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1) A quarter-wave plate is located behind the Wollaston prism to make the linear polarization of the light circular and thereby eliminate the unequal light-propagation conditions in the apparatus.

2) If the diffuse wing (Fig. 1) has a complex structure, then a relaxation time longer than 5×10^{-11} sec is possible.

OBSERVATION OF QUANTUM SIZE EFFECTS IN BISMUTH FILMS BY THE METHOD OF TUNNEL SPECTROSCOPY

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In an earlier paper by Orgin et al. [1] it was reported that quantum size effects were observed in bismuth films of thickness commensurate with the effective de Broglie wavelength of the carriers. In [1] the quantization of the energy spectrum of the carriers was manifest in an oscillatory dependence of the kinetic and galvanomagnetic coefficients on the film thickness.

In this communication we report the results of an experimental investigation of tunnel systems containing size-quantized bismuth films. It is shown in the theoretical papers [2-4] that the current-voltage characteristics of such a system should reveal a number of specific features that yield information on the structure of the carrier energy spectrum.

The measurements were made on Bi (thin film) - dielectric - Bi (thick film), Bi (thin film) - dielectric - Ag, and Bi (thin film) - dielectric - Bi (thin film) systems. We attempted to use vacuum rather than a solid dielectric for the gap, to eliminate as much as possible parasitic effects connected, for example, with tunneling through the "trap" levels in the dielectric. The dielectric employed was the interelectrode gap produced by assembling two independently prepared samples with an appropriate difference in the thickness of the sputtered layers (Fig. 1).

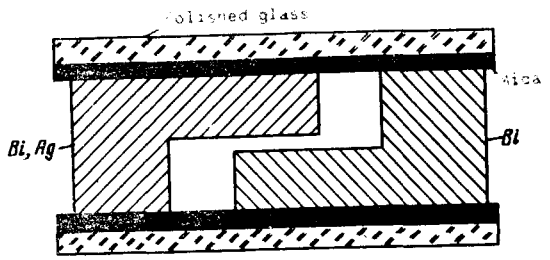

Fig. 1

During the measurements, the tunnel system was placed in liquid nitrogen, so that it is still unclear whether the tunnel gap was a "vacuum" gap or whether it was filled with nitrogen. In view of the very small size of the gap (several dozen Å), we can expect a "vacuum gap" to be produced by capillary action.

The bismuth films were obtained by evaporation on hot mica in vacuum. An electron-diffraction study has shown that the films are close in their structure to a mosaic single crystal. The trigonal axis was perpendicular to the plane of the film. The investigated samples ranged from 800 to 1300 Å in thickness.

