Title: Quantum Field Theory I - Lecture 221107

Speakers:

Collection: Quantum Field Theory I (2022/2023)

Date: November 07, 2022 - 10:45 AM

URL: https://pirsa.org/22110002

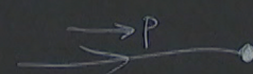
① $-e\cancel{\bar{\psi}}\gamma^{\mu}\cancel{\psi}\cancel{A_{\mu}}$

any vertex

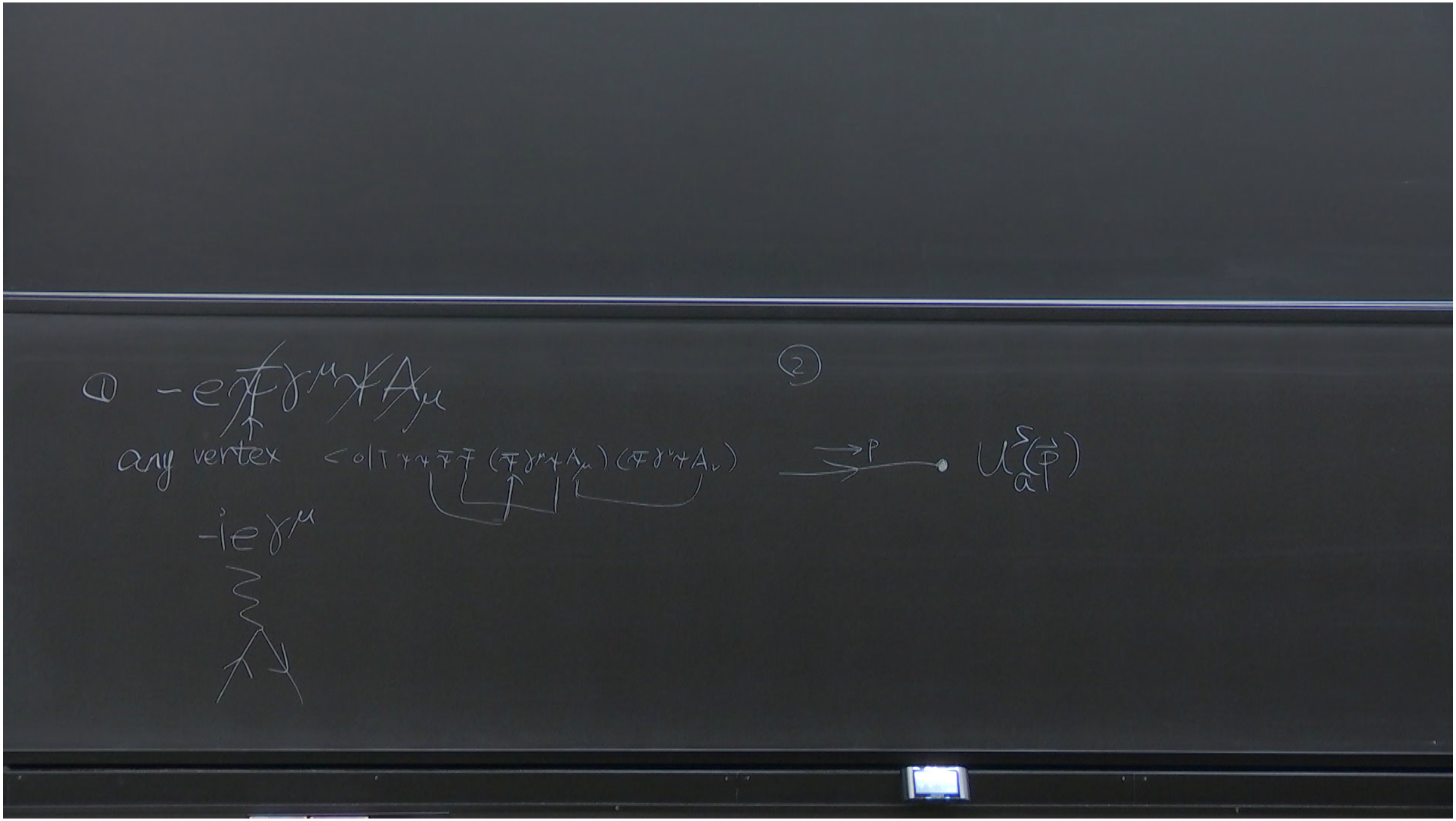
$-ie\gamma^{\mu}$

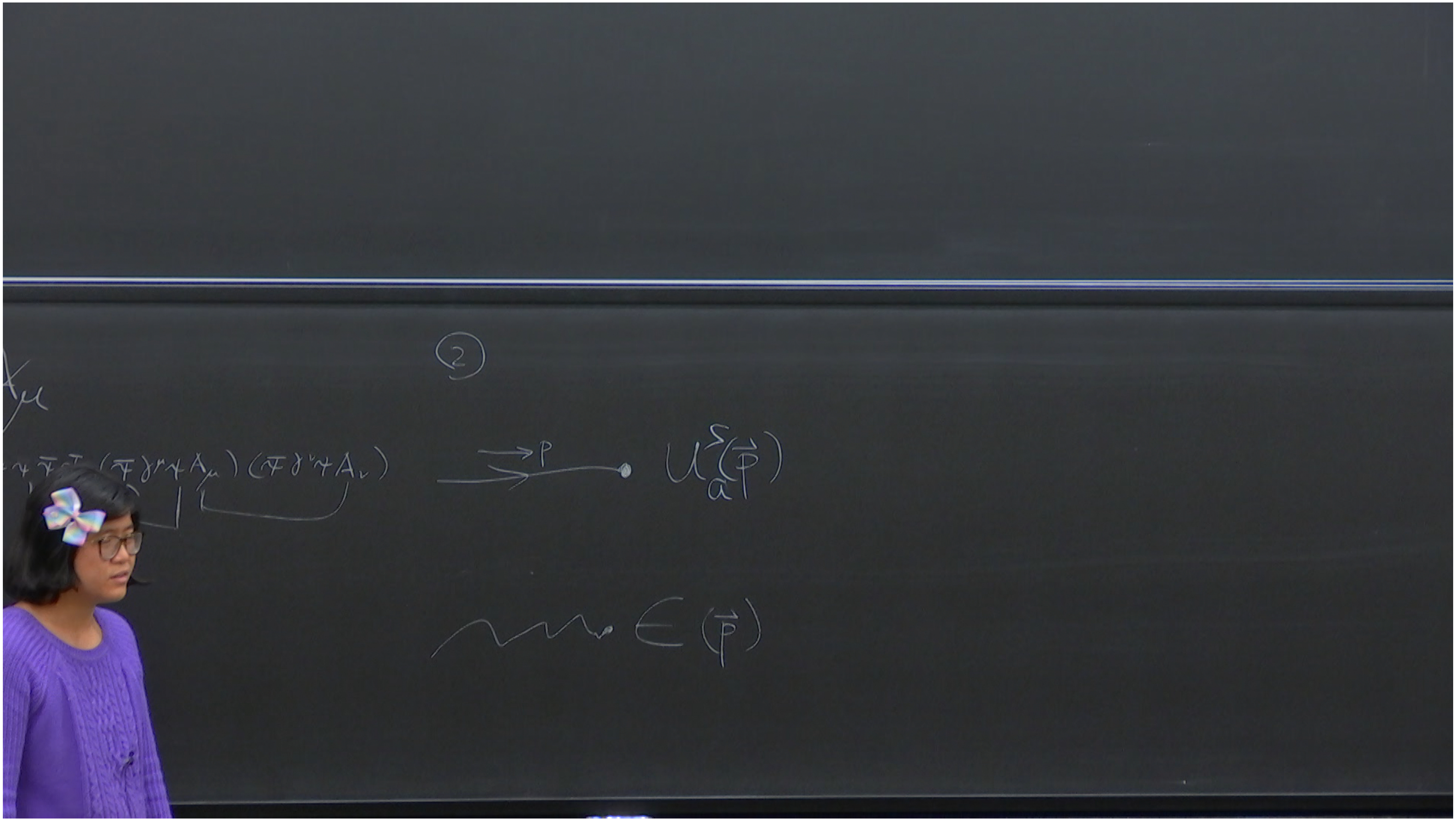
$\langle 0|T\,\psi\psi\bar{\psi}\bar{\psi}\,(\bar{\psi}\gamma^{\mu}\psi A_{\mu})(\bar{\psi}\gamma^{\nu}\psi A_{\nu})$

②



$u_a^s(\vec{p})$

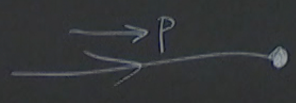

① $-e\bar{\psi}\gamma^\mu\psi A_\mu$
any vertex
$\langle 0|T\,\psi\psi\bar{\psi}\bar{\psi}\,(\bar{\psi}\gamma^\mu\psi A_\mu)(\bar{\psi}\gamma^\nu\psi A_\nu)$
$-ie\gamma^\mu$
②
p
$u^s_a(\vec{p})$



