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POLARIZATION EFFECTS IN THE REACTION $d + e^- \to d + e^-$

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The differential cross section and polarization observables for the elastic reaction induced by deuteron scattering off electrons at rest, $d + e^- \to d + e^-$ are calculated in the one-photon-exchange approximation. The following polarization observables were calculated: 1- the analyzing powers (asymmetries) due to the tensor polarization of the deuteron beam, 2 - the spin correlation coefficients caused by the arbitrarily polarized electron target and the vector polarized deuteron beam, 3 - the coefficients of the polarization transfer from the arbitrarily polarized target electron to the recoil electrons. The differential cross section and polarization observables have been expressed in terms of the deuteron electromagnetic form factors: G_c (charge monopole), G_M (magnetic dipole) and G_Q (charge quadrupole). Numerical estimations are given for the analyzing powers (asymmetries) due to the tensor polarization of the deuteron beam. They are calculated as functions of the deuteron beam energy for some values of the scattering angle (the angle between the deuteron beam and the recoil electron momenta). For the numerical calculation we use the existing phenomenological parametrization of the deuteron electromagnetic form factors. It turns out that the analyzing powers (asymmetries) are increasing with the growth of the deuteron beam energy and they have appreciable sensitivity to the value of the scattering angle. The specific interest of this reaction is to investigate the possibility to use this reaction for the measurement of the polarization of the high energy deuteron beams.
KEY WORDS: polarization phenomena, electron, deuteron, asymmetries, form factors.

The use of the inverse kinematics (where the projectile is much heavier than the target) in experimental investigation of some reactions allows to solve certain problems. The important feature of this kinematics in the hadron electron reactions is that the momentum transfer squared is extremely small. The inverse kinematics was previously used in a number of the experiments to measure the pion or kaon charge radius from the elastic scattering of negative pions (kaons) from electrons in a liquid-hydrogen target. The first experiment was done at Serpukhov [1] with pion beam energy of 50 GeV. Later, a few experiments were done at Fermilab with pion beam energy of 100 GeV [2] and 250 GeV [3]. At this laboratory, the electromagnetic form factors of negative kaons were measured by direct scattering of 250 GeV kaons from stationary electrons [4]. Later on, a measurement of the pion electromagnetic form factor was done at the CERN SPS [5,6] by measuring the interaction of 300 GeV pions with the electrons in a liquid hydrogen target.

The use of the inverse kinematics is proposed in a new experiment at CERN [7] to measure the running of the fine-structure constant in the space-like region by scattering high-energy muons (with energy 150 GeV) on atomic electrons, $\mu e \to \mu e$. The aim of the experiment is the extraction of the hadron vacuum polarization contribution. In the last time the inverse kinematics was used to investigate the nuclear reactions which can be hardly measured by other methods. In the paper [8] it was proposed to measure the neutron capture cross sections of unstable isotopes. To do so the authors suggested a combination of a radioactive beam facility, an ion storage ring and a high flux reactor which allow a direct measurement of neutron induced reactions over a wide energy range on isotopes with half-lives down to minutes. A direct measurement, in inverse kinematics, of the $^{17}O(\alpha,\gamma)^{21}Ne$ reaction has been performed at the DRAGON facility, at the TRIUMF laboratory, Canada [9]. At this laboratory, the $^{22}Ne(p,\gamma)^{23}Na$ reaction has, for the first time, been investigated directly in inverse kinematics [10]. A total of 7 resonances were measured. The authors of the paper [11] analyze the (p, 2p) and (p, pn) reactions data measured, in inverse kinematics, at GSI (Darmstadt, Germany) for carbon, nitrogen and oxygen isotopes in the incident energy range of 300-450 MeV/u (see [12] and references therein).

