ABSORPTION COEFFICIENT OF β AND γ-RAYS

Purpose

To measure total absorption coefficient and half-value width of β and γ-rays in aluminum and lead.
To practice least squares fitting method.

Background

Gamma ray absorption

γ-rays interact primarily with electrons of the matter. However, a gamma ray traversing matter does not gradually lose energy along its path but rather it interacts strongly at one point.

The three principal ways γ-rays lose energy are:

1. Photo absorption: γ + atom → ion + ejected electron
2. Compton scattering: γ + atom → γ' + ion + ejected electron
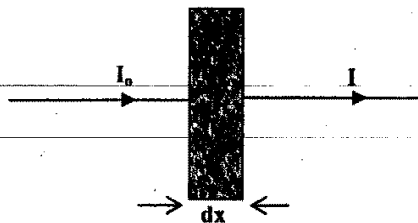3. Pair production: γ + atom → atom + e^+ + e^-

All of the gamma ray energy is transferred to the ejected electron in photo absorption. In Compton scattering some fraction of the incident gamma ray energy is transferred to the ejected electron. In pair production an electron-positron pair is produced.

At low gamma ray energies (≤ 1 MeV) photo absorption dominates. At intermediate energies (~ few MeV) Compton scattering dominates, and pair production is the dominant mechanism at high gamma ray energies.

Pair production will not occur if the gamma ray energy is less than 1.02 MeV. *Why?* (Think of conservation of energy, $e^{\pm}$ mass = 0.51 MeV).

If we have a beam of γ-rays of intensity I_0 incident on a material of thickness dx and an emerging beam of intensity I, the fraction of beam absorbed is proportional to dx.

$$\frac{dI}{I} = -\mu \, dx$$

Where $dI = I - I_0 < 0$ and μ is the total absorption coefficient of the material, which is the sum of three terms: $\mu = \mu_{photo} + \mu_{Compton} + \mu_{pair}$

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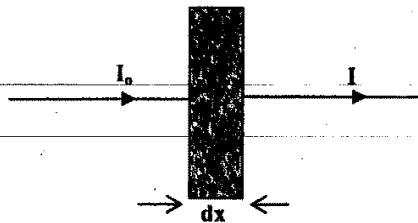3. Pair production: γ + atom → atom + e$^+$ + e$^-$

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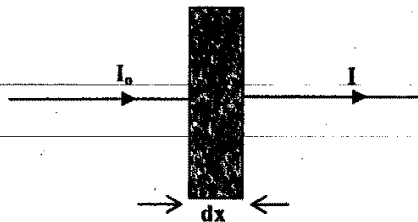3.   Pair production: γ + atom → atom + e$^+$ + e$^-$

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