Pion-Nucleon Analysis

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Since the emergence of chiral perturbation theory (ChPT) as a tool for studying low-energy interactions of hadrons, in particular the interaction of the pion with the nucleon, the need for understanding the interaction phenomenologically has increased.

What is needed is a partial wave analysis, which incorporates the known constraints due to analyticity, unitarity and crossing together with the modern data. There are, however, a number of problems, which require particular attention. One such issue is the question of the electromagnetic corrections. Isospin is also violated due to the u- and d-quark mass difference. The standard technique has been to apply the corrections of Tromborg et al. [1], but this approach ignores a number of effects and the isospin violation due to the quark mass difference is treated only at the level of kinematics. Recently, an order p^3 calculation has been performed in the heavy-baryon version of ChPT including both the strong and the electromagnetic part [2]. Here the accuracy is limited by the low-energy constants and the limited range of validity of the p^3 calculation to be compared with the data. In any case, changes in the electromagnetic corrections are found. For the triangle relation an isospin violation of -0.7 % for the S-wave is found.

It is the aim of the present investigation [3] to perform a fixed-t analysis of the pion-nucleon interaction to fix some of the low-energy constants needed in the ChPT work on few-body systems of pions and nucleons. It is also intended to determine the pion-nucleon coupling constant. The standard value since the 70's has been $f^2 = 0.079$, whereas more recent determinations, e.g. of the VPI-GWU group, favour values close to $f^2 = 0.076$. Furthermore, it is of interest to estimate the value of the pion-nucleon sigma-term, because it reflects the strangeness content of the nucleon, and has implications e.g. to dark matter searches.

References

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