

3) Theory of Packing fraction :-

It was given by Aston. It expressed the variation of isotopic mass from whole number in terms of packing fraction. It may be defined as -

$$\text{Packing fraction} = \frac{\text{isotopic mass} - \text{mass no.}}{\text{mass no.}} \times 10^4$$

Its value may be -ve or +ve.

Consequences

(i) Zero value of packing fraction is found in monoisotopic elements (having no isotope) and in those cases ~~isotopic mass~~ where isotopic mass is equal to mass no. e.g. ^{12}C .

(ii) -ve value of packing fraction indicates that there is mass defect hence binding energy. Such nuclei are assumed to be stable.

(iii) Elements having +ve value of packing fraction are unstable under gaseous fission or fusion process.

e.g. $^1\text{H}^1 \rightarrow$ has (+ve) packing fraction undergoes fusion.
 $^{235}\text{U} \rightarrow$ " " " " " " fission.

He, O, and C has low packing fraction and hence stable.

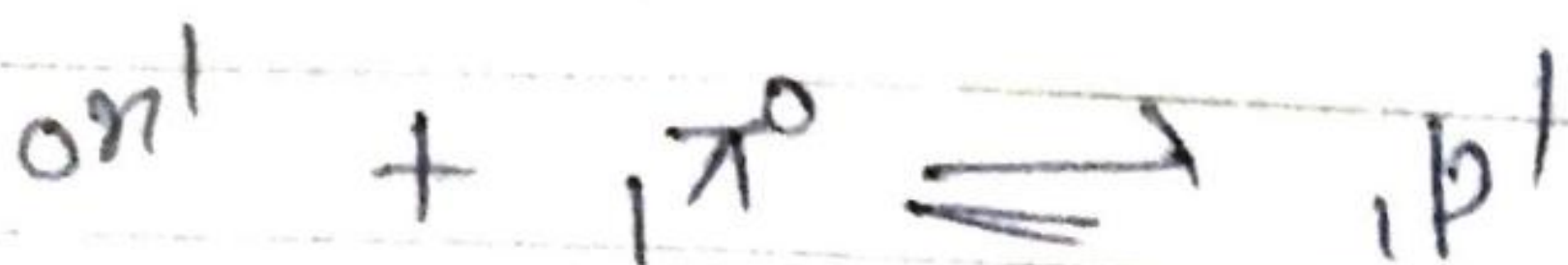
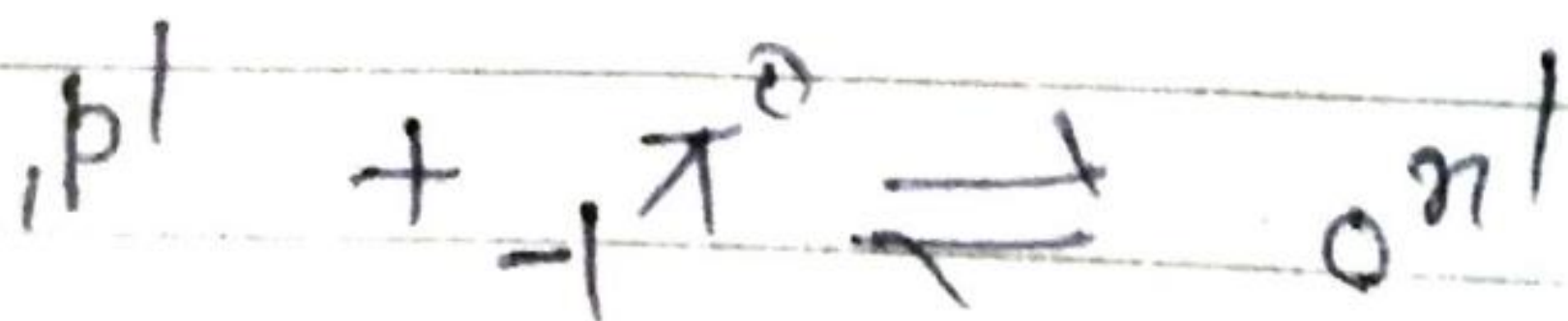
④ ~~Plerson~~ Plerson Theory of Nuclear forces $\therefore \rightarrow$

The force holding the nucleons in the nucleus is called nuclear force, which operates only in the range of 0.1 fm. These are short range forces. These forces do not follow the inverse sq. law.

The exact nature of the nuclear force is not well understood. These forces are believed to be associated with the interconversion of protons and neutrons.

