On the Threshold Behavior
of the Negative to Positive Ratio in Pion Photoproduction.

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Summary. — It is shown that the extrapolation used by Beneventano et al. to obtain the negative to positive ratio at threshold is very sensitive to small alterations which can be made due to the approximate nature of the procedure. Such small alterations bring about very substantial changes in the energy dependence of the ratio near threshold and hence the extrapolation is quite ambiguous in the absence of extensive experimental data on the ratio in this energy region. Since such extensive set of data does not exist at the present time, it is concluded that there is no good reason to believe that the ratio at threshold is in disagreement with the theoretical predictions.

1. — Introduction.

The value of the negative to positive ratio in pion photoproduction and its relationship to other experimental quantities has been somewhat of a puzzle for some time. This quantity is an important clue to the S wave part of the pion-nucleon interaction, which is considerably less well known than the P wave part. In fact, a consistent scheme which includes the interpretation of the threshold ratio in photoproduction, the S wave scattering phase shifts, the Panofsky ratio, and perhaps even other quantities, has been the aim of numerous investigators during the past few years.
One of the important papers in this field has been that of Beneventano et al. (1). This paper, besides presenting some new experimental data, attempted an over-all analysis of photoproduction data in the energy region between threshold and about 240 MeV photon energy in the laboratory system. In particular, it derived a semi-empirical equation (reference (1) Eq. (21)) for the energy dependence of the ratio near threshold and used the coefficients of the angular distribution of positive photopions in conjunction with four pieces of data on the ratio itself to extrapolate and determine the ratio at threshold. The resulting ratio turned out to be 1.85 or even higher. It was remarked that this value strongly disagrees with the value predicted by the threshold theorems and the dispersion approach, which claim that the result of the perturbation theory (about 1.4) should be correct. Similarly, the pion-nucleon coupling constant obtained by the usual extrapolating procedure also turns out peculiarly low when we utilize this high value of the ratio. The value of the coupling constant has been determined with great apparent reliability by several procedures, all agreeing very well, while the coupling constant obtained from this high threshold ratio is more than 20% lower than the commonly accepted value. On the other hand, it was also remarked that the high ratio can be correlated more easily with the latest value of the difference in the slopes of the two $S$ wave scattering phase shifts and with the latest value of the Panofsky ratio. The implication of BBCST is that the real discrepancy is between the theoretical prediction of the ratio and the «experimental» value of the ratio as obtained by BBCST, and that this «experimental» value is in reasonable agreement with other clues to the $S$ wave pion-nucleon interaction.

The purpose of this paper is not to solve this discrepancy and to give a unified scheme for the $S$ wave interaction. Instead, the aim is to show that if one alters slightly the approximations used by BBCST one can obtain a quite different and considerably lower result for the threshold ratio. It is not claimed that the new ratio is a priori a more reliable value than the old one. It is claimed however, that our modification of the BBCST analysis is equally in agreement with the general principles used and with the experimental data which go into the numerical evaluation.

The important criterion for the choice of the extrapolating formula is of course the experimental material on the ratio itself. BBCST used four pieces of data at 90° (see reference (1), Fig. 5). It has been pointed out (2) that apart from the quantitative inadequacy of these data they also fall at higher energies below, and at lower energies above, the value one obtains when inter-

(1) M. Beneventano, G. Bernardini, D. Carlson-Lee, G. Stoppini and L. Tau: Nuovo Cimento, 4, 323 (1956). This paper will be referred to as BBCST.