

The Fundamental Law of Radioactive Decay

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Radioactive decay is an accidental process that occurs with a certain probability. It is impossible to predict exactly which nucleus is being transformed in a specific precise moment. However, if the number of radioactive nuclei is high enough, the process of radioactive transformation can be described mathematically. **The total number of atoms (particles) N in the sample that have not yet been transformed at a time t** , can be obtained from the following equation:

$$N(t) = N_0 \cdot e^{-\lambda t}$$

($N(t)$ is the total amount of radioactive (untransformed) nuclei at a time t . N_0 is the number of radioactive nuclei at a time $t = 0$. e stands for Euler's number which is base of the natural logarithm - $e = 2,71$).

The probability of a nuclear transformation is different for each radioactive nucleus and can be expressed by the **decay constant λ** . This is a constant of the proportion between the decrease of the number of radioactive nuclei (due to spontaneous transformation) and the total number of untransformed radioactive nuclei. The unit of the decay constant is s^{-1} .

As it is shown in the radioactive decay equation (5.1), it is evident that the amount of radioactive nuclei decreases exponentially with time. This way of determining the amount of radioactive nuclei is not suitable for practical purposes and general use. By taking the logarithm of both sides of the equation we obtain the following expression:

$$\ln (N(t) / N_0) = - \lambda t$$

The most suitable way to graphically express the equation 5.2 is to use a semi logarithmic graph (Figure 5.3).

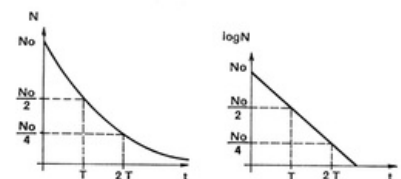


Figure 5.3: The number of radioactive atoms as a function of time, a) x axis - linear, b) y axis - logarithmic (time - linear axis, number of atoms - logarithmic axis). Using these coordinates the graph of the (5.2) equation is a straight line with a slope $-\lambda$.

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