Calculation of the S- and D-state components of the deuteron-triton overlap integral

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The S- and D-state components of the deuteron-triton overlap integral and of the form factor required for a distorted-wave Born-approximation analysis of (d,t) reactions have been calculated for a number of variational triton wave functions corresponding to realistic nucleon-nucleon potentials. It is found that the calculated overlap functions decay too rapidly for large n-d separations, and this has important consequences for the corresponding distorted-wave Born-approximation form factors. In particular, the parameter D_2, which measures the relative importance of the D-state form factor in the low-momentum limit, is found to be more than a factor of 2 smaller than the best experimental value. A more direct calculation of the form factors leads to a much larger value of D_2.

[NUCLEAR REACTIONS DWBA theory; calculated deuteron-triton overlap and form factors for (d,t) reactions.]

I. INTRODUCTION

It has recently been shown[1] that one can obtain information about the internal structure of the triton by studying the spin dependence of (d,t) reactions on heavy nuclei. In a direct (d,t) reaction the deuteron may be thought of as a spectator particle which simply picks up a neutron from the target nucleus to form a triton. Conservation of parity and angular momentum thus ensures that the pickup can take place only if the n-d relative orbital angular momentum (L) is either 0 or 2. Since the dominant term in the triton wave function is an S-state configuration, (d,t) reactions proceed mainly by $L=0$.

It turns out[1] that the tensor analyzing powers are especially sensitive to $L=2$ contributions to the reaction. Measurements of these quantities for $(\vec{d},t)$ and $(\vec{d},{}^3\mathrm{He})$ reactions[1-4] have clearly established the importance of the D-state contributions and in addition have provided quantitative information about the relative strengths of the S- and D-state amplitudes.

It is therefore of interest to determine whether existing three-nucleon wave functions, obtained from Faddeev or variational calculations, are consistent with the experimental results. This requires a calculation of the overlap integral between the deuteron and triton wave functions. In this paper we report calculations of the d-t overlap integrals using the variational triton wave functions of Jackson *et al.*,[5] Delves and Blatt,[6] and Akaishi *et al.*[7] Similar calculations have recently been carried out by Santos *et al.*[8] and by Kim and Muslim.[9]

II. BACKGROUND

In order to determine what effect the D-state amplitude has on the $(\vec{d},t)$ tensor analyzing powers, one makes use of the distorted-wave Born approximation. In a finite-range DWBA calculation, the transition amplitude depends on the internal structure of the deuteron and triton through the matrix element

$$F(\vec{r}) = \langle \chi_n^{\sigma_n} \phi_d^{\sigma_d}(\vec{\rho}) \,|\, V_{nd} \,|\, \phi_t^{\sigma_t}(\vec{r},\vec{\rho}) \rangle . \tag{1}$$

Here ϕ_d and ϕ_t are the internal wave functions of the deuteron and triton, respectively, and χ_n is the spin wave function of the transferred neutron. The quantity $\vec{\rho}$ is the internal coordinate of the deuteron and $\vec{r}$ is the separation of the transferred neutron from the deuteron center of mass. The neutron-deuteron potential V_{nd} is the sum of the nucleon-nucleon potentials between the transferred neutron and the nucleons in the deuteron.

From the behavior of the potential and the wave functions under rotations and spatial reflections, it follows that $F(\vec{r})$ can contain only S- and D-state terms. In particular, $F(\vec{r})$ can be written in the form

$$F(\vec{r}) = \sum_{L=0,2} \sum_{\sigma,\Lambda} \langle L\Lambda, s\sigma \,|\, \tfrac{1}{2}\sigma_t \rangle \langle 1\sigma_d, \tfrac{1}{2}\sigma_n \,|\, s\sigma \rangle v_L(r) Y_L^{\Lambda}(\hat{r}) , \tag{2}$$

where $s=\frac{1}{2}$ for $L=0$ and $s=\frac{3}{2}$ for $L=2$. The radial functions $v_0(r)$ and $v_2(r)$, which we will refer to as the DWBA form factors, contain all of the necessary information about the internal structure of the triton and deuteron. The main goal of the

present work is the calculation of these form factors.

