CONCERNING THE FERMI SURFACE OF NIOBIUM

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We have already reported [1] the results of an investigation of the galvanomagnetic properties of single-crystal niobium with room-temperature to helium-temperature resistance ratios from 400 to 1000. On the basis of the data obtained at that time one could conclude that the Fermi surface of niobium is a grid of corrugated cylinders whose axes are parallel to the fourfold axes of the crystal. Since the purity of the niobium samples employed by us was relatively low, it was of interest to repeat the measurements on purer samples. We succeeded in obtaining niobium samples with $\alpha = r(300^{\circ}K)/r(4.2^{\circ}K) = 30000$. The data on these samples are listed in the table.

The residual resistance r_0 was determined by extrapolating the temperature dependence of the sample resistance in a longitudinal magnetic field to T = 0. Figure 1 shows typical plots of such dependences on the longitudinal magnetic field and also on T^2. The magnetoresistance was measured in a transverse magnetic field produced by a superconducting solenoid. The samples were rotated with a setup described in [2]. The measurements were made on samples whose axes were parallel to [001], [011], and [111]. Plots of $r_H(\phi)$ for a sample with axis parallel to [011] is shown in Fig. 2. This figure shows several split maxima, with shapes characteristic of open directions of the Fermi surface. The centers of the regions of open directions on the stereographic projection coincide with the [001], [110], and [111] directions, and the angular dimensions of the regions are 24, 25, and 7°, respectively. Saturation is observed for all the remaining directions of the magnetic field, and in the saturation region the resistance is 2 - 5 times larger than at H = 0. The dependence of the resistance on the field at the maximum is approximately quadratic. The deviation from the quadratic dependence can be attributed to the inaccuracy of the measurements in the region of such sharp and narrow maxima.

When the temperature is lowered to 1.6°K, the height of the maxima on the resistance rosette increases by about 1.7 time, this being connected with the increase of the effective magnetic field due to the decrease of the resistance of the normal state. The saturation resistance at the minimum of the rosette is also decreased, leading to an increase of the anisotropy of the magnetoresistance.

For a sample whose axis is parallel to the [111] direction, the $r_H(\phi)$ dependence is shown in Fig. 3. In this case the saturation is observed for all directions of the magnetic field, with the exception of directions parallel to <110>.

The obtained data make it possible to refine the previously presented [1] stereographic projection of niobium. The two-dimensional regions of open directions should now be located not only in the vicinity of fourfold axes, as was noted in [1], but also in the vicinity of twofold and threefold axes, the widths of these regions being much smaller than those of the former.

It should be noted that the existence of a two-dimensional region around [111] was in-

Sample No.	$a = r_{T=300°} / r_{T=4,2°}$	Orientation	
		θ	ϕ
1	30000	0	0
2	30000	90	45
3	7000	90	45
4	30000	45	45
5	30000	82	45

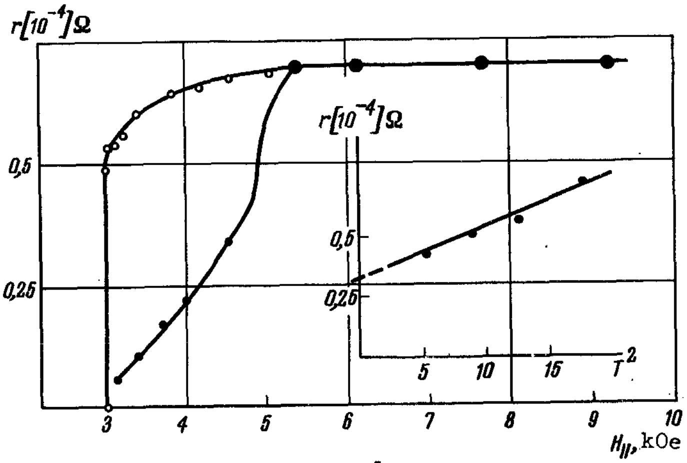

Fig. 1

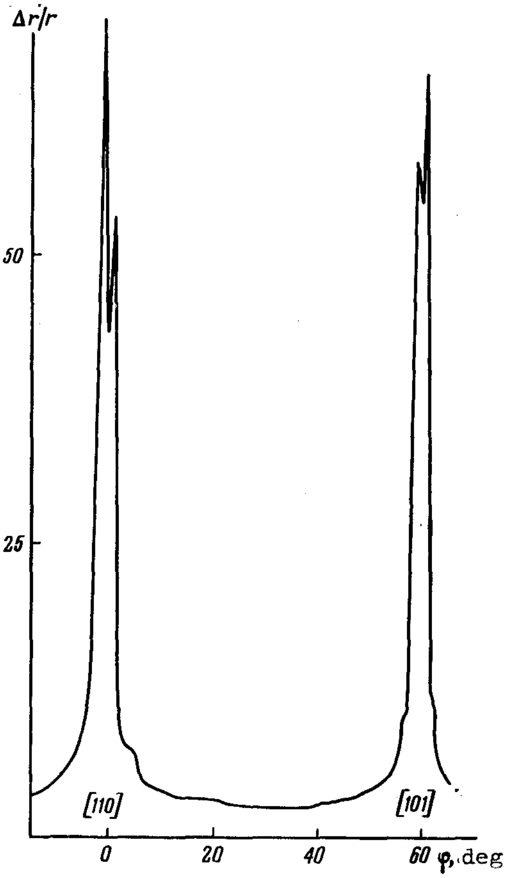

Fig. 3

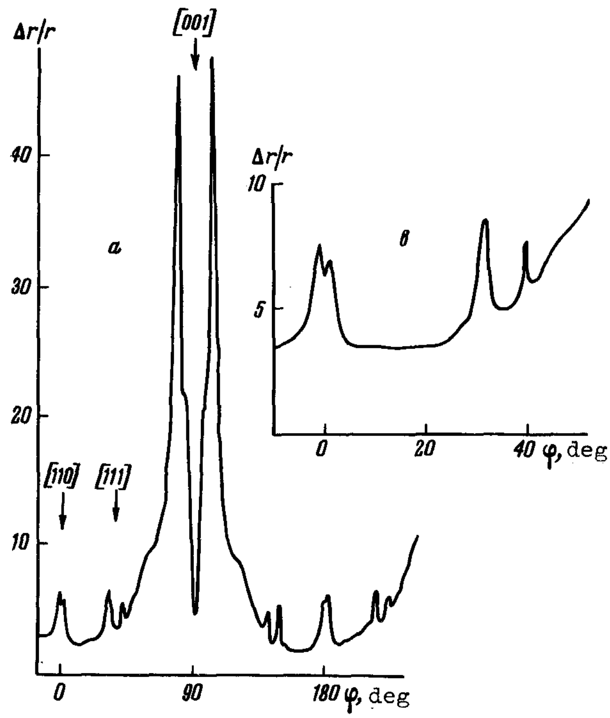

Fig. 2

Fig. 1. Niobium sample resistance vs. longitudinal magnetic field: • - current through sample 2 A, o - 20 A; b - resistance in saturation region vs. T^2.

Fig.2. Resistance of niobium sample 3 vs. magnetic field direction, I ∥ [011], H = 70 kOe, T = 1.6°K. a) Angular dependence of resistance; b) part of curve a recorded with higher sensitivity and lower rotation speed.

Fig. 3. Resistance of niobium sample 4 vs. magnetic field direction, I ∥ [111], H = 72 kOe, T = 4.2°K.

dicated by Reed and Sodem [3], but they did not observe the complex structure of the $r_H*(\phi)$ dependence in the vicinity of directions parallel to [111] and [110].

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[2] N. E. Alekseevskii, A. V. Dubrovin, G. E. Karstens, and N. N. Mikhailov, Zh. Eksp. Teor. Fiz. 54, 350 (1968) [Sov. Phys.-JETP 27, 188 (1968)].

[3] W. A. Reed and R. R. Soden, Phys. Rev. 173, 677 (1968).

CRITICAL FIELDS AND STRUCTURE OF ION-ACOUSTIC INSTABILITY OF THE PLASMA OF AN INDUCTION HIGH-FREQUENCY DISCHARGE IN H_2, Ar, AND Hg IN A MAGNETIC FIELD

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A study of a weakly ionized HF discharge plasma has shown that when the magnetic field reaches the critical value of the plasma becomes unstable both in an induction discharge [1, 2] and an E-discharge [3, 4] (alternating field $\vec{E}_\sim \parallel \vec{H}_0$). The critical fields H_{cr} in a hydrogen plasma were compared in [4] with the theoretical values of the ion-acoustic instability of an inhomogeneous plasma [5, 6], and good agreement was obtained.

Since the ion sound is essentially determined by the electron temperature T_e and by the ion mass M_i, to determine the nature of the instability it is of great interest to study the plasma of various gases. In addition, it is of interest of compare the structure of the oscillations that build up with the structure predicted in [5]:

$$\omega \approx -k_y\sqrt{T_e/M_i} > \Omega_i, \quad k_y \gtrsim \kappa(\Omega_i\tau_i)^{-1}, \quad k_z^2 \lesssim k_y^2(b_i/b_e)$$

(the magnetic field is directed along the z axis, the density gradient along the x axis, $\Omega_i = eH/M_ic$, τ_i is the time between the ion-neutral collisions, and $\kappa = dn/n\,dx$).

We report in this paper the results of measurements in an induction HF discharge plasma in hydrogen, argon, helium, and mercury vapor, in which the electron temperature changed by a factor of 12 and the ion mass by a factor of 100. We measured the critical magnetic fields, the frequencies, and the spatial structure of the developing oscillations. The spatial correlation of the oscillations and of the noise was studied. The results are identified as ion-acoustic instability of an inhomogeneous plasma.

The plasma (f = 20 MHz, $n_e = 10^9 - 10^{10}$ cm^{-3}, H = 0 - 600 Oe, gas pressure $P = 2 \times 10^{-2}$ Torr in H_2, He, Ar and $p = 4 \times 10^{-2} - 2.6 \times 10^{-4}$ Torr in mercury vapor) was produced by a six-turn loop 10 cm long, placed over a glass tube of diameter 2a = 3.2 cm and length 100 cm. T_e varied with the pressure, for example, T_{Hg} = 1.2 V, T_{Ar} = 3.2 V, T_{H_2} = 5 V, and T_{He} = 9 V at $P = 4 \times 10^{-2}$.

1. The critical magnetic fields of the various gases are plotted in Fig. 1 in coordinates $\eta = a/\tau_H\sqrt{b_e/b_i}$ and $\xi = \sqrt{T_e/M_i}\,\kappa\tau_i = \lambda_i/a\sqrt{T_e/T_i}$, in which the individual features of the gas are lost [5]. Here b_e and b_i are the ion and electron mobilities, and r_H the ion Larmor radius calculated from the electron temperature. The solid line indicates the theoretical limit of the ion-acoustic instability [5, 6]. The values of T_e were taken from experiment at $H = H_{cr}$, and b_e and b_i were assumed [7] equal to (in cm^2/sec-V-Torr): a) hydrogen - $b_i = 10^4/P$,