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Coherent π^0–Photoproduction on the Deuteron

E. M. Darwish[a,b,1], **N. Akopov**[c] **and M. El-Zohry**[*,d]
[a] *Applied Physics Department, Faculty of Applied Science, Taibah University, Saudi Arabia*
[b] *Physics Department, Faculty of Science, Sohag University, Sohag 82524, Egypt*
[c] *Yerevan Physics Institute, Br. Alikhanian 2, 0036 Yerevan, Armenia*
[d] *Yerevan State University, A. Manoogian 1, 0025 Yerevan, Armenia*
[1] *E-mail:* eeddarwish@yahoo.com

We consider coherent π^0–photoproduction on the deuteron in the energy region from π-threshold up to 1 GeV using an enhanced elementary pion production operator on the free nucleon and a realistic high-precision *NN* potential model for the deuteron wave function. Numerical results for total and differential cross sections are presented for which the sensitivity to various models for the elementary amplitude is investigated. Considerable dependence of the results on the elementary amplitude is found at photon lab-energies close to π-threshold and above 600 MeV. In addition, the results for differential and total cross sections are compared with the available experimental data and a satisfactory agreement was found.

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*Speaker.

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In the recent work [1], coherent π^0-photoproduction on the deuteron in the energy region from π-threshold up to 1 GeV is investigated. For the elementary $\gamma N \to \pi N$ amplitude, an enhanced elementary pion photoproduction operator [2] which displays chiral symmetry, gauge invariance, and crossing symmetry, as well as a consistent treatment of the interaction with spin-3/2 particles is used. For the deuteron wave function, we used the realistic CD-Bonn potential [3]. The influence of the elementary operator on cross sections is studied.

In the figures we compare calculations with different ingredients. We display separately the contributions from the *bare* and the *dressed* electromagnetic multipoles. We call impulse approximation (IA) to the contribution to the observables using the *bare* electromagnetic multipoles. We name the calculations where the πN-rescattering is included in the elementary reaction IA*. In Fig. 1 we compare results using as elementary reaction amplitudes, the ones provided by the ELA model [2] and those obtained using MAID model [4]. One observed, that the dotted curve which represents the results using the bare electromagnetic multipoles of the ELA model is the nearest one to the data, especially after the peak position. However, the agreement between the results using the MAID model and the data from TAPS [5] is quantitatively not good. One also sees, that none of the models is able to describe the right position of the peak, as well as the behavior of the data points after the peak. In principle, one can speculate that our results using the bare electromagnetic multipoles of the ELA model agrees with the slope at high photon lab-energy, but the results using the MAID model are not.

Fig. 2 shows a comparison between our results for differential cross sections for $\gamma d \to \pi^0 d$ as function of pion angle in the center-of-mass frame and the data from TAPS [6]. At $E_\gamma < \Delta(1232)$, one notes that the agreement between results using different elementary operators is not satisfactory. The reason for this may be due to the neglecting πN-rescattering in the intermediate state which is found to be important [7]. On the contrary, we obtained a qualitatively reasonable agreement between our results and the data from TAPS [6] at energies around the Δ-region. At forward pion angles and high energy, an overestimation of our results using various elementary amplitudes is found. The solid curve which represents the results using the MAID model [4] is the nearest one to the data even at forward angle and small energy. Discrepancies between the results using different elementary amplitudes are found at extreme forward angles, whereas at backward angles discrepancies are observed at small energies. An experimental check of these predictions at extreme forward angles is needed.

Summarizing, we can say that the MAID model [4] provides different predictions for cross sections than the ELA model [2] and that these cross sections provide excellent observables to test different pion production operators.

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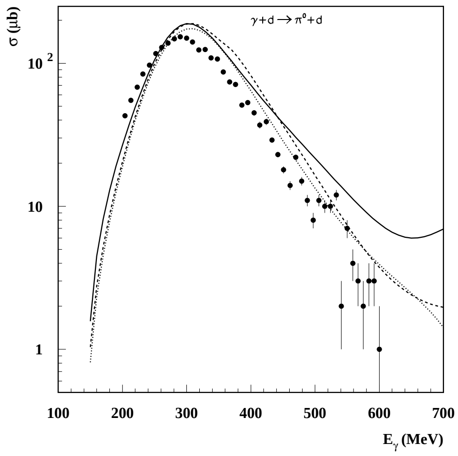

Figure 1: Total cross section for $\gamma d \rightarrow \pi^0 d$. Solid; IA* using MAID [4], Dashed (Dotted); IA* (IA) using dressed (bare) ELA model [2]; Data, TAPS [5].

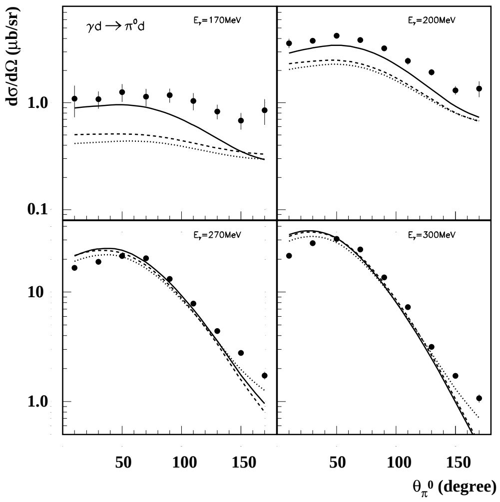

Figure 2: Differential cross sections for $\gamma d \rightarrow \pi^0 d$. Solid; IA* using MAID [4], Dashed (Dotted); IA* (IA) using dressed (bare) ELA model [2]; Data, TAPS [6].

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