$T_1 \simeq 5 \times 10^{-4}$ sec, and the lower working level $^4I_{11/2}$ is short lived, so that $N_{20} \simeq N_0$. After opening the shutter, the gain of the medium K reaches 10^8 per pass, and consequently condition (1) is satisfied in our apparatus.

Figure 2 shows pulses radiated by the medium at $K \simeq 10^8$. The pulse energy was approximately 4 J. The pulse duration at half-maximum was 9 - 12 nsec, and the start of the pulses lagged behind the time of gain switching t_1 by 25 - 30 nsec. The medium is thus de-excited within less than three passes, the main energy being radiated within a time shorter than T_0.

4. The maximum gain of the active medium with the Kerr shutter closed is limited by the self-excitation of the pumped glass rods due to Fresnel reflection of the light, polarized perpendicular to the plane of incidence from the butt end with the Brewster angle, on the lateral matte surface, and subsequent scattering (with depolarization of the radiation) in the backward direction. Inasmuch as the gain of the neodymium glass, unlike ruby, does not depend on the polarization of the light, this leads to a feedback coefficient $\rho \sim (n^2 - 1)^2\Omega_{eff}/2(n^2 + 1)^2 2\pi \simeq 10^{-4}$ (n is the refractive index of the glass), and to a limiting gain of the order of $\rho^{-1} \simeq 10^4$, which agrees with experiment.

5. The power of the obtained superluminescence pulses reached 500 mW/cm^2. Several intense flashes damaged the output end of the rod at the point A (Fig. 1). Thus, self-damage of neodymium glass is possible under the influence of intense incoherent radiation.

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MAGNETOSTRICTION OF RARE-EARTH GALLATE GARNETS

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Tremendous magnetostriction is observed in terbium, dysprosium, and holmium iron garnets at helium temperatures [1], whereas in yttrium and gadolinium iron garnets the magnetostriction is very small. According to modern notions, the large magnetostriction effects in these ferrimagnets are due to the influence of the orbital state of the Tb^{3+}, Dy^{3+}, and Ho^{3+} ions on the crystal lattice.

We investigated the magnetostriction of paramagnetic garnets in which all the iron was replaced by diamagnetic gallium. Iron and gallium garnets have very similar structures [2], and it can therefore be assumed that the investigation of the gallates yields additional in-

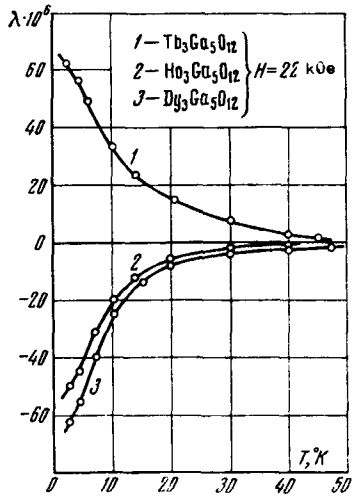

Fig. 1

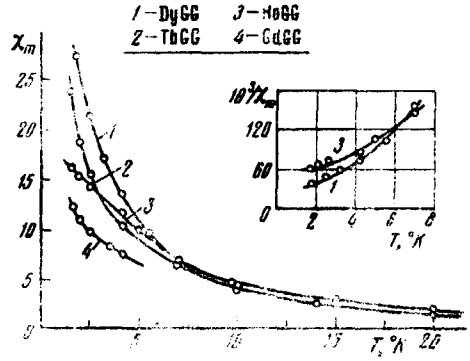

Fig. 2

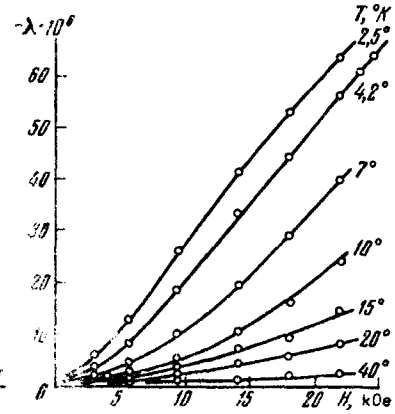

Fig. 3

formation on the behavior of rare-earth ions in the garnet structure. We measured the magnetic and magnetostriction properties of polycrystalline gallate garnets $R_3Ga_5O_{12}$, where R = Gd, Tb, Ho, and Dy, in the temperature interval 1.7 - 50°K. We measured the magnetostriction deformations by the capacitive pickup method, and magnetized the samples by means of a superconducting solenoid (magnetic field up to 25 kOe).

