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1) The question of thermal influence on the character of propagation of light beams in media is not new. It is well known, for example, that heating of the laser medium in the pump field leads to a marked change in the lasing conditions [6].

2) For simplicity we confine ourselves to the case when heating does not give rise to anisotropy of the medium.

3) The time to equalize the temperature over a dimension a by thermal conductivity is $t_\kappa = a^2/4\kappa$; even in good heat conductors we have $t_\kappa > 10^{-1}$ sec for $a = 10^{-1}$ cm.

4) In the paraxial region of the beam $r \ll a$, the parabolic relief is an exact solution of the stationary heat conduction equation with Gaussian source; we do not present the exact solution of the equation for arbitrary r.

5) The results are valid provided the self-focusing length is much shorter than the beam attenuation length, $L_f \ll 1/\alpha$, i.e., provided $\alpha \ll (2\partial\epsilon/\partial T)P/a_0^2\kappa n_0$.

MASS-SPECTROMETRIC OBSERVATION OF LONG-LIVED AUTO-IONIZATION STATES OF THE IONS Ca^+ AND Sr^+

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Auto-ionization states of the lithium-like ions N^{4+} and O^{5+}, which remain excited for $\sim 5 \times 10^{-8}$ sec, were recently observed [1]. The lifetimes [2] of lithium, potassium, and rubidium atoms in the auto-ionization state is much larger, $\sim 5 \times 10^{-6}$, 9×10^{-5}, and 7.5×10^{-5} sec, respectively. It is known from other investigations [3,4] that rapid auto-ionization processes are produced by collisions of electrons with calcium atoms.

From an analysis of all these investigations one would expect that Ca^+ and Sr^+ ions could be produced in auto-ionization states that retain their excitation long enough ($>10^{-6}$ sec) to render them observable with the aid of a mass spectrometer. In other words, we expect that following collision of electrons with Ca and Sr atoms, the Ca^+ and Sr^+ ions, which are isoelectronic to K and Rb, respectively, can attain excited states with lifetimes, relative to either photon or electron emission, longer than the characteristic times of these processes for non-forbidden transitions. The purpose of this paper is to prove the foregoing.

The investigation was carried out with a double mass spectrometer [5]. A beam of Ca^+ or Sr^+ ions accelerated to 2.8 keV was separated by the first magnetic analyzer and guided through a slit into a chamber located between the first and second magnetic analyzers. The doubly charged Ca^{2+} or Sr^{2+} ions produced in the chamber were separated from the beam of the initial singly-charged ions by the second magnetic analyzer and recorded with electrometric amplifiers. These doubly-charged ions could be formed from the singly-charged ions (A^+) via

three basic processes: (i) auto-ionization $A^+ \rightarrow A^{2+} + e$, (ii) stripping by collision with atoms and molecules of the residual gases $A^+ + M \rightarrow A^{2+} + M + e$, (iii) ionization near metallic surfaces $A^+ + Me \rightarrow A^{2+} + Me$. By varying the conditions of the experiment, we could separate any one of the processes and fully suppress the others, or reduce their contribution to a minimum.

To establish the process that leads to these doubly-charged ions, we investigated the effect produced on their intensity and on the intensity of the initial singly-charged ions by the following factors: a change in electron energy from 5 to 120 eV, a change in the electron current from 0.2 to 2.0 mA, a change in the pressure of the extraneous gas (air) in the chamber from 3×10^{-7} to 3×10^{-5} mm Hg. We varied also the geometry of the slits and the intensity of the initial-ion beam. At the same time, we monitored the beam of the doubly-charged ions produced in the ion source by collision between the electrons and the atoms.

Similar measurements were made also with the Ca^{2+} and Sr^{2+} ions formed from the singly-charged Ca^+ and Sr^+ ions in the region between the ion source and the magnetic field of the first analyzer.

The experiments have shown that the ion currents I of the doubly-charged ions Ca^{2+} and Sr^{2+} formed from the singly-charged ions change with gas pressure like $I = k + ap$, where k and a are constants. Their intensity is proportional to the intensity of the initial singly-charged ions and to the electron current.

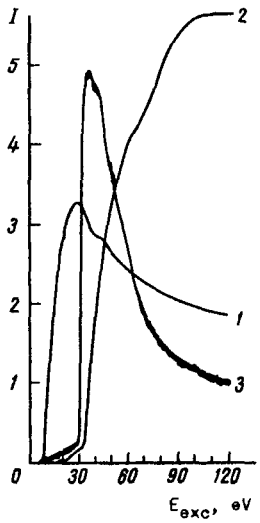

Fig. 1. Ionization curves of calcium. 1 - $Ca + e \rightarrow Ca^+ + 2e$, 2 - $Ca + e \rightarrow Ca^{2+} + 3e$, 3 - $Ca^+ \rightarrow Ca^{2+} + e$. Electron current 0.5 mA, pressure in chamber $\sim 9 \times 10^{-7}$ mm Hg.

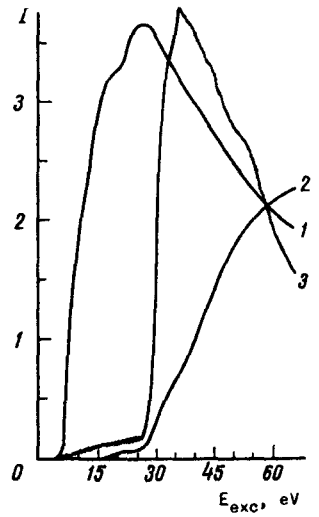

Fig. 2. Ionization curves of strontium. 1 - $Sr + e \rightarrow Sr^+ + 2e$, 2 - $Sr + e \rightarrow Sr^{2+} + 3e$, 3 - $Sr^+ \rightarrow Sr^{2+} + e$. Electron current 0.8 mA, pressure in chamber $\sim 3 \times 10^{-7}$ mm Hg.

Figures 1 and 2 show the ionization curves for Ca and Sr (in arbitrary units), as recorded automatically with an electronic potentiometer. There was no magnetic field in the ion source. It can be seen that the ionization curves of Ca^{2+} and Sr^{2+} have an unusual form.

The currents of the Ca^{2+} and Sr^{2+} ions (curves 2) produced in the ion source increase rapidly at electron energy $\gtrsim$10 eV above their threshold. Such behavior was attributed in the case of calcium [3,4] to rapid auto-ionization processes occurring in the ion source at electron energy ~31 eV, corresponding to the binding energy of one of the internal $3p^6$ electrons of Ca. Similarly, the kink in curve 2 for Sr^{2+} can be attributed to fast auto-ionization processes in the ion source, since the kink occurs at an electron energy close to the binding energy of one of the internal $4p^6$ electrons of Sr, equal to ~27 eV according to [6]. The kinks on curves 3 coincide with these energies within the limits of the experimental error (±1 eV). But these curves characterize the doubly-charged Ca^{2+} and Sr^{2+} ions formed from the corresponding singly-charged ions in the chamber, under conditions when the contributions of the processes are small [2,3]. Consequently, at these electron energies there appears an admixture of strongly excited ions, which retain their excitation for $\gtrsim 10^{-5}$ sec and become doubly charged by auto-ionization. The form of curve s 3 is characteristic of the excitation of optically forbidden states.

It can be expected that other ions, isoelectronic to those investigated, can also have auto-ionization states with large lifetimes.

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NERNST EFFECT IN n-InSb IN A QUANTIZING MAGNETIC FIELD

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It was shown experimentally in [1] that quantization of the energy spectrum of the electrons of indium antimonide placed in a strong magnetic field becomes manifest at low temperatures in an oscillating field dependence of a number of kinetic coefficients. Although the main laws governing the oscillations of the magnetoresistance and the magnetothermal emf of n-InSb in transverse and longitudinal magnetic fields agree with the theory, the behavior of the Hall effect, the phase shift of the magnetothermal-emf curves, and a number of other details connected with spin splitting of the Landau levels, cannot be explained in the existing theory and call for its further development.