The presence of exchange interaction leads to excitation inside the metal, besides the ordinary electromagnetic wave, also of an exchange wave with a wave vector, say for the perpendicular configuration of the external field, given by $|k| = \sqrt{2\pi/A}\,M \approx 10^6$ cm^{-1} (A is the exchange constant). Inasmuch as the high-frequency susceptibility is 10^5 times larger than for the ordinary wave, the boundary conditions can be satisfied only if its amplitude is smaller than the amplitude of the ordinary electromagnetic wave by the same factor. Consequently the transparency of the ferromagnetic metal in the FMAR region is determined by the ordinary wave. Since the amplitude of the transmitted wave in the FMAR is

$$h \sim \frac{k}{\mathrm{sh}(kd)} ,$$

where d is the thickness of the plate, and

$$k_{\parallel} = \frac{2}{\delta_0}\sqrt{\frac{\Delta H_{\gamma}}{\omega}}, \quad k_{\perp} = \frac{1}{\delta_0}\sqrt{\frac{\Delta H}{2\pi M}},$$

it follows that in the case of samples for which $d \geq k_{\mathrm{FMAR}}^{-1}$ the shape and intensity of the FMAR is determined by the attenuation. The values of the Landau-Lifshitz relaxation constant λ, calculated from the results of our FMAR and FMR measurements, are the same; $\lambda_{\mathrm{exp}} \approx 1.4 \times 10^8$ rad/sec.

In conclusion, we wish to thank P. L. Kapitza for making it possible to perform this work, and A. S. Borovik-Romanov for stimulating interest in the work, valuable advice, and discussions. We are grateful to A. I. Shal'nikov for great help in the preparation of the experiments, and Doctors Kaganov, Blank, Frait, and Kamberskii for useful discussions.

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TWO-PHONON PROCESSES IN INELASTIC ELECTRON SCATTERING IN n-InSb

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When the condition for magnetophonon resonance (MPR)

$$\epsilon_{N,S} - \epsilon_{L,S'} = \hbar\omega_0, \; (N, L = 0, 1, 2, \ldots; \; S = S' = \pm\frac{1}{2}) \qquad (1)$$

is satisfied, a number of extrema should appear on the curves of longitudinal ($\rho_{\parallel}$) and transverse ($\rho_{\perp}$) magnetoresistance. In formula (1), $\epsilon_{N,S}$ is the energy of the N-th Landau level with given orientation of the spin S, and ω_0 is the limiting frequency of the optical phonons. Experimental investigations have shown that, in accord with the theory, the transverse magnetoresistance of the n-InSb samples has maxima at magnetic field values

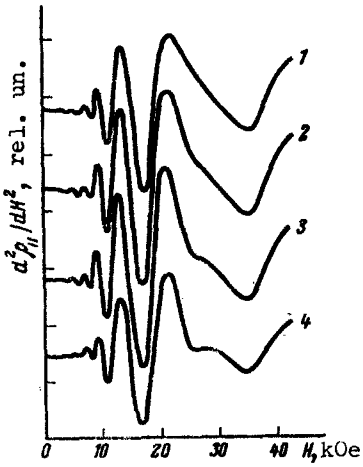

Fig. 1. Dependence of $d^2\rho_{\parallel}(H)/dH^2$ on the magnetic field intensity at temperatures 93°K (1), 111°K (2), 128°K(3), and 144°K (4).

H = 34, 17, ~11, ~8.5, and ~6.7 kOe (the transitions $\varepsilon_{1,S} \leftrightarrow \varepsilon_{0S}$ and $\varepsilon_{5,S} \leftrightarrow \varepsilon_{0,S}$ respectively), and the longitudinal magnetoresistance has minima at the same fields [3].

It was observed in [4] that, besides the indicated extrema of $\rho_{\perp}$ (H), n-InSb has also a maximum at H = 82 kOe, and $\rho_{\parallel}$ (H) has a minimum at H = 24 kOe. The appearance of these additional extrema was attributed in [4] to resonant scattering of the electrons by optical phonons, accompanied by a change of the orientation of the electron spin. According to such an interpretation, the minimum of $\rho_{\parallel}$ (H) at 24 kOe should be due to transitions of the $\varepsilon_{1,1/2} \leftrightarrow \varepsilon_{0,-1/2}$ type. The position of the maximum due to these transitions makes it possible to determine directly the quantity g_0, the spectroscopic splitting factor of the electrons at the bottom of the band. It turns out to equal ~63, whereas spin-resonance experiments [5, 6] yield, in accord with Roth's formula [7], a value $|g_0| \approx 50$.

It must be noted that both additional extrema were small in amplitude, and they could be observed only by subtracting from the total magnetoresistance the part (background) linear in the magnetic field.

We report in this paper an investigation of magnetophonon oscillations of $\rho_{\perp}$ (H) and $\rho_{\parallel}$ (H) of n-InSb samples with $n = 2 \times 10^{14}$ cm^{-3}. The use of the method of double differentiation of the magnetoresistance curve has made it possible to increase greatly the resolution of the nonmonotonic components of $\rho_{\perp}$ (H) and $\rho_{\parallel}$ (H). In addition, we investigated the temperature dependence of the amplitude of the magnetophonon peaks (the measurements in [4] were made only at 120°K).

As seen from Fig. 1, an additional minimum, located at H ≈ 25 kOe, appears on the $d^2\rho_{\parallel}(H)/dH^2$ curve at T > 110°K. The depth of this minimum increases with temperature even when the amplitude of the ordinary magnetophonon minima begins to decrease.

The $d^2\rho_{\perp}(H)/dH^2$ curve has an additional maximum at H ≈ 82 kOe (Fig. 2). The temperature dependence of the amplitude of this maximum also differs from the temperature dependence of the amplitudes of ordinary magnetophonon maxima.

