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POLARIZATION PHENOMENA IN DEUTERON-PROTON BACKWARD ELASTIC SCATTERING, $d + p \to p + d$

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Поляризационные явления в дейтрон-протонном упругом рассеянии назад, $d + p \to p + d$

В терминах четырех независимых амплитуд, определяющих в общем случае структуру амплитуды упругого dp-рассеяния назад, рассмотрены поляризационные эффекты, возникающие в случае, когда обе сталкивающиеся частицы поляризованы. В рамках импульсного приближения найдены выражения для амплитуд в терминах S- и D-компонент волновой функции дейтрона. Получены выражения для обсуждаемых асимметрий, учитывающие возможное наличие P-волны в дейтроне. Рассчитано энергетическое поведение анализирующей способности A_t, связанной с поперечной поляризацией сталкивающихся частиц для нескольких популярных волновых функций дейтрона.

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Sitnik I.M., Ladygin V.P., Rekalo M.P. E1-94-23
Polarization Phenomena in Deuteron-Proton Backward Elastic Scattering, $d + p \to p + d$

Effects due to the polarization of both colliding particles have been analyzed in terms of four independent amplitudes which in the general case define the spin structure of the dp backward elastic scattering amplitude. The expressions for amplitudes in terms of the S- and D-components of the deuteron wave function have been found in the Impulse Approximation approach. The contribution of a possible P-wave component of the deuteron wave function to these effects is also considered. The energy dependence of analyzing power A_t due to the transverse polarization of the colliding particles is predicted using standard deuteron wave functions.

The investigation has been performed at the Laboratory of High Energies, JINR.

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1. Introduction

The knowledge of the short range behavior of the deuteron wave function (DWF) is of central importance for solving a number of problems, for example:

- to understand the role of such non-nucleonic degrees of freedom as quark and isobar configurations and to clarify the regime of transition to these configurations when the distance between nucleons is comparable to their size;
- to check different approaches of description of relativistic bound states;
- to calculate static electromagnetic characteristics such as magnetic dipole and electric quadrupole momenta, and the k_μ^2 - dependence of electromagnetic and weak deuteron formfactors;
- to obtain additional information on the off-mass shell behavior of the nucleon-nucleon amplitudes;
- to clear up the features of below threshold production of heavy particles on deuteron target;
- to determine more accurately mechanisms of different processes involving the deuteron in the initial and final states;
- to predict the momentum distributions of secondary particles from the fragmentation of relativistic nuclei;
- to check the symmetry properties of fundamental interactions.

A direct reconstruction of the DWF from the measured quantities in the framework of the Impulse Approximation (IA) is possible in two types of reactions. First of all, it is the study of the reaction of deuteron electrodisintegration $ed \to e + np$. An inclusive study of this reaction near threshold $d(e,e')np$ [1], where the momentum transfer squared k^2 defines directly the DWF argument, and an exclusive study of the $d(e,e'p)n$ in the region of large production angles of the proton relative to the momentum of the virtual photon are most suitable for this purpose. The process of photodisintegration of the deuteron also allows one to obtain information about the DWF. Attractiveness of ed- interactions for the study of DWF is connected first of all with weakness of electromagnetic interactions, which allows one to use all advantages of the one-photon mechanism. Existing experience in the analysis of the mechanism of the $\gamma^* + d \to n + p$ process

(γ^* is a virtual photon) indicates a lot of problems for deuteron electrodisintegration. The correct mechanism of such a process must contain obligatorily the following ingredients:

- one-nucleon exchanges in the IA;
- meson exchange currents;
- isobar and quark configurations in the ground state of the deuteron;
- strong nucleon interaction in the final state;
- $N\Delta$-rescattering in the $N\Delta \to NN$ process.