2
p
$u^s_a(\vec{p})$
$\epsilon(\vec{p})$

②

$\mp \gamma^\mu + A_\nu)$



$u_a^s(\vec{p})$

$\epsilon_\mu^\lambda(\vec{p})$ ← solution index

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} \qquad F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$\partial^\mu F_{\mu\nu} = 0$$

$\xrightarrow{p}$ $u_a^s(\vec{p})$

$\epsilon_\mu^{in}(\vec{p})$ ← solution index

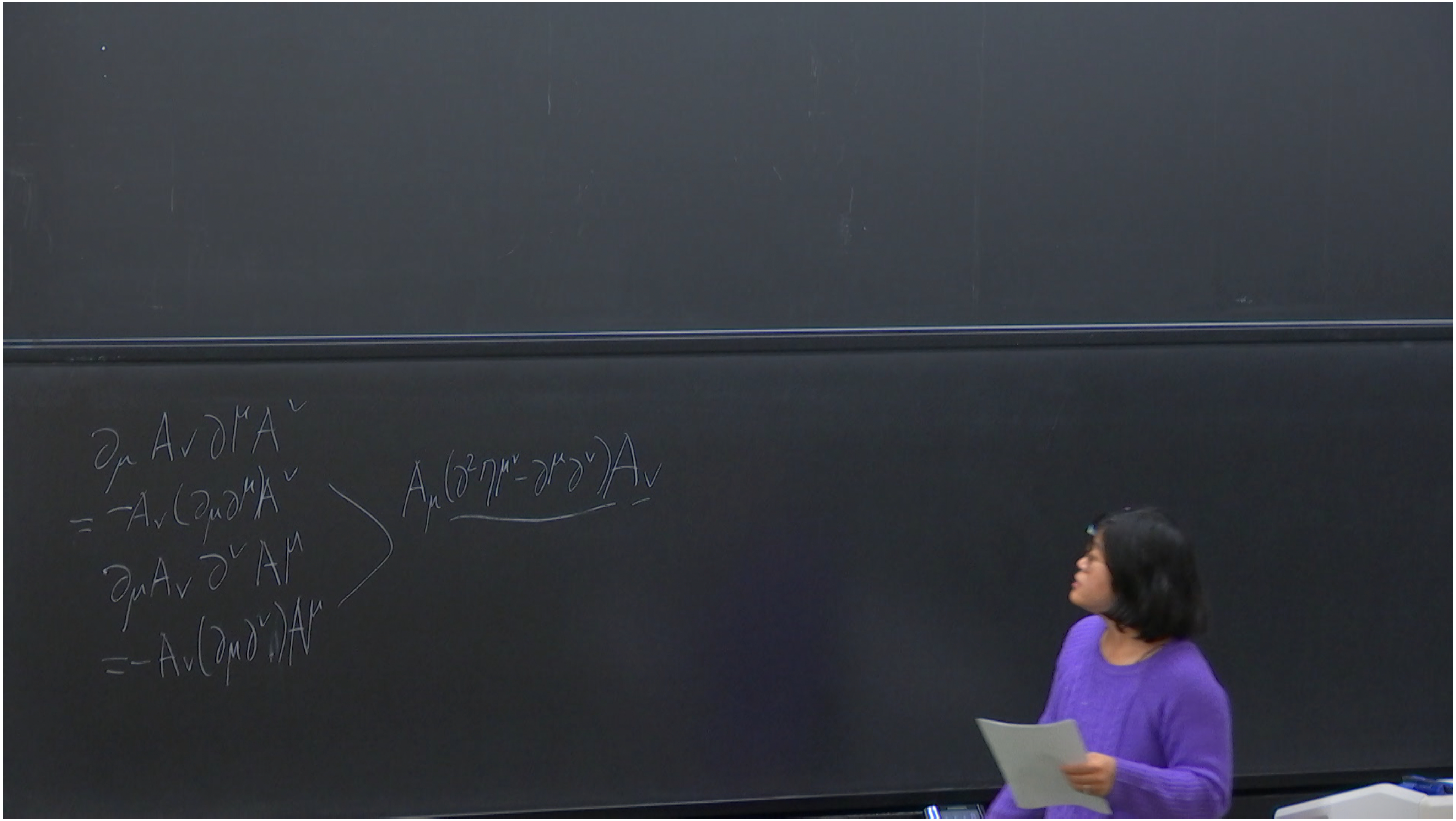
polarization index

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} \qquad F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$\partial^\mu F_{\mu\nu} = 0$$

