We see from Fig. 1 that the observed resonances are characterized by a very small line width, equal approximately to 60 cps (for comparison we note that the minimum line width of ordinary resonance under laboratory conditions is ~250 Hz); this is characteristic of parametric resonance in which there is no saturation [2].

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SINGULARITIES OF TRANSVERSE MAGNETORESISTANCE OF SINGLE-CRYSTAL GADOLINIUM

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It is known [1,2,5] that the direction of the easy-magnetization axes of gadolinium vary rapidly with temperature below the Curie point, and assume all intermediate values between the [0001] axis and the basal plane. According to previously published data [1,2], a "cone" of easy-magnetization axes exists in two temperature regions, from 0 to ~160°K and from ~230 to ~250°K, at temperatures from ~160 to ~230°K the easy-magnetization axes lie in the (0001) plane, and finally above 350°K the gadolinium is a uniaxial ferromagnet with easy axis [0001]. It was therefore of interest to investigate the effect of a change in the magnetic structure on the anisotropy of the transverse magnetoresistance of single-crystal gadolinium in a wide range of temperatures.

We investigated a cylindrical sample cut along the [10$\bar{1}$0] axis, with diameter 1.00 ± 0.05 mm and length 12 mm, prepared by the electric-spark method. The sample was oriented by the Laue method accurate to ±2°. The ratio of the resistances at room and helium temperatures was $R_{293°K}/R_{4.2°K}$ = 20. The resistance was measured by a potentiometer method using a cryostat to maintain the required temperature accurate to 0.2°K.

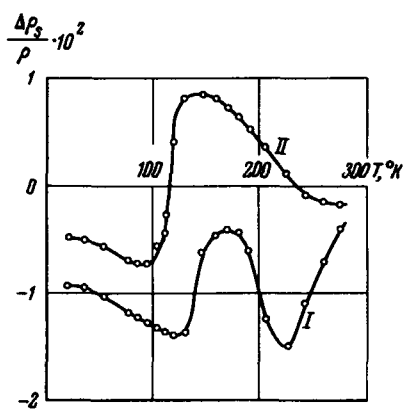

Fig. 1. Temperature dependence of the transverse magnetoresistance of single-crystal gadolinium for two magnetic field orientations: I - H ∥ [11$\bar{2}$0], II - H ∥ [0001].

The isotherms of the transverse magnetoresistance were measured in fields sufficient to produce saturation, and extrapolated to zero field in the sample, equal to $2\pi I_s$ (I_s = saturation magnetization), to exclude the resistance variations due to the paraprocess. The values of the saturation magnetization used to determine the demagnetizing field were taken from [4].

Figure 1 shows the measured temperature dependence

of the transverse saturation magnetoresistance $\Delta\rho_s/\rho$ for two orientations of the external magnetic field H, along the [0001] and [11$\bar{2}$0] axes. We see that $\Delta\rho_s/\rho$ has a complicated temperature variation. Curve I (H ∥ [11$\bar{2}$0]) has two nearly equal minima at 120 and 230°K. Curve II, corresponding to H ∥ [0001], shows that $\Delta\rho_s/\rho$ reverses sign at these temperatures. The latter is probably connected with the fact that the magnetic anisotropy constant K_1 has a maximum near 120°K and vanishes at 230°K [1-3].

The transverse magnetoresistance in the (10$\bar{1}$0) plane is strongly anisotropic. Figures 2 and 3 show some typical $\Delta\rho_s/\rho$ rotation diagrams. It is characteristic that $\Delta\rho_s/\rho$ above

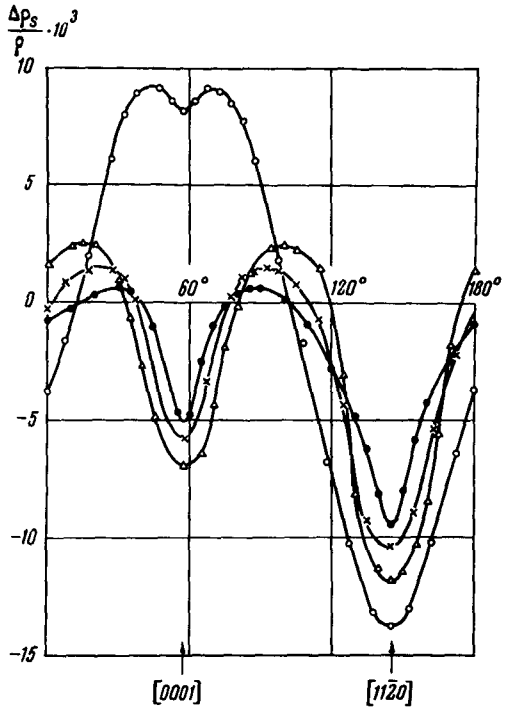

Fig. 2. Anisotropy of transverse magnetoresistance of single-crystal gadolinium in the temperature range 20.4 - 130°K. • - 20.4°K, × - 54°K, △ - 78°K, 0 - 130°K.