To avoid all constraints on possible values of momentum transfer squared (k^2) and the excitation energy of the np- system all of these contributions should be calculated in the relativistic approach. But, of course, conserved electromagnetic current should be "organized" for the $\gamma^* + d \to n + p$ process. Only if an adequate model of amplitude of the $e+d \to e+np$ process exists, one can obtain information about the DWF from corresponding experimental data. Even at the first step of similar calculations, namely at the level of the IA, the following questions arise:

- the number of independent components of the DWF (two in nonrelativistic theory including S- and D-waves or four in relativistic theory including S-, P- and D-waves [2], or six in the so-called spurion models [3]);
- what is the argument of the DWF and furthermore the number of them (one as in standard models or two as in spurion approaches);
- off-mass effects for nucleon electromagnetic current $\gamma^* N^* N$ with virtual nucleon N^*.

Due to difficulties of interpretation of ed- scattering data, the second class of experiments for studying the DWF in the IA is of great interest. Among these are reactions of deuteron fragmentation $A(d,p)X$ and elastic backward deuteron-proton scattering $d + p \to p + d$. The momentum distributions of fragments extracted from the data of the above experiments with electromagnetic and nuclear probes demonstrate, on the one hand, a substantial discrepancy with the predictions using standard DWF in the IA and, on the other hand, a good agreement with one another [4, 5, 6, 7], which gives serious motivations to search for the explanation of the observed effects not only in deviation from the IA but also in nonadequate standard DWF.

To determine the behavior of different components of the DWF, one needs to study polarization observables of the above reactions. At the present time such data exist or are in progress only for nuclear probe reactions.

Apart from cross sections, such observables as the tensor analyzing power T_{20} [8] and the polarization transfer coefficient from the deuteron to the proton κ [9] have been investigated for the reaction $A(\vec{d},p)X$. Such a set of data allows one to arrive at the conclusion that no configuration consisting only of S- and D-waves can be compatible with the data within the framework of the IA [10].

Concerning dp backward elastic scattering, the measurement of T_{20} was one of the first experiments at the SATURNE-2 accelerator [11]. The measurements of κ (and also the remeasurements of T_{20}) at Saclay [12] and of T_{20} at Dubna[13] have been lately made. The new data drastically disagree with the predictions based on the IA calculations using standard DWF. The available set of data is insufficient to separate the deuteron structure from the reaction mechanism. To solve this problem successfully, measurements of new polarization observables are needed.

New polarization observables can be obtained using a polarized proton target. In case of the polarized initial proton the virtual nucleon is polarized, i.e. the spin characteristics of two vertices of the IA diagram (*Fig.1*) should be correlated. In this case both secondary deuterons and protons are polarized, even if the primary beam is unpolarized. We, however, will restrict ourselves by consideration of effects measured after first interaction, when the deuteron beam has a vector polarization. The matter is the double scattering experiments with a polarized target are hardly realistic nowadays because of serious restriction of an intensity of the primary beam, needed in this case. The considered asymmetries allow one to study the mechanism of spin information transfer between two vertices of the IA diagram. More exactly, the analyzing powers of the $\vec{d}+\vec{p} \to p+d$ reaction are sensitive to the mutual spin orientation of the primary deuteron and proton. Such polarization observables as κ and T_{20} do not possess a similar sensitivity. Just therefore the quantities κ and T_{20} for different reactions, $d + p \to p + d$ and $A(d,p)X$, are characterized by equivalent formulas in terms of the S- and D- components of the DWF. The latter polarization observable for dp backward elastic scattering has no analog in the reaction of deuteron fragmentation. ?

In the second chapter we obtain general formulas for polarization observables, which are valid for any reaction mechanism.

In the third chapter we consider the case when the DWF include S- and D-waves in the IA. The behavior of asymmetries in this approach is predicted for different DWF.

In the fourth chapter we consider the effects of the P-wave components of the DWF for the simplest polarization observables of the $d + p \to p + d$ process also in the IA.

The measurements of these asymmetries are possible at Dubna, Saturne and KEK now.

This work based on the report, presented at "Deuteron-93" symposium held in Dubna[14].

