EXPLORATORY MEASUREMENTS OF THE (^{3}He,n) REACTION AT MEDIUM ENERGIES

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About nine shifts of beam time were allocated to run preliminary observations of the (^{3}He,n) reaction for targets of ^{9}Be, ^{12}C, ^{24}Mg, and ^{90}Zr. Time-of-flight huts at 0° and 24° were instrumented so that angular distributions could be taken from 0° to 48° where needed. Detector check-out and efficiency measurements were done first with the ^{7}Li(p,n) reaction at 80 MeV.

The exploratory investigation was motivated by the large number of high-lying states seen in our work at 25 MeV on s-p shell nuclei and the prediction of Broglia and Bes[1] of the existence of high-lying pairing vibrations involving coherent particle-hole pairs across closed shells. For possibly different reasons neither the (^{3}He,n) reaction at lower energies nor the (p,t) reaction have revealed the existence of this additional strength. Even though the L=0 selectivity of the (^{3}He,n) reaction at lower energies may not be retained at 80 MeV, a large range of excitation energy should also be available before the low energy neutron emission overwhelms the yield from discrete states. As pointed out by Kunz et al.[2], the calculations of the energy dependence of the two nucleon transfer reactions using the finite range method have failed. This experiment was designed to address that question as well.

The IUCF Cyclotron provided up to 200 na average current in pulses about 0.8 ns wide every 200 ns. The overall neutron resolution was about 1.8 ns yielding an energy resolution of about 1 MeV. This was adequate for an initial survey. The ^{9}Be(^{3}He,n)^{11}C reaction at 25 and 33 MeV is strong and quite adequate for checking detectors and electronics. At 80 MeV the yield was very small compared to the continuum neutrons. ^{12}C gave significant yield indicating a number of strong states which appear at all angles out to 48°. Angular distributions are not yet available to make comparisons with known L transfers. ^{24}Mg gave a very weak yield of discrete states at 4.8 and 7.1 MeV while ^{90}Zr showed no yield from discrete groups.

These data are in the process of analysis so no quantitative results are available. At 80 MeV the resolution near the ground state was about 1 MeV while at the 25 MeV energy it is about 0.3 to 0.5 MeV and increases quite rapidly with excitation energy. Hence discrete states should show up well above the continuum as they do at 25 MeV. However at 80 MeV the yields are much smaller than expected. Thus questions of the reaction mechanism and the strong energy dependence are raised. However, better energy resolution must be achieved to interpret adequately these and future experiments.

1) R.A. Broglia and D.R. Bes, Phys. Lett. 69B, 129 (1977).

2) P.D. Kunz, J.S. Vaagen, J.M. Bang, and B.S. Nilsson, Phys. Lett. 112B, 5 (1982).