Exercises Physics VI (Nuclei and Particles)

Summer Semester 2009

Exercise sheet Nr. 7

Work out until 25.06.2008

Exercise 1: D^0 Decay (Points: 1)

Draw Feynman diagrams for the decays of D^0 mesons (quark content $c\bar{u}$) into $K^-\pi^+$ and $\pi^-\pi^+$. Estimate the magnitude of the ratio of partial decay widths $\Gamma(D^0 \to K^-\pi^+)/\Gamma(D^0 \to \pi^-\pi^+)$.

Exercise 2: Parity and C-parity (Points: 1)

The K^+ meson has spin 0 and decays mainly via the reaction $K^+ \to \mu^+\nu_\mu$. Sketch the direction of momenta and spin of the muon and neutrino in the rest frame of the kaon. Apply the parity operator P, the C-parity operator and also the combination of both operators CP to this process. Sketch the momenta and spins for the resulting reactions. Which of those three resulting reaction cannot proceed and why?

Exercise 3: Parity and orbital momentum (Points: 2)

The $\pi^+p \to \pi^+p$ reaction at a centre of mass energy of 1232 MeV proceeds practically exclusively through the formation of a resonant intermediate state, which is the Delta resonance $\Delta^{++}(1232)$ (Spin 3/2, parity +1 and decay width 120 MeV).

a) At which pion momentum is the resonance maximum if the proton is at rest in the laboratory system? What is the lifetime of the Delta resonance?

b) At which orbital momentum of the π^+p system does the resonance occur?

Exercise 4: Particle reactions (Points: 3)

Explain why the following reactions are forbidden or strongly suppressed:

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

b) $p \to n + \pi^+$

c) $\Lambda^0 \to \pi^+ + e^- + \bar{\nu}_e$

d) $J/\psi \to \gamma + \gamma$

e) $\nu_\mu + p \to \mu^+ + n$

f) $e^- + \gamma \to e^-$

For the following reactions, identify the dominant interaction:

g) $p + K^- \to \Sigma^+ + \pi^- + \pi^+ + \pi^- + \pi^0$

h) $\bar{\Sigma}^0 \to \bar{\Lambda}^0 + \gamma$

i) $n + p \to \Lambda^0 + K^0 + p$

j) $J/\psi \to \mu^+ + \mu^-$

k) $K^- \to \pi^- + \pi^0$

l) $\tau^- \to \pi^- + \nu_\tau$

m) $\nu_e + p \to e^- + \pi^+ + p$

n) $\pi^0 \to \gamma + e^+ + e^-$

o) $\bar{\Delta}^0 \to \bar{n} + \pi^0$

Give also the quark content of all hadrons involved in those reactions.