Experimental verification of the role of exchange meson currents in the description of photoprocesses in systems with few nucleons

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New experimental data obtained by us are compared with theoretical calculations. It is shown that allowance for the exchange meson currents in the description of the reaction He^4 (γ,n) He^3 in the intermediate photon energy region greatly improves the agreement between theory and experiment.

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Much attention has been paid recently to investigations of various processes connected with nuclei having few nucleons. Since these nuclei are the simplest nucleon systems, they are the most suitable objects with which to check most important theo-

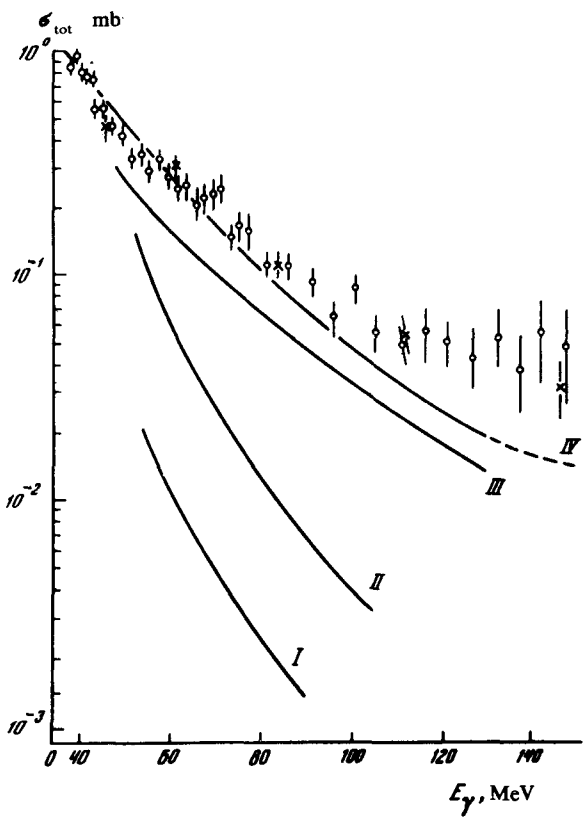

FIG. 1. Dependence of the total cross section of the reaction He^4 (γ,n) He^3 on the photon energy: circles—our data, crosses—Gorbunov's data[4], curves—theoretical calculation of Hebach and Gari[1]: I—shell model; II—shell model with allowance for the correlation in the initial and final states; III—shell model and allowance for exchange meson currents; IV—shell model, allowance for correlations in the initial and final states and for the exchange meson currents.

retical developments (model representations). Great interest attaches, as before, to investigations of electromagnetic interactions of systems with few nucleons. This pertains primarily to the photon energy region between the giant resonance and the threshold for meson production. Until now there was no satisfactory theoretical explanation of the experimental data in this energy region.[1] Recently the German theoreticians Hebach and Gari[1] have proposed a new approach to the analysis of photonuclear reactions for the intermediate energy region. In their calculations they took into account the contribution of the exchange meson currents, and this led to a noticeable improvement in the agreement between theory and experiment in a wide range of energies. They have carried out numerical calculations of the (γ,p), (γ,n), (γ,pn) channels for the nuclei He^4,C^{12},O^{16}. We used a chamber procedure[2,3] to measure the dependences of the total cross sections on the photon energy for the (γ,n) reaction on the He^4 nucleus in the region $E_\gamma = 40$–150 MeV, with large statistics. It is therefore of interest to compare our results with the calculations of Hebach and Gari.

The experimental results are given in Fig. 1 and in Table 1.

TABLE I.

$\bar{E}_\gamma$, MeV	$(\sigma \pm \Delta\sigma)$, mb	$\bar{E}_\gamma$, MeV	$(\sigma \pm \Delta\sigma)$, mb
40	0.87 ± 0.06	77	0.17 ± 0.02
41	0.98 ± 0.07	79	0.16 ± 0.03
42	0.83 ± 0.06	82.5	0.11 ± 0.02
43	0.78 ± 0.06	87.5	0.11 ± 0.02
44	0.74 ± 0.06	92.5	0.096 ± 0.015
45	0.56 ± 0.04	97.5	0.065 ± 0.012
47	0.57 ± 0.04	102.5	0.089 ± 0.015
49	0.47 ± 0.04	107.5	0.056 ± 0.012
51	0.44 ± 0.04	112.5	0.049 ± 0.012
53	0.34 ± 0.03	117.5	0.053 ± 0.013
55	0.36 ± 0.03	122.5	0.051 ± 0.010
57	0.29 ± 0.03	127.5	0.040 ± 0.012
59	0.33 ± 0.03	132.5	0.051 ± 0.013
61	0.27 ± 0.02	137.5	0.037 ± 0.012
63	0.24 ± 0.02	142.5	0.054 ± 0.015
65	0.25 ± 0.03	147.5	0.045 ± 0.02
67	0.21 ± 0.02	–	–
69	0.22 ± 0.02	–	–
71	0.24 ± 0.03	–	–
73	0.24 ± 0.03	–	–
75	0.15 ± 0.02	–	–

It is seen from Fig. 1 that allowance for the contribution of the exchange meson currents in the photon-energy region below the threshold of meson production in the analysis of the investigated process greatly improves the agreement between theory and experiment.

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