2012 APR 27

(GG, Ch 30, P 28)

α: $^{218}_{84}Po \longrightarrow {}^{214}_{82}Pb + {}^{4}_{2}He$

218.008965 u 213.999798 u 4.002603 u

218.008965 u − 213.999798 u − 4.002603 u = 0.006564 u

$0.006564\,u \times \frac{931.5\ MeV/c^2}{1\,u} = 6.11\ MeV/c^2$

$E = 6.11\ MeV$

β^-: $^{218}_{84}Po \longrightarrow {}^{218}_{85}At + e^-$

218.008965 u 218.008681 u

DIFFERENCE = 0.000284 u

$E = 0.265\ MeV = 265\ keV$

Decay Rate

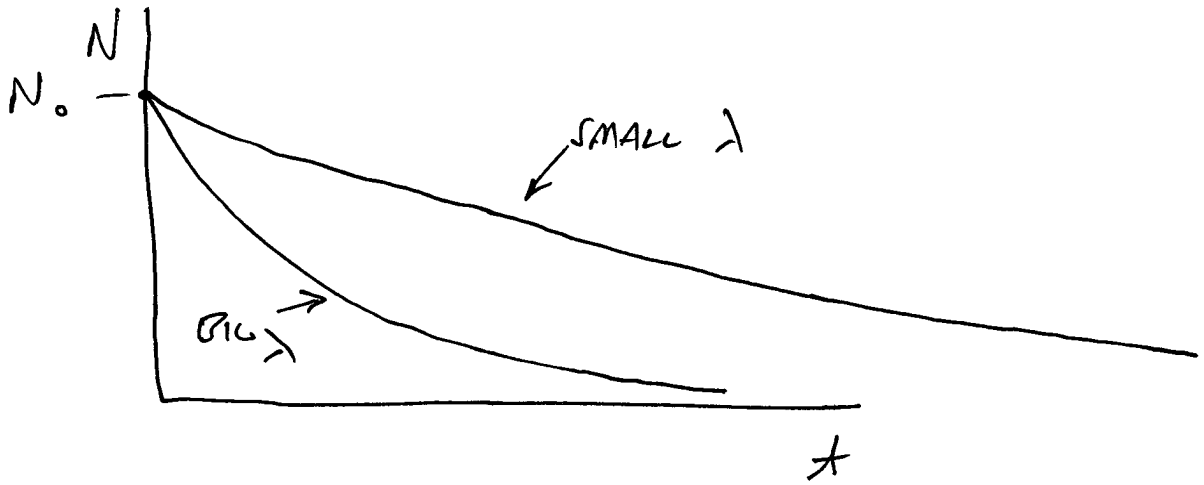
- Nuclear decay is a random event
- Some nuclei decay quickly ($^{214}_{84}Po$ has 164.3 μs half-life)
- Some nuclei decay slowly ($^{14}_{6}C$ has 5730 yr half-life)

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

- N: # particles still undecayed (# left)
- N_0: original # of particles
- λ: decay constant
- t: time

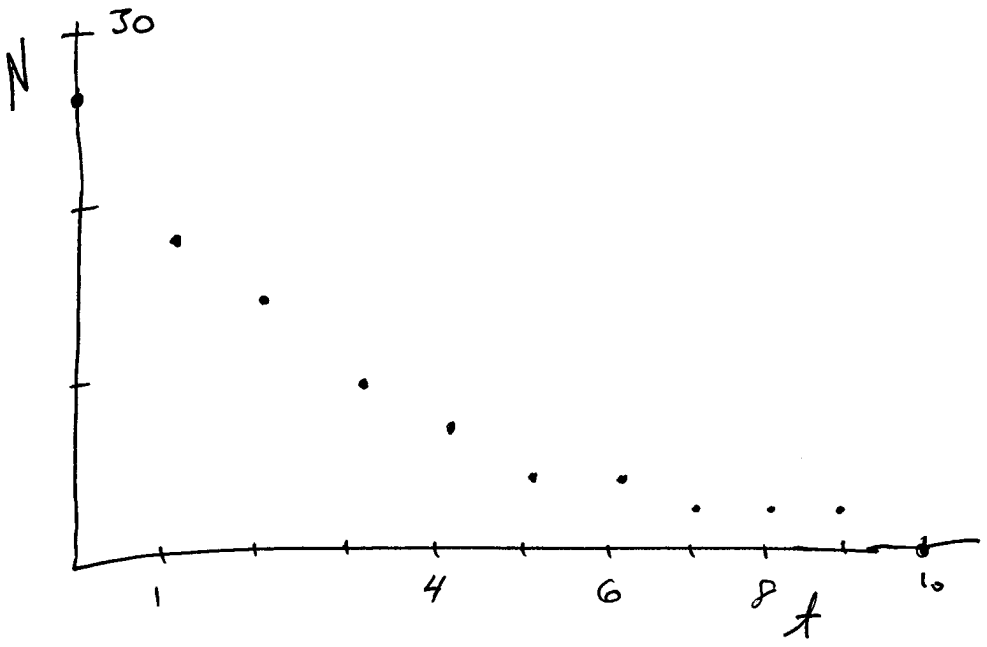
λ big $\Rightarrow$ quick decay

λ small $\Rightarrow$ slow decay



WHY EXPONENTIAL DECAY?

ROUND	N	# DECAYS
	26	
1		8
	18	
2		3
	15	
3		5
	10	
4		2
	8	
5		4
	4	
6		0
	4	
7		2
	2	
8		0
	2	
9		0
	2	
10		2
	0	



EXPONENTIAL DECAY

COMES FROM

CONSTANT PROBABILITY OF DECAY

PER UNIT TIME.

HALF-LIFE IS THE TIME OVER

WHICH HALF OF A SAMPLE WILL DECAY.

$T_{1/2}$ = HALF-LIFE

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

ACTIVITY = # DECAYS/SEC = λN

FRACTION REMAINING = N/N_0

(G6, Ch 30, Ex 30-9)

$$\text{ACTIVITY} = \lambda N \qquad N = 1.00 \times 10^{22}$$

$$T_{1/2} = 5730 \text{ YR}$$

$$\lambda = \frac{\ln 2}{T_{1/2}} = \frac{\ln 2}{5730 \text{ YR}}$$

$$\text{ACTIVITY} = \left(\frac{\ln 2}{5730 \text{ YR}}\right)(1 \times 10^{22}) = 1.21 \times 10^{18} \text{ DECAYS/YR}$$