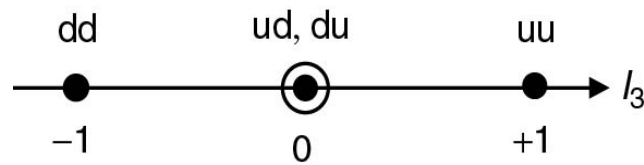
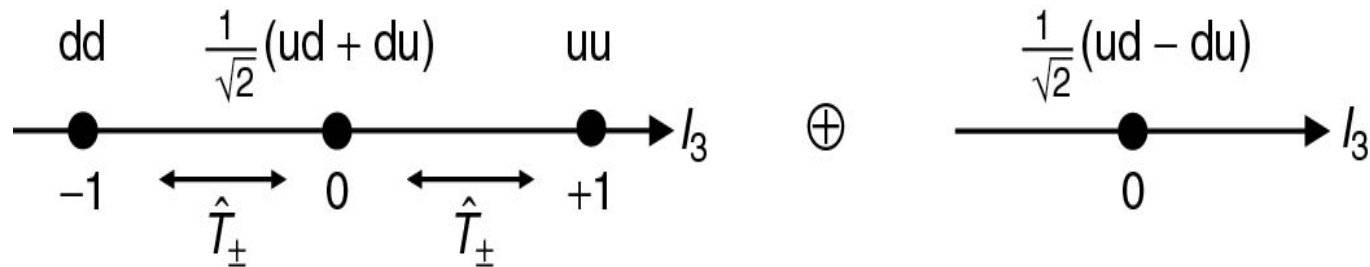


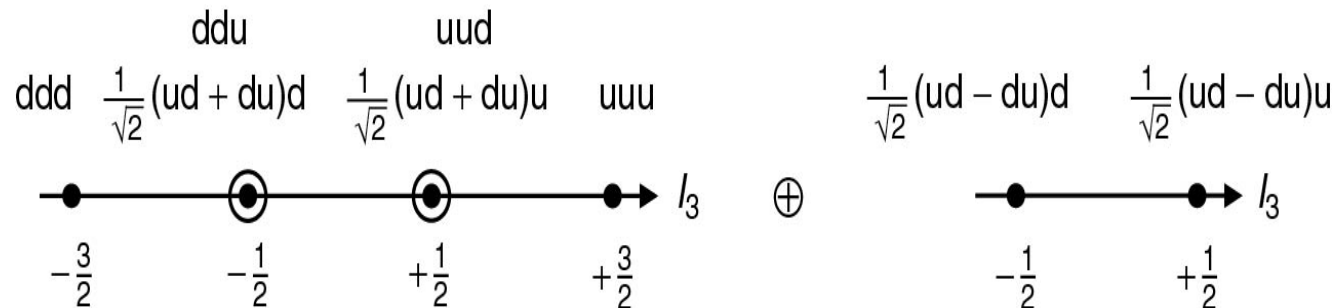
Start with two quark combinations



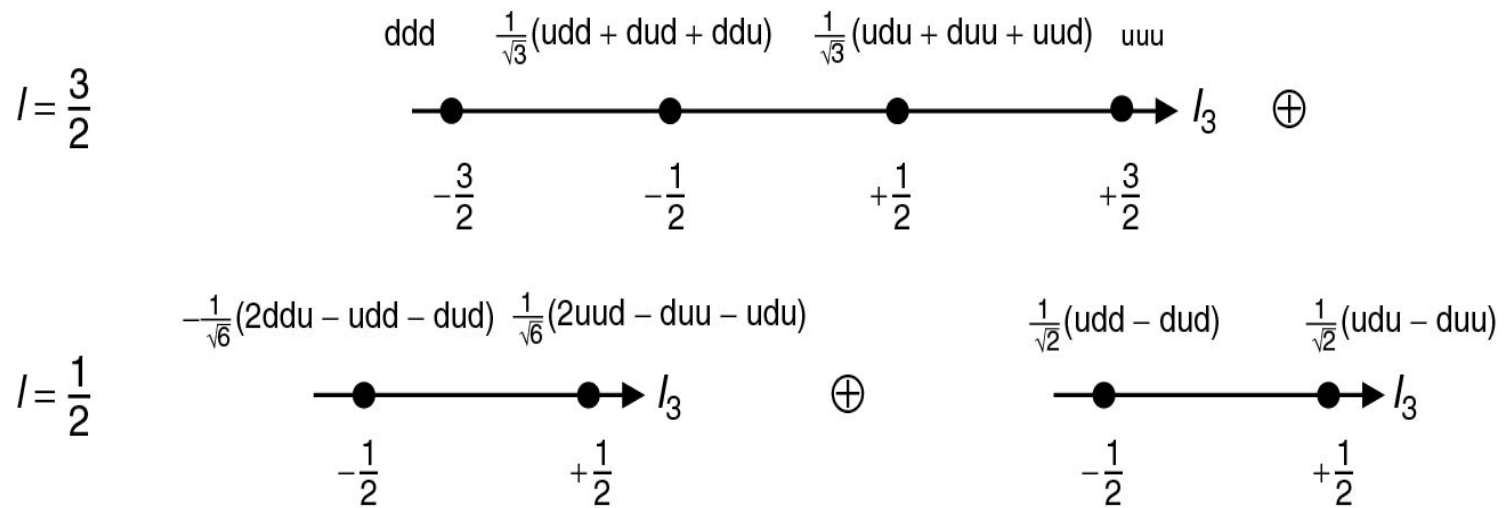
Use ladder operators to define multiplets



