of the vector $\vec{r}$, respectively. The remaining notation is clear from Fig. 2.

It can be assumed that the process described here explains the appearance of radiation on a non-luminescent screen under the influence of an electron beam, which was observed by Schwarz and Hora [1]. Jumps of the amplitude of the normal component of the electric field of the light wave occurred on the boundaries of a thin crystal plate placed by them in the light beam. The parameter LeE/mV^2 (see above) could, under the conditions of [1], be of the order of unity (the presence of two jumps on the two faces of the plate could change only the amplitude of the electron-velocity modulation, cf. [2]).

Without a detailed knowledge of the electron beam geometry, the light intensity can be estimated only very approximately. At an electron-beam divergence angle 10^{-4} rad (see [5]) the visual brightness under the conditions of [1] can be estimated at about 10^{-4} nit.

In conclusion, the author thanks G.A. Askar'yan and I.V. Tyutin for a discussion of the work.

[1] H. Schwarz and H. Hora, Appl. Phys. Lett. 15, 349 (1969).
[2] V.I. Kalinin and G.M. Gershtein, Vvedenie v radiofiziku (Introduction to Radiophysics), GITTL, 1957.
[3] L. D. Landau and E.M. Lifshitz, Teoriya Polya, Fizmatgiz 1960 (Classical Theory of Fields, Addison-Wesley, 1965].
[4] I.M. Frank, Usp. Fiz. Nauk 87, 189 (1965) [Sov. Phys.-Usp. 8, 729 (1966).
[5] P. Hirsch, A. Hovey, R. Nicolson, D. Pashley, and M. Whelan, Electron Microscopy of Thin Crystals , Butterworth, 1966.

NEW POLARON EFFECT IN THE INTERBAND MAGNETOOPTIC ABSORPTION OF SEMICONDUCTORS

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Singularities of interband magnetooptic absorption, occurring at $\Omega_c = \omega_0$ (Ω_c is the electron cyclotron frequency and ω_0 the frequency of the longitudinal optical phonons interacting with the electrons), have been recently observed experimentally [1] and calculated theoretically [2]. These singularities are connected with the fact that when $\Omega_c = \omega_0$, two branches of the electron-phonon-system spectrum intersect, namely, an electron on the bottom of the Landau band $\ell = 1$ and an electron on the bottom of the band $\ell = 0$ plus one optical phonon.

In principle, the intersection of the branches of the spectrum of the electron-phonon system can occur also without a magnetic field. For example, an electron with momentum $p = p_0 \equiv (2m_c\hbar\omega_0)^{1/2}$ and an electron with $p = 0$ plus a phonon with $\hbar\omega_0$. However, calculation shows that the three-dimensional character of the electron motion leads to a very weak singularity in the absorption coefficient. A much stronger singularity arises in the case of one-dimensional motion of the electron, which can be realized in a quantizing magnetic field.

The effect can be qualitatively understood from Fig. 1. The dashed line in the upper part of the figure (the parabola 1 and the line 2) represent two branches of the electron-phonon-system spectrum (without interaction): an electron in the band $\ell = 0$ with momentum p, and an electron in the band $\ell = 0$ with

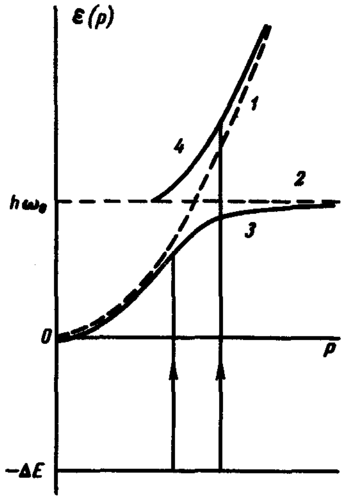

Fig. 1

zero momentum plus a phonon with momentum p. Allowance for the interaction leads, as shown by calculation, to the states of the bound system with branches 3 and 4.

We now consider the coefficient of interband absorption, assuming that the holes do not interact with the optical phonons, or that they lie in another region of momenta p. We shall first assume for simplicity that the hole mass is $m_v = \infty$. In the absence of electron-phonon interaction, the absorption is caused by the electron branch 1, and the absorption coeffliient $K_0(\omega)$ as a function of the light frequency ω is similar to the density of states in this branch (Fig. 2, curve 1). The interaction produces a particularly strong change in the spectrum at the branch-intersection point, corresponding to the optical frequency $\hbar\omega^* = \Delta E + \hbar\omega_0$, where ΔE is the width of the forbidden band with allowance for the shift of the bottom of the conduction band and of the top of the valence band in the magnetic field. $K(\omega)$ will have a singularity at this frequency. It is seen from Fig. 1 that the absorption is due to branch 3 if $\omega < \omega^*$ and to branch 4 if $\omega > \omega^*$ (the corresponding transitions are connected schematically by the vertical arrows). Calculation shows that the absorption coefficient has a dip at the point $\omega = \omega^*$, $K(\omega) = 0$ (Fig. 2, curve 2), since the state of the quasiparticle with the corresponding momentum contains a small contribution of the electron state with the same momentum. If the dispersion in the valence band is not neglected, then the singularity occurs at the same frequency ω^*, but $k(\omega^*) \neq 0$ and has a minimum at $\omega = \omega^*$, where the derivative becomes discontinuous (Fig. 2, curve 3).

