(NU3-5) β/γ Efficiency of Geiger Counter

Aim of experiment

Determination of the GM counter efficiency for detecting β/γ .

Apparatus

GM tube counting station consists of GM counter – ^{60}Co radioactive source- source holder-stop watch, source cabinet made of thick lead.

Theory of experiment

In this experiment β's and γ's will be measured with one of these end-window Geiger tubes. In order to detect gammas with these detectors, a two step process must occur. The gamma must first make a photoelectric or Compton interaction in the gas. The recoil electrons from these interactions then produce the ion-pairs that cause the avalanche. In the experiment, it will be seen that the GM tube is quite efficient for detecting beta particles, and the voltage gradient across the tube will be set such that any of these ionizing particles that enter the sensitive region will cause an avalanche. The output pulse is usually greater than one volt. The GM tube does not differentiate between kinds of particles or energies; it simply gives an output pulse when any ionizing particle triggers this avalanche. These output pulses are then recorded in a scaler which acts as an electronic adding machine.

For a detector that records N_C out of incident N_i ionizing particles, its efficiency is given by the relation;

$$\varepsilon = \frac{N_c}{N_i} x100\%$$

For Co^{60}- source, it decays to excited states in Ni^{60}- daughter nucleus, through γ-emission. These excited states emit two successive γ-rays to its ground states. Then, each β-decay is followed by the emission of two γ-rays, as shown in figure 1.