By making use of the fact that ϕ_d and ϕ_t satisfy their respective Schrödinger equations, it is possible to eliminate the potential energy factor in Eq. (1) and write $F(\vec{r})$ in the form

$$F(\vec{r}) = \frac{3\hbar^2}{4M}(\nabla^2 - \gamma^2)G(\vec{r}), \tag{3}$$

where

$$G(\vec{r}) = \langle \chi_n^{\sigma_n} \phi_d^{\sigma_d}(\vec{\rho}) \,|\, \phi_t^{\sigma_t}(\vec{r}, \vec{\rho}) \rangle, \tag{4}$$

and where

$$\frac{3\hbar^2\gamma^2}{4M} = B_t - B_d. \tag{5}$$

Here M is the nucleon mass and B_t and B_d are the triton and deuteron binding energies. By analogy with Eq. (2), $G(\vec{r})$ can be written as

$$G(\vec{r}) = \sum_{L=0,2} \sum_{\sigma,\Lambda} \langle L\Lambda, s\sigma | \tfrac{1}{2}\sigma_t \rangle \langle 1\sigma_d, \tfrac{1}{2}\sigma_n | s\sigma \rangle u_L(r) Y_L^{\Lambda}(\hat{r}). \tag{6}$$

The radial functions $u_L(r)$ in Eq. (6) will be referred to as the d-t overlap functions. From Eq. (3) we see that $v_L(r)$ and $u_L(r)$ are related by

$$v_L(r) = \frac{3\hbar^2}{4M}\left[\frac{1}{r}\frac{d^2}{dr^2}r - \frac{L(L+1)}{r^2} - \gamma^2\right]u_L(r). \tag{7}$$

Thus, the form factors may be caluclated either directly, using Eqs. (1) and (2), or indirectly, using Eqs. (4)–(7). It should be emphasized that the two methods of finding v_L are equivalent only if ϕ_d and ϕ_t are the exact eigenfunctions of the two- and three-body Hamiltonians. For the variational triton wave functions that we use, this condition is not satisfied and therefore we can expect that the two methods will give different results.

In order to properly include the effect of the D-state term in a DWBA analysis, it is necessary to carry out a full finite-range calculation. However, the D-state effects can be included in an approximate way by making use of the local-energy approximation, in which one assumes that the (d,t) observables are sensitive only to the low-momentum components of the form factors. In this approximation the D-state effect depends on the value of a single parameter, D_2, which is related to the relative strengths of v_2 and v_0 in the zero-momentum limit, i.e.,

$$D_2 = \lim_{k\to 0}[\tilde{v}_2(k)/k^2\tilde{v}_0(k)], \tag{8}$$

where the $\tilde{v}_L$ are the momentum-space functions

$$\tilde{v}_L(k) = \int_0^\infty j_L(kr) v_L(r) r^2 dr. \tag{9}$$

In terms of the coordinate-space functions, D_2 is given by

$$D_2 = \tfrac{1}{15}\int_0^\infty r^4 v_2(r)dr \Big/ \int_0^\infty r^2 v_0(r)dr, \tag{10}$$

or equivalently,

$$D_2 = \tfrac{1}{15}\int_0^\infty r^4 u_2(r)dr \Big/ \int_0^\infty r^2 u_0(r)dr. \tag{11}$$

Experimental determinations of D_2 have been made for a number of $(\vec{d},t)$ and $(\vec{d},{}^3\mathrm{He})$ reactions,[1–4] and D_2 values ranging from -0.22 to -0.37 fm^2 have been obtained by fitting the tensor analyzing power measurements for the various reactions. The most reliable determinations of D_2 come from measurements taken at energies below the Coulomb barrier, since the DWBA calculations are thought to be relatively free of ambiguities in this case. Tensor analyzing power measurements have recently been obtained for a number of sub-Coulomb $(\vec{d},t)$ reactions and these data are best fitted with a D_2 value of -0.275 fm^2.