$$\partial_\mu A^\mu = 0$$

$$\pi^0 = \frac{\partial \mathcal{L}}{\partial \dot{A}^0} =$$


$\partial_\mu A_\nu \partial^\mu A^\nu$
$= -A_\nu (\partial_\mu \partial^\mu) A^\nu$
$\partial_\mu A_\nu \partial^\nu A^\mu$
$= -A_\nu (\partial_\mu \partial^\nu) A^\mu$
$A_\mu (\partial^2 \eta^{\mu\nu} - \partial^\mu \partial^\nu) A_\nu$

$$\partial_\mu A_\nu \partial^\mu A^\nu$$

$$= -A_\nu (\partial_\mu \partial^\mu) A^\nu$$

$$\partial_\mu A_\nu \partial^\nu A^\mu$$

$$= -A_\nu (\partial_\mu \partial^\nu) A^\mu$$

$$A_\mu \underline{(\partial^2 \eta^{\mu\nu} - \partial^\mu \partial^\nu)} A_\nu$$

$$(k^2 \eta^{\mu\nu} - k^\mu k^\nu) k_\nu = 0$$

not invertible

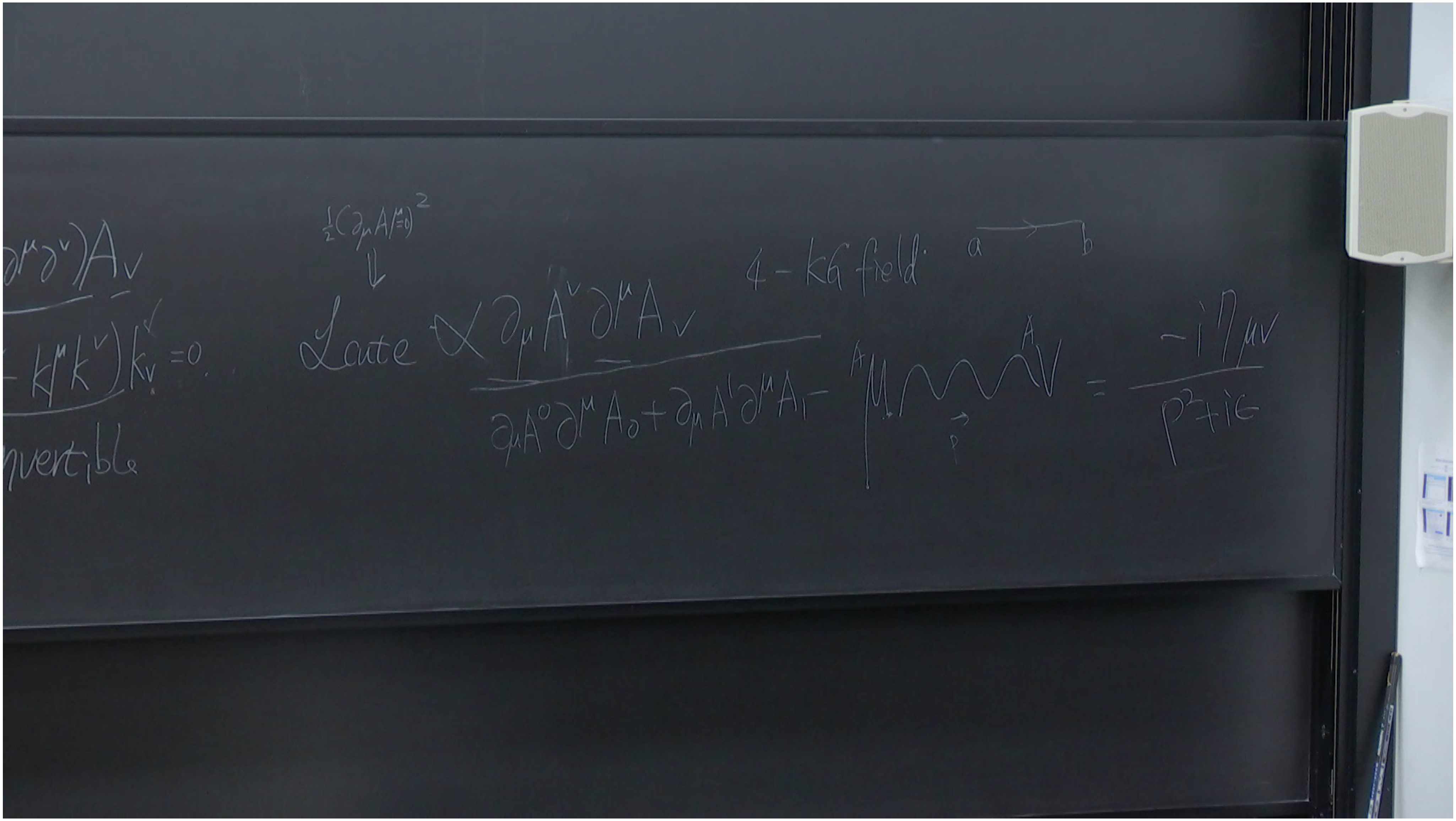
$$\partial_\mu A_\nu \partial^\mu A^\nu$$
$$= -A_\nu (\partial_\mu \partial^\mu) A^\nu$$
$$\partial_\mu A_\nu \partial^\nu A^\mu$$
$$= -A_\nu (\partial_\mu \partial^\nu) A^\mu$$

