[1 - 3]) agrees qualitatively with the predictions of the theory. Indeed, the number of peaks on the distribution function increases with increasing plasma density. Processing of the delay curves that correspond to a sufficiently large smearing of the distribution function yields, as a rule, a "shelf" in the vicinity of v_0, where one can most readily expect a manifestation of the Coulomb collisions that cause diffusion in velocity space and smoothing of the peaks on the distribution function [3].

If the time constant of the recording apparatus in the same system is large ($\tau \simeq 10$ msec), smoothing of the distribution function is observed, with formation of a plateau in the regimes where the most intense HF oscillations are excited.

It should be noted that the distribution functions have different structures for one and the same regime and for a constant total width of the spectrum. As indicated above, this is obviously connected with the nonstationary time behavior of the plasma-beam discharge. The "instantaneous" form of the distribution function does not coincide with its average form, and has a more complicated structure that varies in time. Analogously, the instantaneous spectra of the excited oscillations contain discrete narrow frequency bands, and the averaged spectra have a uniform structure in a broad frequency band [4].

Thus, a velocity analysis of the electron-beam distribution function has revealed the formation of a multiple-peaked electron distribution upon relaxation of the electron beam in the plasma, confirming the prediction of the nonlinear theory, namely that individual electron bunches ("marcoparticles") are produced in velocity space as a result of capture of the beam electrons by the field of the excited wave.

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STUDY OF TWO-DIMENSIONAL MIXED STATE OF TYPE-I SUPERCONDUCTORS

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As already reported [1], when the superconductivity of a hollow cylindrical sample is destroyed by current flowing through it, a thin layer of the "mixed" state predicted by L.D. Landau is produced in its surface; the current flowing in this state has a density greatly exceeding the current density in the normal phase of the sample. In the experiments described below we realized conditions under which a cylindrical layer of such a state could be produced not only on the inner or outer surface of the cylindrical sample, but also inside the sample at an arbitrary distance from the axis. Inasmuch as the mixed state of a type-I superconductor apparently always takes the form of thin layers, we shall use here the term "two-dimensional mixed state" (t.m. state), to distinguish it from the mixed state of a type-II superconductor.

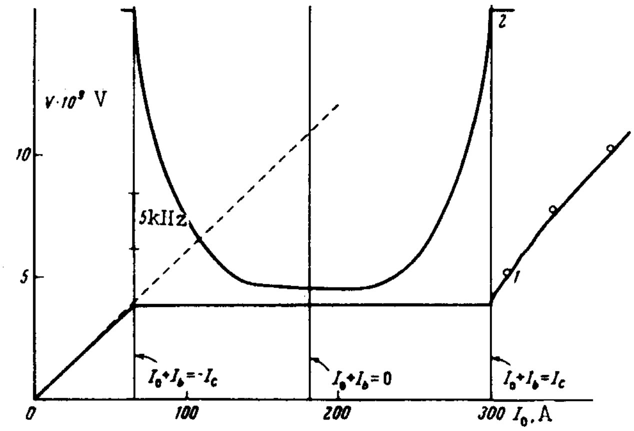

Fig. 1

The sample was a hollow single-crystal cylinder with diameters d_1 = 6.1 mm and d_2 = 7.7 mm and length 55 mm, cast of indium with $\rho_{300°}/\rho_{3.4°} = 2.2 \times 10^4$. The tetragonal axis of the crystal was parallel to the cylinder axis. A lead wire of 4.5 mm diameter was placed in the cavity of the sample and was made to carry a constant current I_b from a superconducting transformer. The current I_0 in the sample was excited, as in [1], by a superconducting generator. All the current leads near the sample were axially symmetrical. Toroidal magnetic-field pickups with permalloy cores [2] were used to measure the currents. The voltage drop across the sample was determined at different values of I_0 and I_b, using a superconducting modulator for this purpose. In addition, coils of copper wire of 20-μ diameter, in the form of flat single-layer spirals measuring 5 × 2 mm, were placed flush against the inside and outside surfaces of the samples and served to reveal the change of the sample surface impedance at frequencies on the order of 10^6 Hz upon occurrence of the t.m. state on the sample surface (what was measured was the change of the signal frequency of the generator to which the coils were connected).