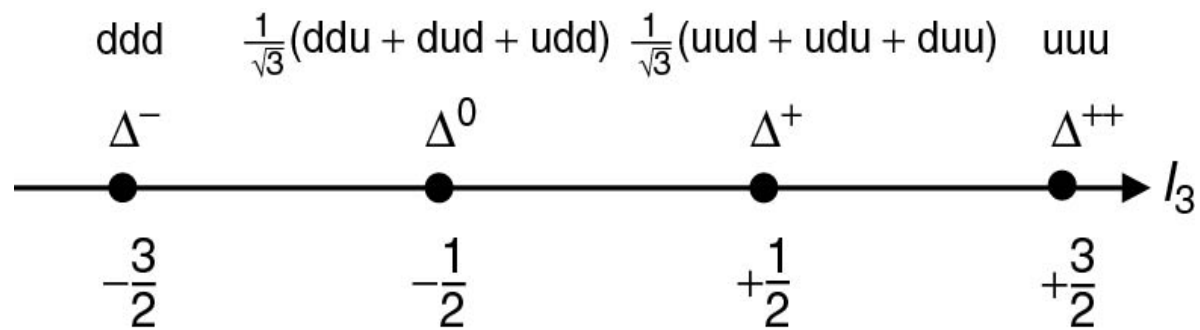
Adding one more quark



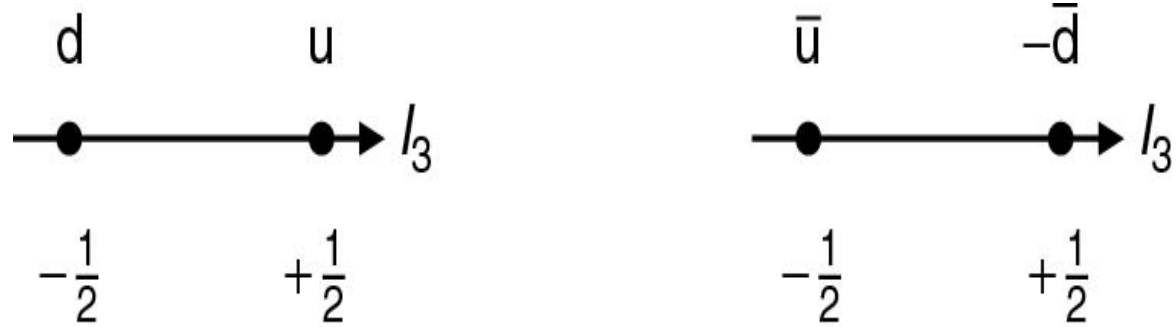
Use ladder operators to define isospin multiplets



