Particle Physics

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$$3 \otimes 3^* = 1 \oplus 8$$

$$T = [T^i{}_j] = [q^i q_j]$$

$$= \begin{pmatrix} u\bar{u} & u\bar{d} & u\bar{s} \\ d\bar{u} & d\bar{d} & d\bar{s} \\ s\bar{u} & s\bar{d} & s\bar{s} \end{pmatrix}$$

$$q^i = \begin{pmatrix} u \\ d \\ s \end{pmatrix} \quad q_i = \begin{pmatrix} \bar{u} & \bar{d} & \bar{s} \end{pmatrix}$$

$$|I_3 Y Q\rangle_u = \left|\frac{1}{2}\frac{1}{3}\frac{2}{3}\right\rangle$$

$$|I_3 Y Q\rangle_d = \left|-\frac{1}{2}\frac{1}{3}-\frac{1}{3}\right\rangle$$

$$|I_3 Y Q\rangle_s = \left|0-\frac{2}{3}-\frac{1}{3}\right\rangle$$

$$|I_3 Y Q\rangle_{\bar{u}} = \left|-\frac{1}{2}-\frac{1}{3}-\frac{2}{3}\right\rangle$$

$$(I_3 Y Q)[T] = \begin{pmatrix} 000 & 101 & \frac{1}{2}11 \\ -10-1 & 000 & -\frac{1}{2}10 \\ -\frac{1}{2}-1-1 & \frac{1}{2}-10 & 000 \end{pmatrix}$$

$$T^i{}_j = (\frac{1}{3}\delta^i_j T^k_k) + (T^i_j - \frac{1}{3}\delta^i_j T^k_k)$$

$$= \frac{1}{\sqrt{3}} S + \bar{T}^i_j$$

$$S = \frac{1}{\sqrt{3}}(u\bar{u} + d\bar{d} + s\bar{s})$$

同位旋二重态

$$\begin{pmatrix} u \\ d \end{pmatrix} \quad \begin{pmatrix} \bar{d} \\ -\bar{u} \end{pmatrix} \quad \begin{pmatrix} K^+ \\ K^0 \end{pmatrix} \quad \begin{pmatrix} \bar{K}^0 \\ -K^- \end{pmatrix}$$

$$|10\rangle = \frac{1}{\sqrt{2}}(\alpha\beta + \beta\alpha) = \frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$$

$$|00\rangle = \frac{1}{\sqrt{6}}(u\bar{u} + d\bar{d} - 2s\bar{s})$$

$$\bar{T}_j^i : \begin{matrix} \bar{T}_1^1 \\ \bar{T}_2^2 \\ \bar{T}_3^3 \end{matrix}$$

$$\bar{T}_k^k = 0$$

$$T_{10} = \frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$$

$$T_{00} = \frac{1}{\sqrt{6}}(u\bar{u} + d\bar{d} - 2s\bar{s})$$

$$\lambda^3 = \begin{pmatrix} 1 & & \\ & -1 & \\ & & 0 \end{pmatrix}$$

$$\begin{pmatrix} \bar{u} & \bar{d} & \bar{s} \end{pmatrix} \begin{pmatrix} 1 & & \\ & -1 & \\ & & 0 \end{pmatrix} \begin{pmatrix} u \\ d \\ s \end{pmatrix} = \bar{u}u - \bar{d}d$$

Gell-Mann-Okubo formula

$$H = H_0 + H' \Longrightarrow SU(2) \times U(1)\text{不変的}$$