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THE ΔN-INTERACTION IN HADRONIC REACTIONS ON A DEUTERON TARGET*

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The π^+d scattering and the $d(p,n)$ charge exchange reaction are used to study the ΔN interaction in the Δ resonance energy region. Various observables, such as inclusive and exclusive cross sections, angular distributions, and analyzing powers, are calculated in a coupled channel approach and shown to be influenced by the ΔN potential.

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In recent years, the Δ excitation in hadronic reactions on a deuteron target has been studied experimentally as well as theoretically. For the π^+d scattering, the final reaction channels πNN, πd and $2p$ have been considered within various models [1,2]. The coupled channel approach to be introduced here can be equally well applied to investigate the $d(p,n)$ charge exchange reaction [3]. While the pion excites the Δ only with spin–longitudinal coupling, the virtual π and ρ meson fields produced by the (p,n) system probe both the spin–longitudinal and the spin–transversal response function. Furthermore, they obey the energy–momentum relation $\omega^2 < q^2$ and thus explore the Δ excitation in a region that is inaccessible to real pion scattering (where $\omega^2 = q^2 + m_\pi^2$).

The scattering mechanisms considered in our model are represented by the diagrams of Fig. 1. The corresponding matrix elements are calculated using the source function formalism [4]. We set up a system of coupled equations for the correlated ΔN wave function, which includes the effects of ΔN interactions, and solve the system with the Lanczos method. The ΔN potential is constructed in a meson exchange model [5] where π, ρ, ω and σ exchange are taken into account. The Δ resonance is treated thereby as a quasi–particle with a given mass and an intrinsic, energy–dependent width.

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After the decay of the Δ, the system turns into one of the possible final states πNN, πd or $2p$. For a more detailed explanation of the theoretical framework, please see Ref. [3].

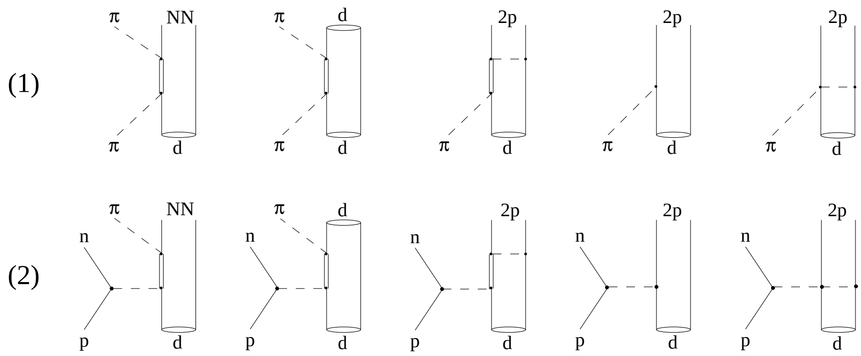

Fig. 1. Scattering mechanisms for the $\pi^+ d$ reaction (1) and the $d(p,n)$ reaction (2). Only the lowest order diagrams are shown, the intermediate ΔN interaction is not depicted explicitly.

Many observables are influenced by the dynamical treatment of the ΔN system. Exemplary, we present in Fig. 2 the differential cross section $d\sigma/d\Omega$ and the analyzing power A_y for the pion absorption $\pi^+ d \to 2p$ at $T_\pi = 142$ MeV. Solid lines are the result of the full model calculation which includes $V_{\Delta N}$ while we put $V_{\Delta N} = 0$ to obtain the dashed lines. Both quantities $d\sigma/d\Omega$ and A_y measure the relative strength of the different πd partial waves and are therefore very sensitive to the ΔN interaction. In the total πd cross section the effects of the attractive potential become manifest as a lowering of the Δ excitation energy, *i.e.* as a downward shift of the Δ resonance peak position.

Fig. 3 shows the total cross section for the inclusive $d(p,n)$ reaction and for the exclusive $d(p,n)\pi^+ d$ coherent pion production at $T_p = 789$ MeV and $\theta_n = 0^o$, plotted as a function of the energy transfer $\omega = E_p - E_n$. The missing inclusive cross section in the dip–region (50 MeV $< \omega <$ 250 MeV) is probably due to meson exchange currents and projectile excitation. Of special interest is the coherent pion production where both the peak energy and the magnitude of the cross section depend substantially on the strength of $V_{\Delta N}$. This is explained by the fact that the πd final channel is strongly coupled to ΔN states of unnatural parity which are subjected to the attractive spin–longitudinal part in the potential. Therefore, the exclusive $d(p,n)\pi^+ d$ reaction allows to directly measure this attraction and may serve as a tool for further investigation of the ΔN interaction.

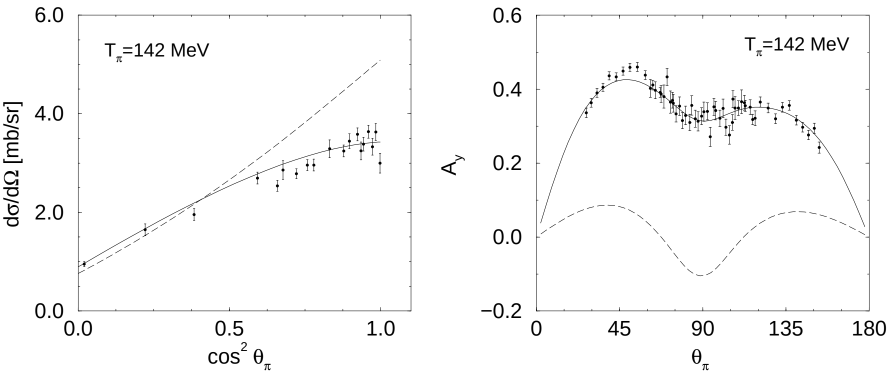

Fig. 2. $d\sigma/d\Omega$ and A_y for the $\pi^+ d \rightarrow 2p$ reaction at $T_\pi = 142$ MeV. Results with (solid) and without (dashed) $V_{\Delta N}$. Experimental data are from Refs. [6, 7].

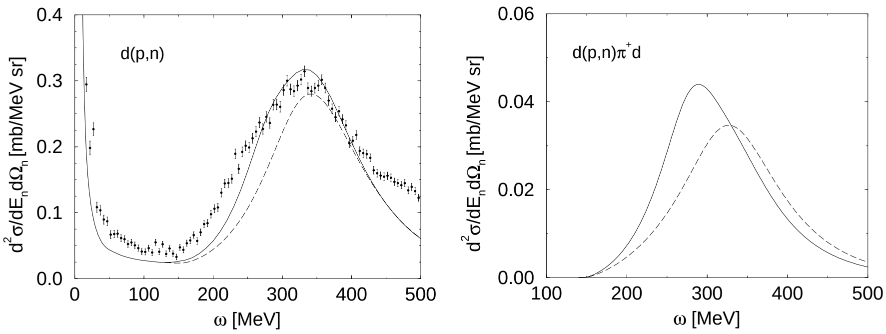

Fig. 3. Inclusive $d(p,n)$ and exclusive $d(p,n)\pi^+ d$ cross section at $T_p = 789$ MeV and $\theta_n = 0^o$. Results with (solid) and without (dashed) $V_{\Delta N}$. Experimental data are from Ref. [8].

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