Title
S-WAVE PIONS IK THE REACTION p + p->n+ + d

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In their phenomenological analysis of the reaction

$$p + p \rightarrow \pi^+ + d, \tag{1}$$

Gell-Mann and Watson[1] use for the c. m. differential cross section the expression

$$4\pi \frac{d\sigma}{d\Omega} = \alpha\eta + \beta\eta^3 \frac{X + \cos^2\theta}{X + 1/3}, \tag{2}$$

where η is the pion c.m. momentum in units $m_\pi c$, and α, β, and X are constants. The first term, $\alpha\eta$, is supposed to arise from S-wave pions, and the second from P-wave pions.

Integration of Eq. (2) yields the total cross section

$$\sigma = \alpha\eta + \beta\eta^3. \tag{3}$$

Lichtenberg has recently made a theoretical calculation[2] of the differential cross section for Reaction (1) at energies near threshold. As a result he concludes that Expressions (2) and (3) are not appropriate for a phenomenological analysis, and that more suitable expressions are

$$4\pi \frac{d\sigma}{d\Omega} = \left(\frac{p_0}{p}\right)^3 \left[\alpha'\eta + \beta'\eta^3 \frac{X' + \cos^2\theta}{X' + 1/3}\right], \tag{2}'$$

$$\sigma = \left(\frac{p_0}{p}\right)^3 \left[\alpha'\eta + \beta'\eta^3\right]. \tag{3}'$$

*This work was done under the auspices of the U.S. Atomic Energy Commissio

[1] M. Gell-Mann and K. M. Watson, Ann. Rev. Nuclear Sci. 4, 219 (1954).

[2] D. B. Lichtenberg, Phys. Rev. 105, 1084 (1957).

where p is the relative incident proton momentum in the cm system, p_0 is the value of p at threshold, and α', β', and χ' are new constants.

Lichtenberg points out that the p^3 dependence in Eq. (3)' has the effect of making the P-wave production rise less rapidly than η^3. Consequently a pure P wave may seem like a mixture of S and P waves if analyzed according to Eq. (3), instead of the more appropriate Eq. (3)'. Lichtenberg concludes that the amount of S wave is poorly known, and that "a rough estimate indicates that $(\alpha'/\beta') \sim 0.03$."

Our experimental differential cross-section measurements are at present the only published results that determine directly the amount of S wave in Reaction (1), through measurement of the momentum dependence fairly near threshold.[3] A least-squares fit of our data[4] to Eq. (2) yielded[3]

$$\alpha = (0.138 \pm 0.015) \text{ millibarn},$$

$$\beta = (1.01 \pm 0.08) \text{ millibarns},$$

$$\chi = 0.082 \pm 0.034,$$

$$\alpha/\beta = 0.137 \pm 0.025.$$

In the light of Lichtenberg's remarks we have reanalyzed our data in terms of Eq. (2)'. We find

$$\alpha' = (0.125 \pm 0.017) \text{ millibarn},$$

$$\beta' = (1.40 \pm 0.10) \text{ millibarns},$$

$$\chi' = 0.13 \pm 0.03,$$

$$\alpha'/\beta' = 0.090 \pm 0.016.$$

We see that the S-wave contribution, α', is still clearly present, although reduced in comparision with the P wave, under the new analysis.

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[3] Frank S. Crawford, Jr., and M. Lynn Stevenson, Phys. Rev. 97, 1305 (1955).

[4] Table I of Reference 3.