lower energies. Consequently, measurement of the phases of the amplitudes on deuterons in the region of energies attainable by the Serpukhov accelerator would be a sensitive method of verifying the Pomeranchuk theorem. It is important to note that it would be particularly useful to determine the energy dependence of these phases, and not merely their values at one energy, since the predictions for each value of $\alpha_{\pm}$ and α_{reg} have been determined from the d.r. only accurate to an additive constant.

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TEMPERATURE DEPENDENCE OF MOBILITY AND LONGITUDINAL MAGNETORESISTANCE OF p-Ge IN A STRONG MAGNETIC FIELD

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In order to study the electron-phonon interaction in germanium, we undertook a measurement of the temperature dependence of the mobility of p-Ge in a strong magnetic field up to 100 kOe in the temperature interval 62 - 200°K.

The experimental and theoretical study of the electron-phonon interaction in germanium has been the subject of a number of papers, a review of which is given in [1]. The reason for the interest in this question is the fact that the mobility $\mu(T)$ in p-Ge varies like $\mu(T) \sim T^{-2.3}$ in the temperature interval 125 - 300°K, whereas in N-Ge the variation is $\mu(T) \sim \mu T^{-1.6}$. A theory that takes into account the scattering of the carriers by the deformation potential of the lattice yields, in the case of a single-valey semiconductor, the relation $\mu(T) \sim T^{-1.5}$, which is close to that observed in the case of n-Ge, although the latter is a many-valley semiconductor. A rigorous theoretical analysis of the temperature dependence of the mobility in a real semiconductor is quite difficult, since the theory includes unknown constants of the interaction between the electrons and the acoustic or optical phonons, as well as the constants of the intervalley scattering. These are usually determined by fitting the theoretical dependence of the mobility of that observed in the experiment. The mobility dependence $\mu(T) \sim T^{-2.3}$ in p-Ge is attributed to the strong interaction between the holes and the optical phonons. It must be borne in mind here, however, that a distinguishing feature of p-Ge is the presence of two types of holes, light with an effective mass $m_1 \simeq 0.04m_0$ (m_0 is the free-electron mass), and heavy with mass $m_2 \simeq 0.3m_0$.

In the analysis of the temperature dependence $\mu(T)$ in p-Ge, no account was taken of the influence exerted on the mobility by each type of hole separately. The mobility of p-Ge in the presence of one type of hole can be experimentally measured in a strong magnetic field. If a strong field of intensity 100 kOe is applied, then the condition $(\hbar\omega_c/2) > kT$ will be satisfied for the light holes in the temperature interval 62 - 100°K. The light holes will then go over into the band with the heavy effective mass, for which no quantization sets in, and the temperature dependence of the mobility will be determined by the interaction between the phonons and the heavy holes only.

We used for the measurements samples with low doping-impurity contents (the hole density was 3×10^{12} cm^{-3}), making it possible to exclude the influence of the impurity scattering on the mobility. The constant magnetic field was produced by the "Solenoid" apparatus [2]. The temperature was measured and stabilized by a method similar to that in [3].

At temperatures up to 180°K, it is possible to neglect the influence of the intrinsic conductivity, and it can therefore be assumed that the sample resistance varies with temperature in inverse proportion to the mobility, $R(T) \sim 1/\mu(T)$. If we represent $\mu(T)$ in the form $\mu(T) \sim T^{-\gamma}$, where $\gamma > 0$, then measurement of the temperature dependence of the resistance $R(T)$ makes it possible to establish whether the exponent of the temperature dependence varies when a strong magnetic field is applied.

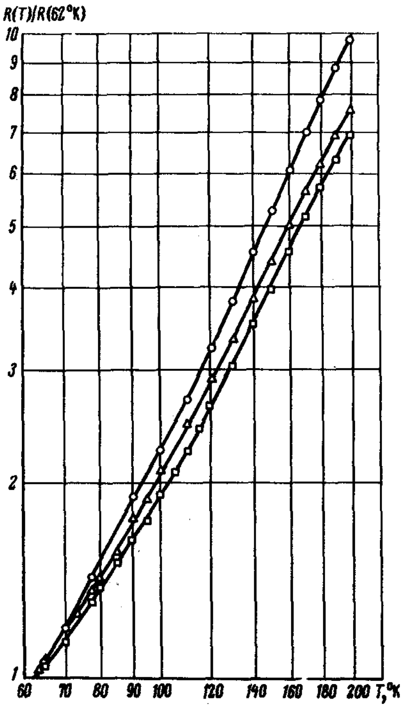

Fig. 1. Temperature dependence of relative variation of the resistance R(T) of p-Ge in a magnitudinal magnetic field: circles - h = 0, triangles - H = 25 kOe, squares - H = 100 kOe.

