SEVENTH ALL-UNION CONFERENCE ON LOW TEMPERATURE PHYSICS

R. CHENTSOV

Usp. Fiz. Nauk **72**, 817-826 (December, 1960)

CONFERENCES on low temperature physics are held in our country every year. The seventh conference took place on July 23-28 of the present year. For this occasion the city of Khar'kov was selected as the site of the conference. Familiarization with the work of the Physico-Technical Institute, Acad. Sci. Ukr.S.S.R., and with its cryogenic laboratories provided much of value to the participants in the conference. The goal of the seventh, like that of the previous conferences, was to provide mutual information on the work carried out during the year in the U.S.S.R., interchange of opinions, and consideration of plans for further work. The role of such conferences is growing, and will grow even more with the "decentralization" of science and the establishment of new, large scientific centers, such as the Siberian Division of the Acad. Sci. U.S.S.R., and others.

Approximately 400 persons took part in the work of the conference, among this number some 200 persons from other cities: Moscow, Kiev, Leningrad, Tbilisi, Alma-Ata, Sukhumi, Makhachkala, Kazan', Sverdlovsk, Baku, Stavropol', Erevan, and the Siberian Division of the Academy of Sciences. Approximately one hundred papers, the theses of which were submitted to the participants, were prepared for the conference. Fifty-three of the most important of them were heard at the plenary sessions, and some at the symposia. Individual symposia were devoted to low temperature techniques, liquid helium, and superconductivity. A most active part in the work of the conference was taken by the most prominent Soviet scientific specialists in the field of low temperature and solid state physics: Academicians P. L. Kapitza, L. D. Landau, and I. V. Obreimov, Member of the Acad. Sci. Ukr.S.S.R. B. G. Lazarev, and Corresponding Members of the Acad. Sci. U.S.S.R. N. E. Alekseevskiĭ, S. V. Vonsovskiĭ, I. M. Lifshitz, and others.

The Director for problems in low temperature and solid state physics of the Academy of Sciences, U.S.S.R., Academician **P. L. Kapitza**, opened the conference. He dwelt briefly upon the history of the development of cryogenic technique, and remarked upon the great growth observed in requirements for liquid helium, in part associated with the advance of low temperature physics into technology. P. L. Kapitza reported that in the Institute for Physics Problems, under his direction, two helium liquefying machines have been developed. Both liquefiers are of the compressed-gas engine type, without a hydrogen circuit. The first machine, working with liquid nitrogen cooling, has a capacity of 5.5 liters of liquid helium per hour, and a starting time of approximately one hour. This machine has already been turned over for introduction into industry. The second, operating without any preliminary cooling by other liquids, is of greater capacity, and at present yields 14 liters of liquid helium per hour. This machine will come into general use within two to three years. In the process of constructing these machines considerable improvement was achieved in the efficiency of the helium piston engines (chiefly as a result of the use of plastic materials in the pistons and valves). P. L. Kapitza also pointed out the change to be observed in the character of work with liquid helium: liquefying machines now all work primarily toward the replenishment of stores of liquid helium in containers which are then removed to the laboratories. P. L. Kapitza analyzed the present state of low temperature physics and the problems confronting it (critical velocities in superfluid liquid helium II, and the relationship of the critical temperature T_c for the onset of superconductivity to the physical structure of pure metals and alloys.) He emphasized the significance which it is evident that studies of polymers at low temperatures will assume in the near future.

I. LIQUID HELIUM

Eight papers were heard on this problem during the plenary sessions.

V. P. Peshkov (Institute for Physics Problems, Acad. Sci. U.S.S.R.) proposed a mechanism for the destruction of superfluidity in helium II in capillaries of circular cross section, and derived an expression for the magnitude of the critical velocity v_s. He considers that attainment of the critical velocity corresponds to the appearance within the superfluid component of the helium II of a vortex ring, with a radius equal to the radius R of the capillary. Using the relation between energy and momentum for the vortex ring, and deriving a relaxation time τ characterizing the process by which the ring arises, he has obtained an expression, which agrees well with many of the experimental results, for the dependence of v_s upon R. **L. D. Landau** and **I. M. Khalatnikov** expressed critical opinions concerning the work, directed fundamentally toward the fact that in the proposed formula for v_s there are two parameters which are selected arbitrarily. **R. A. Chentsov** remarked that, proceeding from Peshkov's theory, one would expect a change in the character of the destruction of superfluidity if the phenomenon were to be investigated at frequencies $\nu \geq \tau^{-1}$ ($\sim 10^3 - 10^4$ cps).

