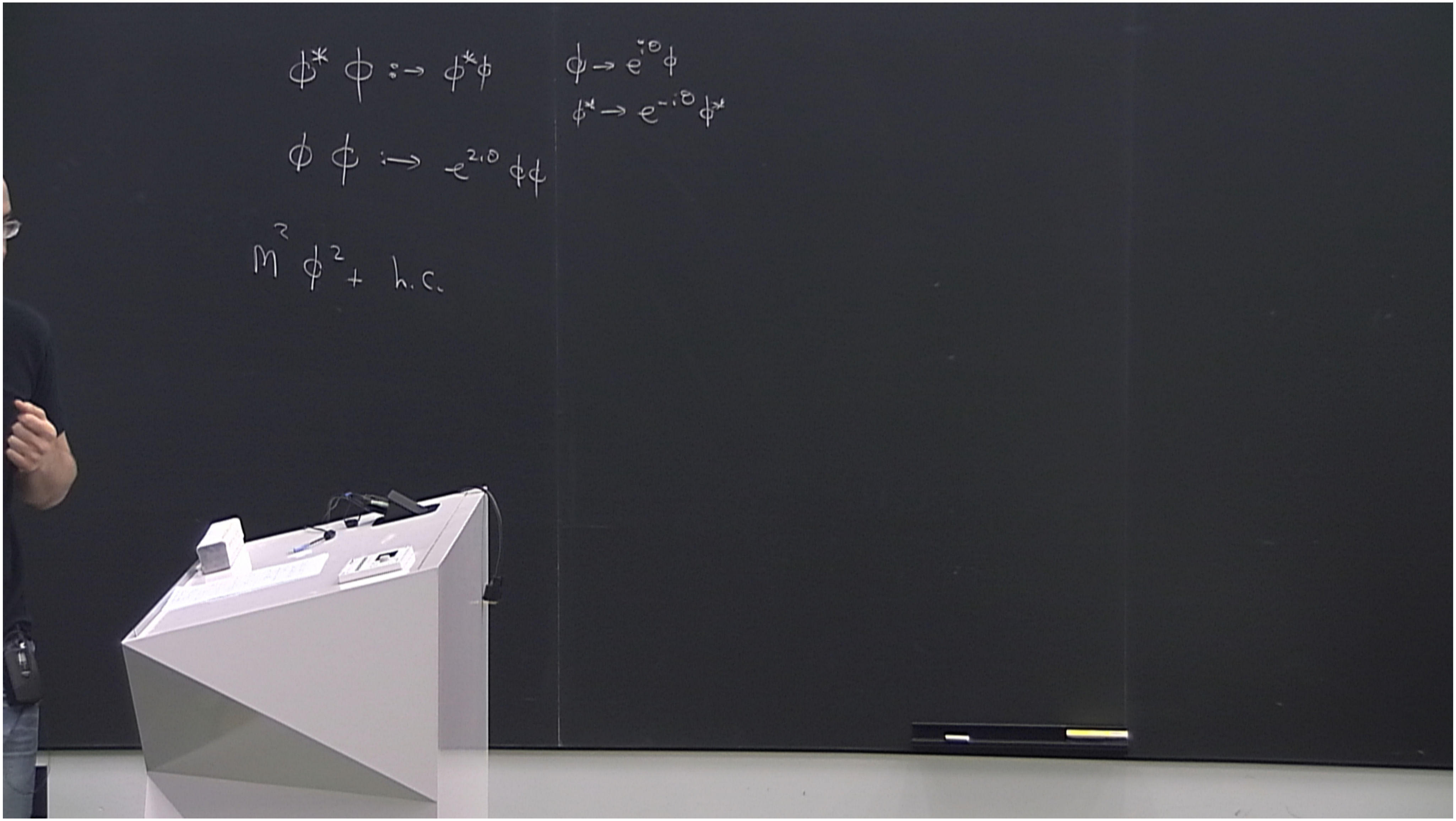
$+ \; \frac{1}{2} M \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger\dot\alpha}$

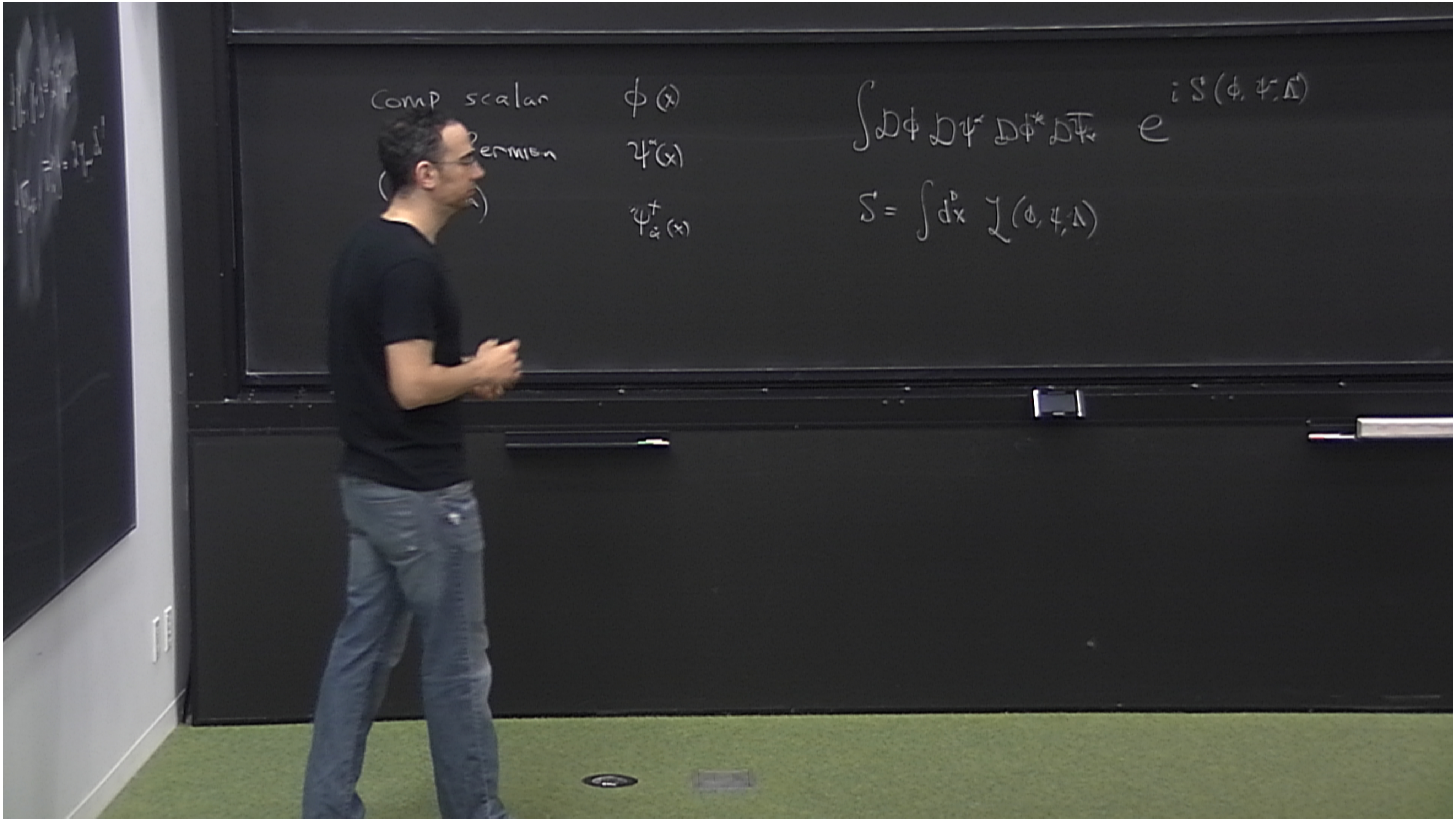

$\partial_\mu \phi^* \partial^\mu \phi$
$\mathcal{L} = \partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi + m^2 \phi^* \phi + \frac{1}{2} \; \phi \, \psi^\alpha \psi^\beta$
$+ i \psi^\dagger_{\dot\alpha} \bar\sigma^{\mu \dot\alpha \alpha} \partial_\mu \psi_\alpha + \frac{1}{2} M \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger \dot\alpha}$

