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TENSOR POLARIZATION IN THE pd BACK SCATTERING AT INTERMEDIATE ENERGIES

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Recent experimental investigation of the quadrupole polarization of deuterons in the pd back scattering shows that its value is about zero within the experimental errors throughout a wide range of incident proton energies $T_0 \sim 400$-1000 MeV [1]. This result is in strong contradiction with the prediction of the single nucleon or excited nucleon exchange models [2] (see the Figure). The smallness of tensor polarization was already predicted in the triangle model in [3]. The polarization second rank tensor T_{ij} in the triangle model can be constructed only using the vector $\vec{q}$ which is the relative momentum of nucleons in the deuteron. As for the integral on $\vec{q}$ the main contribution is given by the small values of q [4,5], the quantity $\langle q_i q_j \rangle$ must have a small value. But this argument is not well established as the d - wave component of the deuteron wave function has large momentum components compared to the s -wave contribution. The main reason for the smallness of $\langle q_i q_j \rangle$ at about 620 MeV energies is perhaps the production of the Δ_{33} isobar in the nucleon-nucleon collision at these energies. It is easy to show that in the triangle model q is equal to zero at the resonance threshold energy, if the resonance has zero width. In the real case, considered below, there are small corrections. Note that the above argument on the small [illegible] of the tensor polarization in the range of Δ_{33} isobar pro[illegible]ction is true not only for the triangle model but for the mechanism with rescattering of isobars [6]* (the contributions of the two models to the amplitude of the pd backward scattering overlap considerably). The value of the tensor polarization in the $pp \to d\pi^+$ reaction must be small, too.

We have calculated the tensor polarization in pd backward scattering in the triangle model using nonrelativistic wave functions for the deuteron. The tensor asymmetry parameter (see its definition in [1,2]) can be written in the following form

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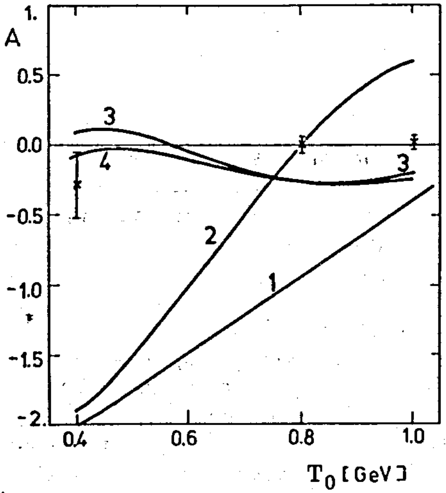
* A calculation of the tensor polarization of deuterons in pd backward scattering in that model has been recently carried out by L.A.Kondratyuk and his coworkers.



The dependence of tensor polarization A in the pd back scattering on the incident proton energies T_0. Experimental values are from ref.[1]. Theoretical curves are calculated by the single nucleon pole model[1], by the isobar model of Kerman and Kisslinger[2], by the triangle model with Reid soft core wave function[3], by the same model with Reid hard core wave function[4].

$$A = \frac{-|f_2|^2 + 2\sqrt{2}\,\mathrm{Re}(f_0 f_2^*)}{|f_0|^2 + |f_2|^2}, \qquad (1)$$

where f_ℓ are defined in[5].

$$f_0 = \int_0^\infty \phi_0(r)\, e^{-\gamma r}\, j_1(pr)\,(1+\gamma r)\,dr\,. \qquad (2)$$

Here $\phi_\ell(r)$ is the $\ell = 0$ or $\ell = 2$ component of the deuteron wave function. The definition of numerical factors γ and p is given in ref.[7].

Generally, in the calculation of the cross section the amplitude of $pp \to d\pi^+$ reaction is replaced by its value at $\vec{q} = 0$. In this approximation for f_2 we have the formula (2) replacing $\phi_0(r)$ by $\phi_2(r)$. In this case A is constant, its value is A = -0.8. But as it has been noticed above this approximation is rather crude for f_2.

We have taken into account the dependence of $F^{pp\to d\pi^+}(T_0, q_z)$ on q_z and we have expanded it into Legendre series

$$F^{pp\to d\pi^+}(T_0, q_z) = \sum_{\ell=0}^{\infty} F_\ell(T_0, q)\, P_\ell(\cos\theta). \qquad (3)$$

The coefficients $F_\ell(T_0, q)$ can be expressed through $F^{pp\to d\pi^+}(T_0, q_z)$ which are assumed to have the Breit-Wigner form in the isobar region with resonance energy T_R = = 620 MeV and width Γ = 300 MeV.

$$F^{pp\to d\pi^+}(T_0, q_z) = F^{pp\to d\pi^+}(T_0)\,\frac{T_R - T_0 - i/2\Gamma}{T_R - T(q_z) - i/2\Gamma}\,. \qquad (4)$$

Using expansion (3) we have got the following form of the amplitude f_2

$$f_2 = \sum_{L,\ell,\ell_1} B(L,\ell,\ell_1) \int_0^\infty e^{-\gamma r}(1+\gamma r)\, j_{\ell_1}(pr) \int_0^\infty \phi_2(q)\, j_L(qr)\, F_\ell(T_0, q)\, q^2\, dq\, dr. \qquad (5)$$

Here $B(L,\ell,\ell_1)$ contains the known normalization and angular momentum coefficients, $\phi_2(q)$ is the d-wave component of the deuteron wave function in momentum space. We notice that formula (3) has a more complicated form. In the real calculations we have used relativistic kinematics and we have taken into account the dependence of the $\Gamma^{N\to N\pi}$ vertex on q_z. Detailed calculations will be published elsewhere.

For the deuteron wave functions we have used the Reid soft core and Reid hard core wave functions[8]. The results are plotted in Figure. They are in agreement with the experiment having small values of A throughout the energy interval. Taking into account the agreement of the calculated and experimental vector polarization in the pd back scattering in the isobar region (500-700 MeV) we can say that the triangle model dominates in the isobar region.

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