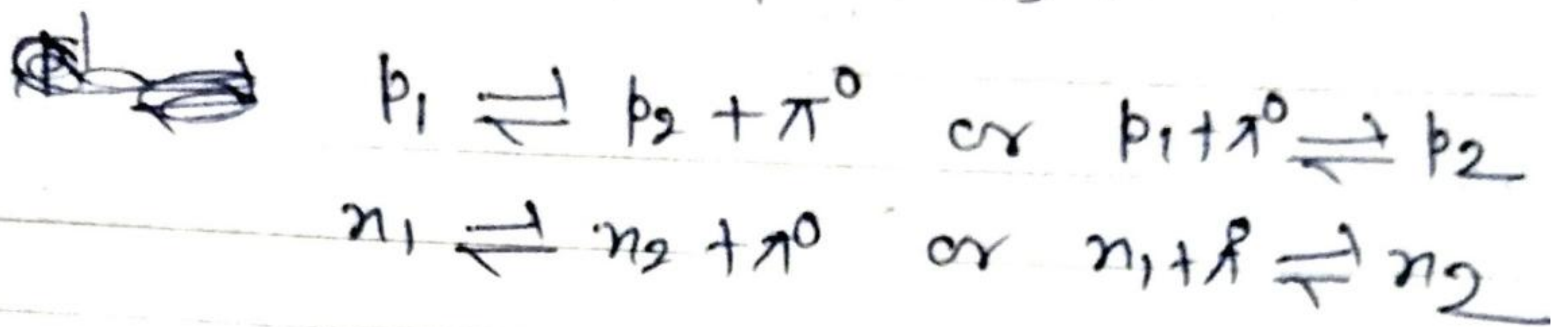
Hideki Yukawa (Japan) in 1935, suggested that another fundamental particle, ~~he called~~ which he called meson, oscillates between neighbouring nucleons with a velocity close to that of light.

Mesons are three types - neutral, $-ve$ and $+ve$. They interact with protons and neutrons as a result of which a p may change into a neutron and a neutron may change into a p , for a part of the time. This may be represented as below \rightarrow



Mesons form glue for nucleons. This results in an attraction between neutron and protons.

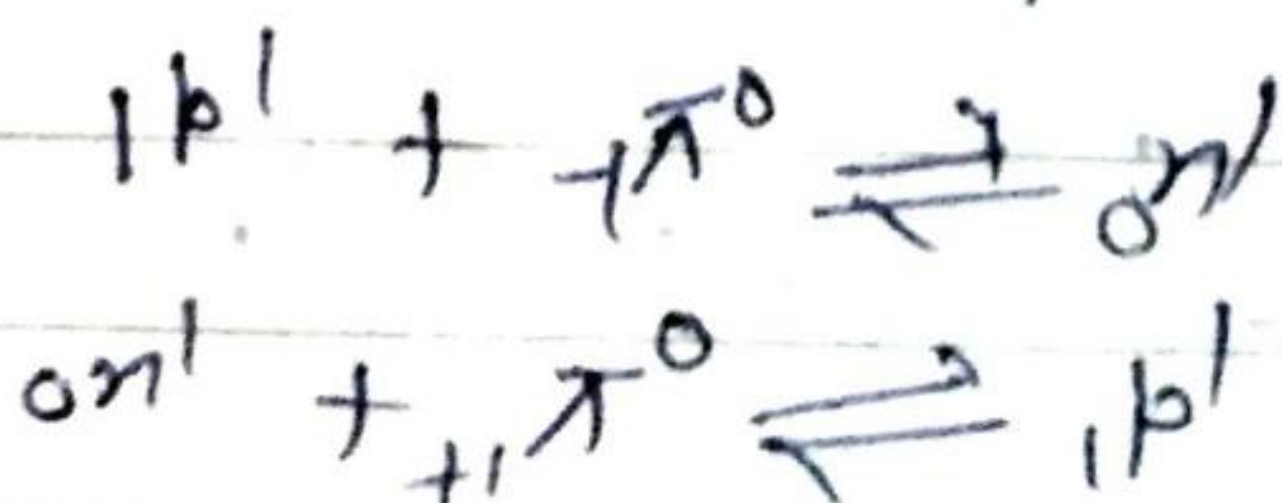
Neutral π mesons also help to create the force between like particles.



Note - How the exchange of meson between two nucleons leads to attractive forces may be understood by a simple analogy in which the two nucleons are considered as two dogs and the meson as a piece of bone which each of them is trying to snatch from the other? In the scuffle, the bone is rapidly exchanged between the two dogs. Since neither of them is prepared to part with the bone, the latter keeps the two dogs ~~bound~~ bound together.

Hideki Yukawa (Japan) in 1935 ~~suggested that~~ explained real nature of nuclear force.

He proposed that nucleons are surrounded by charged π meson e.g. π^+ & π^- mesons interconvert the protons and neutrons.



5) Shell model of nucleus

Nucleons try to be paired in the nucleus, in order to achieve stability. Paired nucleons spin in opposite directions, cancel each other out and creates attractive force to bind them.

Odd no. of protons and neutrons is most unstable combination. On the other hand even no. of protons and neutrons is stable combination.

Magic Numbers

elements having 2, 8, 20, 28, 50, 82 and 126 protons or neutrons. Stable abundant with greater no. of isotopes. These nos. are called magic number.

Eg., ${}_{82}^{208}\text{Pb}$ → 82 p, 126 n both are magic no., hence it is stable.

${}_{92}^{235}\text{U}$ → 92 p, 143 n (unstable) undergoes disintegration.

Unstable nuclei disintegrate to give α , β , γ rays in order to achieve magic no. and become radioactive.