Yu. G. **Mamaladze** described a series of efforts devoted to the experimental and theoretical study of vortices in liquid helium. All of this work has been carried out at the Physics Institute of the Academy of Sciences, Georgian S.S.R. (Tbilisi). É. L. Andronikashvili, together with D. S. Tsakadze, has investigated axial-rotational oscillations of a lightweight disk suspended in rotating helium II. Together with K. B. Mesoed, they have performed similar investigations for the case of a heavy disk. It was found that for the light disk case, rotation of the helium II leads to an increase in the damping of the disk's oscillations, and, at the same time, to a decrease in their frequency. The dependence of this effect upon the rotational velocity was determined. Continuation of previous studies with heavy disks over a considerably broader range of rotational velocities showed that for higher velocities the damping of the disk has a dependence upon velocity of the same character as that for classical liquids. The curves for damping of the disks' oscillations are similar in a system having the coordinates of damping vs. ratio of rotational to oscillatory frequency. As the frequency of the oscillations is reduced, the effect of surface roughness upon the damping of the disk diminishes. Yu. G. Mamaladze has investigated theoretically a mechanism for damping of the disk which consists of the excitation in the vortex lines of two elastic waves having opposite circular polarizations. One wave is responsible for the dissipation of energy; the other, for the variation in the oscillatory frequency. Yu. G. Mamaladze and S. G. Matinyan have solved the system of hydrodynamic equations for rotating helium II and have found the moment of rotation acting upon the oscillating disk. The effect of mutual friction in helium II and of the slippage of the vortices has been analyzed.

Kuang Wei-Yen described measurements of the temperature discontinuity at the boundary between helium II and solid media: lead, tin, platinum, nickel, and crystalline quartz (this work was performed at the Institute for Physics Problems, Acad. Sci. U.S.S.R.). This phenomenon was discovered by P. L. Kapitza, and its theory was developed by Khalatnikov. The discrepancy observed between the absolute magnitude of the effect and the predictions of Khalatnikov's theory have been associated by Kuang Wei-Yen with the existence of an "amorphous" layer at the surface of the metal sample. The correctness of this explanation is confirmed by the fact that electro-polishing the samples leads in several cases (Pb, Ni) to closer agreement with the theory. It is also possible that the helium II layer immediately adjacent to the solid surface suffers changes in its properties. Kuang Wei-Yen has also investigated the temperature jump under conditions of rotation of the helium II, and at the transition of the metal (tin) into the normal state. No effect upon the discontinuity due to these conditions was detected.

I. L. Bekarevich and **I. M. Khalatnikov** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) have predicted theoretically a Kapitza temperature jump at the boundary between a solid surface and He^3, the light isotope of helium, analogous to the discontinuity in the case of helium II. An expression has been found for the magnitude of the discontinuity at low temperatures. The heat transfer coefficient through the boundary turns out to be proportional to the cube of the temperature. The phenomenon described is, in essence, associated with the radiation of "zero sound" in liquid He^3 by a solid body. At higher temperatures ($T \gtrsim 1°K$) radiation of ordinary sound becomes possible in liquid He^3 (as in the case of He II). This should be manifested in a jump in the numerical multiplier in the T^3 law. **V. P. Peshkov** expressed the opinion that measurements at much lower temperatures, of the order of 0.01°K, will be necessary for verification of this hypothesis. **N. E. Alekseevskiĭ** proposed that an arrangement be employed in which the solid body is in contact on one side with ordinary liquid helium, and on the other, with He^3.

T. P. Ptukha (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported on a determination of the coefficients of diffusion and thermal conductivity for weak solutions of He^3 in superconducting He^4. In such solutions there is added to the coefficient of ordinary thermal conductivity a term describing the motion of the normal component of the liquid (this term is directly related to the diffusion coefficient for the He^3 atoms). Measurements have been carried out for solutions of several concentrations in the temperature region from 1.1°K to the λ point. The results are found to be in good agreement with the theory of Khalatnikov and Zharkov. The cross section has been calculated for scattering of a He^3 atom by a roton ($160\,A^2$) and by a phonon ($0.027\,T^5 A^2$).

II. SUPERCONDUCTIVITY

Eight papers in all were presented on superconductivity. **P. A. Bezuglyĭ** and **A. A. Galkin** (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) reported new measurements of the anisotropy in ultrasonic attenuation in tin, testifying to the anisotropy of the energy gap ϵ_0 in the superconductor. The measurements were carried out over a broader range of temperatures, from the critical temperature to 1°K, on extremely pure samples. The ultrasonic frequency was 70 Mc/sec. Using the formula for the attenuation of sound in the superconducting state as given by the macroscopic theory, the authors found that the quantity $2\epsilon_0$ is equal to $3.1\,kT_C$ along the [001] axis and to $3.5\,kT_C$ along [100]. The authors suggest the existence of a relation between the magnitude of the anisotropy of the gap and the character of the Fermi surface. Preliminary measurements on indium, which has a closed Fermi surface, gave a significantly larger value for the energy gap. **L. D. Landau** noted that the formula used for the calculation of ϵ_0 was derived for an isotropic theory, and, when applied to an anisotropic superconductor, yields an effective, strongly-averaged value for the gap. **I. M. Lifshitz** and **M. I. Kaganov** expressed the opinion that a formula for the attenuation, derived with anisotropy taken into account, would have the same exponential form as the present expression.

