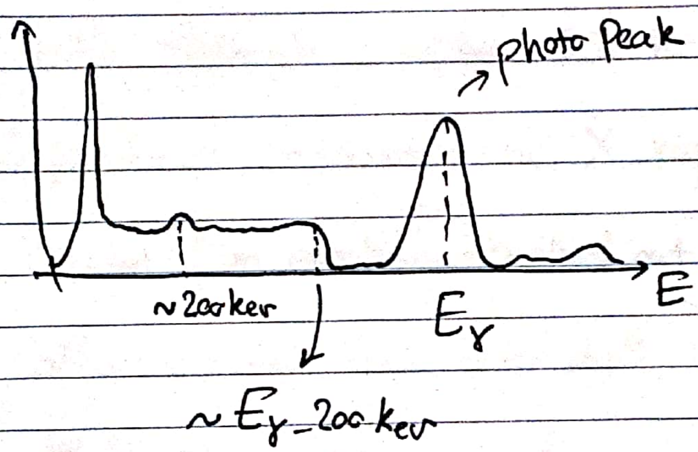
Morphology of γ ray spectrum:

There are two important factors in shaping the morphology of a ~~gamma~~ γ Ray spectroscopy.

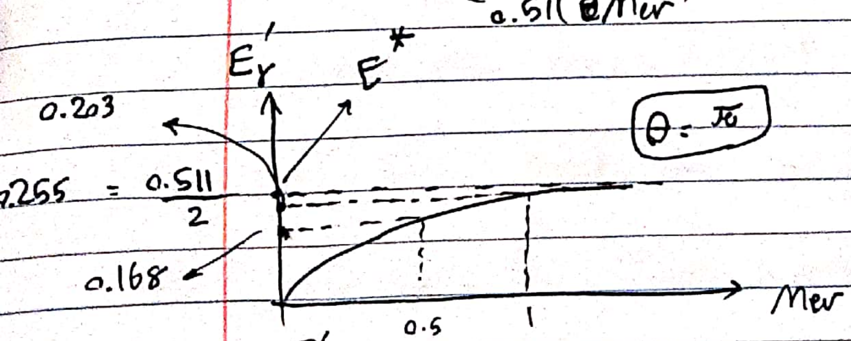
I) Compton Scattering II) Characteristic X Ray

a typical look of γ ray spectrum:



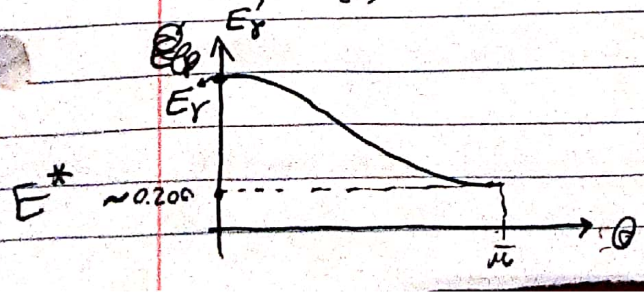
Here is the reason ~~being~~ behind it,

$$E'_\gamma = \frac{E_\gamma}{1 + \left(\frac{E_\gamma}{0.511\ MeV}\right)(1 - \cos\theta)} \Rightarrow \text{Compton Scattering}$$



So in the case of back scattering ($\theta = \pi$) E'_γ will be about 0.200 Mev

Very Important



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when high energy γ ray ~~causes~~ gets into the scintillator,

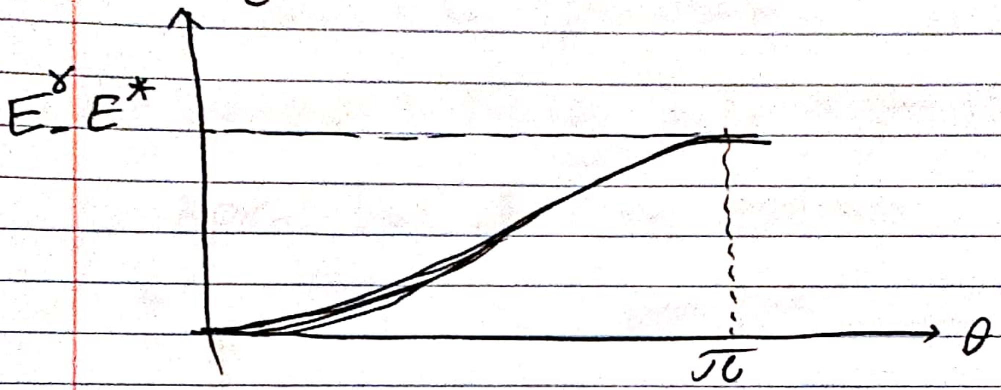
Fallowing interactions might happen
0) γ gets detected without other interactions
I) γ scatters through Compton Scattering and then gets detected
II) γ scatters through Compton Scattering and sescapes from the detector but its product (the "e" which interacted with through Compton Scattering)
III) produces characteristic X-ray from the scintilator crystal (an electrons gets knoked out from the inner shell and other electron from outer shell fills the vicinity and thus X ray gets produced.
IV) pair production (might result in a peak on 0.511 Mev or. it might lead to other energetic electrons through cascade interactions)

let's call $E_\gamma(\pi) \simeq 200\,\text{kev}$ E^*

⇒ "0" leads to main photopeak
⇒ "I" leads to a continium starting from about 0.200 Mev (E^*) ($\theta = \pi$ interaction) up to main photo peak ($\theta = 0$ interaction)
but since scattering cross section is higher for $\theta = \pi$ (klein-Nishina formula), so probability of $\theta = \pi$ interaction is enhanced (we can see peak

II) the amount of energy that $\bar{e}$ would gain through Compton scattering is $-(E'_\gamma - E) = -\Delta E$

$-\Delta E = E_e$



So $\bar{e}$ will have a spectrum of energy in Range

$[0, E^\gamma - E^*]$

⇒ "III" this leads to the characteristic X-ray