IN-PLANE GAMMA-RAY COINCIDENCE CORRELATIONS FOR THE $^{12}C(p_{pol},p'\gamma)^{12}C$ REACTION AT 150 MeV

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Recent measurements[1,2] have aptly demonstrated the enhanced sensitivity of the polarization transfer observables in inelastic proton scattering experiments to the details of the reaction mechanism and nuclear wavefunctions. Techniques which extend these measurements are therefore valuable insofar as they can provide new information on the nuclear response, and in additional probe unexplored kinematic regions of interest.

We have continued our development of the use of the $(p_{pol},p'\gamma)$ reaction as a compliment to the polarization transfer measurements at intermediate energies. In an earlier experiment,[3] the coincidence correlation was measured for inelastic excitation of the 15.11 MeV state in ^{12}C for gamma-rays emitted in a direction normal to the proton scattering plane. These data determine the spin-flip probability S and polarization-analyzing power difference P-A -- observables which are available in some kinematic regions from the polarization transfer measurements.

Recently, we have extended our coincidence measurements to determine the correlation for both this and the 12.7 MeV 1^+ isoscalar excitation in ^{12}C for gamma-ray angles confined to the scattering plane of the proton.

In this geometry the form of the correlation is given by:

$$W(\Theta_\gamma) = A + B \cos 2(\Theta_\gamma + \phi) \qquad (1)$$

where the constants A, B, and ϕ determine the diagonal elements of the density matrix for the excited 1^+ state, information which is not derived from polarization transfer data. Recently, Shepard[4] has demonstrated that the phase ϕ is sensitive to the presence of composite currents of the form $\langle\vec{s}\cdot\vec{j}\rangle$ and $\langle\vec{\sigma}\times\vec{j}\rangle$ in the Relativistic Impulse Approximation (RIA) description of the scattering.

We have measured the coincidence correlation at proton scattering angles of 24.0, 32.5, and 38.3 degrees using the QDDM spectrograph. Coincident gamma-rays were detected with a pair of 4"ϕ x 3" bismuth germanate crystals at angles between 60 and 225 degrees, using an N-type polarized incident beam at 150 MeV. With tight windows placed on the recorded events during replay, we have now succeeded in isolating a coincident contribution from the isoscalar excitation at 12.7 MeV in addition to the strong excitation at 15.1 MeV. (The gamma-ray branching ratio for the isoscalar state is only ~3%.) A complete data replay is currently underway, but the measured on-line correlation for a proton scattering angle of 32.5 degrees using an incident spin-down beam is shown in the figure. These data are well described by the

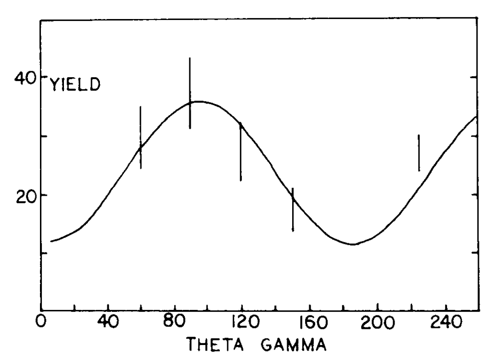

Figure 1. Measured gamma-ray correlation at $\Theta_p = 32.5°$ for a spin-down incident beam.

expected form of the correlation function given by equation (1), as shown by the accompanying fit.

1) C. Olmer in Proceedings of the Conference on Antinucleon- and Nucleon-Nucleon Interactions, Plenum Press (1985).

2) T.A. Carey, Phys. Rev. Lett. 49, 266 (1982).

3) M.A. Kovash et al., 1984 IUCF Scientific and Technical Report.

4) J. Shepard, private communication.

POLARIZATION TRANSFER IN INELASTIC PROTON SCATTERING FROM ^{12}C AND ^{16}O

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During the last year, we have continued our investigation of the in-plane polarization transfer coefficients $D_{LL'}$, $D_{LS'}$, $D_{SL'}$, $D_{SS'}$ for 200-MeV proton inelastic excitation. Our principle goal in this study is to exploit the enhanced sensitivity of these coefficients to spin-dependent terms in the effective nucleon-nucleon interaction in order to provide a sensitive test of various proposed forms of the interaction. We have therefore concentrated on the inelastic excitation of unnatural-parity transitions for which the nuclear structure is relatively well known.

Measurements have recently been completed for excitation of the 1^+, T=0 state in ^{12}C (12.7 MeV), and the 4^-, T=0 (17.79 MeV and 19.80 MeV) and 4^-, T=1 (18.98 MeV) states in ^{16}O. Preliminary results of these experiments have been reported at several conferences[1-2], and the final analysis of these data is expected to be completed by early summer of 1986.

We have also extended these measurements to include the excitation of the 1^+, T=1 state in ^{12}C (15.11 MeV). This transition occurs predominantly by the isovector tensor and central components of the interaction.

Preliminary data for the 1^+, T=1 and the 4^-, T=1 transitions are shown in Figs. 1 and 2. The indicated distorted-wave impulse approximation calculations employ the free effective interactions generated by Franey and Love[3], von Geramb[4] from the Paris potential, and Holinde[5] from the Bonn potential. All of these calculations produce similar predictions over the angular range of interest, and good qualitative agreement with the measurements is achieved. This is in contrast with our observations for the isoscalar transitions, for which large differences are observed among the predictions, reflecting large ambiguities in the relevant terms of the interaction.

Love[6] has recently discussed these isovector data, and has shown that the qualitative features displayed in Figs. 1 and 2 can be understood within the framework of a simple plane-wave impulse approximation in which one focusses on the specific roles of the longitudinal and transverse parts of the t-matrix interaction. The negative values of $D_{LL'}$ and $D_{SS'}$ at