We have confined ourselves to exchange terms of order not higher than the second in the powers of the ferromagnetism vector $\vec{M}$. The term with the introduced constant β indicates that in this substance there exists a linear magnetoelectric effect of exchange origin (since $\beta l_x \vec{M}\cdot\vec{P}$ does not depend on the orientation of the magnetic vectors relative to the crystallographic axes). Incidentally, a linear magnetoelectric effect should be observed for any antiferromagnetic ordering in the Td group.

If $G > 0$, then the vector $\vec{L}$ is parallel to one of the fourfold axes and $P_0 = 0$. If $G < 0$, then $\vec{L}$ is parallel to one of the C_3 [4] and

$$P_0^z = -\kappa a l_x l_y; \quad P_0^y = -\kappa a l_z l_x; \quad P_0^x = -\kappa a l_y l_z.$$

Another interesting effect occurring if invariants of the type (1) are present in the expansion of the thermodynamic potential is the rotation of the vector $\vec{L}$ by the electric field. Thus, for example, in the case under consideration, directing the field parallel or antiparallel to the z axis reverses the sign of the product $l_x l_y$, i.e., it rotates $\vec{L}$ through 90° (this was observed in [5]).

This and similar questions will be considered in detail separately.

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INFLUENCE OF ELECTROMAGNETIC FIELD ON ELASTIC SCATTERING OF ELECTRONS IN SEMICONDUCTORS

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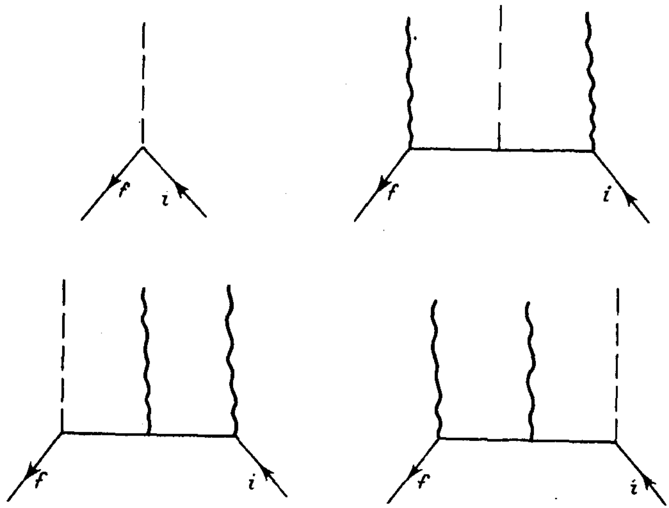
It has been established in a number of experiments that the electric conductivity of semiconductors is altered by microwave and optical radiation. This effect is usually attributed to "heating" of the electrons - to a change of the electron energy distribution, brought about by absorption of electromagnetic radiation by the carriers [1].

We wish to call attention to the fact that in a certain frequency range the dependence of the electric conductivity on the field is determined essentially by a different effect, namely the direct influence of the electromagnetic field on the elastic scattering of the electrons.

The amplitude of the probability of the elastic scattering is equal to the sum of the terms described by the diagrams shown in the figure (if we confine ourselves to second-order terms in the electromagnetic field). The first diagram describes the usual elastic scattering of an electron by an impurity ion or a phonon; the remaining diagrams describe the electron scattering accompanied by virtual absorption and emission of a photon. It is the latter



process which leads to the dependence of the elastic-scattering cross section on the electromagnetic field. The state of the magnetic field does not change; the field quantum is the "catalyst" of the reaction.

The cross section for the scattering of an electron by an ionized impurity in an alternating electric field $\vec{E}_0 \cos\omega t$ is

$$\Sigma = \Sigma_p[1 + \zeta(\epsilon_i)(\cos\theta_i \cos\theta_f - \cos^2\theta_i - \cos^2\theta_f)]$$
$$\zeta(\epsilon) = 2e^2E_0^2\epsilon/\mu\omega^2(\hbar\omega)^2. \qquad (1)$$

Here Σ_p is the Rutherford scattering cross section, μ and ε_i the electron effective mass and energy, and θ_i and θ_f the angles between $\vec{E}_0$ and the initial and final electron momenta.

The dependence of the scattering cross section on the radiation intensity changes the conductivity of the semiconductor upon irradiation. The relative change of the conductivity is $\delta\sigma/\delta\sigma_0 \sim \zeta(\varepsilon)$, where $\varepsilon \sim KT$ for a nondegenerate semiconductor and is the Fermi energy for a degenerate one (σ_0 is the dark conductivity). This holds also for electron scattering by acoustic phonons. The reatio of the photoconductivity $\delta\sigma$ to the photoconductivity $\delta\sigma_h$ connected with electron heating is $\delta\sigma/\delta\sigma_h \sim \gamma(\varepsilon/\hbar\omega)^2$, where γ - fraction of the energy lost by the electron in the collision. It is obvious that our analysis is bounded on the low-frequency side by the condition $\omega \ll \nu$ - the frequency of collision with the ions or phonons, for only in this case can the electromagnetic wave be regarded as monochromatic. If we assume for scattering by the acoustic oscillations $\gamma \sim 10^{-2}$ with $\varepsilon \sim 10^{-2}$ eV and $\hbar\omega \sim 10^{-4}$ eV, then $\delta\sigma/\delta\sigma_h \sim 10^2$. This effect can be appreciable also for fields of higher frequencies at higher light intensities, when $\varepsilon \gg \hbar\omega$ as a result of the heating of the electrons by the light

We note, finally, that formula (1) can be verified by direct measurements of the differential cross section of charged-particle scattering.

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