CHARGE-EXCHANGE REACTIONS

SPIN TRANSFER MEASUREMENTS FOR (p,n) REACTIONS AT INTERMEDIATE ENERGY

T.N. Taddeucci[+]
Univ. of Maryland, College Park, Maryland and Indiana University Cyclotron Facility, Bloomington, Indiana 47405

C.D. Goodman, R.C. Byrd, and I.J. Van Heerden[†]
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

T.A. Carey, J.B. McClelland, L. Rees
Los Alamos National Laboratory, Los Alamos, New Mexico 87545

D.J. Horen
Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830

J.S. Larsen and C. Gaarde
Niels Bohr Institute, University of Copenhagen, DK-2100, Copenhagen, Denmark

J. Rapaport
Ohio University, Athens, Ohio 45701

E. Sugarbaker, D. Krofcheck, A.J. Wagner
Ohio State University, Columbus, Ohio 43214

Polarization transfer observables in intermediate-energy nucleon-nucleus scattering are receiving much current attention. These observables can act as sensitive "filters" for nuclear structure studies and also serve as important tests of reaction models.

In the last two years, measurements of transverse polarization transfer in (p,n) reactions have been carried out at the Indiana University Cyclotron Facility (IUCF).[1-4] These measurements have spanned the bombarding energy range from 80 MeV to 160 MeV for a variety of targets. The nucleus ^{90}Zr has been the object of much study, both experimental and theoretical, in connection with the question of spin-flip strength distributions.

Spin transfer results for ^{90}Zr(p,n) at 160 MeV have been discussed in a previous report and in a recent publication.[3] During 1985 additional data for ^{90}Zr(p,n) at 120 MeV were obtained. Spectra of the new results are shown in Figure 1. The top half of this figure is the differential cross section $\sigma(0°,E_x)$ and the bottom half is the polarization transfer cross section σD_{NN}. The $0^+ \rightarrow 0^+$ isobaric analog state transition, for which $D_{NN} = 1$, stands up prominently in the σD_{NN} spectrum. The giant GT resonance and the low-lying GT states both have negative polarization transfer cross sections because of the characteristic $D_{NN} = -1/3$ signature for 1^+ transitions.

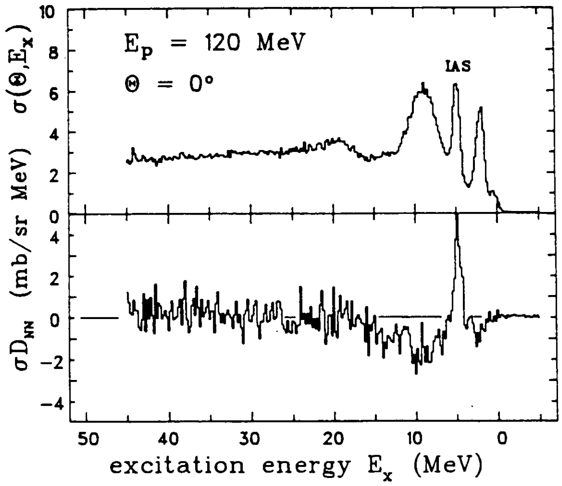

Figure 1. Spectra of the differential cross section and polarization transfer cross section for ^{90}Zr(p,n) at 120 MeV and Θ = 0°.

Spectra of the spin-flip cross section σS_{NN}, the non-spin-flip cross section $\sigma(1-S_{NN})$, and D_{NN} are shown in Figures 2 and 3. The data in these figures have been sorted into bins of 1 MeV width to reduce

