

# Nuclear physics tutorial 3

August 14, 2018

## 1 Activity of a physics student

- a) The atomic mass unit is defined as  $1 u \cong \frac{1}{12} \text{mass}(^{12}\text{C})$  where this mass is expressed in  $\text{Kg}$ . Show that  $1 u = 931.5 \text{ MeV}/c^2$ .
- b) The human body contains about 18% carbon and 0.2% potassium. The natural abundance of  $^{14}\text{C}$  is  $10^{-12}$  and  $1,2 \cdot 10^{-4}$  for  $^{40}\text{K}$ . Compute the number of radioactive carbon and potassium nuclei inside a physics student (take an average mass  $70 \text{ Kg}$ ).
- c) Infer the activity of a physics student given that  $\tau_{1/2}(^{14}\text{C}) = 5730 \text{ years}$  and  $\tau_{1/2}(^{40}\text{K}) = 1,25 \cdot 10^9 \text{ years}$ .

## 2 Gamma ray flux

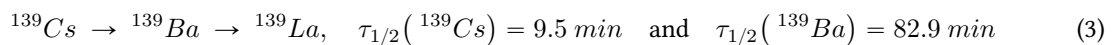
Consider the following chain reaction :



- a) What is the gamma ray flux (number of photons per unit time and unit surface) at a distance of  $1 \text{ m}$  from a source of  $^{60}\text{Co}$  whose activity is  $7.5 \text{ mCi}$  ?
- b) What is the order of magnitude of the half-value layer for gamma ray ?

## 3 Study of a chain reaction

Consider a sample of  $^{139}\text{Cs}$  with a activity of  $1 \text{ mCi}$ . The following nuclear chain is observed :



- a) Derive the coupled ODEs which  $N_{\text{Cs}}(t)$ ,  $N_{\text{Ba}}(t)$  and  $N_{\text{La}}(t)$  obey. Specify the initial conditions.
- b) What is the maximum activity of  $^{139}\text{Ba}$  ?
- c) How many  $^{139}\text{La}$  (stable) are there after one hour ?