$$\gamma^\mu(\partial_\mu - ieA_\mu)\psi + im\psi = 0 \qquad \hat{C} = i\gamma^2\psi^*$$

First conjugate and multiply $i\gamma^2$

$$\Rightarrow i\gamma^2(\gamma^\mu)^*(\partial_\mu + ieA_\mu)\psi - imi\gamma^2\psi = 0$$

$$\underbrace{i\gamma^2(\gamma^\mu)^*(\partial_\mu + ieA_\mu)\psi}\; - im\underbrace{i\gamma^2\psi^*}_{\psi'} = 0$$

$$= i\gamma^2(\gamma^0)^*(\partial_0 + ieA_0) + i\gamma^2(\gamma^1)(\partial_1 + ieA_1) + i\gamma^2(\gamma^2)^* \dots + i\gamma^2(\gamma^3)^* \dots$$

$$= i\gamma^2\gamma^0 \dots + i\gamma^2\gamma^1 \dots - i\gamma^2\gamma^2 \dots + i\gamma^2\gamma^3 \dots$$

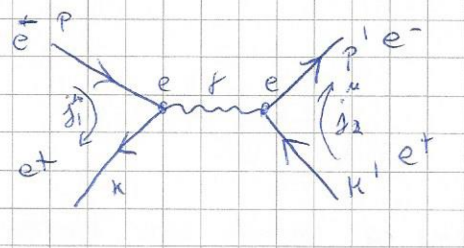
$$= -i\gamma^0\gamma^2 \dots - i\gamma^1\gamma^2 \dots - i\gamma^2\gamma^2 \dots - i\gamma^3\gamma^2 \dots$$

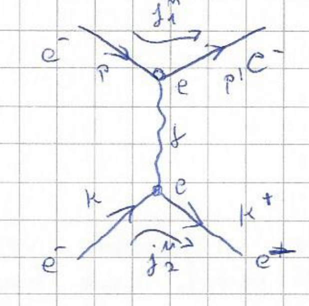
$$= \gamma^\mu(\partial_\mu + ieA_\mu)(-i)\gamma^2 \Rightarrow -\gamma^\mu(\partial_\mu + ieA_\mu)\underbrace{i\gamma^2\psi}_{\psi'} - im\psi' = 0$$

$$\Rightarrow \gamma^\mu(\partial_\mu + ieA_\mu)\psi' + im\psi' = 0$$

We see the same equation but for $\psi \to \psi'$ and $e \to -e$
Same particle mass, but different charge $\to$ Antiparticle

3.4 $\quad e^-(p) + e^+(k) \to e^-(p') + e^+(k')$ $\quad$ | $\quad e^-(p) + e^-(k) \to e^-(p') + e^-(k')$




b) $\mathcal{M}_{fi} = \int j^\mu_{(1)} \frac{-g_{\mu\nu}}{q^2} j^\nu_{(2)}\, d^4x$

$j_1^\mu = \bar{v}(k)[ie\gamma^\mu]u(p) \qquad \gamma: \frac{-ig_{\mu\nu}}{q^2}$

$j_2^\mu = \bar{u}(p')[ie\gamma^\mu]v(k') \qquad e: e$

$$\Rightarrow \mathcal{M}_{fi} = \bar{v}(k)[ie\gamma^\mu]u(p)\frac{-ig_{\mu\nu}}{q^2}\bar{u}(p')[ie\gamma^\mu]v(k')$$

| | | |
|---|---|---|
| Incoming particle | : | $u(p)$ |
| Outgoing Particle | : | $\bar{u}(p)$ |
| Incoming Antiparticle | : | $v(p)$ |
| Outgoing Antiparticle | : | $\bar{v}(p)$ |

$\mathcal{M}_{fi} = \int j^\mu_{(1)} \frac{-g_{\mu\nu}}{q^2} j_2^\mu\, d^4x$

$j_1^\mu = \bar{u}(p')\gamma^\mu u(p)\cdot e \qquad \gamma: \frac{-ig_{\mu\nu}}{q^2}$

$j_2^\mu = \bar{u}(k')\gamma^\mu u(k)\, e \qquad e: e$

$$\Rightarrow \mathcal{M}_{fi} = \bar{u}_e(p')\gamma^\mu u_e(p)\frac{-ig_{\mu\nu}e^2}{q^2}\bar{u}_e(k')\gamma^\nu u_e(k)$$