III. DEUTERON-TRITON OVERLAP CALCULATIONS

A. Results

In calculating the deuteron-triton overlap integral, one is simply projecting out the part of the triton wave function that looks like a deuteron plus a neutron. Thus, we expect that the overlap functions will be mainly sensitive to the properties of ϕ_t and relatively insensitive to ϕ_d. In particular, it is expected[1] that the $L=2$ overlap function will arise primarily from D-state terms in the triton wave function, although strictly speaking, $u_2(r)$ can be nonzero if either ϕ_d or ϕ_t contains a D-state term.

The deuteron-triton overlap functions, u_0 and u_2, have been calculated for a number of triton wave functions. Results are reported for the variational wave functions of Jackson *et al.*,[5] Delves and Blatt,[6] and Akaishi *et al.*[7]

The triton wave function of Jackson *et al.* was generated by a variational calculation employing the Reid soft-core (RSC) nucleon-nucleon potential.[10] The trial function was parametrized as a sum of harmonic oscillator functions and the binding energy was found to be 6.30 MeV. This is smaller than the experimental binding energy, 8.48 MeV. The overlap functions were calculated using the RSC deuteron wave function[10] and the results are given by the solid curves in Fig. 1(a). For comparison, the results of Santos *et al.*[8] are shown by the dashed curves. Santos *et al.* used the triton wave function of Strayer and Sauer[11] which was generated using the same harmonic oscillator parametrization employed by Jackson

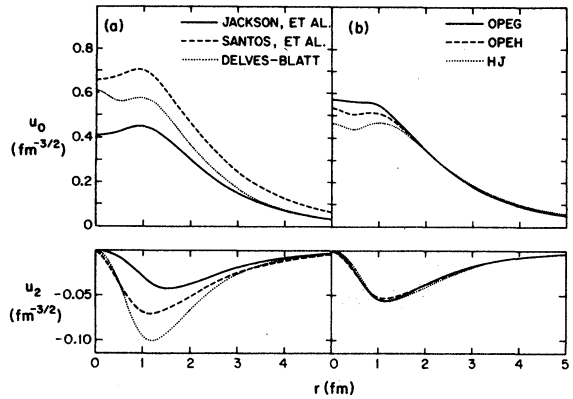

FIG. 1. Deuteron-triton overlap functions $u_0(r)$ and $u_2(r)$. The solid and dotted curves in (a) show the results for the triton wave function of Jackson *et al.* and for the HJ wave function of Delves and Blatt, respectively. The dashed curves are from Ref. 8 and give the results for the wave function of Strayer and Sauer. The curves in (b) were obtained from the wave functions of Akaishi *et al.* and are labeled by the corresponding nucleon-nucleon potentials. A factor of $\sqrt{2}$, which accounts for the presence of two identical neutrons in the triton, has been included in all of the overlap functions.

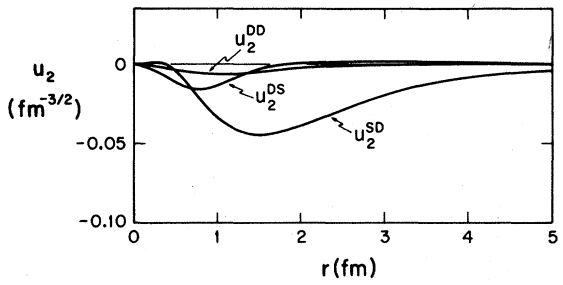

FIG. 2. Contributions to the $L = 2$ overlap function arising from various terms in the triton and deuteron wave functions. The largest contribution, u_2^{SD}, results from the overlap of the deuteron S-state with the D-state terms in the triton. The curves shown are for the HJ wave function of Akaishi *et al.*

et al. However, more terms were included and the resulting binding energy (6.7 MeV) was slightly larger.

