The Islamic University, Najaf

College of Medical Techniques

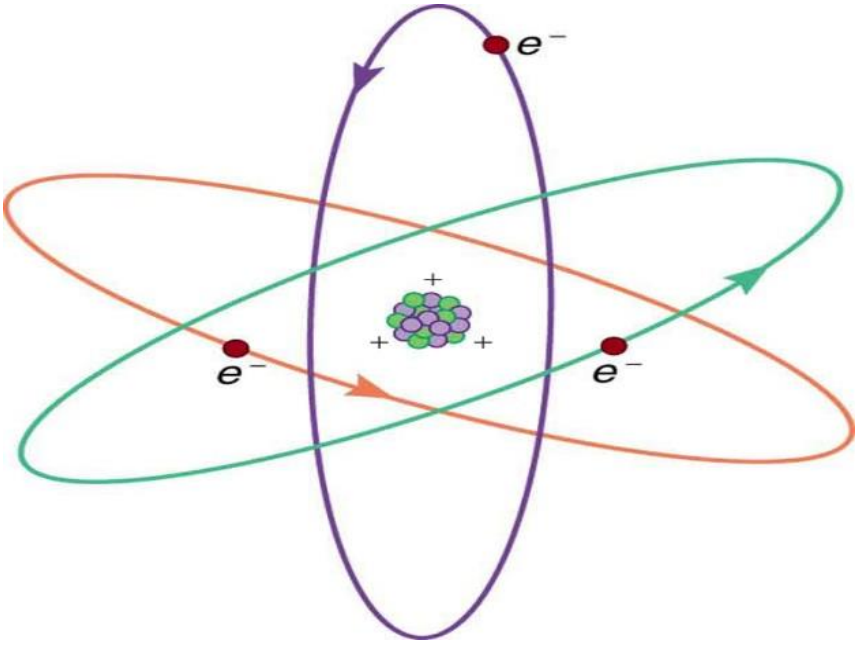
Department of Radiology Techniques

Atomic Physics / experiments

2022-2023

Lecture (1) / stage (1)

Measurement of gamma activity (γ)



Introduction

Radiation: - is the process that results in the release of energy in the form of particles or waves.

How do radiations arise?

An atom consists of a nucleus containing positively charged protons and neutral neutrons, and a few negatively charged electrons revolve around this nucleus. The number of protons in the nucleus is called the atomic number (Z), while the sum of the number of protons + the sum of neutrons is called the mass number (A). In most nuclei of chemical elements, the number of protons inside the nucleus is equal to the number of neutrons, and in some nuclei of some elements, the number of neutrons is greater than the number of protons, and these elements are called isotopes. Some of these isotopes are stable, their atomic composition does not change over time, and they usually have a low atomic number. Some of these isotopes are unstable and often have high atomic numbers and are called radioactive isotopes, and these isotopes will emit nuclear radiation (called alpha rays, beta rays, and gamma rays).

Types of radiation

Ionizing radiation such as x-rays, gamma rays, cosmic rays, beta, and alpha particles, which interact with matter.

Particles Alpha

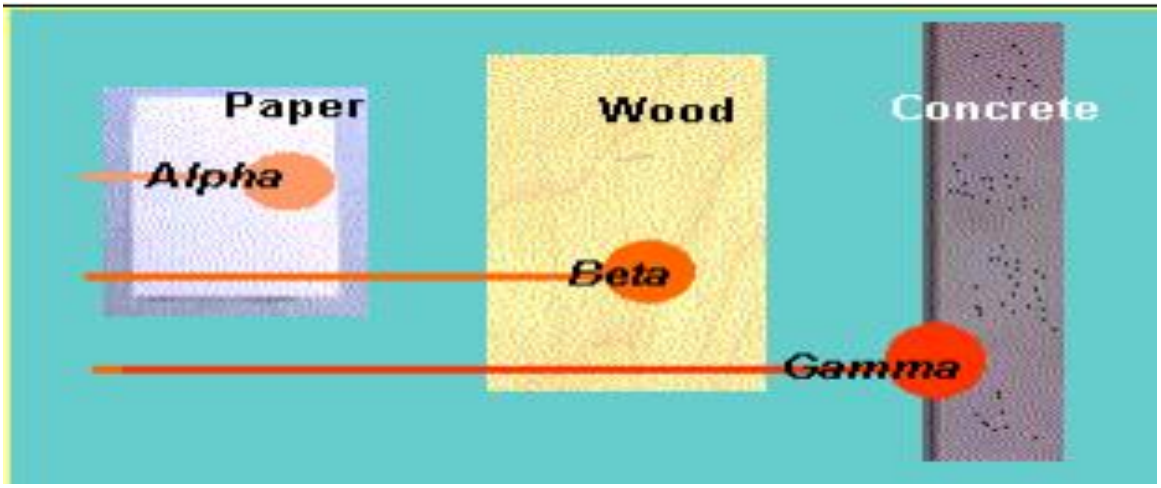
The path of alpha rays can be stopped by a piece of paper or by the human body, but if the vapors of the substance from which the alpha particles radiate are inhaled or swallowed and enter the body because of a wound in it, they will be very harmful.

