Asst.let Alaa Aziz **Asst.let Murtadha A. Hamoozi** **Asst.let Ali H. Shomran** **Asst.let Ali Saeed Jassim**

The Islamic University, Najaf

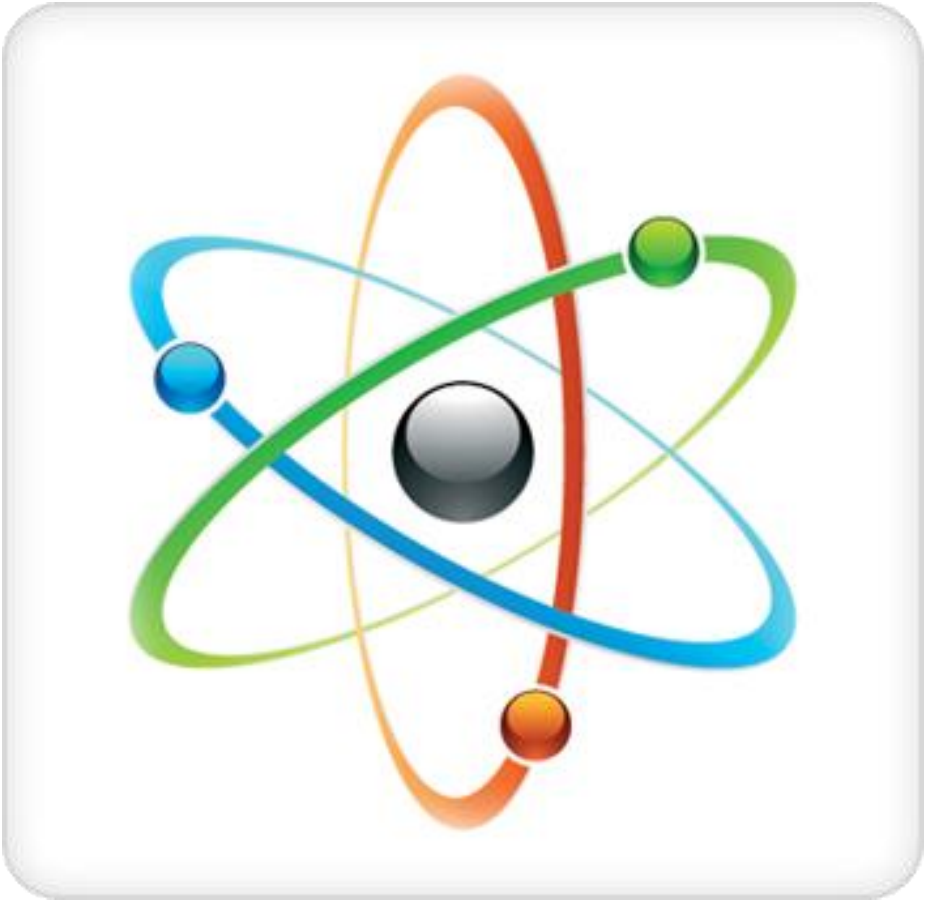
College of Medical Techniques

Department of Radiology Techniques

ATOMIC PHYSICS

2022-2023

LECTURE (2) : RADIOACTIVE DECAY



Asst.let Alaa Aziz Asst.let Murtadha A. Hamoozi Asst.let Ali H. Shomran Asst.let Ali Saeed Jassim

Radiation

Is the emission or transmission of energy in the form of waves or particles through space or through a material medium.

