SU(2) symmetry

The process of forming different iso-spin multiplets from a number of isospin doublets is carried out by the rules of a special type of transformation known as the special unitary group of rank 2 i.e. SU(2) the number 2 in the bracket indicates dimensions of group. It is group of all 2x2 unitary matrices. where determinat.

It is well known that neutron and proton are two states of nucleon which form the fundamental representation of the group. The symmetry operations can transfer a proton into neutron or neutron into proton. This implies that iso-spin will remain conserved under strong interaction :-

The neutron and proton each has iso-spin $T = 1/2$.

The third component $T_3 = \frac{1}{2}$ for proton.

$T_3 = -\frac{1}{2}$ for neutron.

The operators of symmetry group thus change the co-ordinates of iso-spin is such away as to reverse the sign of T_3. Thus the strong interactions are assumed to be invariant under rotations in the iso-spin space.

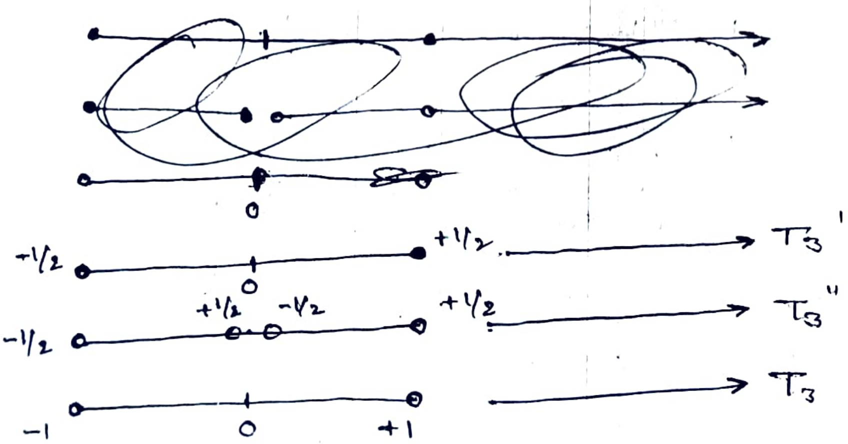

Diagram shows the generating of iso-spin triplet and an isospin singlet from two iso-spin doublet.

From group theory, we ~~have~~ know that two isospin $\frac{1}{2}$ states are the simplest basic states known as SU(2) group of transformation. The pauli-spin matrices are the simplest representation of this group which is intimately related to the group of rotation in iso-spin space. which leads to the conservation of angular momentum and iso-spin.

The unitary group is special because a restriction reduces by unity to the number of operators in the group.

Thus in SU(2) group, instead of $2\times2=4$ operators there are three operators. The group is said to have generator.

In symbollically

$$2 \otimes \bar{2} = 3 \oplus 1.$$

2 & $\bar{2}$ signify doublet ($T = 1/2$) isospin states for a ~~number~~ nucleon and antinucleon respectively.

3 and 1 signify the resultant triplet ($T=1$) and singlet ($T=0$) iso-spin states resulting force the combination of two such doublets. The iso-spin T determines the multiplicity $(2T+1)$ whose third components varies from $T_3 = +T$ to $T_3 = -1$. These substates are identical except for the electric charge. e.g. for pions:-

gso spin $T = 1$

multiplicity $(2T+1) = 3$

There are three charge states of pions with

$T_3 = +1$ for $\pi^+ \longrightarrow p\bar{n}$

$T_3 = 0$ for $\pi^0 \longrightarrow \frac{1}{\sqrt{2}}(n\bar{n} - p\bar{p})$

$T_3 = -1$ for $\pi^- \longrightarrow (-)n\bar{p}$

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The iso spin is strictly conserved in strong interactions, the sub-states of the multiplets would differ in charge and T_3 but not in mass. The ~~sy~~ SU(2) symmetry is violated in electromagnetic interactions and also ~~becau~~ breaks in the case of weak interactions.