(8) that peaks will appear on the current-voltage characteristic at $e\bar{v} = 2\Delta \pm n\Omega$. This phenomenon was observed experimentally by Dayem and Martin [12].

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[1] I. K. Yanson, V. M. Svistunov, and I. M. Dmitrenko, JETP 47, 2091 (1964), Soviet Phys. JETP 20, 1404 (1965).
[2] S. M. Marcus, Phys. Lett. 19, 623 (1966).
[3] G. I. Rochlin and D. H. Douglass, Jr, Phys. Rev. Lett. 16, 359 (1966).
[4] J. R. Schrieffer and J. W. Wilkins, Phys. Rev. Lett. 10, 17 (1963).
[5] A. J. Bennett, Phys. Rev. 140, A1902 (1965).
[6] Yu. M. Ivanchenko, JETP 51, 337 (1966), Soviet Phys. JETP 24, in press.
[7] R. E. Eck, D. J. Scalapino, and B. N. Taylor, Phys. Rev. Lett. 13, 15 (1964).
[8] I. O. Kulik, JETP Letters 2, 134 (1965), transl. p. 84.
[9] Yu. M. Ivanchenko, A. V. Svidzinskii, and V. A. Slyusarev, JETP 51, 194 (1966), Soviet Phys. JETP 24, in press.
[10] I. M. Dmitrenko, I. K. Yanson, and V. M. Svistunov, JETP Letters 2, 17 (1965), transl. p. 10.
[11] D. D. Coon and M. D. Fiske, Phys. Rev. 138, A744 (1965).
[12] A. H. Dayem and R. J. Martin, Phys. Rev. Lett. 8, 246 (1962).

1) The form of the peaks due to many-particle processes will differ greatly from (7) (see [4]).

OSCILLATIONS OF THE MAGNETORESISTANCE OF TELLURIUM

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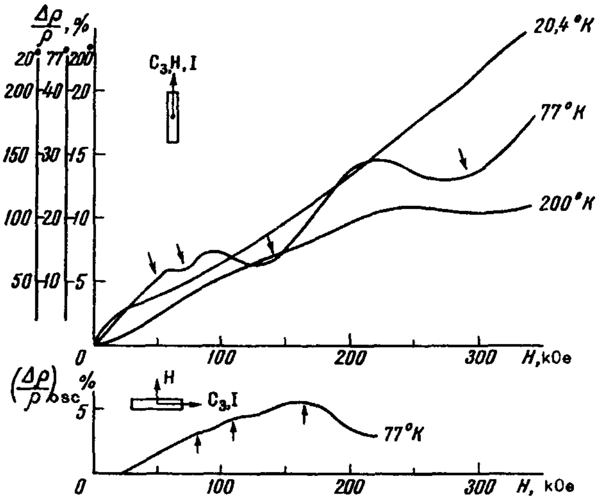
It was observed in an investigation of the effect of a strong pulsed magnetic field on the electric conductivity of tellurium, that the plot of the magnetoresistance against the field intensity H is an oscillating curve with extrema that are periodic in the reciprocal field 1/H. Such a singularity, observed in a nondegenerate semiconductor, may be evidence of magnetophonon resonance, the phenomenon predicted by V. L. Gurevich and Yu. A. Firsov [1] and studied in detail in n-InSb [2]. In magnetophonon resonance the oscillation amplitude should decrease with decreasing temperature, and the period $\Delta(1/H)$ should be independent of the density and determined by the carrier effective mass m^* and by the frequency ω of the optical oscillations of the crystal:

$$\Delta(1/H) = e/m^*\omega c.$$

Favoring the magnetophonon resonance as the cause of the observed oscillations in tellurium are the following experimental data: (i) the period of the oscillations does not depend on the carrier density p, which ranges from 2×10^{14} cm^{-3} to 1×10^{15} cm^{-3}; (ii) the amplitudes of the oscillations decrease markedly when the temperature is lowered from 77 to 20°K and the optical oscillations in the crystals are damped; (iii) an estimate of the frequency that enters in the formula yields a value close to the characteristic frequency of the crystal optical oscillations ($\omega \approx 10^{13}$ sec^{-1}).



Experimental plots of the magnetoresistance of Te single crystals vs. the magnetic field intensity. Hole density 1×10^{15} cm^{-3}, mobility 8000 cm^2/V-sec. Sample dimensions: $\vec{H} \parallel C_3$ - $2 \times 2 \times 20$ mm, $\vec{H} \perp C_3$ - $1 \times 1 \times 8$ mm.

