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ON THE PLUS-MINUS RATIO FROM PROTON BOMBARDMENT OF DEUTERIUM

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October 2, 1952

Berkeley, California

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October 2, 1952

Noyes has calculated the expected ratio of negative to positive π mesons in the forward direction when deuterium is bombarded by 345 Mev protons. Most of the mesons in collisions with free target nucleons have 60-70 Mev energy in the laboratory system. To obtain π mesons in this energy range from p-d collisions, the production must come mostly when the internal momentum of the deuteron is small. For these cases, when the proton and neutron are far apart, the uncertainties in the deuteron wave function are minimized and Noyes' assumptions are most likely to be valid. He finds a $\pi^{\pm}\pi^{-}$ ratio of 8.2 ± .8 at 60 Mev if the $p + p \rightarrow \pi^{+}$ cross section differs from $p + n \rightarrow \pi^{-}$ only in a factor of two for the two protons and in the different interactions between the final nucleons. The final proton and neutron after π^{+} production are taken to be in a ^3S state. Any admixture of singlet lessens the ratio. The matrix elements are assumed to be energy independent. If they vary like the square root of the meson center of mass kinetic energy, the ratio is a few percent smaller.

The experimental value of the forward plus-minus ratio at 60 Mev[2] is about three times larger than predicted, implying that the $p + n \rightarrow \pi^{-}$

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matrix element is surpressed relative to $p + p \rightarrow \pi^+$. This also seems to be true at 90°[3].

If isotopic spin is conserved in meson production and the π^- meson is emitted predominantly into a p-state, the initial p-n system is ^3S or ^3D and therefore has isotopic spin zero. Then in the final state of a π^- meson and two protons, the π^- and either proton must be in a state of isotopic spin one-half. To the extent that the interaction is strong only when leading to π^--proton states of isotopic spin 3/2, the π^- production will be forbidden[4]. It is interesting to note that while isotopic spin does not contribute a selection rule for $p + p \rightarrow \pi^+$, the angular distribution indicates that the final state is one in which the π^+ and either nucleon have angular momentum 3/2[5].

This work was performed under the auspices of the Atomic Energy Commission.

REFERENCES

1. H. P. Noyes, Phys. Rev. 81, 924 (1951).

2. J. Carothers and C. G. André, Phys. Rev. (accompanying letter).

3. S. Passman, M. M. Block, and W. W. Havens, Jr., Phys. Rev. 85, 370 (1952).

4. This would not necessarily imply that, at these energies, the scattering of π -mesons in hydrogen should be strong only in isotopic spin 3/2 states since the scattering could involve matrix elements which cannot contribute to single meson production, viz., a meson pair coupling (J. V. Lepore, Phys. Rev. (in press); G. Wentzel, Phys. Rev. 86, 802 (1952)).

5. K. Brueckner and K. M. Watson, Phys. Rev. 86, 923 (1952).