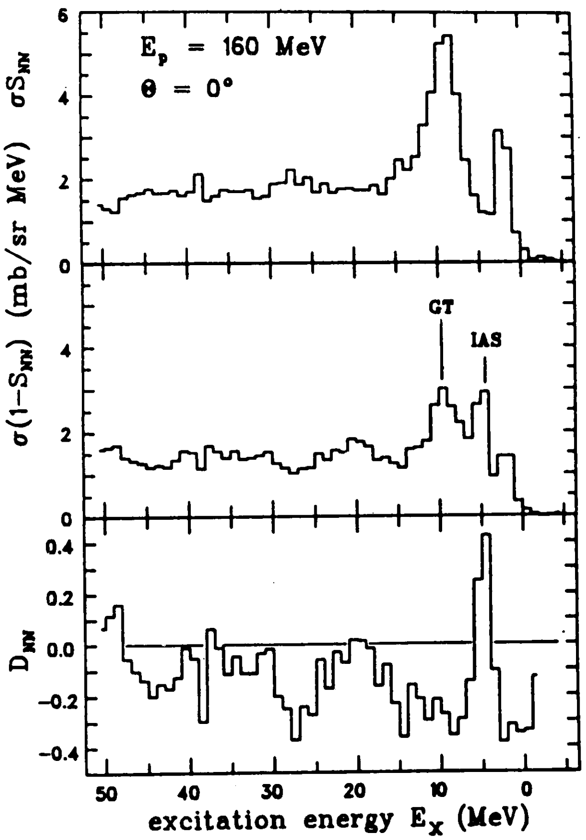

Figure 2. Spin-flip cross section (top), non-spin-flip cross section (middle), and D_{NN} (bottom) for $^{90}Zr(p,n)$ at 120 MeV and 0°.

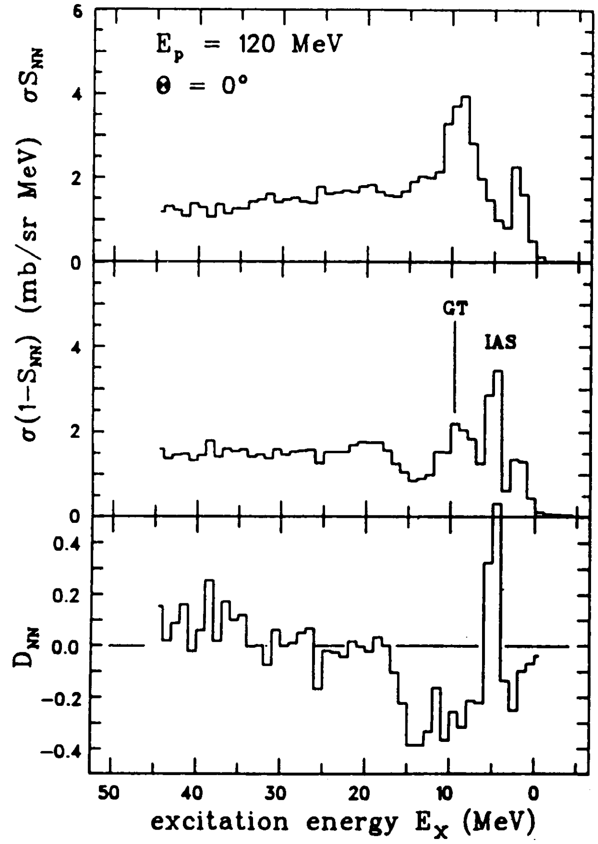

Figure 3. Spin-flip cross section, non-spin-flip cross section, and D_{NN} for $^{90}Zr(p,n)$ at 160 MeV and 0°.

statistical scatter. Some interesting features emerge. In particular, the D_{NN} spectrum at 160 MeV reveals a sequence of regions where natural parity and unnatural parity excitations are alternately most important.

The observed values of D_{NN} for the region of the giant GT resonance are close to the nominal value of -1/3 expected for pure GT excitations. The present data cannot exclude the possibility of other unnatural parity excitations in this region. However, the experimental results are consistent with theoretical predictions that most of the cross section in this region corresponds to GT excitations.

