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* In the diagonalization of the spin Hamiltonian we have assumed that the constants D and E are negative.

OBTAINING A FALLING VOLTAGE-CURRENT CHARACTERISTIC IN SEMICONDUCTORS IN CROSSED ELECTRIC AND MAGNETIC FIELDS BY SHORT CIRCUITING THE TRANSVERSE HALL FIELD

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JETP Pis'ma 5, No. 7, 212-214, (1 April 1967)

As is well known, The resistance of a semiconductor in crossed electric and magnetic fields depends strongly on the geometry of the sample. In long samples, where the transverse current is equal to zero, the resistivity is given by

$$\rho_{xx}^{(1)} = \frac{\sigma_{xx}}{\sigma_{xx}^2 + \sigma_{xy}^2}.$$

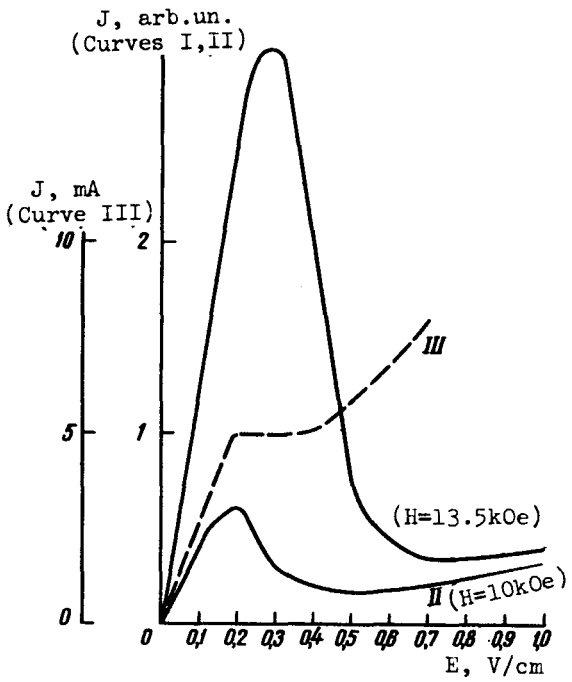
In the case when the transverse Hall field is equal to zero, i.e., in a Corbino disk or in short samples, where the Hall current is short-circuited by the electrodes, we have $\rho_{xx}^{(2)} = 1/\sigma_{xx}$, i.e., in strong magnetic fields, when $\sigma_{xy} \gg \sigma_{xx}$, we get $\rho_{xx}^{(2)} \sim 1/\rho_{xx}^{(1)}$. Therefore if σ_{xx}, say, falls with increasing electric field, then $\rho_{xx}^{(1)}$ also falls, whereas $\rho_{xx}^{(2)}$ increases, and vice-versa. This is correct, of course, if σ_{xy} remains constant, i.e., the change of σ_{xx} is due to the change of the scattering probability, and not of the concentration. Thus, by shorting out the Hall-current it is possible to transform an S-shaped voltage-current characteristic into an N-shaped one and vice-versa.

It is obvious that to obtain a falling voltage-current characteristic in the case of a Corbino disk it is necessary to have σ_{xx} decrease more rapidly that E^{-1}, starting with certain values of the field E. As shown by Kazarinov and Skobov [1], this is precisely the field dependence of the conductivity that should be observed in a quantizing magnetic field

for different scattering mechanisms.

The characteristic is made to fall by the heating of the electrons in the strong electric field.

A decrease in the resistivity $\rho_{xx}^{(1)}$ was observed experimentally in long n-InSb samples with impurity density of the order of 10^{14} cm^{-3} at T = 1.5°K and in magnetic fields from 4 to 13 kOe, in the electric field region from 0.1 to 1 V/cm^2 [2]. The results of a recalculation of these data to the case of the voltage-current characteristics of a Corbino disk is shown in the figure. The dashed curve is the voltage-current characteristic obtained by us experimentally for a Corbino disk made of n-InSb with impurity density on the order of 10^{14} at T = 1.7°K. The measurements were made with a current source having a large capacitance and large internal resistance. Under these conditions when the maximum of the voltage-current characteristic was reached, a transition was observed from one rising branch to the other. This transition occurred within a time of 1 sec, corresponding to the time constant of the circuit.



Unlike other cases in which falling characteristics are realized, for example in the case of the Hilsum-Ridley-Watkins mechanism, it is easy in this case to change the form of the voltage-current characteristic by varying the magnetic field. The form of the falling section of the characteristic can be obtained here by means of measurements with long samples, whereas in other cases the plotting of the falling section is a complicated problem, owing to the appearance of instabilities.

As is well known, in the presence of a falling voltage-current characteristic, instabilities of the Gunn type appear under certain conditions [3]. We can expect in our case a similar instability. The singularities indicated above make it possible to study the influence of the form of the voltage-current characteristic and its parameters on the Gunn effect. The relatively weak electric fields make it possible to carry out the measurements in a continuous rather than pulsed mode.

In conclusion, the authors are grateful to A. R. Regel' who supported the start of this work.

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NOTE

Concerning the article by B. N. Bogomolov et al., Vol. 5, No. 7

As pointed out by Sh. M. Kogan, the possibility of obtaining N-shaped current-voltage characteristics in Corbino discs placed in a magnetic field, which was experimentally demonstrated in our letter (JETP Letters 5, 212, 1967, transl. p.169), was theoretically predicted by F. G. Bass (JETP 48, 275, 1965, Soviet Phys. JETP 21, 181, 1965).

The authors express their apology for omitting a reference to this article.