HIGH-SPIN STRETCHED STATES IN NUCLEI EXCITED VIA (p,n) REACTIONS

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The (p,n) reaction provides unique information in the study of isovector particle-hole states in nuclei. We performed new measurements in October 1986 to continue our (p,n) studies of high-spin stretched state excitations. The targets studied were ^{20}Ne, ^{24}Mg, ^{45}Sc, ^{144}Sm, and ^{208}Pb. The measurements were performed with the IUCF neutron time-of-flight beam-swinger facility at an incident beam energy of 135 MeV. Large-volume neutron detectors were placed in detector stations (or huts) at 0°, 24°, and 45° with respect to the undeflected beam direction; the flight paths were 133.6, 131.2, and 81.4 m respectively. The overall energy resolution was about 300 keV in the first two huts and about 400 keV in the third hut.

The (p,n) reaction on the self-conjugate nuclei ^{20}Ne and ^{24}Mg provides an umambiguous mapping of the isovector strength, including the excitation of both the "0 $\hbar\omega$", 5^+ and the "1 $\hbar\omega$", 6^- strength. A time-of-flight spectrum for the ^{24}Mg(p,n)^{24}Al reaction at 45° is shown in the top panel of Fig. 1. The analog of the known T=1, 6^- state (at E_x = 15.1 MeV in ^{24}Mg) is seen clearly, as well as a likely candidate for the $[(d_{5/2}), (d_{5/2})^{-1}]5^+$ state at lower excitation energy. The fragmentation of the T=1, 6^- strength observed here will be extracted and compared with that observed in (p,p') and (e,e') studies.[1,2] The excitation of the "0 $\hbar\omega$" 5^+ state, which is not possible in (p,p') or (e,e') inelastic-scattering studies, will contribute additional information on the neutron and proton occupancies in the $d_{5/2}$ orbital.

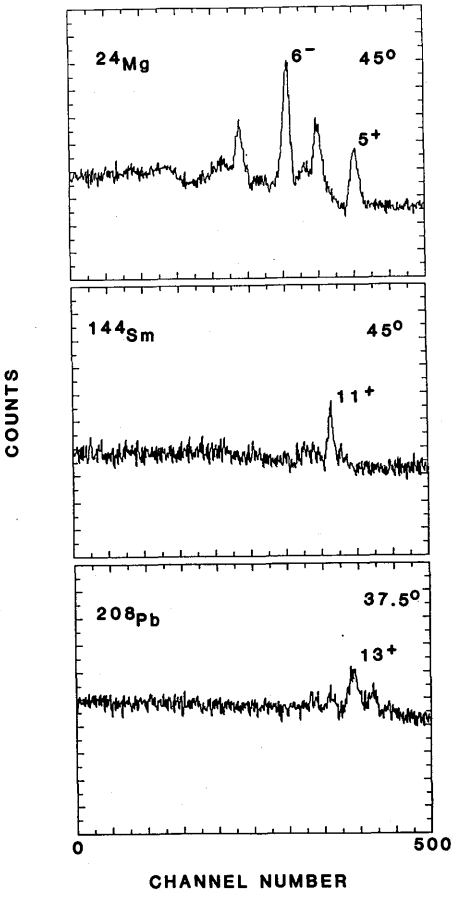

Figure 1. Time-of-flight spectra from the (p,n) reaction at 135 MeV.

The time-of-flight spectrum for the ^{144}Sm(p,n)^{144}Eu reaction at 37.5° is shown in the middle panel of Fig. 1. A likely candidate for the $[(h_{11/2}),(h_{11/2})^{-1}]11^+$, "0 $\hbar\omega$" stretched state is seen. It is interesting that the ^{144}Sm(p,π^-) reaction does not seem to show a strong excitation of the expected $31/2^-$ stretched state formed from a 2p-1h configuration in the $h_{11/2}$ orbital.[3] While additional

spectral analysis may clarify the situation, this result is somewhat surprising since similar stretched states are observed to be strongly excited with the (p,π^-) reaction for targets near (high-spin) neutron subshell closure throughout the periodic table. The analysis of the strength observed in the (p,n) excitation of the 11^+ state will provide additional information on the fragmentation of the $h_{11/2}$ orbital.

In an earlier experimental run, we studied the $^{208}Pb(p,n)^{208}Bi$ reaction. Unfortunately, the energy resolution in that run was only about 800 keV at the larger angles. We observed a strong concentration of strength near 3 MeV of excitation with an angular distribution consistent with a transition to the $[(i_{13/2}),(i_{13/2})^{-1}]13^+$ "$0\hbar\omega$" stretched state.[4] The DWIA normalization factor required for this state is ~0.9; which is 50% larger than that required for any other "$0\hbar\omega$" stretched-state excitation observed thus far. Either this case is anomalously high, or the peak observed is actually an unresolved complex of states. In the bottom panel of Fig. 1, we show a time-of-flight spectrum from our recent experimental run for a ^{208}Pb target at 37.5°; the energy resolution was about 400 keV. The spectrum shows two peaks separated by about 800 keV. The larger peak has ~2/3 of the total observed strength and, if we assume that it is the 13^+ state, then the amount of "$0\hbar\omega$" stretched-state strength for this case will be reduced to an amount consistent with that observed in other nuclei.

The measurements of this recent experimental run are now being analyzed more completely.

1) G.S. Adams et al., Phys. Rev. Lett. 38, 1387 (1977).

2) H. Zarek et al., Phys. Rev. Lett. 38, 750 (1977).

3) W.W. Jacobs et al., IUCF Scientific and Technical Report, p. 58 (1984); to be published.

4) B.D. Anderson et al., Phys. Rev. Lett. 52, 1872 (1984).