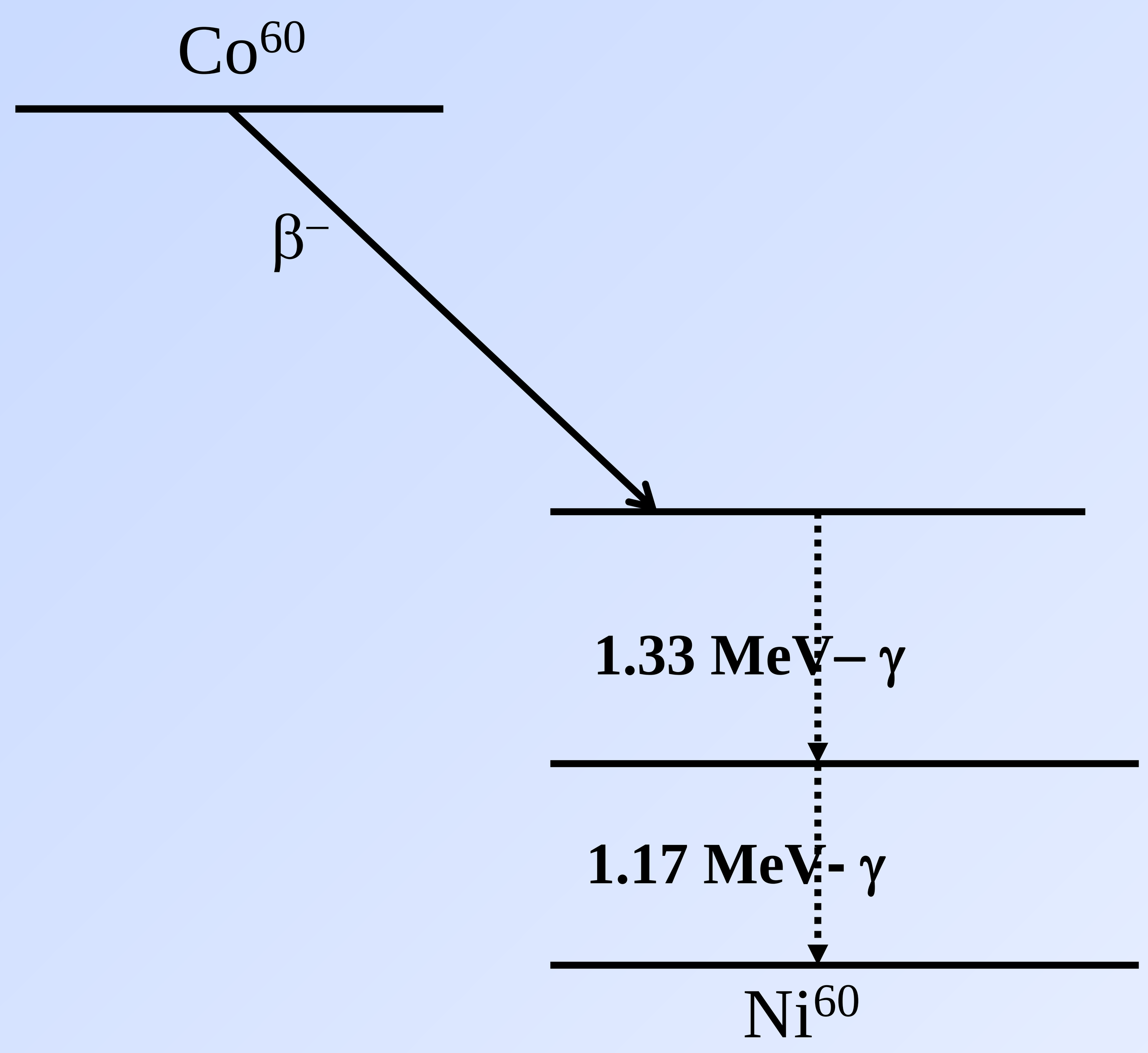


Figure 1. Decay scheme of Co^{60} to Ni^{60}

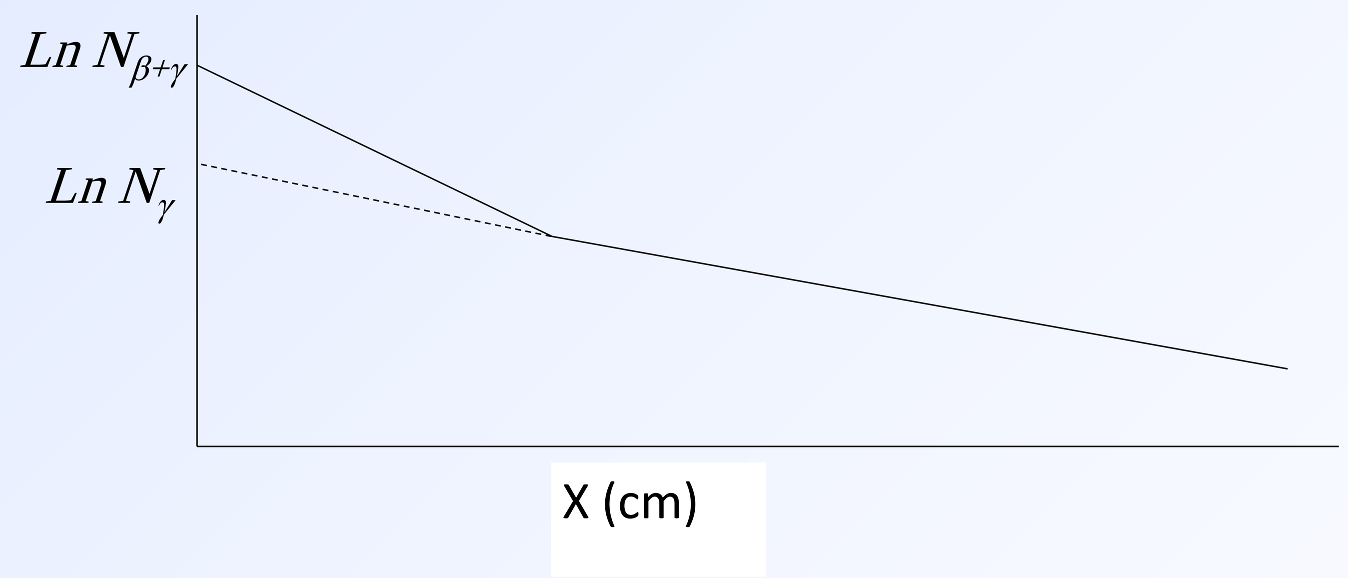
Hence, for Co^{60}, $N_\gamma = 2N_\beta$

$$\varepsilon_\beta = \frac{N_{c\beta}}{N_{i\beta}} x100\%$$

$$\varepsilon_\gamma = \frac{N_{c\gamma}}{N_{i\gamma}} x100\%$$

$$\varepsilon_{\beta/\gamma} = \frac{2N_{c\beta}}{N_{c\gamma}}$$

So, from absorption in Al thin foils, one can obtain the Nc_β and Nc_γ, from which $\varepsilon_{\beta/\gamma}$ can be calculated.



Procedure

1. Set the voltage of the GM tube at its operating value. Obtain a 5 minute background, $N`_{bg}$, count and determine the background counting rate, N_{bg}.
2. Place ^{60}Co source on a suitable shelf. Take a 5 minute count, calculate the counting rate, $N`$, subtract the background rate and record this value, N, in your data table.
3. Place the thinnest aluminum absorber between the source and the window of the detector. Determine the corrected counting rate for this absorber.
4. Repeat for enough absorbers to reduce the initial intensity to back ground value.
5. Draw a graph between ***ln N*** and the thickness X and determine the β/γ efficiency from the relation:

$$\varepsilon_{\beta/\gamma} = \frac{2(N_{\beta+\gamma} - N_\gamma)}{N_\gamma}$$

Results

N_{bg}=

X (cm)	N' (c/s)	$N = N' - N_{bg}$	Ln (N+ √N)	Ln (N- √N)

$\varepsilon_{\beta/\gamma}$ = %

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