$$\frac{1}{\tau_k} = \frac{1}{\tau} + k^2 D; \quad \frac{1}{\tau} = \frac{4\pi\sigma h k}{\epsilon}.$$

Here $\omega = 2\pi f$, $\sigma = e\mu n$, $s = 2.6 \times 10^5$ cm/sec is the speed of sound determined by us from the delay time of the pulse in the sample, k is the wave vector of the sound, D is the coefficient of carrier diffusion in the semiconductor, and h is the thickness of the layer in the CdSe. The coefficient A depends significantly on the type of the acoustic wave (surface, volume, etc.) and was not calculated in this paper. The curves in Fig. b are therefore shown in arbitrary units.

We see that there is a similarity between the experimental and the theoretical curves. In both cases α reverses sign (the absorption changes into amplification) at a carrier drift velocity $\mu E \approx s$. When $E < 0$ we always have $\alpha > 0$. The shapes of the theoretical and experimental curves change in similar fashion with changing μ and n. All this favors the assumption that α is due to an electron-phonon interaction proportional to the applied electric field. Were the absorption connected with the usual piezoelectric interaction [3], then the $\alpha(E)$ would be centrally symmetrical with respect to the point $E = s/\mu$; at $E = 0$ we would have $\alpha \neq 0$; $\alpha_{E=0}$ would depend on the illumination. None of these properties are observed in the described cases.

Additional absorption (amplification) of ultrasound was observed also in $BaTiO_3$ doped with bismuth and antimony oxide and coated with a layer of CdSe. The amplification effect turned out to be of the same order as in the preceding case. However, the growth of the sound absorption that does not depend on the electron-phonon interaction with increasing E turned out to be much less than in the preceding case. We therefore succeeded in observing an absolute amplification of sound on the order of several dB/cm.

We note that in a system consisting of the same semiconductor and a ceramic with small ϵ (T-80 ceramic, $\epsilon = 80$), no additional absorption of the ultrasound was observed upon application of an electric field and of illumination.

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METHOD OF REDUCING THE RELAXATION TIME OF A PASSIVE NEODYMIUM-GLASS LASER SHUTTER

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Theoretical investigations [1, 2] have shown that radiation of a laser with a rapidly-relaxing passive shutter should constitute single ultrashort pulses (USP) with duration $\Delta t \sim (c\Delta\nu)^{-1}$, where $\Delta\nu$ is the width of the generation spectrum. However, for the widely used neodymium-glass laser passive shutters the relaxation time of the population of the working levels is $\tau_{rel} > \Delta t$ [3, 4], and groups of closely-lying pulses are separated in the axial period of the laser radiation. The duration of these groups can be different

and equal in order of magnitude to τ_{rel}. Therefore, from the point of view of separating single USP, and consequently of considerably increasing the laser power, it is urgently necessary to develop a passive shutter with minimum possible relaxation time. Two ways are possible: the first is to search for new dyes, and the second is to decrease the relaxation time of the already-known dyes by changing different physical factors influencing the duration of the excited state of the dye molecules.

It is known that the lifetime of the excited state of dye molecules is determined not only by the structure of the molecule, but depend also on the properties of the surrounding medium [5]. By varying the characteristics of this medium, such as the nature of the solvent, its temperature, viscosity, etc., we can expect a change in the relaxation time of the dye. We have undertaken to act on a dye for the purpose of decreasing its relaxation time by means of effects connected with a change in the dye concentration, one of which may be the well-known effect of concentration quenching.

Unfortunately, there are at present no reliable direct methods of measuring the dye relaxation time in the range 10^{-12} - 10^{-11} sec. We can, however, use a method proposed in [3] of estimating the relaxation time of a passive laser shutter from the smallest duration of the separated groups of USP. The presence of groups of USP in the emission of a laser with a passive shutter, for which $\tau_{rel} > \Delta t$, leads to the formation of a characteristic "plateau" on the two-photon luminescence (TPL) track. This makes it possible to determine the duration T of the USP groups from the length of the "plateau," and consequently to estimate the relaxation time of the dye from the smallest value of T for each solution concentration.

