Übungsblatt 8

8.1 Strange pseudo-scalar and vector mesons (25 Points)

The lightest mesons containing a strange quark are the K - mesons. In total, there are four of them.

a) Write down their quark contents and group them into the proper isospin multiplets.

b) The K - mesons are "pseudoscalar mesons" with spin - parity assignment 0^- . There exist four excited states with exactly the same quark contents, but with spin - parity assignment 1^- ("vector mesons"), called $K^*(892)$, for short K^*. The K^{*+} - meson has two decay channels: $K^+ \pi^0$ and $K^0 \pi^+$.

Determine the relative branching fractions for these decays. Make use of the tables of Clebsch - Gordan coefficients.

8.2 Isospin assignment of two-particle states (25 Points)

Write down all possible isospins (i.e. total isospin I and third component I_3) for the following two-particle states:

a) $(\pi^+ \pi^+)$; $(\pi^+ \pi^0)$; $(\pi^0 \pi^0)$

b) $(\pi^+ p)$; $(\pi^+ n)$; $(\pi^- p)$; $(\pi^0 n)$

c) $(K^+ p)$; $(K^0 p)$

d) $(\overline{K^0} p)$; $(\overline{K^0} n)$

8.3 A non-observed meson decay (25 Points)

The mesonic resonance $\rho^0(770)$ decays at nearly 100 % into two charged pions: $\rho^0 \rightarrow \pi^+ \pi^-$. The decay into two neutral pions is obviously forbidden. For this interdiction, one can state three (independent) reasons. With your present knowledge, you should be able to write down two of them. Please explain your statement.

8.4 How to measure a quark's momentum: (25 Points)

In high - energy electron - proton interactions with large 4-momentum transfer between electron and proton, called "deep inelastic scattering (DIS)", one believes that the exchanged virtual photon "probes" the proton by interacting with a single quark inside. In this framework it is possible to "measure" the fraction of the mother - proton's momentum which was carried by the "struck quark", just with the knowledge of the kinematics of the incoming particles and the

4-momentum of the scattered electron:

Calculate the quark's fraction of the proton - momentum in terms of k, the incoming electron's 4-momentum, p, the proton's 4-momentum, and k', the 4-momentum of the scattered electron.

Hint: Start from a simplifying assumption, namely that the virtual photon with 4-momentum q is absorbed by the (quasi-free) "struck" quark inside the proton, which after this interaction continues again as a quasi-free particle with 4-momentum, say, R. Neglect quark masses at the appropriate stage of your calculation!