$$A_\mu (\partial^2 \eta^{\mu\nu} - \partial^\mu \partial^\nu) A_\nu$$

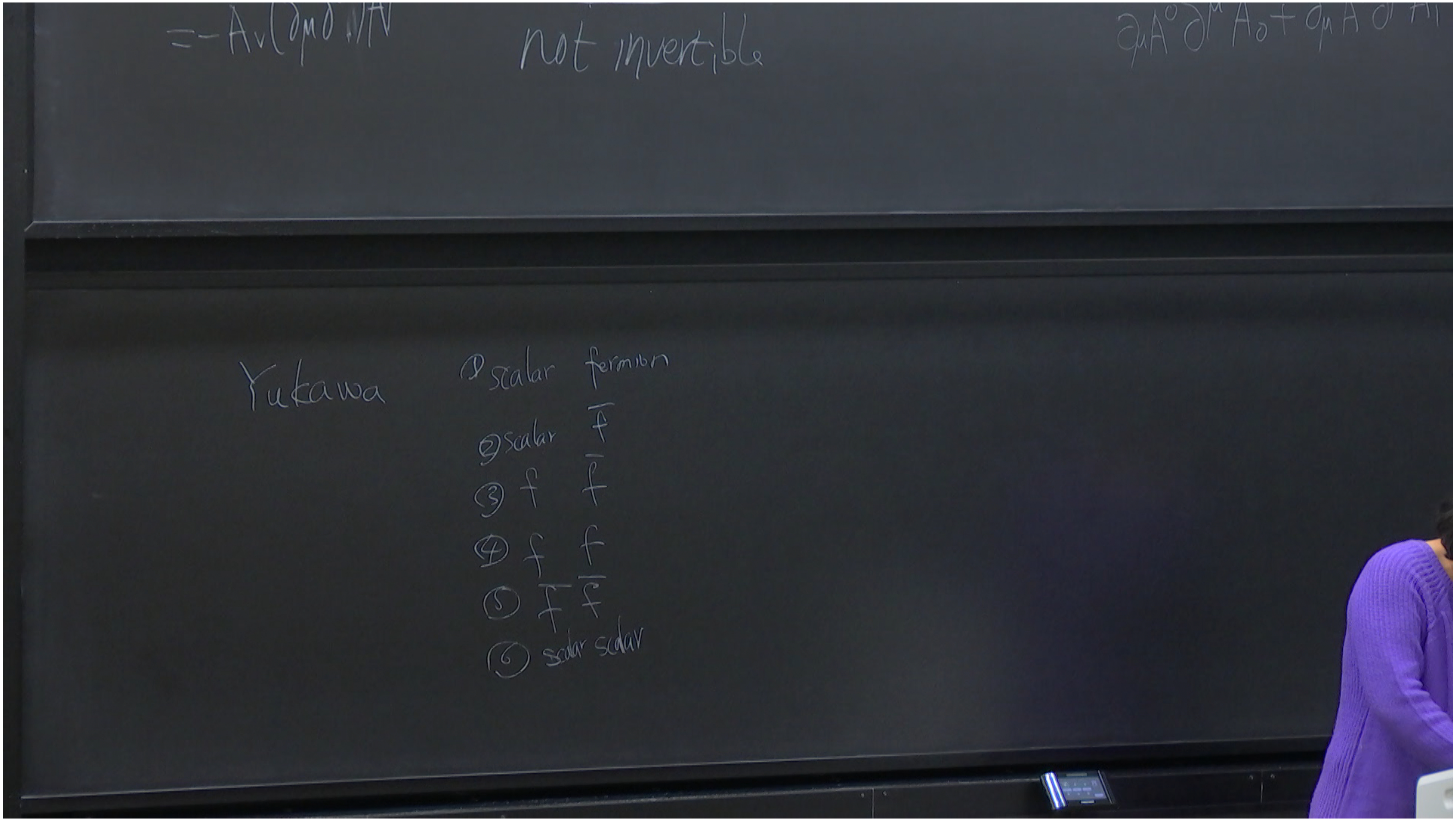
$$(k^2 \eta^{\mu\nu} - k^\mu k^\nu) k_\nu = 0$$

not invertible

$$\tfrac{1}{2}(\partial_\mu A^\mu = 0)^2$$
$$\downarrow$$
$$\mathcal{L}ate \propto \partial_\mu A^\nu \partial^\mu A_\nu$$



