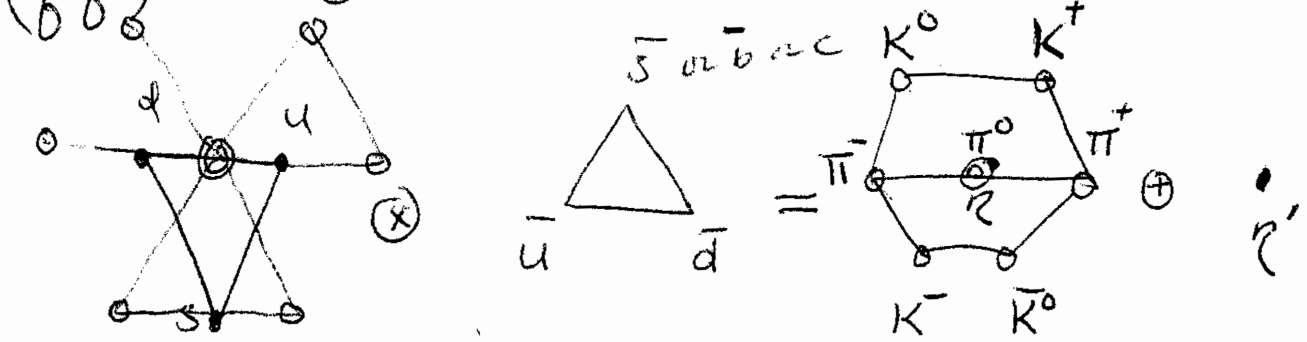
$(q\bar{q})$ $3 \otimes \bar{3}$



3

$$\bar{3} \otimes 3 = 8 \oplus 1$$

triplet

$\rho^0, \pi^0 \quad \dfrac{u\bar{u} - d\bar{d}}{\sqrt{2}}$

Octet

$\eta, \omega_8 = \dfrac{u\bar{u} + d\bar{d} - 2s\bar{s}}{\sqrt{6}}$

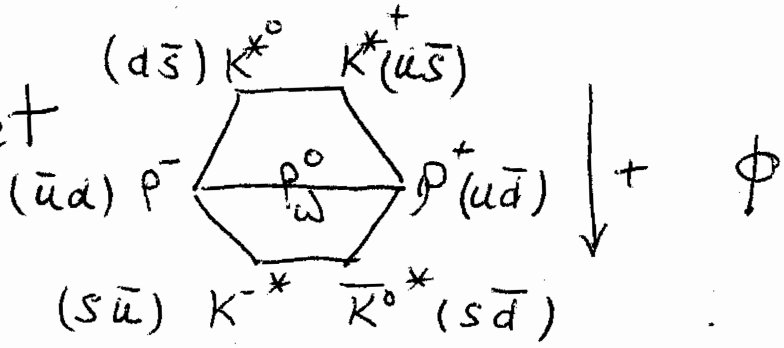
Singlet

$\omega_1 = \dfrac{u\bar{u} + d\bar{d} + s\bar{s}}{\sqrt{3}}$

mass eigenstates

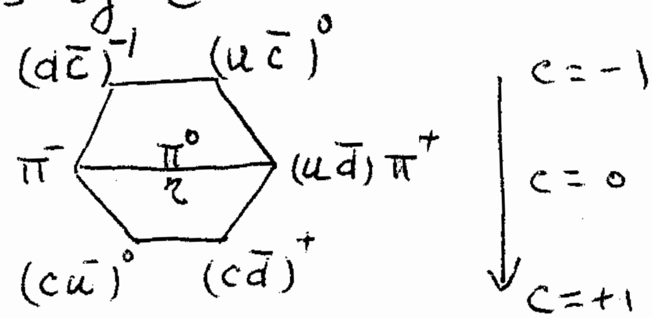
mass mixing $\longrightarrow$ $\rho_0, \omega = \dfrac{u\bar{u} \mp d\bar{d}}{\sqrt{2}}$ $\qquad \phi = s\bar{s}$

