# NUCLEAR AND PARTICLE PHYSICS

PHY3C10

What is a nuclear physics?

- A field of physics that studies atomic nuclei and their constituents and interactions.
- It has applications in many fields such as nuclear power, medicines, weapons, radio carbon dating etc..

NUCLEUS

- Nucleus of an atom is a tiny, dense region which is positively charged and provides the atom with most of its mass.
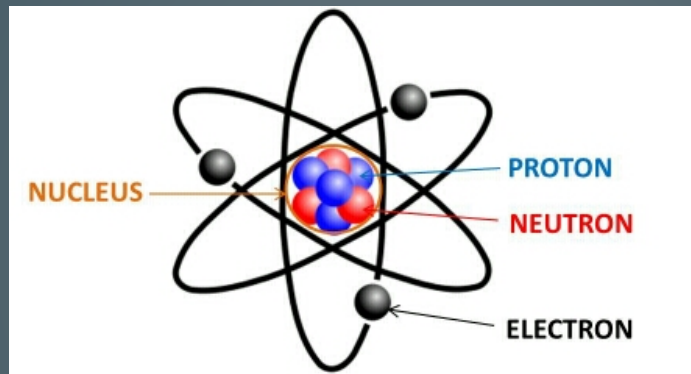
- Properties of nucleus

      1. Static properties – charge, radius, mass, binding energy, angular momentum, parity etc.

      2. Dynamic properties – reaction probabilities, decay etc.

Nuclear Radius

- By experimental techniques it is found that

    Volume of nucleus ∝ no of nucleons it contains
    (i.e. Mass number, A)

- $4/3\ \pi R^3 \propto A$

    re arranging the equation we get

    $R = R_0 A^{1/3}$ where $R_0 = 1.2*10^{-15}$ m

Question 1

- The ratio of the sizes of $^{208}Pb_{82}$ and $^{26}Mg_{12}$ nuclei is approximately?

1. According to $R = R_0 A^{1/3}$

$$\frac{R_{Pb}}{R_{Mg}} = \frac{A_{Pb}^{1/3}}{A_{Mg}^{1/3}} = \frac{(208)^{1/3}}{(26)^{1/3}}$$

$$= \left(\frac{208}{26}\right)^{1/3} = (8)^{1/3}$$

$$\frac{R_{Pb}}{R_{Mg}} = 2.$$

Question 2

- Find the density of the $^{12}C_6$?

Binding energy

- The missing energy that keeps nucleons together.
- Consider Deuterium isotope($^2H_1$)of hydrogen

no of protons = 1

no of neutrons= 1

expected mass of deuterium = mass of 1 proton +mass of neutron

=1.007825 u+1.008665 u

=2.016490 u

But the measured mass of deuterium = 2.014102 u

i.e. 0.002388 u less then combined masses

Why there is a missing mass???

Binding energy (continues)

- The missing mass corresponds to energy required to form a deuterium isotope from free proton and neutron.
- That energy equivalent of missing mass of a nucleus is called Binding energy.

- $BE = \{[Zm(^1H) + Nm_n] - m(^AX)\}c^2$

m(^{1}H) : is the mass of a hydrogen atom

m(^{A}X) : is the atomic mass of the nuclide

M_n : is the mass of a neutron

Z : No of protons

N : No of neutrons

Question 3

- The binding energy of a missing isotope $20Ne_{10}$ is 160.647MeV. Find its atomic mass.