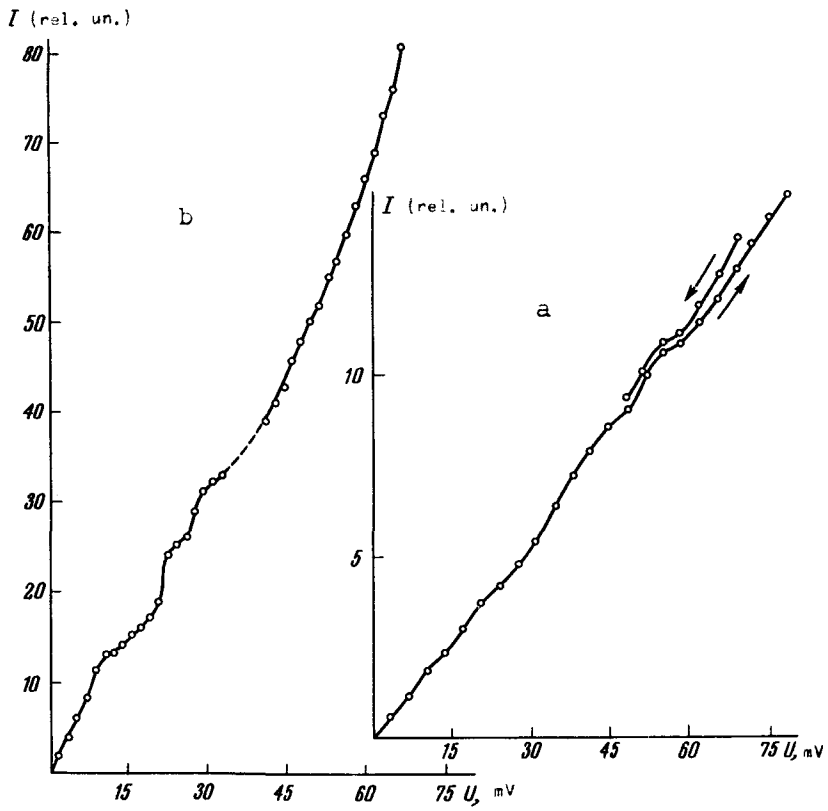

Fig. 2

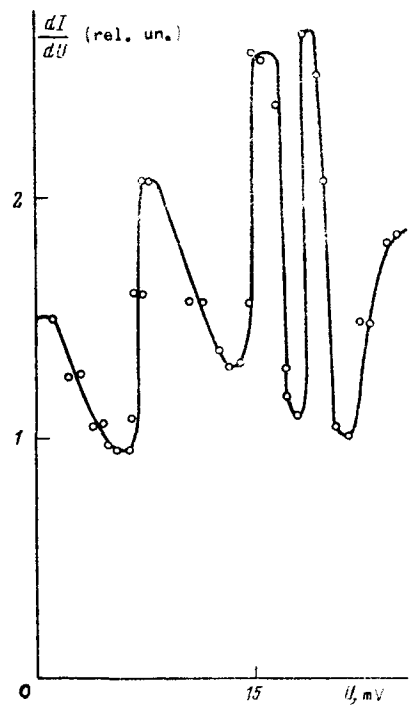

Fig. 3

Figure 2 shows by way of an example two voltage-current characteristics. Curve a pertains to the Bi-Ag system, curve b to the Bi (thin film) - Bi (thick film) system. The characteristics show the oscillations clearly. The nonmonotonic character of the current variation is even more pronounced when the obtained characteristics are differentiated. Figure 3 shows the results for the Bi (thin film) - Bi (thin film) system.

In the case of a quadratic dispersion law, the dependence of the state density on the energy in the quantized film has the form of a steplike function, the "length" of the step increasing with increasing energy. Accordingly, the distance between the singularities on the voltage-current characteristic, in the case of electron tunneling from the quantized film

into bulk metal, should decrease; when the polarity of the voltage is reversed, the indicated distance should increase. Further, at a voltage corresponding to a shift of the Fermi level of the bulk electrode below the bottom of the first sub-band in the thin film, the nonmonotonic dependence should give way to a monotonic growth of the current. We can estimate from this the position of the Fermi level in the bismuth film.

All the foregoing regularities are actually observed in the experiments. The experimentally obtained values of the Fermi energy lie in the range between 0.02 and 0.027 eV, i.e., they are close to the known values of the Fermi energy in bulk bismuth (see the table in [5]).

The distance between the singularities on the voltage-current characteristic allows us to estimate the component of the effective mass of the electrons in Bi, corresponding to the direction of the trigonal axis. This turned out to be equal to $\sim 0.012 m_0$, which is in good agreement with the known values obtained from measurements of the de Haas - van Alphen effect [6].

In conclusion we note that Kirk [7] observed nonmonotonic voltage-current characteristics in the Al-Al_2O_3-Al system. However, in view of the fact that in Al the conditions were unfavorable for the realization of size-effect quantization, the observed nonmonotonicity is probably connected, in our opinion, with phenomena in the Al_2O_3 layer.

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CONTRIBUTION TO THE THEORY OF SHOCK WAVES IN NONCONDUCTING MEDIA IN THE PRESENCE OF AN ELECTRIC FIELD

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The theory of shock waves usually does not deal with the case when an external electric field is present. We show in this article that in the presence of an external electric field a low-intensity shock wave can be a rarefaction wave.

If we denote by braces the difference between the values of a quantity on both sides of the discontinuity, and by ρ, V, v, T, s, w, u, ϵ, E, and D the density, volume per unit mass,