A. A. Abrikosov and **L. P. Gor'kov** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) propounded a theory for superconductors containing paramagnetic impurities in small concentration. It was demonstrated rigorously that the presence of an exchange interaction between the conduction electrons and electrons in inner, unfilled shells of the impurity atoms leads to a reduction in T_c. In the authors' opinion, the theoretically predicted decrease in T_c was observed by Matthias, et al., in lanthanum containing germanium as an impurity. Of interest is the behavior of an alloy for concentrations near to n_c, the latter value corresponding to a reduction of T_c to zero (disappearance of the specific correlation of the electrons). It turns out that for concentrations near $0.9\ n_c$ the energy gap must vanish; this is manifested experimentally by the disappearance of the threshold for the absorption of electromagnetic energy, and by a power (rather than exponential) law for the specific heat near absolute zero. The paper evoked a lively discussion, in which **P. L. Kapitza**, **L. D. Landau**, **B. G. Lazarev**, **N. E. Alekseevskiĭ**, and **M. Ya. Azbel'** participated. It was noted that the influence of impurities in higher concentration, the effect of non-magnetic impurities, and the employment, in place of lanthanum, of less chemically-active subjects for study (for example, investigation of the system vanadium-iron) would be of interest.

S. V. Vonsovskiĭ, **B. V. Karpenko** (Institute of Metal Physics, Acad. Sci. U.S.S.R., Sverdlovsk) and **M. S. Svirskiĭ** (Chelyabinsk Pedagogical Institute) presented a theoretical paper on the connection of superconductivity with ferromagnetism and antiferromagnetism. It was shown that the interior electrons taking part in the magnetic ordering of the atomic lattice prevent the formation of Cooper pairs. Two effects of this sort exist. One of these, resulting in the appearance of repulsive forces between conduction electrons induced by ferromagnons, should occur in both ferro- and antiferromagnets. A quantitative study of the effect has been carried out within the framework of the microscopic theory, for a small ratio T_c/θ (θ is the Curie temperature). A criterion was established for the simultaneous occurrence of ferromagnetism and superconductivity. The latter is unlikely for ferromagnetics with high θ. In the course of the discussion following the paper the question was raised of the possibility of superconductivity at extremely high current densities, as predicted by Parmenter. If Parmenter's scheme is correct (and on this score there was no unity of opinion), then, in the opinion of S. V. Vonsovskiĭ, the possibility of superconductivity for large currents even in ferromagnetics with high θ is not excluded.

A. A. Abrikosov and **L. A. Fal'kovskiĭ** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) have investigated theoretically the problem of Raman scattering of light in superconductors. It has been shown that for normal incidence of an electromagnetic wave upon a superconducting surface, there appears in the reflected light a satellite having a smeared-out spectrum (with ω ranging from $\omega_0 - 2\epsilon_0/h$ downward, where ω_0 and ω are the frequencies of the incident and reflected light, and ϵ_0 is the energy gap). Quantitatively, the effect is extremely small and, at least with the capabilities existing at present, cannot be observed experimentally.

N. V. Zavaritskiĭ (Institute for Physics Problems, Acad. Sci. U.S.S.R.) described investigations of the thermal conductivity of the hexagonal metals zinc and cadmium, and of several other superconductors. A difference was found between the temperature dependence of the thermal conductivity in the direction of the principal axis [001] and in a perpendicular direction. The anisotropy in the magnitude of the energy gap was calculated from an expression derived by Khalatnikov. Minima of ϵ_0 lie in (001) planes. For zinc, $\epsilon_{min} \approx 1.2\ kT_c$ and $\epsilon_{max} \sim 1.7\ kT_c$; for cadmium, $\epsilon_{min} \sim 1.35\ kT_c$. In Cd, the anisotropy is less than in Zn. The speaker also reported studies of the thermal conductivity of extremely pure tin and thallium; the data obtained provide a basis for supposing that at the transition into the superconducting state there occurs a sharp increase in the scattering of electrons by phonons.

B. K. Sevast'yanov and **V. A. Sokolina** (Institute of Crystallography, Acad. Sci. U.S.S.R., and Moscow State University) presented a paper concerning an investigation of the magnetic properties of thin films of tin and indium. The experimental data were treated on the basis of theoretical work of **G. F. Zharkov** (Academy of Sciences Physics Institute). The latter has carried through a calculation (within the framework of the London theory) of the magnetic moment of thin superconducting ellipsoids of revolution in a field directed along the axis of rotation. Films of Sn and In of thickness $d \geq 0.4\mu$ were obtained by vacuum evaporation onto a substrate of polished crystalline quartz, cooled to the temperature of liquid nitrogen. The film samples had the form of arrays of disks (of minimum diameter $D = 50\mu$) and could be regarded, approximately, as thin ellipsoids. The force couple acting upon a sample placed in a homogeneous field, nearly parallel to the film, was measured on a torsion balance. The perpendicular component of the magnetic moment ($M_\perp$) was computed as a function of field strength and temperature. It followed from Zharkov's computations that $M_\perp$ need not depend upon d, provided $\sqrt{Dd} > \lambda$.