2. Amplitude of the d+p $\to$ p+d ($\theta = 180^0$) process and general analysis of the polarization effects

As known the spin structure of the amplitude of the $d+p \to d+p$ process is very complicated in the general case; there are 12 independent complex helicity amplitudes depending on total energy $\sqrt{s}$ and scattering angle θ in the CMS of the process. This structure can be reconstructed in a complete experiment which contains measurements of at least 23 different polarization observables. The situation is much simpler in case of backward scattering when the total helicity of interacting particles is conserved. Indeed, in this case we have only four independent amplitudes for the following transition $\lambda_d, \lambda_p \to \lambda_d', \lambda_p'$,

$$\begin{array}{c}(++ \to ++),\\ (-+ \to -+),\\ (-+ \to 0-),\\ (0+ \to 0+),\end{array} \qquad (1)$$

where $\lambda_d(\lambda_p)$ corresponds to the deuteron (proton) spin projection on the 3-momentum of the initial deuteron ($+1, -1, 0$ for deuteron, $\pm\frac{1}{2}$ for proton). Other possible amplitudes (with other λ_d, λ_p combinations) are connected with amplitudes (1) by conditions of strong interaction P-invariance and identity of the initial and final states.

Due to the total phase uncertainty, restoration of four amplitudes (complex in the general case) is possible after performing 7 independent polarization

experiments (apart from measurements of energy dependence of differential cross sections with unpolarized particles). As noted above, two experiments, namely the measurements of T_{20} and κ, have been carried out. Taking into account P-invariance of strong interaction, one can obtain the following formulas for the amplitude of the $d + p \to p + d, \theta = \pi$ process:

$$\mathcal{M} = \chi_2^+ F \chi_1$$

$$\begin{aligned} F = {} & g_1(s)\left[\vec{U}_1\vec{U}_2^* - \vec{n}\vec{U}_2^*\right] + g_2(s)\left[\vec{n}\vec{U}_1 \cdot \vec{n}\vec{U}_2^*\right] \\ & + ig_3(s)\left[\vec{\sigma}(\vec{U}_1 \times \vec{U}_2^*) - \vec{\sigma}\vec{n} \cdot \vec{n}\underbrace{(\vec{U}_1 \times \vec{U}_2^*)}_{?}\right] \\ & + ig_4(s)\left[\vec{\sigma}\vec{n} \cdot \vec{n}(\vec{U}_1 \times \vec{U}_2^*)\right], \end{aligned} \qquad (2)$$

where $\vec{U}_1(\vec{U}_2)$ is the 3-vector of polarization of the initial (final) deuteron, $\vec{n}$ is the unit vector along the 3-momentum of the initial deuteron, $\chi_1(\chi_2)$ is the two-component spinor of the initial (final) proton, $\vec{\sigma}$ are the Pauli matrices and $g_1(s)$-$g_4(s)$ are the amplitudes of the $d + p \to p + d$ reaction depending at $\theta = \pi$ only on one variable, namely the total energy squared s.

The amplitudes $g_1 - g_4$ (called scalar) are related to helicity amplitudes as follows: (следует из (2)):

$$\begin{aligned} F_{0+\to 0+} &= g_2(s), \\ F_{++\to ++} &= g_1(s) + g_4(s), \\ F_{-+\to -+} &= g_1(s) - g_4(s), \\ F_{0+\to +-} &= -\sqrt{2}g_3(s), \end{aligned} \qquad (3)$$

i.e. only one amplitude, namely $g_3(s)$, is responsible for proton spin flip.

Of course, all polarization effects can be described in terms of the scalar or helicity amplitudes.

Let us write formulas for the simplest polarization observables in this process. We use the following formulas for the density matrices of the initial proton and deuteron:

$$\rho_p = \frac{1}{2}(1 + \vec{\sigma}\vec{P}), \qquad (4)$$

where $\vec{P}$ is the 3-vector of proton polarization;

$$\rho_d = U_{1i}U_{1j}^* = \frac{1}{3}(\delta_{ij} + i\epsilon_{ijl}S_l + Q_{ij}), \qquad (5)$$

where vector $\vec{S}$ and tensor Q_{ij} characterize vector and tensor deuteron polarization, $Q_{ij} = Q_{ji}, Q_{ii} = 0$.

