The laser radiation consisted of one pulse of polarized light with energy 2 J and duration not more than 20 sec at the 1/2 level. The pulse duration was determined by the resolution time of the FEU-15 photomultiplier (see [1]). The laser beam divergence did not exceed 15'.

The laser pulse was fed to an optical amplifier consisting of one rod 120 mm long and 12 mm in diameter. The radiation energy at the output of the amplifier was 4 J. When this radiation was focused in air with the aid of long-focus lenses (F = 250 and 400 mm), several "sparks" were produced. After the passage of the radiation pulse through the amplifier, local damage to the material occurs within the amplifier rod.

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EFFECTS OF OPTICAL INTERACTION OF TWO DIODE LASERS

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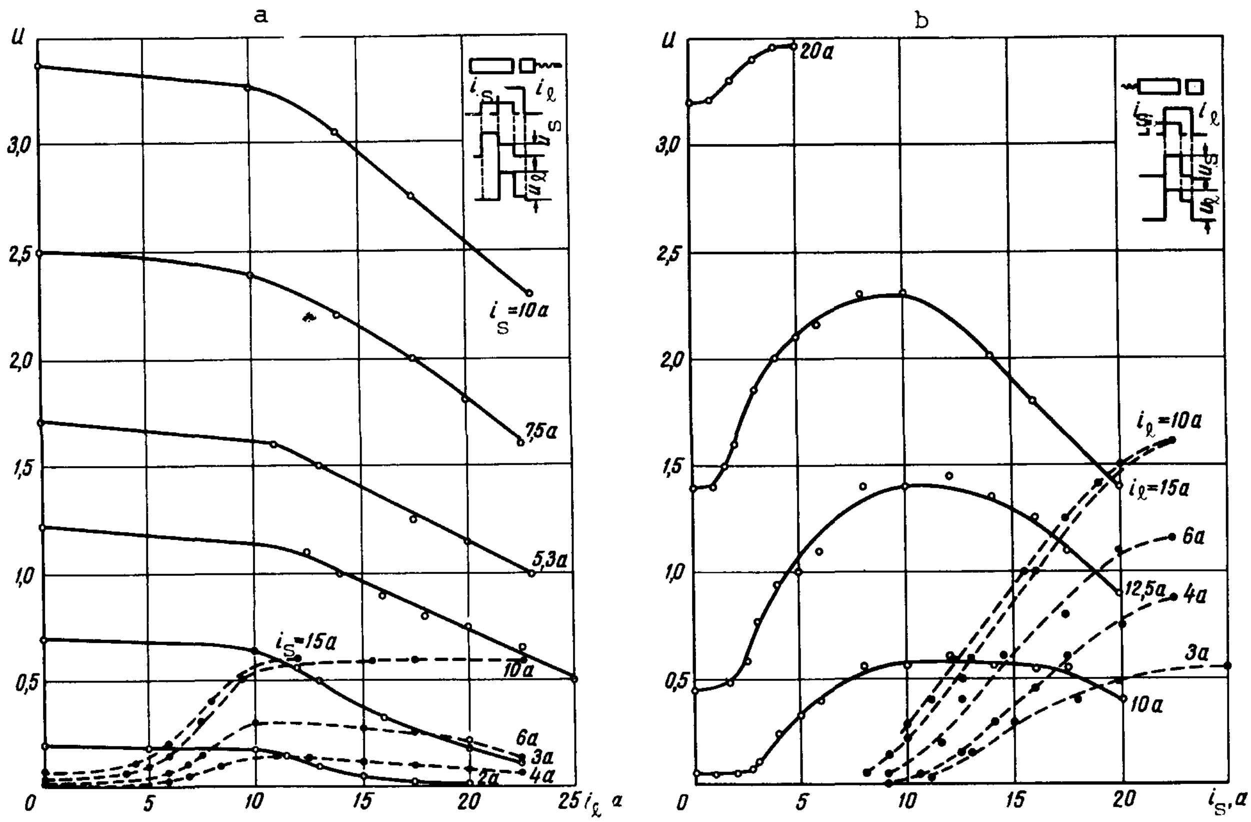
Much attention has been paid recently to the investigations of optical interaction of diode lasers, in connection with the possibility of using these effects to produce logical elements for computer devices [1]. However, an experimental realization of an optical interaction entails considerable difficulties, since the thickness of the active region of diode lasers amounts to several microns. The published experimental papers pertained either to a study of the interaction of two diode lasers with a common resonator [2], or else contained only a qualitative description of the observed effect in the case of separated resonators located at a distance of several dozen microns, when the effects of interaction are not strongly pronounced [3,4].

We present in this communication the results of an experiment on the optical interaction of two gallium arsenide diode lasers located at a distance smaller than 5 μ. The mirrors of their resonators were parallel, and the p-n junctions were in the same plane.

The pair of diodes was obtained by cleaving one crystal, first mounted in a crystal holder, into two parts 425 and 1450 μ long, to which separate contacts were then soldered. The diodes were placed in liquid nitrogen, and were fed with two square-wave pulse generators at amplitudes 0.5 - 25 A and durations 1.5 μsec. The emission spectrum was investigated with type ISP-51 and DFS-8 spectrographs and recorded with a FEU-22 photomultiplier.

The generation spectrum of the short diode was in the wavelength interval λ_s = 8420 - 8435 Å, and consisted of modes spaced 1.7 Å apart. The generation spectrum of the long diode was in the interval λ_ℓ = 8465 - 8478 Å, with the mode spaced 0.8 - 0.9 Å apart. No detailed measurements were made of the fine structure of the spectrum during the optical interaction.

The main measurements were made with the ISP-51 spectrograph at a resolution on the order of 15 Å. The emission spectra of the pair, both for coinciding pulses and pulses of supply current, consisted of two lines 15 - 25 Å wide. When the pulses coincided, the relative values of the maxima changed noticeably, thus offering evidence of the presence of optical interaction. On the side of the short diode, a decrease was observed in the radiation intensity at the wavelength λ_s and an increase in the wavelength λ_ℓ, while on the long-side an increase in intensity was observed at both wavelengths.



Figs. 1a, b. Dependence of u_s and u_ℓ (in relative units) on the supply current

Figure 1 shows families of the plots of the photomultiplier-output signal amplitudes (u_s and u_ℓ), at the wavelengths corresponding to the maxima of the spectral lines λ_s and λ_ℓ, against the diode currents. In observations from the short-diode side, at a fixed current i_s, the intensity at λ_s decreases with increasing i_ℓ (Fig. 1a, continuous curves). This decrease becomes noticeable only when $i_\ell > i_{\ell.thr} \approx 10$ A, and is linear in i_ℓ. The radiation at λ_ℓ at fixed i_ℓ first increases with increasing i_s, reaches a maximum, and begins to decrease (Fig. 1b - dashed curves). The plots showing the variation of the radiation at λ_s, observed from the side of the long diode, as functions of i_s at fixed i_ℓ, have sharp maxima (Fig. 1b - dashed curves), and the radiation at λ_s for fixed current i_s increases monotonically with increasing

i_ℓ to a value $i_\ell = i_{\ell.thr} \approx 10$ A, after which saturation and slow decrease set in (Fig. 1b - continuous curves).

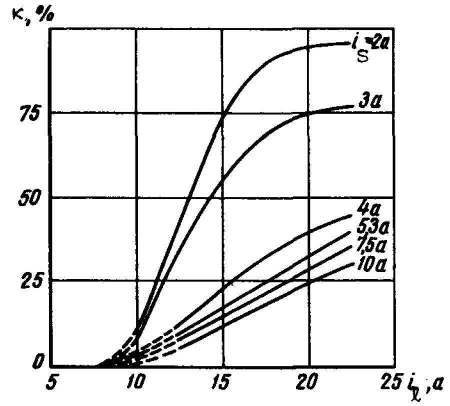


Fig. 2. Dependence of hindrance coefficient on the supply current.