This result has been confirmed experimentally. A dependence upon d is found only for films with small D, and in non-homogeneous granular films, which behave like accumulations of "isolated" grains with small D. The critical fields determined from the magnetization curves agreed well with the predictions of the macroscopic Ginzburg-Landau theory (even for temperatures a half-degree removed from T_c), and permitted determination of the penetration depth λ_0. For tin $\lambda_0 = 8.5 \times 10^{-6}$ cm; for indium $\lambda_0 = 1.0 \times 10^{-5}$ cm. N. E. **Alekseevskiĭ** noted that in this work, for the first time, a solution was sought to the problem of measuring the magnetic moment of thin films and subjecting the data obtained to a quantitative treatment. Part was also taken in the discussion by **L. D. Landau, B. G. Lazarev**, and others.

A. M. Kolchin, Yu. G. Mikhaĭlov, N. M. Reĭnov, A. V. Rumyantseva, A. P. Smirnov, and **V. N. Totubalin** (Physico-Technical Institute, Acad. Sci. U.S.S.R., Leningrad) reported the results of a study of the destruction by current of superconductivity in thin films of tin having the form of strips of dimensions 10 × 0.15 mm. The resistance of the samples was measured as a function of current, for constant current and for pulses of varying form and duration. The influence of current heating and other factors upon the kinetics of the transition to the normal state was noted. The speed of the return transition to the superconducting state was found to depend upon whether the sample had transformed wholly into the normal state, or whether superconducting regions remained in it. In the latter case the transition into the superconducting state was strongly retarded. For a simple transition, under known conditions, transition times of less than 0.01 microsecond are observed.

B. G. Lazarev, E. E. Semenenko, and **A. I. Sudovtsov** (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) described studies of the electrical conductivity of beryllium films condensed onto a cooled substrate. The conditions of the evaporation and condensation exert a fundamental influence upon the superconductivity of these films. For rapid (~ 10 seconds) evaporation of the metal onto a substrate at liquid helium or liquid hydrogen temperature, films are obtained having a sharp superconducting transition at 8.5 — 9°K, and losing completely the ability to transform into the superconducting state after heating above 40°K. At the same time, films obtained as a result of slow (~ 20 minutes) evaporation show a smeared-out superconducting transition; traces of superconductivity are retained at low temperatures by these films even after heating to room temperature. The authors have also investigated the properties of iron and copper films. While the resistance of a copper film varies smoothly as it is warmed from helium temperature, the resistance of an iron film falls sharply and irreversibly over a narrow temperature interval near 40°K. This evidently reflects a structural change in the Fe film, and leads one to believe that, like Be, Bi, Ga, and Hg, iron has in the freshly-condensed state another modification, transforming into the ordinary one only upon elevation in temperature. Superconductivity was not found in the iron films.

The latter question was subjected to a rather lively discussion. N. V. **Zavaritskiĭ** reported that measurements performed at the Institute for Physics Problems also have shown that iron films, of $10^{-5} - 10^{-7}$ cm thickness, condensed at liquid helium temperatures, have a finite resistance, and show no traces of superconductivity. At the same time, it was indicated in a communication by **E. A. Nikulin, N. M. Reĭnov**, and **A. P. Smirnov** (Physico-Technical Institute, Acad. Sci. U.S.S.R.) that iron films of thickness $\sim 10^{-5}$ cm deposited at $T \sim 5°$K do possess superconductivity. The transition to the normal state was determined by a contact-less method. **N. E. Alekseevskiĭ, B. G. Lazarev, P. L. Kapitza**, and others, participated in the discussion. The general opinion was that the problem requires further experimental verification and clarification.

III. ELECTRONIC PROPERTIES OF METALS

Ten papers were heard on this topic.

N. E. Alekseevskiĭ and **Yu. P. Gaĭdukov** (Institute for Physics Problems, Acad. Sci. U.S.S.R.), **I. M. Lifshitz** (Physico-Technical Institute, Acad. Sci. Ukr. S.S.R.), and **V. G. Peschanskiĭ** (Khar'kov University) presented a paper entitled "Form of the Fermi Surface for Tin, according to Data from Galvanomagnetic Measurements". The paper was read by Yu. P. Gaĭdukov. A detailed study of resistance variation in a magnetic field and of the Hall effect was carried out at the Institute for Physics Problems, on a large number (~ 40) of extremely pure samples (in general $\rho_{300°K}/\rho_{4.2°K}$ = 20,000 to 60,000) having various crystalline orientations. The measurements were made in fields of up to 34,000 oe at a temperature of 4.2°K. Comparison of the stereographic projections obtained for the directions of magnetic field and current with the theory of Lifshitz and Peschanskiĭ, as well as analysis of the Hall effect data, made it possible to develop a reasonably clear representation of the form of the Fermi surface. The open Fermi surface for tin consists of two "corrugated planes" with normals in the [001] direction of the reciprocal lattice; these planes are connected by tubes whose axes coincide with the [001] edge of the reciprocal lattice. The distances between the planes and the diameters of the tubes are approximately equal to half the reciprocal lattice constant. In addition, tin also evidently possesses a closed surface of the same volume (within the boundaries of a unit cell of the reciprocal lattice). The closed surface is electronic; the open one is associated with the holes. The balance of the volumes of the electron and hole Fermi surfaces may explain the quadratic rise in resistance for a variety of orientations. In addition to the authors, **L. D. Landau**, **E. S. Borovik**, **M. I. Kaganov**, and others, participated in the discussion of this work.