Delves and Blatt have obtained variational wave functions for a number of nucleon-nucleon potentials by employing a trial function parametrized in terms of exponentials. The number of terms in the trial function was not large, and correspondingly, the binding energies obtained in the calculation were quite small. The overlap integral was evaluated using the deuteron wave function of McGee.[12] Results for the triton wave function derived from the Hamada-Johnston (HJ) potential[13] are shown by the dotted curves in Fig. 1(a). Similar results were obtained for the wave function corresponding to the Yale potential.[14]

Akaishi *et al.* construct a trial wave function using a method which makes it possible to properly include nucleon-nucleon correlations. The wave function contains very few variational parameters, but the binding energies are typically 6–7 MeV. Overlap integrals have been calculated for wave functions corresponding to the HJ potential, the OPEG and OPEH potentials of Tamagaki[15] and the super-soft-core (SSC) potential of de Tourreil and Sprung.[16] The deuteron wave function of Ref. 12 was used in all cases. Results are shown in Fig. 1(b) for the HJ, OPEG, and OPEH wave functions. The overlap functions for the SSC potential are similar to the OPEG results.

In Fig. 2 we show the separate contributions to $u_2(r)$ which result from various terms in the triton and deuteron wave functions. As expected, u_2 is dominated by the contribution u_2^{SD}, which arises from the overlap between the S-state of the deuteron and the D-state terms in the triton wave function. The contributions from the overlap of the deuteron D-state with the S- and D-state parts of the triton (u_2^{DS} and u_2^{DD}, respectively) are relatively insignificant. The curves shown in Fig. 2 are for the HJ wave function of Akaishi *et al.* Similar results are obtained for the other wave functions.

For purposes of comparison with experiment, it is useful to calculate the parameter D_2, using Eq. (11). The results obtained for each wave function are given in Table I, along with values of the variational binding energy and the D-state probability. The calculated values of D_2, which range from -0.07 to -0.12 fm^2, are more than a factor of 2 smaller than the best experimental value.

It is also of interest to calculate the DWBA form factors using Eq. (7). For reasons of consistency, the quantity γ was calculated from Eq. (5) with B_t set equal to the binding energy obtained in the variational calculation. The form factors are shown in Fig. 3 for the OPEH wave function of Akaishi *et al.* The results for the other wave functions are qualitatively similar for $r > 1$ fm. The behavior of v_0 for small r is quite different for the various wave functions, but this is relatively unimportant because of the r^2 weighting factor which always appears in integrals involving v_0.

B. Discussion

The magnitude of the discrepancy between the experimental and theoretical values of D_2 is surprisingly large. Although it is possible that the empirical values are grossly in error, or that the phenomenological potentials used to obtain the triton wave functions are somehow incorrect (e.g., if the nucleon-nucleon interaction is nonlocal or if

TABLE I. Calculated values of D_2 for various wave functions along with values of the variational binding energy B_t and the D-state probability P_D.

Wave function	Potential	B_t (MeV)	P_D (%)	D_2 (fm^2)
Delves-Blatt	HJ	2.6	8.4	−0.119
	Yale	2.5	7.8	−0.074
Akaishi *et al.*	HJ	6.0	8.7	−0.088
	SSC	7.1	7.5	−0.086
	OPEG	6.6	7.1	−0.086
	OPEH	6.6	7.1	−0.085
Jackson *et al.*	RSC	6.3	8.5	−0.083
Strayer and Sauer	RSC	6.7	8.8	−0.113 [a]

[a]Reference 8.

three-body forces are important), a more likely explanation is that the triton wave functions obtained from the variational calculations are not sufficiently accurate.

