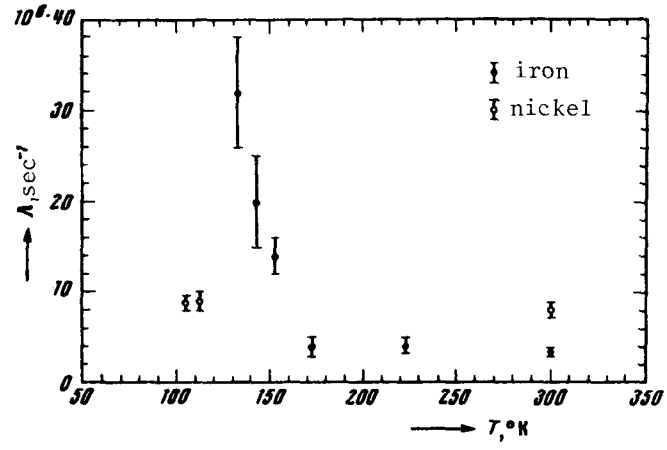
zation of the muon with increasing temperature was indeed observed in magnetized iron.

The experiment was performed with the beam of polarized μ^+ mesons of the JINR synchrocyclotron (Dubna). The figure shows the attenuation rates λ_{Fe} and λ_{Ni} of the muon precession amplitudes in magnetized samples of iron and nickel. The samples were flats ellipsoids of revolution of 60 mm diameter and maximum thickness 10 mm. The external field H = 750 Oe was parallel to the major axis of the ellipsoid. It is seen from the figure that at T < 170°K the attenuation rate λ_{Fe} in iron increases rapidly with decreasing temperature, while λ_{Ni} remains constant in the temperature range T = 100 - 300°K.



Temperature dependence of the damping rate λ of positive-muon spin-precession amplitude in magnetized iron and nickel sample. $\lambda = 1/t_e$, where t_e is the time required for the amplitude to decrease by a factor e.

The independence of λ_{Ni} of the temperature can be explained by assuming that the μ^+ meson, like hydrogen [1] is in the center of the unit cell, which is a face-centered cube in the case of nickel. It is easy to show that in the center of such a cell (in the octapore) the magnetic field produced by the symmetrically disposed magnetized nickel atoms is equal to zero. The diffusion of the muons therefore does not affect the rate of relaxation of their spins in nickel. In the iron unic cell (body-centered cube), the dipole magnetic fields produced by the magnetized iron atoms amount to several kilogauss in both the octapore and the tetrapore. It is therefore intuitively clear that the decrease of the muon diffusion rate in iron with decreasing temperature causes the muon spin relaxation rate to increase.

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SINGULARITIES OF MAGNETO-OPTICAL EFFECTS IN INHOMOGENEOUSLY MAGNETIZED MEDIA

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An anomaly of the magneto-optical effect was observed following the reversal of the magnetization of single-crystal iron borate crystals. This anomaly is attributed to the onset of an inhomogeneous magnetic structure that contributes to the increase of the magneto-optical rotation

This paper deals with singularities in the propagation of electromagnetic waves in a transparent magnetically-ordered medium with inhomogeneous magnetization.

We chose for the investigations iron borate $FeBO_3$, which has high transparency in visible light and magnetic anisotropy of the easy-plane type. The investigated samples were single-crystal plates measuring 3 x 5 x 0.05 mm, the large surface being perpendicular to the principal axis of the crystal.

Reversal of the magnetization of weak ferromagnets with easy-plane anisotropy can give rise to a regular magnetic structure with periodicity along an axis perpendicular to the easy plane of magnetization [2]. A number of experiments have shown that a layered domain structure similar to that predicted in [2] is observed in local sections of the indicated samples during

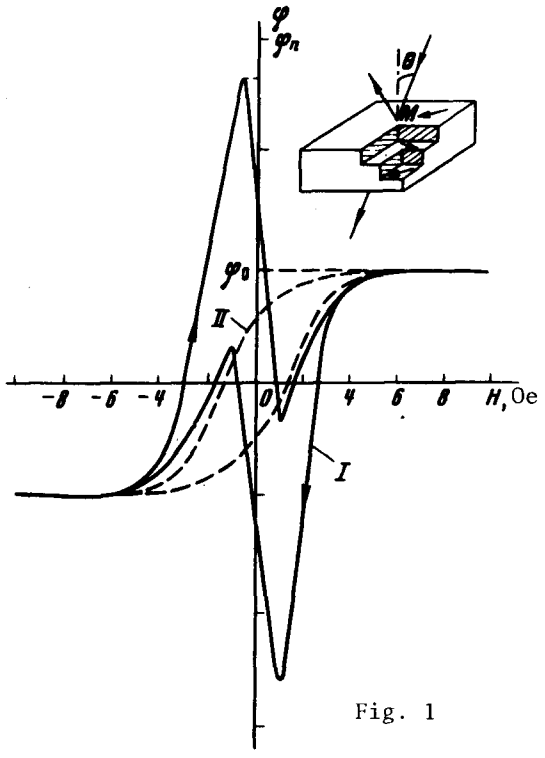

Fig. 1

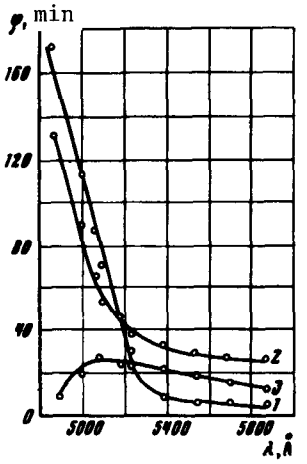

Fig. 2

Fig. 1. Dependence of the rotation of the polarization plane on the applied field H: 1 - sample in which a domain structure is observed, 2 - ordinary magnetization curve.

Fig. 2. Dispersion curves of polarization-plane rotation for different magnetic states of the sample: 1, 2 - $H \leq H_c$, 3 - H exceeds the saturation field.

the magnetization reversal. Figure 1 shows schematically the produced layer structure.

The polarization-plane rotation in this medium was investigated with the aid of the Faraday effect, and the angle of incidence of the linearly-polarized light was 45°. This figure shows also the amplitude of the magneto-optical effect (ϕ) as a function of the field applied parallel to the surface of the plate. Curve I was obtained from a section of 100 μ diameter, in which a layered domain structure along the sample thickness was observed. Curve II shows the rotation of the magnetization plane following reversal of magnetization of samples in which no inhomogeneous magnetic-moment configuration is produced along the sample thickness[1]. When the saturating field decreases to values corresponding to the appearance of inhomogeneity of the magnetization in the investigated section,, the value of the magneto-optical effect (ϕ_n) does not decrease as under ordinary conditions, but increases in comparison with its value (ϕ_0) in the saturated state. The anomalous character of the magneto-optical effect allows us to state that the magnetic inhomogeneity has singular optical properties.

The theory of the optical properties of a transparent magnetically-ordered medium with a regular domain structure, for light propagating normally to the magnetic moment, has been developed in [3]. Experiment has shown, however, that a decrease in the incidence angle decreases the value of the anomaly, and there is no anomaly at $\theta = 0$. We can therefore conclude that even magneto-optical effects [3] play a negligible role in the phenomenon described above. To exclude the magnetic linear dichroism, which can cause an additional rotation of the polarization plane, the sample was mounted normal to the light beam and was saturated in succession in two mutually perpendicular directions, both inclined 45° to the polarization plane. Under these conditions, no change was observed in the intensity of the light passing through the analyzer. It follows from these experiments that the anomalous increase of the polarization-plane rotation is due to the linear magneto-optical effect, i.e., to the off-diagonal component of the dielectric tensor.