É. A. Kaner (Institute of Radiotechnics and Electronics, Acad. Sci. Ukr.S.S.R., Khar'kov) described work of his own, in which a theory for ultrasonic attenuation in a pure metal placed in a magnetic field H has been developed in detail. He has shown that the resonance attenuation of ultrasonic waves discovered by Pippard assumes specific features depending upon the character of the Fermi surface: the curve showing the ultrasonic attenuation coefficient as a fundtion of magnetic field intensity may have not the ordinary sinusoidal shape, but the form of oscillations with extremely sharp resonance peaks accompanied by broad, asymmetric minima. The occurrence of a resonance of this type for $\mathbf{k} \perp \mathbf{H}$ ($\mathbf{k}$ being the wave vector) indicates the presence of open, periodic electron trajectories. The characteristics of ultrasonic attenuation in a strong magnetic field were also investigated.

A. A. Galkin and **A. P. Korolyuk** (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R. and Institute of Radiotechnics and Electronics, Acad. Sci. Ukr.S.S.R.) reported the results of an experimental study of ultrasonic attenuation in a magnetic field in tin, as well as in indium and zinc. The measurements were performed upon monocrystalline samples of high purity, in the 60 — 140 Mc/sec range. In tin, for certain relative orientations of field, sound propagation, and crystallographic axes, there were found non-sinusoidal oscillations of the type described by Kaner. The attenuation coefficient is periodic in H^{-1}. The occurrence of such oscillations for $\mathbf{k} \perp \mathbf{H}$ testifies to the existence of open, periodic trajectories. For In and Zn, only harmonic oscillations were observed. Saturation of the attenuation coefficient in strong fields, and anisotropy of the former, were observed (for all three metals). Qualitatively, the experiments agree with the theory developed by Kaner; quantitative agreement, however, is lacking at a number of points (for example, the amount of the increase in the attenuation coefficient in the field should be much greater than that observed). **I. M. Lifshitz** and **N. E. Alekseevskiĭ** took part in the discussion, noting the great potential possibilities of ultrasonic measurements in a magnetic field as a volume method for studying Fermi surfaces; **P. L. Kapitza**, **M. I. Kaganov**, and others, also participated.

M. S. Khaĭkin (Institute for Physics Problems, Acad. Sci. U.S.S.R.) described a study of a new phenomenon — an oscillatory dependence of the surface resistance of a metal upon field, for a weak magnetic field (~ 6 oe). The basic measurements were carried out on a monocrystalline plate of tin, cut perpendicular to the second-order axis. The field was applied parallel to the plate (along the tetragonal axis). The measurements were made by an extremely sensitive frequency-modulation technique, at a frequency of 9400 Mc/sec. The oscillations are most pronounced for parallel constant and high-frequency fields. The effect is anisotropic, and decreases as one goes to less pure samples. The periodicity is observed, not in H^{-1} but in log H: $H_{n+1}/H_n \approx 1.6$. At temperatures $T = 3.8$ to 4.2°K the effect is weakly temperature-dependent. According to preliminary data, however, it disappears for $T \sim 10$°K. This effect is also observed in cadmium ($H_{n+1}/H_n \approx 2.1$) and in indium; it is not observed in aluminum. It is possible that varying degrees of purity of the metals are reflected in these results. **Yu. V. Sharvin** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported in the discussion that he and V. F. Gantmakher had evidently observed this same phenomenon at a frequency of 1.9 Mc/sec, in a cylindrical sample of tin placed in a longitudinal magnetic field. The amplitude of the oscillations at 4.2°K was considerably less than at 3.8°K. These communications aroused great interest. Part in the discussion was taken by **I. M. Lifshitz**, **M. I. Kaganov**, **B. G. Lazarev**, **M. Ya. Azbel'** (who noted that a periodicity in log H might be observed, if regions of the Fermi surface having small projections or depressions participate in the effect), **P. L. Kapitza**, and **L. D. Landau**.

