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Author

Rad, F.N.

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MEASUREMENT OF THE PROTON ANALYZING POWER IN THE
p-d BREAKUP REACTION*

F. N. Rad, H. E. Conzett, R. Roy⁺, and F. Seiler[†]
Lawrence Berkeley Laboratory, University of California
Berkeley, California 94720

We report in this paper on the measurement of the proton analyzing power A_y in the $^2\text{H}(\vec{p},p)d^*$ reaction at $E_p = 22.7$ MeV, which corresponds to the same center of mass energy as that in the $^1\text{H}(d,p)d^*$ reaction reported by Conzett¹⁾. Here, d^* denotes final-state np pairs with relative energy $E_{np} \leq 1$ MeV, in both the singlet and triplet states. Previously, there had been measurements of the vector analyzing power in the $^2\text{H}(\vec{p},2p)n$ (ref.2) and $^1\text{H}(d,2p)n$ (ref.3) transitions to the np final-state interaction (FSI) region at $E_p = 10.5$ MeV and $E_d = 12.2$ MeV, respectively. In both instances the analyzing powers were very small or consistent with zero. The higher energy results at $E_d = 45.4$ MeV¹⁾ showed values of A_y reaching 0.15 ± 0.02 . The exact three-body calculations^{4,5)}, which have been successful in fitting N-d breakup cross sections, have so far been limited to S-wave N-N input interactions and, thus, provide no polarization.

Our experimental results for A_y in the reaction $^2\text{H}(\vec{p},p)d^*$ are shown in Fig. 1, where the errors are purely statistical. For comparison the elastic scattering analyzing power is shown as the smooth curve. As can be seen, A_y in the breakup reaction reaches substantial values at angles greater than 70° and its angular distribution is quite similar to that of the elastic $A_y(\Theta)$. A comparable behavior of the deuteron vector analyzing power was observed in the $^1\text{H}(d,p)d^*$ reaction¹⁾. This similarity between the elastic and inelastic analyzing power is rather unexpected in view of the results that were reported by Brückmann et al.⁶⁾. In the analysis of their $^1\text{H}(d,d^*)p$ data at 52.3 MeV, they identified the separate contributions to the cross section from the production of singlet and triplet np pairs,

$$(d\sigma/d\Omega) = (d\sigma/d\Omega)_s + (d\sigma/d\Omega)_t. \quad (1)$$

They found that between $\Theta_{cm} = 85^\circ$ and 150° the production of singlet pairs exceeded that of triplet pairs ($E_{np} \leq 1$ MeV), with the ratio $(d\sigma/d\Omega)_s / (d\sigma/d\Omega)_t$ reaching a value of about 10 near 120° . Thus, even though the angular dependence of $(d\sigma/d\Omega)_t$ was similar in shape to that of the elastic cross section, the d^* production cross-section (given in eq.(1)) showed little resemblance to the elastic angular distribution. Furthermore, the recent exact three-body calculation of Kluge et al.⁵⁾ very nicely reproduces the ratio of the singlet to triplet d^* production cross sections for $E_{np} = 0$.

We can, in the same way, express our analyzing power results as the sum of the singlet and triplet d^* production contributions,

$$A_y = \frac{A_y^s (d\sigma/d\Omega)_s + A_y^t (d\sigma/d\Omega)_t}{(d\sigma/d\Omega)_s + (d\sigma/d\Omega)_t}. \quad (2)$$

We then see, from the similar angular distributions of A_{y,d^*} and $A_{y,elastic}$ shown in Fig. 1 that a tenable conclusion is that,

(a) $A_{Y,d*}^t(\theta)$ is similar to that of $A_{Y,elastic}(\theta)$ and, (b) $A_{Y,d*}^s(\theta)$ is similar to $A_{Y,d*}^t(\theta)$. Condition (a) is certainly reasonable. However condition (b) is, a priori, quite unexpected, particularly in view of the marked dissimilarities of $(d\sigma/d\Omega)_s$ and $(d\sigma/d\Omega)_t$ at the nearby equivalent energy $E_p = 26.1$ MeV. Thus, there is an obvious need to include in the exact three-body calculations the more realistic N-N tensor and P-wave interactions in an effort to explain these polarization results.

Fig. 1

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- + National Research Council of Canada, Postdoctoral Fellow.
- ‡ On leave of absence from the University of Basel, Switzerland.
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