solution. The use of such low concentrations excludes the possibility of glow of the proposed impurities, since their concentration in the solutions (analytically pure dyes were used) would be of the order of 10^{-8} - 10^{-9} m/l.

When dye II was simultaneously excited by ruby-laser radiation and its second harmonic, a lowering of the intensity of the short-wave fluorescence was observed. This indicates that the long- and short-wave fluorescence bands belong to the same molecule.

In two-step excitation by a single-pulse ruby laser (power $\sim$50 MW) of the same dye made it possible to observe simultaneously generation on the $S_1 \to S_0$ transition and short-wave fluorescence. It was established that the dependence of the intensity of the short-wave fluorescence on the pump intensity is linear. Such a dependence will be observed in the case when the generation from the S_1 is stationary, and the short-wave fluorescence is connected with $S_2 \to S_0$ transitions in the same molecule. In the case of impurity fluorescence, the excitation would have a two-photon character and the corresponding dependence would be quadratic.

The weak coupling between the first and second excited states can be probably attributed to the predominant localization of the excitation on the polymethine chain and on the heterocyclic nuclei of the molecules for the second.

In conclusion we note that the investigated dyes can be used to obtain generation on the $S_2 \to S_0$ transition.

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TEMPERATURE PULSATIONS AND MULTIFREQUENCY GENERATION OF $YAlO_3:Nd^{3+}$

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1. The spectral composition and polarization of stimulated emission (SE) of lasers based on anisotropic activated crystals are determined by the polarization of the radiation of the ensemble of elementary radiators of the impurity atoms, by the crystal-optical properties of the base matrix, and by the temperature. This is the basis of several highly effective and widely used temperature methods of SE spectroscopy, which make it possible to extract extensive information on the electron-phonon interaction and on the processes occurring in the excited state on the generation conditions, and can also yield most accurate information on the position of the energy levels of the activator ions.

So far, laser media[1)] with exceedingly simple crystal-optical properties[2)] have been used.

The purpose of the present communication is to illustrate, using as an example the results of the investigation of the observed temperature pulsations and multi-frequency generation of a laser based on the presently most promising [1] rhombic crystals $YAlO_3:Nd^{3+}$ (D_{2h}^{16} - Pbnm), the new possibilities of temperature methods of SE spectroscopy, which are uncovered by the study of laser media having complex crystal-optical properties.

The investigations have shown that these effects are observed when the active medium is made up of several $YAlO_3:Nd^{3+}$ crystals with different orientations, coaxially mounted in the optical resonator, or when one inhomogeneous crystal consisting of several disoriented sections is used.

2. Figures 1 and 2 illustrate the effects for one such crystal. It is seen that when the temperature changes from 77 to 600°K generation arises three times on lines A (transition 11421 cm^{-1} $^4F_{3/2} \rightarrow {}^4I_{11/2}$ 2158 cm^{-1}), C (11421 cm^{-1} $^4F_{3/2} \rightarrow {}^4I_{11/2}$ 2023 cm^{-1}), and D (11421 cm^{-1} $^4F_{3/2} \rightarrow {}^4I_{11/2}$ 2097 cm^{-1}) and twice on the line E (11537 cm^{-1}) $^4F_{3/2} \rightarrow {}^4I_{11/2}$ 2156 cm^{-1}) (see Fig. 3). For comparison, Fig. 2 shows plots of the excitation threshold E_{thr} of the laser based on two defect-free $YAlO_3:Nd^{3+}$ crystals with different orientations (dashed curves). These plots show no "pulsations" and behave differently for the transitions between the $^4F_{3/2}$ and $^4I_{11/2}$ terms of the neodymium media [2], i.e., up to $T \simeq 500$°K the variation of E_{thr} follows the variation of the width of the luminescence line connected with the given induced transition, and at higher temperatures the $E_{thr}(T)$ plot begins to be influenced by the temperature variation of the population of the states $^4I_{11/2}$

