by a method described in [1]. The energy was measured by a calorimetric method and its largest value was 0.4 J at a pulse duration 10 nsec, corresponding to a peak power of 40 MW.

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DETERMINATION OF THE IONIC COMPOSITION OF AN ARC-DISCHARGE PLASMA IN CESIUM VAPOR

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One of the most important problems connected with the physical properties of the presently employed non-equilibrium ($T_e > T_a$) discharge plasma in cesium vapor is the nature of the ionization processes occurring in it [1]. In particularly, a highly debatable question now under discussion is the possible existence in such a plasma of molecular-associative ionization in accordance with any one of the schemes:

$$1)\ 2Cs^*_{6P} \rightarrow Cs^*_2 \rightarrow Cs^+_2 + e,$$
$$2)\ Cs^{**} + Cs \rightarrow Cs^*_2 \rightarrow Cs^+_2 + e$$
or
$$3)\ Cs^+ + 2Cs \rightarrow Cs^+_2 + Cs.$$

Here Cs^*_{6p} and Cs^{**} are cesium atoms excited to the resonance level 6p with energy 1.4 eV and to higher levels with energy $\geq$ 3.2 eV. It is therefore necessary to determine by a direct experiment the role of this process which, unlike all other possible ones, leads to the formation of molecular cesium ions in the plasma. Incidentally, we note at the same time (i) the possibility, indicated in [2], of producing a current-free and obviously molecular-cesium plasma by irradiating its vapor with the resonance radiation of cesium, and (ii) the known possible presence of a noticeable amount of molecular ions in a plasma in inert gases.

To answer this important question, we used a direct method of mass-spectrometric analysis of the ion composition in an arc-discharge plasma in cesium vapor at different pressures p. To this end we constructed an integrally-sealed glass instrument consisting of two sections: 1) an arc-discharge tube provided with a probe for the determination of the density n_e and the temperature T_e of the electrons of the investigated plasma, and 2) a time-of-flight mass analyzer with an electron multiplier on the inside and an S1-17 oscilloscope at the output. Both sections were separated by a solid partition with a very narrow aperture, $\approx$ 0.1 mm, through which the ions were drawn from the plasma into the analyzer drift space. The ratio of the concentrations n_2 and n_1 of the molecular and atomic cesium ions in the plasma ($n_1 + n_2 = n_e$) should be characterized approximately by the ratio of the signal amplitudes at the output, $I_2/I_1 \approx n_2/n_1$, and their drift times should amount in our case to

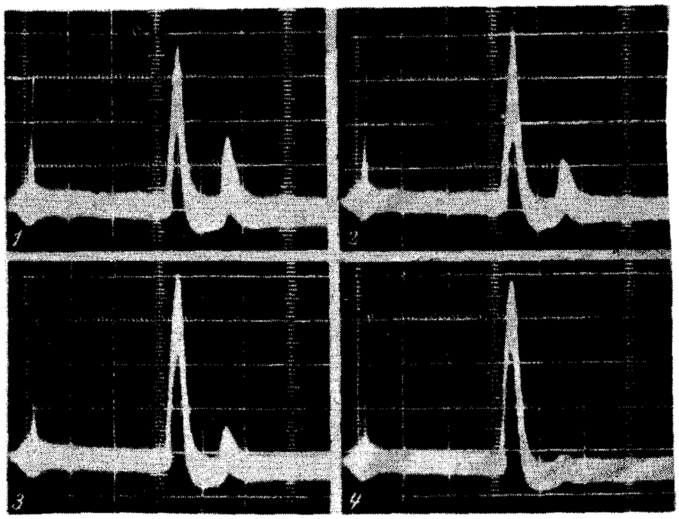

Fig. 1

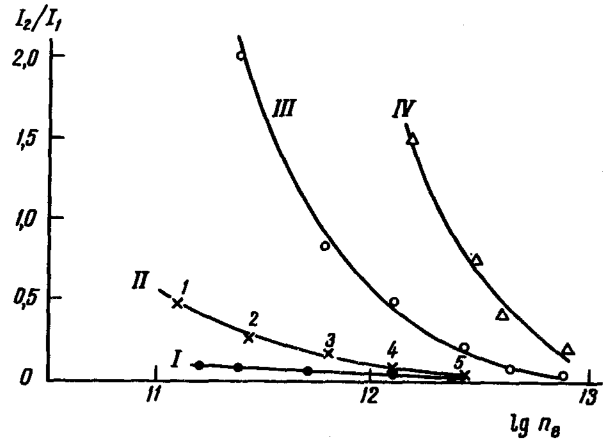

Fig. 2

46 and 33 μsec. Finally, as shown by calculation, under our conditions the relative fraction of the neutral molecules in cesium vapor should be quite small (<< 1%); therefore the appearance of a noticeable number of molecular ions in the plasma can be due in practice only to associative ionization.

Our measurements, made in a typical region of values of p and n_e (see below), enabled us to observe immediately not only atomic but also molecular cesium ions. As an illustration, Fig. 1 shows four successively obtained oscillograms with scale 10 μsec/cm for the case corresponding to points 1 - 4 of curve II of Fig. 2; the left-hand signal corresponds to atomic cesium ions, and the right-hand to molecular ones. Figure 2 shows also the results of all measured ratios I_2/I_1 as functions of log n_e, for four values of p = 0.007(I), 0.02(II), 0.005(III), and 0.1 (IV) mm Hg. The figure demonstrates the following:

1. The number of molecular cesium ions in the discharge plasma can actually become appreciable, and may even exceed sometimes the number of atomic ions. This means, in particular, the need for revising our present notion that a predominant role is played in such a plasma by ordinary stepwise ionization with production of only atomic cesium ions.

2. The number of these ions decreases noticeably with increasing electron density n_e in the plasma, and increases with increasing cesium vapor pressure $p = n_a kT_a$; it should be noted here that with increasing n_e, especially at small p, a corresponding decrease of the electron temperature can also take place.

Without discussing as yet, for lack of data, the final choice of the actual ionization mechanism (see above), we point nevertheless to the third. In fact, from the balance between the rates of such an arbitrarily associative ionization and ordinary dissipative recombination $\beta n_1 n_a^2 = \alpha n_2 n_e$ it follows that $n_2/n_1 = (\beta/\alpha)n_a^2/n_e$, where β and α are the ionization and recombination coefficients. This expression, as can be readily verified, is in very satisfactory agreement with most of the experimental plots of Fig 2, leading, for example, to the likely order of magnitude $\beta \approx 10^{-26}$ cm^6/sec at $\alpha \approx (1 - 2) \times 10^{-8}$ cm^3/sec, etc. All these interesting facts stimulate our further investigations of this important problem.

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SUPERRADIANCE SPECTRA OF INJECTION LASERS AND DISTRIBUTION OF INHOMOGENEITIES ALONG A p-n JUNCTION

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We investigated epitaxial and diffusion GaAs laser diodes operating in the pulsed mode at a temperature 77°K.

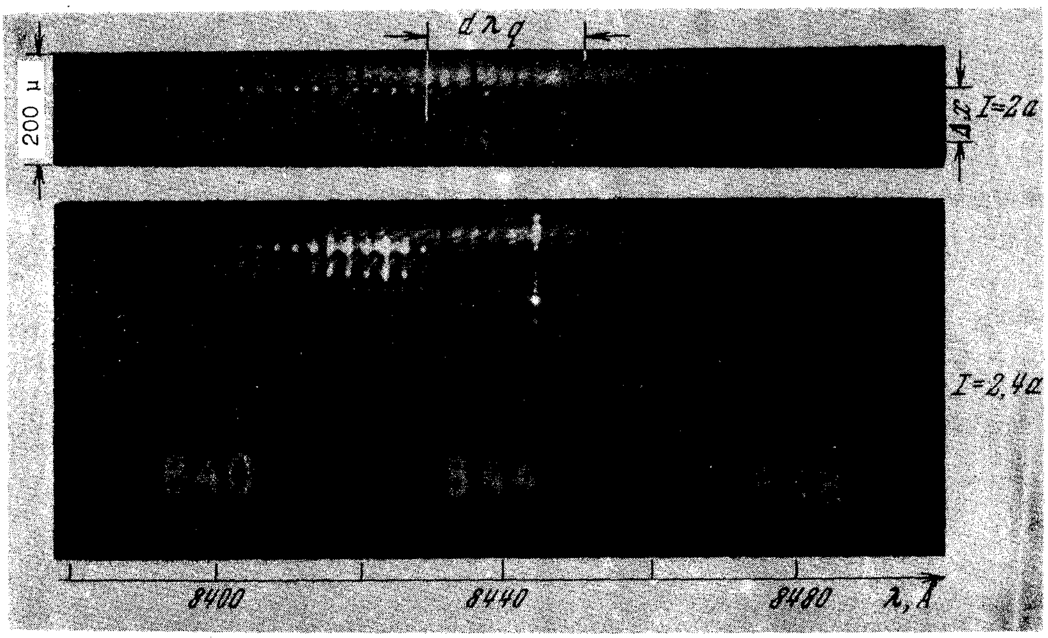

Fig. 1. Spectral-spatial picture of the emission of an epitaxial laser diode

Figure 1 shows the spectral-spatial picture of the superradiance of an epitaxial laser diode, observed with the aid of a P-4 electron-optical converter placed at the output of a DFS-8 spectrograph. The strongly magnified image of the p-n junction was focused on the input slit of the spectragraph parallel to its direction.

In accordance with the idealized models, one should have expected the picture to comprise a set of equidistant vertical lines, i.e., the wavelength of any longitudinal mode of the superradiance should be the same for all the points of the p-n junction.

The experiment revealed, on the other hand, that the wavelength of the superradiance modes varies along the p-n junction. Using the spectral-spatial pictures of the superradiance it is possible to obtain qualitative and quantitative information on the spatial inhomogeneity of the optical characteristics of the p-n junction of a laser diode. We shall assume that