CROSS SECTION OF PHOTONEUTRON REACTIONS ON Li⁷

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Abstract

Full Text

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E. B. BAZHANOV, Academician of the Academy of Sciences of the Ukrainian SSR A. P. KOMAR,
A. V. KULIKOV

CROSS SECTION OF PHOTONEUTRON REACTIONS ON Li7

Absolute values of the cross sections of photoneutron reactions σ and their dependence on the energy of γ radiation $\sigma(E_\gamma)$ for the nucleus Li7, determined by various authors, agree poorly with one another. One of the possible reasons for the discrepancies may be the different dependence of the efficiency of neutron registration on their initial energy, owing to design features of the experimental apparatus used in different experiments (1).

Fig. 1. Cross section of photoneutron reactions on the Li7 nucleus. *a* —data of work (10); *b* —result of smoothing the structure of the observed cross section

In the present communication we give the results of investigations of the cross sections of photoneutron reactions on the Li7 nucleus in the energy interval from the threshold value of the (γ, n) reaction (E_γ = 7.25 MeV) to 50 MeV. For this purpose a lithium target of composition $\sim$ 99% Li7 and thickness 4.5 g/cm2 was used. To determine neutron yields at different γ-quantum energies, the apparatus described in (2) was used; special measures were taken to reduce to a minimum the dependence of the efficiency of neutron registration on the initial energy.

The background level in neutron registration was, for γ-radiation energies E_γ near 20 MeV, 4%; for energies near 10 MeV, 10%; and for energies near 50 MeV, 7%. The statistical accuracy of neutron-yield measurements varied from 1% (for the energy interval 10-12 MeV) to 0.2-0.3% (for the energy interval 20-50 MeV). The root-mean-square error of the absolute measurements did not exceed 10%.

The yield curve was processed without any preliminary smoothing of the exper-

imental data. The processing was carried out by method ([3]) separately for two families of points shifted relative to one another by 0.5 MeV. Tables with $\Delta = 1$ MeV were used. The processing results are presented in Fig. 1 in the form of a histogram; statistical errors are indicated.

A characteristic feature of $\sigma(E_\gamma)$ is the presence of a considerable number of peaks extending beyond the limits of statistical accuracy. Table 1 gives the energy values corresponding to the observed peaks.

Table 1

Energies of excited states detected by various methods in photodisintegration of the nucleus

Energies of maxima obtained in studies of yield curves	Energies of maxima obtained in studies of yield curves	Energies of maxima obtained in studies of yield curves	Energies of maxima obtained in studies of yield curves	Energies of maxima obtained in studies of yield curves	Energies of maxima obtained in studies of energy spectra	Energies of maxima obtained in studies of energy spectra	Energies of maxima obtained in studies of energy spectra	Energies of maxima obtained in studies of energy spectra	Energies of excitation levels
a) photoneutrons	a) photoneutrons	a) photoneutrons	a) photoneutrons	b) photoprotons	a) photoprotons	a) photoprotons	b) phototritons	b) phototritons	Energies of excitation levels
([1])	([4])	([5])	our data	([6])	([6])	([7])	([6])	([8])	([9])
	9.6							9.6	
	10.8	(11.3)	11.5$±0.3	11.0±0.2	12.5	11.7	10.8	12.4	12.6	13.5	14.1±0.2	13.5	14.0	13.6	14.0	13.5

The same table gives the energy values assigned to excitation levels of the Li^7 nucleus in studies of the (γ, n) reaction ([1], [4], [5]), the (γ, p)- and (γ, t)-reactions ([6–8]), and from the review ([9]).

From consideration of the data of Table 1 and Fig. 1 it is clear that the positions of many peaks in Fig. 1 and the values of the energy levels from which decay proceeds, investigated by various authors, differ very little in practice. The coincidence of the energy positions of excitation levels determined by recording protons, tritons, or neutrons is to a certain extent a reflection of the substantial role of many-particle decay channels of the Li^7 nucleus.

The greatest differences in level positions are observed when comparing data from different laboratories; this, apparently, is associated with errors in establishing the energy scales and with some difference in the real γ-radiation spectra of the accelerators.

According to Fig. 1, excitation levels of the Li^7 nucleus associated with neutron emission are observed at energies of 30–40 MeV, and possibly higher.

Comparison of the smoothed curve $\sigma(E_\gamma)$ (Fig. 1, b) with the analogous curve of work ([10]) shows good agreement. The difference in integral cross sections determined in the energy interval 7.25–50 MeV does not exceed 10%. According to our data this value is 85 MeV · mb.

The theoretical treatment of the photodisintegration of Li^7 was carried out in Ref. ([11]). Approximate calculations indicate the presence of excited states of Li^7 at energies of 10–15, 18–24, and 25–30 MeV. Thus, a detailed comparison of the results of theory and experiment is premature.

A. F. Ioffe Physico-Technical Institute
Academy of Sciences of the USSR

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