STRUCTURE OF THE CROSS SECTION OF THE $Pb^{208}(\gamma, Tn)$ REACTION

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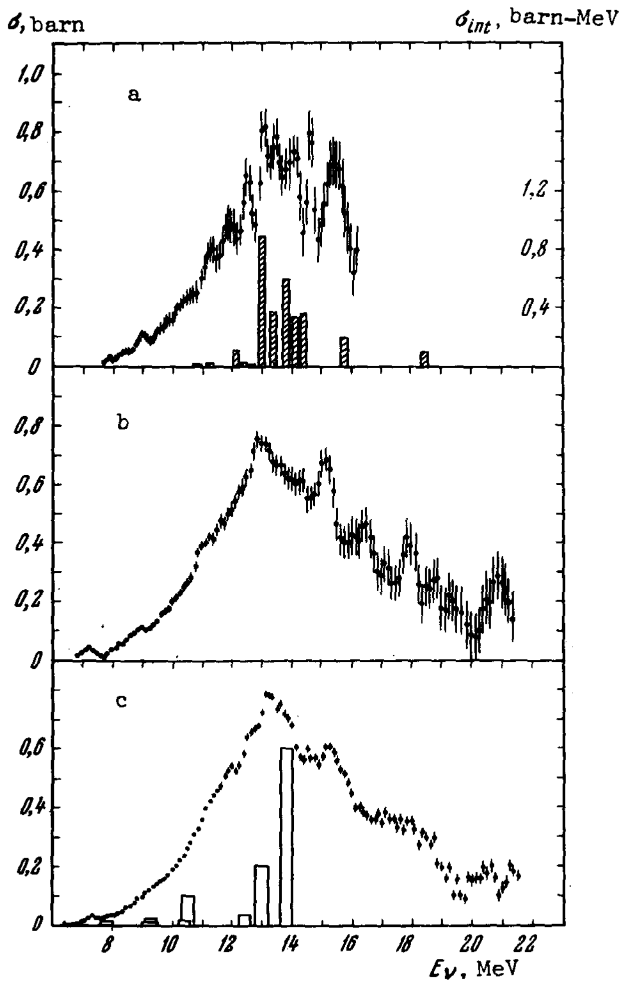
One of the most important problems in the description of the photodisintegration of nuclei is the problem of explaining the structure of the "giant" resonance. The main source of discussions concerning this question remain, as before, the experimental results obtained by investigating the absorption of a γ quantum by the doubly-magic nuclei O^{16}, Ca^{40}, and Pb^{208}.

We present here the results of an investigation of the effect of the cross section of the reaction $Pb^{208}(\gamma, Tn)$ in the γ-quantum energy region from threshold to 22 MeV. The measurements were performed with the betatron of the Nuclear Physics Research Institute of the Moscow State University by the method of direct registration of the neutrons with a spherical detector containing 80 counters filled with BF_3 gas at ~1 atm. The efficiency of the neutron detector was approximately 0.13. The time drift of the apparatus was suppressed by using a method described in [1]. The reaction yield curve was measured in steps of 0.125 MeV. The statistical accuracy in individual points of the yield curve was better than 0.1%. The Penfold-Leiss method was used to calculate from the obtained data the cross section of the $Pb^{208}(\gamma, Tn)$ reaction (see the figure). The yield curve was analyzed in steps of ΔE = 1 MeV, ΔE = 0.5 MeV, and ΔE = 0.2 MeV.

In the present investigation we obtained, for the first time, the structure of the cross section of the described reaction.



Effective neutron-production cross section in the interaction between γ-quanta and the Pb^{208} nucleus: a - analysis with energy steps ΔE = 0.2 MeV. Vertical columns - theoretical calculations by Bunatyan [3] (the calculated absolute values are marked on the right, the experimental ones on the left); b - analysis in energy steps ΔE = 0.5 MeV; c - analysis in energy steps ΔE = 1.0 MeV. Vertical columns - theoretical calculation of Balashov, Shevchenko, and Yudin [2].

The integral cross section, measured up to an energy E_γ = 18.5 MeV, is $\sigma_{int} \approx 4.0$ barn-MeV. A considerable number of theoretical papers have been devoted to the study of the photodisintegration of Pb^{208} [2-4]. Comparing our experimental results with the particle-hole calculations we can draw the following conclusions: 1. Both experiment and calculation show that the resonance has a complicated structure, this being connected with the fact that in the case of Pb^{208} the scatter of the dipole state over the particle-hole levels of negative parity plays a definite role. 2. This type of interaction is not the only one, as is evidenced by the more complicated structure obtained in our experiment (it is apparently connected with states of the two particles - two "holes" type).

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CONCERNING ONE MECHANISM OF ION-LEVEL RELAXATION IN A PLASMA

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The level population of atoms and ions in an equilibrium plasma are determined by the formulas of Boltzmann and Saha. In the case when there is no equilibrium, the level population can be obtained by solving a system of equations describing the particle balance for each state (see [1]). The coefficients of such an equation are the velocities of different collision and radiation processes: excitation and ionization by electron impact, impacts of the second kind and triple recombination, spontaneous emission and photorecombination, photoabsorption, and stimulated emission (in lines and in the continuous spectrum).

Under certain conditions (low temperatures and high concentrations) one more population-relaxation mechanism can play a role in the establishment of the equilibrium. This mechanism is connected with the presence of auto-ionization levels and is therefore important only for ions.

Let us consider a concrete example. Assume that we are interested in the rate of decay of the He II level with principal quantum number n = 2 (see Fig. 1). We shall consider only

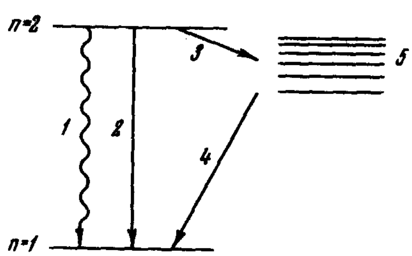

Fig. 1. Different decay channels of the level n = 2 of a hydrogenlike ion: 1 - spontaneous emission, 2 - impacts of the second kind, 3 - recombination at the auto-ionization levels, 4 - auto-ionization, 5 - auto-ionization levels.