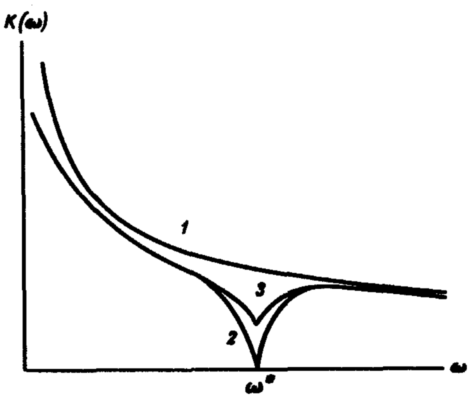

Fig. 2

The described effect is similar to the observed splitting of the peak in interband magnetooptic absorption [1], since this splitting is actually the result of an absorption dip near resonance. It is therefore natural to expect it to appear in n-InSb under the same conditions at which splitting of the resonance peak was observed. The effect, however, is not connected with the resonance condition $\Omega_c = \omega_0$, and should be observed on the slope of the resonant peak.

The calculation scheme follows [2], where the absorption coefficient is expressed in terms of the Fourier transform of the electron Green's function. If we limit ourselves for simplicity to the case $\Omega_c \gg \omega_0$, then only the Green's function of the electron with $\ell = 0$ has to be determined. The first approximation for the mass operator in terms of the electron-phonon coupling α yields

$$\Sigma_1(\omega) = -i\alpha\hbar\omega_0\left(\frac{\omega_0}{\omega-\omega_0}\right)^{1/2}, \quad (\Sigma_1(\omega) < 0, \text{ if } \omega < \omega_0). \tag{1}$$

The absorption near the singularity has in this approximation, at $m_v = \infty$, the form

$$K_1(\omega) \sim \mathrm{Re}\,[\hbar\omega - \Delta E - \Sigma_1(\omega + \omega_0 - \omega^*)]^{-1/2}. \qquad (2)$$

Allowance for the higher-order approximations in Σ shows that the approximation cannot be used in a "forbidden" interval of order of $\alpha\omega_0$ near ω^*. This expression is meaningful, however, since the characteristic interval of ω near ω^*, where $dK_1/d\omega$ differs noticeably from $dK_0/d\omega$, is $\alpha^{2/3}\omega_0$, which is larger than the "forbidden" interval. The most significant among the higher-order diagrams are those without intersection of the phonon lines. The summation of these diagrams leads to a renormalization of ω^* by an amount on the order of $\alpha\omega_0$ and to a narrowing of the "forbidden" interval to $\alpha^2\omega_0$.

In the foregoing calculation, just as in [2], no account was taken of the Coulomb interaction between the electron and the hole; this interaction can lead to exciton effects near the singularity in question. If this interaction is appreciable, then the character of the singularity near ω^* may change. But even in the latter case, no singularity of the absorption occurs near ω^*.

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[1] E.J. Johnson,and D.M. Larsen, Phys. Rev. Lett. 16, 655 (1966); J. Phys. Soc. Japan Suppl. 21, 443 (1966).
[2] L.I. Korovin and S.T. Pavlov, Zh. Eksp. Teor. Fiz. 53, 1708 (1967) [Sov. Phys.-JETP 26, 979 (1968)].

EXCITATION OF STIMULATED LIGHT SCATTERING BY BROAD-SPECTRUM PUMPING

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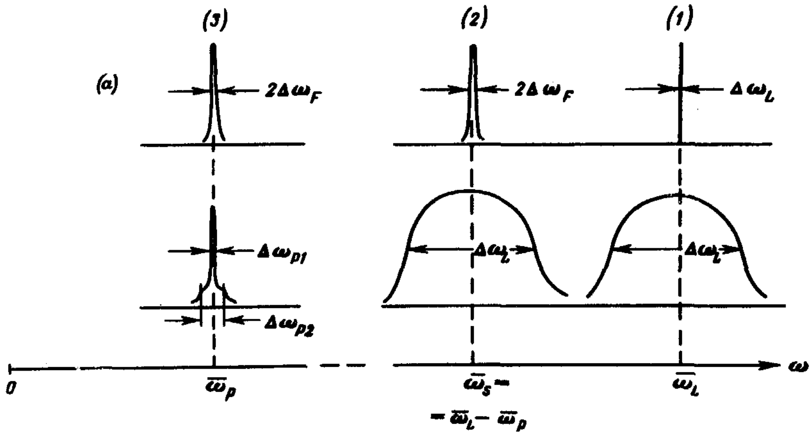
1. To observe stimulated Mandel'shtam-Brillouin scattering (SMBS) and stimulated Roman scattering (SRS) in the stationary regime, the pump laser is chosen to have a bandwidth $\Delta\omega_L$ narrower than the bandwidth $\Delta\omega_0$ of the spontaneous scattering.



Theoretical spectra of pump (1), the scattered light (2), and the hypersound in the case of narrow-band (a) and broadband (b) exciting radiation.

We have made estimates that show that it is possible to use just as effectively (without a decrease in the scattering efficiency at a given average pump intensity $\bar{I}_L$) stationary pumping with a broad spectrum ($\Delta\omega_L \gg \Delta\omega_0$). The smearing of the pump spectrum, connected with the finite duration T of its p pulse, is assumed to be negligible: $\Delta\omega_L T \gg 1$, and also $\Delta\omega_0 T \gg 1$.