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Berkeley, California

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Radiation Laboratory, Department of Physics
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In a previous letter[1] initial results were reported on the measurement of the cross section for production of π^+ mesons at 0 degrees by proton-proton interaction. This letter presents the additional information given at the UCLA meeting of the Physical Society.

The high peak in the meson spectrum at maximum meson energy results from the strong interaction of the product nucleons. (The formation of a deuteron in the process had been suggested earlier by other workers.[2,3]) This sharp peak provides a method of measuring the π^+ meson mass, since the meson energy at the peak depends only on the meson mass, the proton beam energy, and the total mass of the resulting nucleons. (The binding energy of the deuteron is available to the reaction if the nucleons come off bound.)

The effect of the interaction of the resulting nucleons on the meson production cross section has been investigated theoretically by Watson and Brueckner,[4] on a suggestion by Brueckner, Chew, and Hart.[5]

[1] Cartwright, Richman, Whitehead, Wilcox. Phys. Rev. 78, 823, 1950

[2] Barkas. Phys. Rev. 75, 1109, 1949

[3] Morand, Cuer, Moucharafyeh. Comptes Rendus 226, 1948

[4] Watson and Brueckner. In Press

[5] Brueckner, Chew, and Hart. In Press

We have improved the measurement on the meson spectrum so that with the increased resolution we can now compare directly the experimental results with the theoretical spectra of Brueckner and Watson. The shape of the theoretical curves assuming no deuteron formation is incompatible with the experimental spectrum. The curves based on deuteron formation, the dominant feature of which is a line spectrum removed 4 Mev from a continuum, essentially agree with the experiment, when the finite resolution of the apparatus is taken into account. The resolution is determined by the proton beam energy spread, the straggling in range and multiple small angle scattering of the mesons.

The proton beam energy was accurately measured from its Cerenkov radiation by Mr. R. Mather to an accuracy of $\pm$ 1 Mev. The energy of the meson is determined from its range, as calculated from the recent range energy curves.[6,7,8]

If, in spite of the above evidence for deuteron formation,[9] one assumes no binding of the nucleons, the measured proton beam energy and maximum meson energy require that the π^+ meson mass be 268.0 $\pm$ 3.5 electron masses. This is below the value of 276 $\pm$ 6 electron masses found previously by the film program at Berkeley.[10] (The film program is engaged in a more accurate determination which will be

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[6] Aron, Hoffman, and Williams. AECU-663

[7] Bakker and Segre. In Press

[8] Mather and Segre. In Press

[9] In addition to this evidence, Crawford, Crowe, and Stevenson recently detected directly the deuteron in this reaction. (Letter in press.)

[10] Smith, Barkas, Bishop, Bradner, Gardner. Phys. Rev. 78, 86, 1950

published soon.)

With deuteron formation the π^+ meson mass as determined by this experiment is 275.1 $\pm$ 2.5 electron masses. The systematic errors are included and account for most of the quoted probable error.

The details of the entire experiment will be published shortly.

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

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