An increase of the solution concentration at a fixed value of the transmission of the passive shutter T_{pn}, which amounted to T_{ph} = 50%, called for the use of cells of small thickness. Therefore, in addition to the customarily employed cell of 1 mm thickness, we used cells of thickness 40, 6, and 3 μ.

A cell with a solution of the dye No. 3955 in nitrobenzene was placed at the Brewster angle in a non-selective ring resonator produced by mirrors M_1 - M_4 (Fig. 1). The reduction of ∿100 microphotographs of TPL tracks has shown that the length of the "plateau" decreases with increasing concentration. By way of illustration, Figs. 2a and 2c show typical microphotographs of TPL tracks for cells with thickness ℓ = 1 mm and ℓ = 3 μ. Figures 3a and 3b show the number of observed groups of USP with duration T for cells with the same thicknesses. The results show that the duration of the groups of USP separated by the passive shutter decreases strongly with increasing solution concentration.

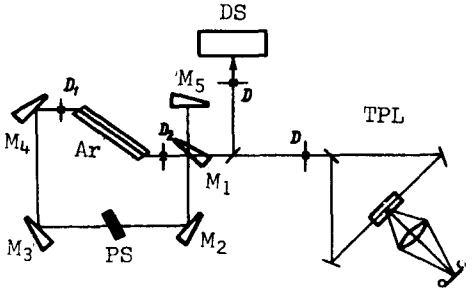

Fig. 1. Experimental setup: Ar - active rod (neodymium glass) 15 mm diameter × 260 mm, PS - cell with passive shutter. The mirror reflection coefficients are R_1 = 0.82 and $R_2 = R_3 = R_4 = R_5 = 1.0$. Mirror M_5 is used to obtain the "traveling" wave regime. DS - diffraction spectrograph with resolution 0.15 cm^{-1}. TPL - setup for the registration of the tracks of two-photon luminescence. The resonator length is 200 cm. To separate and investigate the radiation of only the axial modes of the laser, diaphragms D_1 and D_2, with 2 mm diameter, were installed inside the resonator, and diaphragms D outside the resonator.

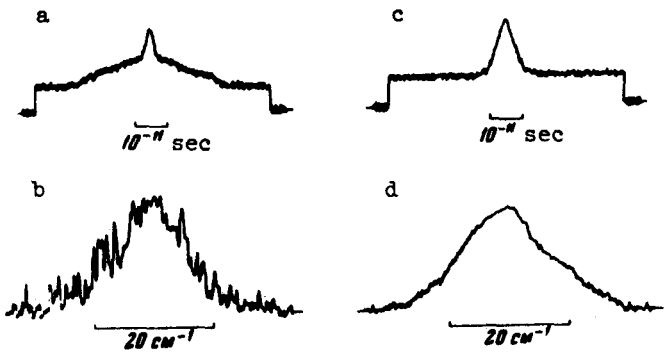

Fig. 2

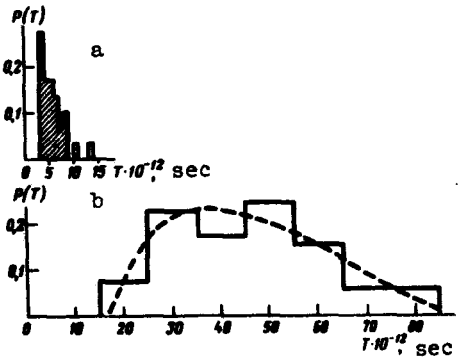

Fig. 3

Fig. 2. Microphotographs of simultaneously obtained TPL tracks and laser emission spectra at cell thicknesses ℓ = 1 mm (a, b) and ℓ = 3 μ (c, d).

Fig. 3. Experimentally obtained distribution of the probability density P(T) of the duration of the USP groups for cells with thickness ℓ = 3 μ (a) and ℓ = 1 mm (b). The width of the column is equal to double the measurement error (∿10%).

