atoms in the discharge; $\langle Q_i \rangle$ and $\langle Q_a \rangle$ are the corresponding cross sections for the electric conductivity. Estimates indicate that in our case the term $N_i \langle Q_i \rangle$ $(\langle Q_i \rangle \sim 10^{-14}$ cm$^2)$ can be neglected, with accuracy ~15%, compared with the term $N_a \langle Q_a \rangle\ k_\sigma(0) \sim 1$. The electric-conductivity cross section $\langle Q_a \rangle$ was calculated as a function of the electron temperature by P. L. Rubin 1). It is equal to 8×10^{-16} cm^2 at 5×10^4 °K and 6×10^{-16} cm^2 at 9×10^4 °K. The calculated values of N_e are listed in the table. They are in satisfactory agreement with the values experimentally determined from the half width of the hydrogen line H_β. It is also seen from the table that when j is doubled, N_e (the electron concentration) also almost doubles. Summarizing, we can state that the foregoing investigations have yielded the basic characteristics of the discharge used for the argon ionic laser, which are of undisputed interest for the explanation of the mechanism that ensures population inversion. We emphasize that the fact established by us, that T_e increases with current density, is not subject to doubt, but the absolute values of the temperature must be verified by other independent methods.

In conclusion the authors thank A. A. Rukhadze for valuable discussions and advice.

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1) We take the opportunity to thank P. L. Rubin for supplying the calculated electric-conductivity cross sections prior to publication.

THE DE HAAS - VAN ALPHEN EFFECT IN ZINC IN PULSED MAGNETIC FIELDS

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The present investigation was devoted to the de Haas - van Alphen effect in zinc in pulsed magnetic fields up to 75 kOe. The experiments in static magnetic fields up to 30 kOe [1,2] (a review of earlier work is given in the paper by Joseph and Gordon [1]) did not give a sufficiently complete picture of the high-frequency oscillations connected with the large parts of the Fermi surface. This connection, as is well known, is given by the relation $F = cS/2\pi e\hbar$ [3], where F is the oscillation frequency in Oe and S the area of the extremal section of the Fermi surface in a plane perpendicular to the direction of the magnetic field in k-space, in units of $(2\pi/\text{Å})^2$.

The pulsed magnetic field was produced by discharging a 2000 μF capacitor bank charged to 2100 V through an inductance coil. A test coil containing the sample was placed in the center of the solenoid and its axis could be rotated ±30° relative to the direction of the magnetic field. The elements of the apparatus will be described in detail in a separate article. Inasmuch as the Fermi surface of zinc is very complicated and has a large number of extremal sections in all directions of the magnetic field (Fig. 1), a resonance procedure [4] at 33 kcs resonant frequency was used to separate the frequencies connected with each type of section.

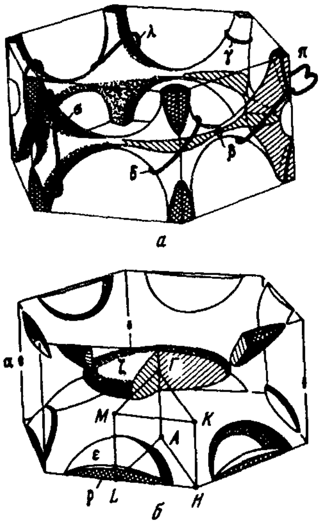

Fig. 1. Form of the Fermi surface of zinc with allowance for the spin-orbit interaction (from the paper by M. P. Shaw et al., Phys. Rev <u>142</u>, 399, 1966).