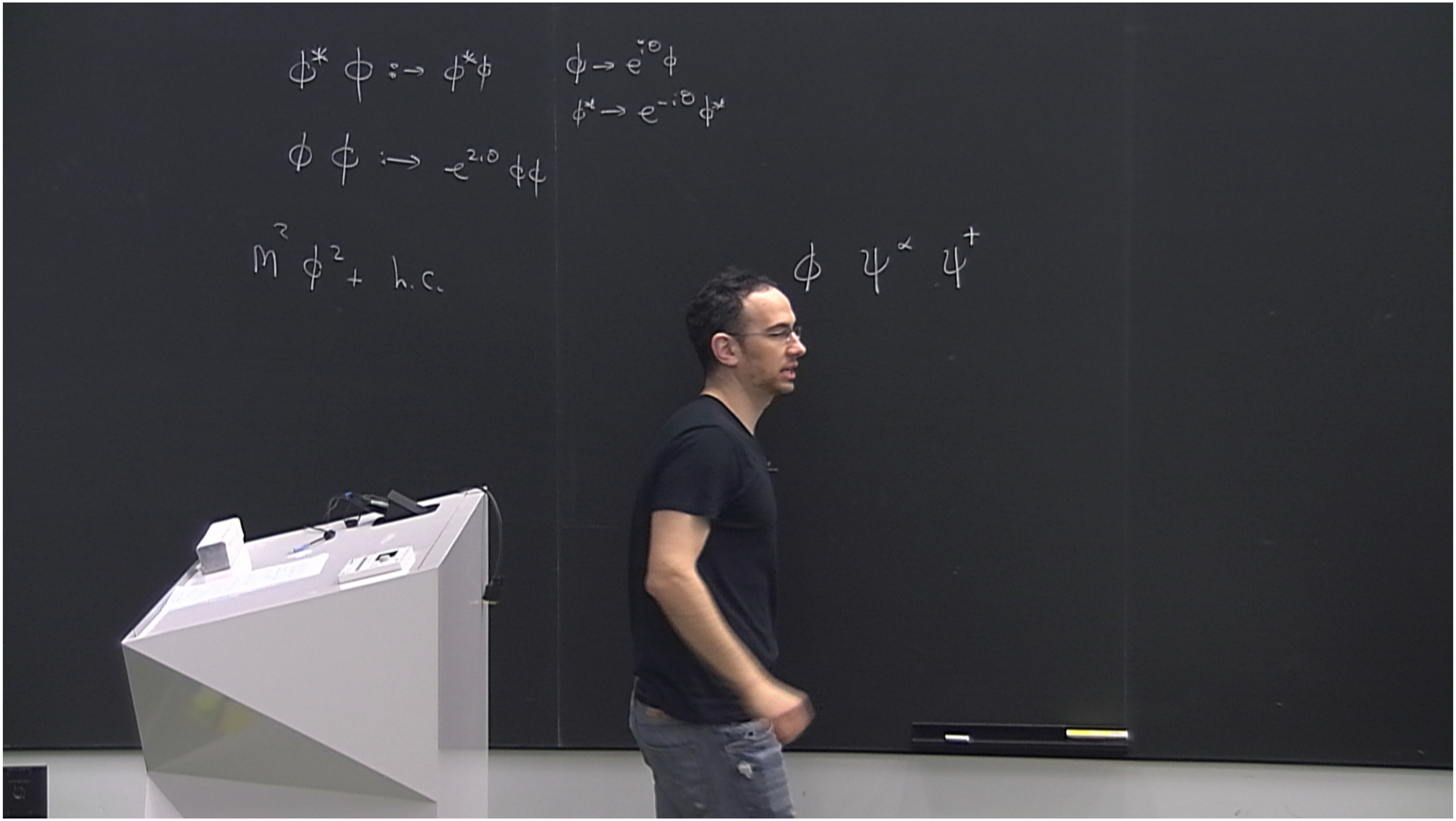
$$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi} + m^2 \phi^*\phi + \frac{1}{2} y \, \phi \, \psi^\alpha \psi^\beta \epsilon_{\alpha\beta}$$

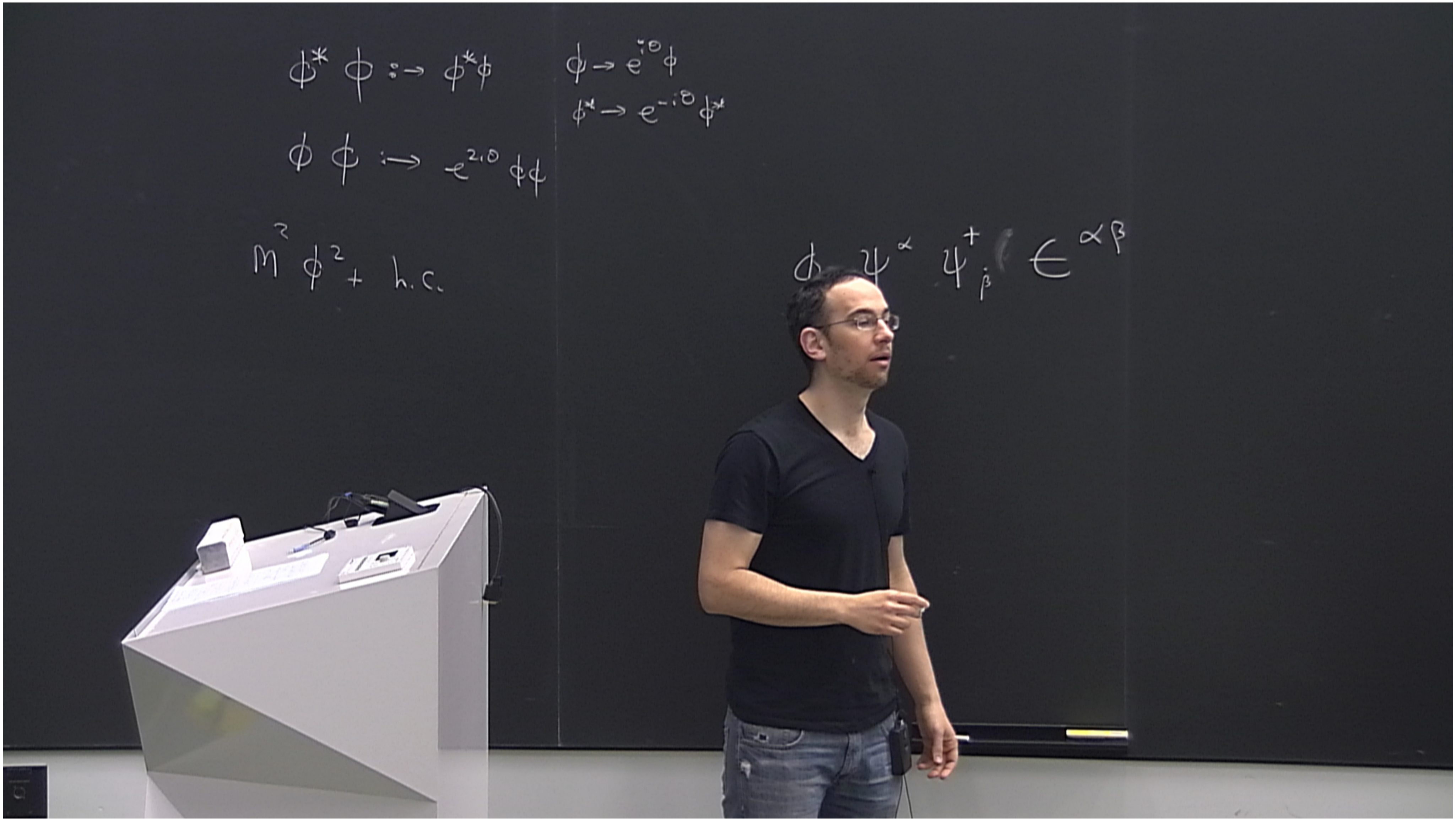
$$+ \, i \psi^\dagger_{\dot\alpha} \bar{\sigma}^{\mu \dot\alpha \alpha} \partial_\mu \psi_\alpha + \frac{1}{2} M \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger \dot\alpha}$$

