destruction (using the expression for H_{c2}, we have $N \sim 0.4e/\xi$).

4. It should be noted that the behavior of some of the bridges prepared in this manner differed from that described here. Namely, the Josephson current steps were not observed, and at the same time I_c increased somewhat ($\lesssim 10°$) under the influence of the microwave field. In addition, the values of I_c for the same bridges were as a rule larger than theoretical. These results can be qualitatively explained by assuming that in these cases the inevitably present inhomogeneities of the bridge film result in such a disposition of the weak sections[2], that the vortex moves through a "channel" that passes mainly through them. Then the remaining sections of the bridge play actually the role of "shores," i.e., the effective length of the bridge decreases and I_c should increase. In the region of the dynamically mixed state, the currents then become larger than the pairing current of the weak sections and cause a practically complete destruction of the superconductivity in the "channel." In this case, naturally, there are no Josephson current steps. Nor is it surprising that a microwave-enhanced superconductivity appears under these conditions, since this effect is observed in bridges with length on the order of ξ [5].

5. Thus, the present results give grounds for assuming that coherent motion of vortices is realized in sufficiently homogeneous superconducting bridges with dimensions much larger than ξ even in the absence of the ordering action of magnetic and microwave fields. In all probability, direct observation of Josephson generation from such bridges is possible.

[1] It is recognized here that I_c is in fact π times larger than that given by formula (5) of [3].

[2] That is to say, regions of local minima of the self energy of the vortex.

[1] P. Anderson and A. Dayem, Phys. Rev. Lett. 13, 195 (1964).
[2] A. T. Fiory, Phys. Rev. Lett. 27, 501 (1971).
[3] K. K. Likharev, Zh. Eksp. Teor. Fiz. 61, 1700 (1971) [Sov. Phys.-JETP 34, 906 (1971)].
[4] V. N. Gubankov, K. K. Likharev, and N. N. Margolin, Fiz. Tverd. Tela 14, 953 (1972) [Sov. Phys.-Solid State 14, 819 (1972)].
[5] A. F. G. Wyatt, V. M. Dmitriev, W. S. Moore, and F. S. Sheard, Phys. Rev. Lett. 16, 1166 (1966); A. Dayem and I. Wiegand, Phys. Rev. 155, 419 (1967).

NONCOLLINEAR MAGNETIC STRUCTURE OF RARE-EARTH METALS AND ANOMALOUS HALL EFFECT

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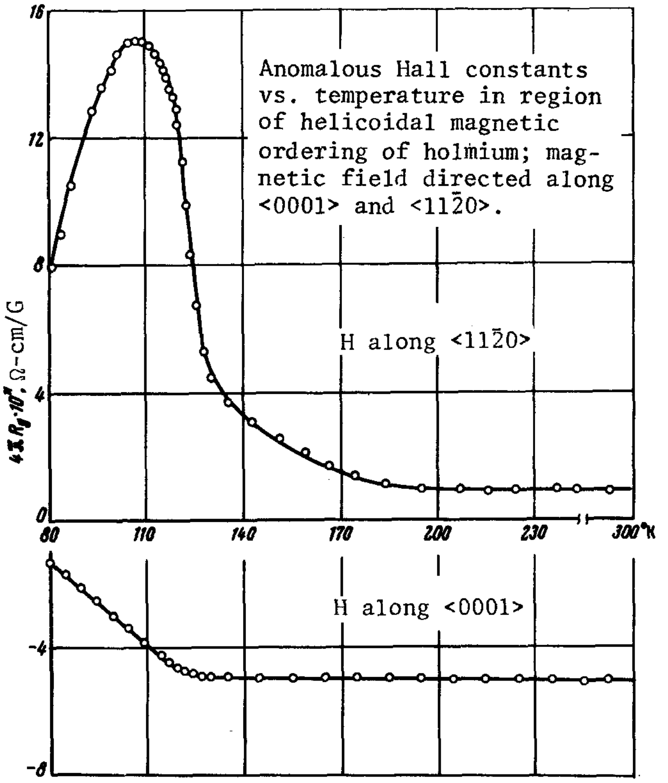
The temperature dependences of the anomalous Hall constants in holmium single crystals in the region of helicoidal magnetic ordering have been obtained for the first time.