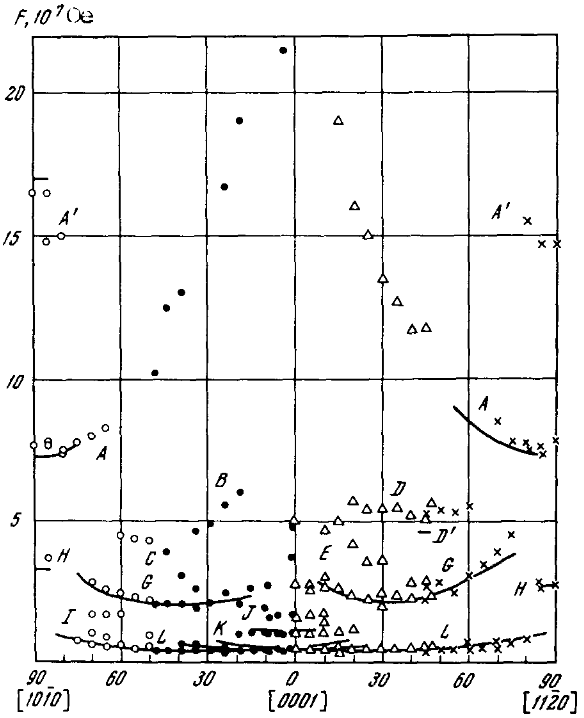

Fig. 2. Oscillation frequency F vs. direction of the magnetic field for the planes (10$\bar{1}$0) and (11$\bar{2}$0). o - Zn-16, ● - Zn-19, △ - Zn-18, × - Zn-15, solid curves - results of [1,2].

The experimental results and the published data are given in Fig. 2, where the letters A to K denote series of points identified with various sections. The frequencies G, H, and L agree with the data obtained in static fields, where they are related respectively to the sections δ, σ, and γ (Fig. 1). The sections corresponding to the frequency A are possible only at the central lens in the third band (ζ on Fig. 1). The obtained values of the frequencies (~22 x 10^7 Oe along [0001] and 7.7 x 10^7 Oe in the basal plane) agree with the predictions of the nearly-free-electron model [5], and comparison with the data of Priestley and Mondino [6] shows agreement for the minimal section and a 20% discrepancy for the maximal section, due to the smallness of the amplitude near [0001]. The frequency A' near the basal plane is apparently a harmonic of the frequency A.

The frequency D exists in the angle interval from 20 to 60° in the (10$\bar{1}$0) plane, has a weakly expressed minimum at 40 - 50°, equal to 5.3 x 10^7 Oe, and increases to 5.7 x 10^7 Oe at 20°. This frequency was observed by Higgins et al. [2] in the 45° region and amounted to 4.6 x 10^7 Oe (line D' on Fig. 2). To explain this frequency it is proposed that a π orbit exists (Fig. 1) in the two-band model, i.e., in the case of magnetic breakdown of the spin-orbit gap. This orbit should pass along the diagonal arm of the monster from the place where it is joined by horizontal bridges to the corner of the Brillouin zone, and then along the adjacent diagonal arms of the monsters of the neighboring cells in the expanded band scheme. According to the estimate of Higgins et al. [2], the corresponding frequency should be 6.5 x 10^7 Oe, and starting from the electrical considerations, the extremal section should exist in a wide range of angles (approximately from 20 to 75°).

In the same plane, there is a frequency E, equal to 5 x 10^7 Oe at 10° from [0001] and decreasing to the level of the frequency G at 50° (~2.5 x 10^7 Oe); the amplitudes of these oscillations are small. To explain this frequency one can propose the presence of magnetic breakdown between the monsters in the expanded second band through the needle in the third zone, as proposed by Priestley for magnesium (the ξ orbit on Fig. 12a of Priestley's paper [7]). An estimate by the free-electron model gives a rise in frequency from 3 x 10^7 Oe at 50° to 5.7 x 10^7 Oe at 20°. Account must be taken here of the fact that the orbits encompassing the monster are not oblique sections of δ, but pass only around one horizontal arm.

In the $(11\bar{2}0)$ plane there is observed near the [0001] direction a frequency B, which rises from 4.6 x 10^7 Oe at 35° to 6 x 10^7 Oe at 20°. The frequency B can be connected with an orbit of the same type as in the case of the frequency D. This follows from the equality of the frequencies, but apparently a different interpretation is also possible, for example breakdown through the needle or an orbit of the type λ on Fig. 1.