The most interesting is the case when I_0 and I_b flow in opposite directions. Figure 1 shows the current-voltage characteristics $V(I_0)$ at a fixed I_b = -181 A and T = 2.95°K (curve 1) and the dependence of the impedance of the outer sample surface on I_0 at 4.8 MHz, drawn to an arbitrary scale (curve 2). To the left of the curve is shown the scale of the observed changes in the frequency of the measuring generator. Under the experimental conditions $|I_b| > I_c$, where I_c is the current producing on the outer surface of the sample a field $H = H_c$. As a result the sample was completely normal in the interval $0 \leq I_0 < -I_b - I_c$, and its resistance V/I_0 and impedance were practically constant. With further increase of I_0, the field H became smaller than H_c in absolute magnitude, a layer of the t.m. state was produced on the surface, and the impedance began to decrease sharply, almost reaching its value for a purely superconducting surface near the point $I_0 = -I_b$, where H = 0. When I_0 increases, in the interval $-I_b - I_c < I_0 < I_b + I_c$, the voltage across the sample remained constant and flowed in the normal metal, while the magnetic field on the boundary between the normal metal and the t.m. layer remained equal to H_c. At the same time the current in the t.m. layer increased from 0 to $2I_c$, and the field H changed from $-H_c$ to H_c.

At the point $I_0 = I_b + I_c$, the sample surface assumed the normal state, as shown by measurements of the surface impedance, but the t.m. state layer, obviously, did not vanish but only started to move into the interior of the sample, continuing to carry current in excess of that given by the current-voltage characteristic of the normal state, shown dashed in Fig. 1. Assuming that the layer has the form of a cylinder of radius r and carries a current $I_L = crH_c$, that the magnetic field experiences on the layer a jump from $-H_c$ to

H_c, and that the current density in the remainder of the sample is constant, it is easy to express I_L in terms of I_0, I_b, and I_c. The satisfactory agreement between the points obtained in this manner and the experimental curve on Fig. 1 confirms the foregoing assumptions.

Whenever I_0 and I_b had the same sign, the coil placed on the inner surface made it possible to reveal the vanishing of the t.m. layer when I_b reached the value $(d_1/d_2)I_c$ at which the field on the outer surface was equal to the critical value.

Thus, layers of the t.m. state can exist in doubly-connected samples of type-II superconductors. If we neglect their thickness, these layers are magnetic-field discontinuity surfaces. The magnetic-field discontinuity is $\Delta H = 2H_c$ if the layer is inside the sample and $\Delta H \leq 2H_c$ when the layer is on the sample surface.

The diagram of the states of a hollow cylindrical sample at different values of I_b and of the sum $I_0 + I_b$ should have, in accord with the foregoing representations, the form shown in Fig. 2 (for currents I_0 small compared with the current needed to destroy the t.m. layer, which is our case exceeded I_c by several tens of times).

We are grateful to A.F. Andreev for a discussion of the questions touched upon in the article.

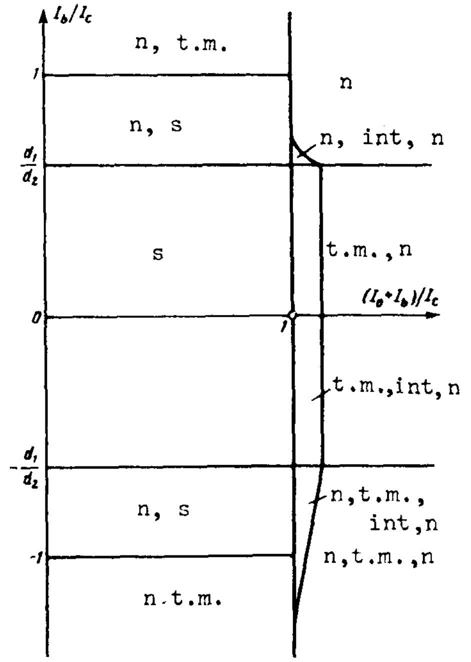

Fig. 2. Diagram of states of hollow cylindrical sample. For each region, the states of the coaxial layers in the sample are listed from the inside layer to the outside one; s - superconducting state, n - normal, i - intermediate, t.m. - two-dimensional mixed state.

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TWO-FREQUENCY OPTICAL STANDARD

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1. We report here for the first time observation of narrow resonances in the radiation power of a gas laser with nonlinear absorption in a stable regime of generation of two longitudinal modes that are symmetric about the center of the absorption line, and stabilization of the frequency in this generation regime with a small value of frequency instability ($\Delta\nu/\nu = 10^{-12}$). The obtained highly-stable generation of two oscillation modes permits a) an appreciable extension of the capabilities of optical frequency standards,