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OSCILLATIONS OF THE PHOTOMAGNETIC EFFECT WITH THE MAGNETIC FIELD

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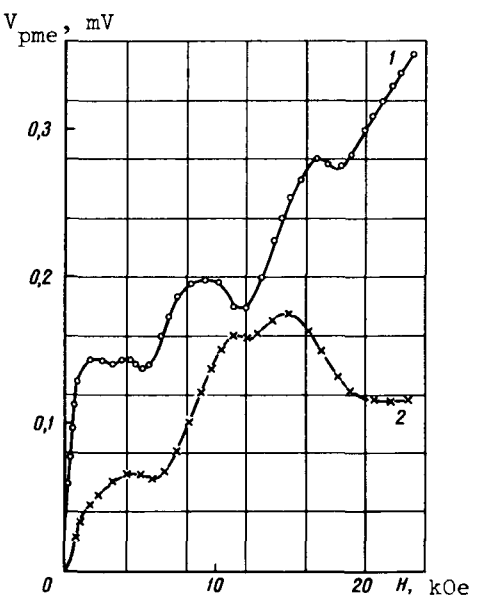
It might be expected on the basis of general considerations that the magnitude of photomagnetic effects in semiconductors should oscillate under certain conditions with the magnetic field. Recently, at the suggestion of Yu. M. Kagan, a theory was developed [1], from which it follows that oscillations of the photomagnetic effect should be observed in relatively weak magnetic fields if the following conditions are satisfied: the carrier relaxation time is $\tau \gg m^*c/eH \equiv 1/\omega$ (m^* = carrier effective mass, H = magnetic field intensity, c = velocity of light, e = electron charge, ω = carrier cyclotron frequency), and the Fermi energy is $E_F \gg \hbar\omega \gg kT$. These conditions are satisfied by indium antimonide at low temperatures. We have therefore undertaken an investigation of both the even and odd photomagnetic effects in InSb in magnetic fields up to 23,000 Oe at liquid-helium temperature (T = 4.2°K). The carrier density in the investigated sample was 10^{15} at/cm^3. The sample was equipped with two electrodes for the measurement of the odd photomagnetic emf, and two electrodes perpendicular to them to measure the even photomagnetic emf. During the investigation of the even photomagnetic effect the plane of the sample was inclined 30° to the direction of the magnetic field. Measurements of the even photomagnetic emf were made in the direction of the projection of the magnetic field on the plane of the sample [2].



The figure shows the odd and even photomagnetic emf's (curves 1 and 2, respectively), as functions of

the magnetic field intensity H.

We see from the figure that the oscillations begin at relatively weak magnetic fields, 2000 Oe, for the odd photomagnetic effect, and at 4000 Oe for the even effect.

The experimental data for the odd effect agree qualitatively with the theory of [1]. As to the even effect, in view of the absence of a quantitative theory, we regard its interpretation as premature. We plan to carry out in the nearest future investigations of the oscillations of the Hall effect and of the planar Hall effect with the same samples.

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POPULATION INVERSION IN ADIABATIC EXPANSION OF A GAS MIXTURE

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Several new methods of obtaining population inversion have been proposed recently [1-3]. We show in this article that in some mixtures of molecular gases, population inversion states in the vibrational levels are produced and exist for some time following the adiabatic expansion. To this end, the molecules of the mixture must differ appreciably in their vibrational relaxation times and be capable of exchanging vibrational-excitation energy.

Effective transfer of vibrational excitation between molecules of different species occurs when the energies of the vibrational levels of the molecules are close to each other. More accurately, for resonance exchange of vibrational-excitation energy it is necessary to satisfy the condition $|\Delta E| \ll kT$, where ΔE is the energy deficit.

By way of an example of resonant exchange of vibrational excitation we can cite mixtures of nitrogen with carbon dioxide or with nitrogen dioxide [4]. In the first mixture the exchange is between the level v = 1 of the N_2 molecule and the level $(0\ 0^0 1)$ of the CO_2 molecule. At room temperature the transfer probability in one molecule collision is $\alpha \sim 10^{-5}$.

We assume for simplicity that the concentration of the molecules that carry the vibrational excitation in the mixture is much larger than the concentration of the working molecules at whose levels the population inversion takes place. We can then assume during the description of the relaxation processes that the concentration of the excited carrier molecules in the mixture remains constant in time.

The equations that describe the change in the number of molecules of the working gas at three vibrational levels, of which one (the third) can exchange vibrational excitation with the level b of the carrier molecule (see the figure) are written in the form

$$\frac{dn_3}{dt} = -w_{ab}n_3 + w_{ba}n_1 - w_{31}n_3 + w_{13}n_1 - w_{32}n_3 + w_{23}n_2,$$

$$\frac{dn_2}{dt} = w_{32}n_3 + w_{12}n_1 - w_{23}n_2 - w_{21}n_2; \quad n_1 + n_2 + n_3 = n.$$