Deuteron Breakup pd $\to$ pnp and Short-Range NN-Interaction

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The short-range structure of the lightest nuclei is related to fundamental problems of the theory of strong interactions. At present, the main task consists of clear experimental observation of this structure. In the framework of the impulse approximation (IA) the available experimental data on spin averaged cross section of the deuteron disintegration in inclusive experiments $\vec{d}+p \to p(0^\circ)X$, $\vec{d}+^{12}C \to p(0^\circ)X$ are compatible with the realistic wave functions of the deuteron (from, e.g. the Paris or Bonn potentials) only at low internal momenta of the nucleons inside the deuteron $q < 0.3$ GeV/c. At higher momenta q a systematic deviation from the IA is observed. This disagreement is very strong for the tensor analyzing power T_{20} of these reactions. A possible explanation of such a behaviour is the presence of a NN^*-components in the deuteron [1]. However, other interpretations based on the virtual pion exchange are available too. The experimental data on exclusive experiments $p+d \to p+n+p$ show a similar deviation from the IA, which can be explained by rescattering in the final state and excitation of the $\Delta-$isobar [2]. An important role of the final-state interaction and excitation of the nucleon isobars in these reactions leads to large screening effects in the corresponding observables. At present, a correct treatment of these screening effects is a nontrivial problem for the theory. It can be seen from the analysis of the backward elastic pd-scattering in the framework of the coherent sum of the one nucleon exchange (ONE), $\Delta-$ isobar excitation (Δ), pN single scattering (SS). The ONE+Δ+SS model describes qualitatively the spin-averaged cross sections at initial energies $T_p = 0.2-1.5$ GeV and scattering angle $\theta_{\rm c.m.} = 180^\circ$ but does not solve the longstanding T_{20}-problem [3] at $T_p > 0.4$ GeV.

Making use of the conditions minimizing the screening effects [4], we have proposed [5] to study the deuteron breakup $p+d \to (np)_s + p$ and $p+d \to (pp)_s + n$ with formation of the singlet $(NN)_s$-pair in kinematics of the backward (quasi)elastic pd-scattering. An analysis of the reaction $p+d \to (pp)_s + n$, performed in the framework of the ONE+Δ+SS model, shows two main features: i) Compared to the ONE mechanism the contribution to the cross section with Δ-excitation is diminished by an isotopic-spin factor 1/9 and the suppression takes place for several diagrams including, in particular, the N^*-excitation. ii) For the requested small relative momentum in the final pp-pair ($k < 50$ MeV/c), the pp-scattering amplitudes in the states with nonzero orbital momenta are strongly suppressed. As a result, a node of the half-off-shell $pp(^1S_0)$-amplitude $t(q,k)$, predicted by many realistic NN-interaction potentials at $q \sim 0.4$ GeV/c, can be visible in the observables. Rescattering in the initial and final states, taken into account for the dominant ONE-mechanism in the eikonal version of the DWBA method [6], does not change the main features of the cross section as can be seen from Fig.1(a). In particular, the node of the half-off-shell $pp(^1S_0)$-scattering amplitude results in a dip in the cross section. Due to rescattering and interference with Δ and SS-mechanisms there is a strong bump in T_{20} at the position of this node (Fig.1(b)). The parameter $C_{y,y}$ shows similar features [7].

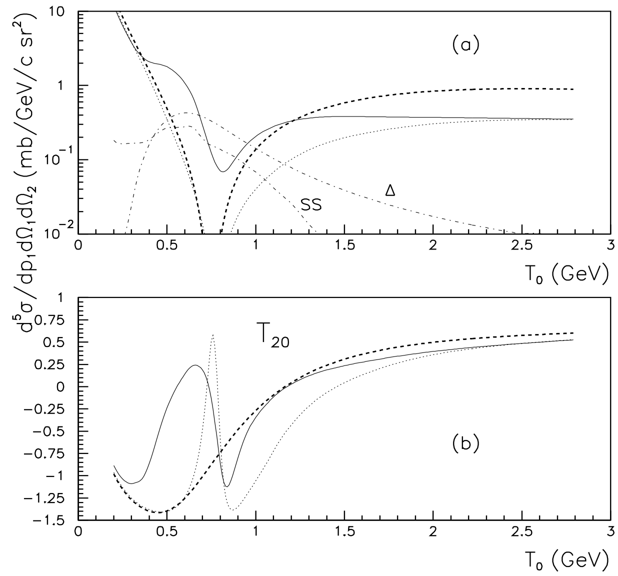

Figure 1: Laboratory cross section (a) and T_{20} (b) for the reaction $p+d \to (pp)(0^\circ) + n(180^\circ)$ at a relative pp-pair energy $E_{pp} = 3$ MeV calculated for different mechanisms: ONE (dashed), ONE with rescattering (dotted), coherent sum of the Δ+SS+ONE with rescattering (solid). In (a) the SS- and Δ-contributions are shown separately by dashed-dotted curves. The figure is from ref. [7].

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