INVESTIGATIONS OF CONCENTRATED (p,π^-) REACTION STRENGTH ON C AND Ca ISOTOPES

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The recent discovery of strong and unexpected systematic concentrations of reaction strength in (p,π^-) spectra[1,2] — believed to be based on high-spin stretched or nearly-stretched 2p(protons)-1h(neutron) configurations with respect to the target ground state — has prompted further investigation of this strength concentration for selected carbon and calcium isotopes. The aim of these follow-up investigations is five-fold. First, we want to obtain cross section and analyzing power angular distributions for a small, and hopefully interesting, subset of the known occurrences of this strength concentration. Second, in the medium-mass nuclei where the observed peak is broader than the resolution of the QQSP spectrometer, we seek to resolve constituent transitions to facilitate comparison with structure and reaction calculations. Third, we will investigate the energy dependence of the dominant transitions for outgoing pion energies from ~25 to ~70 MeV, over which range the influence of the (3,3) resonance on the reaction mechanism might change significantly. Fourth, we will look for population of the same states seen in (p,π^-) via other reactions which may also favor high-spin transitions, in an attempt to verify our scenario. Fifth, we would like to investigate the feasibility of selected spectroscopic applications of the (p,π) reactions, within our high-spin state scenario.

Three of the above aims have already been partially realized. A run has been completed using the QDDM spectrometer to measure cross sections and analyzing powers for the ^{49}Ti(p,p') reaction. Reasonably strong (p,p') transitions were observed (see Fig. 1) in the high level density region near the excitations of interest in ^{48}Ca$(p,\pi^-)^{49}$Ti, but the

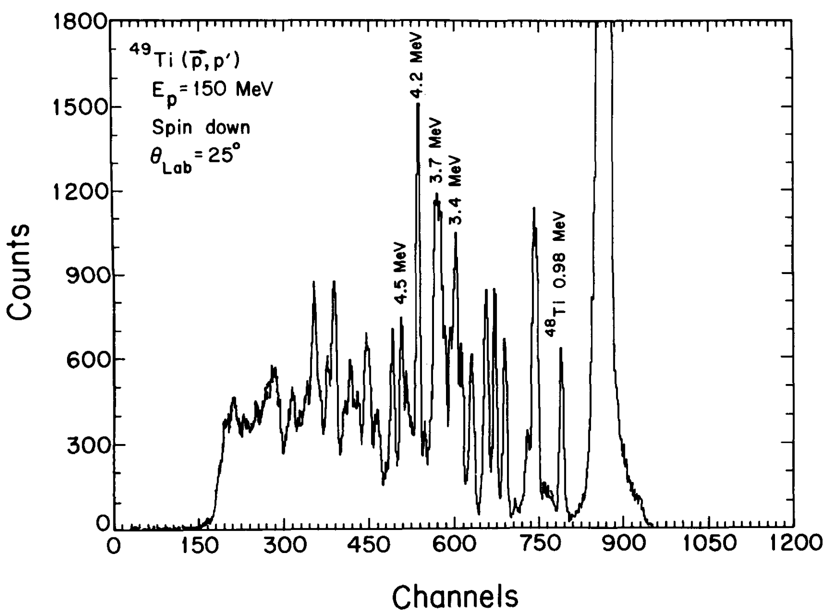

Figure 1. Typical ^{49}Ti(p,p') spectrum showing the excitation energy region corresponding to that of the observed reaction strength concentration in ^{48}Ca$(p,\pi^-)^{49}$Ti.

(p,p') angular distributions do not seem to support spins as high (e.g., 19/2$^-$ or 17/2$^-$) as expected from our (p,π^-) scenario. Future analysis of these data, involving a comparison of the angular distributions of the states in ^{49}Ti(p,p') to the angular disributions of known states in ^{48}Ti(p,p'), measured during the same run, should help to clarify the spins of the inelastically excited states. In order to decide whether these may be the same states as populated in (p,π^-), we need to improve the energy resolution and energy calibration of the pion spectra.

Forward angle data on ^{42,48}Ca(p,π^-) at E_p = 205 MeV have been taken using the QQSP pion spectrometer. The cross section angular distributions for both ^{42}Ca and ^{48}Ca(p,π^-) are forward peaked with the ^{42}Ca being smaller than the ^{48}Ca by a factor of 5. For the two most forward angles (θ_{lab}=30° and 45°), the ^{48}Ca(p,π^-) strength concentration was resolved into two components about 400 keV apart, which appear to have quite different angular distributions. The measured analyzing powers A_y at forward angles are similar for ^{42,48}Ca(p,π^-), small and positive in both cases. In conjunction with our earlier conclusions[3] regarding the sign of A_y for ground-state transitions, this result may suggest the importance of the spin flip of the incident proton as well as of the charge-exchanged neutron in the two-nucleon mechanism we propose to explain the strength concentration.

Future measurements will be made in order to completely realize the earlier mentioned aims. These measurements will involve the completion of the ^{42,48}Ca(p,π^-) cross section and analyzing power angular distributions at E_p = 205 MeV, as well as a second run on ^{48}Ca at a lower proton energy. The run at the lower energy will serve two purposes. First, it will provide information on the energy dependence of the strength concentration and also of the continuum π^- yield, and second, since the intrinsic energy spread of the beam should be smaller at the lower energy and the beam intensity should be greater, it will allow better energy resolution and a more definitive calibration of the excitations of the constituent states. Finally, measurements will be made on ^{13}C(p,$\pi^\pm$) going to the mirror nuclei ^{14}C and ^{14}O. These data will provide a further test of our scenario, which predicts[4] a complementary nature in the population of certain high-spin (4$^-$, 5$^-$) configurations in the (p,π^+) vs. (p,π^-) spectra. Withi. this scenario, for example, we should be able to locate as yet unknown 5$^-$ states with dominant configurations of the type

$$^{12}C \otimes (\pi p_{1/2})(\pi p_{3/2})^{-1}(\nu d_{5/2})(\nu p_{1/2})\rangle_{5^-} \text{ in } ^{14}C \text{ and}$$
$$^{12}C \otimes (\pi d_{5/2})(\pi p_{1/2})(\nu p_{1/2})(\nu p_{3/2})^{-1}\rangle_{5^-} \text{ in } ^{14}O.$$

1) S.E. Vigdor et al., Phys. Rev. Lett. 49, 1314 (1982).

2) S.E. Vigdor et al., this Report, p. 75.

3) W.W. Jacobs et al., Phys. Rev. Lett. 49, 855 (1982).

4) S.E. Vigdor et al., Nucl. Phys., in press.