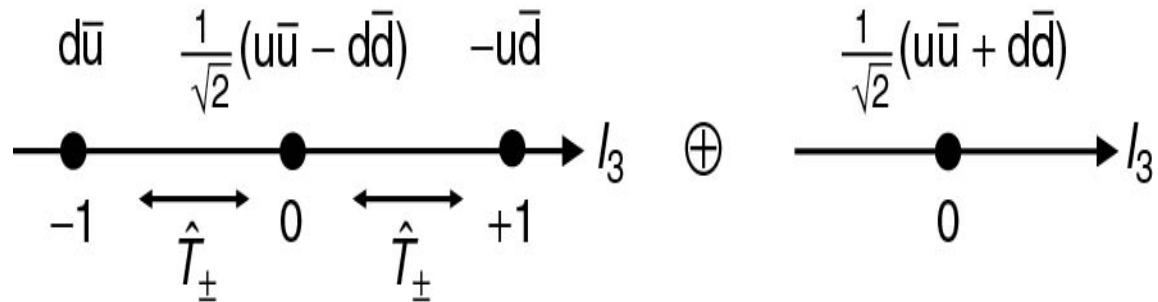
$I = 3/2$ light quark baryons, $S=3/2$



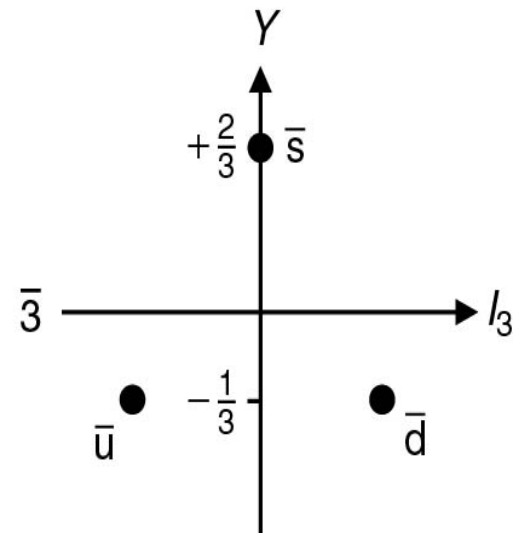
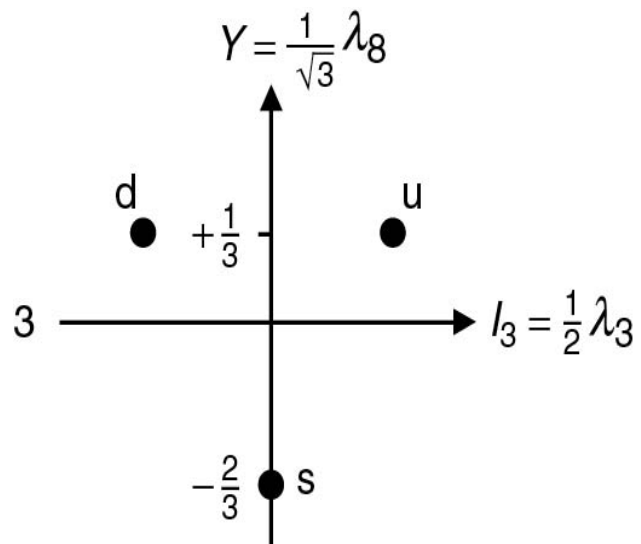
Isospin representation of d and u quarks and anti-d and anti-u quarks



