PHYS 512 Problem Set 3

2. Radio decay: $N = N_0 e^{-kt}$ k: constant $\frac{dN}{dt} = -k$

half life: $N = \frac{N_0}{2} = N_0 e^{-kT_{\frac{1}{2}}} \Rightarrow k = \frac{\ln 2}{T_{\frac{1}{2}}}$

In radio decay chain, for example: $A \to B \to C$

$\Delta N_B = \Delta N_{A\to B} - \Delta N_{B\to C} \Rightarrow \left(\frac{dN}{dt}\right)_B = \left(\frac{dN}{dt}\right)_{A\to B} - \left(\frac{dN}{dt}\right)_{B\to C} = k_A - k_B$

U^{238} decay chain

$U^{238} \xrightarrow{\alpha} Th^{234} \xrightarrow{\beta} Pa^{234} \xrightarrow{\beta} U^{234} \xrightarrow{\alpha} Th^{230} \xrightarrow{\alpha} Ra^{226} \xrightarrow{\alpha} Rn^{222} \xrightarrow{\alpha} Po^{218} \xrightarrow{\alpha} Pb^{214} \xrightarrow{\beta} Bi^{214}$

$4.5\times10^{9}\,yr \quad 0.066\,yr \quad 2.23\times10^{6}\,yr \quad 2.4\times10^{5}\,yr \quad 7.7\times10^{4}\,yr \quad 1.6\times10^{3}\,yr \quad 1.05\times10^{-2}\,yr \quad 5.57\times10^{-6}\,yr \quad 3.06\times10^{-2}\,yr \quad 3.79\times10^{-5}\,yr$

$Pb^{206} \xleftarrow{\alpha} Po^{210} \xleftarrow{\beta} Bi^{210} \xleftarrow{\beta} Pb^{210} \xleftarrow{\alpha} Po^{214} \xleftarrow{\beta} Bi^{214}$

Stable $\quad 0.379\,yr \quad 1.37\times10^{-2}\,yr \quad 22.3\,yr \quad 0.5\times10^{-11}\,yr$

$\because T_{U^{238}} \Rightarrow$ Test $\quad \therefore U^{238}$ decays to Pb^{206} instantly

$\Rightarrow \frac{N_{Pb^{206}}}{N_{U^{238}}} = \frac{N_0 - Ne^{-kt}}{N_0 e^{-kt}} = e^{kt} - 1 \quad k: k_{U^{238}}$