In heavy rare earth metals (REM), an essential feature of the conduction-electron scattering mechanisms in comparison with d-metals, besides sharp localization of 4-f electrons and large magnetic-anisotropy energy, is the presence of a complicated noncollinear magnetic structure below the Neel temperature T_N. In all the experiments performed to date on the Hall effect in REM with noncollinear magnetic structure, only the spontaneous Hall resistance was measured in strong magnetic fields close to the saturation field, when the noncollinear magnetic structure was in essence completely destroyed by the effective magnetic field. Undisputed interest attaches, however, to the regularities observed by us, for the first time, of the anomalous Hall effect in the region where a noncollinear magnetic structure exists; the presence of this structure, as is well known, leads to qualitative changes in the energy spectrum of the REM conduction electrons. We present here the results of an investigation of the Hall effect in single-crystal holmium samples with the magnetic field directed along <0001> and <11$\bar{2}$0>. The vector of the primary current density was directed in both cases along the <10$\bar{1}$0> axis. By measuring the magnetic susceptibilities of the same samples, we determined the anomalous Hall constant in the region of existence of the helicoidal magnetic structure, which we designated R_g (to distinguish it from R_s, which is observed in magnetic fields stronger than critical).



Anomalous Hall constants vs. temperature in region of helicoidal magnetic ordering of holmium; magnetic field directed along <0001> and <11$\bar{2}$0>.

The figure shows the temperature dependences of the aforementioned constants near the Neel temperature $T_N = 125°K$. It is seen that the helicoidal magnetic structure of the holmium, which leads in accord with the theory to the appearance of new Brillouin-zone boundaries and to the distortion of the Fermi surface, becomes strongly manifest in the temperature dependence of the Hall constants. The constant R_g(H along <0001>) varies linearly with the temperature in the helicoidal region near T_N, and is independent of the temperature in the paramagnetic region. The regularity observed for R_g shows unequivocally that this constant is determined by the scattering of the conduction electrons by inhomogeneities of the spin system, a scattering that does not depend on the temperature above T_N and decreases in proportion to $(T_N - T)$ below T_N. Thus, the constant R_g(H along <0001>) is described in the helicoidal region by the relation $R_g = (R_g)_{T>T_N} + C(T_N - T)$, where C is a constant independent of the temperature $(C > 0)$, $(R_g)_{T>T_N} < 0$.

A more complicated temperature dependence is observed for the helicoidal Hall constant R_g when the magnetic field is directed along <11$\bar{2}$0>. In the paramagnetic temperature region, R_g is independent of the temperature, just as in the case when H is directed along <0001>. However, if a magnetic superstructure exists in holmium below T_N then an essential singularity is observed in the temperature dependence of R_g(H along <11$\bar{2}$0>), connected with the sharp growth of this constant near T_N. It might seem that the constant R_g(H along 11$\bar{2}$0) should decrease as a result of the decrease in the scattering by the spin inhomogeneities below T_N, just as in the case of R_g(H along <0001>). The observed growth of R_g(H along <11$\bar{2}$0>) is due to the presence of energy gaps in the conduction-electron spectrum. These gaps lead to an anomalous increase of the magnetic component of the electric resistance, and by the same token to an anomalous increase of the Hall resistance in this direction.

Thus, the helicoidal magnetic structure of holmium, which leads to the appearance of new Brillouin-zone boundaries and to deformation of the Fermi surface, is indeed strongly manifest in the temperature dependence of the helicoidal Hall constants.

JUMPS OF THE RADIOELECTRIC CURRENT IN BISMUTH

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A jump was seen to appear on the oscillogram of the radioelectric effect in bismuth (4.2°K) in the presence of a constant magnetic field when the threshold value of the microwave power was reached.

Much attention is being paid presently to theoretical investigations [1 - 4] of the contributions of various nonlinearity mechanisms to the radioelectric effect (REE)1). We have attempted to study the time evolution of the REE in single-crystal bismuth at 4.2° in the presence of a constant magnetic field (H_0). Unlike experiments carried out in the stationary regime [5, 6], we used a pulse technique (τ_p = 2 - 10 μsec). This enabled us to increase appreciably the power P (in the pulse) without causing an average temperature rise.