Figure 1 shows plots of R(T)/R(62°K) against T at H = 0, 25, and 100 kOe, drawn through experimental points plotted in steps of 5 - 10°K in the temperature interval 62 - 200 °K. The intrinsic conductivity comes into play at T > 180°K and a bend appears in the R(T) curve. In the 130 - 180°K interval at H = 0, it is seen that $\mu(T) \sim T^{-2.3}$. With decreasing temperature, γ decreases, as predicted by the theory of [1]. At H = 25 and 100 kOe, we have $\gamma \simeq 1.9 - 2.0$ in the same temperature interval. In the temperature interval 75 - 110°K we have $\gamma \simeq 2.0$ at H = 0, $\gamma \simeq 1.7 - 1.8$ at H = 25 kOe, and $\gamma \simeq 1.5$ at H = 100 kOe.

Thus, the exponent of the temperature dependence of the mobility $\mu(T)$, plotted for heavy holes only in the temperature interval 75 - 110°K coincides with the value $\gamma = 1.5$ given by the theory for a single-valley semiconductor. With further rise in temperature, γ increases. This can be attributed to the fact that at temperatures 150 - 180°K we have $(\hbar\omega_c/2) \simeq kT$, and the holes begin to move from the band with the heavy effective mass into the band with the light effective mass. In addition, the heavy holes also interact with the optical phonons, the number of which increases exponentially with the temperature.

First, the contribution of the light holes to the conductivity is large at H = 0, as is evidenced by the large change of γ when a strong magnetic field is applied. This is natural, since the carrier mobility in scattering by phonons is

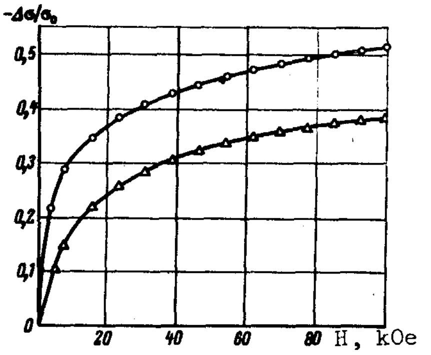

Fig. 2. Relative decrease of the conductivity, $-\Delta\sigma/\sigma_0$, in a longitudinal magnetic field for two temperatures, 77°K (circles) and 155°K (triangles).

proportional to $m^{-5/2}$ [1], although the fraction of the light holes is determined by the mass ratio $(m_1/m_2)^{3/2}$ and amounts to only 4%. Second, the light holes interact strongly with the optical phonons, the number of which decreases exponentially with temperature, leading to a stronger temperature dependence of the mobility than the predicted $\mu(T) \sim T^{-1.5}$.

From the fact that the light holes makes a large contribution to the conductivity it can be concluded that their quantization should also lead to the appearance of longitudinal magnetoresistance, as was indeed observed by us in the experiment.

Figure 2 shows plots of the relative change of conductivity, $-\Delta\sigma/\sigma_0$, in a magnetic field H for two temperatures, 77 and 155°K. We see that $-\Delta\sigma/\sigma_0$ first changes rapidly with increasing magnetic field, and the change slows down when $H > 60$ kOe, but the behavior of the curves in the region of rapid variation of $-\Delta\sigma/\sigma_0$ is different for 77 and 155°K. Doubling the temperature causes the rate of the rapid change of $-\Delta\sigma/\sigma_0$ as a function of H to be approximately half as large for T = 155°K as for T = 77°K; this should indeed be the case if the change of the conductivity is due to the quantization of the light-hole band and is a function of $\eta = (\hbar\omega_c/kT)$.

The slow change of $-\Delta\sigma/\sigma_0$ when $H > 60$ kOe can be attributed to a certain nonsphericity of the constant-energy surface of the heavy holes [4].

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PARAMAGNETIC STRUCTURE DUE TO EXCHANGE INTERACTION OF ELECTRONS IN A METAL

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The theoretical prediction of diamagnetic domains and periodic diamagnetic structures in normal metals, and the subsequent experimental observation of their manifestations [1, 2] has resulted by now in a large number of theoretical papers (cf., e.g., the review [3]) providing a definite understanding of the nature of such a structure. An important feature of the domains discussed in this case is that their nature is governed to a considerable degree by the quantization of the electron levels in the magnetic field. Therefore, the diamagnetic structures are connected with quantum de Haas - van Alphen magnetization oscillations. In this paper we indicate another possibility, of a different physical nature, of the existence of inhomogeneous magnetic structures in normal metals. Such structures are possible under conditions when the quantization of the orbital motion of the electrons is insignificant, and consequently the magnetization oscillations are likewise insignificant. At the same time, the magnetic structures discussed below can occur in sufficiently strong fields.

An indication of the existence of a spatially inhomogeneous static state of a metal with different values of magnetization at different points of space can be obtained with the aid of the dispersion equation for the electromagnetic waves in a metal. Namely, the presence of solutions of such an equation in the