Chiral approach to the two pion decay of the Roper

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The unitary extension of chiral perturbation theory[1] has allowed to study the meson meson interaction up to 1.2 GeV and generates dynamically the scalar resonances up to this energy, among them the σ meson which appears around 500 MeV with a width of around 400 MeV. This fact allows one to tackle the question of the scalar isoscalar NN interaction from the point of view of the exchange of two interacting pions which are treated within the context of this $U\chi PT$[2]. The Roper decay into two mesons is analyzed in ref.[3] in terms of the emission of a heavy σ of around 800 MeV with a width equally large, together with the decay into $\Delta\pi$. Yet, in view of all recent finding of a σ mass and width substantially smaller, a reanalysis of Manley's work becomes necessary. We have done so while at the same time constructing a theoretical model which provides the two pion decay of the Roper. Our model consists of open diagrams with two pion emission and N, Δ or N^* in between them, and closed diagrams, where the pions in the former diagrams are allowed to rescatter as they do in the case of the σ exchange in ref.[2]. The strength of the $N^* \to \Delta\pi$ is fixed by demanding that the total two pion width coincides with experiment. After this is done, the distribution of $\pi\pi$ invariant masses is calculated and now the closed diagrams reflect the realistic two pion distribution in the scalar isoscalar channel, contrary to Manley's results where the isoscalar decay has a pure phase space distribution. It is interesting and surprising that although the individual contributions from the isoscalar production and $\Delta\pi$ production are very different in the two models, the sum is remarkably similar. Hence we are able to reinterprete Manley's phenomenology whithin a context consistent with chiral theory, while at the same time providing a theoretical framework for it in which only the $N^*\Delta\pi$ coupling is fitted to the experiment. Given the fact that the isocalar Roper decay amplitude plays an important role in all two pion production processes near threshold, the findings of this work should have a great relevance in the chiral dynamical interpretation of these processes.

References

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