The experimental curves (see the figure) pertain to two arrangements of the current $\vec{j}$ and of the field $\vec{H}$ relative to the principal crystal axis C_3. When $\vec{H} \perp \vec{j}$ the smooth background of the magnetoresistance increases very rapidly, so that the weak oscillating part is separated in this case in the form of a difference signal by applying to the amplifier an out-of-phase signal which is linear in the field.

A quantitative analysis of the experimental curves can hardly lead at present to unambiguous results, since the available data on the physical properties of tellurium still explain neither the detailed form of the equal-energy surfaces of the valence band, nor the complete oscillation spectrum of the complex lattice of tellurium. A possible interpretation of the experimental results is the following:

On the basis of considerations detailed in [1,2], it should be assumed that the resonant values of $\vec{H}$ correspond to minima of the $\frac{\Delta\rho}{\rho}(H)$ curve when $\vec{H} \parallel \vec{j}$ and the maxima of the curve when $\vec{H} \perp \vec{j}$. The minima at H = 47, 70, and 140 kOe have a periodicity $\Delta(1/H) = 7 \times 10^{-6}$ Oe^{-1}, and the maxima at H = 85, 110, and 160 kOe show a periodicity 3×10^{-6} Oe^{-1}, indicating that the first maximum on the side of stronger fields should be sought in the region above 300 kOe. If we assume for the effective-mass tensor components of the holes at T = 77°K the values obtained from optical [3] and thermoelectric [4] investigations ($m_\perp = 0.3m_0$ and $m_\parallel = 0.45m_0$), and put in formula (1) $m^* = 0.3$ for $\vec{H} \parallel C_3$ and $m^* = \sqrt{0.3 \times 0.45}\, m_0$ for $\vec{H} \perp C_3$, then we obtain for the optical frequencies causing the magnetophonon resonance in Te $\omega_\parallel = 0.83 \times 10^{13}$ sec^{-1} and $\omega_\perp = 1.6 \times 10^{13}$ sec^{-1}. It must be noted in connection with these results that the experimental curve of infrared transmission of Te [3] has a deep minimum at $\omega \approx 1.7 \times 10^{13}$ sec^{-1}, and that it is of interest to extend the experimental investigation of this curve to frequencies $\omega < 0.8 \times 10^{13}$ sec^{-1} ($\lambda > 240\ \mu$). The additional deep minimum at H = 290 kOe may be connected with the spin splitting of the Landau levels, which violates the periodicity of (1).

However, the numerical value of the g-factor, which can be determined in this case from the formula $g\mu_B H = \hbar\omega$, turns out to be too high ($|g| = 3$) compared with the results of paramagnetic-resonance investigations of Te [5] 1).

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[1] V. L. Gurevich and Yu. A. Firsov, JETP 40, 199 (1961) and 47, 734 (1964), Soviet Phys. JETP 13, 137 (1961) and 20, 489 (1965).

[2] R. V. Parfen'ev, S. S. Shalyt, and V. M. Muzhdaba, JETP 47, 444 (1964), Soviet Phys. JETP 20, 294 (1965).

[3] R. C. Caldwell and H. Y. Fan, Phys. Rev. 144, 664 (1959).

[4] I. N. Timchenko and S. S. Shalyt, FTT 4, 3612 (1962), Soviet Phys. Solid State 4, 2642 (1963).

[5] W. R. Datars, G. Fischer, and P. C. Eastman, Canad. J. Phys. 41, 178 (1963).

1) The authors of [5] conclude with no particular certainty that g = 2 for free holes in Te.

ELECTROOPTICAL EFFECT IN GaAs

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The optical properties of semiconductors placed in strong electric fields have been the subject of many theoretical and experimental studies. Most of them describe the behavior of the absorption edge. Some papers present also data on the variation of the refractive index of homogeneous Ge [1] and Si [2] in an external electric field and in the field of a p-n junction in GaP [3] and GaAs [4,6]. We have investigated the change in the refractive index n in homogeneous semi-insulating GaAs placed in an external electrostatic field, and observed also the shift of the absorption-band edge.

As noted many times by a number of authors [1,2,5-7], a change in the absorption in an electric field should be accompanied, by virtue of the Kramers-Kronig relations, by a change in the refractive index. In general, however, a direct substitution of the formulas of [8-10] into the dispersion relations does not yield the correct results, since the dispersion relation between the imaginary and real parts of the dielectric constant $\epsilon_{ik}(\omega)$ is integral in the frequency, whereas the formulas of [8-10] are valid only in a narrow range of frequencies near the absorption edge. On the other hand, a direct calculation for semiconductors with cubic lattice, having no inversion center and having isotropic effective mass, leads to the following dependence of $\epsilon_{ik}(\omega)$ on the field $\vec{E}$ and on the frequency ω when $\hbar\omega < \Delta$: