gion that can be regarded as the region of the "static skin effect." Figure 1 shows typical plots obtained for F.

b) Plates. According to [3], a drop in resistance should be observed for P in a magnetic field, up to values $r \approx \lambda_\infty^2/d$. Further, up to fields $r \approx d$, the resistance should increase like $A_1 + B/(c - \ln H)$, after which the resistance anisotropy connected with the Fermi-surface topology comes into play.

If we regard the region of the magnetic field up to values $r \approx \lambda_\infty^2/d$ (several Oe), the measurements for P agree qualitatively with the conclusions of [3], although the value of r is not well known for zinc.

There are no essential differences between the $\rho(H)$ plots for P and F.

4. According to [3], in the case of F an increase of the longitudinal magnetic field leads to a gradual drop of the resistance. In fields for which $r \approx d$, it reaches the value $\rho_{\infty;H}$ typical of the bulky sample. For P (excluding the region up to $r \approx \lambda_\infty^2/d$), the resistance will increase, reach a maximum at $r \approx \sqrt{\lambda_\infty d} = 1/H_{max}$, and then start to drop to the value $\rho_{\infty;H}$ reached in strong fields ($r < d$). Figure 2 shows two typical experimental curves for a filamentary whisker and a plate of equal thickness. We see that both for F and P the resistance first increases sharply, reaches a maximum, and then drops. This behavior is qualitatively similar to the picture described in [3] only for P. The value of H_{max} depends lineary on d^{-1}, and not on $d^{-1/2}$ as in [3]. $H_{max}d \approx 1.5$ cm-Oe for P. A similar variation is observed also in F, for which $H_{max}d \approx 3.8$ cm-Oe. It is impossible to relate these quantities with any particular large group of electrons, owing to the extreme complexity of the Fermi surface of zinc. They correspond more likely to a certain average over all parts of the Fermi surface. We note also that the observed behavior of the longitudinal magnetoresistance is connected almost fully with the size effect, since the role of the volume magnetoresistance is negligible when $\lambda_\infty \gg d$. This is experimentally manifest, in particular, in the fact that the thinner the sample the larger the specific magnetoresistance. This is most clearly pronounced in F, for which the increment of the resistance in the field is approximately proportional to d^{-1}.

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ANISOTROPY OF THE FARADAY EFFECT IN IRON GARNETS

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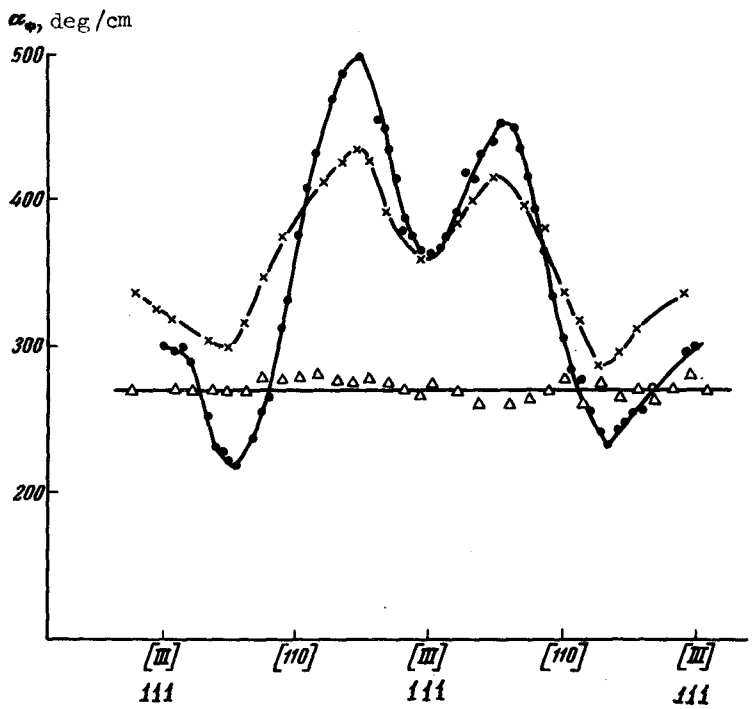
The Faraday effect in transparent ferromagnets in the visible and infrared regions of the spectrum and in a broad temperature interval has been the subject of a large number of

investigations [1-4]. The anisotropy of the resonant properties of yttrium iron garnets with small amounts of Tb added was investigated at helium temperatures in [5] and was attributed to the presence of almost-intersecting energy levels of the Tb^{3+} ions. In the present investigation we observed anisotropy of the Faraday effect in a wide interval of the infrared region of the spectrum in $Tb_3Fe_5O_{12}$ at room temperature. The radiation sources were He-Ne lasers operating at wavelengths 1.15 and 3.39 μ, and an IKS-21 spectrometer at 5.2 μ.

The investigations were made in magnetic fields up to 16 kOe. The dependence of the Faraday effect on the direction of the magnetizing field in a $Tb_3Fe_5O_{12}$ plate 1.5 mm thick, cut in the (211) plane, is shown in the figure for two values of the magnetizing field, 6 and 16 kOe. It is seen from this figure that the Faraday effect in $Tb_3Fe_5O_{12}$ at 1.15 μ and at room temperature is highly anisotropic. An investigation of the Faraday effect in $Y_3Fe_5O_{12}$ at room temperature has shown that, within the limits of experimental accuracy, this effect is isotropic. The anisotropy of the Faraday effect in $Tb_3Fe_5O_{12}$ is apparently connected with the anisotropy of the Fe^{3+} - Tb^{3+} exchange interaction or with the anisotropy of the spin-orbit splitting of the levels of the Tb^{3+} ions. The anisotropy of the exchange splitting in $Yb_3Fe_5O_{12}$ was observed at 77°K [6] in the $^2F_{7/2} \rightarrow {}^2F_{5/2}$ absorption band in the region of $\lambda = 1$ μ. The anisotropy of the fine structure of the absorption band $^7F_0 \rightarrow {}^7F_4$ of the Eu^{3+} ion in $Eu_3Fe_5O_{12}$ was investigated [7]. In our case we deal apparently with the



Faraday effect (α_F, deg/cm) in $Tb_3Fe_5O_{12}$ and in $Y_3Fe_5O_{12}$ at wavelength 1.15 μ vs. the orientation in the (211) plane, ●●● - $Tb_3Fe_5O_{12}$, H = 6 kOe; ××× - $Tb_3Fe_5O_{12}$, H = 16 kOe; △△△ - $Y_3Fe_5O_{12}$, H = 6 kOe.

anisotropy of the exchange or spin-orbit splitting of the optical transitions in the Tb^{3+} ion in the visible and ultraviolet regions of the spectrum, which make the main contribution to α_F in $Tb_3Fe_5O_{12}$. A very appreciable anisotropy of the Faraday effect, having the same symmetry as shown in the figure, was observed by us also at wavelengths 3.39 and 5.2 μ. In the latter case, however, the obtained angular resolution was poorer. The per-unit rotation of the plane of polarization in ferrimagnets with two magnetic sublattices can be written in the form [8]

$$\alpha_F = \frac{2\pi\sqrt{\epsilon}}{c}(\gamma_1 I_1 - \gamma_2 I_2) + A(\omega) + B(\omega).$$

The first term is the frequency-independent rotation determined by the off-diagonal component of the magnetic-permeability tensor at the optical frequencies, γ_1, γ_2, I_1, and I_2 are the gyromagnetic ratios and the magnetizations of the iron and rare-earth sublattices, $A(\omega)$ and $B(\omega)$ are the frequency-dependent contributions to α_F from the Fe^{3+} and Tb^{3+} sublattices, respectively. The Faraday effect in $Y_3Fe_5O_{12}$ is isotropic (see the figure), so that $A(\omega)$ can also be assumed isotropic. The contribution made to α_F by the frequency-dependent term is about 300 deg/cm for $Tb_3Fe_5O_{12}$ at 300°K. The contribution to the anisotropy at the 1.15 μ wavelength is therefore due to the term $B(\omega)$. If the Faraday effect is connected with the exchange splitting of the levels of the Tb^{3+} ion, then it is possible to obtain from the angular dependence of $B(\omega)$ the anisotropy of the product of the tensors g and G which enter in the Hamiltonian of the system [6,9].