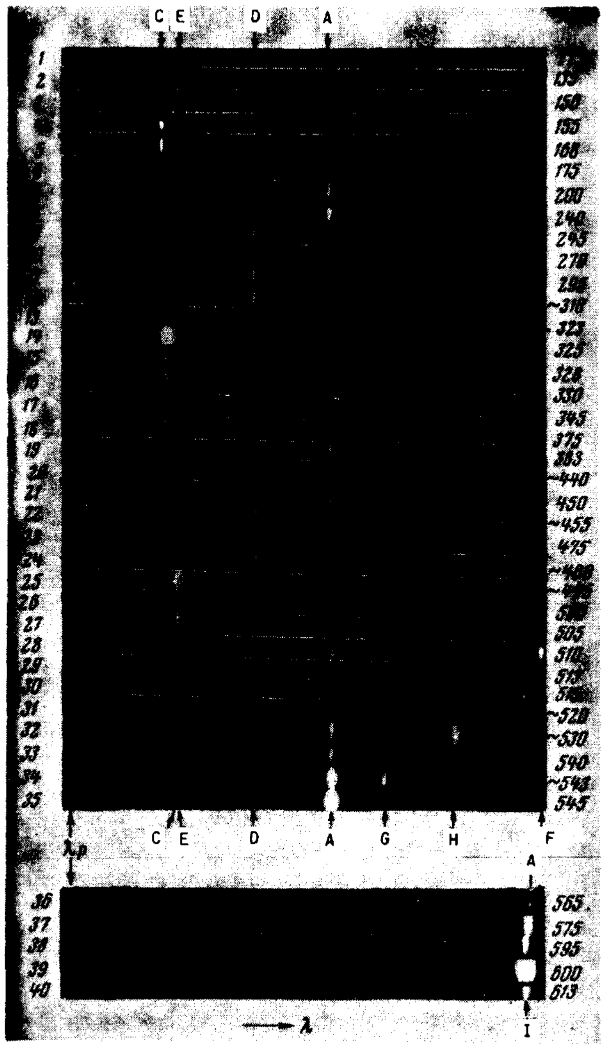

Fig. 1. SE spectra of a laser based on the crystal $YAlO_3:Nd^{3+}$ ($\angle$ Fa $\simeq$ 60° and $\angle$ Fc $\simeq$ 50°) with complex crystal-optical properties, transition $^4F_{3/2} \rightarrow {}^4I_{11/2}$. The arrow denotes the reference line width λ_r = 10561.5 A.

[1)] Prof. M. Weber and co-workers obtained at 300°K an output power ~100 W (efficiency ~2.7%). They used $YAlO_3:Nd^{3+}$ (F || b, $\ell \simeq 75$ mm, $\phi \simeq 6$ mm) and two Kr lamps in a gold-coated double elliptic illuminator. The authors thank Prof. Weber for reporting these results prior to publication (see also G.A. Massey and J.M. Yarborough, Appl. Phys. Lett. 18, 576 (1971)).

[2)] It is assumed that the indicatrix of the refractive indices has a constant orientation over the entire length of the laser.

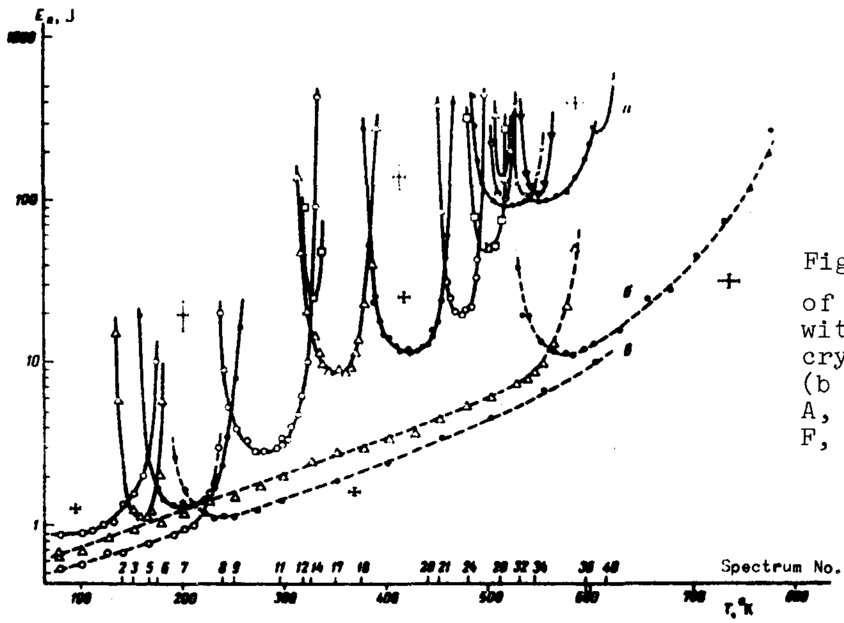

Fig. 2. Dependence of $E_{thr}(T)$ of a laser based on $YAlO_3:Nd^{3+}$ with complex (a) and simple crystal-optical properties (b and c) for the lines: ● - A, Δ - C, o - D, ◻ - E, ◉ - F, ▼ - G, × - H, ◊ - I.

and $^4F_{3/2}$ [3]. Preliminary results of a study of the SE pulsations show that the SE is due primarily to temperature variation of the polarization properties of the disoriented sections of the $YAlO_3$ relative to the polarization of the electronic transitions of the Nd^{3+} ions, which depends little on the temperature. The presence of sharp transition boundaries between the disoriented sections also contributes considerably to the pulsation phenomenon.