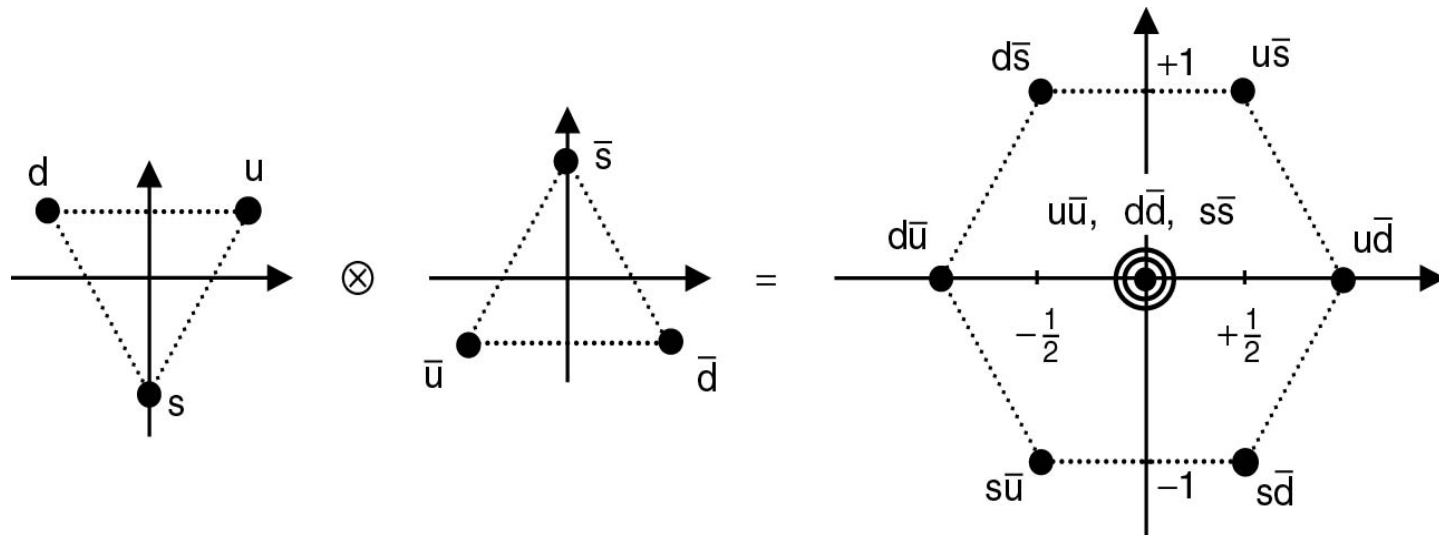
The meson isospin triplet and singlet



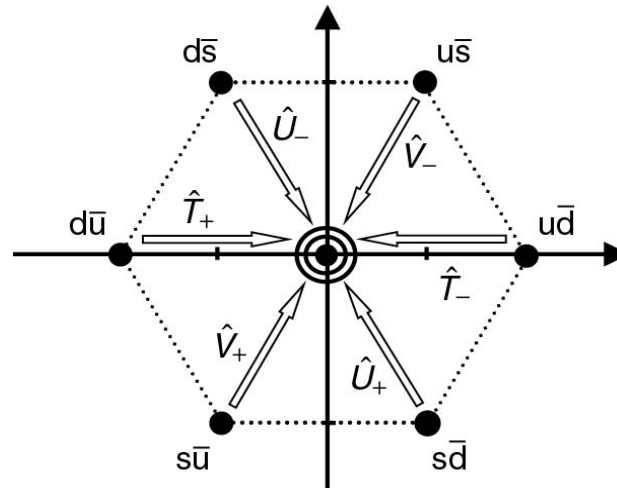
Isospin and hypercharge in SU(3) flavour symmetry for quarks and antiquarks



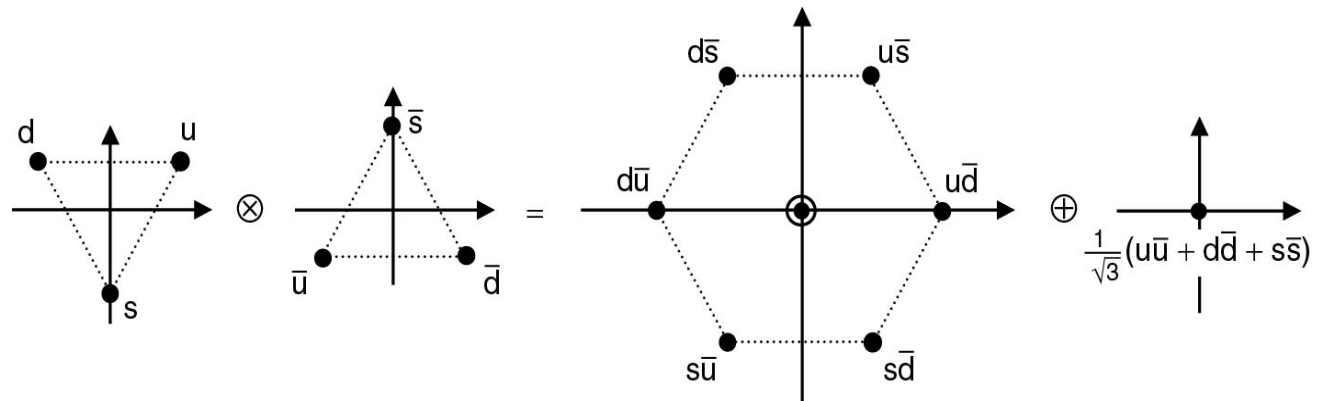
Isospin and hypercharge assignments of the nine possible quark-antiquark combinations

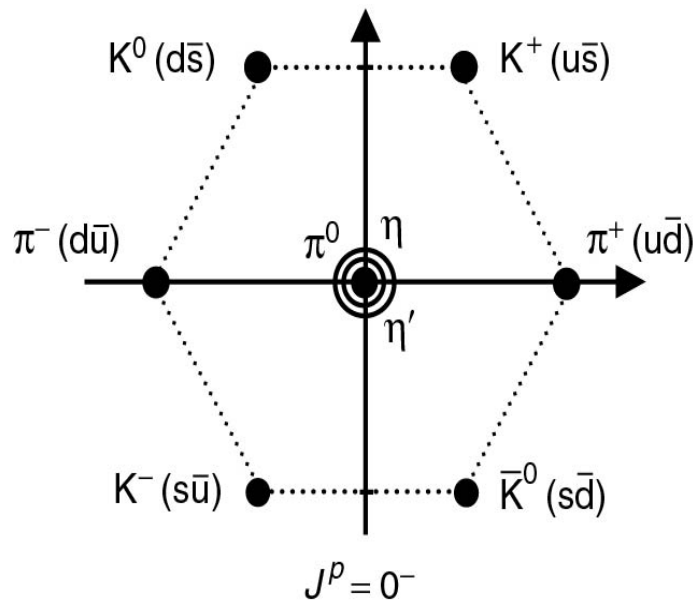


Exploit ladder operators

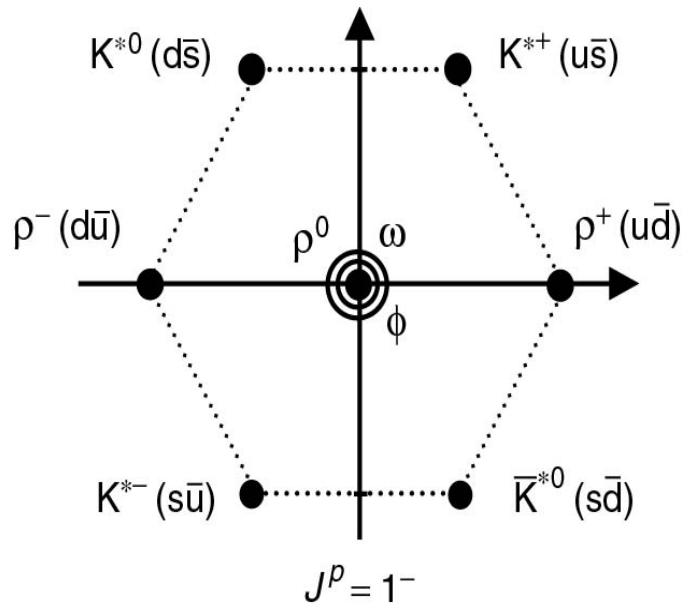


... to define multiplets





Pseudoscalar mesons, $L=0$, $S=0$



Vector mesons, $L=0$, $S=1$

Multiplet of two quarks in SU(3)

$$\begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \otimes \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} = \begin{array}{c} \frac{1}{\sqrt{2}}(ud + du) \\ dd \quad \bullet \quad \bullet \quad uu \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ \bullet \quad \bullet \\ \diagup \quad \diagdown \\ \bullet \quad ss \end{array} \oplus \begin{array}{c} \frac{1}{\sqrt{2}}(ud - du) \\ \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array}$$

adding one more quark

$$(a) \quad \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \otimes \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \otimes \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} = \left[\begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \oplus \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \right] \otimes \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array}$$

$$(b) \quad \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \otimes \begin{array}{c} \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} = \begin{array}{c} \bullet \quad \bullet \\ \diagup \quad \diagdown \quad \diagup \quad \diagdown \\ \bullet \quad \bullet \quad \bullet \quad \bullet \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ \bullet \quad \bullet \quad \bullet \quad \bullet \end{array} = \begin{array}{c} \frac{1}{\sqrt{3}}(uud + udu + duu) \\ \bullet \quad \bullet \quad \bullet \\ \diagup \quad \diagdown \quad \diagup \quad \diagdown \\ \bullet \quad \bullet \quad \bullet \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ \bullet \quad \bullet \quad \bullet \end{array} \oplus \begin{array}{c} \frac{1}{\sqrt{6}}(2uud - udu - duu) \\ \bullet \quad \bullet \quad \bullet \\ \diagup \quad \diagdown \quad \diagup \quad \diagdown \\ \bullet \quad \bullet \quad \bullet \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ \bullet \quad \bullet \quad \bullet \end{array}$$

$$(c) \quad \begin{array}{c} \frac{1}{\sqrt{2}}(ud - du) \\ \bullet \\ \diagup \quad \diagdown \\ \bullet \quad \bullet \\ \diagdown \quad \diagup \\ \bullet \end{array} \otimes \begin{array}{c} d \quad u \\ \diagup \quad \diagdown \\ \bullet \\ \diagdown \quad \diagup \\ s \end{array} = \begin{array}{c} \frac{1}{\sqrt{2}}(udu - duu) \\ \bullet \quad \bullet \\ \diagup \quad \diagdown \quad \diagup \quad \diagdown \\ \bullet \quad \bullet \quad \bullet \quad \bullet \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ \bullet \quad \bullet \quad \bullet \quad \bullet \end{array} \oplus \begin{array}{c} \frac{1}{\sqrt{6}}(uds - usd + dsu - dus + sud - sdu) \\ \bullet \end{array}$$

Observed octet and decuplet of light baryon states