From the theoretical point of view, the inverse kinematics was considered in a number of papers. A large interest in inverse kinematics (for the case of the elastic pe scattering) was arisen due to possible applications - the possibility to build the beam polarimeters, for the high-energy polarized proton beams, in the RHIC energy range [13]. The calculation of the spin correlation parameters, for the case of polarized proton beam and electron target, are sizeable and the polarimeter using this reaction can measure the polarization of the proton beam [13]. The cross section and another polarization observables for the proton-electron elastic scattering were derived in a relativistic approach assuming the one-photon-exchange approximation [14]. The numerical estimations of the polarization observables have also been done. The authors showed that polarization effects may be sizeable in the GeV region, and that the polarization transfer coefficients for $\vec{p} + e \to \vec{p} + e$ reaction could be used to measure the polarization of the high-energy proton beams. The suggestion to use this reaction for the determination of the proton charge radius was considered in [15]. The modelindependent radiative corrections to the differential cross section for elastic proton-electron scattering have been calculated in [16] in the case of experimental setup when both the final particles are recorded in coincidence. The differential cross section for the elastic scattering of deuterons on electrons at rest is calculated taking into account the QED radiative corrections to the leptonic part of interaction [17].

In this work, we calculated, in the one-photon-exchange approximation, the differential cross section and some polarization observables for the elastic deuteron-electron scattering. Numerical estimations are given for some polarization observables. The following polarization observables were calculated: 1- the analyzing powers (asymmetries) due to the tensor polarization of the deuteron beam, 2 - the spin correlation coefficients caused by the arbitrarily polarized electron target and the vector polarized deuteron beam, 3 - the coefficients of the polarization transfer from the arbitrarily polarized target electron to the recoil electrons. Numerical estimations are given for the analyzing powers (asymmetries) due to the tensor polarization of the deuteron beam. They are calculated as functions of the deuteron beam energy for some values of the scattering angle (the angle between the deuteron beam and the recoil electron momenta). For the numerical calculation we use the existing phenomenological parametrization of the deuteron electromagnetic form factors.

UNPOLARIZED CROSS SECTION

Let us consider the reaction

$$d(p_1)+e^-(k_1)\to d(p_2)+e^-(k_2), \tag{1}$$

where the particle momenta are indicated in parentheses. The reference system is the laboratory (Lab) system, where the electron target is at rest. The maximum value of the four-momentum transfer squared, in the scattering on electrons at rest, is:

$$\left(-k^2\right)_{max}=\frac{4m^2\left(E^2-M^2\right)}{M^2+2mE+m^2}, \tag{2}$$

where m (M) is the electron (deuteron) mass, E is the deuteron beam energy.
In the one-photon-exchange approximation, the matrix element M of the reaction (1) can be written as:

$$M=\frac{e^2}{k^2}j_\mu J_\mu, \tag{3}$$

where $j_\mu(J_\mu)$ is the leptonic (hadronic) electromagnetic current and $k=k_1-k_2=p_2-p_1$ is the four-momentum of the virtual photon. The leptonic current is

$$j_\mu=\overline{u}(k_2)\gamma_\mu u(k_1), \tag{4}$$

where $u(k_{1,2})$ is the bispinor of the incoming (outgoing) electron. The hadronic electromagnetic current can be written as

$$J_\mu=(p_1+p_2)_\mu\left[-G_1(k^2)U_1\cdot U_2^*+\frac{1}{M^2}G_3(k^2)\left(U_1\cdot kU_2^*\cdot k-\frac{k^2}{2}U_1\cdot U_2^*\right)\right]+ \tag{5}$$

$$+G_2(k^2)\left(U_{1\mu}U_2^*\cdot k-U_{2\mu}^*U_1\cdot k\right),$$

where $U_{1\mu}$ and $U_{2\mu}$ are the polarization four vectors for the initial and final deuteron states. The functions $G_i(k^2)$, i=1,2,3, are the deuteron electromagnetic form factors.