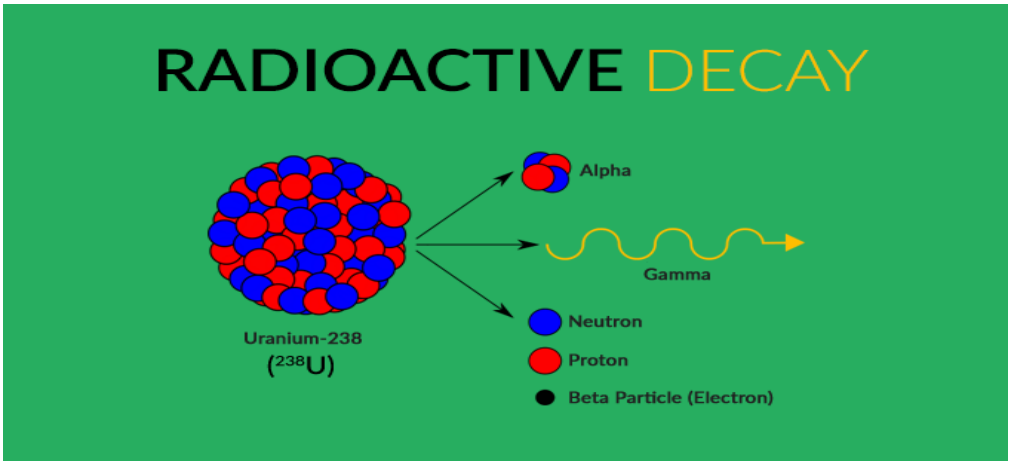
Radioactivity

Is the spontaneous decay of an unstable atom through the emission, from the atomic nucleus, of a particle of ionising radiation. The different types of radiation can be identified by their ability to pass through matter. In 1899 Ernest Rutherford named alpha, α, beta, β, and gamma, γ, radiation, after the first three letters of the Greek alphabet.

Radioactive decay

Is the emission of energy in the form of ionizing radiation. Ionizing radiation can affect the atoms in living things, so it poses a health risk by damaging tissue and DNA in genes. The ionizing radiation that is emitted can include alpha particles.

Asst.let Alaa Aziz Asst.let Murtadha A. Hamoozi Asst.let Ali H. Shomran Asst.let Ali Saeed Jassim



Radioactive decay

Radioactive materials

Are a class of chemicals where the nucleus of the atom is unstable. They achieve stability through changes in the nucleus (spontaneous fission, emission of alpha particles, or conversion of neutrons to protons or the reverse). This process is called radioactive decay or transformation, and is often followed by the release of ionizing radiation (beta particles, neutrons, or gamma rays).

Activity measurements

In radioactive-decay processes, the number of disintegrations per second, or the number of unstable atomic nuclei that decay per second in a given sample. Activity is determined by counting, with the aid of radiation detectors and electronic circuits, the number of particles and photons (pulses of electromagnetic energy) ejected from a radioactive

material during a convenient time interval. This experimental count, however, must be interpreted in the light of a thorough knowledge of the particular manner of radioactive decay in the sample material, because some sources emit more than one particle or photon per disintegration.

Activity is expressed in the International System of Units by the becquerel (abbreviated Bq), which is exactly equal to one disintegration per second. One becquerel is a very small amount of radioactivity. For example, household smoke detectors typically contain 0.3 micrograms of the radioactive isotope americium-241, which emits about 37,000 Bq. The old standard unit was the curie (abbreviated Ci), which is equal to 3.7×10^{10} Bq.

Half - life

In radioactivity, the interval of time required for one-half of the atomic nuclei of a radioactive sample to decay (change spontaneously into other nuclear species by emitting particles and energy), or, equivalently, the time interval required for the number of disintegrations per second of a radioactive material to decrease by one-half.

The radioactive isotope cobalt-60, which is used for radiotherapy, has, for example, a half-life of 5.26 years. Thus after that interval, a sample originally containing 8 g of cobalt-60 would contain only 4 g of cobalt-60 and would emit only half as much radiation. After another interval of 5.26 years, the sample would contain only 2 g of cobalt-60.

Half-lives are characteristic properties of the various unstable atomic nuclei and the particular way in which they decay. Alpha and beta decay are generally slower processes than gamma decay. Half-lives for beta decay range upward from one-hundredth of a second and, for alpha decay, upward from about one one-millionth of a second. Half-lives for gamma decay may be too short to measure (around 10^{-14} second), though a wide range of half-lives for gamma emission has been reported.

The half-life of a first-order reaction is a constant that is related to the rate constant for the reaction:

$$t_{1/2} = \ln 2/\lambda = 0.6931/\lambda$$

The decay constant, λ (lambda), is the "probability" that a particular nucleus will decay per unit time. The decay constant is unaffected by such factors as temperature, pressure, chemical form, and physical state (gas, liquid, or solid).

Example:

Find the decay constant of a 1 g sample of ^{226}Ra given that $t_{1/2}$:1620 years?

$$\lambda = 0.6931/t_{1/2}$$

$$0.693/1620 = 4.28\times10^{-4}\ \text{year}^{-1}$$

$$= 1.36\times10^{-11}\ \text{s}^{-1}$$