Non-examinable

Spin-spin corrections to meson and baryon masses.

Cont. from Handout 7:

Meson, and especially baryon masses within a given multiplet are different. Especially the case for excited v.s. ground state multiplets.

One can derive corrections to the mass formulas.

We know (QED) two dipols interact as:

$$U \sim \mu_1 \cdot \mu_2$$

=> for spins we have:

$$U \sim \frac{e}{m_1}\vec{S}_1 \cdot \frac{e}{m_2}\vec{S}_2 \sim \frac{\kappa}{m_1 m_2}\vec{S}_1 \cdot \vec{S}_2$$

QED -> QCD and)

Therefore, for $\ell = 0$ mesons one can derive:

$$m(q\bar{q}) = m_1 + m_2 + \frac{\text{Const}}{m_1 m_2}\langle \vec{S}_1 \cdot \vec{S}_2 \rangle$$

Similarly for baryons but with 3 terms.

unknown, have from experiment?

Since here $\vec{S} = \vec{S}_1 + \vec{S}_2$ => $\vec{S}^2 = \vec{S}_1^2 + 2\vec{S}_1 \cdot \vec{S}_2 + \vec{S}_2^2$

$$\Rightarrow \vec{S}_1 \cdot \vec{S}_2 = \frac{1}{2}\left(\vec{S}^2 - \vec{S}_1^2 - \vec{S}_2^2\right)$$

$$= \frac{1}{2}\left(\underbrace{S(S+1)}_{q\bar{q}\text{ system}} - \underbrace{S_1(S_1+1) - S_2(S_2+1)}_{\text{individual } q\text{'s}}\right)$$

=>

Pseud scal. mesons ($S=0$) $\quad m_p = m_1 + m_2 \boxed{-} \frac{3C}{4m_1 m_2}$ ← lighter!

Vector mesons ($S=1$) $\quad m_v = m_1 + m_2 + \frac{C}{4m_1 m_2}$

$m_d = m_u \simeq 0.3\ \text{GeV}$ $m_s \simeq 0.5\ \text{GeV}$ $C \simeq 0.06\ \text{GeV}^3$