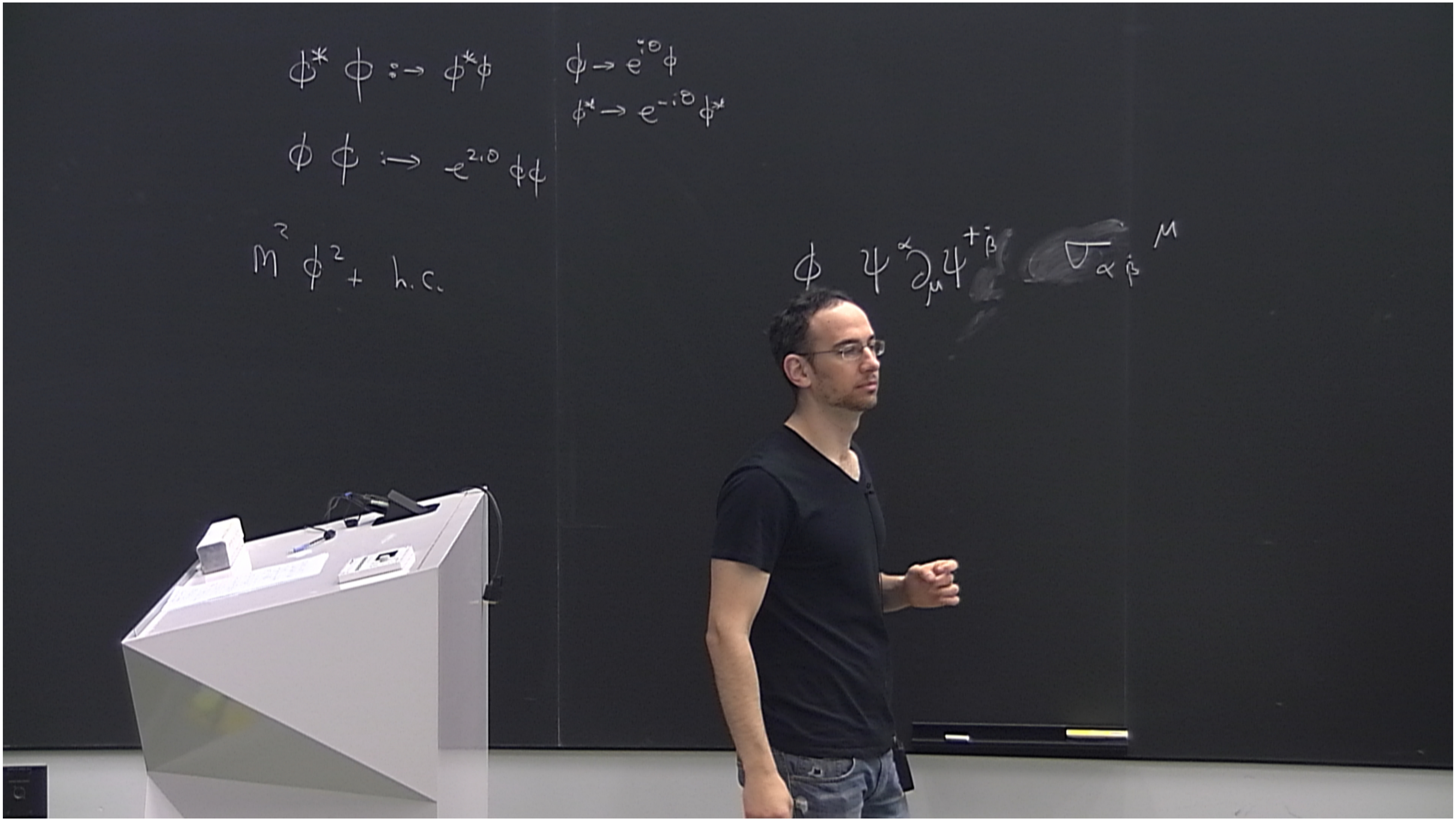

$\mathcal{L} = \overbrace{\partial_t \phi^* \partial_t \phi - \vec{\nabla}\phi^* \cdot \vec{\nabla}\phi}^{\partial_\mu \phi^* \partial^\mu \phi} + m^2 \phi^{*}(x)\phi(x) + \frac{1}{2} y \phi \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} y^* \phi^* \psi^\dagger_{\dot\alpha} \psi^\dagger_{\dot\beta} \epsilon^{\dot\alpha\dot\beta}$
$+ i \psi^\dagger_{\dot\alpha} \bar\sigma^{\mu\dot\alpha\alpha} \partial_\mu \psi_\alpha + \frac{1}{2} M \psi^\alpha \psi^\beta \epsilon_{\alpha\beta} + \frac{1}{2} M \psi^\dagger_{\dot\alpha} \psi^{\dagger\dot\alpha}$

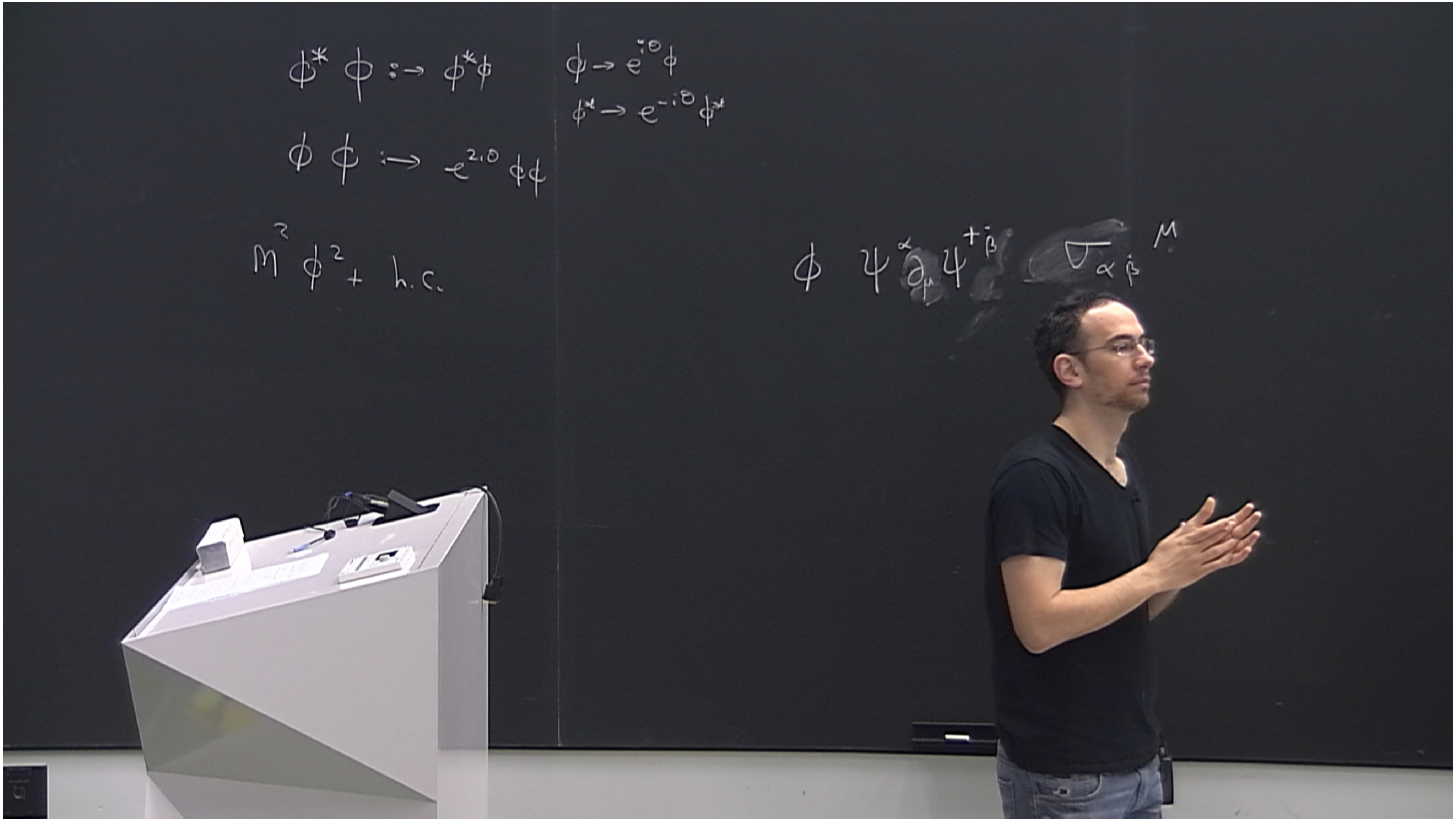

$\phi^* \phi \mapsto \phi^* \phi$
$\phi \phi \mapsto e^{2i\theta} \phi\phi$
$m^2 \phi^2 + h.c.$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$

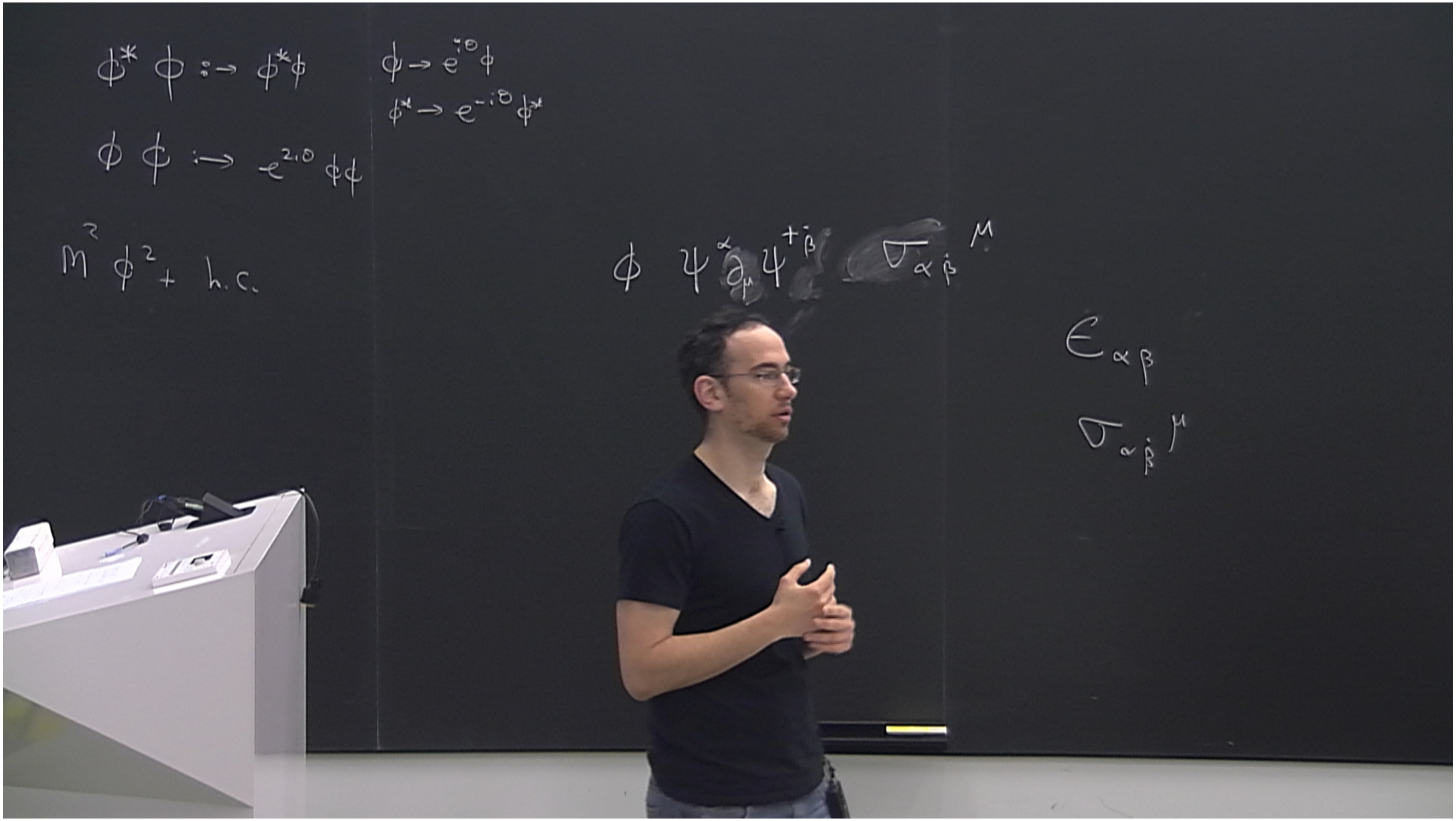

Comp scalar
φ(x)
ermion
ψ^α(x)
ψ^+_α̇(x)
∫Dφ Dψ^α Dφ* Dψ̄_α̇ e^{iS(φ, ψ, Λ)}
S = ∫d^D x L(φ, ψ, Λ)

