

$$(p_1 - p_3)^2 = p_1^2 + p_3^2 - 2p_1 \cdot p_3$$

$$= 2m_e^2 - 2(E_1 E_3 - \vec{p}_1 \cdot \vec{p}_3)$$

$$\text{for } E \gg m_{e,\mu}: E = |\vec{p}|$$

$$\text{also, in cm frame: } \vec{p}_1 = -\vec{p}_2$$

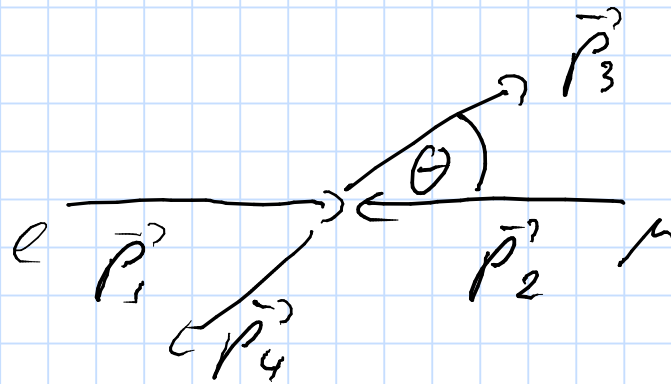
$$p_3 = -p_4$$

$$|\vec{p}_1| = |\vec{p}_3|$$

Then:

$$(p_1 - p_3)^2 = 2m_e^2 - 2E_1^2(1 - \cos\theta)$$

$$\approx 2E_1^2(1 - \cos\theta) = \frac{1}{2}s(1 - \cos\theta)$$



$$M_{fi} = \frac{8\pi\alpha}{s(1 - \cos\theta)}$$