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Vector- and Tensor-Analyzing Powers in Deuteron Elastic Scattering at 22 MeV

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A systematic study of the measurements of the analyzing powers in deuteron-nucleus scattering is now in progress. The purpose of the experiment was to obtain data for an optical-model analysis. Specifically, the intention is to obtain information about the tensor coupling in the deuteron-nucleus interaction.

Angular distributions of the cross sections and vector- and tensor-analyzing powers, iT_{11}, T_{20}, T_{21} and T_{22}, have been measured for deuteron elastic scattering from Ca(A=40), Ni(A=58,60,62,64), Zr(A=90), Mo(A=92,100) and Pd(A=104,106,108,110) nuclei at E_d=22 MeV. The experiment was performed with the vector- and tensor-polarized beams from a tandem accelerator at UTTAC. Scattered particles were detected by two pairs of Si surface-barrier detector telescopes mounted in the horizontal plane at symmetric scattering angles to the beam axis with a solid angle of 2msr. Measurements were made from θ_{lab}=30° to 170° in 5° steps. Isotopic enriched self-supporting targets with a thickness near 1mg/cm^2 were used.

The data have been analyzed by the optical model. First, the tensor interaction between the deuteron and the target nucleus is neglected. Only a vector spin-orbit coupling has been considered. The values of the potential depth parameters and the geometrical parameters which best fit the cross-section and vector-analyzing power data for each nucleus were determined using an automatic parameter-search computer code MAGALI[1]). The starting values of the optical model parameters are those of Daehnick et al.[2]). The optical model fits are shown in fig. 1. The calculated tensor-analyzing powers T_{20} and T_{22} are also fairly well reproduced. However, the calculated tensor analyzing powers T_{21} are in disagreement with the measurements. The predicted T_{21} are considerably too small in magnitude and their angular dependence at backward angles is out of phase with the measurements.

Next, the data have been analyzed by the optical model including a T_R-type tensor interaction[3]). The values of the optical model parameters are determined using an automatic parameter-search computer code DDTP[4]) to fit the cross-section and vector- and tensor-analyzing power data. The radial dependence of T_R-potential can be well approximated by the analytic expressions of Keaton and Armstrong[5]) using second and third derivatives of Woods-Saxon parametrization for real and imaginary part, respectively. The optical model fits including the T_R-potential for ^{58}Ni are shown in fig. 2 by dashed lines while for the solid lines the T_R-potential is neglected. The obtained strength of real and imaginary part of T_R-potential are 1.89 and 1.25 MeV, respectively. The radius (diffuseness) parameters of real and imaginary parts are 1.07 and 1.20 fm (0.44 and 0.89 fm), respectively. The tensor-analyzing power T_{21} can be reproduced fairly well including T_R-potential especially at backward angles.
A systematic optical model analysis including the tensor interaction for other nuclei is now in progress.

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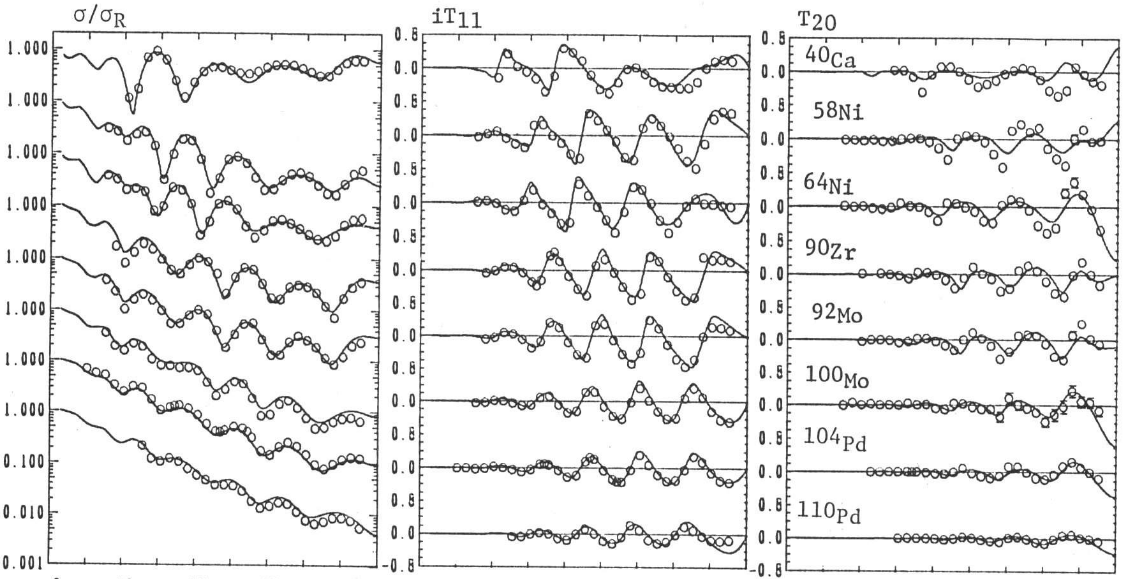

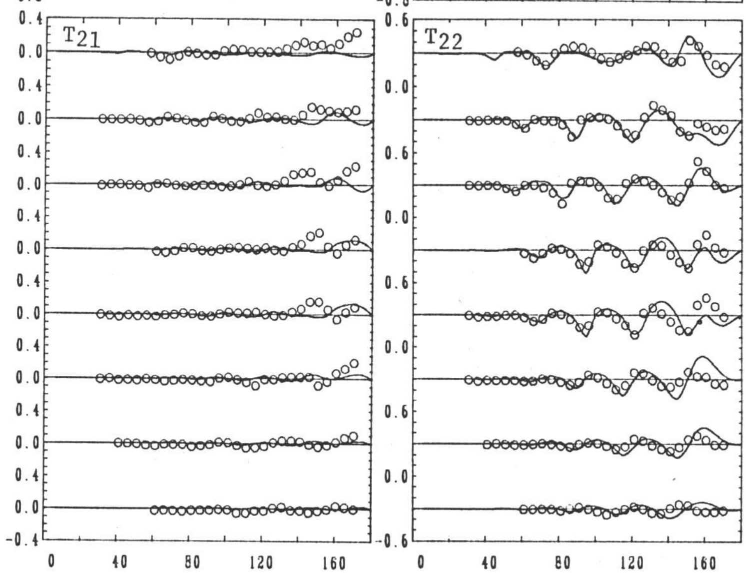

Fig. 1

Measured cross section and vector- and tensor-analyzing powers. The solid lines are result of optical model calculations to fit both cross section and vector-analyzing power for each target.

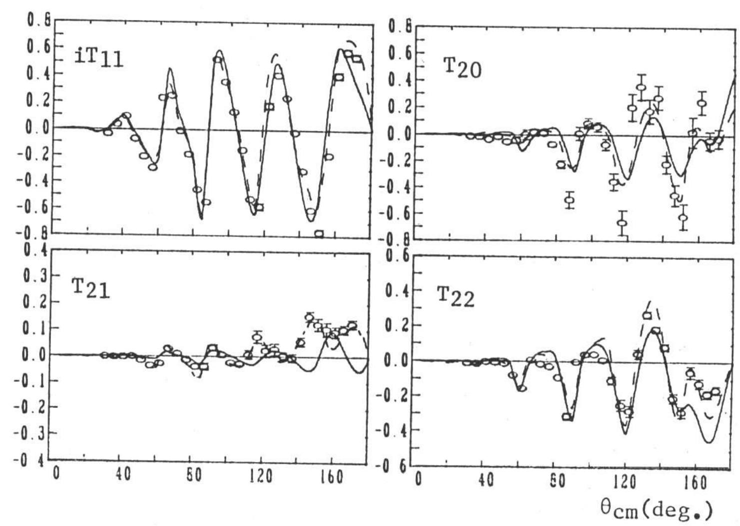

Fig. 2

Comparison of the optical Model calculation for ^{58}Ni. The dashed lines include T_R-potential, the solid lines neglect tensor potential.