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Authors
Boschitz, E.T.
Chabre, M.
Conzett, H.E.
et al.

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University of California

Ernest O. Lawrence Radiation Laboratory

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STUDY OF THE $He^4(p,d)He^3$ REACTION WITH POLARIZED PROTONS AT 55 AND 63 MeV*

E. T. Boschitz†, M. Chabre‡, H. E. Conzett and R. J. Slobodrian

Lawrence Radiation Laboratory
University of California
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The $He^4(p,d)He^3$ reaction, and the inverse stripping reaction $He^3(d,p)He^4$ are not yet well understood. DWBA fits on intermediate energy data are not very convincing, whereas a simple diffraction approach seems more successful[1,2,3]. Studies with polarized particles may help to elucidate the reaction mechanism. We have measured the asymmetry in the $He^4(p,d)He^3$ dross section with polarized protons, at 55 MeV where data are available for the cross section[4] and at 63 MeV.

We have used the polarized proton beam of the Berkeley 88-inch cyclotron, produced by alpha-hydrogen scattering. At forward angles the deuterons were detected and identified by two large (4 cm^2) E-ΔE solid state detector pairs. At backward angles the deuteron energies were too low to go through the ΔE detectors. Therefore we counted instead the He^3 recoils at forward angles, with CsI crystals of adequate thickness to stop only the He^3. For those measurements, the main uncertainty is due to the continuous background subtraction, while for the deuteron measurements the peaks are very clean and the precision is limited almost purely by statistics. Figure 1 shows the observed asymmetries with P_1 being the polarization of the incident proton beams.

The asymmetry in a pick up reaction induced by polarized protons is related to the deuteron polarization by the formula[5]

$$\left(\frac{d\sigma}{d\Omega}\right)_{\text{polarized}} = \left(1 + \frac{1}{2} \underset{\sim}{P}_p \cdot \underset{\sim}{P}_d\right) \left(\frac{d\sigma}{d\Omega}\right)_{\text{unpolarized}}$$

Therefore we measure the component of the deuteron polarization parallel to the proton polarization. In an s nucleon pick up, the deuteron polarization is due to spin orbit distortion. In such a case a derivative rule analogous to the one for elastic scattering has been suggested[6]. However, comparing our data with the cross section data at 55 MeV we find that the asymmetry changes sign only close to the minima of the cross section, which occur near 30°, 95°, and 150°, but no zero of the asymmetry can be associated with maxima of the cross section. It may be that here also another approach, such as a diffraction model, could be more successful than the DWBA treatment in describing our results.

One knows that the asymmetry in a reaction induced by polarized particles is connected to the polarization occurring in the inverse reaction induced by unpolarized particles[7,8]. Our measurements of asymmetries are therefore equivalent to the measurement of the proton polarization in the stripping reaction $He^3(d,p)He^4$ at the corresponding energies 43 and 54 MeV.

FOOTNOTES AND REFERENCES

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†On leave from NASA, Lewis Research Center, Cleveland, Ohio.

‡NATO fellow, on leave from CNRS, Institut Fourier, Grenoble, France.

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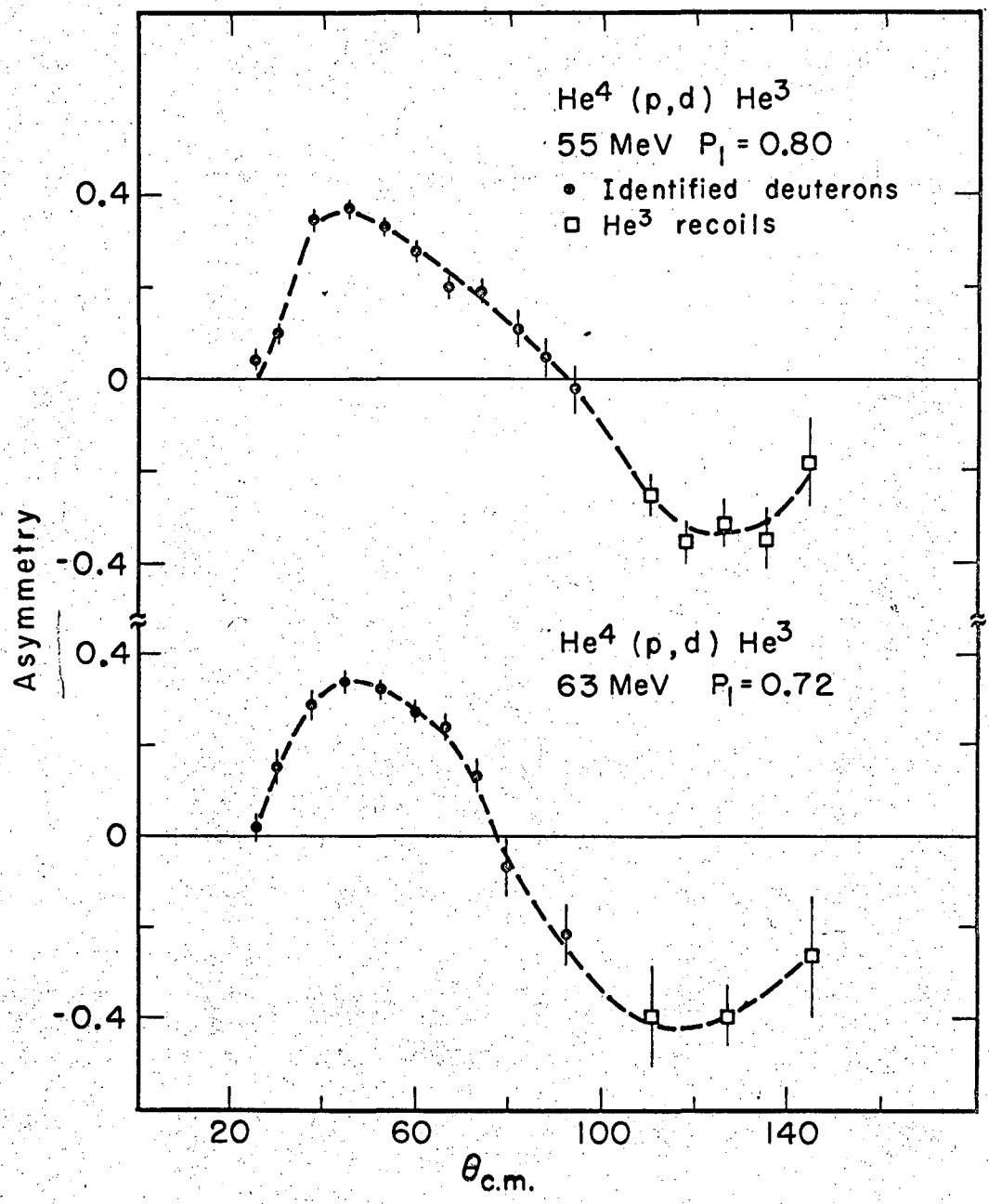

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Fig. 1