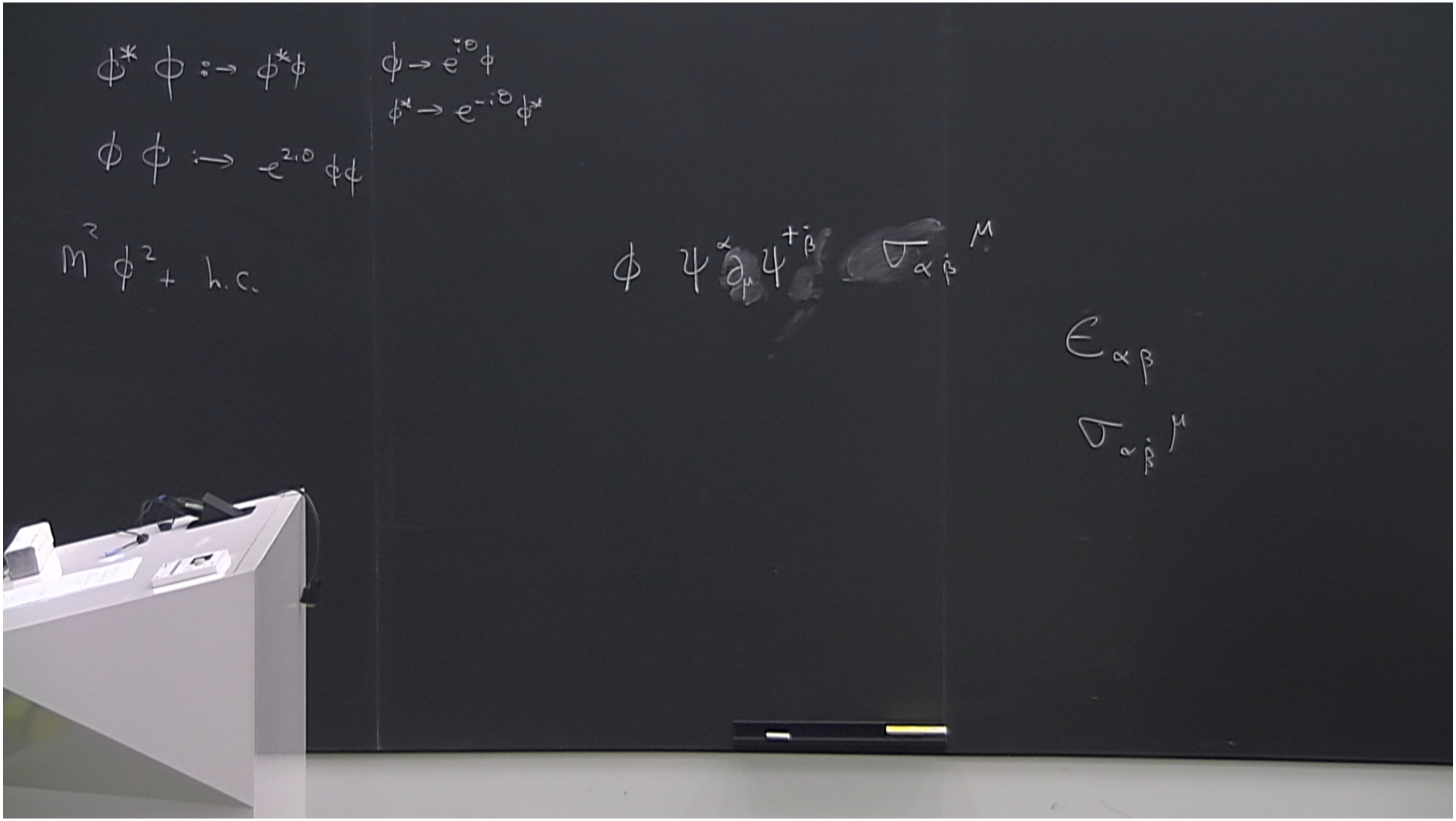

$\phi^* \phi :\to \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi :\to e^{2i\theta} \phi \phi$
$m^2 \phi^2 + h.c.$
$\phi \ \psi^\alpha \ \psi^+$

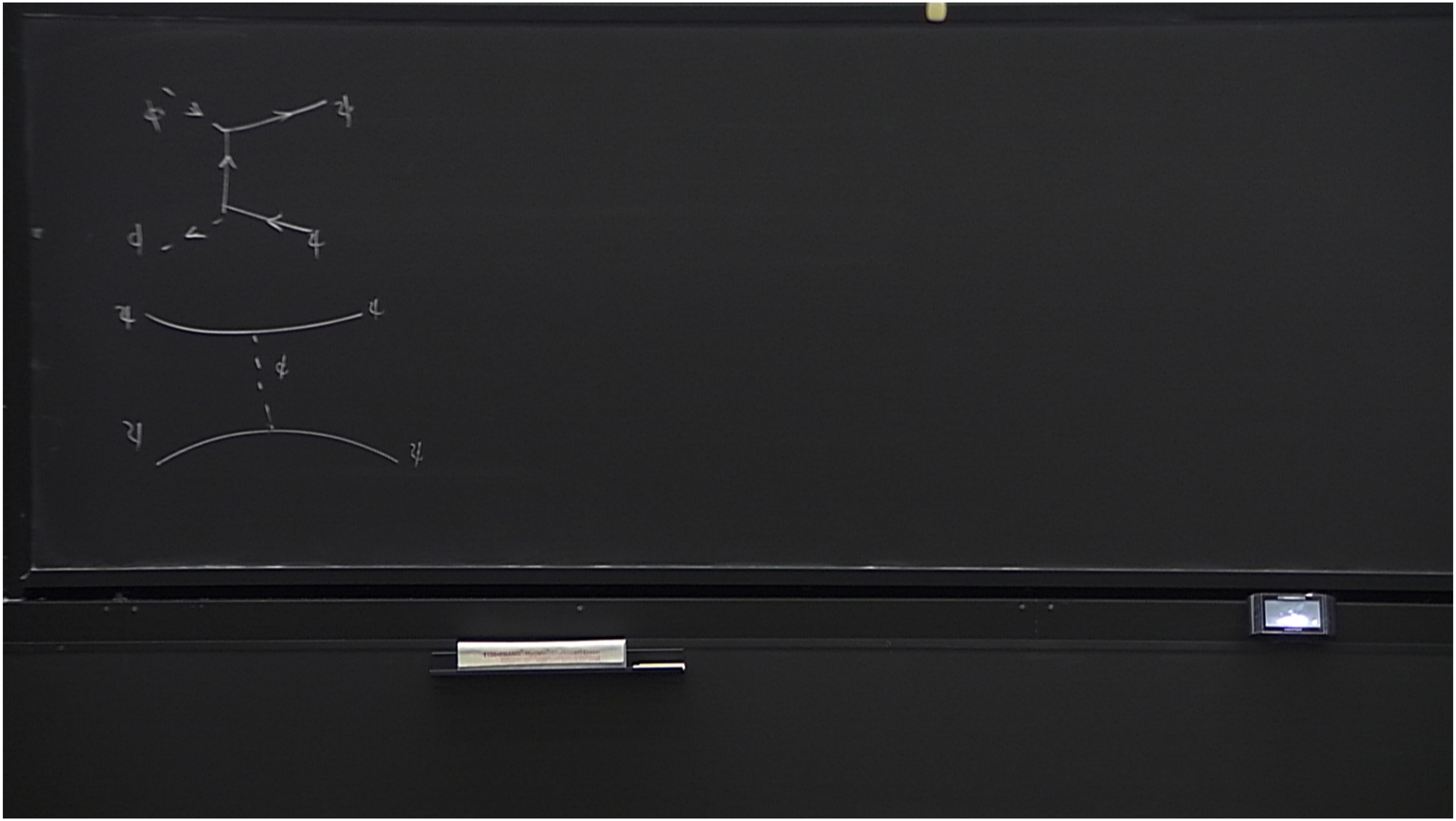

$\phi^* \phi \mapsto \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi \mapsto e^{2i\theta} \phi\phi$
$m^2 \phi^2 + h.c.$
$\phi \psi^\alpha \psi^+_\beta \epsilon^{\alpha\beta}$