Then the following formulas are valid for the differential cross section and for the polarization $\vec{P}_2$ of secondary protons

$$
\begin{aligned}
\frac{d\sigma}{d\Omega} &= \frac{1}{2}\mathcal{N}\,\overline{SpF(1+\vec{\sigma}\vec{P})F^{+}}, \\
\vec{P}_2\frac{d\sigma}{d\Omega} &= \frac{1}{2}\mathcal{N}\,SpFF^{+}\vec{\sigma}, \qquad\qquad (6)\\
\mathcal{N} &= \frac{1}{64\pi^2 s},
\end{aligned}
$$

where the line indicates summation over final deuteron polarization .

In case of unpolarized target, $\vec{P} = 0$, the differential cross section $\frac{d\sigma^{(T0)}}{d\Omega}$ depends only on the tensor polarization of initial deuterons:

anal. pow initial d

$$
\begin{aligned}
\frac{d\sigma^{(T0)}}{d\Omega} &= \frac{d\sigma^{(00)}}{d\Omega}(1 + T_{20}t_{20}), \\
\mathcal{N}^{-1}\frac{d\sigma^{(00)}}{d\Omega} &= 3U + T, \\
T_{20} &= -\sqrt{2}\cdot\frac{T}{3U+T}, t_{20} = \frac{1}{\sqrt{2}}Q_{zz}, \qquad\qquad (7)\\
U &= |g_1(s)|^2 + |g_3(s)|^2 + |g_4(s)|^2, \\
T &= -|g_1(s)|^2 + |g_2(s)|^2 + |g_3(s)|^2 - |g_4(s)|^2,
\end{aligned}
$$

where $\frac{d\sigma^{(00)}}{d\Omega}$ is the differential cross section when both the initial proton and deuteron are unpolarized, and T_{20} is the analyzing power due to tensor polarization of the initial deuteron.

As is seen from (7), only modules of the amplitudes $g_i(s)$ determine the values of $\frac{d\sigma^{(00)}}{d\Omega}$ and T_{20}.

Let us write expressions for the normal (κ_t) and longitudinal (κ_l) polarization transfer coefficient from the vector-polarized deuteron to the secondary proton:

$$
\begin{aligned}
\mathcal{N}^{-1}\kappa_t\frac{d\sigma^{(T0)}}{d\Omega} &= 3\cdot Re\{g_3(s)\cdot[g_1(s)+g_2(s)+g_4(s)]^*\}, \\
\mathcal{N}^{-1}\kappa_l\frac{d\sigma^{(T0)}}{d\Omega} &= 3\cdot\{|\,g_3(s)\,|^2 + 2Re\,[g_1(s)\cdot g_4(s)^*]\}. \qquad\qquad (8)
\end{aligned}
$$

If the proton target is polarized, then due to P-invariance of strong interaction, the differential cross section of the $\vec{d} + \vec{p} \to p + d$ process should have the

following dependence on the axial $\vec{S}$ and $\vec{P}$ vectors:

$$
\frac{d\sigma}{d\Omega} = \frac{d\sigma^{(T0)}}{d\Omega}\left[1 + \frac{3}{2}A_t(\vec{S}\cdot\vec{P} - (\vec{n}\cdot\vec{S})(\vec{n}\cdot\vec{P})) + \frac{3}{2}A_l(\vec{n}\cdot\vec{S})(\vec{n}\cdot\vec{P})\right]. \qquad (9)
$$

From (9) one can see that the term $A_t(A_l)$ is responsible for the asymmetry effect when spin orientations of both participants of the reaction are normal(longitudinal) to the direction of the initial deuteron 3-momentum.

In terms of scalar amplitudes the expressions for $A_{t,l}$ have the following form:

$$
\begin{aligned}
A_t\mathcal{N}^{-1}\frac{d\sigma^{(T0)}}{d\Omega} &= -2\cdot Re\{g_3(s)\cdot[-g_1(s) - g_2(s) + g_4(s)]^*\}, \\
A_l\mathcal{N}^{-1}\frac{d\sigma^{(T0)}}{d\Omega} &= -2\cdot\{|\,g_3(s)\,|^2 - 2Re\,[g_1(s)\cdot g_4(s)^*]\} \qquad\qquad (10)
\end{aligned}
$$

and contain the interference contributions $Re(g_i\cdot g_k^*)$ in contrast to the differential cross section and T_{20}.

