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GENERATION INDUCED IN A Q-SWITCHED RUBY LASER BY AN EXTERNAL SIGNAL

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As follows from a theoretical analysis of the dynamics of the generation of a giant pulse in a laser with active Q-switch [1-3], the time τ_d of linear development of generation depends on the average number of spontaneous photons in the oscillation mode at the instant when the Q-switch is turned on. An estimate [1] has given for the corresponding energy W_0 a value on the order of 10^{-16} J.

So small an initial energy makes it possible in principle to control τ_d over a rather wide range by introducing into the laser cavity, after opening the shutter, energy from another laser, in spite of the fact that τ_d has a relatively weak dependence on W_0, in the form

$$\tau_d = K_1 \ln \frac{K_2}{W_0}. \tag{1}$$

(K_1 and K_2 are determined by the laser and pump parameters).

An investigation of this possibility is of interest both for the solution of the problem of synchronous operation of several lasers having the same spectral output, and for obtaining a single frequency giant-pulse generation regime.

We have therefore experimentally investigated the singularities produced in giant-pulse generation by a ruby laser when the fraction of the energy, ΔW, of another laser is introduced in its cavity after the opening of the electrooptical shutter. The second laser is also Q-switched. The experimental setup is shown in Fig. 1, where the following symbols are used: C - electrooptical cells, G - Glan-Thomson prisms, R - ruby rods, M - laser cavity mirrors, S - semitransparent mirrors, F - filter system. Both lasers were pumped simultaneously. The high-voltage pulse fed to the electrooptical cell used to Q-switch the synchronized laser (henceforth referred to as the second laser) was fed from a generator (VPG) through a 135-nsec delay line (DL).

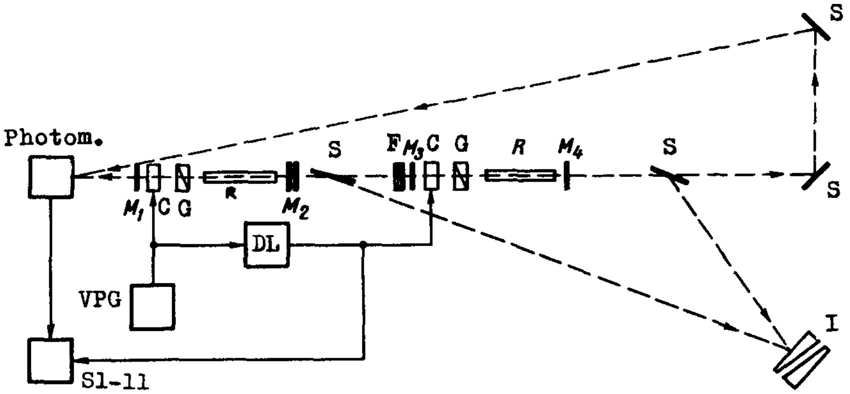

Fig. 1

The time of linear development of the lasing of the driving (henceforth - first) laser was 150 nsec and thus its pulse entered the second laser 15 nsec after the Q-switch of the latter opened.

Both pulses were fed to a photomultiplier and photographed from the screen of an oscilloscope (S1-11), the sweep of which was triggered simultaneously with the opening of the Q-switch of the second laser. In addition, the emission spectrograms of both lasers were simultaneously photographed with the aid of one Fabry-Perot interferometer. To this end, their emission was directed to the interferometer at such angles that the spectra of the two lasers were located in different halves of the image in the focal plane of the lens. The interferometer dispersion region was 0.715 cm^{-1} and the resolution limit was 5×10^{-3} cm^{-1} (150 MHz). To investigate the spectral features of such a regime, efforts were made to obtain in the experiment the largest possible difference between the spectra of the generators. The reflection coefficient of mirror M_1 was 0.98, and mirror M_2 was a resonant reflector; in addition, the first generator operated at near-threshold pumping. The reflection coefficients of mirrors M_3 and M_4 were 0.9 and 0.98 respectively.

