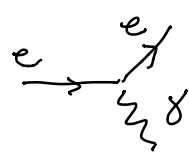
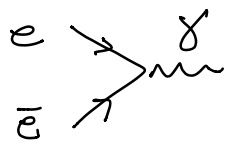


annihilation

"pair production"

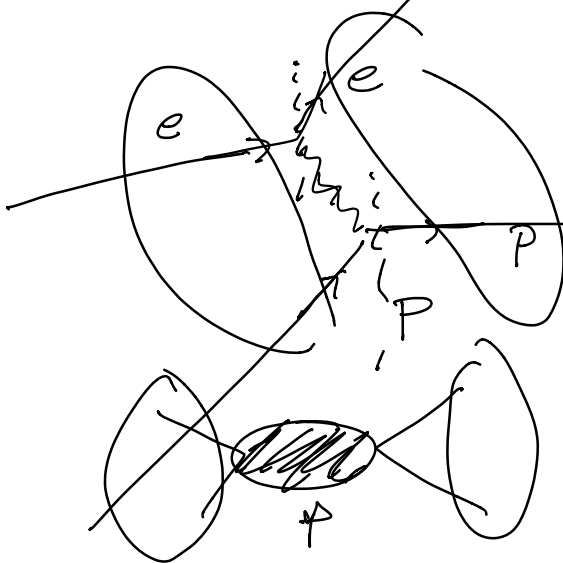
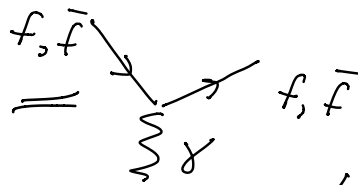
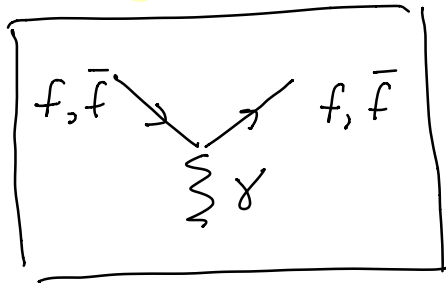
"radiation"





"pair annihilation"

PRIMITIVE DIAGRAM

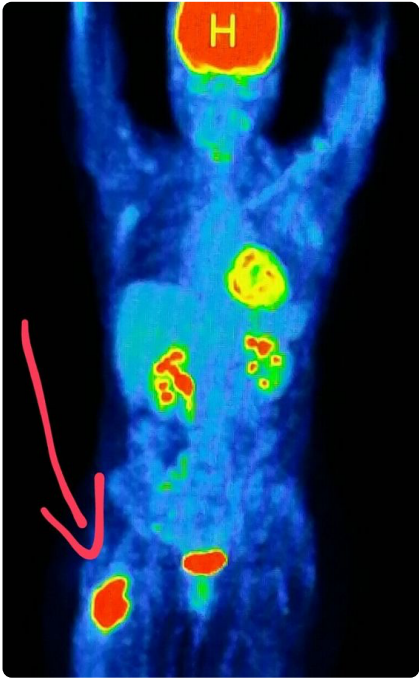


$e + e \rightarrow e + e$

$e + p \rightarrow e + p$

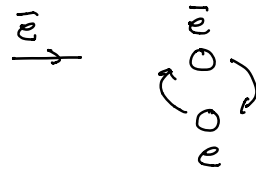
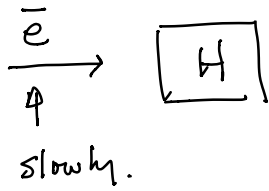


PET

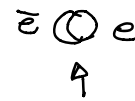
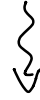


scan of a tumor in the leg...

11 $66 \times 10 \text{ J s}$

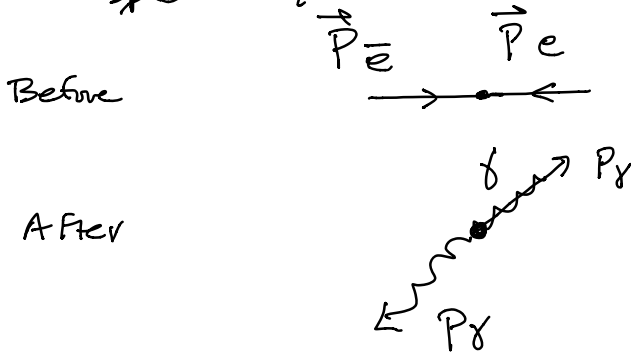


positronium



Momentum

space diagram.



$$\bar{e} + e \rightarrow \gamma + \gamma$$

$$E_0 = E$$

$$m_e c^2 + m_{\bar{e}} c^2 = 2E_\gamma$$

$$m_e = m_{\bar{e}}$$

$$2m_e c^2 = 2E_\gamma$$

$$E = hf$$

$$E_\gamma = m_e c^2$$

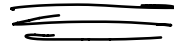
$$E_e = m_e c^2 = (0.511 \text{ MeV}/c^2) \left(\frac{10^6 \text{ eV}}{\text{MeV}} \right) \left(1.6 \times 10^{-19} \frac{\text{J}}{\text{eV}} \right)$$

$$E_e = 8 \times 10^{-14} \text{ J}$$

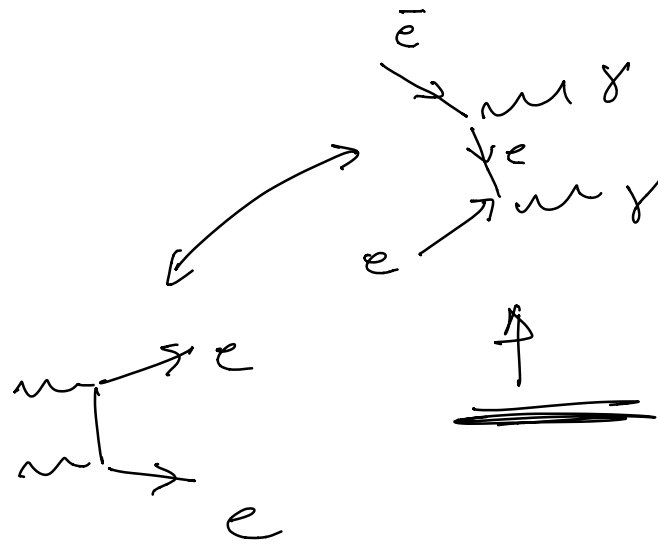
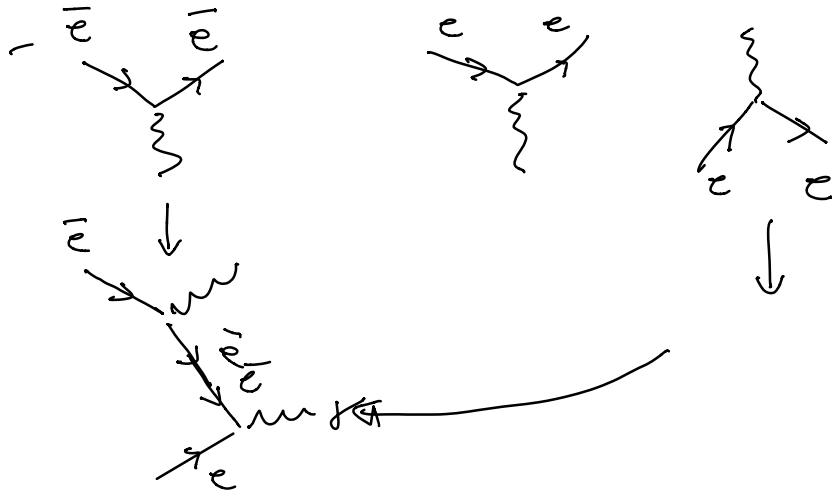
$$E_\gamma = hf$$

$$f = \frac{E_\gamma}{h} = \frac{8 \times 10^{-14} \text{ J}}{6.6 \times 10^{-34} \text{ J s}}$$

$$f = 1.2 \times 10^{20} \frac{1}{s} \quad (\text{Hz})$$



$$e + e^- \rightarrow 2\gamma$$



$$\gamma + e \rightarrow \gamma' + e'$$