



HF-P CLASS 09 (20)
 LA-COMSA 2022
 JAL 2022/03/31
ELECTRODYNAMICS

$$\frac{1}{4} F_{\mu\nu} F^{\mu\nu} - A_{\mu} J^{\mu} \quad \leftarrow$$

$$A \rightarrow \hat{A} = A - \partial \chi$$

$$\hat{F} = F$$

$$\begin{aligned}
 \hat{A}_{\mu} J^{\mu} &= (A_{\mu} - \partial_{\mu} \chi) J^{\mu} \\
 &= \underline{A_{\mu} J^{\mu}} - \partial_{\mu} \chi J^{\mu} \quad \begin{matrix} 0 \\ \parallel \end{matrix} \\
 &= A_{\mu} J^{\mu} - \partial_{\mu} (\chi J^{\mu}) + \chi \underline{\partial_{\mu} J^{\mu}}
 \end{aligned}$$

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

$$\tilde{A}^\mu = A^\mu - \partial^\mu \chi$$

$$\partial_\mu \tilde{A}^\mu = \cancel{\partial_\mu A^\mu} - \partial_\mu \partial^\mu \chi$$

$$= -\square \chi = 0$$

$$\bar{\psi} (i\gamma^\mu (\partial_\mu + iq\tilde{A}_\mu)) \psi$$

$$\psi = e^{iq\chi} \psi$$

$$\bar{\psi} = e^{-iq\chi} \bar{\psi}$$

$$e^{-iq\chi} \bar{\psi} (i\gamma^\mu (\partial_\mu + iq\tilde{A})) e^{iq\chi} \psi$$

$$e^{-iq\chi} \bar{\psi} i\gamma^\mu \partial_\mu (e^{iq\chi} \psi) +$$

$$+ \cancel{e^{-i\cancel{g}x}} \bar{\psi} i\gamma^m i\cancel{g} \hat{A}_m \cancel{e^{+i\cancel{g}x}} \psi$$

$$\cancel{e^{-i\cancel{g}x}} \bar{\psi} i\gamma^m \left(i\cancel{g} \partial_\mu x \cancel{e^{+i\cancel{g}x}} \psi + \right.$$

$$\left. \cancel{e^{+i\cancel{g}x}} \partial_\mu \psi \right) - \bar{\psi} \gamma^m i\cancel{g} \hat{A}_m \psi$$

$$= \bar{\psi} \left(-\gamma^m \cancel{g} \partial_\mu x + i\gamma^m \partial_\mu \overbrace{\cancel{g} \hat{A}_m} \right)$$

$$= \bar{\psi} \left(\overbrace{-\cancel{g} \gamma^m \partial_\mu x} + i\gamma^m \partial_\mu - \overbrace{\cancel{g} \gamma^m \hat{A}_m} \right) \psi$$

$$\underbrace{+\cancel{g} \gamma^m \partial_\mu x} \psi = i \bar{\psi} \gamma^m \underline{D}_\mu \psi$$