$J^P = 1^-$ nonet

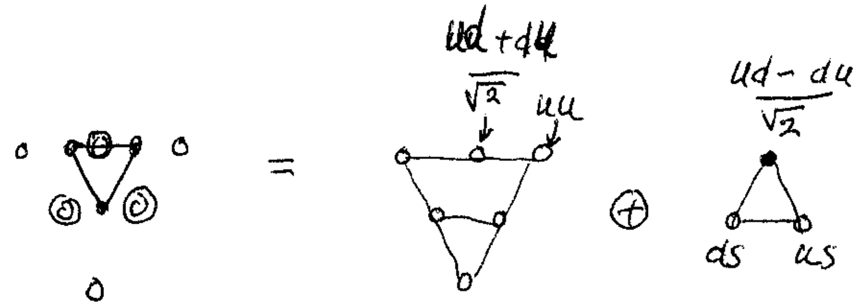


Replace s by b, $\longrightarrow$ B family

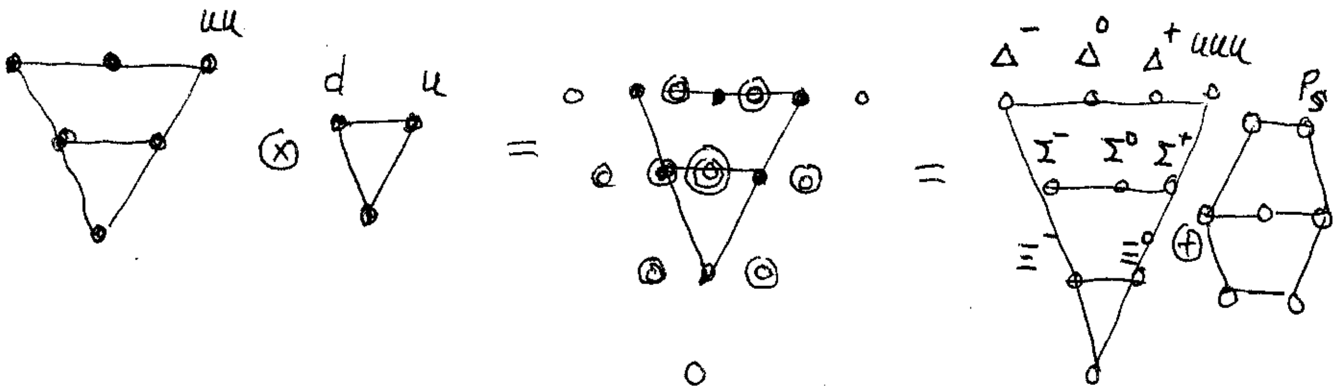
13) s by c



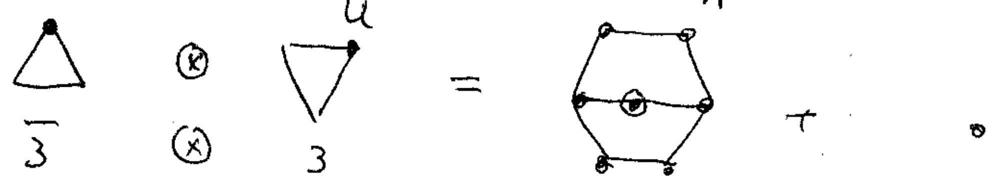
2.11 $q\bar{q})$

$\checkmark$ = 

$3 \otimes 3 = 6 \oplus \bar{3}$



$6 \otimes 3 = 10 \oplus 8$



$\bar{3} \otimes 3 = 8 + 1$

Sym. $\Delta^+ = \frac{uud + (ud+du)u}{\sqrt{3}} = \frac{uud + udu + duu}{\sqrt{3}}$

Sym $1 \rightleftarrows 2$ $P_S = \frac{1}{\sqrt{6}}[(ud+du)u - 2uud] \Rightarrow \perp$ to Δ^+ and P_A

anti-sym $P_A = \frac{1}{\sqrt{2}}(ud-du)u$

$$\text{Spin}\quad \underset{\frac{1}{2}}{} \quad \underset{\frac{1}{2}}{} \qquad\qquad\qquad 1 \qquad 0 \qquad\qquad \tfrac{1}{2}$$

$$(2 \otimes 2) \otimes 2 = (3_S \oplus 1_A) \otimes 2$$

$$\qquad\quad \tfrac{3}{2} \qquad\quad \tfrac{1}{2} \qquad\quad \tfrac{1}{2}$$

$$= 4 \oplus 2 \oplus 2$$

$$S \qquad M_S \qquad M_A$$

$$\underbrace{M_S \quad M_A}_{8_{1,2}}$$

$$S \longrightarrow$$

$$\chi(S) = \frac{1}{\sqrt{3}}\left[\uparrow\uparrow\downarrow + (\uparrow\downarrow + \downarrow\uparrow)\uparrow\right]$$

