

Problem-11

Mukesh Tekwani

How is the size of a nucleus experimentally determined? Write the relation between the radius and mass no. of the nucleus. Show that the density of nucleus is independent of its mass number.

The size of the nucleus is experimentally determined using Rutherford's α -scattering experiment and the distance of closest approach and impact parameter.

The relation between radius (R) and mass no. (A) of nucleus is,

$$R = R_0 A^{1/3},$$

where $R_0 = 1.2 \text{ fm} = 1.2 \times 10^{-15} \text{ m}$

Density $S = \text{mass} / \text{volume}$

Therefore volume of the nucleus (assumed spherical) is:

$$V = \frac{4}{3} \pi R^3 = \frac{4}{3} \pi R_0^3 (A^{1/3})^3 = \frac{4}{3} \pi R_0^3 A$$

So, the volume of the nucleus is proportional to mass number A.

$$\text{Nuclear Density } \rho = \frac{\text{Mass of nucleus}}{\text{Volume of nucleus}}$$

$$\therefore \rho = \frac{mA}{\frac{4}{3} \pi R^3} \quad m = \text{mass of each nucleon.}$$

$$\therefore \rho = \frac{mA}{\frac{4}{3} \pi (R_0 A^{1/3})^3}$$

$$\therefore \rho = \frac{\cancel{mA}}{\frac{4}{3} \pi R_0^3 \cancel{A}} = \frac{m}{\frac{4}{3} \pi R_0^3}$$

Therefore nuclear density does not depend on mass no

-x-