M. Ya. Azbel' (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) presented a paper in which a new resonance effect in pure metals at high frequencies was predicted. The effect should be observed for the case of a non-quadratic dispersion law for the conduction electrons. It consists of a decrease in field with penetration into the metal which is not monotonic, but shows sharp (~ 10^{-5} cm) "splashes" at certain depths which are large by comparison with the thickness of the skin-layer. The splashes have a form reminiscent of anomalous dispersion curves, and are repeated at intervals of ~ 10^{-3} cm. A second peculiarity in the behavior of the field is the extraordinarily slow rate of decrease in the amplitude of the splashes; appreciable weakening of them occurs at depths on the order of a millimeter. The physical basis of the phenomenon (pointed out by P. L. Kapitza) consists of the formation of gigantic "atoms" of electrons undergoing Larmor precession. In the ordinary case an assortment of various radii is present, but for a non-quadratic spectrum the resonance conditions lead to the selection of a completely distinct radius. This resonance should be experimentally manifested in a number of effects: selective transparency for plates of ~ 1 mm thickness at resonance; discontinuities in impedance and the occurrence of transparency in the plates under rotation of a constant magnetic field in the plane of the plate, and an electron "echo," observation of which gives direct information concerning the Fermi surface. The effect should be found in extremely pure metals for magnetic fields of ~ 10^{-4} oersted in the centimeter range. The work met with lively interest.

M. S. Khaĭkin (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported on an investigation of cyclotron resonance in tin, carried out by a highly sensitive frequency-modulation method. Resonance spectra were obtained for various orientations of the magnetic field. The resonances are strongly dependent upon the temperature T (the study was carried out for $T > 1.8°K$), and disappear for $T > 4°K$. The maxima are periodic in H^{-1}; the positions of the maxima do not depend upon T. Values were computed for the effective masses of the electrons participating in the resonance. **I. M. Lifshitz** commented that this appears to be the first work in which cyclotron resonance appears, not as an end in itself, but as a means for studying a metal. During the discussion, **A. A. Galkin** reported the preliminary results of an investigation of cyclotron resonance with the aid of ordinary radiospectroscopy. **M. Ya. Azbel'** and others also spoke.

M. Ya. Azbel' (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) also described work devoted to the possibility of determining the Fermi correlation function $\Phi(p, p')$ for a Fermi-liquid, which, together with the dispersion law, is the most important characteristic of a metal. It was found that at resonance, at high frequencies (millimeter waves) in strong magnetic fields ($10^4 - 10^5$ oersteds), the width of the resonance depends upon Φ. Measurements of the surface impedance under the indicated conditions (quite extreme ones, from the experimental point of view) can provide information concerning the correlation function.

S. V. Vonsovskiĭ, N. V. Vol'kenshteĭn, Yu. P. Irkhin, G. V. Fedorov, and **V. P. Shirokovskiĭ** (Institute of Metal Physics, Acad. Sci. U.S.S.R., Sverdlovsk) presented the results of an extensive experimental investigation of Hall effect anisotropy in the ferromagnetics Ni, Co, Gd, and Ni_3Mn. The measurements were made on monocrystalline samples (except for gadolinium) over a broad range in T from liquid helium to room temperature. Anisotropy was found in the ordinary Hall coefficient R_0, and a non-monotonic dependence of R_0 upon T. The mobility of the carriers at low temperatures was computed from the data obtained. For cobalt, anisotropy was also found in the spontaneous Hall coefficient. A calculation of the Hall effect in an anisotropic ferromagnet was carried out under the assumption that the electrical conductivity of the metal depends upon the magnetic field and the intensity of magnetization. It was found that R_0 may be anisotropic even in ferromagnets with cubic symmetry.

N. B. Brandt (Moscow State University) reported on an investigation of the influence of a lead impurity upon the electron energy spectrum of bismuth, using the method of studying the quantum oscillations in magnetic susceptibility. The measurements were made for various orientations of the magnetic field relative to the crystalline axes of the samples, over the temperature range $1.7 - 4.2°K$. It was found that the shape of the Fermi surface and the effective masses of the electrons remain constant for impurity concentrations $c < 0.04\%$; moreover, the electron concentration and the Fermi boundary energy decrease as c increases. For $c \sim 0.1\%$ the dependence of the magnetic susceptibility upon c may be explained by the influence of holes. **L. D. Landau** stated that this work represents great progress in the study of the electronic structure of bismuth, which thus acquires a clearer form.

Yu. A. Bychkov (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported on a theoretical study of the influence of impurities upon the quantum oscillations in magnetic susceptibility in metals having a quadratic dispersion law. The problem of collisions of electrons with impurities is considered using the methods of quantum electrodynamics. Results are obtained which are close to the results of Dingle, who investigated qualitatively the problem of the amplitude of the de Haas-van Alphen oscillations, considering the smearing-out of levels due to the influence of the electron mean free path. Fundamental improvements in accuracy were also introduced into Dingle's formula. As was noted by I. M. Lifshitz, the chief significance of this work consists of the demonstration of how much the application of the methods of quantum field theory can aid in the study of the electronic structure of metals.

IV. LOW-TEMPERATURE MAGNETISM

Nine papers were heard on magnetism.

