① Summary – Introduction to nuclear and particle physics

Basic definitions:

$^{A}_{Z}X_{N}$

A – atomic mass number ← based on $^{12}C = 12\,u$

Z – number of protons – atomic number

N – number of neutrons

Isotopes: a chemical element with different A and N but the same number of protons
→ similar chemical behaviours
→ but different physical behaviours
e.g. ^{1}H, ^{2}H, ^{3}H, ^{12}C, ^{13}C, ^{14}C, ^{35}Cl, ^{37}Cl, ^{235}U, ^{238}U

Isotone: same number of N but different Z ^{2}H & ^{3}He

Isobar: same A : ^{3}He, ^{3}H, ^{40}S, ^{40}Cl, ^{40}Ar

Isotopologues: molecules that differ only in the isotopes: ^{12}CO, ^{18}CO

Basic particles and forces:

Fermions → spin = $\frac{1}{2}$

quarks: up, charm, top / down, strange, bottom } interact through the strong force

leptons: electron, muon, tau / ν_e ν_μ ν_τ } do not

Bosons → force carriers, spin = integer

gluon, photon, Z boson, W boson } gauge or vector bosons, spin = 1

higgs } scalar boson, spin = 0

elementary particles → no further sub-division
+ anti particles: same mass but opposite charge, except ν

Composit particles:

Hadrons: bound states of quarks : e.g. p^+, n^0
two types – **baryon**: composed of 3 quarks : p^+, n^0
anti baryon: 3 antiquarks
– **meson**: have the same number of quarks and anti quarks. e.g. π^0, π^-, π^+

(2) Forces

- strong force : force carrier : gluons
  ↳ keeps p^+ and n^0 together
- electromagnetic force : force carrier : γ
- weak force : force carrier : W^+, W^-, Z^0 bosons
  ↳ responsible for β decay
- gravity : no known force carrier, not important on the scale of nuclear and particle physics

→ basic quantum mechanics

→ properties of nuclei