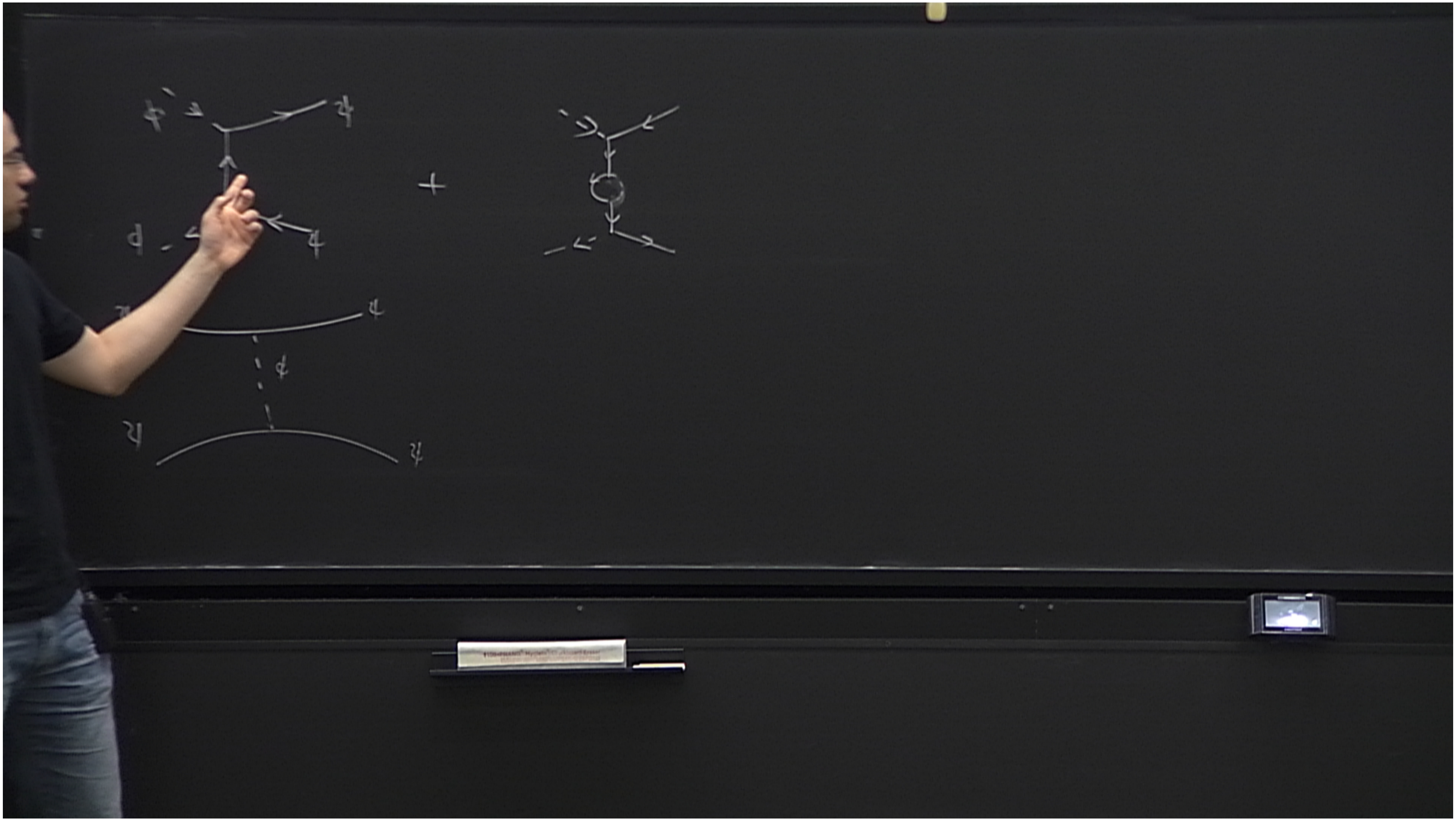

$\phi^* \phi \mapsto \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi \mapsto e^{2i\theta} \phi\phi$
$m^2 \phi^2 + h.c.$
$\phi \, \psi^\alpha \partial_\mu \psi^{\dagger \dot\beta} \, \sigma_{\alpha\dot\beta}^\mu$

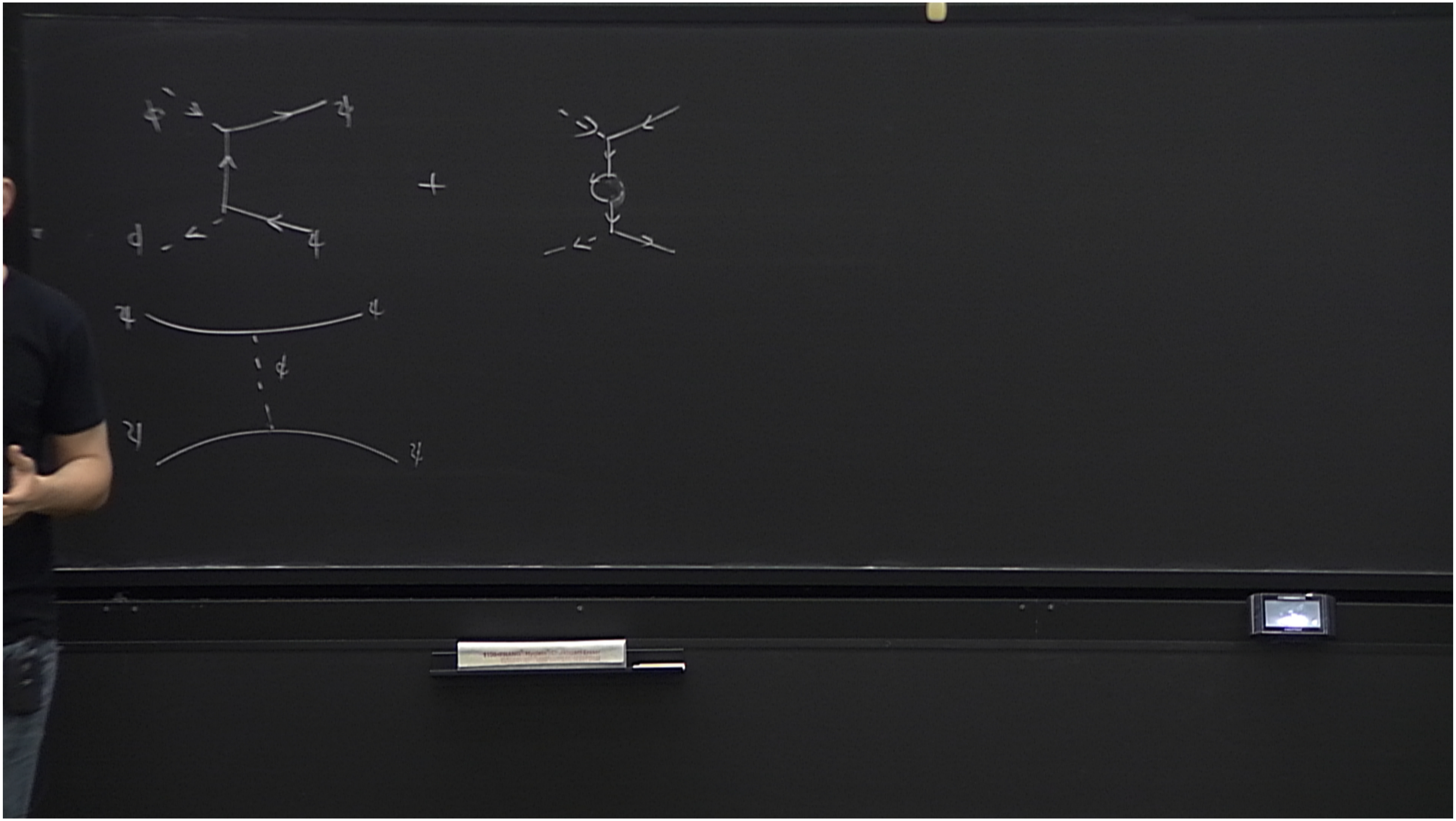

$\phi^* \phi :\to \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi :\to e^{2i\theta} \phi\phi$
$m^2 \phi^2 + h.c.$
$\phi \, \psi^\alpha \partial_\mu \psi^{\dagger \dot\beta} \sigma_{\alpha \dot\beta}^{\mu}$

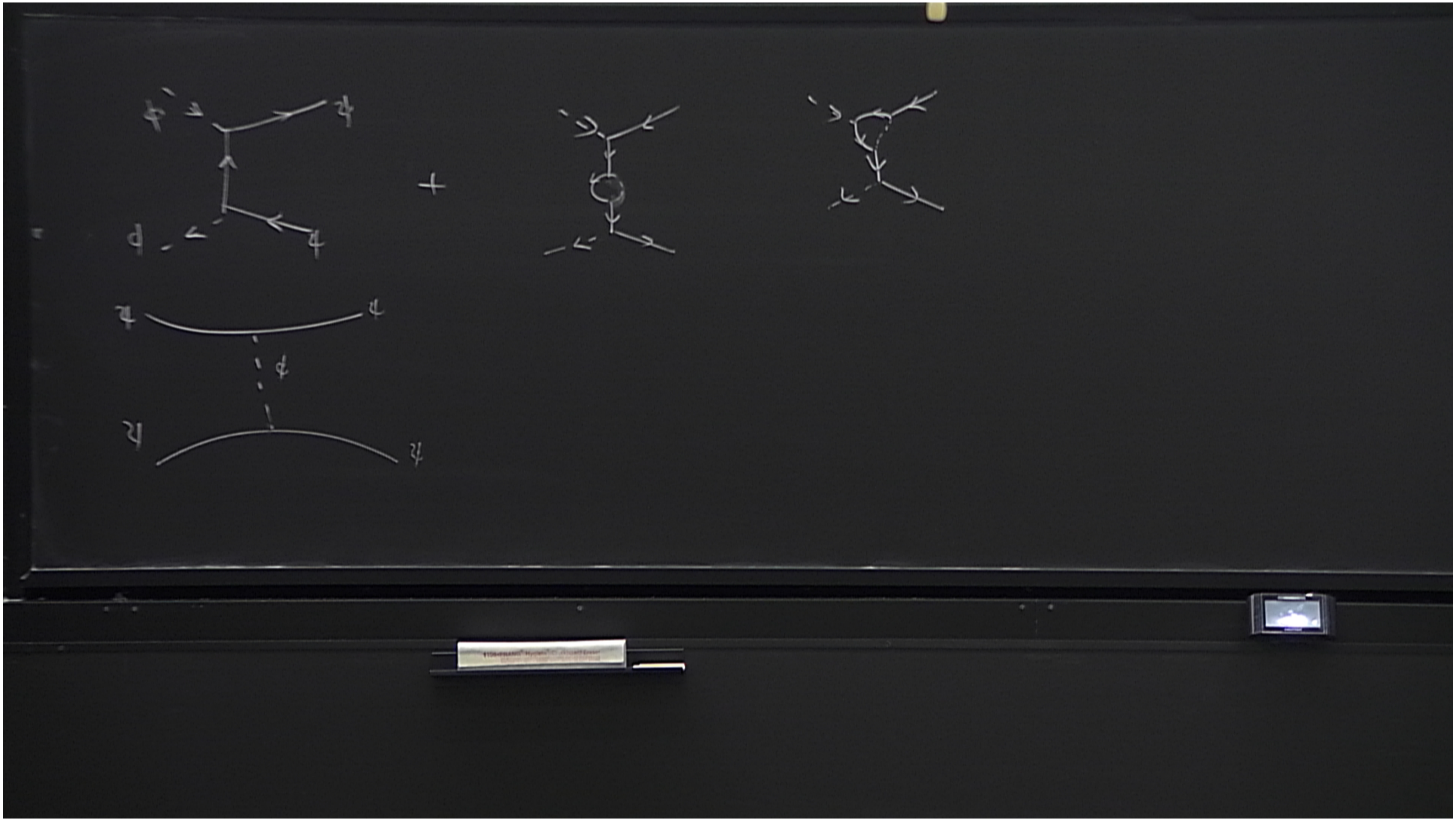

$\phi^* \phi :\to \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi :\to e^{2i\theta} \phi \phi$
$m^2 \phi^2 + h.c.$
$\phi \psi^\alpha \partial_\mu \psi^{+\dot\beta} \sigma_{\alpha\dot\beta}{}^\mu$
$\epsilon_{\alpha\beta}$
$\sigma_{\alpha\dot\beta}{}^\mu$

