ANALYZING POWERS FOR DEUTERON-INDUCED
REACTIONS LEADING TO CONTINUUM FINAL STATES

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In a recent article[1)], it was reported that the analyzing powers are large for protons that inelastically scatter to states in the continuum. Those analyzing powers rise with angle in a trend similar to the analyzing powers for elastic scattering. This suggests a connection between the spin-dependent distortions in the entrance channel and the trends of the analyzing powers regardless of the nature of the excited states.

For intermediate-energy deuterons, the onset of rainbow scattering creates very large vector and tensor analyzing powers. The experiment described here was undertaken to see how far these trends persist for reactions to continuum states. The cross sections were already available,[2)] along with a comparison to a calculation assuming that the projectile energy was dissipated in the formation of particle-hole states in the target.

The experiment was carried out in the 64-inch scattering chamber using three-element telescopes. The elements of the telescopes were chosen from various thicknesses of silicon and high-purity germanium to provide information on the outgoing p, d, t, ^{3}He and ^{4}He fragments at energies between 20 and 100 MeV. In front of each telescope, the collimating slit was made of plastic scintillator (see Figure 1). Its signal was used to veto pulses in the telescope. This technique greatly reduces slit-edge scattering background. At angles where the elastic-scattering analyzing powers are large, this background could introduce some false false spin dependence into the continuum spectrum.

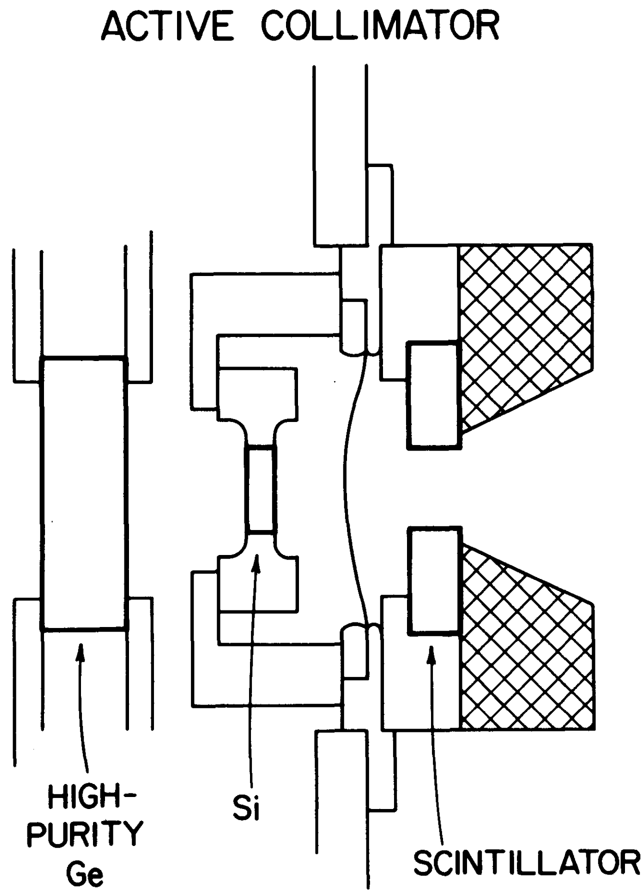

Figure 1. Layout of the active-collimator assembly showing two elements of the detector telescope. This collimator fits in front of the window of the germanium-detector cryostat. The solid collimator (hatched area) is beveled to eliminate scattering into the telescope system.

The deuteron beam energy was 80 MeV. Both vector (A_y) and tensor (A_{yy}) analyzing powers were measured at angles between 30° and 105° in the laboratory. The target was chosen to be ^{58}Ni to maintain compatibility with the earlier studies of elastic scattering.

A sample analysis of the vector and tensor analyzing powers for inelastic deuteron scattering is shown in Figure 2 as a function of excitation energy in the final nuclear system. Points analyzed in the continuum are indicated by a horizontal bar giving the excitation energy range over which they apply. The analyzing powers for the transitions to discrete final states are remarkably similar at large angles, indicating an absence of diffraction pattern information on the configuration of the final nucleus. These analyzing powers are all similar to that for elastic scattering.

In the continuum, the vector analyzing power remains large, even at very high excitation. This is true also for the (d,p) reaction channel, but not for (d,t), (d,^{3}He), or (d,α). In these latter cases, the analyzing power falls much more quickly to zero.

The tensor analyzing power A_{yy} also falls quickly to zero with increasing excita ion energy. For elastic scattering, the large values of A_y and A_{yy} mean that the scattering is dominated by deuterons from the m=+1 substate in the primary beam. However, in the continuum, the analyzing powers are characterized rather by the absence of the m=-1 substate. This change suggests a sensitivity of the m=0 projection to the structure of the final nucleus, an implication that will be pursued in future experiments on particular reactions.

These conclusions are quite similar to the results obtained at 56 MeV at Osaka.[3)] In addition, they measured A_{xx} and found negative values for the discrete states, and tensor analyzing powers going rapidly to zero in the excitation region of the continuum. These negative values for A_{xx} agree with the trends given in optical-model calculations for elastic scattering.

Like protons, deuterons show large vector analyzing powers in the continuum. This result reaffirms that the spin-orbit distortions in the entrance channel largely control which projections of the incoming beam can initiate reactions. It is this distortion, and not the structure of the excited nuclear system, that dominates the analyzing power for inelastic scattering and particle transfer reactions at large scattering angles. If structure information is to be obtained, it may well appear only in relative changes in the tensor analyzing powers.

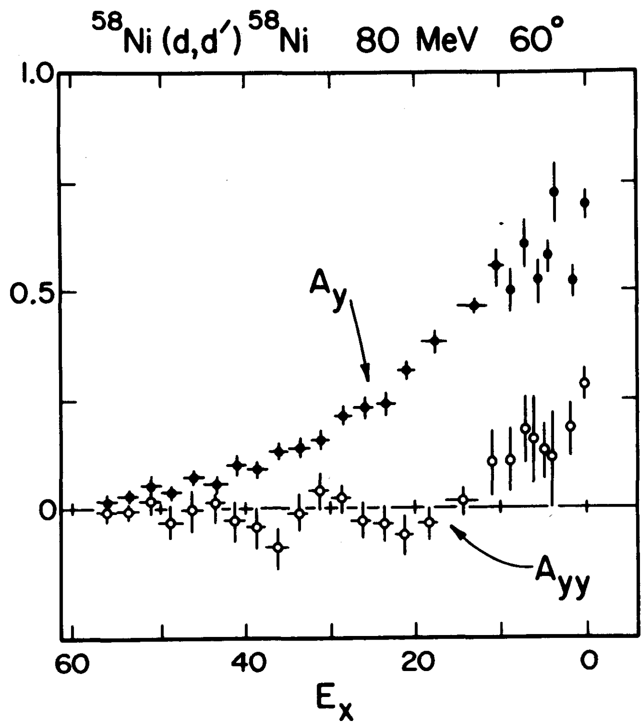

Figure 2. Vector (A_y) and tensor (A_{yy}) analyzing powers for deuterons inelastically scattered from ^{58}Ni as a function of the excitation energy.

1) H. Sakai, K. Hosono, N. Matsuoka, S. Nagamachi, K. Okada, K. Naeda, and H. Shimizu, Phys. Rev. Lett. 44, 1193 (1980).

2) J.R. Wu, C.C. Chang, and H.D. Holmgren, Phys. Rev. C19, 370 (1979).

3) H. Sakai, N. Matsuoka, K. Hatamaka, K. Okada, and H. Shimizu, Annual Report of the Research Center for Nuclear Physics, Osaka, 1979.