The anomalous temperature dependence of the amplitudes of the additional extrema, i.e., their increase with increasing temperature in the temperature region where the amplitudes of the ordinary magnetophonon extrema decrease, suggests that these extrema are due to electron inelastic resonant scattering in which two optical phonons take part. Indeed the probability of the two-phonon scattering process below the Debye temperature is proportional to $\exp(-2\hbar\omega_0/kT)$, while the probability of single-phonon scattering is proportional to $\exp(-\hbar\omega_0/kT)$.

In the case of two-phonon scattering, the MPR condition (1) takes the form

$$\epsilon_{N,S} - \epsilon_{L,S} = 2\hbar\omega_0. \qquad (2)$$

For a non-parabolic Kane conduction band in InSb we have

$$\epsilon_{N,S} = -\frac{\epsilon_g}{2} + \sqrt{\frac{\epsilon_g^2}{4} + \epsilon_g\left[\left(N + \frac{1}{2}\right)\hbar\Omega + S|g_0|\mu_B H\right]} \qquad (3)$$

where ϵ_g is the width of the forbidden band, $\Omega = eH/m^*_0c$ is the cyclotron frequency, m^*_0 is the effective mass of the electron at the bottom of the band, and μ_B is the Bohr magneton. Condition (2) for the known parameters of InSb, namely $m^*_0 = 0.014m_0$, $\epsilon_g(140°K) = 0.21$ eV, $|g_0| = 50$, and $\omega_0 = 3.7 \times 10^{13}$ sec^{-1}, corresponds to magnetic fields 83.5 kOe ($\epsilon_{1,S} \leftrightarrow \epsilon_{0,S}$ transition), 39 kOe ($\epsilon_{2,S} \leftrightarrow \epsilon_{0,S}$), 25.5 kOe ($\epsilon_{3,S} \leftrightarrow \epsilon_{0,S}$), and 18.5 kOe ($\epsilon_{4,S} \leftrightarrow \epsilon_{0,S}$). Thus the minimum of $\rho_{\parallel}(H)$ at 25 kOe corresponds to two-phonon resonant scattering of electrons between the zeroth and third Landau levels, and the maximum of $\rho_{\perp}(H)$ at 82 kOe corresponds to two-phonon scattering between the zeroth and first Landau levels.

It is seen from Figs. 1 and 2 that the intensity of the peaks due to two-phonon processes is low. When the double-differentiation method is used, the various peak amplitudes shown in Figs. 1 and 2 are distorted, since they are proportional to the factor $\alpha(H^2_m - H^2_{res})/(\Delta H)^2$, where H_m is the maximum field at which the $\rho(H)$ curve is plotted (107 kOe on Fig. 2), H_{res} is the field at which the given peak is located, ΔH is the half-width of this peak, and $\alpha \approx 0.5$.$^{1)}$ As to the true amplitude of the two-phonon peaks, estimates show that, for example in the case of transverse magnetoresistance, the amplitude of the two-phonon maximum at 163°K is about 20% of the amplitude of the most intense single-phonon maximum, located at 35 kOe, or about 1% of the entire magnetoresistance. Some of the two-phonon extrema almost coincide in position with the much more intense single-phonon ex-

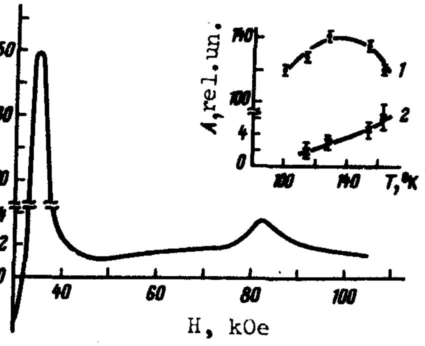

Fig. 2. Dependence of $d^2\rho_\perp(H)/dH^2$ on the magnetic field intensity at 163°K. In the upper right corner is shown the dependence of the amplitude of the m maximum A of $d^2\rho_\perp(H)/dH^2$ at 34 kOe (curve 1) and 82 kOe (curve 2) on the temperature.

trema. In addition, the longitudinal magnetoresistance in n-InSb has a deep minimum at 75 kOe [8]. These are apparently the reasons why we were not able to observe all the peaks due to two-phonon transitions.

It is thus clear from our results that the two-phonon processes make a definite contribution to the magnetoresistance of n-InSb.

The appearance of additional minima with increasing temperature was observed by Stradling and Wood [9] in an investigation of the longitudinal magnetoresistance of n-InAs and n-GaAs in constant magnetic fields up to 140 kOe, and was also attributed by them to two-phonon resonance transitions.

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SCATTERING ASYMMETRY AND POLARIZATION OF THE PHOTODISINTEGRATION PRODUCTS OF ^{4}He

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A study of the scattering asymmetry and polarization of photo-nuclear reaction products, together with their angular distributions, makes it possible to estimate in an independent manner the contributions of small electric and magnetic multipoles in γ-quantum absorption, to choose and refine the type of the nucleon-nucleon interaction potential, and to obtain information on the nuclear structure.

So far, experimental and theoretical studies of the asymmetry of scattering and polarization of photoproducts have been made on few nuclei [1 - 5]. There are no published theoretical calculations and experimental measurement data on the asymmetry of the scattering and polarization of the photodisintegration products of ^{4}He.

Preliminary measurement results on the asymmetry of the scattering and polarization were obtained for p and ^{3}H from the reaction

$$^4\text{He} + \gamma \to p + {}^3\text{H} \tag{1}$$

and for ^{3}He from the reaction

$$^4\text{He} + \gamma \to n + {}^3\text{He} . \tag{2}$$

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