These form factors are related to the standard deuteron form factors: G_C (charge monopole), G_M (magnetic dipole) and G_Q (charge quadrupole) by the following relations:

$$G_M(k^2)=-G_2(k^2), G_Q(k^2)=G_1(k^2)+G_2(k^2)+2G_3(k^2), \tag{6}$$

$$G_C(k^2)=\frac{2}{3}\tau\left[G_2(k^2)-G_3(k^2)\right]+\left(1+\frac{2}{3}\tau\right)G_1(k^2), \tau=-\frac{k^2}{4M^2}.$$

The standard form factors have the following normalization:

$$G_C(0)=1, G_M(0)=\frac{M}{m_N}\mu_d, G_Q(0)=M^2Q_d, \tag{7}$$

where m_N is the nucleon mass, $\mu_d=0.857(Q_d=0.2857\ \text{fm}^2)$ is the deuteron magnetic (quadrupole) moment.

$$|M|^2=16\pi^2\frac{\alpha^2}{k^4}L_{\mu\nu}H_{\mu\nu}, L_{\mu\nu}=j_\mu j_\nu^*, H_{\mu\nu}=J_\mu J_\nu^*, \tag{8}$$

where $\alpha=e^2/4\pi=1/137$ is the electromagnetic fine structure constant. The leptonic tensor, $L_{\mu\nu}^{(0)}(L_{\mu\nu}^{(p)})$, for unpolarized initial and final electrons (polarized electron target) averaging over the initial electron spin, has the form:

$$L_{\mu\nu}^{(0)}=k^2g_{\mu\nu}+2(k_{1\mu}k_{2\nu}+k_{1\nu}k_{2\mu}), L_{\mu\nu}^{(p)}=2im\varepsilon_{\mu\nu\rho\sigma}k_\rho s_{1\sigma}, \tag{9}$$

where $s_{1\sigma}$ is the initial electron polarization four-vector which satisfies following conditions: $k_1\cdot s_1=0, s_1^2=-1$. We use the condition $\varepsilon_{1234}=1$.
The spin density matrix of the initial deuteron has the following form:

$$\rho_{\alpha\beta}^{(i)}=-\frac{1}{3}\left(g_{\alpha\beta}-\frac{1}{M^2}p_{1\alpha}p_{1\beta}\right)+\frac{i}{2M}<\alpha\beta\eta_1p_1>+Q_{\alpha\beta}^{(i)}, \tag{10}$$

where $<\alpha\beta ab>=\varepsilon_{\alpha\beta\rho\sigma}a_\rho b_\sigma$. Here $\eta_{1\alpha}$ and $Q_{\alpha\beta}^{(i)}$ are the four vector and tensor describing the vector and tensor polarization of the initial deuteron. The four-vector of the vector polarization satisfies the following conditions: η_1^2=-1, $\eta_1\cdot p_1=0$. The tensor $Q_{\alpha\beta}^{(i)}$ satisfies the conditions $Q_{\alpha\alpha}^{(i)}=0,\ Q_{\alpha\beta}^{(i)}=Q_{\beta\alpha}^{(i)},\ Q_{\alpha\beta}^{(i)}p_{1\alpha}=0$.
The hadronic tensor $H_{\mu\nu}(0)$ which corresponds to the case of unpolarized initial and final deuterons can be written as

$$H_{\mu\nu}(0)=H_1(k^2)\tilde{g}_{\mu\nu}+\frac{1}{M^2}H_2(k^2)P_\mu P_\nu, \tag{11}$$

where $\tilde{g}_{\mu\nu}=g_{\mu\nu}-(k_\mu k_\nu)/k^2$, $P_\mu=(p_1+p_2)_\mu$. Averaging over the spin of the initial deuteron, the structure functions $H_i(k^2)$, $i=1,2$, can be expressed in terms of the electromagnetic form factors as:

$$H_1(k^2)=\frac{2}{3}k^2(1+\tau)G_M^2(k^2), H_2(k^2)=M^2\left[G_C^2(k^2)+\frac{2}{3}\tau G_M^2(k^2)+\frac{8}{9}\tau^2G_Q^2(k^2)\right]. \tag{12}$$

