PHYSICS

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Figure 1

Figure 1: Figure 1

Abstract

Full Text

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PASSAGE OF ELECTROMAGNETIC WAVES THROUGH BISMUTH

The possibility of penetration of electromagnetic waves into metals was pointed out in works ([1–3]). Such penetration, accompanied by the excitation of magnetoplasma oscillations, was observed by M. S. Khaikin and coauthors ([4]). The method they used was based on measuring the coefficient of reflection of power from a resonator, part of which consists of the specimen under study, or else on measuring the power passing through the resonator. This method of working in reflection is generally accepted in studies of changes in the surface resistance of metals, for example in the case of cyclotron resonance. However, when studying bulk effects, for example standing waves in the thickness of a metal, it is possible to work not only in reflection, but also in transmission. This method consists in recording the radiation penetrating through the specimen.

Fig. 1. Dependence of the power passing through bismuth on the magnetic field. Along the ordinate is plotted the value of the derivative of the transmitted power

To observe such an effect, the following experimental arrangement was used. Two adjacent strip resonators had a common wall, which was the bismuth specimen under investigation, of diameter 23 mm and thickness 1.4 mm. The first resonator was excited by a klystron generator with a frequency of 9600 MHz. The second resonator was connected to the input of a superheterodyne receiver. Both resonators with the specimen were located in the field of an electromagnet. The angle between the direction of the field and the normal to the specimen could be varied from 0 to 90°. The experiment was carried out at a temperature of about 1.8° K. In the absence of a magnetic field, microwave oscillations did not pass through the bismuth and there was no signal at the receiver output. However, when a magnetic field was applied perpendicular to the surface of the specimen, transmission of power through the bismuth was observed. The magnitude of the transmitted power oscillated with increasing field, as shown in Fig. 1. The maximum transmitted power in this figure corresponds to approximately

−35 dB relative to the power entering the input of the first resonator. When the magnet was rotated by 90°, the transmission of power decreased very sharply. Raising the temperature of the specimen to 4.2° K led to disappearance of the effect.

It should be noted that, when working in reflection, magnetoplasma oscillations in our case were practically not observed because of the poor quality of the sample, for which $R_{293^\circ}/R_{4.2^\circ} = 7$. The use of the transmission method makes it possible to detect oscillations with complete confidence even in such an unfavorable case.

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Note: Figure translations are in progress. See original paper for figures.