Particles Beta

These are of two types, negative electrons (and positive) positrons. Beta particles cannot be stopped by a piece of paper, and the transmission of these rays can be stopped by a piece of wood, and they may cause serious harm if they penetrate the body.

Rays Gamma

It is one of the most dangerous types of radiation and has a very high penetrating power, much greater than alpha rays and beta rays. Its flow can be stopped by a concrete barrier.



Non-ionizing radiation, such as electromagnetic radiation, including radio waves, radar waves, and ordinary light, which no interact with matter.

Experiment (1)

Measurement of gamma activity

Purpose

The purpose of this experiment is to outline the procedure for this method and measure of the activity of gamma rays emitted by an isotope of ^{137}Cs.

Apparatus

- High Voltage Power Supply
- Scintillation Detector (NaI)
- Scintillation Preamplifier
- Linear Amplifier
- Single-Channel Analyzer
- Timer & Counter
- Oscilloscope
- One ^{137}Cs, radioactive source
- Connecting Cables.

Introduction

Activity it represents the ability of some atom nuclei to spontaneously transform into other nuclei, and this process is accompanied by radiation. The unit of activity is curie, which is equivalent to $3.7x10^{10}$ disintegrations per second. But more practical is 1 curie = $3.7x10^{10}$ dis./sec.

The following formula used to calculate the activity of U1. The units in

equation are disintegrations per second.

$$\textbf{Activity of } U1 = \frac{\Sigma U1 - \Sigma b1}{t_L} * \frac{1}{G\varepsilon_p f} \text{ ..... (1)}$$

Where

t_L is the live time in seconds equal to 10s.

εp is the intrinsic peak efficiency for the gamma-ray energy and detector size equal to 0.24.

f is the decay fraction of the unknown activity, which is the fraction of the

total disintegrations in which the measured gamma ray is emitted equal to 0.851.

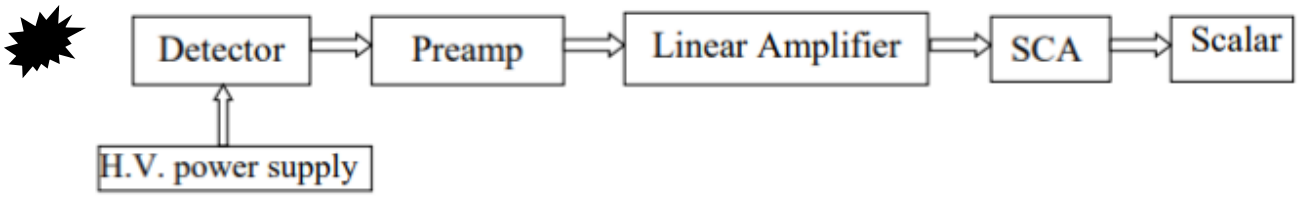
$$G = \frac{r^2}{4s^2}$$

s is the source-to-detector distance in cm equal to 9.3 cm.

r is the radius of the counter crystal equal to 2.2 cm.

Procedure

1. Connect the electronic equipment as shown below:



2. Place the ^{137}Cs radioactive source at 9.3 cm from the face of detector.

3. Setup the operating voltage of 850 V.

4. Obtain the spectrum of ^{137}Cs by taking counts/sec for every setting of Bias Line Voltage.

5. Calculate sum of counts under peak of the source.

6. Evaluate background counts rate.

7. Use equation (1) to calculate the activity of source.