$$\chi(M_A) = \frac{1}{\sqrt{2}}(\uparrow\downarrow - \downarrow\uparrow)\uparrow$$

$$\chi(M_S) = \frac{1}{\sqrt{6}}\left[(\uparrow\downarrow + \downarrow\uparrow)\uparrow - 2\uparrow\uparrow\downarrow\right]$$

15)

Combine $\quad$ flavor $\quad$ spin

$$10 \oplus 8 \oplus 8 \oplus 1 \qquad 4 \oplus 2 \oplus 2$$

$$S \quad M_S \quad M_A \quad A \qquad S \quad M_S \quad M_A$$

symmetric decuplets $\quad$ octet

$S: \quad (10,4) + \underbrace{(8,2)} \qquad (S,S) + [(M_S, M_S)$

$S = 3/2 \qquad + M_A, M_A)] \frac{1}{\sqrt{2}}$

$M_S: \quad (10,2) + (8,4)$

$+ (8,2) + (1,2)$

$A,$

$M_A \quad (10,2) + (8,4) + (8,2) + (1,2)$

$A \quad (1,4) + (8,2)$

Isospin spin

$\Delta^{++} \quad \frac{3}{2}, \frac{3}{2} \quad \therefore$ symmetric

$\therefore$ Color $= \frac{1}{\sqrt{6}} (RGB \quad + \quad - \quad + \quad - \quad)$

anti-sym

$$|p\uparrow\rangle = \sqrt{\tfrac{1}{2}} \left[P_S \, \chi(M_S) + P_A \, \chi(M_A) \right]$$

$$= \qquad (2.71)$$

$|n\uparrow\rangle \quad d \rightleftarrows u$

2.12

mag. dipole $\mu_i = Q_i \frac{e}{2m_i}$

$$\mu_p = \sum_1^3 |P\uparrow> \mu_i(\sigma_3) | P\uparrow>$$

$$= \frac{1}{3}(4\mu_u - \mu_d)$$

$$\mu_n = \frac{1}{3}(4\mu_d - \mu_u) \qquad \mu_u \sim -2\mu_d$$

$$\frac{\mu_n}{\mu_p} = -\frac{2}{3}$$

Ground-state mass

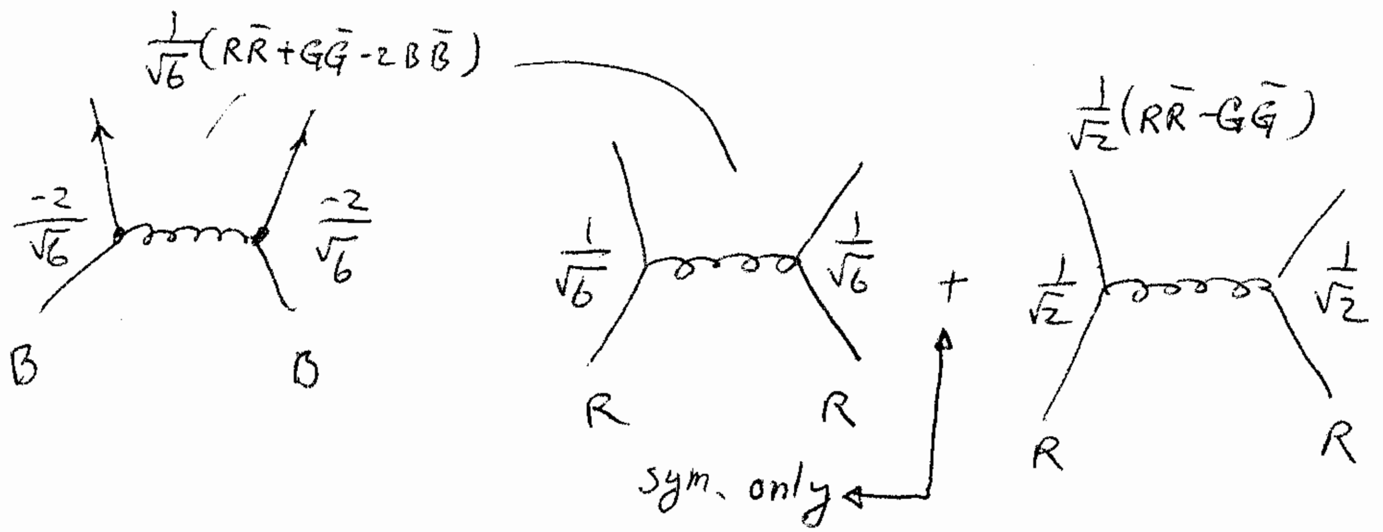
$$m(q\bar{q}) = m_1 + m_2 + a\left(\frac{\vec{\sigma}_1 \cdot \vec{\sigma}_2}{m_1 \; m_2}\right) + S \cdot L + \cdots$$