The value of D_{NN} observed near E_x = 20 MeV is particularly noteworthy. This is the excitation energy about which the giant isovector dipole resonance is centered. The polarization transfer measurements indicate that a large fraction of the strength observed in this region at 0° has natural parity. This result is at odds with recent calculations by Osterfeld, Cha, and Speth,[5] who predict very little natural parity strength at 0° for E_p = 200 MeV. The location of natural parity strength indicated by the present results is in good agreement with low energy measurements which are most sensitive to the $\Delta S=0$ component of the 1^- resonance.[6]

It is interesting to compare the trend in D_{NN} in the high-lying continuum (E_x > 25 MeV) for the two bombarding energies. The alternating regions of natural parity and unnatural parity strength seen at 160 MeV are no longer evident at 120 MeV. It is not yet clear whether this difference can be attributed to changes in the effective interaction as a function of energy and momentum transfer or whether it is evidence for other reaction mechanisms becoming important at the lower energies. For example, at 120 MeV the amount of multistep contributions might be larger than at 160 MeV. Recent calculations by Esbensen and Bertsch[7] have pointed out the possible importance of multiple scattering even at 200 MeV. Note, however, that randomization of the neutron spin, as might be expected from a simple multiple scattering model, would result in $D_{NN} = 0$. If this effect is indeed important, then comparison of D_{NN} measurements to theoretical DWIA predictions will be valid for spectroscopic purposes only for the highest bombarding energy.

The observed region of positive D_{NN} near $E_x \simeq 40$ MeV in the 120-MeV spectrum must still be explained, especially since positive D_{NN} is the signature for $\Delta S = 0$ in a single step transition and such transitions should be enhanced at the lower bombarding energy relative to $\Delta S = 1$ transitions.

[+] Present address: Los Alamos Natl. Lab, P2 Division, Los Alamos, NM 87545

1) T.N. Taddeucci et al., Phys. Rev. Lett. 52,1960 (1984).

2) T.N. Taddeucci et al., Phys. Rev. C (in press).

3) C.D. Goodman et al., Phys. Rev. Lett. 54, 877 (1985).

4) T.N. Taddeucci et al., Nucl. Instr. and Meth. A241, 448 (1985).

5) F. Osterfeld, D. Cha, and J. Speth, Phys. Rev. C 31, 372 (1985).

6) W.A. Sterrenburg, Sam M. Austin, R.P. DeVito, and Aaron Galonsky, Phys. Rev. Lett. 45, 1839 (1980).

7) H. Esbensen and G.F. Bertsch, Phys. Rev. C 32 533 (1985).

STRETCHED STATE EXCITATIONS IN THE $^{26}Mg(p,n)^{26}Al$ REACTION AT 134 MeV

B.D. Anderson, C. Lebo, T. Chittrakarn, A.R. Baldwin, J.W. Watson, and R. Madey
Kent State University, Kent, Ohio 44242

C.C. Foster
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

For a target with a neutron excess, the (p,n) reaction (with $\Delta T = 1$) can excite strength in the final nucleus with isospin T − 1, T, or T + 1, where T is the isospin of the target. By contrast, inelastic electron and proton scattering are restricted to the two highest isospin components. Because the lower isospin component is usually found at lower excitation energies, it usually is fragmented less by configuration mixing. The '0 $\hbar\omega$' stretched states observed in the (p,n) reaction[1] are good examples of T − 1 stretched states. In some cases, usually for lighter nuclei, it is possible also to see T − 1 components of '1 $\hbar\omega$' stretched states; the $^{26}Mg(p,n)^{26}Al$ reaction is a good example. Because ^{26}Mg is a T = 1 nucleus, the (p,n) reaction can excite T = 0, 1, and 2 isospin components in the ^{26}Al residual nucleus. The (p,p′) and (e,e′) inelastic scattering reactions (with both $\Delta T = 1$ and $\Delta T = 0$), can excite only states in ^{26}Mg, which has $T_z = 1$; thus, these reactions excite only T = 1 and T = 2 components in the final nucleus. Both the (p,p′) and (e,e′) reactions[2,3] have been used to study the isovector 6^- stretched