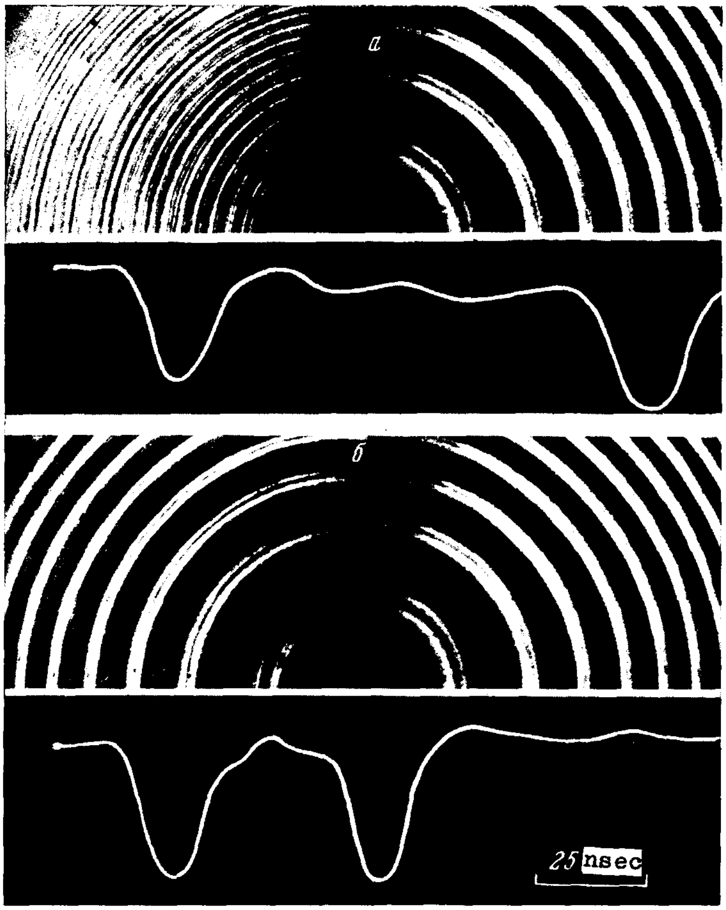

Fig. 2.

The cavities of the first and second generators were 53 and 56 cm long, respectively.

Figure 2a shows a spectrogram and oscillogram of the emission of both lasers in the case when $\Delta W = 0$, and Fig. 2b shows the same for $\Delta W = 4 \times 10^{-4}$ J. The pump energy of the second laser was 2.9 kJ (threshold value 1.7 kJ). It is clearly seen that the spectrum of the second generator remains perfectly identical to that of the first, and the time of linear development of the lasing is greatly reduced. (Account must be taken of the fact that the pulse of the second generator is delayed by 15 nsec, owing to the different distances from the generators to the photomultiplier.)

Figure 3 shows a plot of τ_d against $-\ln \Delta W/n$, where n is the number of oscillation modes (according to our estimates n ≃ 10) for two values of the second-generator pump. We see that these plots agree qualitatively with (1), with the exception of the end sections. "The saturation" at small values of ΔW is due to the fact that ΔW becomes comparable with the energy of spontaneous emission in the cavity after the shutter is opened. A certain tendency to "saturation" in the region of large values of ΔW is apparently attributable to the fact that those modes of the first generator which do not coincide with those of the second and therefore do not take part in the lasing, begin to lift an appreciable part of the inversion. The spectra of both generators remain identical in the entire range of ΔW up to values 10^{-10} J.

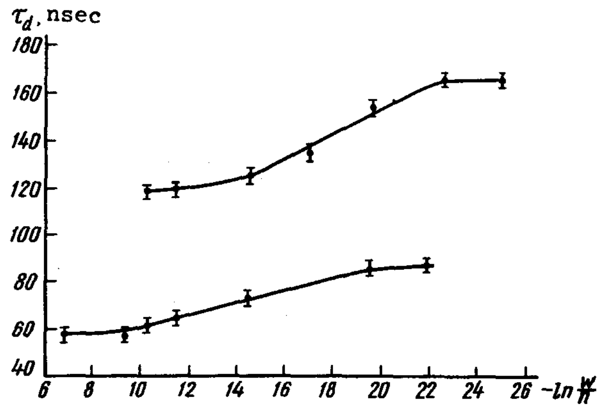

Fig. 3

We are continuing the present investigations in order to obtain synchronous lasing of several lasers using a driving laser operating in a single-frequency regime.

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OBSERVATION OF FOUR-PHOTON INTERACTION IN THE SPECTRUM OF STIMULATED SCATTERING OF THE LIGHT OF THE RAYLEIGH LINE WING

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We have previously reported observation [1] and experimental [2] and theoretical [1,3] investigations of stimulated scattering of light in the wing of the Rayleigh line (RLW) when there is no interaction between the exciting, Stokes, and anti-Stokes waves with the nonlinear medium (four-photon interaction).

We report here that we have observed four-photon interaction in stimulated scattering of light in the RLW at small angles, which is the same as scattering of light by light in an optically nonlinear medium. In other words, the four-photon interaction effect observed by us is a particular case of parametric interaction between light waves in a nonlinear medium consisting of anisotropic molecules, when the angle between the propagation directions of these waves is small [2]. This question was considered theoretically by one of us [3] and also by Chiao et al. [4].

It follows from the theory [3] that for the case of four-photon interaction in RLW at the optimal angle $\theta_{opt} = |E_0|A^{1/2}$ the maximum gain is