$$m(qqq) = \sum_i^3 m_i + \frac{a'}{2} \sum_{i>j} \left(\frac{\vec{\sigma}_i \cdot \vec{\sigma}_j}{m_i \; m_j}\right) +$$

$$\sigma_1 \cdot \sigma_2 = \frac{(\sigma_1+\sigma_2)^2 - \sigma_1^2 - \sigma_2^2}{2}$$

2.15 color factor

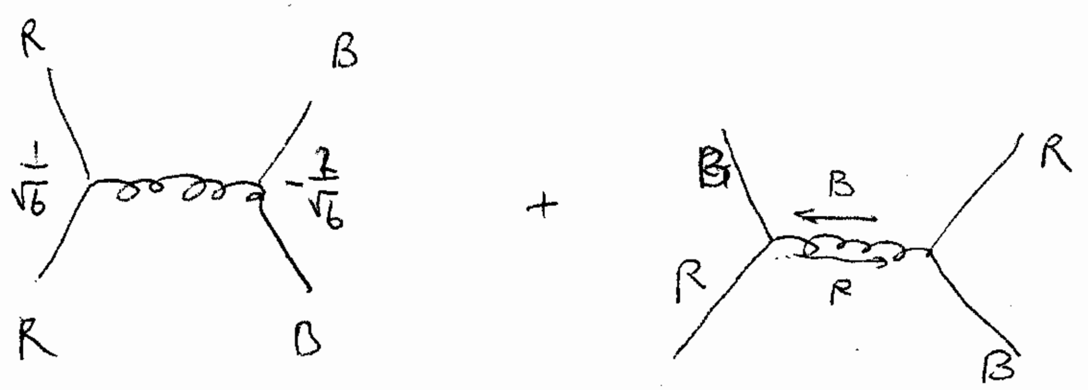
a) QQ of same color :



$= \frac{4}{6} = \frac{2}{3}$ $\qquad \frac{1}{6} + \frac{1}{2} = \frac{2}{3}$ repulsive

independent of color

b) QQ of diff. color :

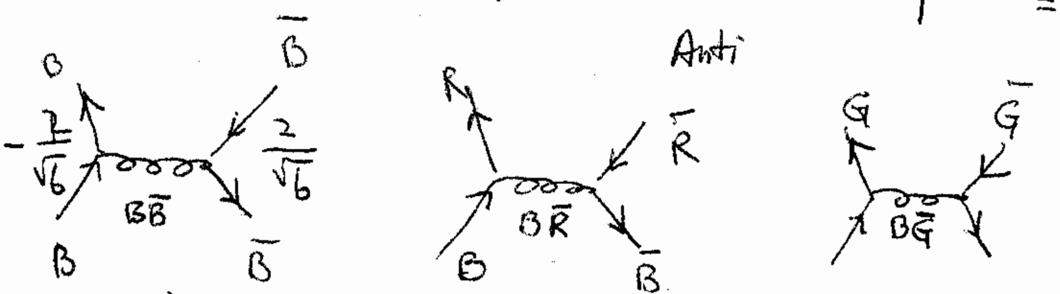


$\frac{-2}{6}$ $\qquad \pm$ — sym $\qquad 1 \quad = \quad \frac{2}{3}$

$-\frac{4}{3}$ Inside p

Attractive!

Anti



Inside mesons

18) $-\frac{2}{3}$ $\qquad -1 \qquad -1 \qquad = -\frac{8}{3}$ $\qquad$ "