If we use a triton wave function which is not an exact eigenfunction of the three-body Hamiltonian, it is quite possible that the resulting form factors and D_2 values will be significantly in error. As we pointed out earlier, the derivation of Eq. (3) assumes that ϕ_t is the correct solution to the three-body Schrödinger equation and if this condition is not met, Eq. (3) as well as the results which follow from it [specifically Eqs. (7) and (11)] are no longer valid.

From the behavior of the overlap functions and form factors shown in Figs. 1 and 3 it is apparent that the variational wave functions have some shortcomings. From Eq. (7) we see that for large r, where v_L goes to zero, u_L should fall off exponentially with a decay constant characteristic of the triton-deuteron binding energy difference, i.e.,

$$u_L(r) \to N_L h_L^{(1)}(i\gamma r), \tag{12}$$

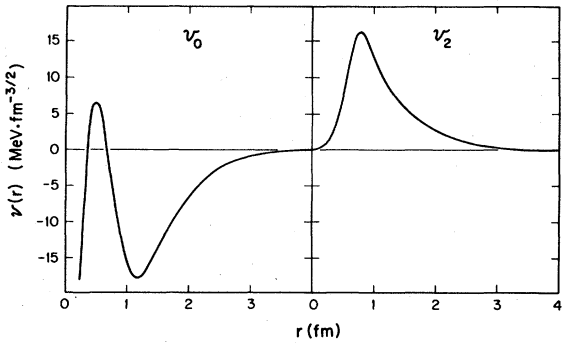

FIG. 3. DWBA form factors $v_0(r)$ and $v_2(r)$ derived from the deuteron-triton overlap functions by using Eq. (7). The results shown are for the OPEH wave function of Akaishi *et al.*

where $h_L^{(1)}$ is a Hankel function. The calculated overlap functions do not have this property. For all of the wave functions considered in this paper the S- and D-state overlap functions decay too rapidly. Santos *et al.*[8] also encountered this problem and have discussed its consequences.

The problem is illustrated in Fig. 4, which shows a log plot of u_0 and u_2 for the wave function of Jackson *et al.* and for the OPEG wave function of Akaishi *et al.* The corresponding Hankel functions, normalized to the calculated overlap functions at $r = 5$ fm, are given by the dashed curves. For the Akaishi wave function, the asymptotic behavior of u_0 is nearly correct, but in all other cases the calculated functions fall off too rapidly. The calcu-

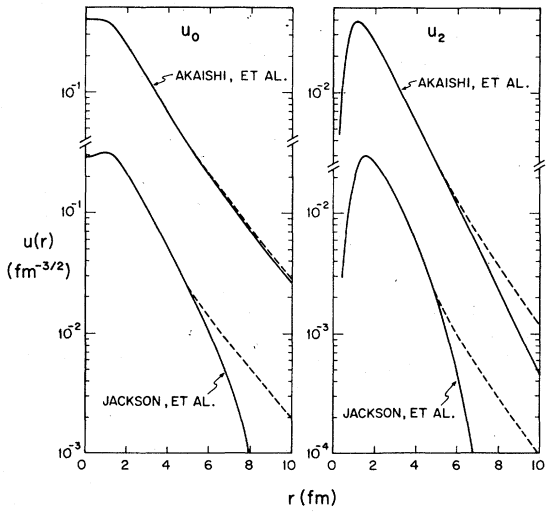

FIG. 4. Deuteron-triton overlap integrals for the OPEG wave function of Akaishi *et al.* and for the wave function of Jackson *et al.* The dashed curves show the appropriate Hankel functions normalized to the calculated u_L at $r = 5$ fm. The value of γ used here corresponds to the binding energy obtained in the variational calculation.

lated form factors also behave incorrectly for large r. Although it is not apparent from Fig. 3, both v_0 and v_2 cross zero at $r \simeq 5$ fm and have a long-range tail which is small in magnitude but which extends to very large values of r. This will have important consequences for DWBA calculations at low energies, since the low-momentum content of v_0 and v_2 is especially sensitive to the long-range behavior of the form factors. In particular, we see from Eq. (10) that D_2 depends on integrals in which v_0 and v_2 are weighted by factors of r^2 and r^4 respectively. The problem is thus particularly serious for the D-state integral. In this case the integrand $r^4 v_2(r)$ peaks for $r \simeq 2$–3 fm and is still quite large in magnitude for $r > 5$ fm where $v_2(r)$ has the wrong sign. In view of this it is not surprising that the calculated values of D_2 are too small.