3. The investigations have revealed new possibilities of activated crystals, which make it possible to produce lasers with temperature-controlled spectral and polarization characteristics. The present results also indicate that an analysis of laser media with complex crystal-optical properties greatly extends the capabilities of SE spectroscopy [3], particularly in the study of the temperature shift and broadening of generation lines, giving valuable information concerning the interaction of activator ions with the dynamics of the matrix. Thus, in the example presented, using only one $YAlO_3:Nd^{3+}$ sample in an ordinary laser scheme without special dispersion elements in the optical resonator, we were able to observe and analyze the behavior of more than half of the transitions between the terms $^4F_{3/2}$ and $^4I_{11/2}$ by varying the temperature (77 - ∿600°K) [4]. Some spectroscopic parameters of the laser described above, on the basis of $YAlO_3:Nd^{3+}$, can be reproduced in temperature experiments with the aid of a single defect-free crystal and a rotating polaroid [5].

4. The experimental technique and the research methods were analogous to those used in [1, 2, 4]. The presented SE spectra were obtained with a crystal $YAlO_3:Nd^{3+}$ (∿1wt.%) with length ∿14 mm and diameter ∿4 mm,

[3] The switching of the SE at ∿210 and ∿550°K to the line A (Fig. 2) is due principally to the resonances of the transitions.

[4] The results will be published in a separate paper.

[5] The use of a polaroid and a $YAlO_3:Nd^{3+}$ crystal with F || b (where b is the crystallographic axis and F the geometric axis of the laser element) have enabled the authors of [5] to obtain SE on lines A and C (300°K).

with plane-parallel end faces (∿3")[6]. For convenience in comparing the data of Figs. 1 and 2, the numbering of the SE spectra is connected with the temperature scale of Fig. 2. The spectra 36 - 40 (Fig. 1) are shown on an enlarged scale (relative to λ), so as to illustrate the switching of the SE at $T \geq 600°K$ to the transition I (11533 cm^{-1} $^4F_{3/2} \rightarrow {}^4I_{11/2}$ 2271 cm^{-1}) with λ_g = 10796 Å. At these temperatures, $\lambda_g(A)$ = 10801 Å (Fig. 2a and 2b). The flare-up of the high-temperature lines F, G, H, and I is due, on the one hand, to the change of the polarization properties of the crystal, and on the other to the temperature growth of the population of the upper level of the $^4F_{3/2}$ term, and also to the resonances (for certain lines).

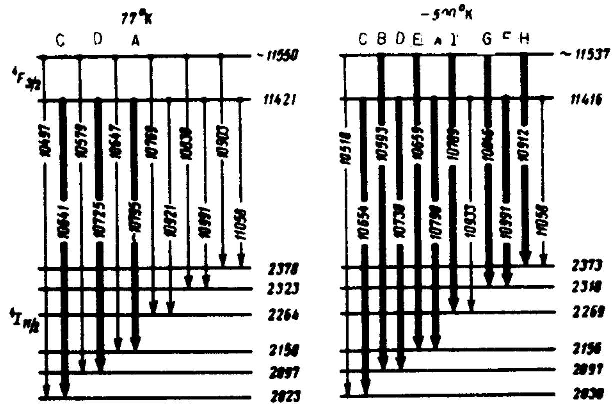

Fig. 3. Schemes of crystal splitting of the $^4F_{3/2}$ and $^4I_{11/2}$ terms of the Nd^{3+} ions in $YAlO_3$ for 77 and ∿500°K. The level positions are indicated in cm^{-1}, and the transitions between them in Å. The heavy arrows denote inducing transitions (scheme for 77°K) registered below 300°K and (for 500°K) above 300°K. The SE on line B was obtained with a laser with ($YAlO_3:Nd^{3+}$ + $SrF_2:LaF_2:Nd^{3+}$) [1].

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SUPERCONDUCTIVITY AND STRUCTURE OF COMPOUNDS BASED ON NIOBIUM AND VANADIUM

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The question of the connection between the temperature T_c of the transition to the superconducting state and different structural characteristics of

[6] Owing to the presence of boundaries between the disoriented sections of the given sample, the He-Ne laser radiation passing through it (6328 Å) forms a system of symmetrical beams with mutually perpendicular polarization and with sharply decreasing intensity, with divergence ∿1, ∿2°, etc., lying in one plane.