E. G. Guseĭnov (Institute of Physics, Acad. Sci. Azerbaidjanian S.S.R., Baku), **V. E. Naĭsh** and **E. A. Turov** (Institute of Metal Physics, Acad. Sci. U.S.S.R., Sverdlovsk) presented a theoretical paper devoted to the peculiarities of ferromagnetics whose sublattices have non-collinear magnetic moments. The magnetic properties of the orthoferrites (rare-earth ferrites with perovskite structure) and MnP were analyzed on the basis of the theory thus developed. **S. V. Vonsovskiĭ** noted that this work makes it feasible to measure a number of constants of the theory. **N. E. Alekseevskiĭ** and **G. A. Smolenskiĭ** also participated in the discussion.

A. S. Borovik-Romanov and **V. I. Ozhogin** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) have investigated the magnetism of a monocrystal of $CoCO_3$, at temperatures of $1.3 - 300°K$. Below $T_N = 18.1°K$ an antiferromagnetic ordering with weak ferromagnetism is established. $CoCO_3$ is characterized by an extremely large anisotropy in its paramagnetic susceptibility, a considerable spontaneous ferromagnetic moment, and a sharp maximum for $\chi_\perp$ in the vicinity of T_N. The possibility of the appearance of antiferromagnetic ordering for $T < T_N$ upon application of a magnetic field has been demonstrated theoretically for substances whose symmetry permits the existence of a spontaneous ferromagnetic moment in the presence of such ordering. The results obtained have also been compared with the conclusions which may be drawn on the basis of spin wave theory. **L. D. Landau, M. I. Kaganov**, and **G. A. Smolenskiĭ** took part in the discussion.

N. M. Kreĭnes (Institute for Physics Problems, Acad. Sci. U.S.S.R.) described a study of weak ferromagnetism in the anhydrous sulfates of transition-group elements $CoSO_4$ and $CuSO_4$. A strong field dependence was found for the temperature of the transition into the antiferromagnetic state (this effect is observed along the axis for which, at lower temperatures, a transition to a ferromagnetic state occurs upon application of a sufficiently strong magnetic field). A theoretical analysis has been carried out which has made it possible to provide a qualitative explanation for the principal anomalies which have been discovered. **A. S. Borovik-Romanov**, and **E. A. Turov** spoke during the discussion. **N. E. Alekseevskiĭ** noted that success in these efforts depends upon the feasibility of producing monocrystals of ferrites and antiferromagnetics.

D. I. Astrov (All-Union Scientific Research Institute for Physico-Technical and Radiotechnical Measurements, Moscow) reported the discovery of an interesting new phenomenon: a magnetoelectric effect, consisting of the appearance of a magnetic moment when an electric field is applied to a substance. The author reported that this phenomenon had been predicted by **L. D. Landau** and **E. M. Lifshitz**, while **I. E. Dzyaloshinskiĭ** had reached the conclusion that the effect should occur in Cr_2O_3. When a monocrystal of Cr_2O_3 was placed in a sinusoidal electric field $E_{\|}$, parallel to the c_3 axis, there did in fact appear a magnetic moment $M_{\|} \approx -2.5 \times 10^{-4} E_{\|}$ (at 20°C). In the basal plane the ratio M/E is smaller by an order of magnitude. The effect disappears at the antiferromagnetic transition point T_N, while for $T < T_N$ it has the temperature dependence which is characteristic of the intensity of magnetization in ferromagnetics. **L. D. Landau, N. E. Alekseevskiĭ, G. A. Smolenskiĭ**, and **A. S. Borovik-Romanov** participated in the discussion, which was principally devoted to consideration of the mechanism for the appearance of the magnetic moment.

A. I. Akhiezer, V. G. Bar'yakhtar, and **S. V. Maleev** (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) have developed a theory for elastic and inelastic scattering of slow neutrons in ferrites and antiferromagnetics. The elastic scattering cross section is determined by the magnetic moments of the sublattice (as well as the Debye-Waller factor), and the inelastic scattering cross section, by the emission and absorption of magnons. Study of inelastic scattering should permit determination of the spin wave dispersion law. The discussion was devoted to consideration of the feasibility of distinguishing the effect due to spin waves from scattering involving phonons (**A. S. Borovik-Romanov, L. D. Landau**, and others.)

A. I. Akhiezer, V. G. Bar'yakhtar, G. I. Urushadze, and **S. V. Peletminskiĭ** (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) described work on the theory of relaxation phenomena in ferri- and antiferromagnetics. The treatment proceeded within the framework of the phenomenological spin wave theory. The relaxation times for the magnetic moments were determined. **E. A. Turov** and **M. I. Kaganov** spoke during the discussion, the latter noting the need for experimental investigation of non-resonance absorption of high-frequency energy in solid bodies, in order to determine the various interaction mechanisms.

R. T. Mina (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported measurements of relaxation absorption electromagnetic energy in the antiferromagnetic $CoCl_2$. These studies were carried out on $CoCl_2$ monocrystals at a frequency of 37,300 Mc/sec. Absorption is observed over a definite range in temperature (near T_N) and field, and has an anisotropic character. Similar absorption is observed in $CoBr_2$. The phenomenon is evidently analogous to the relaxation absorption of sound in liquid helium and in ferroelectrics near the second-order phase transition temperature. Ideas concerning a possible absorption mechanism were advanced by **N. E. Alekseevskiĭ, A. S. Borovik-Romanov, M. I. Kaganov**, and **G. A. Smolenskiĭ**.

