



FIG. 7. Angular dependence of the oscillation period of the susceptibility caused by the smallest group of mobile charges: a — for the unconstrained crystal Zn-2 and b — for the homogeneously compressed crystal Zn-2 at  $p = 1700 \text{ kg/cm}^2$ .

give the low-frequency component of the effect, caused by the smallest group of mobile charges in zinc. It may be seen that the homogeneous compression of the crystals under a pressure of  $p \approx 1700 \text{ kg/cm}^2$  changes very markedly all the characteristics of the  $\Delta\chi(1/H)$  curves: the period of the oscillations increases noticeably, the amplitude of the oscillations decreases by a large factor (particularly in small fields), and the maximum of the attenuated  $\Delta\chi(1/H)$  curves is displaced towards greater field strengths.

The curves of Fig. 7 illustrate the angular dependence of the period of oscillation of the susceptibility without pressure and for a homogeneously-compressed crystal. It can be seen that the period of oscillation has increased in the homogeneously compressed crystal for all values of the angle  $\theta$ . This increase in the period of oscillation is somewhat larger for small angles, where it reaches 48%, and somewhat less for large angles, where it equals 40 to 43%.

The homogeneous compression of the crystal also changes the period and the amplitude of the oscillations of the fine structure of the de Haas — van Alphen effect. The high-frequency oscillations

do not disappear under pressure, but their period increases noticeably; at  $\theta = 80^\circ$  the increase in the period of oscillation of the fine structure amounts to 12%. The amplitude of the high-frequency oscillations decreases under pressure.

The numerical values of the periods of oscillation for the low-frequency and high-frequency components of the  $\Delta\chi(1/H)$  curves are listed in Table I for Zn-2 crystals, unconstrained and under homogeneous compression. On removing the pressure the values of the periods of oscillation are completely restored.

The homogeneous compression of the crystals leads to a strong decrease in the amplitude of the oscillations. The decrease in the amplitude of the oscillations under pressure is particularly pronounced for large values of  $\theta$  and for small fields. On removing the pressure the amplitude of the oscillations is not completely restored. The hysteresis is greatest for small fields; it decreases with increasing field strength.

The temperature variation of the amplitude of the oscillations, caused by the smallest group of mobile charges in unconstrained and in homogeneously-compressed crystals, has been investigated at  $\theta = 80^\circ$ . Numerical values for the ratio of the amplitudes of the oscillations  $A_2/A_1$  are given in Table II for different values of  $1/H$  and for two different experimental temperatures.

## 5. DISCUSSION OF THE RESULTS

The de Haas — van Alphen effect is a feature common to a group of 15 elements, in which the absolute magnitude of the susceptibility increases with decreasing temperature and which crystallize in anisotropic structures (in many cases in lamellar structures). In crystal chemistry it is usually assumed that complicated mixed types of interaction (partially covalent or van der Waals forces)

TABLE I

Period of oscillation $T \times 10^4, \text{Oe}^{-1}$					
$\theta^\circ$	Low-frequency component $\Delta\chi(1/H)$		$\theta^\circ$	High-frequency component $\Delta\chi(1/H)$	
	$p = 0$	$p \approx 1700 \text{ kg/cm}^2$		$p = 0$	$p \approx 1700 \text{ kg/cm}^2$
10	0.516	0.763	80	0.0138	0.0154
20	0.494	0.724	84	0.0125	0.0145
30	460	650			
40	405	570			
50	340	484			
55	303	435			
60	276	387			
65	237	338			
70	196	283			
74	157	224			
80	93	126			

TABLE II

$p = 0; T_1 = 4.2^\circ\text{K}, T_2 = 2.0^\circ\text{K}$		$p = 1700 \text{ kg/cm}^2; T_1 = 4.2^\circ\text{K}, T_2 = 1.6^\circ\text{K}$	
$(1/H) \cdot 10^4, \text{Oe}^{-1}$	$A_2/A_1$	$(1/H) \cdot 10^4, \text{Oe}^{-1}$	$A_2/A_1$
1.2	3.2	0.8	2.2
1.1	2.7	0.75	2.7
1.0	1.9	0.7	2.2
0.9	1.5	0.65	2.0
0.8	1.0	0.6	1.8
0.7	1.05	0.55	1.42
0.6	1.09	0.5	1.23