IV. DIRECT CALCULATION OF THE FORM FACTORS

From the preceding discussion it is clear that if one wishes to determine the form factors by calculating the deuteron-triton overlap, it is critically important that the triton wave function behave properly in the asymptotic region. However, if one calculates the v_L directly by using Eqs. (1) and (2) the results should be relatively insensitive to the long-range behavior of ϕ_t.

Evaluation of the integral in Eq. (1) is rather tedious, and for this reason, the calculations have been performed only for the wave functions of Akaishi *et al.* For simplicity, we completely neglected the spin-orbit, quadratic spin-orbit, and $\vec{L} \cdot \vec{L}$ terms in the various nucleon-nucleon potentials and retained only the central and tensor terms. The neglected terms probably would not have a large effect on the form factors.

The results for the two soft-core potentials, SSC and OPEG, are shown by the solid and dashed curves in Fig. 5. Qualitatively, the form factors are similar to the results shown in Fig. 3, but in detail there are some important differences. The differences are readily apparent in Fig. 6, which shows a direct comparison between the form factors obtained by the two different methods. In order to emphasize the regions, which are important for determining the low-momentum behavior, v_0 and v_2 have been multiplied by r^2 and r^4 respectively. The solid curves show the form factors obtained by the direct method, using Eqs. (1) and (2), while the dashed curves give the results which we obtained by using Eqs. (4)–(7). All of the results shown in Fig. 6 are for the OPEG wave function.

From Fig. 6 it is clear that the form factors obtained in the direct calculation will lead to much

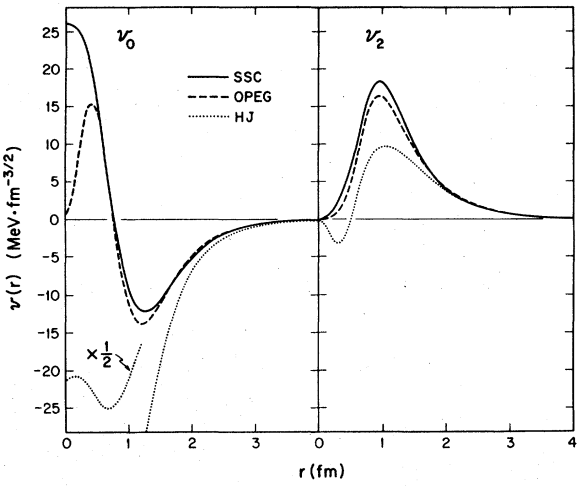

FIG. 5. DWBA form factors $v_0(r)$ and $v_2(r)$ obtained from Eqs. (1) and (2). The curves shown are for the triton wave functions of Akaishi *et al.* and are labeled by the corresponding nucleon-nucleon potentials. A factor of $\sqrt{2}$, which accounts for the presence of two identical neutrons in the triton, has been included in all of the form factors.

larger values of D_2. For the two soft-core potentials we find

$$D_2(\text{OPEG}) = -0.381 \text{ fm}^2,$$
$$D_2(\text{SSC}) = -0.377 \text{ fm}^2. \tag{13}$$

These results are about a factor of 4 larger than the values obtained in the indirect calculation (see Table I).

