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1) The authors are grateful to V. F. Gantmakher and I. P. Krylov for reporting this result prior to publication.

IONIZATION OF THE XENON ATOM BY THE ELECTRIC FIELD OF RUBY LASER EMISSION

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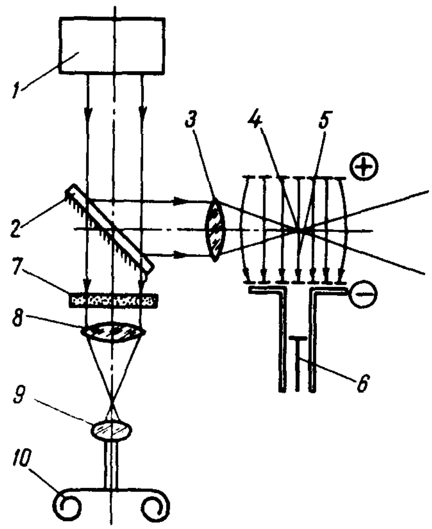
The ionization of the xenon atom by the electric field of a light wave with $\lambda = 6943$ Å was observed experimentally. The ionization potential of xenon is I = 12.13 eV, so that its ionization necessitates the absorption of seven quanta with $h\nu = 1.78$ eV. The ionization effect has a typical threshold character. The threshold value of the electric field for xenon is $E_{thr} = 8.0 \times 10^6 - 1.5 \times 10^7$ V/cm. No ionization of helium is observed at this electric field intensity.

The electric field was produced by focusing the radiation of a Q-switched ruby laser[1]. The intensity and spatial distribution of the electric field were measured by a photometric method (see the figure). The emission of the laser 1 was aimed with the aid of mirror 2 onto objective 3. The ions produced at the focus 4 were drawn out by a uniform electric field 5 of intensity ~ 10 V/cm to the collector 6. Part of the laser radiation, transmitted through the mirror 2 and attenuated by neutral filters 7, was incident on objective 8, identical with objective 3 and located at the same distance from the laser. The spatial distribution of the illumination in various sections of the focusing region was photographed on an enlarged scale by means of micro-objective 9 and photographic film 10.



The experiments were carried out at a pressure $< 10^{-2}$ mm Hg, corresponding to a mean free path $\lesssim 1$ cm. This is two orders of magnitude larger than the dimension of the region in which the already cited electric field intensity is realized. The observed effect is thus due to the action of the field on the individual atoms.

A major experimental difficulty was the elimination of the ion background produced on the surface of the last lens of the focusing objective. In our set-up we were able to eliminate this background completely by drawing out the ions onto a collector with a dc electric field. The ions produced outside the focusing region did not reach the collector. The sensitivity threshold was 4×10^3 ions. Within the time $\tau = 20$ nsec of laser emission, some 10^5 xenon ions are produced, corresponding to an efficiency $\sim 1\%$ and an ionization probability $\sim 5 \times 10^5$ sec^{-1}.

The results obtained are at great variance with the data of Damon and Tomlinson[1] who, in our opinion, registered the above-mentioned background. In an experiment with a set-up similar to that of [1], we also registered ions whose number, as in [1], depended little on the type of gas in the apparatus. It was established experimentally that the registered ions are formed outside the focus of the laser emission. No ion signal was observed when the above-described probe was used, provided the field was smaller than 8×10^6 V/cm.

The experimentally observed threshold field was compared with the theoretical calculations of Keldysh[2] and of Gold and Bebb[3]. Calculations with formulas for hydrogen-like atoms[2], with allowance for the fact that xenon has 8 external electrons, of which 6 are in the p-state, yields $E_{thr} = 4.5 \times 10^7$ V/cm. If xenon has levels with energy differences (relative to the ground state) close to an integral number of quanta, then this can lower the threshold field by an additional factor 1.5 - 2. A numerical calculation made in [3] yields $E_{thr} = 2.7 \times 10^7$ V/cm. We note that not account was taken in [2] and [3] of the smearing of the upper levels in a strong electric field, which can lead to a decrease in the number of quanta needed for ionization.

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EXCITATION AND THERMALIZATION OF ELECTRON PLASMA WAVES IN A STRONG-CURRENT GAS DISCHARGE

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The theoretical principles underlying the use of two-stream instabilities to heat plasma were developed in papers of Fainberg[1] and Buneman[2]. In Zavoiskii's experiments[3] this heating mechanism is realized by the large vortical electric field on the shock wave in the plasma. Analagous processes should occur in a strong-current gas discharge upon thermalization of plasma waves excited by "runaway" electrons.

In our earlier studies[4,5] we investigated in detail the conditions for the excitation of two-stream instabilities in a current-carrying plasma.