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ELASTIC SCATTERING OF 100 MeV POLARIZED PROTONS FROM ^{4}He

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The interaction between few-nucleon systems is of considerable interest to both theorists and experimentalists because (1) a limited number of nucleons are involved, (2) very few reaction channels are open, and (3) multiple scattering is greatly reduced. Thus it is possible to carry out fundamental calculations in terms of basic nucleon-nucleon forces, e.g. in the framework of resonating group theory, three-body cluster models utilizing Fadeev equations, or a coupled reaction channel formalism. Such calculations also provide a means for the direct evaluation of different prescriptions for the nucleon-nucleon interaction.

The success of such studies in providing a more complete understanding of nuclear reactions rests on the availability of a large body of accurate experimental data on few-nucleon systems, including elastic scattering as well as reaction data. For the p + ^{4}He system, data of good quality are available for elastic scattering in the form of differential cross sections and analyzing powers up to 65 MeV[1] and in the 200 to 500 MeV range.[2] These measurements show characteristic qualitative differences between the lower-energy data and the higher-energy data. The differential cross sections at the lower energies exhibit strong backward peaking, presumably due to coupled-channel or exchange effects, in contrast to the higher-energy data. Up to 65 MeV, the analyzing powers are generally small in the forward hemisphere, with a moderate negative swing around 100° followed by a large positive maximum near 140°. For proton energies beyond 200 MeV, on the other hand, one observes strong oscillations of the analyzing powers in the forward hemisphere, with peak values decreasing with increasing energy [$\simeq \pm 1$ at 200 MeV to $\simeq \pm 0.5$ at 500 MeV]. In the backward hemisphere the analyzing powers are predominantly negative.

In response to the paucity of high-quality data in

the transition region between 65 and 200 MeV an experimental program on the investigation of few-nucleon systems is under way at IUCF. Initially, differential cross-section and analyzing power data have been obtained[3] for the elastic scattering of 100 MeV polarized protons on ^{4}He. These results are shown in Fig. 1. The back-angle peaking of the cross section observed at lower energy is still present at 100 MeV, while the forward-hemisphere analyzing power shows the development of a maximum reminiscent of the higher-energy data. Preliminary optical model calculations indicate clearly a need for a Majorana space-exchange term to reproduce both the cross section and analyzing power. This is an indication that resonating-group calculations[4] would be most appropriate to explain the data, or that at least a more explicit inclusion of triton exchange (e.g., in a distorted wave Born approximation framework[5]) needs to be considered.

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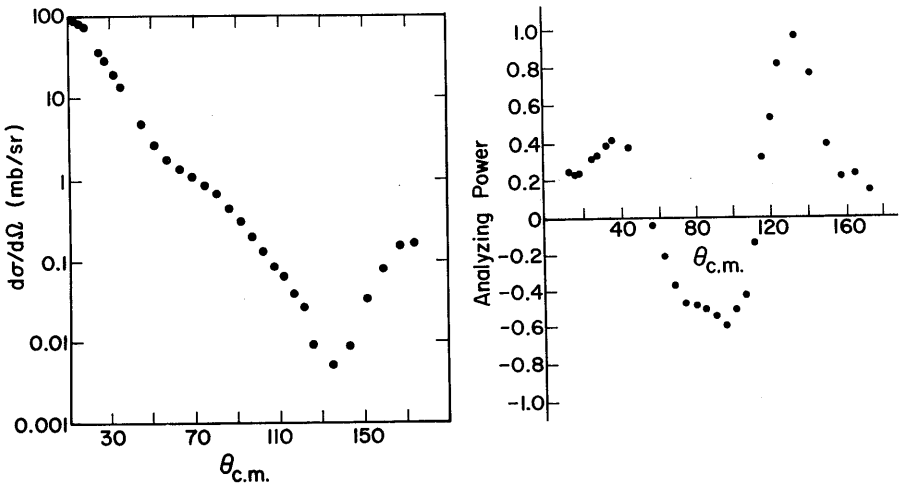

Figure 1. Differential cross-section and analyzing-power measurements for p + ^{4}He at 100 MeV.