Stochastics of Radioactive Decay

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Fundamental distribution in the stochastics of radioactive decay is the binomial distribution. The Poisson distribution is only valid when the measuring time $T \ll t_{½}$, the half life. The parameters of binomial distribution are the number of nuclides N when $t = 0$, and the ratio of the half life and measuring time T or the disintegration probability p. We know $\frac{dN}{N}/dt = -\lambda$ *and* $n = N(1-\exp(-\lambda T))$ is the count number measured in time T. Is there really $p = 1 - \exp(-\lambda T)$? $\lambda = \ln(2)/ t_{½}$. The parameter of Poisson distribution is the mean value n. The basic mathematics I have presented in [1].

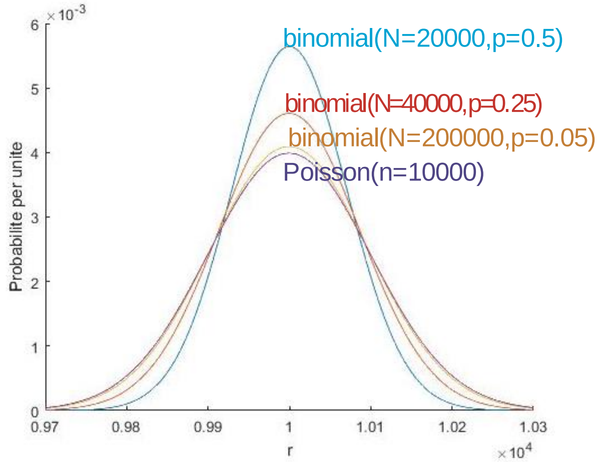

Fig. 1. Binomial and Poisson statistics. Distributions for the mean value $n = Np = 10000$. r is the random number of disintegrations in the time T. $p = 1 - \exp(-\lambda T)$.

The binomial distributions have been calculated for ^{14}C and ^{40}K as well as the corresponding Poisson distributions for certain T.

The ideal detector counts all the disintegrations of a group of atoms of a very short life nuclide without error.

In real measurements you must consider the background, R_b its counting rate. You must stop counting surely not later than the counting rate $R(t) = 2R_b$.

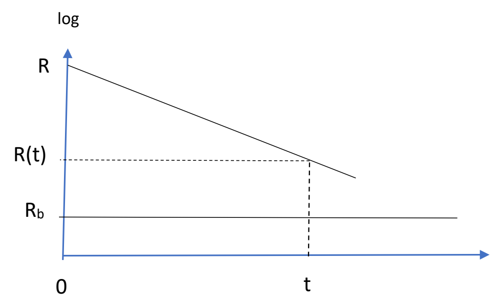

Fig. 2. A schema for seeking optimal counting time.

Keywords: radioactivity, disintegration statistics, background, error

[1] S.S.H. Kasi, "Error of number of radioactive disintegrations", Journal of Physical Science and Application 4(3), 2014), 193.