The frequencies C between 30 and 60° and J near the [0001] direction correspond apparently to the same section, namely to the orbit ϵ on Fig. 1, passing over the surface made up of two intersecting discs (four-winged butterfly). C has a value 4.5 x 10^7 Oe near 30° and J a value 1.7 x 10^7 Oe near [0001]. A plot of F^{-2} against cos 2φ for the frequency C - J is a straight line, which may serve as proof of the ellipsoidal character of the surface. On approaching the $[10\bar{1}0]$ axis, breakdown of the spin-orbit gap takes place and this part of the Fermi surface goes over from a butterfly in the third band and a cigar in the fourth band into the clamshell which is characteristic of the dual third - fourth Brillouin zone. The frequency I (1.7 x 10^7 Oe) can correspond to the section of such a clamshell and the frequency K to the section of a cigar (1.1 x 10^7 Oe).

In view of the complexity of the Fermi surface of zinc, the proposed interpretation may not be fully unambiguous.

In conclusion the authors consider it their pleasant duty to thank L. F. Vereshchagin for interest in the work and A. P. Kochkin for valuable discussions during the interpretation of the results.

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PROOF OF THE EXISTENCE OF TWO SHARPLY DISTINCT FERROELECTRIC PHASES IN $NaH_3(SeO_3)_2$

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Crystalline sodium hydroselenite $NaH_3(SeO_3)_2$ is a ferromagnetic with a Curie point at -79°C [1,2], and is presently under presistent investigation [3-6], but a number of its most important properties have not been disclosed so far. Yet the data presented below give grounds for assuming that $NaH_3(SeO_3)_2$ is one of the most interesting representatives of not only an isomorphic series of ferroelectric hydroselenites.

Large homogeneous single crystals of $NaH_3(SeO_3)_2$ were grown from the aqueous solution by the method of dropping the temperature, and had a Curie point $T_C = -78.6°$ and a melting temperature 111 ± 0.5°C. Measurements of the low-frequency (800 cps) dielectric constant (Fig. 1) at a measuring-field intensity 10 V/cm were made for three mutually perpendicular cuts oriented parallel to the principal sections of the optical indicatrix: the crystal-physics directions were taken to be the principal axes of the indicatrix, so that the x, y, and z axes were directed respectively along the acute and obtuse bisectors and the normal to the plane of the optical axes. We measured the temperature dependence of the rotation of the indicatrix φ(T) about the y axis (Fig. 2) and the components of the spontaneous polarization.

The measurements have demonstrated quite obviously the presence of one more phase transition in $NaH_3(SeO_3)_2$ at -172.5°C, at which a jumpwise decrease takes place in the components of the dielectric constant. The transition has a temperature hysteresis of 10.5°. Consequently, the transition is of first order. A high value of ε is retained in the region $-172.5°C < T < T_C$, owing, as will be shown below, to the domain contribution. At -78.6°C the peak of the dielectric constant is

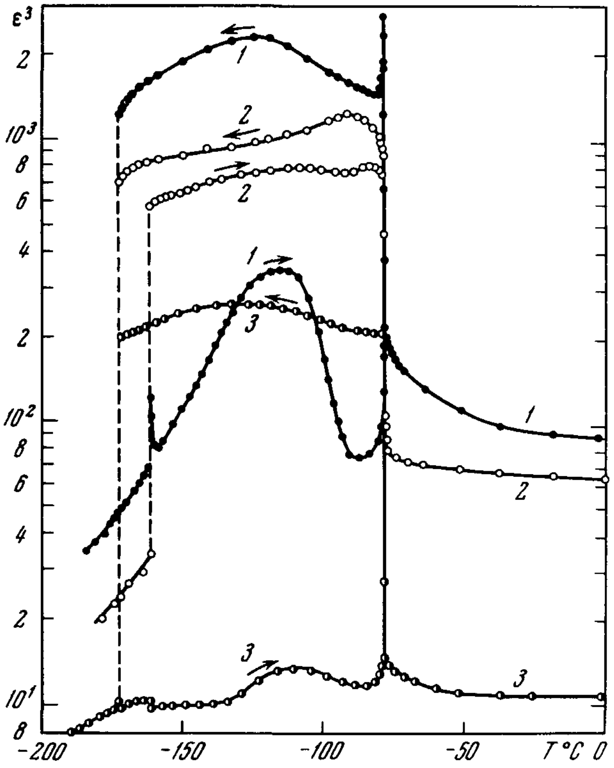

Fig. 1