DEPENDENCE OF THE γ^3He→pd CROSS SECTIONS ON THE NUCLEAR WAVE FUNCTIONS IN THE GIANT RESONANCE REGION

V.V. Kotlyar
National Science Center "Kharkov Institute of Physics and Technology", Kharkov, Ukraine

The differential cross section and the asymmetry coefficient for the two-body ^{3}He break up by linearly polarized photons are calculated with the wave functions for Reid soft core, Paris and Bonn potentials.

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The differential cross section for the reaction $\gamma^3He \to pd$ at photon energies $E_\gamma<25$ MeV was shown [1] to depend substantially on choice of the nuclear wave functions (WFs). The calculations were performed in momentum space with the Faddeev WFs for 3N bound state for Reid soft core (RSC), Paris and Bonn potentials. The Siegert theorem was applied in [1] to take into consideration a part of the interaction current effects in the electric multipoles.

Explicitly the meson exchange currents (MEC) were treated in [2,3] where parametrization [4] of the ^{3}He WF for RSC potential was used. It was demonstrated [2,3] that the MEC contributions sizably increase the values of the cross section reducing discrepancies between the results of the calculations and the experimental data.

Role of the interaction currents and rescattering in the pd system was studied [5-9] in the proton-deuteron radiative capture. Area of energies examined in [5-9] corresponds to $E_\gamma^{lab} \leq 139.1$ MeV in the ^{3}He photodisintegration. Results [7-9] allow one to single out a kinematic region where the effects of final state interaction (FSI) do not appear to be crucial for the cross section of $\gamma^3He \to pd$ and give an opportunity to scrutinize manifestation of the P- and D-components of the 3N bound state WF.

Aim of this paper is to carry on investigation [3] and to study dependence of the energy and angular distributions of the cross section and the beam asymmetry on the ^{3}He WFs using precise numerical solutions of the Faddeev equations obtained in Ref. [10].

The observables are computed with the nuclear current including contributions from convection and spin currents, the two-body currents generated by pion exchange (πEC). The Riska model is taken for the latter. The πNN form factors in the operators of MEC are chosen in the monopole form with the cut-off parameter $\Lambda_\pi=1.2$ GeV. The reaction amplitudes are calculated in the framework of Refs. [2,3], where details regarding the techniques can be found.

In Fig. 1 the differential cross sections obtained with the Hannover-Helsinki WF [4] for RSC potential and the Bochum-Cracow WFs [10] for Bonn and Paris potentials are compared with the results of Ref. [1]. According to the present calculations there is only a rather moderate dependence of the cross section on the nuclear WFs that corresponds to the conclusions of Refs. [7-9] and contrasts with inferences of Ref.[1].

The angular distributions for Bonn and Paris potentials have been analyzed to study the variations of the cross section in detail. The different sets $N_\alpha=2$, 5, 10, 18, 26, 34 of the partial wave components of the ^{3}He WFs have been considered.

The contributions of the S-waves correspond to the set $N_\alpha=2$. D-waves are included in $N_\alpha=5$. The set $N_\alpha=10$ consists of S-, P- and D-components with the total angular momentum in the two-body subsystem J=0 and 1. Partial waves with $J\leq 2$ are involved in the case $N_\alpha=18$. The components of the ^{3}He WF with $J\leq 3(4)$ are taken into account in $N_\alpha=26(34)$. It turns out that no significant potential dependence appears in all the cases analyzed.

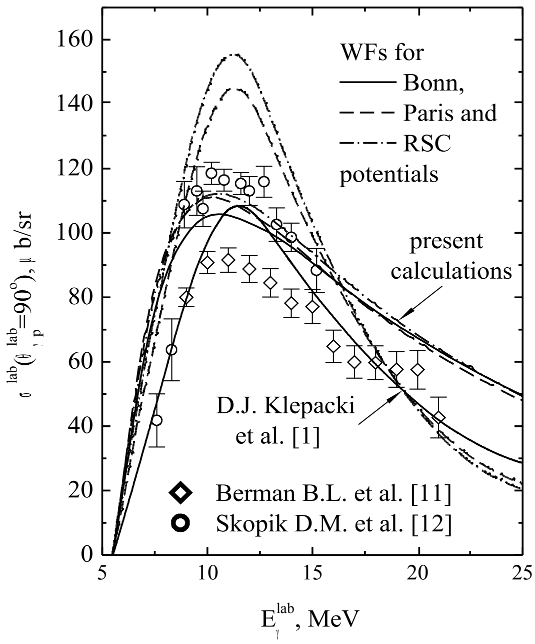

Fig. 1. *Potential model dependence of the differential cross section* $\sigma=d\sigma/d\Omega_{\gamma p}$ *for* $\gamma^3He \to pd$.