When a magnetically-hard metallic film (FeNiCo, $H_c \sim 10$ Oe) is sputtered on one of the surfaces of the iron-borate plate, the dimensions of the sections in which the anomalous effect is observed increase, as does the magnitude of this effect. We analyzed the resultant light, which was a superposition of the reflections from the iron-borate surface and the crystal-film interface. The Kerr rotation of the film was measured with the sample heated above the Curie temperature of $FeBO_3$ ($T_C = 348°K$), and turned out to be a negligibly small quantity under these conditions, making thus no contribution to the increase of the anomaly. It can be assumed that

the role of the magnetically-hard film reduces to a change in the perfection of the $FeBO_3$ periodic structure, which leads to a considerable increase of the anomalous effect.

The dependence of the polarization-plane rotation on the incident-light wavelength was measured in the samples with the sputtered magnetic films. Figure 2 shows the dispersion rotation curve at different magnetization states. Curves 1, 2, and 3 correspond to magnetic fields 0, 1, and 8 Oe applied in the plane of the sample. As seen from the figure, the rotation in the bule part of the spectrum decreases for the saturated states, and increases in fields corresponding to the presence of a regular domain structure along the sample thickness. The apparent reason is that in the latter case the wavelength of the propagating radiation comes close to the inhomogeneity period or to its multiple.

We note that the presence of a regular inhomogeneity in anisotropic media, and in particular a helical configuration of dipole electric moments in cholesteric liquid crystals, gives rise to an anomaly in their optical properties [4].

In conclusion, the authors thank A. S. Borovik-Romanov and E. I. Kats for useful discussions, and V. N. Seleznev for supplying the single crystals.

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[1] It should be noted that the magnetization-reversal curve obtained by an inductive method for samples in which anomalies of the magneto-optic effect occur is of similar form.

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PREPARATION, SUPERCONDUCTING PROPERTIES, AND STRUCTURE OF TECHNETIUM FILMS

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Technetium films were obtained by the ion sputtering method. The dependence of the critical temperature, resistance, and structure of the film samples on their thickness was investigated. For films of thickness d < 150 Å we observed a new modification, stable at room temperature and having an FCC structure with lattice parameter $a_0 = 3.68 \pm 0.05$ Å.

An ultrahigh-vacuum installation for ion sputtering (Fig. 1) was used to produce polycrystalline technetium films of thickness from 17 to 1600 Å, which were coated for protection with a synthetic-diamond film 40 Å thick [1]. The installation was outgassed for 10 hours at 250°C, after which the ion sputtering was performed at liquid-nitrogen temperature and at the following partial pressures: krypton 5×10^{-6} Torr; hydrogen $<10^{9}$ Torr; nitrogen, oxygen, and water $<10^{-10}$ Torr.

The films were deposited on glass substrates with four platinum leads. Sodium-chloride substrates were used for the structure investigations. Eight pairs of technetium samples of varying thickness were prepared simultaneously. After the end of the sputtering, the samples were heated to room temperature and transferred to a helium cryostat.

We investigated the dependence of the critical temperature of the technetium films on their thickness. The temperature of the superconducting transition ranged from 7.70°K for the tickest films, d > 150 Å (which practically coincides with T_c of bulky pure technetium, viz., 80°K [2]), to 4.90°K for a film of thickness d = 50 Å.

Figure 2 shows a plot of $T_c = f(d)$. It is nonmonotonic and has a discontinuity in the 100 - 150 Å region. At the same thicknesses there is also a jump on the plot of $R_n(d)$, where R_n is the resistance of the sample above the transition temperature.

This behavior of the superconducting-transition temperature and of the resistance of the technetium films can attributed to the presence of a polymorphic transformation in the thickness range 100 - 150 Å. This is confirmed by electron-diffraction and electron-microscope studies. Figure 3 shows electron micrographs and electron-diffraction patterns of techetium samples with