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Analyzing-Power Measurements in the $^{48}Ca(p,n)^{48}Sc$ Reaction at 134 MeV

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The $^{48}Ca(p,n)^{48}Sc$ reaction provides one of the best "test" cases for descriptions of the (p,n) reaction because ^{48}Ca is believed to be a relatively good closed-shell nucleus and because it has excess neutrons providing simple analog-state transitions. In two earlier papers,[1] we presented cross section measurements for this reaction at 134 and 160 MeV. These papers showed that the cross section angular distributions for the excitation of the $(f_{7/2},f_{7/2}^{-1})$ particle-hole band and for the strongly-excited 1^+-state spectrum can be described reasonably well by distorted-wave impulse-approximation (DWIA) calculations with 1f-2p shell-model wavefunctions.

We present here analyzing-power measurements for some of these same transitions. The measurements were performed in about 6° steps from 0° to 60°. The neutron energies were measured by the time-of-flight technique with the beam-swinger facility at the IUCF. The proton beam was provided by an atomic-beam polarized ion source with a typical polarization of 70%. The neutrons were detected in large-volume, mean-timed neutron detectors[2] at flight paths from 40 to 70 m. The overall neutron energy resolution varied from 400 keV for angles out to 48° and to 750 keV at wider angles.

The angular distributions for several transitions are shown in Fig. 1. Shown also are DWIA predictions from the code DWBA70[3] with the N-N effective interaction of Love and Franey[4] and the global optical-model parameters of Schwandt et al.[5] The nuclear structure assumed for the ^{48}Ca ground state and each of the final states was from a 1f-2p shell-model calculation.[1] The general shape of each angular distribution is indicated clearly by the DWIA calculations, even though most of these shapes are quite different. The low-lying 0^+(IAS), 1^+, 3^+ and 7^+ transitions are to members of the $(f_{7/2},f_{7/2}^{-1})$ band of states. The transitions to the 1^+(GTGR) and the 1^+(16.8 MeV) states are to the dominant T=3 and T=4 components of the Gamow-Teller strength in this reaction, respectively. Although we find that the DWIA calculations are not very sensitive to small changes in the various ingredients, they are very sensitive to the inclusion of all of the major ingredients, including the use of distorted waves, the presence of all of the terms in the effective interaction, and the dominant nuclear structure assumed.

It is significant to note that the experimental (and theoretical) shapes for the angular distributions of the 0^+(IAS) and 1^+(2.52 MeV) states are similar; but that the shape for the 1^+(16.8 MeV) state is different. Both 1^+ transitions necessarily involve spin-transfer, while the 0^+ transition cannot. The low-lying 0^+(IAS) and 1^+(2.52 MeV) states are predominantly $(f_{7/2},f_{7/2}^{-1})$ in structure, whereas the 1^+(16.8 MeV) state is predominantly $(f_{5/2},f_{7/2}^{-1})$ in structure. Hence the observed (and calculated) shapes indicate that the analyzing powers for these central transitions are more sensitive to the nuclear structure involved than to whether or not spin transfer is involved.

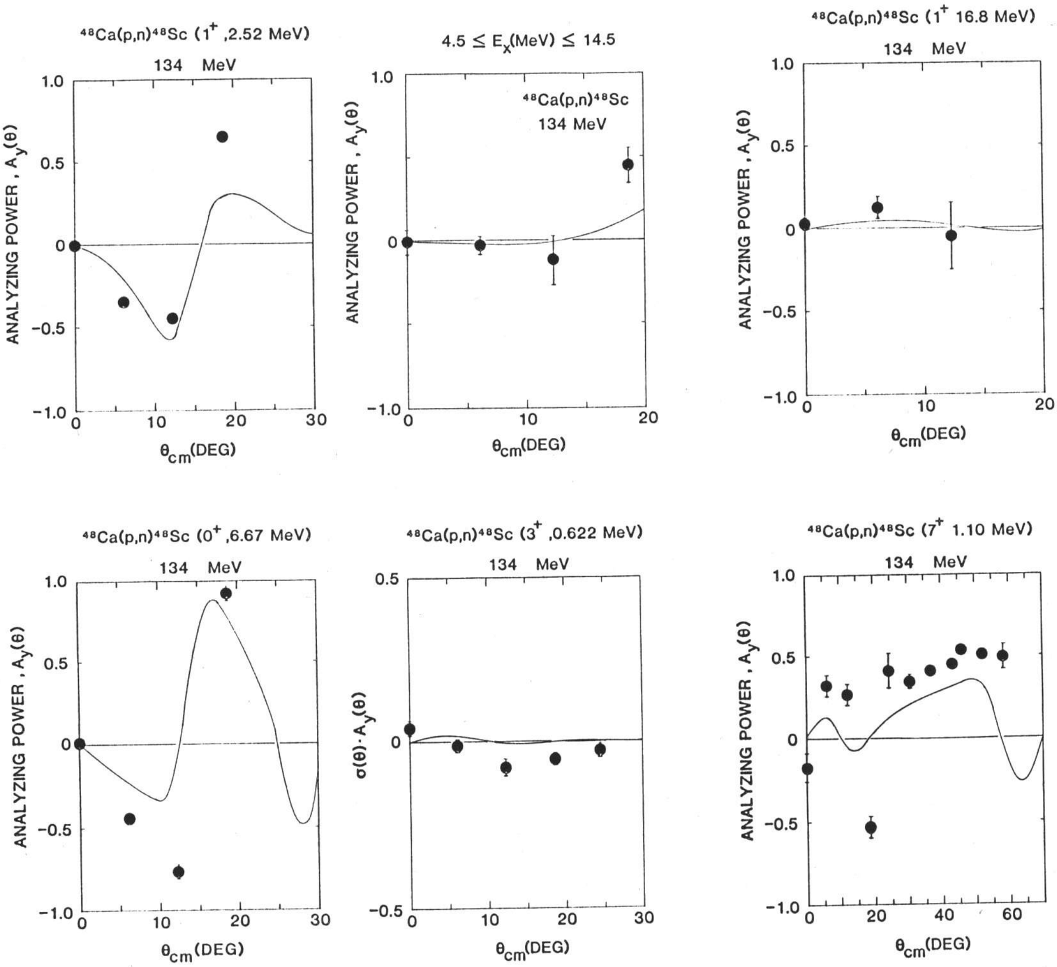

Figure 1. Analyzing-power measurements for the $^{48}Ca(p,n)^{48}Sc$ reaction at 134 MeV.

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