Figure 1 shows the temperature dependence of magnetostriction of Tb, Dy, and Ho gallate garnets, obtained in a 22-kOe field. We see that with decreasing temperature the magnetostriction increases abruptly, reaching the appreciable magnitude (for paramagnets) ~60 x 10^{-6}. In gadolinium gallate, the magnetostriction is two orders of magnitude smaller and amounts to +0.25 x 10^{-6} at 4.2°K, being no longer reliably measurable at T = 15°K (the sensitivity of the apparatus is ~5 x 10^{-8}). It is interesting to note that the signs of the magnetostriction of the investigated gallate garnets are the same as of the corresponding iron garnets (positive for Tb and negative for Dy and Ho).

Figure 2 shows the temperature dependence of the molar susceptibility of Gd, Tb, Dy, and Ho gallate garnets; they agree qualitatively with the data of [3]. As seen from the figure, the susceptibility increases sharply in the liquid-helium temperature region, and a weak inflection is seen on the χ(T) curve. Such a temperature dependence of the susceptibility can serve as evidence of magnetic ordering, whose temperature lies below 1.7°K (the possibility of antiferromagnetic ordering in gallate garnets at low temperatures is noted in [4]). This assumption makes it possible to explain the appreciable magnitudes of the magnetostriction effects observed in gallate garnets. Owing to the large spin-orbit interaction existing in rare-earth garnets, magnetic ordering of the spin magnetic moments (under the influence of exchange forces) is accompanied also be ordering of the orbital magnetic moments, which "disturbs" the local electrostatic field of the crystal, giving rise in turn to a large magnetostriction. Consequently, magnetostriction can serve as a sensitive indicator of the process of magnetic ordering as Θ is approached from the high-temperature side.

In the region of the ordering temperature, a change takes place also in the character of the $\lambda(H)$ dependence. In Fig. 3 we show by way of an example the isotherms of the magnetostriction of $Dy_3Ga_5O_{12}$, which show the quadratic growth of magnetostriction with magnetic field characteristic of ferromagnets. Deviation from this relation takes place already at $T = 4.2°K$, and at 2.5°K the inclination of the curve relative to the field axis reverses. A similar situation is observed in the behavior of even magnetic effects when the Curie point of a ferromagnet is approached from the high-temperature side [5].

One cannot exclude, however, the possibility that the character of the magnetostriction isotherms at low temperatures, which we have described above, is connected with paramagnetic saturation in the strong magnetic field.

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INFLUENCE OF THERMAL EXPANSION ON THE SINGULARITIES OF THE KINETIC COEFFICIENTS AT THE CURIE POINT

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1. Near second-order phase-transition points and critical points, the fluctuations increase appreciably. Variation of the character of the scattering of the carriers gives rise to singularities of the kinetic coefficients; these were calculated in many papers within the framework of the Landau theory [1-4].

Besides such a singularity, which is essentially connected with the mechanism of the phase transition and with the spectral structure responsible for the transition, the kinetic coefficients should also exhibit singularities that do not depend on the details of the scattering process and which are the consequence of singularities of the thermodynamic mean values. We consider below a singularity resulting from the dependence of the carrier dispersion law on the lattice constant, and through it - owing to the thermal expansion of the crystal - on the temperature. For concreteness we shall speak of electrons and electric conductivity. If we assume the non-deformed state of the crystal to occur at zero temperature (this choice, of course, is perfectly arbitrary), then in the approximation linear in u_{ik} the dispersion law $\epsilon(\vec{p}, T)$ can be represented in the form of an expansion about the dispersion law $\epsilon_0(\vec{p})$ at $T = 0$: