each of the experimental points has been obtained by averaging the data for 10—15 electron tracks belonging to a given interval of the logarithmic energy scale.

As can be seen from Fig. 2, a satisfactory agreement with the experiment is observed of the expected effect of the radiative correction on the ionization losses, both as to the sign and the magnitude of the correction Δ_∞, and the region in which the correction attains saturation.

In conclusion, the authors would like to thank E. L. Feĭnberg for a helpful discussion of the results, and also the team of laboratory assistants for carrying out the preliminary reduction of data.

[1)]The upper limit of the energy transfer determines basically the difference in the energy dependence of the two quantities: ionization and ionization loss.

[2)]Similar corrections were calculated also for heavy particles (the final results of the calculation depend only on ϵ_p/mc^2).

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DIMENSIONAL EFFECT IN A METAL IN MULTIPLES OF A CERTAIN MAGNETIC FIELD

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Submitted to JETP editor May 18, 1962

J. Exptl. Theoret. Phys. (U.S.S.R.) **43**, 345-347 (July, 1962)

A new dimensional effect has been discovered on measurement of the dependence of the surface impedance of tin on a 1—5 Mc magnetic field at helium temperatures.

A flat sample was placed in a coil of rectangular cross section which was part of an oscillating circuit. A constant magnetic field was applied along the plane of the sample. The frequency of the oscillator f varied with the magnitude of the field because of variation of the reactance X of the sample. The dependence of the frequency on the field was measured by a modulation method; the field modulation frequency was 20 cps.

The sample was a single crystal of high-purity tin (about $10^{-4}\%$ impurities) grown from the melt in a demountable quartz mold. The sample surface was perpendicular to the [100] axis. The thickness of the plate was 0.39 mm, the electron mean free path reached $(1-3) \times 10^{-1}$ cm at helium temperatures, and the skin-effect depth was 10^{-4} cm at 1—5 Mc.

In a field $H_0 = 2cp/ed$ (p is the half-width of the extremal electron orbit in the momentum space along a direction at right angles to the magnetic field and to the sample-surface normal; d is the plate thickness), when the width of the electron trajectory on the extremal cross section of the Fermi surface becomes equal to the plate thickness, a singularity [1] appears on the X(H) curve and this singularity can be used to measure the Fermi surface cross section. Further experiments have shown that singularities on the X(H) curve appear also in fields that are multiples of H_0 (we found them up to a field $5H_0$) when the thickness of the plate is equal respectively to 2, 3, or more widths of the electron trajectory. Figure 1 shows curves on which the singularities are clearly visible in fields of $2H_0$ and $3H_0$.

The reason for the appearance of these singularities in multiple fields is as follows. Electrons in an orbit passing through the skin layer experience a systematic increase in velocity Δv due

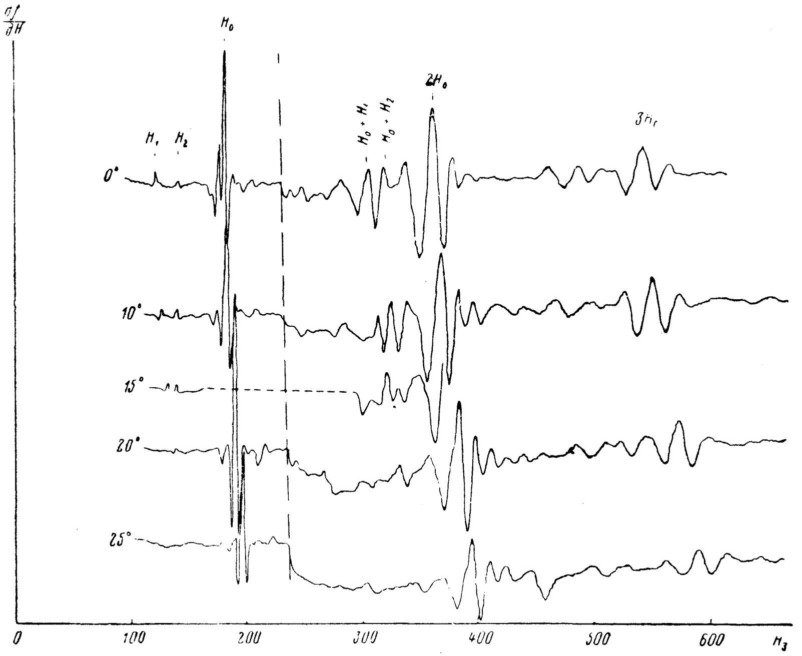

FIG. 1. Records of the dependence of $\partial f/\partial H$ on H. The oscillation frequency is 3.06 Mc and the temperature 3.5° K. The high-frequency field is $H_\sim \parallel [001]$. The angles between the constant field H and the [001] axis are indicated at the curves. The ordinate scale on the right of the vertical dashed line is magnified by a factor of 9 compared with the left-hand side.

to interaction with the electric field; this governs the participation of such electrons in conduction. As they move along the trajectory, these electrons reach after a time a depth equal to the trajectory width 2p and the increase of their velocity reverses sign (for the sake of simplicity we assume that the electric field is at right angles to the magnetic field and that the electron mean free path is much greater than the perimeter of its trajectory). Thus we have in the interior of the metal a current equal in magnitude and opposite in direction to the current in the surface layer. The density of this current is very low since electrons participating in conduction belong to different cross sections of the Fermi surface and therefore move away from the surface to different depths.

However, near the extremal cross sections of the Fermi surface, and correspondingly at the extremal widths of the electron trajectories in the plate, the number of electrons increases strongly and therefore the current density at the depth equal to the width of the extremal trajectory rises sharply. The nature of the dispersion law near the extremal cross section may tend to intensify the effect. This happened in the experiment referred to here: the effect was observed on the very nearly cylindrical part of the Fermi surface [2,3] (the experimental points in Fig. 2 indicate that the Fermi surface diameter in this cross section varies only 2–3%). Therefore all the surface electrons contribute to the effect. Moreover the form of the orbit is such that the curvature of the trajectory is small where the electrons are farthest from the surface and the electrons move parallel to the surface for a relatively long time.

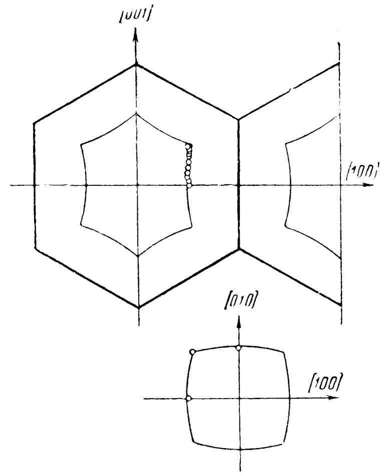

FIG. 2. Cross sections of the fourth hole zone in tin according to the model of nearly free electrons. o – Experimental results from [3] and from dimensional-effect measurements [1] which agreed well with each other.

In this experiment the skin layers are on both sides of the surface and the electric field vectors at the two surfaces are in antiphase. In the $2H_0$ field the trajectories of electrons passing through the skin layers touch in the center of the plate and this produces an interaction between the skin layers and a change in the impedance. In the $3H_0$ field the trajectory width is d/3 so that the coupling between the skin layers is via a chain of three trajectories; in the $4H_0$ field a chain of four trajectories is involved, and so on. There was no difference between the form of the lines corresponding to the even and odd numbers of consecutive trajectories.

The curves of Fig. 1 show also singularities in fields close to $H_0 + H_1$ and $H_0 + H_2$. These singularities can be explained by assuming that one of the trajectories of a chain which couples the skin layers is replaced by the trajectory of an electron belonging to the Fermi surface of another zone. The first-order effect of the trajectories with smaller widths is clearly visible in the left-hand parts of the curves in Fig. 1 (the fields H_1 and H_2).

Local penetrations of the electromagnetic field into the interior of a metal were predicted theoretically by Azbel';[4] however, he discussed only the high-frequency case when the electrons that contribute to this effect take part in cyclotron resonance. Therefore Azbel's theory is not directly applicable to our experiments although the phenomenon dealt with by him and our effect are very similar.

The author is deeply grateful to Yu. V. Sharvin for constant guidance, to M. S. Khaĭkin and R. T. Mina for useful discussions, and to A. I. Shal'nikov for his interest.

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THE COHERENCE AND DIRECTIVITY OF EMISSION FROM A RUBY LASER

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Submitted to JETP editor May 18, 1962

J. Exptl. Theoret. Phys. (U.S.S.R.) **43**, 347-349 (July, 1962)

THE directivity of the emission from a ruby laser is usually worse than the diffraction limit set by the dimensions of the crystal. This is caused by the optical imperfection of the crystals. Nelson and Collins[1] have shown that the emission is coherent over small regions of the end faces of the crystal. It was assumed that diffraction at the boundaries of these regions also caused angular divergence of the generated beam. However, as was shown by Masters and Parrent,[2]

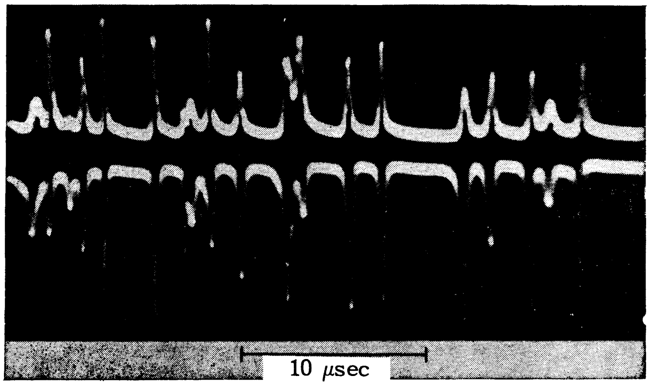

FIG. 1. Oscillogram of the emission from two sections of the end face of a ruby laser crystal.

the radiation is coherent in sections that are separated by more than 3 mm from each other.

The purpose of the experiments described below was the investigation of the relation between the coherence and directivity of the emission from a ruby laser. First of all, it was shown that the pulsations of the emission during generation arise simultaneously in all radiating surfaces of the crystal. Figure 1 shows an oscillogram obtained from photomultipliers which received radiation from two different sections of the crystal separated by 2 mm. As can be seen from the figure, the pulses of the radiation always originate simultaneously in different parts of the crystal, although sometimes a difference in relative intensity of the peaks is observed.

For the investigation of coherence, the following interference experiments were carried out. The end face of the crystal was focused by an objective O_1 on a diaphragm D consisting of two or five apertures (Fig. 2). The objective O_2 forms an image of the principal focal plane of objective O_1 on the photographic plate F. Thus, each point of the image corresponds to rays leaving the crystal in a specific direction.

The pattern obtained in the absence of diaphragm D differed for different crystals and was characteristic of the directivity of the crystal as a whole. An example of such a pattern for one of the crystals is shown in Fig. 3. Upon insertion of the two-hole diaphragm the intensity distribution on F changed drastically, and, in addition, interference bands were observed. The five-hole diaphragm gave a complex interference pattern that could be observed particularly well in the somewhat more distant plane F_1. Interference of the

FIG. 2. Arrangement for observing interference.