Note that for realization of the complete experiment program it is necessary to obtain data for the polarization observables containing the $Im(g_i\cdot g_k^*)$ contributions. As such terms are nonzero only for complex amplitudes due to their T-odd nature, similar combinations appear only for triple correlations of vector polarizations: $\vec{S}_1\times\vec{S}_2\cdot\vec{S}_3$, $\vec{n}\vec{S}_1\cdot\vec{n}\vec{S}_2\times\vec{S}_3$ and so on, where $\vec{S}_i$ is the polarization vector of an i-particle in the reaction $d + p \to p + d$.

3. Polarization effects in the IA

All above mentioned formulas for polarization observables are valid for any mechanism of the $d + p \to p + d$ process. Using them, let us analyze polarization effects in the framework of the IA (*Fig.1a*).

The matrix element, which corresponds to this mechanism, takes the following form:

$$
\mathcal{M} = \chi_2^{+}\left[(\vec{\sigma}\cdot\vec{U}_1)a(s) + (\vec{\sigma}\cdot\vec{n})(\vec{n}\cdot\vec{U}_1)b(s)\right]\left[(\vec{\sigma}\cdot\vec{U}_2)a(s) + (\vec{\sigma}\cdot\vec{n})(\vec{n}\cdot\vec{U}_2)b(s)\right]\chi_1 \qquad (11)
$$

where $a(s)$ and $b(s)$ are the combination of the S- and D- states in the deuteron

$$
\begin{aligned}
a(s) &= \Psi_s + \frac{1}{\sqrt{2}}\Psi_d, \\
b(s) &= -\frac{3}{\sqrt{2}}\Psi_d. \qquad\qquad (12)
\end{aligned}
$$

Comparing the matrix elements (11) with the general structure (2), we obtain the following expression for $g_i(s)$ in terms of the DWF components:

$$g_1(s) = g_4(s) = a^2(s),$$
$$g_2(s) = a^2(s)\cdot(1+R)^2 = a^2(s)\cdot x^2,$$
$$g_3(s) = a^2(s)\cdot(1+R) = a^2(s)\cdot x, \qquad (13)$$

where $R = b(s)/a(s)$ and $x = R+1$. All $g_i(s)$ amplitudes are real, i.e. all T-odd polarization correlations are equal to zero in this approximation, and, besides,

$$g_1(s)g_2(s) = g_3^2(s). \qquad (14)$$

Of course, this relation simplifies the analysis of the polarization effects in backward proton-deuteron scattering:

$$U = a^4(s)\cdot(3+2\cdot R+R^2) = a^4(s)\cdot(x^2+2),$$
$$T = a^4(s)\cdot R\cdot(2+R)\cdot(3+2\cdot R+R^2) = a^4(s)\cdot(x^2-1)\cdot(x^2+2),$$

therefore

$$\mathcal{N}^{-1}\cdot\frac{d\sigma^{(00)}}{d\Omega} = a^4(s)\cdot(x^2+2)^2 = 9(\Psi_s^2+\Psi_d^2)^2,$$
$$T_{20} = -\sqrt{2}\cdot\frac{x^2-1}{x^2+2} \qquad (15)$$

4 The expression for T_{20} in another but equivalent form has been obtained earlier[16].

The expressions for the polarization transfer coefficients (when the deuteron tensor polarization is equal to zero) have the following forms:

$$\kappa_t = \frac{3\cdot x}{(x^2+2)},$$
$$\kappa_l = \frac{3}{(x^2+2)} \qquad (16)$$

Substitution of (13),(14) into (10) gives:

$$A_l = -2\cdot\frac{(x^2-2)}{(x^2+2)^2},$$
$$A_t = 2\cdot\frac{x^3}{(x^2+2)^2}, \qquad (17)$$

when the deuteron tensor polarization is equal to zero.

