CUSPS IN THE KAON DECAYS

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The pion mass difference creates a pronounced cusp in the $\pi^0\pi^0$ invariant mass distribution for $K^+ \to \pi^+\pi^0\pi^0$ decays. The determination of the parameters of this cusp with high precision enables one to carry out an independent measurement of a particular isospin combination $a_0 - a_2$ of the S-wave $\pi\pi$ scattering lengths [1,2] (similar phenomenon occurs also in the decays of the neutral mesons $K_L \to 3\pi^0$ and $\eta \to 3\pi^0$). The major theoretical challenge in the study of the above decays consists in deriving an accurate parameterization of $K \to 3\pi$ amplitudes in terms of the threshold parameters of $\pi\pi$ scattering that would enable one to determine the scattering lengths from the fit to the available experimental data.

Another source for determining the S-wave $\pi\pi$ scattering lengths is provided by the K_{e4} decays [3]. It can be seen that the isospin breaking leads to a pronounced effect for this decay process as well – most notably, a sub-threshold cusp emerges in the $\pi\pi$ scattering phase, extracted from the data by using Watson theorem. Only after removing this large effect, a meaningful comparison of the experimental results with the theoretical predictions for the $\pi\pi$ scattering lengths is possible [4].

It turns out that the most convenient and systematic language to describe the cusp phenomena in all above decay processes is provided by the non-relativistic effective field theory. In this talk, which is based on recent publications [5-6] as well as more work in preparation done in collaboration with M. Bissegger, G. Colangelo, A. Fuhrer, J. Gasser and B. Kubis, I describe the construction of the framework. As particular applications, I address the issue of electromagnetic corrections in $K \to 3\pi$ decays (which are already important at the accuracy of the available data). Modification of Watson theorem in the presence of isospin-breaking effects is also considered.

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