^{3}He(p,pp)d AND ^{3}He(p,pp)d* REACTIONS AT 136 MeV

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The ^{3}He(p,pp)d/d* reactions were observed at the incident proton energy of 136 MeV. Two detector telescopes were used to observe the quasifree scattering process in a kinematically complete experiment. The angle pairs chosen were: 42.7°-42.7°, 35.0°-50.4°, 28.0°-57.2°.

Quasifree scattering data can be compared to predictions from the plane wave impulse approximation (PWIA). The expression for the three body cross section is:

$$\frac{d^3\sigma}{d\Omega_1 d\Omega_2 dE_1} = N \cdot KF \cdot \left.\frac{d\sigma}{d\Omega}\right|_{CM} |\Phi(k_3)|^2$$

where N is a normalization constant, KF is a kinematic factor, $d\sigma/d\Omega$ is the two body differential cross section evaluated in the center of mass (CM), and $\Phi(k)$ is the Fourier transform of the relative wavefunction of the spectator within its original nucleus (as the d or d* in the ^{3}He system).

There are many possible choices for $\Phi(k)$. One can use the Fourier transform of a Hulthen wave function. A slightly better approximation is to use a Hulthen wave function for the deuteron and an Irving-Gunn for the ^{3}He nucleus, and take the Fourier transform of the overlap integral between these two wave functions. Chi Yu Hu[1] has developed a program that allows one to use a trion wave function generated by a Hamada-Johnston potential for the ^{3}He nucleus. In principle, one should be able to adjust parameters for this wave function to best fit both the ^{3}He(p,pp)d and ^{3}He(p,pp)d* reaction cross-sections. Further, by examining the ratio of these two cross sections any distortion effects not included in the PWIA are expected to cancel since the final states differ by only 2.225 MeV. It has been suggested that this ratio may be particularly sensitive to the S′ component of the ^{3}He wave function.[2] The primary objective of this experiment is to measure the ratio of these two cross sections and determine the S′ component of the ^{3}He wave function consistent with this measurement.

A ^{3}He gas target was used with the gas confined in a cylindrical, aluminum cell pressurized to 250 psi. A collimation system was designed to limit target thickness and define solid angles for the detectors. The front collimator was a rectangular slit placed 10 cm from the target center. The rear slit was circular with a diameter of 1.27 cm placed 34 cm from the target center. A DE-E telescope was arranged on each leg consisting of a 1000 micron, Li-drifted Si surface barrier detector and a 1"x2" cylindrical NaI detector.

Standard NIM electronics were used to process the data. Five signals (DE_1,E_1,DE_2,E_2, and gated TAC) were recorded in coincidence with a 70 nsec. resolving time. The program GENPRP was used to record the data, and the numerous data tapes were brought back to the Naval Research Laboratory (NRL) for further analysis.

At NRL, the data tapes have been processed using the program IUTAPANA. This program sorts the data event by event, performs particle identification, and displays the data in several different configurations. If the energies from both detectors are summed, the kinematic broadening of the peaks is eliminated. Detector resolution can be folded into the theoretical expressions for the wave function and phase space. By fitting these curves, the desired cross section ratio can be determined.

At this stage, only individual runs have been examined, and it will be necessary to sum various runs in order to produce sufficient statistics to make a definite statement about the S′ probability. This work is currently in progress. Additionally, efforts are being made to fit each quasifree peak to check the validity of PWIA at this energy. Although no ^{3}He excited states are apparent, a more detailed search will be undertaken after the major objectives are accomplished.

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1) C.Y. Hu, private communication.

2) C.Y. Hu, M.B. Epstein, I. Slaus, and D.L. Shannon, Few Particle Problems in the nuclear interaction, ed. I. Slaus et al. (North-Holland, Amsterdam, 1972), p. 648.