Radiation

Paolo Bettelini

Contents

1 Radioactivity

1.1 Definition

Radioactivity is a set of physical-nuclear processes through which some unstable or radioactive atomic nuclei decay, in a certain period of time called decay time.

An unstable nuclei will keep emitting radiations and transmuting to other nuclei until the atom is stable.

1.2 Decay

The mass of a radioactive material will decrease exponentially.

$$M(t) = M_0 \cdot e^{-kt}$$

$M(t)$ is the mass (or number or particles) after a certain time t. M_0 is the initial mass and k is the rate of decay.

1.3 Half-life

The time of half-life is given by $t_{\frac{1}{2}} = \frac{\ln 2}{k}$.

$$\begin{aligned} \frac{1}{2}M_0 &= M_0 e^{-kt} \\ \frac{1}{2} &= e^{-kt} \\ \ln\left(\frac{1}{2}\right) &= -kt \\ t &= \frac{\ln 2}{k} \end{aligned}$$

1.4 Types of radiations

There are three types of radiations that can be emitted by an unstable nucleai.

1.4.1 α particles

An α particle is a helium nuclei. For example

$$^{238}_{92}\mathrm{U} \longrightarrow {}^{4}_{2}\alpha + {}^{234}_{90}\mathrm{Th}$$

1.4.2 β particles

There are two types of β particles. β^+ and β^-. A β^+ particle is emitted when the nuclei is unstable due to having too many protons, whist the β^- one is emitted when it has too many neutrons.

$$\begin{cases} \beta^+, & {}^{0}_{+1}\mathrm{e} \text{ (positron)} \\ \beta^-, & {}^{0}_{-1}\mathrm{e} \text{ (electron)} \end{cases}$$

1.4.3 γ particles

γ rays are photons of electromagnetic energy. They have 0 mass and 0 charge.