Exercise Sheet 6

Lecturers: Prof. F. Canelli, Prof. N. Serra
Assistant: Dr. A. de Cosa

1. Electron-quark scattering

Calculate the the total cross section for the underlying interaction of the deep inelastic electron-proton scattering at parton level, involving antiquarks $(e^- \bar{q} \to e^- \bar{q})$, in the following steps.

a) Draw the Feynman diagram and calculate the corresponding lowest-order matrix element.

1 pt

b) Evaluate the amplitude for this process, computing the matrix element in the centre-of-mass frame.

2 pt

c) Estimate its total cross section.

1 pt

2. Kaon decay

Draw the lowest-order Feynman diagrams for the decays

a)
$$K^0 \to \pi^+\pi^-, \quad K^0 \to \pi^0\pi^0, \quad \bar{K}^0 \to \pi^+\pi^-, \quad \bar{K}^0 \to \pi^0\pi^0,$$

and state how the corresponding matrix elements depend on the CKM matrix elements.

1 pt

3. D^0 decay

Draw the lowest order Feynman diagrams for the weak decays:

$$D^0 \to K^- + \pi^+ \text{ and } D^0 \to K^+ + \pi^-$$

a) Explain the observation that:

$$\frac{\Gamma(D^0 \to K^- + \pi^+)}{\Gamma(D^0 \to K^+ + \pi^-)}$$

is of the order of 10^{-3}

4. Colour factors

Draw the lowest QCD Feynman diagram for the antiquark-antiquark scattering $(\bar{q}\bar{q} \to \bar{q}\bar{q})$.

a) Write the matrix element for this process and compute its colour factor.

5. Particle

State which decays are allowed and by which interaction:

a) $\Lambda^0 \to p + \pi^+$

b) $B^0 \to D^- + \pi^+$

c) $\Lambda^0 \to K^- + \pi^+$