The expression of the differential cross section for unpolarized deuteron-electron scattering, in the coordinate system where the electron is at rest, can be written as:

$$\frac{d\sigma}{dk^2}=\frac{\pi\alpha^2}{2m^2\vec{p}^{\,2}}\frac{D}{k^4}, D=(k^2+2m^2)H_1(k^2)+2\left[k^2M^2+2mE\left(2mE+k^2\right)\right]\frac{H_2(k^2)}{M^2}, \tag{13}$$

where $\vec{p}$ is the momenta of the deuteron beam.

POLARIZATION OBSERVABLES

Let us choose the following orthogonal system: the z axis is directed along the direction of the deuteron beam momentum $\vec{p}$, the momentum of the recoil electron $\vec{k}_2$ lies in the xz plane (θ_e is the angle between the deuteron beam and the recoil electron momenta), and the y axis is directed along the vector $\vec{p}\times\vec{k}_2$. So, the components of the deuteron beam and recoil electron momenta are the following

$$p_x = p_y = 0, p_z = p, k_{2x} = k_2 sin\theta_e, k_{2y} = 0, k_{2z} = k_2 cos\theta_e,$$

where $p(k_2)$ is the magnitude of the deuteron beam (recoil electron) momentum.

Asymmetries A_{ij}, caused by the tensor polarized deuteron beam

Consider the scattering of the tensor polarized deuteron beam on the unpolarized electron target. The hadronic tensor which corresponds to this case can be written as

$$H_{\mu\nu}\left(Q^{(i)}\right) = H_3\left(k^2\right)\bar{Q}^{(i)}\tilde{g}_{\mu\nu} + H_4\left(k^2\right)\frac{\bar{Q}^{(i)}}{4M^2}P_\mu P_\nu + H_5\left(k^2\right)\left(P_\mu\tilde{Q}_\nu^{(i)} + P_\nu\tilde{Q}_\mu^{(i)}\right) + H_6\left(k^2\right)\tilde{Q}_{\mu\nu}^{(i)}, \tag{14}$$

where

$$\tilde{Q}_\mu^{(i)} = Q_{\mu\nu}^{(i)}k_\nu - \frac{k_\mu}{k^2}\bar{Q}^{(i)}, \tilde{Q}_\mu^{(i)}k_\mu = 0, \tilde{Q}_{\mu\nu}^{(i)} = Q_{\mu\nu}^{(i)} + \frac{k_\mu k_\nu}{k^4}\bar{Q}^{(i)} - \frac{k_\nu k_\alpha}{k^2}Q_{\mu\alpha}^{(i)} - \frac{k_\mu k_\alpha}{k^2}Q_{\nu\alpha}^{(i)}, \tag{15}$$

$$\tilde{Q}_{\mu\nu}^{(i)}k_\nu = 0, \bar{Q}^{(i)} = Q_{\alpha\beta}^{(i)}k_\alpha k_\beta.$$

The structure functions $H_i(k^2)$ are related to the deuteron electromagnetic form factors by
:

$$H_3(k^2) = -G_M^2, H_4(k^2) = G_M^2 + \frac{4}{1+\tau}\left(G_C + \tau G_M + \frac{\tau}{3}G_Q\right)G_Q, \tag{16}$$

$$H_5(k^2) = -\tau(G_M + 2G_Q)G_M, H_6(k^2) = 4M^2\tau(1+\tau)G_M^2.$$

The components of the quadrupole polarization tensor $Q_{ij}^{(i)}$ which are defined in the Lab system can be related to the corresponding ones in the rest system of the deuteron beam (denote them as R_{ij}) by the following relations

$$Q_{xx}^{(i)} = R_{xx}, Q_{yy}^{(i)} = R_{yy}, Q_{xz}^{(i)} = \frac{E}{M}R_{xz}, Q_{zz}^{(i)} = \frac{E^2}{M^2}R_{zz}.$$

