Title: Construction of pseudoscalar meson amplitudes in chiral perturbation theory using a dispersive approach

Author: Martin Zdráhal

Department: Institute of Particle and Nuclear Physics, Faculty of Mathematics and Physics, Charles University in Prague

Supervisor: RNDr. Jiří Novotný, CSc.

Abstract:
We have developed a method enabling a construction of two-loop $2 \to 2$ scattering amplitudes of pseudoscalar mesons based on the dispersion and the unitarity relations. This method is illustrated on the construction of the amplitudes of all such processes in chiral perturbation theory in isospin limit taking into account strong interactions only.

Then it was used for the construction of $\pi\pi$ scattering amplitudes and of $K \to 3\pi$ and $\eta \to 3\pi$ decay amplitudes including isospin breaking effects induced by different masses of the particles belonging to the same isomultiplet. These parametrizations are prepared for various phenomenological analyses of the $\pi\pi$ scattering lengths and of the isospin breaking effects, both of which could provide us important information for the understanding of quantum chromodynamics at low energies.

Finally, we have performed the phenomenological study of $\eta \to 3\pi$ decay and obtained a value of the quark mass ratio $1/R = (m_d - m_u)/(m_s - \hat{m})$. Our conservative estimate is $R = 39.6^{+2.5}_{-5.1}$. This value supplemented by the values of the isospin symmetric masses $\hat{m} = (m_u + m_d)/2$ and m_s from other methods (as sum-rules or lattice) enables us to obtain currently the most precise determination of the m_u and m_d quark masses, whose values are quoted in the text.

Keywords: pseudoscalar meson processes, dispersion relations, chiral perturbation theory, isospin breaking, quark masses determination