In class, we have derived that the probability for a single nucleus to be around at time t equals $p(t) = e^{-kt}$ for some value of k that depends on the material under consideration.We then went on to compute the probability $P_n(t)$ to find exactly n nuclei if there were N to begin with. Let us visualize these probabilities for $N = 5,\ k = 1$:

$P := (n, t) \rightarrow \frac{N!}{n!\,(N-n)!} \cdot p(t)^n \cdot (1 - p(t))^{N-n};$

$$(n, t) \rightarrow \frac{N!\, p(t)^n\, (1 - p(t))^{N-n}}{n!\, (N-n)!} \quad (1)$$

$p := t \rightarrow \exp(-k \cdot t);$

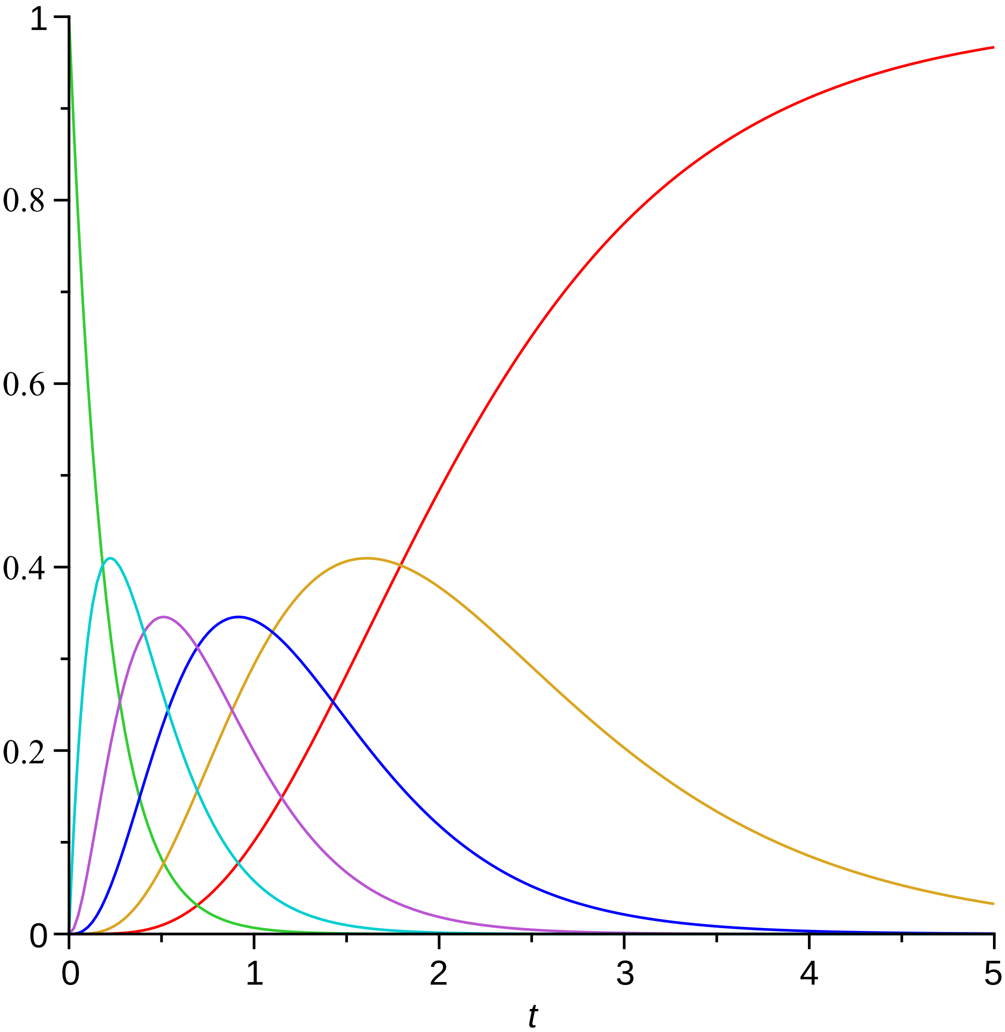
$$t \rightarrow e^{-kt} \quad (2)$$

$N := 5;\ k := 1;$

$$5$$

$$1 \quad (3)$$

$plot(\{seq(P(i, t), i = 0..N)\}, t = 0..5);$



As you can see, at the beginning we know for sure (with probability one) that there are 5 nuclei; this probability drops rapidly and the probability to find 4, 3, 2 or less nuclei first grows and then decreases again as it becomes more and more likely that in fact no nuclei are around any more (i.e. $P_0(t)$, the red curve, grows).