For the hard-core potentials (HJ and OPEH) evaluation of the matrix element in Eq. (1) did not lead to reasonable results. The calculated form factors for the HJ potential are shown by the dotted curves in Fig. 5. Note that for small r, the S-state form factor is much larger than those obtained with

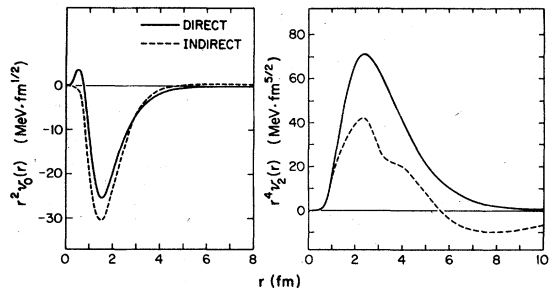

FIG. 6. Comparison of the functions $r^2 v_0(r)$ and $r^4 v_2(r)$ obtained from two different methods. The solid curves result from a direct calculation using Eqs. (1) and (2), while the dashed curves were derived from the deuteron-triton overlap functions by using Eq. (7). The curves shown are for the OPEG wave function.

the soft-core potentials.

One reason for believing that the soft-core form factors are more correct than the hard-core form factors is that the zero-range DWBA normalization constant does not come out right in the latter case. According to the conventional definition,[17] the (t,d) normalization constant D_0 is related to the S-state form factor by

$$D_0 = -\sqrt{4\pi}\int_0^\infty r^2 v_0(r)dr\,. \tag{14}$$

For the soft-core potentials we find $D_0 \simeq 140$ MeV fm$^{3/2}$, whereas the hard-core potentials give $D_0 \simeq 280$ MeV fm$^{3/2}$. Cross section measurements for (d,t) reactions give an average experimental value (Ref. 18) of $D_0 = 164 \pm 16$ MeV fm$^{3/2}$, while a dispersion analysis[19] of n-d elastic scattering [where $D_0^2 = (9\pi\hbar^4\gamma/2M^2)C_0^{\,2}$] leads to $D_0 = 168 \pm 10$ MeV fm$^{3/2}$.

It is not difficult to understand why the normalization factor is too large for a hard-core potential. For a soft-core potential, the triton wave function is small but not zero for nucleon-nucleon separations smaller than the core radius r_c. Since the potential is very large in this region, $V\phi_t$ may be significant. The repulsive core will therefore contribute to $F(\vec{r})$, and it is presumably the core that causes v_0 to go positive for $r < 1$ fm (see Fig. 5). For a hard-core potential, on the other hand, ϕ_t is zero when the nucleon-nucleon separation is less than r_c and consequently the repulsive core makes no contribution at all to the form factors.

In a direct calculation of the form factors it is clearly important that the triton wave functions have the proper behavior for small r. Fortunately, the method used by Akaishi *et al.*[7] to construct their variational wave functions ensures that the nucleon-nucleon correlations are properly accounted for. It is quite possible that if other variational wave functions were used in the calculation, difficulties would be encountered in the treatment of the repulsive core.

In the present calculation we find that the form factors are quite insensitive to the small pieces in the triton and deuteron wave functions. If we neglect the triton S' state we find that the integral of $r^2 v_0(r)$ increases by 6% while the integral of $r^4 v_2(r)$ changes only slightly. Neglecting the D-state terms in either the triton or deuteron wave function also leads to rather small changes, typically on the order of 2 or 3%. This suggests that one can obtain a useful estimate of the form factors by employing simple wave functions which contain only the dominant S-state terms. In this case the wave functions can be written as products of spin and spatial factors, i.e.,

$$\phi_d^{\sigma_d} = [4\pi]^{-1/2}\psi_d(\rho)\chi_d^{\sigma_d} \tag{15}$$

and

$$\phi_t^{\sigma_t} = [8\pi^2]^{-1/2}\psi_t(r,\rho,\mu)\chi_t^{\sigma_t} \tag{16}$$