An investigation of α_F in the region $\lambda > 6.5$ μ, where the contribution of $A(\omega) + B(\omega)$ to the rotation of the polarization plane becomes vanishingly small, makes it possible to determine the anisotropy of the g-factor of the Tb^{3+} ion and to explain its difference from the g-factor of the free ion. From α_F at $\lambda = 1.15$ μ it is possible to determine the tensor G. If the frequency-dependent Faraday effect in $Tb_3Fe_5O_{12}$ is due to spin-orbit splitting, then the interpretation of the results calls for the construction of the theory of the Faraday effect in rare-earth garnets, inasmuch as at present there exists only a theory for $Y_3Fe_5O_{12}$ [10]. The anisotropy of α_F at the 1.15 μ wavelength was observed by us at room temperature also in $Sm_3Fe_5O_{12}$.

It is seen from the figure that $d\alpha_F/dH$ is negative at the points with the largest α_F and equals 5 deg/kOe, and $d\alpha_F/dH > 0$ at the points with the smallest α_F. We have thus shown that in the region $\lambda = 1.15$ μ, $d\alpha_F/dH$ in $Tb_3Fe_5O_{12}$ can be either negative, as was observed in $Tb_3Fe_5O_{12}$ [11], or positive. The decrease of α_F with increasing H in $Y_3Fe_5O_{12}$ at $\lambda = 6328$ Å [12] and in the near infrared [13], as well as the results of investigating α_F as a function of H in $Tb_3Fe_5O_{12}$, may perhaps be attributed to the absorption-edge shift considered by Callen [14].

It is of interest to extend the frequency and temperature intervals in which the anisotropy of α_F is investigated. In the low temperature region, the effective Hamiltonian of the rare-earth ions contains a smaller number of parameters, and important factor when it comes to an interpretation of the results.

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EXPERIMENTAL DETERMINATION OF THE "SIGN" OF THE DZYALOSHINSKII INTERACTION IN AN ANTIFERROMAGNET

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In a two-lattice antiferromagnet (AF) with an AF-structure that is even relative to the principal axis, the expression for the energy of the Dzyaloshinskii interaction (DI) is

$$\mathcal{E}_D = -\vec{\beta}\cdot\vec{m} \times \vec{l} = 2\vec{\beta}\cdot\vec{S}_1 \times \vec{S}_2. \quad (1)$$

Here $\vec{m} \equiv \vec{S}_1 + \vec{S}_2$ and $\vec{l} \equiv \vec{S}_1 - \vec{S}_2$ are respectively the ferro- and antiferromagnetic vectors, $\vec{S}_1$ and $\vec{S}_2$ are the spins of the neighboring ions belonging to different magnetic sublattices of the AF, and $\vec{\beta}$ is a constant vectors whose components characterize the magnitude of the DI. The expression for $\mathcal{E}_D$ should be invariant against an operation (which we shall designate by the letter N) consisting of renumbering the sublattices ($1 \rightleftarrows 2$). But $N\vec{l} = -\vec{l}$, and therefore when the sublattices are renumberd the sign of $\vec{\beta}$ is also reversed: $N\vec{\beta} = -\vec{\beta}$ (this also follows from the microscopic equation derived for $\mathcal{E}_D$ by Moria [2]. It follows therefore that the scalar product $\vec{\beta}\cdot\vec{l}$ is invariant against the operation N, and therefore, in particular, its sign should have a definite physical meaning. We shall demonstrate this, using as an example the most popular AF, hematite (α-Fe_2O_3). By virtue of the known symmetry of the crystal (D^6_{3d}) the vector $\vec{\beta}$ is directed along the C_3 axis [2], i.e., if $z \parallel C_3$, then $\vec{\beta} = (0, 0, \beta)$. Let us consider the easy-axis temperature phase of hematite (at $T < T_M \approx 262°K$), since in this phase we have in the absence of an external magnetic field $l \parallel C_3$ and therefore $\vec{\beta}\cdot\vec{l} \neq 0$. If we apply an external magnetic field $\vec{H}$ in the direction of the axis $x \perp C_3$ then, as shown in [3, 4], an increase in the field causes not only an increase in the inclination of the moments of the sublattices to the field, but also a rotation of the moments around the field direction. The direction of the rotation is uniquely connected with $\text{sign}(\vec{\beta}\cdot\vec{l})$, namely, the equilibrium vector $\vec{l}$ is rotated from the z axis counterclockwise (looking in the negative direction of $\vec{H}$) if $\text{sign}(\vec{\beta}\cdot\vec{l}) = -1$, and clockwise in the opposite case. This follows from the fact that in