The dependence of the differential cross section of the reaction (1) on the polarization characteristics of the deuteron beam, in case when beam is tensor polarized, has the following form

$$\frac{d\sigma}{dk^2}\left(Q^{(i)}\right) = \left(\frac{d\sigma}{dk^2}\right)_{un}\left[1 + A_{xx}\left(R_{xx} - R_{yy}\right) + A_{xz}R_{xz} + A_{zz}R_{zz}\right], \tag{17}$$

where A_{ij}, $i, j = x, y, z$ are the asymmetries which characterize $\vec{d}e$ scattering, when the deuteron beam is tensor polarized.

The expressions for the asymmetries, as a functions of the deuteron form factors, can be written as:

$$DA_{xx} = 4\tau\left(1 - \frac{k^2}{k_{max}^2}\right)\left[(m^2p^2 + \tau M^4)G_M^2 - mEk^2G_MG_Q + (1+\tau)^{-1}(M^2k^2 + 2mEk^2 + 4m^2E^2)G_Q\left(\tau G_M + G_C + \frac{\tau}{3}G_Q\right)\right],$$

$$DA_{xz} = -\frac{2\tau}{mpM}\left[-k^2\left(1 - \frac{k^2}{k_{max}^2}\right)\right]^{1/2}\left\{M^2k^2\left(M^2 + mE\right)G_M^2 + 2[m^2p^2\left(k^2 + 4mE\right) + \right. \tag{18}$$

$$\left. +2mEk^2\left(M^2 + mE\right)\right]G_MG_Q - 4\left(1+\tau\right)^{-1}\left(M^2 + mE\right)\left(M^2k^2 + 2mEk^2 + 4m^2E^2\right)G_Q\left(\tau G_M + G_C + \frac{\tau}{3}G_Q\right)\Big\},$$

$$DA_{zz} = \frac{k^2}{M^2}\left\{-\left[m^2p^2 + 2\tau\left(\tau - 1\right)M^4 + \tau mM^2\left(m + 2E\right) + 3\tau^2\frac{M^6}{m^2p^2}\left(M^2 + 2mE + m^2\right)\right]G_M^2 + \right.$$

$$+4\tau\left[mEM^2\left(3-4\tau\right)+2\left(m^2E^2-\tau M^4\right)-3\tau E\frac{M^4}{mp^2}\left(M^2+2mE+m^2\right)\right]G_MG_Q+$$

$$+4\left(1+\tau\right)^{-1}\left(m^2E^2-2\tau mEM^2-\tau M^4\right)\left[1-2\tau-3\tau\frac{M^2}{m^2p^2}\left(M^2+2mE+m^2\right)\right]G_Q\left(\tau G_M+G_C+\frac{\tau}{3}G_Q\right)\Bigg\}.$$

Spin correlation coefficients, C_{ij}, caused by the polarized electron target and the vector polarized deuteron beam

Consider the scattering of the vector polarized deuteron beam (the polarizations of the final particles are not detected). In this case a non-zero polarization effects arise only when the electron target is also polarized. So, the part of the hadronic tensor related to the vector polarized deuteron beam and unpolarized scattered deuteron can be written as:

$$H_{\mu\nu}(\eta_1)=i(1+\tau)MG_M^2<\mu\nu\eta_1k>+\frac{i}{2M}G_M\left(G_M-2G_C-\frac{2}{3}\tau G_Q\right)\left(P_\mu<\nu\eta_1kp_1>-P_\nu<\mu\eta_1kp_1>\right). \quad (19)$$

In the considered frame, where the target electron is at rest, the polarization four-vectors of the electron target and of the deuteron beam have the following components