We note that the authors of [6] propose that the duration of the USP groups can be reduced by decreasing the thickness of the cell, assuming the relaxation time of the dye to be constant. From our point of view, however, at large dye-solution concentrations it is necessary above all to take into account the change of its relaxation time, and, as will be shown, this change is the decisive factor in the decrease of the duration of the USP groups in the laser radiation. To confirm this, we performed a control experiment with a laser operating in the "traveling" wave regime, eliminating by the same token the effect of the resuperposition of the pulses traveling opposite to each other in the cell. The "traveling" wave regime was realized by using a return mirror M_5 in the ring resonator of the laser (Fig. 1). The ratio of the intensities of the forward and backward waves was not less than 50. The results of this experiment have shown that in a "traveling" wave laser, just as in a laser operating in the steady-wave regime, the length of the USP groups decreases by one order of magnitude with increasing dye-solution concentration, from $\sim 4 \times 10^{-11}$ to $\sim 4 \times 10^{-12}$ sec. The distribution of the duration of the separated USP groups is analogous to that shown in Fig. 3a.

Thus, an experiment with a laser operating in the "traveling" wave regime demonstrates that the decisive factor in the decrease of the duration of the USP groups is the decrease of the relaxation time of the dye. On the basis of the presented experimental data (Fig. 3) we can conclude that an increase in the concentration of the dye solution (with decreasing thickness of the cell from 1 mm to 3 μ) leads to a decrease of the relaxation time by at least one order of magnitude.

Such an appreciable decrease of the relaxation time of a passive shutter has led to the appearance of peculiarities in the experimentally observed temporal and spectral characteristics of the radiation of a laser with a passive shutter. The main tendency for the spectra to broaden with increasing dye-solution concentration and for their structure to become smoothed out to such an extent that "smooth" spectra appear (Figs. 2b and 2d), something not observed for cells with 1 mm thickness. Such a smoothing of the structure of the spectra signifies, in temporal language, a decrease in the number of USP in the group, to the extent that single pulses appear.

Attention is also called to the fact that when the solution concentration is increased, an increase is observed in the scatter in the values of the width of the emission spectrum from flash to flash. The width of the spectrum varied from flash to flash in the range from $\Delta\nu = 2.5$ cm^{-1} to $\Delta\nu = 13$ cm^{-1} for a laser with a cell thickness $\ell = 1$ mm and from $\Delta\nu = 2$ cm^{-1} to $\Delta\nu = 60$ cm^{-1} for $\ell = 3$ μ. The increase in the scatter of the width of the spectra agrees with the concepts developed in [7], where the observed scatter is connected with separation by means of a passive shutter with $\tau_{rel} > \Delta t$ of short-duration realizations of the noise picture of the radiation. The slower the duration of the separated groups of USP, the larger should be the value of the scatter.

The demonstrated possibility of reducing the relaxation time of a shutter makes it possible to make substantial progress towards the solution of the problem of increasing the power of existing solid-state lasers, which is presently hindered considerably by the lack of rapidly-relaxing dyes.

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HYPOTHESIS OF GRAVITATIONAL RADIATION OF A RAPIDLY ROTATING NEUTRON STAR

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It is assumed in this article that rapidly-rotating neutron stars can assume tesseral equilibrium shapes (see the figure), and should at the same time emit powerful pulses of gravitational radiation on going over from one tesseral shape to another. It is possible that these pulses were registered by J. Weber a few years ago [1, 2].

Assume we have a self-gravitating liquid of mass M and constant density ρ, rotating as a whole with angular velocity Ω about a certain axis z passing through the center of gravity of the liquid. This rotating drop assumes an equilibrium form such that the following condition is satisfied on its surface [3]

$$\Phi(x, y, z) - \frac{\Omega^2}{2}(x^2 + y^2) = \text{const}. \qquad (1)$$

where Φ is the gravitational potential and (x, y, z) are Cartesian coordinates. The shapes of a rotating liquid most thoroughly investigated and known at present are: a) oblate ellipsoid of revolution (the so-called Maclaurin ellipsoid), b) triaxial ellipsoid (the Jacobi ellipsoid). The M and J ellipsoids have