(NU3-4) Beta Efficiency of Geiger Counter

Aim of experiment

Determination of the GM counter efficiency for detecting β-particles

Apparatus

GM Tube Counting Station Consists of GM Counter –Sr^{90} Radioactive Source- Source Holder-Stop Watch, Source Cabinet Made of Thick Lead.

Theory of experiment

In this experiment β's will be measured with one of these end-window Geiger tubes. In the experiment, it will be seen that the GM tube is quite efficient for detecting beta particles relative to the detection of γ -rays. These ionizing particles that enter the sensitive region will cause an avalanche. 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 scalar which acts as an electronic adding machine.

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

$$\varepsilon = \frac{n}{m} x100\%$$

If for example the activity, R, of the source is 5 μCi where 1Ci = 3.7 x 10^{10} decays/sec. If we need to calculate the flux at a distance d from a source which emits radiation uniformally in all directions, one considers a sphere of radius d and the flux on the surface is given by;

$$A = \frac{R}{Sphere\ surface\ area} = \frac{1.85x10^4}{4\pi d^2} \quad decays/\sec/m^2.$$

To find the total decays, n, that enter the detector of radius r, of window area, πr^2 m^2, located at a distance d is given by;

$$n = \frac{1.85x10^4}{4\pi d^2} x\pi r^2 \quad decays/\sec.$$

So, if we measure the number of decays counted per second, m, then one can calculate the efficiency of Geiger-Muller counter to measure β- particles.

Procedure

1. Switch on the power of the counting station, and leave to warm up for few minutes.
2. Set the GM tube to its operation voltage; mentioned in the specification sheet.
3. Keep all radioactive sources far away from the detector and count the background for; say 5 minutes, and then calculate the back ground activity, N'_{bg}.
4. Put Sr^{90}- source on its tray, and then set the tray in front of the detector, about 5-10 cm.
5. Start counting for 10 minutes, and then calculate the detected rays per seconds, m''.
6. Subtract the background from $m'=m''-N'_{bg}$
7. Correct the obtained readings for dead time of the device to obtain m.
8. Calculate the efficiency from the relation

$$\varepsilon = \frac{n}{m} x100\%$$

9. Repeat steps 5-8 two extra times and calculate the average efficiency.

Results

Calculated n=

Background N'_{bg}=

Trial	m''	$m'=m''-N'_b$	m	ε %
1				
2				
3				
Average efficiency=				

- In calculating the average, take into consideration the statistical error, which equals the square root of the final calculated activities.

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