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POLARIZATION TRANSFER IN PROTON-DEUTERON ELASTIC SCATTERING

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DISCLAIMER

POLARIZATION TRANSFER IN PROTON-DEUTERON ELASTIC SCATTERING*

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The polarization transfer coefficient $K_y^{y'}(\theta)$ in N-d scattering has been measured at E_d = 45.4 MeV, θ_{Lab} = 38°, 41°, and 44°. Our results are in good agreement with the recent three-body calculations using a perturbation technique with rank-1 separable potentials.

*Work supported by the U. S. Atomic Energy Commission.

TRANSFERT DE POLARISATION DANS LA DIFFUSION PROTON-DEUTON*

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La mesure du coefficient de transfert de polarisation $K_y^{y'}(\theta)$ dans la diffusion N-d a été effectuée à E_d = 45.4 MeV pour θ_{Lab} = 38°, 41° et 44°. Les résultats sont en accord avec des calculations récentes utilisant, pour le système à trois corps, des potentiels séparables de rang un dans un contexte de perturbation.

*Travail supporté par U. S. Atomic Energy Commission.

POLARIZATION TRANSFER IN PROTON-DEUTERON ELASTIC SCATTERING*

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Within the past two years considerable theoretical progress has been made in fitting the nucleon polarizations measured in nucleon-deuteron elastic scattering at energies below 50 MeV.[1,2] These three-body calculations, based on the Faddeev equations, have also provided predictions of the deuteron vector and tensor polarizations and, more recently, of polarization transfer coefficients[2] at energies below 25 MeV. Subsequent determinations of deuteron polarizations[3] were in good agreement with the calculations. These studies showed that the P-wave part of the two-body N-N interaction was chiefly responsible for the vector polarizations, whereas, in addition, the $^3S_1$-$^3D_1$ N-N tensor force was required in order to provide agreement with the observed tensor polarizations.

It is clear that the polarization results have provided the important and essential tests of the calculations and of the sensitivity of the N-d observables to the details of the input N-N potentials. As a further test of the theoretical predictions, we report here on measurements of the vector polarization of the recoil protons in d-p elastic scattering with incident 45.4 MeV vector polarized deuterons. These $^1H(\vec{d},\vec{p})^2H$ measurements provide determinations of the vector-to-vector polarization transfer coefficient, $K_y^{y'}(\theta)$, defined by the equation[4]

$$p_{y'} = (A_{y'} + \frac{3}{2} p_y K_y^{y'})/(1 + \frac{3}{2} p_y A_y) \quad ,$$

where p_y in the polarization of the purely vector polarized incident deuteron beam, $p_{y'}$ is the observed polarization of the outgoing (recoil) proton, and A_y and $A_{y'}$ are, respectively, the deuteron vector analyzing power and the proton analyzing power in N-d elastic scattering. The Madison convention[5] is followed in defining the cartesian forms of the polarization and analyzing power, and the y and y' axes are taken along $\vec{k}_d \times \vec{k}_p$. From time-reversal-invariance, the same coefficient describes the transfer of vector polarization in the inverse $^2H(\vec{p},\vec{d})^1H$ scattering process at the equivalent proton energy of 22.7 MeV[4]. Thus, our measurements can be compared directly with Pieper's[2] calculated $K_y^{y'}(\theta)$ at that energy. Previous measurements[6] of vector-to-tensor polarization-transfer coefficients in p-d scattering below 10 MeV were consistent with zero within the experimental error, while a single measurement[7] of $K_x^{x'}$ was found to be two-standard-deviations from the theoretical value.[2] It was clear that more data were required for a significant comparison with the calculated values, and that substantial values of $K_y^{y'}$ were expected at E_p = 22.7 MeV for the θ_{cm} that we found to be experimentally accessible. The polarized deuteron beam from the Berkeley 88-in. cyclotron, passed through a high-pressure liquid-nitrogen cooled hydrogen gas target, positioned in the 36-in-diam scattering chamber. The areal density of the gas was 12.8 mg/cm^2 at the operating pressure of 12.4 atm. and the mean-energy in the gas was 45.4 MeV. Two silicon polarimeters, similar to those described elsewhere,[8] were used in these measurements and were positioned at equal angles to the left and right of the beam. The angular resolution defined by tantalum collimators, was 0.8° (FWHM). The vector polarization of the beam, monitored continuously with a ^{4}He polarimeter placed downstream of the scattering chamber, was .815±.015 of the maximum possible value p_y = 2/3, with zero tensor components. For each $K_y^{y'}(\theta)$ determination, runs were taken with the spin vector of the beam oriented up and down with respect to the scattering plane. This mode of operation along with the left-right polarimeters provided several internal consistency checks. The silicon polarimeters were calibrated with polarized protons elastically scattered from ^{4}He and ^{12}C, for which $K_y^{y'}$ = 1.0.

Preliminary values of our experimental results are shown in fig. 1., where the errors indicated are purely statistical. The solid curve is Pieper's calculated result, and it is seen that the agreement with experiment is very good. Since this constitutes the first significant comparison between experimental and calculated polarization-transfer coefficients in N-d elastic scattering, this agreement represents yet another substantial success of the three-body calculations.

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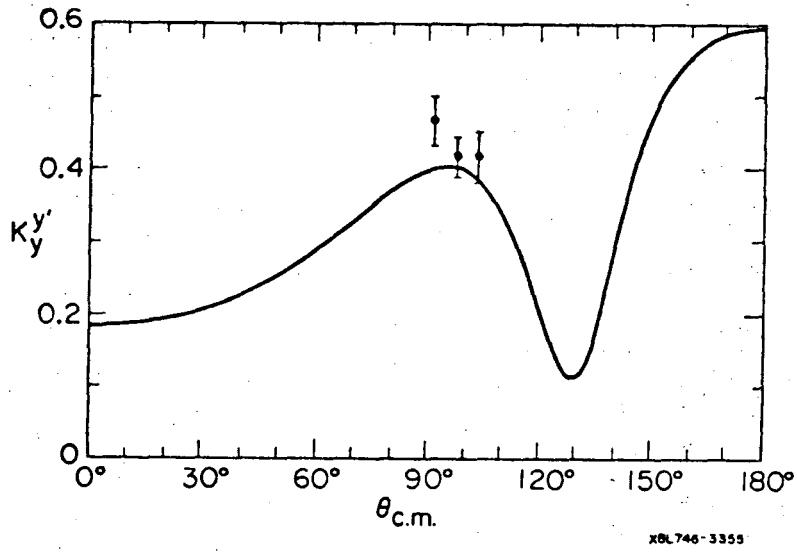

FIGURE 1

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