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 photo-disintegration 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

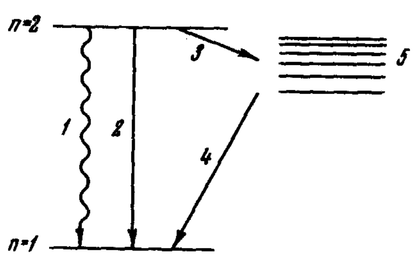

Fig. 1. Different decay channels of the level n = 2 of a hydrogenlike ion: 1 - spontaneous emission, 2 - impacts of the second kind, 3 - recombination at the auto-ionization levels, 4 - auto-ionization, 5 - auto-ionization levels.

those processes which lead to the transition $n = 2 \to n = 1$. In a rather wide interval of electron concentrations N and temperatures T, the spontaneous emission ($A = 7.5 \times 10^9$ $\sec^{-1}$) prevails over impacts of the second kind. However, the radiative decay is not the only channel for the disintegration of the $n = 2$ states. At low temperatures and high concentrations there is a high probability of capture of a free electron (recombination) at the auto-ionization levels. The auto-ionization levels are short-lived. They undergo nonradiative decay within times that are shorter by many orders of magnitude than those of the corresponding spontaneous transitions. Therefore recombination at the auto-ionization levels leads to the $n = 2 \to n = 1$ transition. This opens one more channel for the decay of states with $n = 2$.

We present some quantitative estimates. The probability of a spontaneous transition from a certain level of a hydrogenlike ion to all low-lying levels is [2]

$$A = \frac{1{,}66 \cdot 10^{10} \cdot Z^4}{n^{9/2}}, \tag{1}$$

where Z is the charge of the nucleus and n is the principal quantum number of the level. This formula was derived under the assumption that $n \gg 1$. However, it turns out to be sufficiently accurate for small n, too.

The coefficient of recombination at the auto-ionization levels can be determined for the region of electron concentrations and temperatures under consideration by means of the formula [3]

$$\alpha = \frac{4\pi^{3/2}\sqrt{2}\, e^{10} L (Z-1)^3 N}{9 m^{1/2} T^{9/2}}, \tag{2}$$

where L is the Coulomb logarithm, and e and m are the charge and mass of the electron.

Comparing formulas (1) and (2), we find that at concentrations exceeding a certain critical value

$$N > N_{\text{crit}} \cong \frac{10^{18}}{\sqrt{L}} \frac{Z^2}{(Z-1)^{3/2}} \left(\frac{T_{\text{eV}}}{n}\right)^{9/4} \text{cm}^{-3} \tag{3}$$

the recombination at the auto-ionization levels prevails over radiative decay (see Fig. 2). The value of N_{crit} depends little on the charge of the nucleus. The factor $Z^2/(Z-1)^{3/2}$ for $2 \leq Z \leq 10$ ranges from 3 to 4.

The effect under consideration becomes stronger with increasing principal quantum number n.

Recombination at the auto-ionization levels leads essentially to $n \to n-1$ transitions. This is connected with the fact that auto-ionization occurs predominantly at a closely-lying level. The auto-ionization probability is on the order of 10^{14} $\sec^{-1}$ and depends little on the charge Z. With increasing n, the auto-ionization decreases, but much more slowly than the spontaneous emission. For example, the probability of auto-ionization from the very

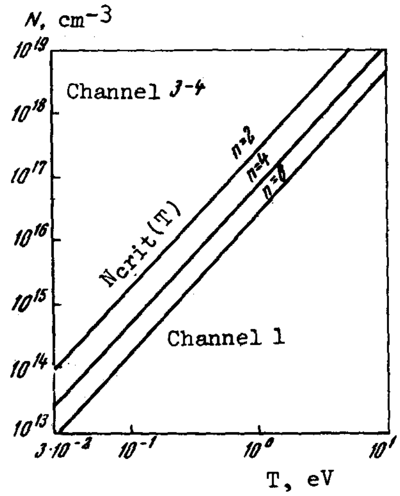

Fig. 2. Regions of predominant decay at the level n of a hydrogenlike ion (Z = 2) through different channels (see Fig. 1).

lowest auto-ionization level to the level n - 1 varies approximately like n^{-1}. Thus, the relative role of the auto-ionization increases with increasing principal quantum number. However, for very high levels it can be greatly weakened by the resonant capture of an electron by an ion in the state n - 1.

The indicated effect must be taken into account in considering the kinetics of the ion level population under conditions of rapid cooling of the electrons. Such conditions are of interest for certain applications of quantum radiophysics [4].

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ESTIMATE OF THE ENERGY DENSITY OF SUBCOSMIC RAYS FROM MEASUREMENT OF THE ULTRAVIOLET BACKGROUND

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Charge exchange of protons of subcosmic rays on interstellar hydrogen with capture of an electron in the 2p state should lead to emission of L_α quanta of a wavelength that is shifted as a result of the Doppler effect. Measurements of the radiation flux from the Milky Way in the wavelength range λ = 1225 - 1340 Å ($F = 3 \times 10^{-7}$ erg/cm^2-sec-sr), performed with the "Venera" research satellites [1], made it possible to obtain the upper limit of the energy density of the subcosmic rays with energy 25 - 100 keV ($w_1 < 5 \times 10^{-3}$ eV/cm^3) and to estimate it up to energies on the order of 1 MeV.