$\partial^\mu \partial^\nu) A_\nu$
$k^\mu k^\nu) k_\nu = 0$
invertible
$\frac{1}{2}(\partial_\mu A^\mu = 0)^2$
$\mathcal{L}_{ate} \propto \partial_\mu A^\nu \partial^\mu A_\nu$
$\partial_\mu A^0 \partial^\mu A_0 + \partial_\mu A^1 \partial^\mu A_1 -$
4 − KG field
a
b
$= \frac{-i\eta_{\mu\nu}}{p^2 + i\epsilon}$


not invertible
Yukawa
① scalar fermion
② scalar $\bar{f}$
③ f $\bar{f}$
④ f f
⑤ $\bar{f}$ $\bar{f}$
⑥ scalar scalar

$= -A_\nu (\partial_\mu \partial^\mu) A^\nu$

not invertible

$\partial_\mu A^0 \partial^\mu A_0 + \partial_\mu A \partial^\mu A$

Yukawa

leading order

① draw diagrams.

pass the left

② pick one diagram

write $\mathcal{M}$ pass the left

to hide

③ stare → process

initial = final scattering

① scalar fermion

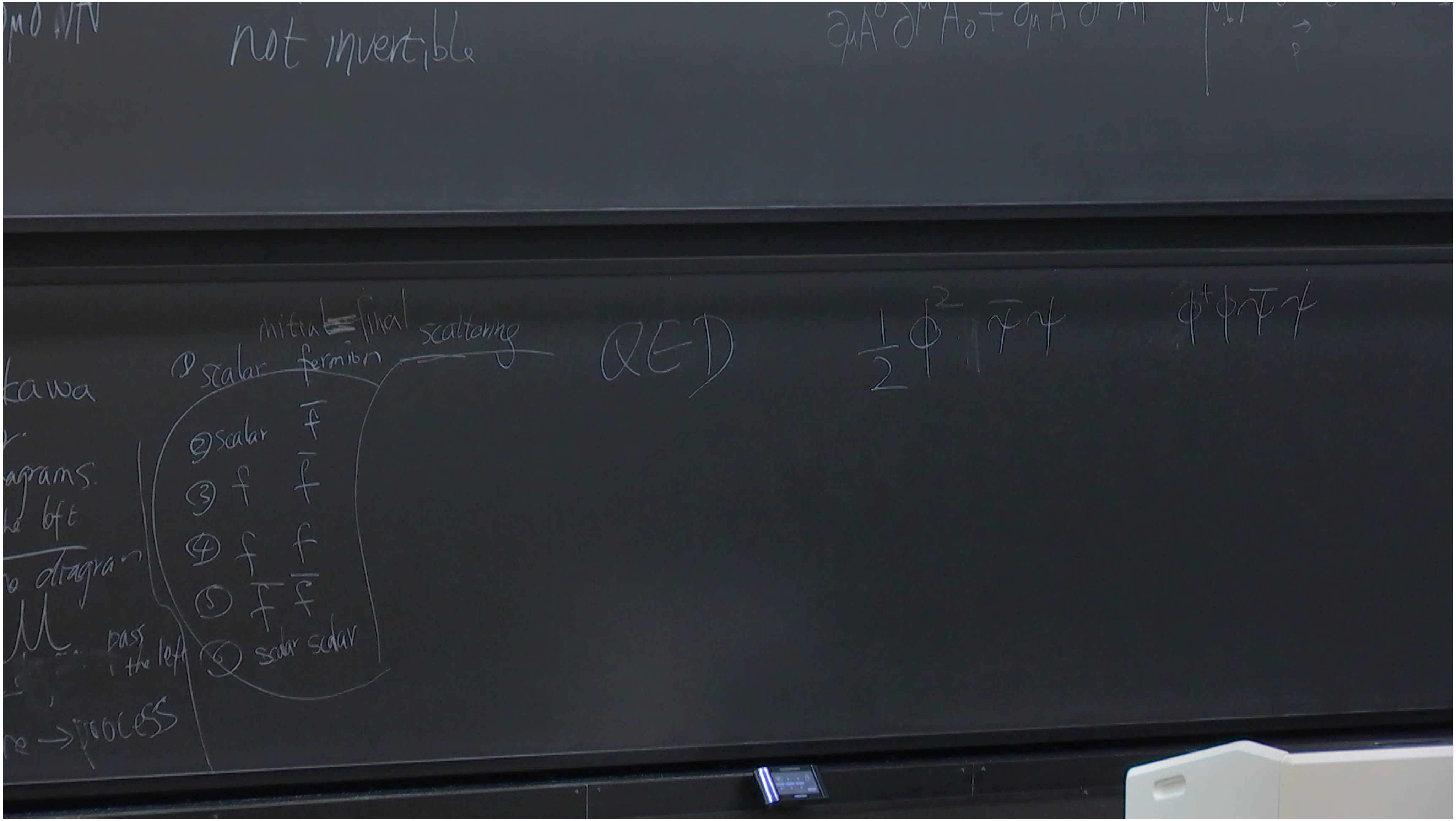
② scalar $\bar{f}$