Influence of the ^{3}He WF components with orbital angular momenta 2...5 on angular distributions of the cross section and the beam asymmetry is demonstrated in Figs. 2 and 3.

The calculations in the plane wave approximation overestimate the data at forward and backward angles. Enhancement of the cross section at $\theta_{\gamma p}^{lab} \leq 30°$ and $\theta_{\gamma p}^{lab} \geq 150°$ rides on contributions of spin current and πEC. As it follows from comparison with the results of experiments [13] and theoretical investigations [7-9], the effects of the FSI cannot be neglected under these kinematic conditions. The P- and D-states in the ^{3}He WF influence the cross section just in a vicinity of its maximum at E_γ=9-16 MeV where nonorthogonality of the initial and final state WFs does not play a decisive role at least for this observable.

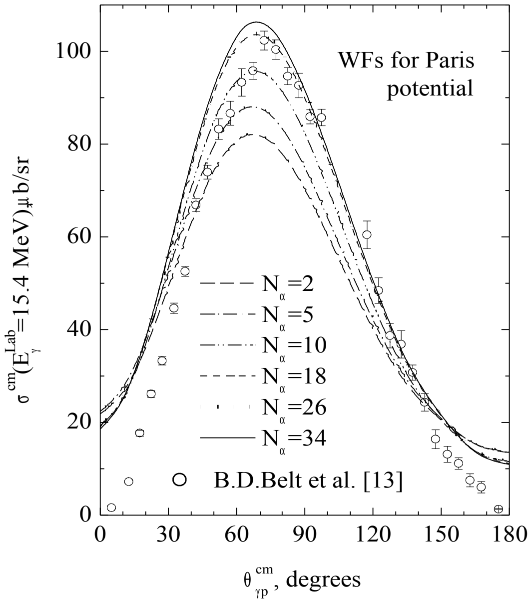

Fig. 2. *Angular distribution of the differential cross section for $\gamma^3He\to pd$.*

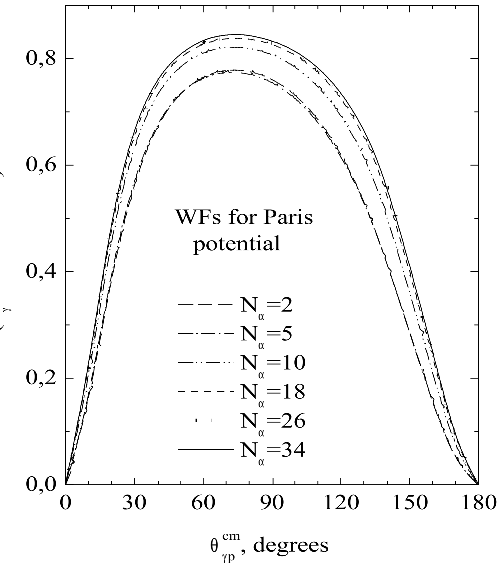

Fig. 3. *Angular dependence of the asymmetry coefficient for γ $^3He\to pd$ with linearly polarized photons*

Being calculated with the convection current, the asymmetry coefficient Σ>1 at $30° \le \theta^{lab}_{\gamma p} \le 140°$. Inclusion of spin current or/and πEC decreases Σ values and changes the shape of the angular distribution reducing its width.

As seen from Fig. 3, the asymmetry Σ is affected by the P-wave components of the 3N WF (cf. curves for N_α=5 and 10). This observation does not seem to be very surprising in view of the fact that polarization observables in Nd elastic scattering [14] and pd radiative capture [15,16] were found to be remarkably sensitive to the NN interaction in states with L=1.

Nevertheless, before one can draw definite conclusions whether the reaction γ ^{3}He→pd is of interest for studying properties of the P-states in ^{3}He WF, the role of the FSI effects in masking the sensitivity of the asymmetry coefficient to the components of the WF has to be investigated.

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