

# What is Nucleus

→ It is the central core of all atoms.

→ It was discovered by 

Atom v/s Nucleus
$1 \text{ \AA} (10^{-10} \text{ m}) / 10^{-15} \text{ m (Fermi)}$

  
Rutherford thru  $\alpha$ -scattering expt.

→ Most of the mass & all the +ve charge is concentrated in a very small vol.

# Units of Mass: a.m.u. (u) & energy unit

Atomic  
Physics

Nuclear  
Physics

Nuclear  
Physics only.

Charge  $\rightarrow$  C

$$[e] = \underline{1.6 \times 10^{-19} \text{ C}}$$

## Units of Mass: a.m.u. (u) & energy unit

$$m = E/c^2$$

$$\begin{aligned} 1 \text{ a.m.u.} &= \frac{1}{12} \left[ \text{Mass of } {}_6^{12}\text{C} \text{ atom @ rest} \right. \\ &\quad \left. (6p, 6e^-, 6n) \text{ \& in ground state} \right] \\ &= 1.6605402 \times 10^{-27} \text{ kg.} \\ &= 931.478 \text{ MeV}/c^2. \end{aligned}$$

$$e = 1.60217663 \times 10^{-19} \text{ C}$$

Units of Mass: a.m.u. (u) & energy unit

$$\boxed{kg}$$

$$\boxed{m = \frac{E}{c^2}}$$

$$\boxed{\frac{\text{MeV}}{c^2}}$$

1 a.m.u.  $\left( 1.6605402 \times 10^{-27} \text{ kg} \right) \times \left( 299792458 \right)^2$   $\begin{matrix} \downarrow \\ \text{eV} \\ \downarrow \\ \text{MeV} \end{matrix}$

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$\left( 1.6 \times 10^{-19} \right) \times 10^6$

$\boxed{931.478 \text{ MeV}/c^2} = 931.478 \text{ MeV}$

# Nuclear Constitution

- charge & mass

- proton → charge (+e)

Symbol



Mass →  $1.6726231 \times 10^{-27} \text{ kg}$

$1.00727 \text{ amu (u)}$

charge  $938.27331 \text{ (MeV/c}^2\text{)}$

- neutron

Symbol



charge, mass →  $1.6749286 \times 10^{-27} \text{ kg}$ .

(zero)

$1.00866 \text{ amu}$

$939.56563 \text{ MeV/c}^2$

electron → charge (-e)

mass →  $9.1093897 \times 10^{-31} \text{ kg}$

$0.00055 \text{ amu}$

$510.99 \text{ (keV/c}^2\text{)}$

$0.51099 \text{ (MeV/c}^2\text{)}$

# Forces inside nucleus

- Gravitational force  $\rightarrow$  weakest force  
 $\rightarrow$  attractive
- Electrostatic force  $\rightarrow$  ~~p-n~~ / p-p / ~~n-n~~
- Nuclear force  $\rightarrow$  p-n / p-p / n-n

# Features of nuclear force

- The strongest force in the universe → attractive & repulsive
- Dependence on distance
  - ① very short range force, (4-7) fermi → nuclear force → 0.
  - ② if dist is less than 0.8 fm → repulsive
  - ③ <sup>more</sup> small variations in distance ⇒ large changes in the force. 0.8 fm → attractive.
- Dependence on charge ④ Not a central force.
- Dependence on spin → doesn't depend on charge. ( $\vec{F} \propto \frac{1}{r^n} \vec{r}$ )

# Nuclear Constitution: Nucleons

- protons

- neutrons

All the nucleons are held together by nuclear & electrostatic forces



# Atomic Number & Mass Number

Atomic Number  $\rightarrow$  It is the number of protons in a nucleus. ( $Z$ ). For a neutral atom no of electrons equals atomic no.

Mass Number  $\rightarrow$  It is no. of nucleons (protons + neutrons) in the nucleus. ( $A$ ).

Atomic Mass  $\rightarrow$  It is the mass of all the nucleons in a nucleus.