

are playing an important part in the lattices of the above elements along with the metallic type of bond.

The basic experimental data on the de Haas-van Alphen effect (the complicated frequency spectrum, large periods and amplitudes of the susceptibility oscillations), as well as the variation of the susceptibility of these elements with temperature, are explained by the well-known assumption that these elements contain one or more exceptionally small groups of mobile charges besides the large fundamental group. The origin of these exceptionally small groups has not been explained; it is possible that the complicated energy spectrum of the mobile charges is connected with the above-mentioned mixed types of bonds in the lattices of these elements.¹⁴

The period of oscillation T of the magnetic susceptibility, caused by the small group β of the mobile charges, is determined by the area of the extremal section $S_m^\beta(\xi_\beta)$ through the Fermi surface for these charges:

$$T = eh / cS_m^\beta(\xi_\beta), \quad (1)$$

where ξ_β is the chemical potential, measured from the "bottom" of the β -energy zone. The investigation of the temperature variation of the oscillations of the magnetic susceptibility makes it possible to determine still another important characteristic of the energy spectrum of the mobile charges:

$$m_\beta = \frac{1}{2\pi} (dS_m^\beta / d\xi_\beta). \quad (2)$$

For the general case of an arbitrary dispersion law, m_β is a function of the lattice parameters a_i and of the chemical potential. In the special case of a quadratic dispersion law, m_β coincides with the effective mass of the charge carrier as usually defined. This mass depends only on the lattice parameters and not on the energy.

Very recently Kosevich¹⁵ has treated the effect of an elastic lattice deformation on the electron spectrum in a semi-quantitative manner and has considered the peculiarities of the de Haas-van Alphen effect in a deformed metal. The elastic deformation of the lattice (in particular the homogeneous compression of the lattice) leads to a change in the chemical potential

$$\delta\xi = \delta S_m^\beta / 2\pi \bar{m}_\beta, \quad (3)$$

where $\bar{m}_\beta = \frac{1}{2}(m_\beta^0 + m_\beta^p)$, and δS_m^β is the variation of the section through the Fermi surface under pressure.* In the case of a homogeneous compression

$\delta\xi = ap$, where

$$a = \delta\xi/p \quad (4)$$

is of the same order of magnitude as the volume occupied by one particle of the charge-carrier "gas" in the metal.

$\delta\xi$ may be of the order of ξ_β and then the elastic deformation of the lattice will change little the properties that are determined by the majority group of charges, and will change very strongly those properties which are determined by the minority group of charges. Thus, in spite of the fact that the deformation and consequently the relative changes of the lattice parameters are small, the chemical potential and the oscillation period of the susceptibility will change by a factor comparable to ξ_β and S_m^β , respectively. In the special case of a quadratic dispersion law, m_β depends neither on the energy nor, consequently, on the pressure.

The investigation of the temperature variation of the oscillation period of the susceptibility in the constrained and in the deformed crystal, carried out at $\theta = 80^\circ$, makes it possible to determine m_β^0 and m_β^p in this orientation, without any assumptions concerning the form of the dispersion law for the charge carriers in the small group, and hence to calculate $\delta\xi$ and a . The results of these calculations are given below.

$$\begin{array}{ll} T_p/T_0 = 1.355. & m_\beta^p \cdot 10^{29} = 7.5; \\ S_m^p/S_m^0 = 0.740. & \bar{m}_\beta \cdot 10^{29} = 6.3; \\ \delta S_m/S_m^0 = -0.260. & \delta\xi \cdot 10^{14} = -0.62 \text{ erg}; \\ m_\beta^0 \cdot 10^{29} = 4.9. & a \cdot 10^{23} = 0.36. \end{array}$$

A comparison of the quantities m_β^0 and m_β^p gives evidence of a considerable dependence of m_β on the pressure, i.e. of a non-quadratic dispersion law for the small group of mobile charges in zinc crystals.

From an analysis of the data quoted it can be seen that the changes of the chemical potential by homogeneous compression of the lattice under a pressure of $p \approx 1700 \text{ kg/cm}^2$ are of the same order of magnitude as the chemical potential of the charge carriers of the small group.^{12,16} The value of the parameter α , calculated on the basis of the experimental data, is also in good agreement with the value estimated for it by Kosevich¹⁵ from general considerations.

Since the theoretical determinations of these quantities are based on the assumption that there exist exceptionally small groups of charge carriers, one may conclude that the experiments on the homogeneous compression of the zinc crystals and the large changes in the oscillation periods and in the chemical potential detected in these experi-

*In what follows a zero in the superscript indicates a given quantity in the unconstrained crystal, and p in the superscript indicates the same quantity in the deformed crystal.