Units of h : $[h] = \dfrac{[E]}{[\nu]}$

$= \dfrac{M L^2 T^{-2}}{T^{-1}} = M L^2 T^{-1}$

$\Rightarrow \boxed{[h] = M L^2 T^{-1}}$ $\quad [h] = [L]$

Angular momentum

Spin ½ particle $\equiv |\vec{S}| = \frac{1}{2}\hbar$

$[h] = [r][p]$

$m \quad \frac{h}{p} \rightarrow \frac{h}{mc} \equiv$ Compton Wavelength of a particle

($\neq$ de Broglie Wavelength)

We can associate a length with it.

There exist a particle. What will be the wavelength of the photon that has the energy equal to the ~~rest~~ rest energy of the particle

$$mc^2 = E_r = h\nu = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{mc^2}$$

$$\Rightarrow \boxed{\lambda = \frac{h}{mc}}$$

Let us calculate the Compton wavelength of an e^-.

$$\lambda_c(e^-) = \frac{h}{mc} = \frac{2\pi\hbar c}{m_e c^2}$$

$$= \frac{2\pi\,(197.33\ \text{MeV fm})}{0.511\ \text{MeV}}$$

$$= 2426\ \text{fm} = \boxed{2.426\ \text{pm}}$$

"photon" quanta for energy,

also has momentum

$$\boxed{E^2 - p^2c^2 = m^2c^4}$$

$$E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\left(E = \frac{1}{2}mv^2, \quad p = m\vec{v} \Rightarrow E = \frac{p^2}{2m} \right)$$

photons: $M_\gamma = 0$ $\quad \boxed{E_\gamma = pc}$

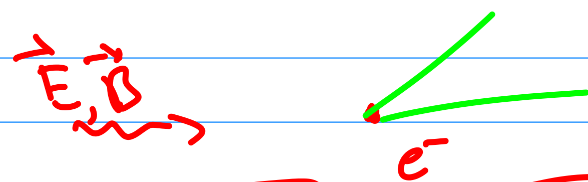
$$p_\gamma = \frac{E_\gamma}{c} = \frac{h\nu}{c} = \frac{h}{\lambda}$$

$$\boxed{p_\gamma = \frac{h}{\lambda}}$$

Compton Scattering

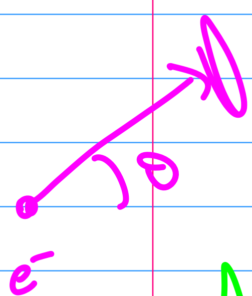
photon scattering on e^-s that are "virtually" free.

→ violation of classical Thompson Scattering



$$\boxed{\frac{d\sigma}{d\Omega} = \left(\frac{e^2}{mc^2}\right)^2 \frac{1}{2}\left(1+\cos^2\theta\right)}$$

units of Area

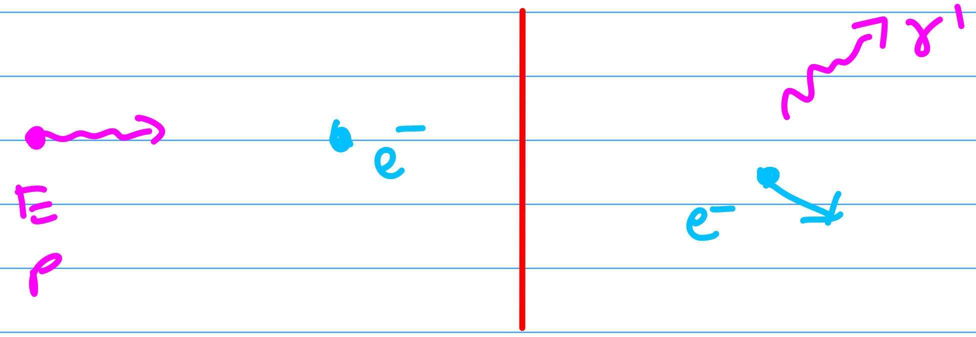


Area should be thought of as the area that captures (from the incoming beam) the energy that is being sent into this solid angle.

Outgoing wave has the same frequency as the original wave.

What did compton find?

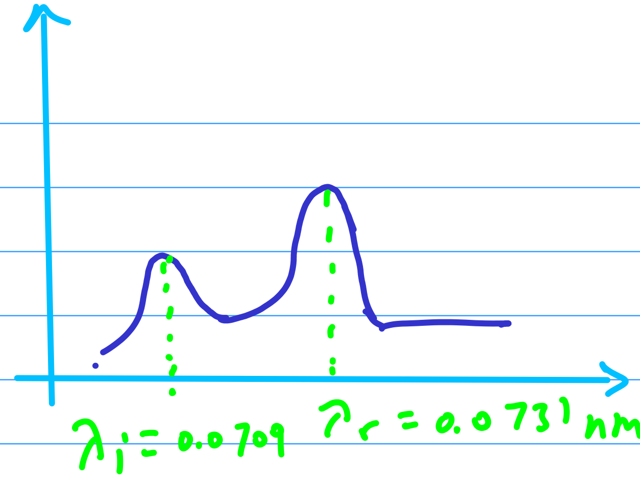
Treat the photon as a particle'



Here, photon loses energy : $\boxed{\lambda_f > \lambda_i}$

$$\boxed{\lambda_f = \lambda_i + \underbrace{\frac{h}{m_e c}}_{\ell_c(e^-)}(1-\cos\theta)}$$

Experiment



Molybdenum , $E_\gamma = 17.49$ keV

X-rays $\lambda = 0.00709$ nm

$$\Delta\lambda = 0.0731 - 0.0709 = 0.0022\ \text{nm}$$

$$\boxed{\Delta\lambda = 0.0022\ \text{nm} \approx \lambda_c(e^-) = 2.426\ \text{pm} = 0.0024\ \text{nm}}$$