On the Letter to the Editor of I. M. Tsidil'kovskii and F. G. Bass[1]

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IN a recent letter, Tsidil'kovskii and Bass made several critical comments on our researches[2,3] We consider it necessary to answer these comments.

General formulas were obtained in Refs. 2 and 3 for the thermoelectric, galvanometric, thermo- and photomagnetic effects in semiconductors, which are valid for a very wide class of the stationary, spherically symmetric part of the distribution function (for sufficiently weak external magnetic field H and temperature gradient ΔT), in particular, they are valid in the presence of initial heating, and also, in a whole series of cases, for ionization by the field E. Here there appeared certain peculiarities of the phenomenon of transfer under these conditions. Inasmuch as this type of work has not been published up to the present, we feel that the work possessed some new content bearing on the problem of the behavior of semiconductors in strong electric fields.

As is known, the majority of transfer phenomena arise under definite, artificially created (or, using the expression of Tsidil'kovskii and Bass, "far-fetched"), experimental conditions. Therefore, we presumed that, where it was necessary, artificial initial heating of the electrons, in the investigation of transfer phenomena under conditions of initial heating, was no more far-fetched than, let us say, the artificial imposition of a magnetic field on the semiconductor in the investigation of electric conductivity, which is usually done. The purpose in the two cases is the same: by creating artificial conditions, it is possible to discover physical properties of the semiconductors. Incidentally, the artificial initial heating assumed by us is the natural phenomenon in the operation of certain semiconductor devices.

Further, we do not agree with the statement on the existence of a contradiction in our calculation of the coefficient of electron heat conductivity k_e. The case $j = 0$ was used by us as a method which permitted the separation of the heat current, associated with the flow, from heat current which is proportional to the temperature gradient. Calculation of the coefficient of proportionality k itself is carried out under general conditions, which is evident from our Eqs. (3) and (8)[2].

Tsidil'kovskii and Bass attributed to us the statement that there is no necessity "of solving the equations of Davydov for the case in which f_0 depends on E, H and r." Such a statement by us, in such an unrestricted form, was not made. After the statmement on p. 675[3], "The solution of this system (the discussion is about a system of kinetic equations) in the general form is at least very difficult; however, there is no necessity of this," there is added, "The fact is that for sufficiently large dimensions of the semiconductor, and for sufficiently small temperature, concentration and field gradients along all three directions x, y and z (which usually is the case), one can neglect products of the spatial distributions functions in Eqs. (2.3) and (2.4) of Ref. 1.

"Further, inasmuch as we, in our calculations, restricted ourselves to weak magnetic fields, then, in the determination of the moments χ^{ν}, it suffices to find f_0 for the case in which the magnetic field is equal to zero."

In particular, let us see why we can look for f_0 by setting $H = 0$ in our case. The following expression was obtained on p. 565 of Ref. 2 for the asymmetrical part of the distribution function ($\Omega = eH/mc$):

$$\mathbf{f}_1 = \frac{-(l/v)\,\mathbf{R} + (l^2/v^2)\,[\mathbf{R}, \vec{\Omega}] + [l^3/v^3]\,\vec{\Omega}\,(\vec{\Omega}\cdot\mathbf{R})}{1 + (l^2/v^2)\,\Omega^2} \qquad (1)$$

It was shown on p. 566 that all our calculations are derived under the assumption that

$$(l\Omega / v)^2 \ll 1. \qquad (2)$$

Consequently, f_0 [for f_1 taken from Eq. (3)] is determined on p. 675 from Eq. (3.3)[3], which do not contain the field H. Thus, if f_0 were to depend essentially on H, then this would be taking place under the conditions unlike those assumed by us [the inequality (2)].

$$\mathbf{f}_1 = l\mathbf{R} / v.$$

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[1] I. M. Tsidil'kovskii and F. G. Bass, J. Exptl. Theoret. Phys. (U.S.S.R.) 28, 245 (1955); Soviet Phys. JETP 1, 180 (1955).

[2] G. M. Avak'iants, J. Exptl. Theoret. Phys. (U.S.S.R.) 26, 562 (1954).

[3] G. M. Avak'iants, J. Exptl. Theoret. Phys. (U.S.S.R.) 26, 668 (1954).

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