

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 of 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 $t_{\frac{1}{2}} = \frac{\ln 2}{k}$.

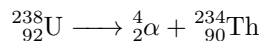
$$\begin{aligned}\frac{1}{2}M_0 &= M_0 e^{-kt} \\ \frac{1}{2} &= e^{-kt} \\ \ln\left(\frac{1}{2}\right) &= -kt \\ t &= \frac{\ln 2}{k}\end{aligned}$$

1.4 Types of radiations

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

1.4.1 α particles

An α particle is a helium nuclei. For example



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, whilst the β^- one is emitted when it has too many neutrons.

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

1.4.3 γ particles

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