A natural combination x^2+2 (squared in this case) remains in the denominators of both asymmetries A_l, A_t, but the numerators of A_l, A_t contain such combinations of the Ψ_s and Ψ_d functions which are absent in T_{20} and κ. It is worth to underline that asymmetry A_t is an even function of variable x and so one can obtain the only solution for x (and hence for R) at any value of the DWF ? argument. A direct analog of A_l, A_t is absent in the deuteron break-up reaction.

The behavior of A_t asymmetry for different popular DWF is presented in *Fig.2* versus k, the intrinsic nucleon momentum in the light cone approach. The connection of k with the measured quantities is given, for example, in ref.[7, 15]. A strong sensitivity of A_t asymmetry can be seen to choose the DWF. One can also ? expect not a lesser deviation of data in future experiments from the predictions than that found in the measurements of T_{20}[11, 12, 13].

4. P-wave contribution in the polarization effects

Let us first write the spin structure of the $\bar{n}+p\to d$ vertex which corresponds to the P-wave component of the DWF in the relativistic regime:

$\vec{\mathcal{U}}^{(p)} = -\vec{\mathcal{U}}$

$$\vec{n}\cdot\vec{U}p_1(s) + i\vec{\sigma}\cdot\vec{U}\times\vec{n}p_2(s) \qquad (18)$$

where p_1 and p_2 are two independent P-wave functions. Linearity of (18) relative to the components of vector $\vec{n}$ corresponds to the P-wave in the system $\bar{n}+d$ because parity of the fermion-antifermion system is negative. The spin of the $\bar{n}+d$ system is equal to $\frac{1}{2}$ or $\frac{3}{2}$, and so the corresponding wave functions are connected with $p_{1,2}$ as follows:

$$\Psi_p^{\frac{1}{2}} = \frac{1}{3}\cdot(2p_2-p_1)$$
$$\Psi_p^{\frac{3}{2}} = \frac{1}{3}\cdot(p_1+p_2) \qquad (19)$$

Thus, the contribution of the antinucleon component to the matrix element of elastic backward dp-scattering can be written in the following form:

$$\mathcal{M}_P = \chi_2^+\left[(\vec{n}\cdot\vec{U_1})p_1 + i\vec{\sigma}\cdot\vec{U_1}\times\vec{n})p_2\right]\left[(\vec{n}\cdot\vec{U_2^*})p_1 - i\vec{\sigma}\cdot\vec{U_2^*}\times\vec{n})p_2\right]\chi_1 \qquad (20)$$

Then the following expressions are valid for the $g_i(s)$ amplitudes which correspond to the two mechanisms of *Fig.1*:

$$g_1(s) = a^2(s)(1+r_2^2),$$

$$
\begin{aligned}
g_2(s) &= a^2(s)(x^2 + r_1^2), \\
g_3(s) &= a^2(s)(x - r_1 \cdot r_2), \\
g_4(s) &= a^2(s)(1 - r_2^2)
\end{aligned} \tag{21}
$$

where $r_1 = \frac{p_1(s)}{a(s)}$ and $r_2 = \frac{p_2(s)}{a(s)}$.

Of course, inclusion of P-wave destroys the above relations between the $g_i(s)$ amplitudes. It is not difficult to show that in this case equivalence between the expressions for T_{20} and κ for the $d + p \to p + d$ and $A(d,p)X$ reactions disappears.

Using general formulas for the polarization effects in terms of the $g_i(s)$ amplitudes, let us calculate contributions due to P-wave keeping only main (quadratic) terms assuming that $| r_{1,2} | \ll 1$.

Then the formula for differential cross section with unpolarized particles should be deformed as follows:

$$
\mathcal{N}^{-1} \cdot \frac{d\sigma^{(T0)}}{d\Omega} \approx a^4(s) \cdot \left[(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2\right] \tag{22}
$$

Finally, the following expression emerges for the above discussed asymmetries:

$$
T_{20} \approx -\sqrt{2} \cdot \frac{(x^2-1)(x^2+2) + 2x^2 r_1^2 - 2 x r_1 r_2}{(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2} \tag{23}
$$

$$
\kappa_t \approx 3 \cdot \frac{x(x^2+2) - r_1(r_2(x^2+2) - x r_1)}{(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2} \tag{24}
$$

$$
\kappa_l \approx 3 \cdot \frac{(x^2+2) - 2 x r_1 r_2}{(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2} \tag{25}
$$

$$
A_t \approx 2 \cdot \frac{x^3 - x^2 r_1 r_2 + x(r_1^2 + 2 r_2^2)}{(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2} \tag{26}
$$

$$
A_l \approx -2 \cdot \frac{(x^2-2) - 2 x r_1 r_2}{(x^2+2)^2 + 2x^2 r_1^2 - 8 x r_1 r_2} \tag{27}
$$

Using (23-27), one can estimate the above polarization effects for any model of the DWF with P-wave components.

5. Conclusions

Thus, we have calculated both possible independent asymmetries in dp backward elastic scattering due to the vector polarizations of colliding particles.

Of course, the measurements of the analyzing powers A_t, A_l (in addition to T_{20} and κ) do not realize completely the full experiment program even in case

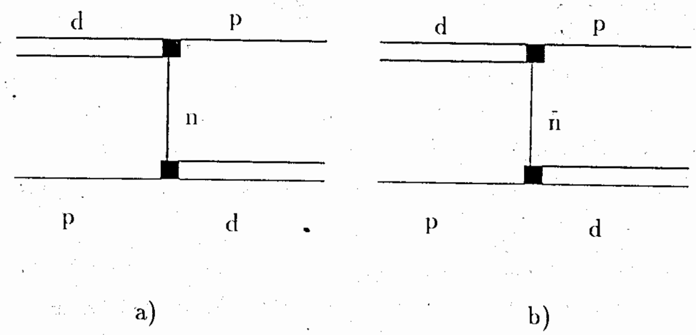

Fig.1 The IA diagrams for the $p(d,p)d$ reaction: a) exchange by the neutron; b) exchange by the antineutron.

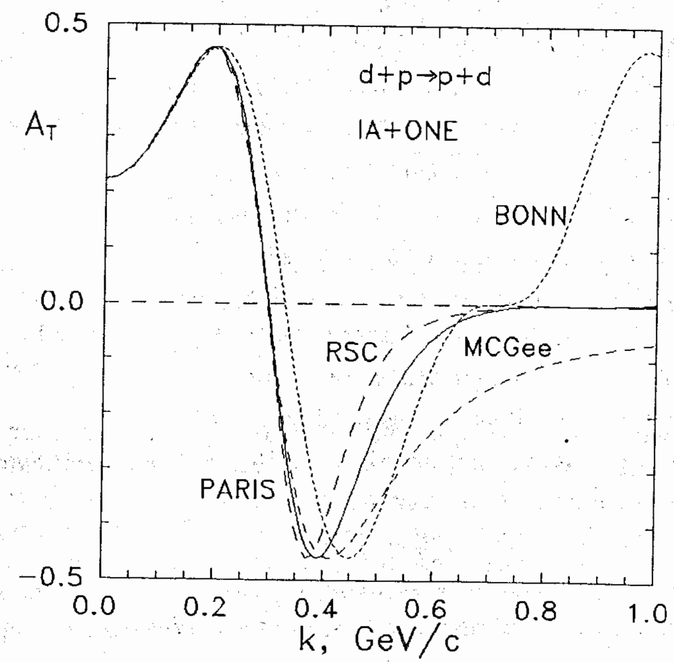

Fig.2 Asymmetry A_t versus intrinsic proton momentum in the light cone approach.

of collinear kinematics (backward scattering), when the process is characterized by only four amplitudes in the general case. Nevertheless, one can assert that the measurement of the analyzing power $A_t(s)$ will be important to determine more accurately the limits of the IA validity and to clarify the role of a possible P-wave component in the deuteron structure. We would like to note, that the measurement of the analyzing power A_t is one of the most realizable polarization experiments for the $d + p \to p + d$ reaction to date.

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