THE ASSYMETRY IN THE DECAY OF THE ρ^0

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Received 11 September 1964

Since the results on angular distribution of the pions coming from the ρ^0 decay were made known during 1961 [1], and confirmed in later publications [2-4], the problem of explaining or interpreting the observed asymmetry was raised [5,6].

Hagopian and Selove [4] gave some results of a phase shift analysis of their data, considering the elastic scattering of two real pions, (neglecting the "off mass shell" effect), that indicates a strong $I = 0$, S-wave.

Studying the two "peripheral" reactions:

$$\pi^- + p \rightarrow n + \omega^0 \quad (\omega^0 \rightarrow \pi^+ + \pi^-)$$

$$\pi^- + p \rightarrow n + \rho^0 \quad (\rho^0 \rightarrow \pi^+ + \pi^-)$$

Islam and Pinon [7] found that they are incoherent and that therefore the observed asymmetry in the ρ^0 cannot be attributed to an interference with the ω^0, at least if those models are valid.

In this letter, we give the complete results of a phase shift analysis of the angular distribution of the pions from the ρ^0 decay, including up to d-waves, based on the experimental data obtained by the Saclay-Orsay-Bari-Bologna Collaboration [2]. To obtain the solutions we use a numerical method that searches for the minimum χ^2.

We consider the elastic scattering of two pions, taking into account the "off mass shell" effect by introducing the correction factor suggested by Selleri [8]. The phase shift with the quantum numbers of the ρ is taken to be $\delta_1{}^1 = 90^o$.

As solutions, we obtain two sets of values for the phase shifts, with the same $\chi^2 = 28.5$. They are shown in table 1.

Table 1
Phase shifts which better fits the angular distribution of the pions coming from ρ^0 decay. The subscript represents the angular momentum l and the superscripts the isotopic spin I.

Phase shifts	Set I [°]	Set II [°]
δ_0^0	130 ± 14	45 ± 15
δ_2^0	28^{+2}_{-10}	160^{+6}_{-14}
δ_0^2	134^{+20}_{-30}	49 ± 26
δ_2^2	9 ± 11	150^{+37}_{-7}

The errors indicated in the table have the following meaning: in their limits the probability associated to the respective χ^2 falls to one half that corresponding to the mean value.

(For comparison, the fit with an algebraic polynomial of fourth degree gives $\chi^2 = 17.6$.)

It is not surprising that two sets of phase shifts are obtained as solutions by the numerical method. The partial wave development of the scattering amplitude is invariant under the simultaneous exchange $\delta_l{}^I \rightarrow \pi - \delta_l{}^I$ for all the four phase shifts. Thus the numerical results can be considered as a test of goodness of the method.

To decide between both sets, we make the following considerations:
a) The $\delta_2{}^0$ takes on the value 90° at the energy of the f^0 resonance, that is at $m_{\pi\pi}$ = 1250 MeV. One can hope it has an intermediate value (between 0° and 90°) at the energy of the ρ ($m_{\pi\pi}$ = 750 MeV).
b) One can expect tg $\delta_0{}^2$ to be negative, like it was found in the charge state of the dipion system [9].

Both considerations rule out set II. The remaining set I is compatible with the values given by Hagopian and Selove [4] and is in accordance with observations made by Berthelot [6].

The angular distribution obtained from the phase shifts of set I is drawn in fig. 1 together with the experimental results considered.

It is not easy to find a unique way for making compatible our results of set I with those of Booth et al. [10] on the ABC effect. If the ABC is not a resonance, the existence of more than one ghost pseudobond state of $m_{\pi\pi}{}^2 < 0$ may give an acceptable explanation.

We wish to thank Dr. S. W. Mac Dowell for his valuable help that enabled to make this work possible, Dr. A. Pignotti for many fruitful discussions contributing to some aspects of this letter, and the computing centre of the University of Buenos Aires, particularly to Mr. E. Waisman, Dr. R. Guber and Mrs. C. Berdichevsky.

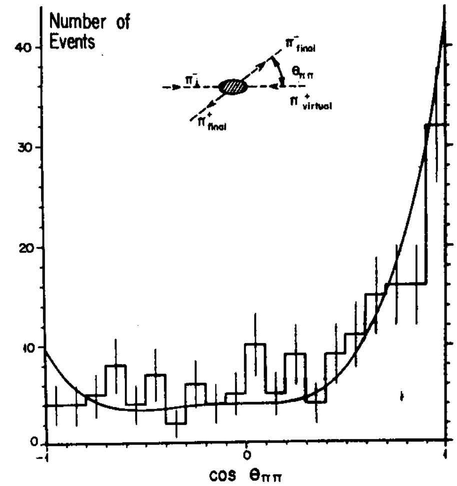

Fig. 1. Angular distribution of the pions coming from the ρ^0 decay. Experimental values are those given by the Saclay-Orsay-Bari-Bologna Collaboration. The curve was determined with the set I of phase shifts.

References

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