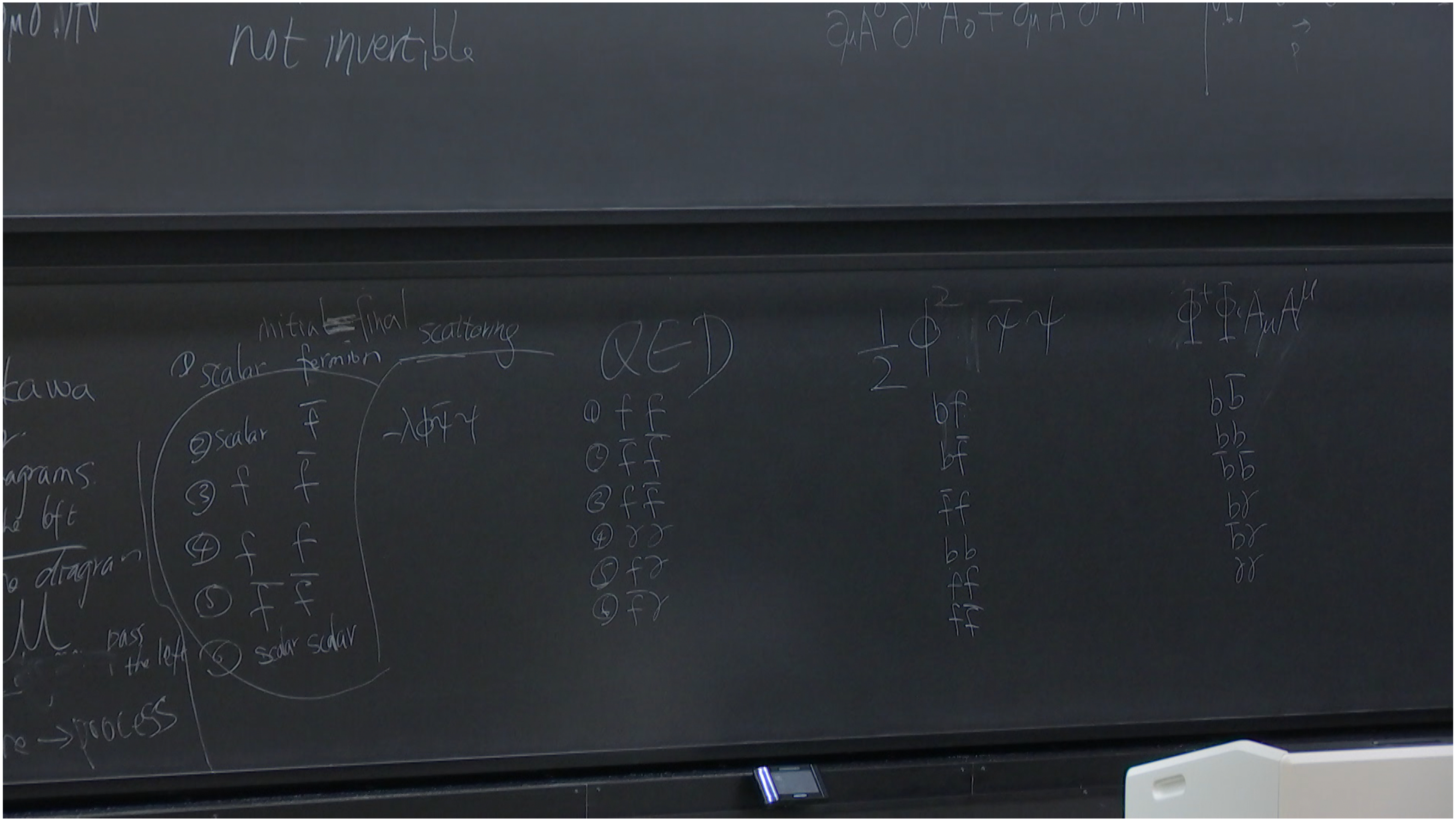
③ f $\bar{f}$

④ f f

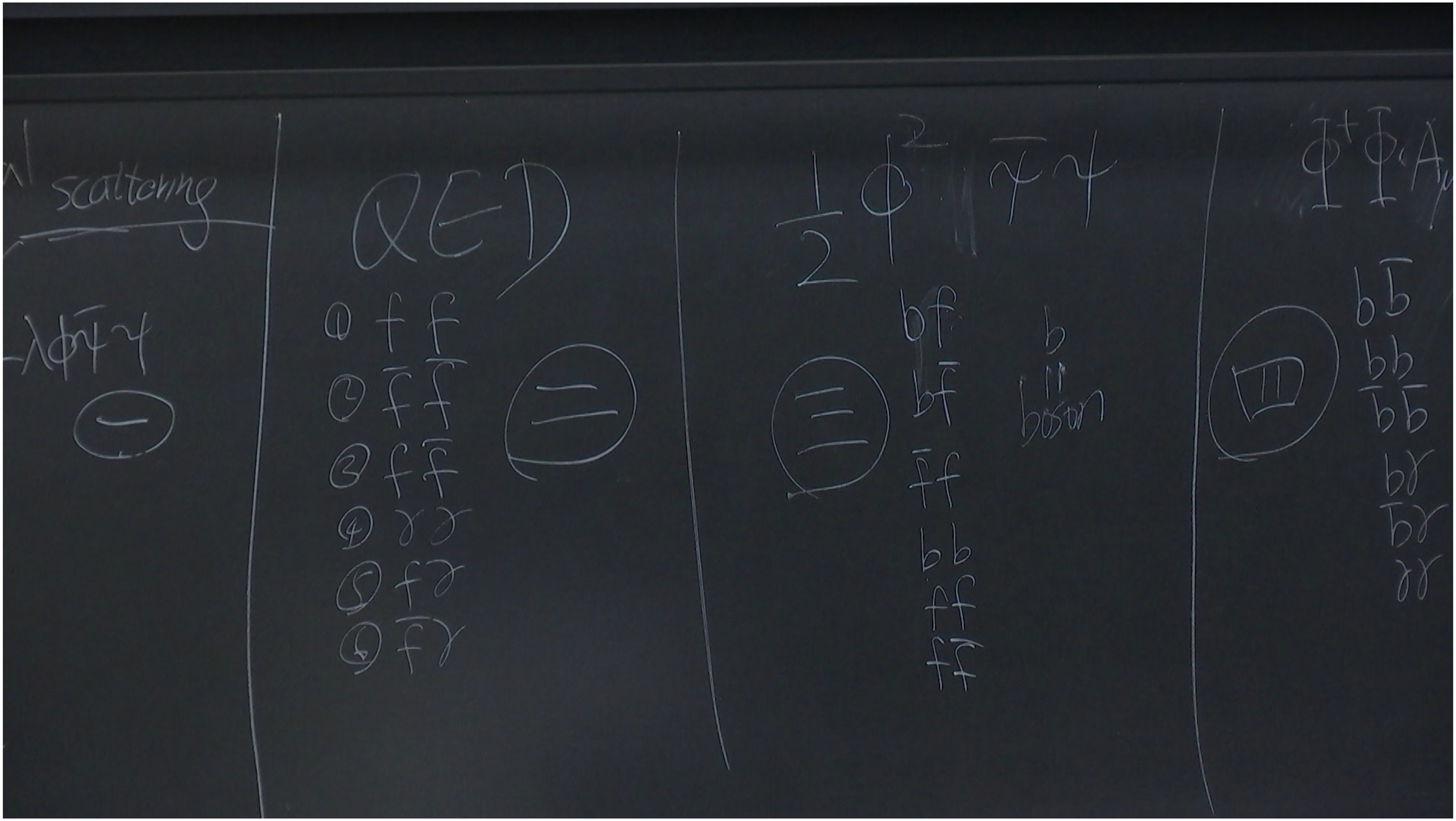
⑤ $\bar{f}$ $\bar{f}$

⑥ scalar scalar


not invertible
initial final
scattering
① scalar fermion
② scalar f
③ f f
④ f f
⑤ f f
⑥ scalar scalar
QED
$\frac{1}{2}\phi^2\bar{\psi}\psi$
$\phi^\dagger\phi\bar{\psi}\psi$
process



not invertible
initial final
scattering
scalar fermion
scalar
QED
process


scattering
QED
boson