Thus, the effects due to the optical interaction, observed from the side of the short diode, were the presence of hindrance, i.e., a decrease in the intensity of emission of the short diode when external radiation is introduced into its active layer, while the effect observed from the side of the long diode was realization of optical coincidence logic, i.e., and increase in the intensity of radiation at the wavelengths λ_s and λ_ℓ when the pump currents coincide in time. For a quantitative description of these effects we can use the coefficient and efficiency of the hindrance, and also the ratio of the signal to the noise during coincidence (the ratio of the signal for coinciding currents to the signal in the presence of only one of the currents). Figure 2 shows plots of the hindrance coefficient $\kappa = [1 - u_s(i_\ell)/u_s(0)] \times 100\%$ vs. current in the circuit of the long diode i_ℓ at different values of the current in the short diode. At currents i_s close to threshold, the hindrance at the wavelength in the short diode was practically complete ($\kappa > 95\%$). At the same time, the hindrance efficiency $\eta = \kappa(2i_s/i_\ell)$ changed from 5% at $i_\ell \approx 10$ A to 25% at $i_\ell = 22.5$ A, and depended little on i_s. The signal to noise ratio $\rho = u^*_s(i_\ell)/u^*_s(0)$ at the wavelength λ_s, observed on the side of the long diode, had a maximum value of 20 - 30 when the current i_s changed in the range 4 - 15 A, and when the current through the long diode was $i_\ell \approx 10$ A. Further increase in the current i_ℓ led to hindrance of the radiation at λ_s and by the same token to a decrease in ρ.

An explanation of the observed effects of optical interaction of a pair of laser diodes can be presented by starting from the following considerations. The coupling between the different oscillation modes causing the effects of optical interaction is only via their influence on the populations of the energy levels. This influence is the larger, the larger the corresponding intensity of radiation. In a system of two coupled resonators it is possible to obtain either the modes that correspond to each individual resonator, or the modes of the resonator pair [5]. The relative Q of these modes is determined by the coupling between the resonators and by the ratios of their optical lengths. If we assume that the losses in the gap between the diodes are due only to the divergence of the radiation, then when the distance between diodes is 5 μ these losses can be assumed small, and therefore it is to be expected that the common modes of the diode pairs will have a higher Q than the modes of the individual resonators.

When current pulses are applied only to the short diode, generation takes place at modes lying in the region of the wavelengths λ_s corresponding to the short diode. If at the same time we increase the current i_ℓ flowing through the long diode, then, prior to occurrence of generation of the longer wavelength, the spontaneous emission of the long diode will influence weakly the emission from the short one. At a certain value of the current $i^*_{\ell.thr}$, generation sets in at the wavelength λ_ℓ corresponding to the higher-Q common modes of the pair of coupled resonators. Therefore the generation threshold $i^*_{\ell,thr}$ turns out to be smaller than the threshold value of the current for the long diode, and the radiation shifts twoards the longer wavelengths.

Emission at the common modes, becoming amplified in the short diode, reduces the population inversion for the levels corresponding to λ_s, as a result of which the radiation intensity at λ_s decreases, i.e., it becomes hindered. Radiation at the wavelength λ_s is absorbed as it passes through the long diode, the absorption coefficient decreasing with increasing current i_ℓ up to the instant of occurrence of generation at the common modes. With further increase in the current i_ℓ, the absorption coefficient (which can become negative) remains unchanged, but owing to the hindrance in the short diode, the radiation at the wavelength λ_s observed from the side of the long diode, becomes attenuated.

When the current through the short diode is sufficiently large, and the radiation intensity at λ_s in the long diode exceeds the emission at the common modes, the radiation at the larger wavelength becomes attenuated as a result of the population-inversion decrease connected with the intensified radiation at λ_s. This leads to the appearance of maxima on the plots of Figs. 1a and 1b.

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ON THE COMPLEX LINE STRUCTURE IN THE SPECTRA OF STIMULATED RAMAN SCATTERING OF LIGHT

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We observed a unique splitting of the lines into several components in an investigation of the spectra of stimulated Raman scattering in the region of the first Stokes component. This phenomenon is manifest particularly clearly at a small excess of excitation-radiation power over the threshold value. The splitting has an irregular character: the number of components changes from 1 or 2 to 5 or 6, and the distance between the outermost components changes from 1 - 2 to 10 - 12 cm^{-1}. The number of components and the distance between them decrease with increasing power of the exciting radiation, leaving only a single sharp line when the excitation exceeds the threshold by a factor 2 - 4.

This splitting was observed in several liquids, for example styrene, isoprene, and pentadiene-1,3, and was investigated in detail in benzene and nitrobenzene, with a detailed study of the first Stokes line. The investigations were carried out with the apparatus described in [1,2].