(NU3-3) Dead Time of Geiger Detector by Two Sources Method

Aim of experiment

Determination of dead time by two sources method.

Apparatus

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

Theory of experiment

In the earlier discussion it was mentioned that an ionizing particle enters the GM tube through the window and loses its energy by creating electron-ion pairs. The electrons that are produced in the resulting avalanche are accelerated to the anode and collected in a short period of time. The positive ions, however, are more massive and make their way slowly to the cylindrical cathode. If electron-ion pair average transient time is called Δt_1, the GM tube is busy during Δt_1. If another ionizing particle enters the GM tube during Δt_1, it will not be counted. This time $\tau = \Delta t_1$ is called the "dead time" of the tube. Then the dead time is defined as the time following the counting of ionizing radiation at which the counter in not detecting. Also the recovery time is that time elapsed for the detector to be ready to count. If the dead time of the GM tube and the correction factor which can account for these lost events is determined, the number of the actual incident detected radiation is obtained.

The counting rate of a single source, a, during the dead time, t, is given by:

$$N_{ai} - N_{ad} = N_{ai} N_{ad} \tau$$

Where N_{ai} is the rate of incident radiation, N_{ad} is the rate of detected radiation by the detector of dead time t.

The dead time can be derived for two sources method as follows:

$$N_{ai} = \frac{N_{ad}}{1 - N_{ad}\tau}$$

$$N_{bi} = \frac{N_{bd}}{1 - N_{bd}}$$

$$N_{(a+b)i} = \frac{N_{(a+b)d}}{1 - N_{(a+b)d}}$$

$$\because N_{(a+b)d} = N_a + N_b - N_{bg}$$

$$\because \frac{n}{1+n\tau} \approx n + n^2\tau$$

$$\tau = \frac{N_{ad} + N_{bd} - N_{(a+b)d} - N_{bg}}{2N_{ad}N_{bd}}$$

Procedure

1. Switch on the power of the counting station, and leave to warm up for few minutes
2. Set the GM counter at its operating voltage.
3. Count the first source, *a,* for 5 min, N_{ad}.
4. Calculate the counting rate and call this rate R_{ad}.
5. Repeat the measurement for the second source, *b,* and call this rate R_{bd}.
6. Now count both sources together for t=5 min and call this rate $R_{(a+b)d}$.
7. Count the background, N_{bg}, for 5 min and calculate rate R_{bg}.
8. Calculate the dead time of the GM tube and the error of the dead time. from the following relation

$$\tau = \frac{R_{ad} + R_{bd} - R_{(a+b)d} - R_{bg}}{2R_{ad}R_{bd}}$$

Results

$R_{ad}=N_{ad}/300=$ $R_{bd}=N_{ad}/300=$

$R_{(a+b)d}=N_{(a+b)d}/300=$ $N_{bg}/300=$

$R_{bg}=$

$\tau=$ s