EXPONENTIALLY DECAYING NUMBER ALWAYS OBEYS A BINOMIAL DISTRIBUTION

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Let N be a number decaying as

$$n = N(1-\exp(-\lambda T)) \qquad (1)$$

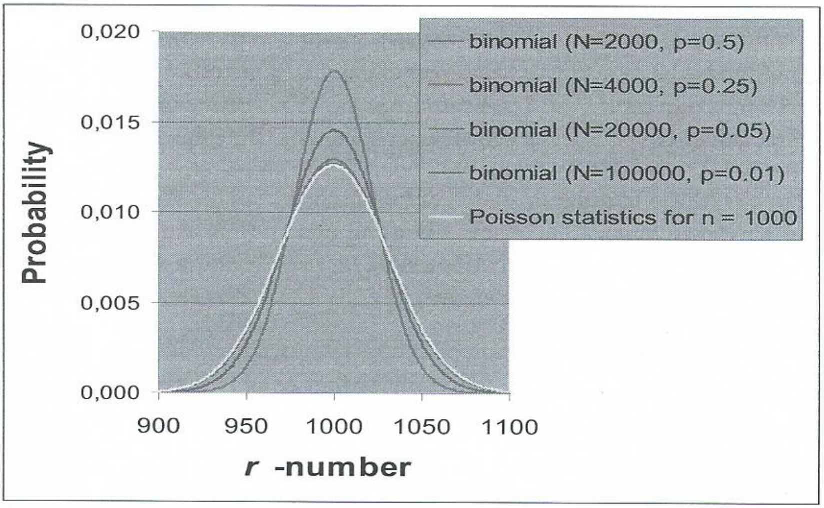
during the time period T. The number n has been decayed (failed, disintegrated, etc.), and N-n is left. $\lambda = \ln(2)/T_{½}$. $T_{½}$ is the half-life of the decay. (1) is generally valid for the radioactive nuclides. That n has the binomial distribution is in [1] shown thoroughly.

$$p = (1-\exp(-\lambda T)) \qquad (2)$$

has been set for the probability of disintegration of a single nuclide. We have the standard deviation

$$\Delta n = \sigma(r) = \sqrt{n}\exp(-\lambda T/2) \qquad (3)$$

for the stochastic variable r of n. Δn is small when T is very small, and also when T is very large, that is, when $n = N$. If $T << T_{½}$ you can use the Poisson statistics. The binomial distribution can be calculated as fast as that of Poisson statistics (below, also [2]).



Above the estimate E(r) = n. However, N is seldom known exactly. The problem is Bayesian. n can often be determined (measured). When $T << T_{½}$ then E(r) = n + 1 [3]. The situation must be another (maybe contrary) when n is close to N.

[1] S.S.H. Kasi, Error of number of radioactive disintegrations is to be published.
[2] S.S.H. Kasi, Stochastics of radioactive decay is to be published. It has a poster.
[3] Rainwater, L.J., Wu, C.S., 1947, Application of probability theory to nuclear particle detection. Nucleonics 1, October, 60-69.