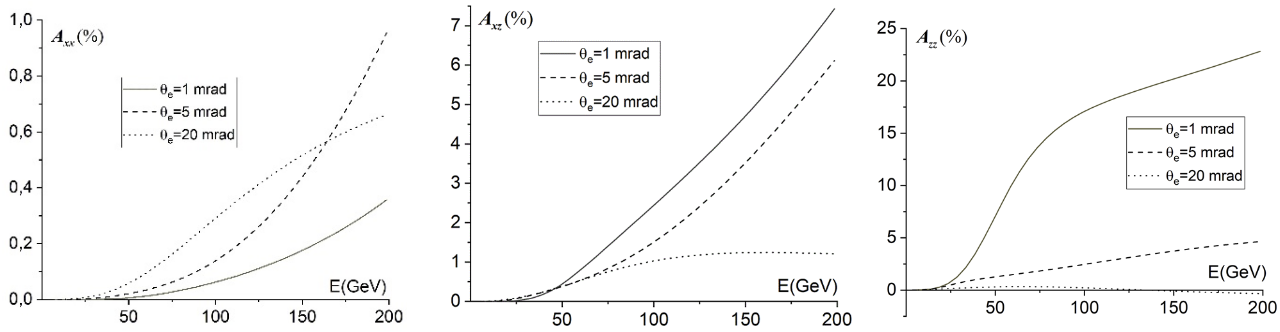

Figure 1. The asymmetries, which are caused by the tensor polarization of the deuteron beam, as a function of the deuteron beam energy E at various values of the scattering angle

$$s_1=\left(0,\vec{\xi}_1\right),\eta_1=\left(\frac{\vec{p}\cdot\vec{S}_1}{M},\vec{S}_1+\frac{\vec{p}\left(\vec{p}\cdot\vec{S}_1\right)}{M\left(E+M\right)}\right), \quad (20)$$

where $\vec{S}_1(\vec{\xi}_1)$ is the unit vector describing the vector polarization of the deuteron beam (the electron target polarization) in its rest system.

The dependence of the differential cross section on the polarization of the initial particles has the following form:

$$\frac{d\sigma}{dk^2}\left(\vec{\xi}_1,\vec{S}_1\right)=\left(\frac{d\sigma}{dk^2}\right)_{un}\left[1+C_{xx}\xi_{1x}S_{1x}+C_{yy}\xi_{1y}S_{1y}+C_{zz}\xi_{1z}S_{1z}+C_{xz}\xi_{1x}S_{1z}+C_{zx}\xi_{1z}S_{1x}\right], \quad (21)$$

where C_{ij}, $i,j=x,y,z$ are the spin correlation coefficients which determine the $\vec{d}\vec{e}$ scattering, when the deuteron beam is vector polarized and electron target is arbitrarily polarized.

The explicit expressions of the spin correlation coefficients, as a function of the deuteron form factors, can be written as:

$$DC_{yy}=-4mMk^2(1+\tau)G_M\left(G_C+\frac{\tau}{3}G_Q\right),$$

$$DC_{xx}=-2\tau mMk^2G_M\left[\left(\frac{k^2}{k_{max}^2}-1\right)G_M+2\left(1-\frac{4M^2}{k_{max}^2}\right)\left(G_C+\frac{\tau}{3}G_Q\right)\right],$$

$$DC_{xz}=\frac{k^2}{p}(mE+M^2)\left[-k^2\left(1-\frac{k^2}{k_{max}^2}\right)\right]^{1/2}G_M[\tau G_M+2G_C+2\frac{\tau}{3}G_Q], \tag{22}$$

$$DC_{zx}=4mMp\left[-k^2\left(1-\frac{k^2}{k_{max}^2}\right)\right]^{1/2}G_M[\tau(G_M-2G_C-\frac{2}{3}\tau G_Q)+\frac{1}{4}\frac{E+m}{m}\frac{k^2}{p^2}\left(\tau G_M+2G_C+\frac{2}{3}\tau G_Q\right)],$$

$$DC_{zz}=-2k^2G_M\left[2\left(mE-\tau M^2\right)\left(G_C+\frac{\tau}{3}G_Q\right)+\tau\left(M^2+mE\right)G_M-\tau\frac{E+m}{m}\frac{M^2}{p^2}\left(M^2+mE\right)\left(\tau G_M+2G_C+\frac{2}{3}\tau G_Q\right)\right].$$

Coefficients of the polarization transfer from the target electron to the recoil one, t_{ij}

Consider the scattering of the unpolarized deuteron beam on the polarized electron target (the polarization of the scattered deuteron is not measured) in the case when the polarization of the recoil electron is measured.
The part of the leptonic tensor which corresponds to the case of the polarized target and recoil electron has the following form

$$L_{\mu\nu}(s_1,s_2)=-\left(k_1\cdot s_2k_2\cdot s_1+\frac{k^2}{2}s_1\cdot s_2\right)g_{\mu\nu}+\frac{k^2}{2}\left(s_{1\mu}s_{2\nu}+s_{1\nu}s_{2\mu}\right)- \tag{23}$$

$$-s_1\cdot s_2\left(k_{1\mu}k_{2\nu}+k_{1\nu}k_{2\mu}\right)+k_1\cdot s_2\left(s_{1\mu}k_{2\nu}+s_{1\nu}k_{2\mu}\right)+k_2\cdot s_1\left(s_{2\mu}k_{1\nu}+s_{2\nu}k_{1\mu}\right),$$

where $s_{2\mu}$ is the polarization four-vector of the recoil electron which satisfies the following conditions: $k_2\cdot s_2=0, s_2^2=-1$.

In the Lab system, where the target electron is at rest, the polarization four-vector of the recoil electron has the following components

$$s_2=\left(\frac{\vec{k}_2\cdot\vec{\xi}_2}{m},\vec{\xi}_2+\frac{\vec{k}_2\left(\vec{k}_2\cdot\vec{\xi}_2\right)}{m+\varepsilon_2}\right), \tag{24}$$

where $\vec{\xi}_2$ is the unit vector describing the polarization of the recoil electron in its rest system and ε_2 is the recoil electron energy.

The dependence of the differential cross section of the reaction $d+\vec{e}\to d+\vec{e}$ on the polarizations of the initial and recoil electrons has the following form

$$\frac{d\sigma}{dk^2}(\vec{\xi}_1,\vec{\xi}_2)=\frac{1}{2}\left(\frac{d\sigma}{dk^2}\right)_{un}\left[1+t_{xx}\xi_{1x}\xi_{2x}+t_{yy}\xi_{1y}\xi_{2y}+t_{zz}\xi_{1z}\xi_{2z}+t_{xz}\xi_{1x}\xi_{2z}+t_{zx}\xi_{1z}\xi_{2x}\right], \tag{25}$$

where t_{ij}, $i,j=x,y,z$ are the coefficients of the polarization transfer from initial electron to the recoil one.

The explicit expressions of the polarization transfer coefficients, as a function of the deuteron form factors, can be written as

$$Dt_{xx}=\left(2m^2-k^2sin^2\theta_e\right)\left\{H_1+4\frac{H_2}{M^2}\left[E^2-\lambda\left(M^2+2mE\right)\right]\right\}+$$

$$+4k_2sin\theta_e\frac{H_2}{M^2}\left\{4\lambda mpEcos\theta_esin\theta_e+M^2k_2\left[\left(1+\tau\right)cos\theta_e-sin\theta_e\left(\tau+2\frac{E^2}{M^2}\right)\right]\right\}$$

$$Dt_{yy}=2m^2\left\{H_1+4\frac{H_2}{M^2}\left[E^2-\lambda\left(M^2+2mE\right)\right]\right\}, \tag{26}$$

$$Dt_{zz}=4k_2cos\theta_e\frac{H_2}{M^2}\left[\left(M^2-2E^2\right)k_2cos\theta_e+4\lambda mp\left(m+E+Ecos^2\theta_e\right)\right]+$$

$$+2m^2\left(1+2\lambda cos^2\theta_e\right)\left\{H_1+4\frac{H_2}{M^2}\left[E^2-\lambda\left(2E^2-M^2+2mE\right)\right]\right\},$$

$$Dt_{xz}=4k_2 sin\theta_e\frac{H_2}{M^2}\left[\left(M^2-2E^2\right)k_2cos\theta_e+2mpE\right]+$$

$$+4\lambda cos\theta_e sin\theta_e\left\{m^2H_1+\frac{H_2}{M^2}\left[4mE\left(mE+pk_2cos\theta_e\right)+k^2\left(M^2+2mE\right)\right]\right\},$$

$$Dt_{zx}=4k_2 sin\theta_e\frac{H_2}{M^2}\left[\left(M^2-2E^2\right)k_2cos\theta_e+2mp\left(2m\lambda+2\lambda E-E\right)\right]+$$

$$+4\lambda cos\theta_e sin\theta_e\left\{m^2H_1+\frac{H_2}{M^2}\left[4mE\left(mE+pk_2cos\theta_e\right)+k^2\left(E^2+p^2+2mE\right)\right]\right\},$$

where $\lambda=-k^2/(4m^2)$.

In conclusion, the differential cross section and polarization observables for the elastic reaction induced by deuteron scattering off electrons at rest are calculated in the one-photon-exchange approximation. The following polarization observables have been calculated:

1 - the asymmetries, A_{ij}, caused by the tensor polarized deuteron beam,

2 - the spin correlation coefficients, C_{ij}, caused by the polarized electron target and the vector polarized deuteron beam,

3 - the coefficients of the polarization transfer from the target electron to the recoil one, t_{ij}.

Numerical estimations are given for the analyzing powers (asymmetries) due to the tensor polarization of the deuteron beam (see Fig.1). They are calculated using the parametrization of the electromagnetic deuteron form factors from Ref. [18].

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ПОЛЯРИЗАЦІЙНІ ЕФЕКТИ В РЕАКЦІЇ $d + e^- \to d + e^-$

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Диференціальний переріз та поляризаційні спостережувані для пружної реакції індукованої розсіянням дейтрона на електроні в стані спокою $d + e^- \to d + e^-$ обчислені в однофотонному наближенні. Обчислені наступні поляризаційні спостережувані: 1- аналізуючі здатності (асиметрії), 2- коефіцієнти спінових кореляцій обумовлених довільною поляризацією електрона мішені та вектора поляризації пучка дейтронів, 3- коефіцієнтів передачі поляризації від довільно поляризованого електрона мішені до електрона віддачі. Диференціальний переріз та поляризаційні спостережувані виражені в термінах електромагнітних формфакторів дейтрона: G_c (зарядовий монополь), G_M (магнітний диполь) та G_Q (зарядовий квадруполь). Приведені числові оцінки для аналізуючих здатностей (асиметрій) обумовлених тензорною поляризацією дейтронного пучка. Вони обчислені як функції енергії пучка дейтронів для деякої величини кута розсіяння (кута між напрямом пучка дейтронів і імпульсом електрона віддачі). Для числових обчислень використано існуючу феноменологічну параметризацію електромагнітних формфакторів дейтрона. Виявляється, що аналізуючі здатності (асиметрії) збільшуються з ростом енергії пучка дейтронів і вони мають помітну чутливість до величини кута розсіювання. Особливий інтерес до цієї реакції полягає у дослідженні можливості використати таку реакцію для вимірювання поляризації пучка дейтронів високої енергії.

КЛЮЧОВІ СЛОВА: поляризаційні явища, електрон, дейтрон, асиметрії, формфактори