Problem Set 6

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Problem 1 (3.16)

Draw the lowest-order Feynman diagrams at the quark level for the following decays:

(a) $D^- \to K^0 + \pi^-$

(b) $\Lambda \to p + e^- + \bar{\nu}_e$

where the quarks composition of the D^- and the Λ are given in Table 3.3.

Quark composition:

$$D^- = d\bar{c} \tag{1}$$
$$K^0 = d\bar{s} \tag{2}$$
$$\pi^- = d\bar{u} \tag{3}$$
$$\Lambda = uds \tag{4}$$
$$p = uud \tag{5}$$

a)

$$D^- \to K^0 + \pi^- \quad = \quad d\bar{c} \to d\bar{s} + d\bar{u} \tag{6}$$

Problem 2 (3.13)

The particle Y^- can be produced in the strong interaction process $K^- + p \to K^+ + Y^-$. Deduce its baryon number, strangeness, charm, and bottom, and, using these, its quark content. The $Y^-(1311)$ decays by the reaction $Y^- \to \Lambda + \pi^-$. Give a rough estimate of its lifetime.

Problem 3 (3.11)

Find the values of the parity P and, where appropriate, the charge conjugation C for the ground-state ($J = 0$) mesons $\pi^\pm$ and π^0, and their first excited ($J = 1$) states $\rho^\pm$ and ρ^0, where the latter have a mass of about 770 MeV/c^2. Why does the charged pion have a longer lifetime than the charged ρ? Explain also why the decay $\rho^0 \to \pi^+\pi^-$ has been observed, but not the decay $\rho^0 \to \pi^0\pi^0$

Problem 4 (3.21)

Derive the allowed combinations of charm C and electric charge Q for mesons and baryons in the simple quark model.