Comment on "Determination of the πNN Coupling Constant from Elastic Pion-Nucleon Scattering Data"

A determination by the VPI group [1] of the πNN coupling constant for charged pions, $f^2=0.0735\pm0.0015$, has been reported using their recent SM90 phase-shift analysis [2] of πN scattering data. This value is in reasonable agreement with that reported by the Nijmegen group [3] for the $\pi^0 pp$ coupling constant, 0.0749 ± 0.0007, determined from their phase-shift analysis of pp scattering data below $T_{\rm lab}=350$ MeV. Both results are lower, by more than 3 times the quoted errors, than the result of Koch and Pietarinen [4], who obtained $f^2=0.079\pm0.001$ from the 1980 Karlsruhe πN phase-shift analysis. Until the VPI determination, the common explanation of this difference was the breaking of charge independence in πN interactions. The most recent results of the Nijmegen group [5] show that there is no evidence for any charge dependence of the pion-nucleon coupling constant. Regardless, it is now of interest to determine if the two values from πN analysis differ because of the incorporation of newer data or because of differences in technique or parametrization. The errors determined for f^2 are also of fundamental interest.

Calculations done by the Karlsruhe group [6] using earlier VPI solutions have shown that they were not consistent with analyticity. This suggested that a detailed check of the new VPI solution with fixed-t dispersion relations (FTDR) should be made. The method used by VPI is the same as that described by Karlsruhe [7].

We have evaluated Eq. (1) from Ref. [1] using the same partial wave solution, VPI SM90, which was provided to us by the authors. This solution has much smaller deviations from FTDR than earlier versions (see [6]) but some inconsistency with FTDR still exists. An extrapolation of the relation for the B_+ amplitude in $\pi^+ p$ scattering shows a clear tendency toward a value for the coupling constant which is even higher than that of Koch and Pietarinen. There is a deviation from linearity in the region $0.2\le \nu_B+\nu \le 0.3$ GeV, which was not plotted in [1]. The deviation shows that the inconsistency with FTDR is larger than the quoted error for f^2. When evaluating this relation for values in the range $0.1\le -t\le 0.3$ GeV^2, the results obtained for f^2 vary between 0.070 and 0.075. This variation is another manifestation of the remaining incompatibility with FTDR.

An additional method of obtaining the pion-nucleon coupling constant f^2 is based on the interior dispersion relations (IDR) [8]. We have used IDR for determining the pion-nucleon coupling constant and as a test of analyticity and crossing symmetry. We have evaluated Eq. (2.5) of Ref. [8] using the SM90 solution for evaluation of the integral along the s-channel cut. The $\pi\pi \to N\bar{N}$ partial waves given by Höhler and Pietarinen [9] were used to evaluate the integral along the t-channel cut, which is small [10] compared to the other terms. We made several calculations using values of the path parameter a (see [8]) in the range $-0.7\le a\le 0$ GeV^2. This range corresponds to lab scattering angle $95°\le\theta_L \le 180°$. The partial wave expansion in the t channel converges for $a>-0.7$ GeV^2. The resulting values for f^2 increase from 0.067 ($a=0$) to 0.070 ($a=-0.7$).

The VPI approach does not take into account the well-established left-hand singularities of the πN partial waves. Theoretical constraints such as FTDR or IDR make it more difficult to obtain "the best" fit to the data. However, analytical constraints should be included if an analysis is to be used to extrapolate outside the physical region, such as determinations of f^2 or the pion-nucleon sigma term.

A strength of the VPI analysis is the timely manner in which new data can be incorporated. It has proven to have predictive capabilities superior to other analyses due to this feature and it may well be true that the inclusion of the new data is responsible for lowering the value of f^2. However, many of the data sets below 100 MeV are incompatible so the results of any new analysis will depend on data selection.

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J. Stahov
Faculty of Technology, University of Tuzla
75000 Tuzla, Yugoslavia

M. E. Sadler
Department of Physics, Abilene Christian University
Abilene, Texas 79699

V. V. Abaev
Leningrad Nuclear Physics Institute
Gatchina, Leningrad District, 188350 U.S.S.R.

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