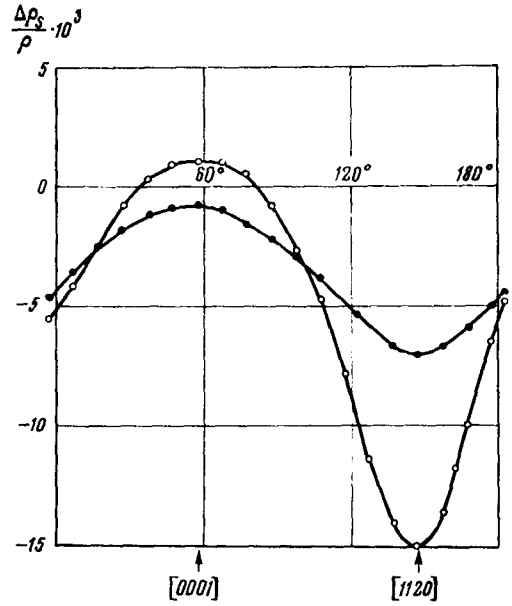

Fig. 3. Characteristic anisotropy curves of transverse magnetoresistance of single-crystal gadolinium in the temperature region 225 - 260°K. 0 - 225°K, • - 260°K.

250°K is negative in all directions, and its absolute value is minimal when the field is applied along [0001], which at these temperatures is the easy-magnetization axis. When the temperature drops to 225°K, the symmetry of the $\Delta\rho_s/\rho$ curves remains unchanged, i.e., it retains the form characteristic of uniaxial ferromagnets. We see from Fig. 3 that below 130°K the curves acquire two maxima symmetrical about [0001], the distances between which depend strongly on the temperature. The presence of these maxima is connected, in all probability, with the appearance of the "cone" of easy-magnetization axes.

We have thus observed in the single-crystal gadolinium a correlation between the temperature dependence of the galvanomagnetic effect and the magnetic structure.

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SELF-FOCUSING OF A LIGHT BEAM UPON EXCITATION OF THE ATOMS AND MOLECULES OF THE MEDIUM IN THE BEAM

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The increase in the refractive index of a medium in a powerful light beam causes self-focusing of the beam [1-3]. This increase can be connected with various processes, such as striction [1,2], heating [1,4], optic Kerr effect [3], hydrodynamic scattering [7], etc.

We note in this article that the vibrational, rotational, and electronic excitation of the molecules and atoms of the medium and disintegration of their associations under the influence of the light beam or processes accompanying it can contribute to the self-focusing of the beam.

Indeed, any excitation of the atom or the molecule makes their electronic structure more friable and increases their polarizability. Thus, for example, electronic excitation of a very simple atom to the n-th level increases its dimensions by n^2 times ($a_n \simeq n^2 a_1$) and its polarizability by n^6 times ($\kappa_n \sim e^2/m\omega_n^2 \sim a_n^3 \sim n^6\kappa_1$), making the change in the dielectric constant $\Delta\epsilon = \sum N_n(n^6 - 1)\kappa_1$, where N_n is the number of particles in the state n. Even when $n \simeq 2 - 3$ the polarizability can increase by a factor $\sim 10^2 - 10^3$, and even more for resonance levels (the resonance polarizability is $\kappa \simeq e^2/m[(\omega^2 - \omega_2^2)^2 + \gamma^2\omega^2]^{1/2} \to e^2/m\gamma\omega$ as $\omega \to \omega_r$).

When rotational and vibrational motions are excited in the molecule, the increase in its optical polarizability is smaller in magnitude (since the electron shells of the atom are squeezed less when their mutual attraction decreases), but this can result in a noticeable change in the dielectric constant, in view of the larger fraction of the molecules which are excited in this manner. The disintegration of molecule associations can also increase the polarizability of the medium.

It must be noted that these processes can occur not only when the medium is heated, but also when the probability of excitation by the temperature rise ($\Delta N_n^T \simeq N_n \mathcal{E}_n \Delta T/kT^2$) is much smaller than the probability of direct optical excitation, and certainly in the case when the excitation relaxation time is much longer than the duration of the light pulse, as is frequently the case in gases. Self-focusing by heating, for media with $d\epsilon/dT > 0$ was considered re-