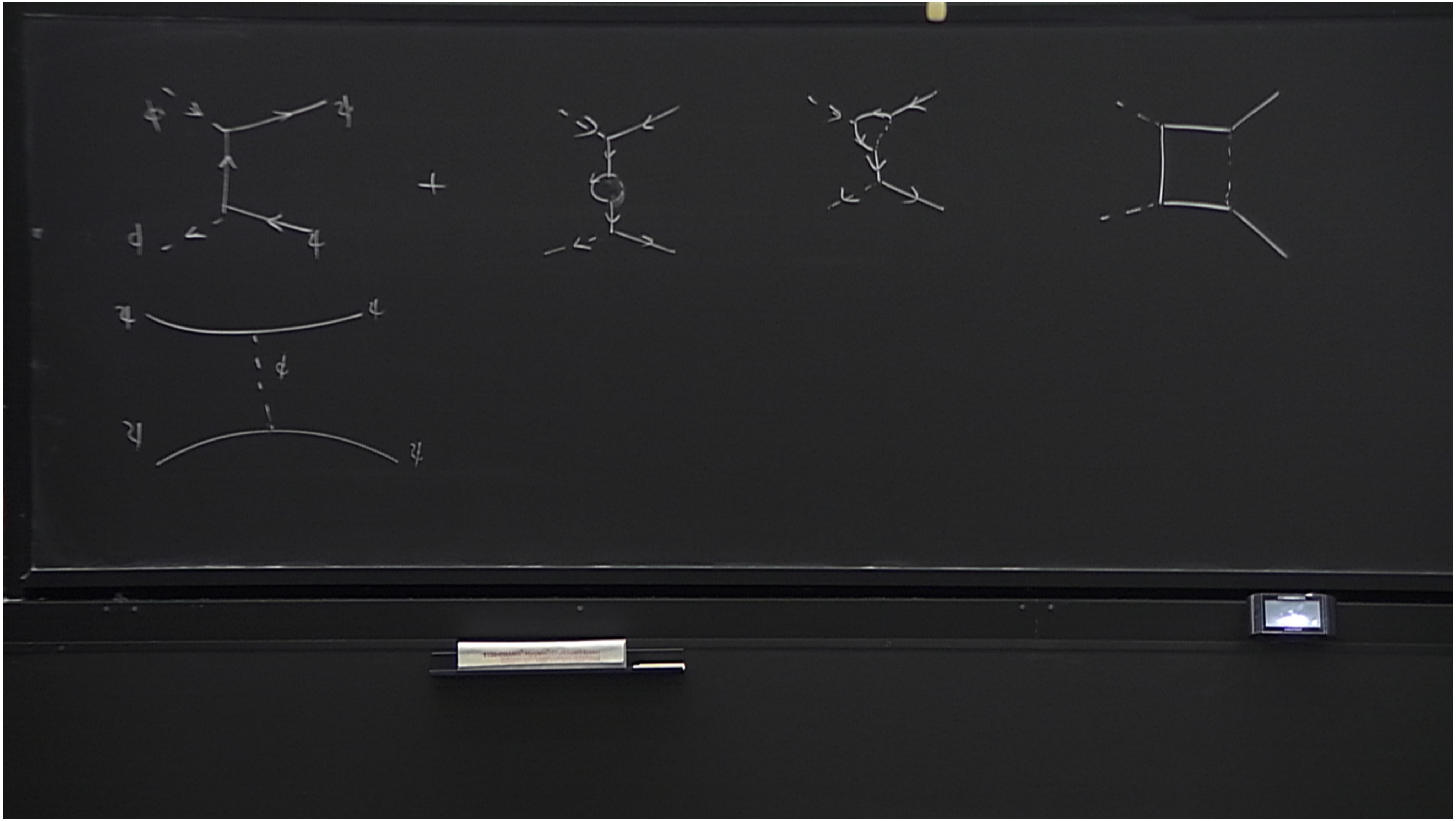

$\phi^* \phi \mapsto \phi^* \phi$
$\phi \to e^{i\theta} \phi$
$\phi^* \to e^{-i\theta} \phi^*$
$\phi \phi \mapsto e^{2i\theta} \phi\phi$
$m^2 \phi^2 + h.c.$
$\phi \, \psi^\alpha \partial_\mu \psi^{+\dot\beta} \, \sigma_{\alpha\dot\beta}{}^\mu$
$\epsilon_{\alpha\beta}$
$\sigma_{\alpha\dot\beta}{}^\mu$

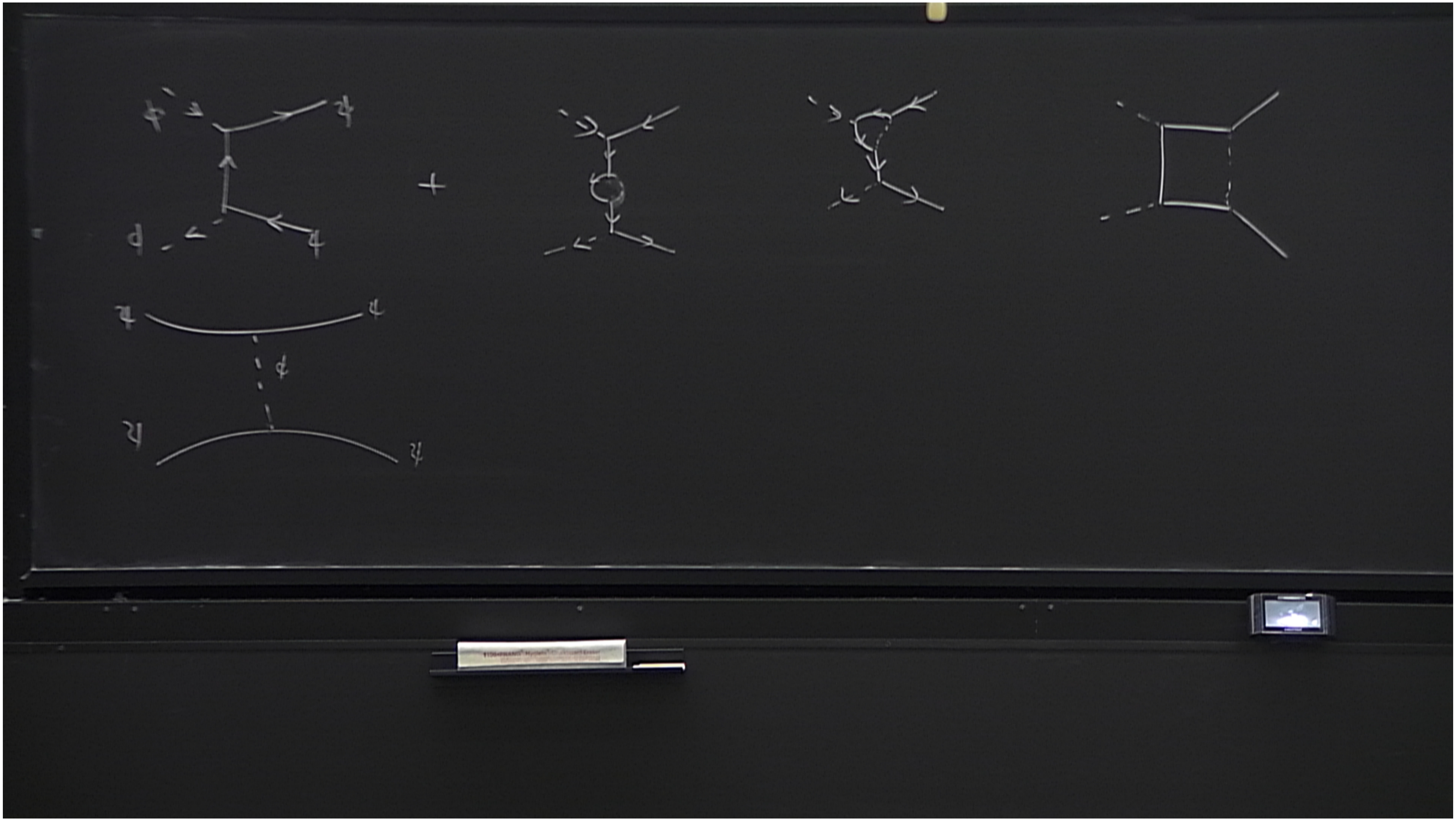


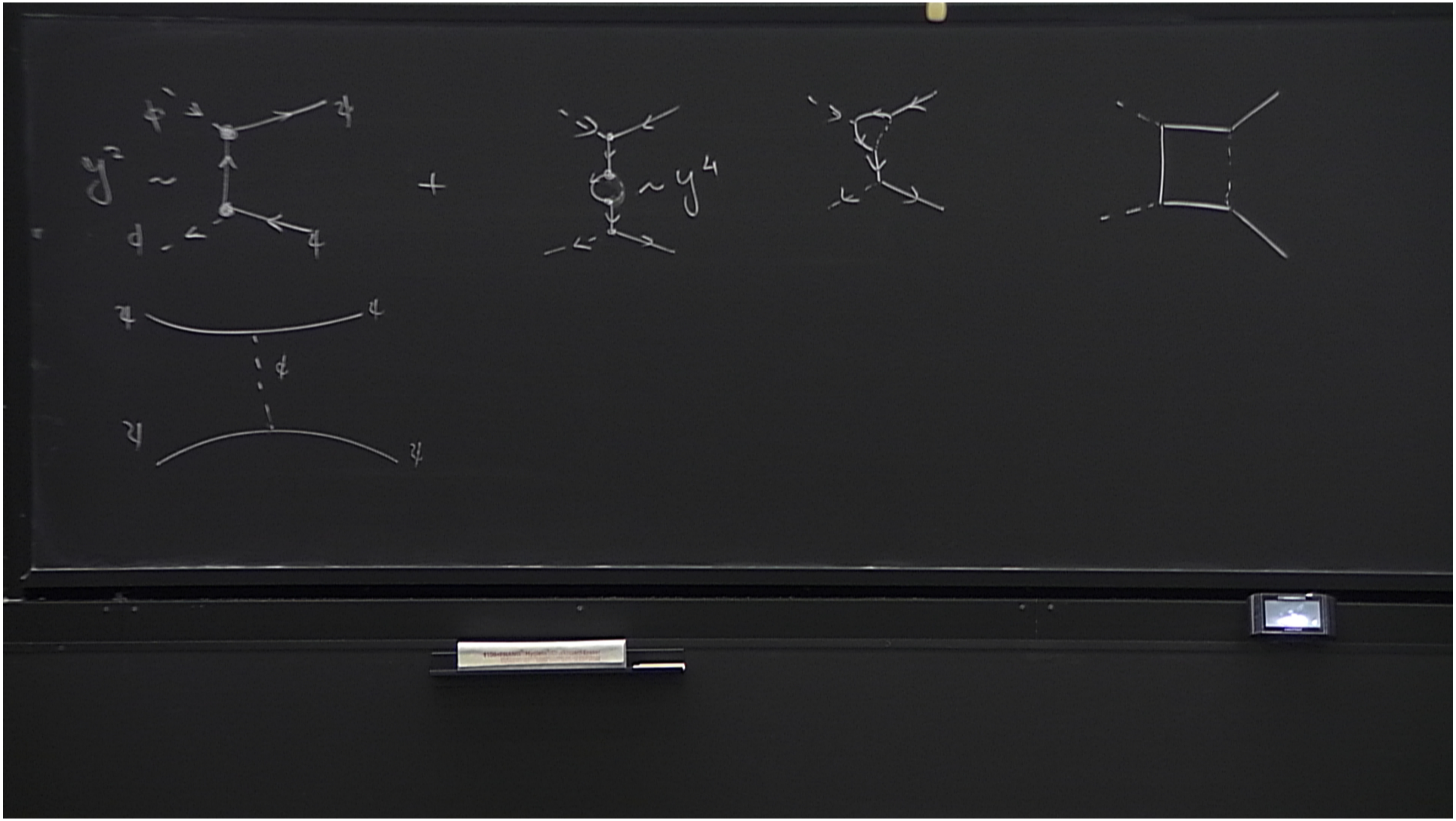


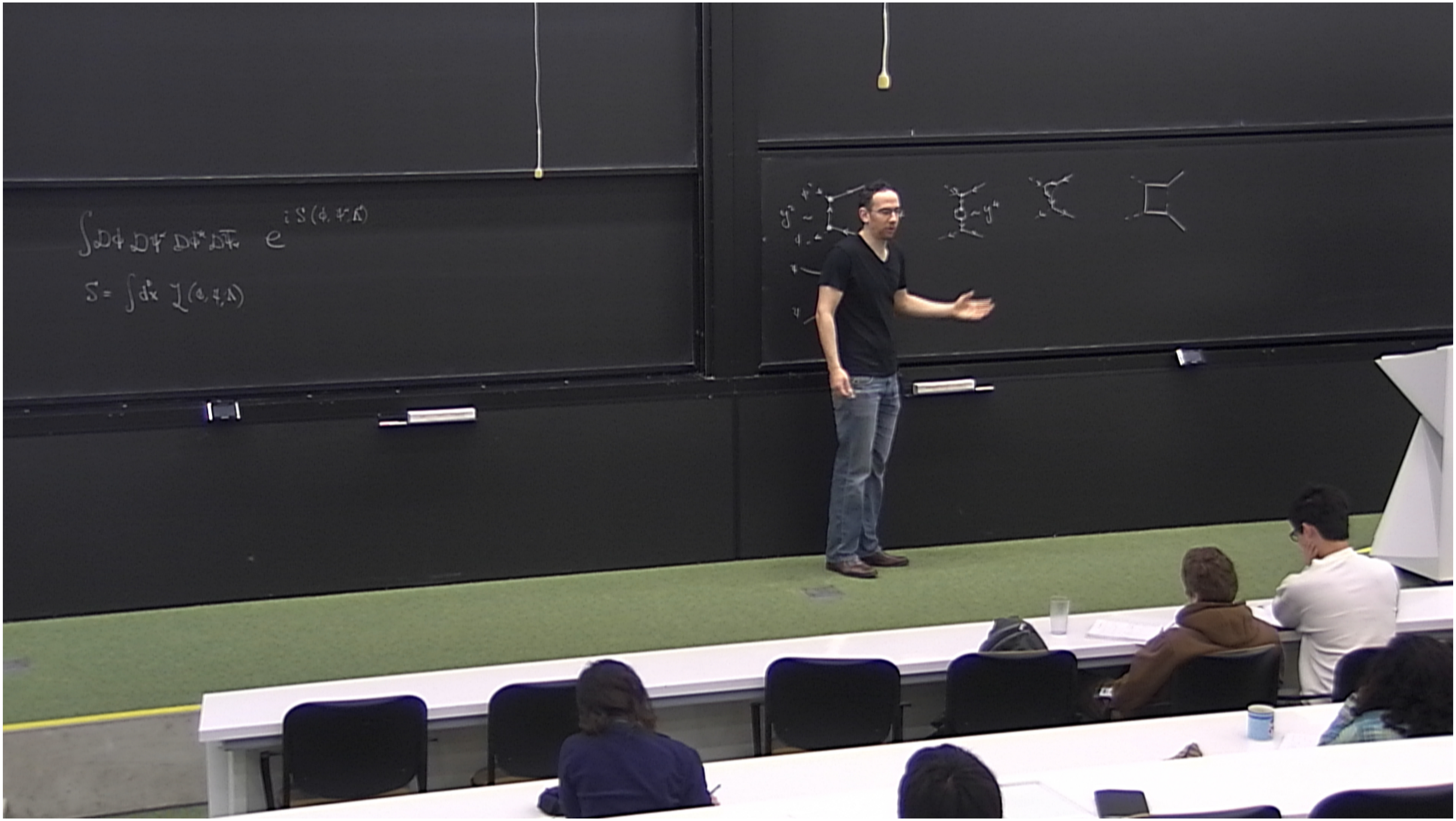


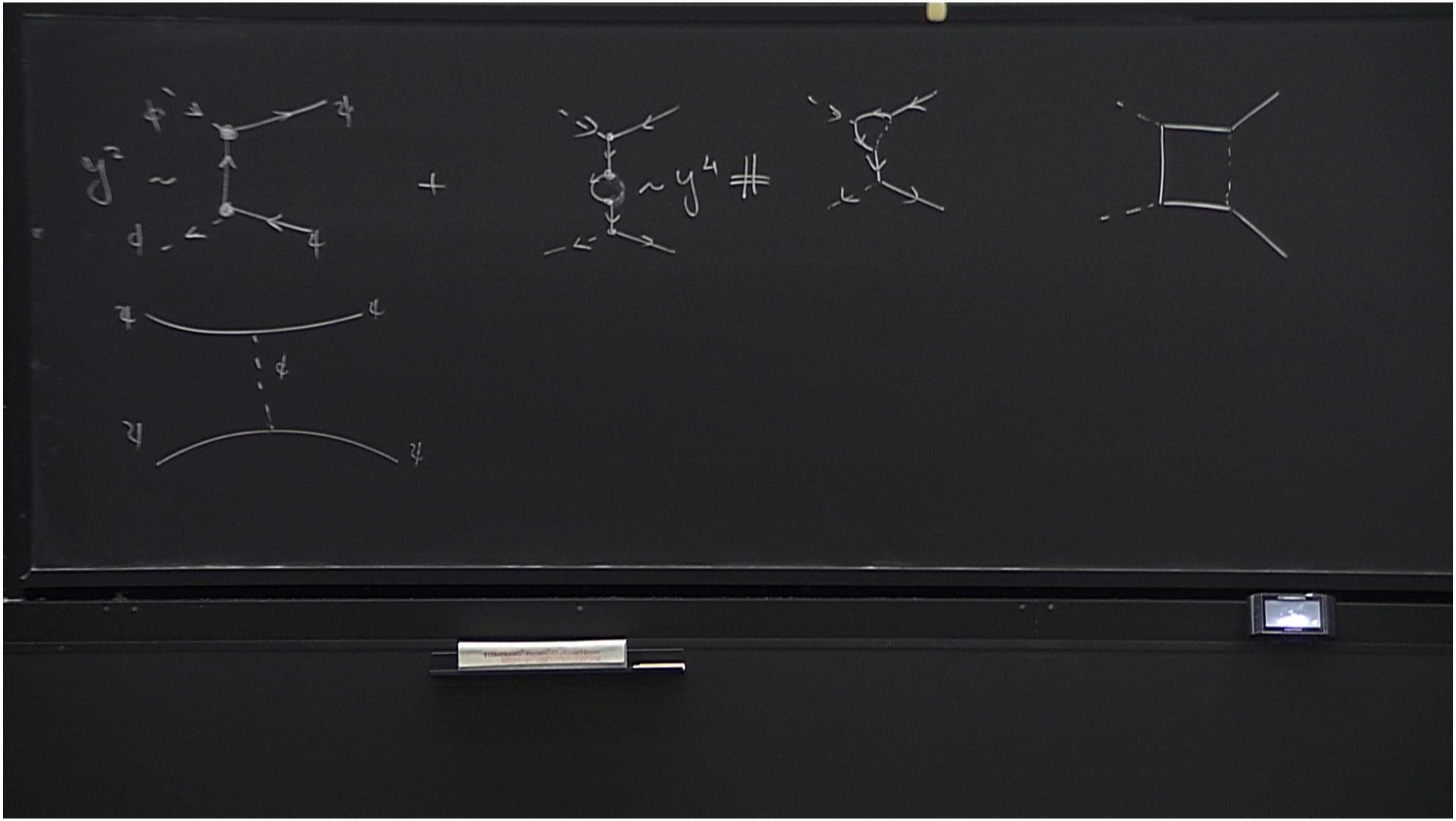


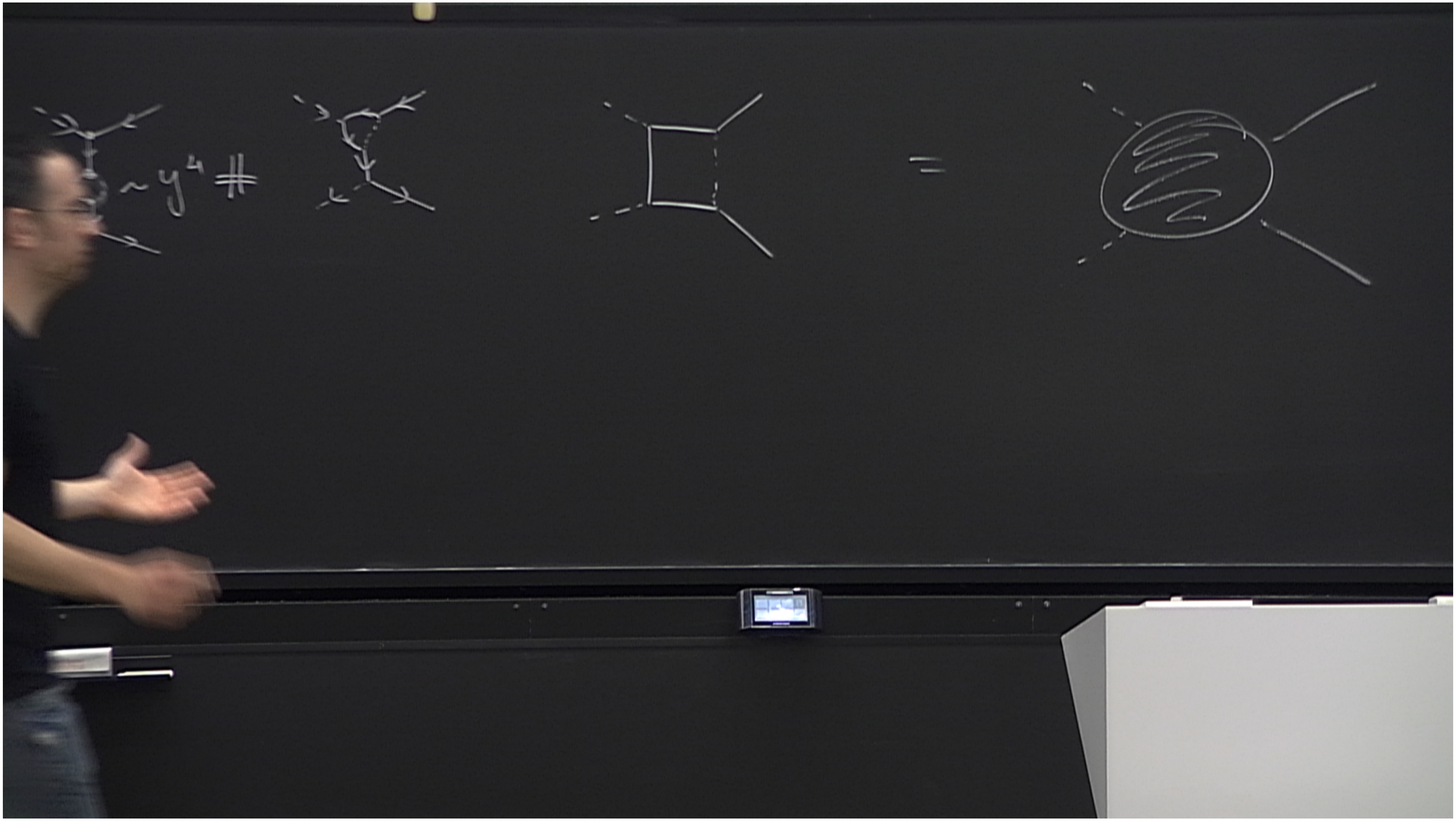


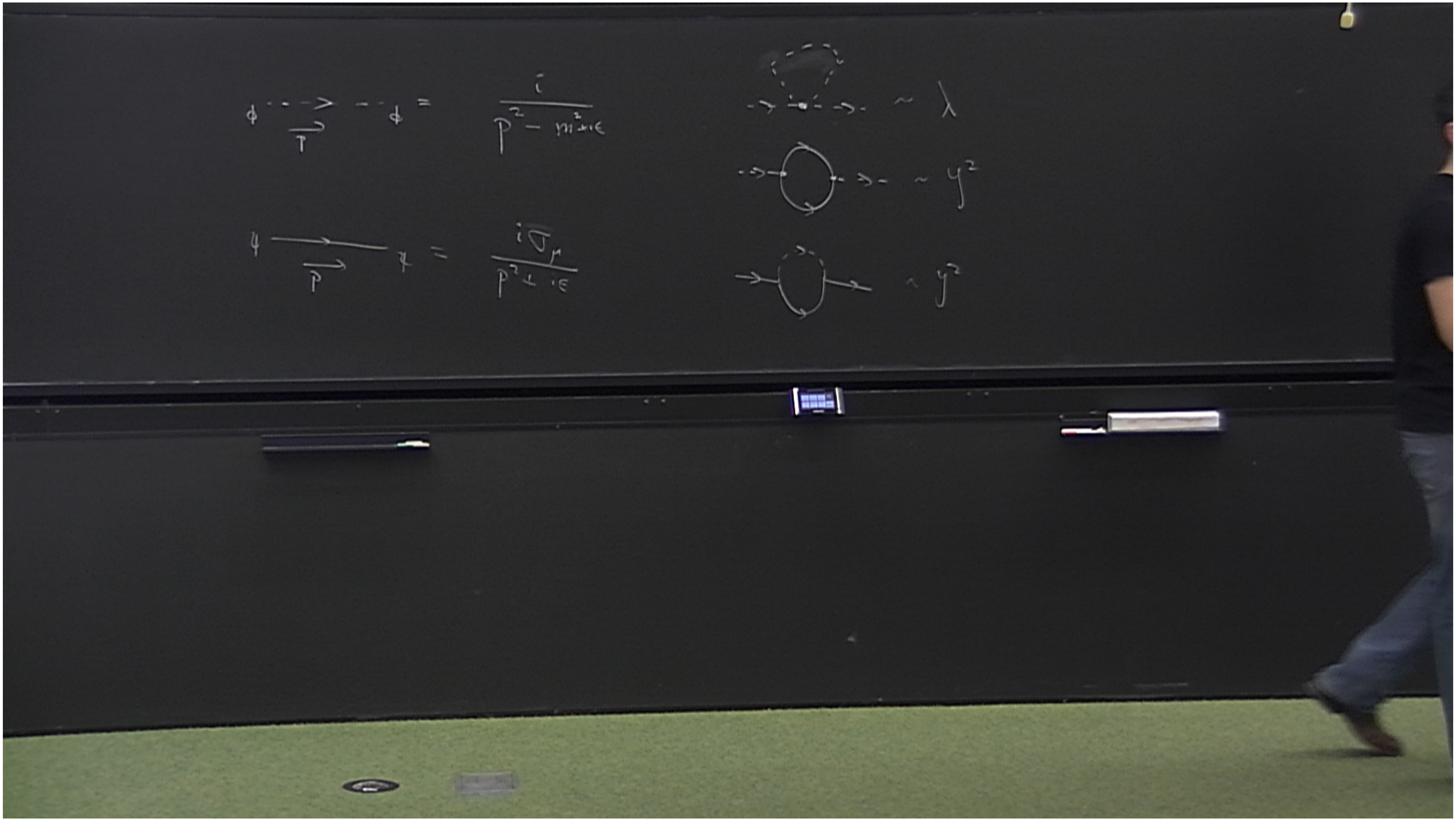



$y^2 \sim$
+
$\sim y^4$




y^2 ~
+
~ y^4


~y⁴ #
=


$\frac{i}{p^2 - m^2 + i\epsilon}$
$\frac{i\bar{\sigma}_\mu}{p^2 + i\epsilon}$
$\sim \lambda$
$\sim y^2$
$\sim y^2$