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CHARGE INDEPENDENCE IN THE REACTIONS $p+d \to \pi^0 + \mathrm{He}^3$ AND $p+d \to \pi^+ + \mathrm{H}^3$ AT 450 Mev*

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According to the principle of charge independence, the ratios of the cross sections for the two reactions $p+d \to \pi^+ + \mathrm{H}^3$ and $p+d \to \pi^0 + \mathrm{He}^3$ should be exactly a factor of two. This statement should be true both for the total cross section and the differential cross section. A previous attempt to establish this ratio has been made[1] in which measurements of E and dE/dx were used to identify the He^3. Owing to the large background of protons and deuterons, this separation was difficult to achieve. In order to measure the cross section for the second reaction, both the π^+ and the H^3 in coincidence were detected.

In the present experiment the differential cross sections for these two reactions were measured by counting only the heavy particles. First of all a momentum analysis was performed in order to substantially reduce the background. This momentum analysis was performed with the aid of a magnet which has been previously described.[2] The deflected particles were counted with a quadruple coincidence arrangement consisting of three counters in coincidence and the last one in anticoincidence. An absorber was placed between the last of the three counters and the anticoincidence counter. Upon the receipt of a signal showing that a particle had stopped in the absorber the pulse height in the third counter was measured with a 50-channel pulse-height analyzer. This measurement of pulse height served to distinguish the H^3 and He^3 from the background of protons and deuterons.

The external proton beam from the University of Chicago's synchrocyclotron was focused into a spot about 1/2 in. in diameter on a polymerized CD_2 target. The thickness of this target was chosen to be approximately 0.8 mm. This was necessary because the range of the lowest momentum He^3 particle is only 4 mm of plastic scintillator. The secondary particles from the target were then deflected by the magnet into the counter telescope. The whole system of proton beam pipe, target, and magnet was maintained under vacuum at a pressure of a few microns. The experiment consists of taking CD_2-C differences at various magnet current settings and measuring the pulse-height spectrum at each setting. The magnet can approach within 8 degrees of the forward direction without the proton beam striking the magnet, and the maximum angle of emission of either of the heavy particles is 15 degrees. We have measured the production of these heavy particles from 8 to 13 degrees in the laboratory system for the low-momentum portion of the spectrum. Owing to the small range of the He^3 particles, it was necessary to

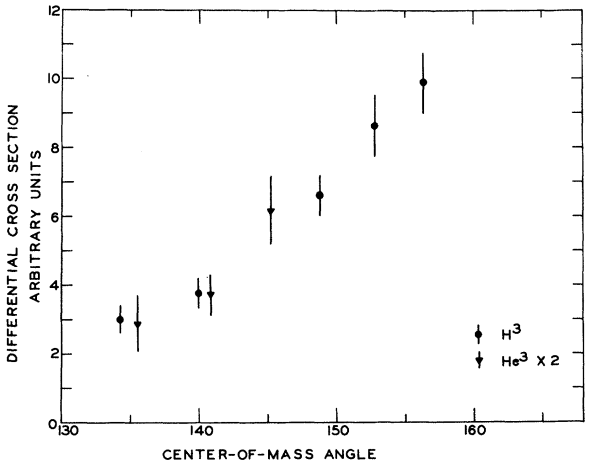

FIG. 1. The differential cross sections for the reactions $p+d \to \pi^+ + \mathrm{H}^3$ and $p+d \to \pi^0 + \mathrm{He}^3$ with 450-Mev protons. The measured cross sections for the second reaction have been multiplied by a factor of two in order to facilitate a direct comparison. The cross sections are given in arbitrary units which are, however, approximately microbarns/steradian.

use only three counters in this part of the experiment. However, measurements on the H^3 were repeated in order to show that the efficiency of detection was identical in the two cases.

The differential cross section of these two processes at the angles measured is shown in arbitrary units in Fig. 1. The differential cross section for the production of He^3 has been multiplied by a factor of 2 on this graph. A weighted mean for the branching ratio $\sigma_{H^3}/\sigma_{He^3}$ has been computed from these data to be 1.91 ± 0.25. Accordingly we conclude that there is no evidence to show that the principle of charge independence does not hold in these reactions.

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