to the larger amplitude of the zero-point oscillations, and this likewise leads to a decrease of Δ.

For the 0.25% solution, the temperature dependence of D has a similar character, but the region of vacancion diffusion is much narrower, so that it is impossible to determine reliably the characteristic parameters Δ and D_0.

We note further that the inverse proportionality of D and x, which is characteristic of impuriton diffusion and has been observed earlier near the melting curve [1, 2], takes place at low temperatures, according to our experiments also for V = 20.7 cm^3/mole.

It should be noted in conclusion that curve 1 of the figure makes it possible, for the first time, to trace the continuous transition from vacancion diffusion to impuriton diffusion.

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COHERENT MOTION OF VORTICES IN SUPERCONDUCTING BRIDGES OF LARGE DIMENSIONS

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Experimental proof is presented that coherent vortex motion can be realized in superconducting film bridges "of variable thickness" in the absence of the ordering action of magnetic and microwave fields even if the bridge dimensions greatly exceed the coherence length.

1. It is known that coherent motion of vortices in superconducting film bridges (constellations) having dimensions much greater than the coherence length ξ(T) can be realized by synchronizing their motion with an external microwave field [1]. This synchronization is facilitated by imposing a constant magnetic field normal to the plane of the bridge [2].

Coherent motion of vortices in an autonomous bridge is revealed by the appearance of Josephson current steps on its current-voltage characteristic following of application of a weak (probing) microwave signal. The signal is regarded as small if no changes occur in the other sections of the current-voltage characteristic, say the critical current I_c. We have observed this effect in tin bridges of "variable" thickness, in which the thickness d of the film making up the bridge is much less than the thickness d_0 of the "shore" films.

2. The bridges were rectangular in shape and their characteristic dimensions were the dimension along the transport current, $\ell \simeq 6 - 7\ \mu$, and the width, $w \simeq 30\ \mu$. The bridges were produced in two stages. Thick films ($d_0 \simeq 2000$ Å, square resistance $(R_\square)_{4.2°K} \simeq 10^{-1}$ ohm) were first evaporated on a substrate of optically polished crystalling quartz. A quartz thread

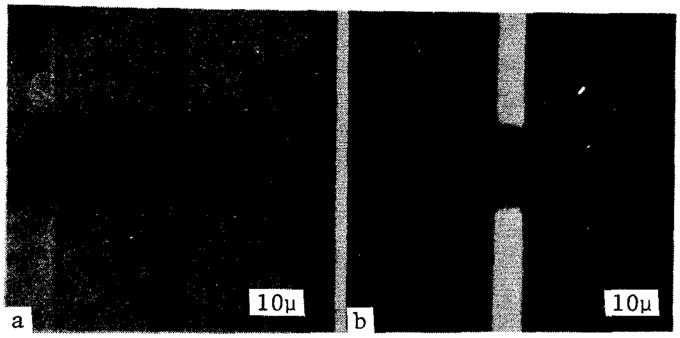

Fig. 1. Microphotograph of typical bridge in reflected light (a) and transmitted light (b).

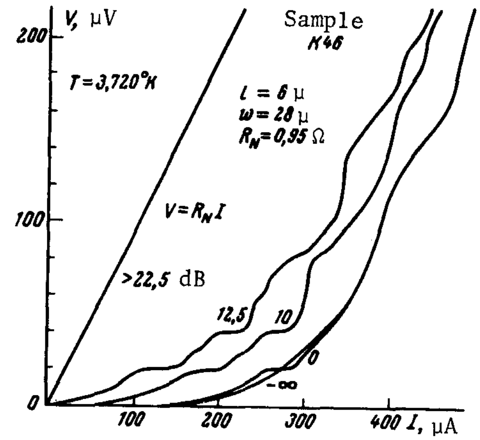

Fig. 2. Family of current-voltage characteristic at different levels of the incident microwave power (frequency 9.86 GHz).

served as a screen and its diameter determined the future length of the bridge. The thread was then removed and a mask with a slit of width w was installed. The thin film of the bridge (d ∿ 50 - 100 Å, $(R_{\square})_{4.2°K} \simeq 2 - 10$ ohm) was then evaporated through the slit. A photograph of one of the bridges prepared by this method is shown in Fig. 1.

3. Figure 2 shows the effect of microwave radiation (wavelength 3 cm) on the current-voltage characteristic of one of the bridges. It is seen that when the signal is weak the first Josephson current step is symmetrical relative to the current-voltage characteristic of the autonomous bridge. This, as is well known, is typical of all coherent Josephson systems.

As shown in [3], the possibility of realizing coherent vortex motion in bridges of "variable" thickness is connected with the clear-cut localization of the vortex motion region. The vortex moving in such a bridge is effectively repelled from its positive images in the shores. Therefore, if the electrodynamic dimension of the vortex (of the order of the characteristic depth $\delta_{\perp}$ of penetration of the normal magnetic field into the film) exceeds ℓ, and if in addition $w \gtrsim \ell$, then with increasing current the first vortices move in a single row, and at sufficiently small film inhomogeneities it is coherent.

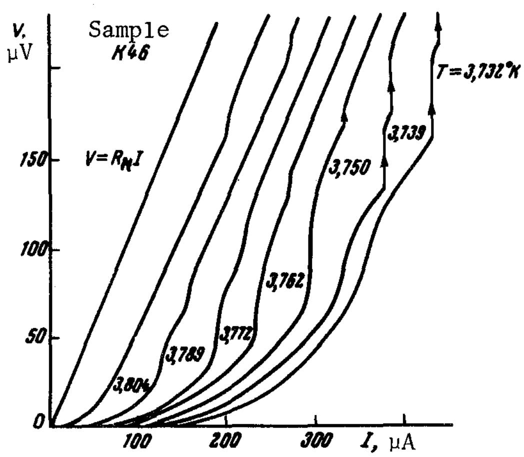

Fig. 3. Family of current-voltage characteristics at different temperatures. The decreasing sections at relatively low values of T are due to the non-isothermal character of the current-voltage characteristics.

The fact that the destruction of the Meissner state of the bridge by the transport current proceeds via formation of a single moving row of vortices is confirmed also by the agreement between the experimental values of I_c at temperatures T close to the critical temperature T_c and the values calculated in [3]. For example, for sample K46 in the range 5×10^{-2}°K $\lesssim (T_c - T) \lesssim 2\ 10^{-2}$°K, in which the theoretically proposed [3] inequalities $\xi \ll \ell \ll w \ll \delta_{\perp}$ were satisfied, the critical current was $I_c \sim (T_c - T)$, and $|dI_c/dT| = (2.0 \pm 0.1)$ mA/°K, whereas theory yields $|dI_c/dT| = (2.1 \pm 0.2)$ mA/°K [1].

With increasing current through the bridge, the second and next rows of vortices can be produced. This should lead to periodic variations of the differential resistance R_g with increasing current. This effect was observed for all bridges (see, e.g., Fig. 2, and also Fig. 3, which shows the variation of the shape of the current-voltage characteristics with changing temperature). The number of oscillations of R_g prior to reaching the asymptotic straight line with $R_g = R_n$ is approximately equal to the maximum number N of vortex rows, calculated from the condition of superconductivity 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.

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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).