where μ is the cosine of the angle between $\vec{r}$ and $\vec{\rho}$. In Eqs. (15) and (16), χ_d and χ_t are normalized spin functions, while the spatial functions are normalized according to

$$\int |\psi_d(\rho)|^2 \rho^2 d\rho = 1 \tag{17}$$

and

$$\iiint |\psi_t(r,\rho,\mu)|^2 r^2\rho^2 dr\,d\rho\,d\mu = 1\,. \tag{18}$$

In this special case the form factors reduce to

$$v_0(r) = -\sqrt{3}\iint \psi_d^*(\rho)[\tfrac{3}{4}{}^1V_c(r_{12}) + \tfrac{1}{4}{}^3V_c(r_{12})] \times \psi_t(r,\rho,\mu)\rho^2 d\rho\,d\mu \tag{19}$$

and

$$v_2(r) = \sqrt{6}\iint \psi_d^*(\rho)^3V_T(r_{12})\left[1 + \frac{3}{8}\left(\frac{\rho}{r_{12}}\right)^2(\mu^2-1)\right] \times \psi_t(r,\rho,\mu)\rho^2 d\rho\,d\mu\,. \tag{20}$$

Here ${}^1V$ and ${}^3V$ are the singlet-even and triplet even nucleon-nucleon potentials and $\vec{r}_{12} = \vec{r} + \frac{1}{2}\vec{\rho}$. We see that in this approximation the S- and D-state form factors depend in a rather simple way on the nucleon-nucleon central and tensor interactions.

V. SUMMARY AND CONCLUSIONS

Recent experiments have shown that D-state components in the triton wave function can have large effects on the tensor analyzing powers for $(\vec{d},t)$ reactions. To study these effects we have evaluated the S- and D-state components of the DWBA form factor using a number of variational triton wave functions derived from realistic nucleon-nucleon interactions. Two methods were used to calculate the form factors. In the first we evaluate the deuteron-triton overlap integral. In all cases studied, we find that the calculated overlap functions decay too rapidly in the asymptotic region and that the corresponding form factors also behave in an unphysical manner. The values of D_2 obtained from these calculations range from -0.07 to -0.12 fm^2. These results are considerably smaller than the best experimental value (-0.275 fm^2), and it appears that the small values of D_2 result, to a large extent, from the failure of the overlap functions to exhibit the correct exponential falloff. In view of this difficulty, it would be of interest if a method could be developed

for constructing variational triton wave functions which are assured of having the proper asymptotic behavior.

The second method of calculating the form factors involves the direct evaluation of the matrix element in Eq. (1). In this case one is presumably less sensitive to the long-range properties of the wave function. We have included only the central and tensor components of the nucleon-nucleon potential. For soft-core potentials, the form factors obtained from this calculation lead to D_2 values of about -0.38 fm^2, which is in somewhat better agreement with the experiments. However, we believe that the form factors may be quite sensitive to the behavior of the triton wave function for very small nucleon-nucleon separations and to the nature of the repulsive core.

Because of these problems, we are not yet in a position to say whether the empirical value of D_2 is consistent with what is already known about the nucleon-nucleon interaction, and it is clear that more accurate triton wave functions will be needed if we are to make a meaningful comparison between experiment and theory. Unfortunately, when variational wave functions are used one can never be certain whether a discrepancy results from a failure of the variational calculation to accurately reproduce the exact eigenfunction, or from a more fundamental problem. With Faddeev wave functions one does not have this problem (provided of course that the calculations are done with sufficient accuracy). It is encouraging to note that the recent calculation by Kim and Muslim,[9] in which a Faddeev wave function was used to determine the asymptotic normalization of the deuteron-triton overlap functions, leads to a D_2 value of -0.24 fm^2, which agrees quite well with the experiments. Further calculations employing Faddeev wave functions would clearly be of interest. Such calculations may help to answer the question of whether the empirical determination of D_2 places any new constraints on the internal structure of the triton or on the form of the nucleon-nucleon interaction.

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