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3.36 Determination of the Asymptotic D- to S-State Normalization of the ^{3}H and ^{3}He- Wave Functions

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The triton and ^{3}He wave functions contain, similarly to the well known deuteron configuration D-state, terms in addition to the dominant S-state component. Recently , there has been a great interest in these D-state components of the few nucleon wave functions, since serious doubts have been expressed about the usefulness of the D-state probability P_D as a quantitative measure of the effect of the tensor interaction between nucleons[1)]. The indeterminancy of the wave function at short distances is basically the source of this difficulty. It has been suggested that ρ_D, the ratio of the asymptotic amplitude of the D-state component to the asymptotic amplitude of the S-state is a more realistic quantity to be associated with tensor effects [1)]. Physically, an asymptotic normalization constant reflects the internal dynamics present in the wave function through overall normalization and therefore it has been proposed that the ^{3}H and ^{3}He asymptotic normalization constants be accorded the same status as other trinucleon observables[2)]. It is hoped that these quantities will provide a mean for discriminating between trinucleon wave functions generated from various realistic models of the NN interaction.

Among the methods for the determination of ρ_D the empirical continuation of differential cross section and tensor polarization components to the nonphysical values of the angular variable has proved to be a useful tool[4-6)]. This method can determine the corresponding vertex constant to a high accuracy. Interesting cases are provided by reactions where the same procedure yields vertex constants for various nuclei which should be equal for full isospin invariance. In such cases some of the possible systematic errors are common for both vertex constants; therefore the existence of a difference can be established with high reliability. Such measurements and analysis were performed by our group for the ^{2}H($\vec{d}$,p)^{3}H reaction in order to determine ρ_D of the deuteron and triton wave functions [6)].

An interesting further possibility for studying the ^{3}H and ^{3}He vertex constants simultaneously is provided by the ^{4}He($\vec{d}$,t)^{3}He reaction. At forward angles of the outgoing triton the process is dominated by neutron transfer whereas for backward angles (or forward angles for the emitted ^{3}He) the dominating process is the proton transfer. Therefore by analyzing the very same data one can extract the $\rho_D{}^{^3H}$ and $\rho_D{}^{^3He}$. Many of the possible errors like absolute normalization and some parts of the systematic errors produced by the analyzing procedure cancel and one gets a strict constraint of the values of the vertex constants.

For this aim we have measured at E_d = 35 and 45 MeV the cross section and the polarization observables of the reaction ^{4}He(d,t)^{3}He with the aid of the polarized deuteron beam from the SIN injector cyclotron. Four telescopes, each composed of three detectors, are used at the same time. They are installed in the scattering chamber symmetric with respect to the incident beam. The first two detectors of each telescope are used as a ΔE-E telescope to discriminate ^{3}He against ^{4}He, whereas the second and third detectors act as a ΔE-E telescope to discriminate ^{3}H against protons and deuterons. The results for E_d = 35 MeV are shown in fig. 1. At present, an analysis in order to obtain $\rho_D{}^{^3H}$ and $\rho_D{}^{^3He}$ as well as the ratio of these values is in progress.

In this reaction the cross section and the analyzing powers A_{yy} and A_{xx} should be symmetric and the A_y antisymmetric around 90^o as long as there is complete isospin invariance. This means the Barshay-Temmer type of relations[7)] should hold. However, as can be seen from fig. 1, this symmetry is broken because of Coulomb effects and genuine isospin breaking. An investigation of the genuine isospin breaking effects requires theoretical few body calculations including the proper

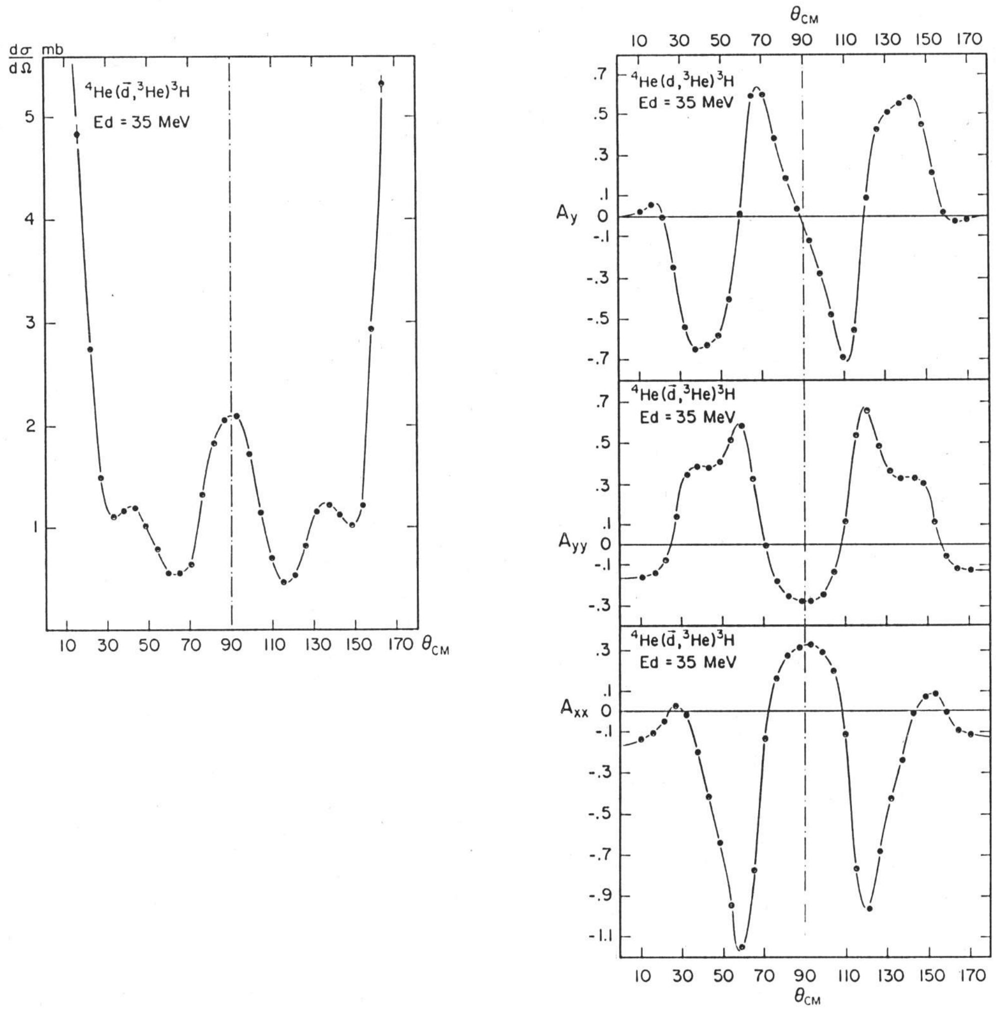

Fig. 1 Differential cross section $\frac{d\sigma}{d\Omega}$ (mb/sr), the vector analyzing power A_y and the tensor analyzing powers A_{yy} and A_{xx} of the reaction $^4He(\vec{d},{}^3He)^3H$ at E_d = 35 MeV.

Coulomb effects. Only a discrepancy between the experimental data and such a theoretical prediction can indicate the magnitude of the genuine isospin breaking effect.

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