Yu. A. Izyumov and **E. A. Turov** (Institute of Metal Physics, Acad. Sci. U.S.S.R., Sverdlovsk) described a theoretical investigation of the problem of ferromagnetic resonance line width in metals. The interaction between the oscillations in intensity of magnetization excited at resonance and the conduction electrons, and its influence upon the position and width of the resonance absorption lines, were investigated for the limiting cases of normal and extreme anomalous skin effect.

L. I. Buishvili, G. R. Khutsishvili, and **O. D. Cheĭshvili** (Institute of Physics, Acad. Sci. Georgian S.S.R., Tbilisi) presented a theory of magnetic relaxation in a ferromagnetic metal, the latter being regarded as an aggregate of magnetic ions (d spins) and conduction electrons (s spins) with s-d interaction present. In the general case, the solution is characterized by two relaxations: first, equilibrium in the s-d interaction is rapidly established, and then, more slowly, overall equilibrium.

V. MISCELLANEOUS PROBLEMS (NUCLEAR RESONANCE, SPECTROSCOPY, EXPERIMENTAL TECHNIQUE, ETC.)

I. M. Lifshitz (Physico-Technical Institute, Acad. Sci. Ukr.S.S.R.) described further theoretical studies of the kinetics of the appearance of an ordered phase out of an initial disordered one in a transition of the second kind. In this case relaxation is accomplished by a unique mechanism, neither a homogeneous process (with an uninterrupted transition from the initial to the final state) nor one of nucleation (characteristic of transitions of the first kind). At the beginning of the process, a web-like interweaving of ordered regions of various types appears, filling the whole crystal. The boundaries between the regions move in such a way that the web "swells," and the mean linear dimensions grow according to a law $R \sim \sqrt{t}$ (t representing time). This movement of the boundaries is directed solely toward the diminution of their surface energy. In the case of the ordering of a quenched, body-centered alloy, there exist two equivalent positions of order. In other cases (for example, for a number of antiferromagnets) there may be more than four such positions; here the boundaries are prevented from shifting, and a domain structure arises, with "rigid" combinations of regions. In this case, only external influences (pressure, magnetic field) can lead to movement of the boundaries. Thus, the domain structure in antiferromagnetics is "metastable"; it is connected with the kinetics, in contradistinction to the domain structure of ferromagnetics, which is stable in a thermodynamic sense. This paper provoked a lively discussion. **V. S. Kogan** reported that the order-disorder kinetics of the alloy Fe_3Al, annealed at 300°K, are found from x-ray data to correspond to the picture advanced by **I. M. Lifshitz**. **A. S. Borovik-Romanov** pointed out that domains are observed in antiferromagnetic carbonates, in which six sublattices exist, and are absent in fluorides, in agreement with the predictions of the theory. **I. V. Obreimov**, emphasizing the great significance of the work of **I. M. Lifshitz**, noted the progress which the application of topology has brought to a number of important problems of modern physics.

V. S. Kogan (Physico-Technical Institute, Acad. Sci., Ukr. S.S.R.) reported the results of x-ray (carried out together with R. F. Bulatova and B. G. Lazarev of the same Institute) and neutron-diffraction [carried out together with B. G. Lazarev (Ukrainian Physico-Technical Institute) and G. S. Zhdanov and R. P. Ozerov (Physico-Chemical Institute, Moscow)] studies of the structures of solid H_2 and D_2. The neutronographic studies were carried out in a special cryostat, with a container of a Ti-Zr alloy and indium seals, at a temperature of 11 — 12°K. It was established that H_2 and D_2 possess a body-centered tetragonal lattice ($a = 4.5$ A, $c/a = 1.73$ for H_2, 3.35 A and 1.73 for D_2). The neutron-diffraction studies made it possible to determine that molecules of ortho- and parahydrogen (ortho- and paradeuterium) in the solid H_2 (D_2) lattice are in an ordered state; specifically, they are situated at the vertices and at the center of the elementary tetragonal prisms. In some cases the structure turned out to be more complex: the ordering of the ortho- and para-molecules occurs over a volume greater than that of the elementary unit cell. Recently, solid hydrogen-deuterium, HD, has been investigated; it has the same structure as H_2 and D_2. The structure of neon isotopes (Ne^{20} and Ne^{22}) has also been studied, at 4.2°K. Neon has a face-centered cubic structure. The atomic volumes of the two isotopes differ by ~ 10%, which appears to result from the influence of zero-point lattice vibrations. **V. P. Peshkov**, **S. V. Vonsovskiĭ**, **P. L. Kapitza**, and **I. M. Lifshitz** took part in the discussion.

In a paper by **I. A. Gindin**, **B. G. Lazarev**, and **Ya. D. Starodubov** (Physico-Technical Institute, Acad. Sci. Ukr. S.S.R.) the results of a study of the mechanical properties of lithium in relation to its low-temperature polymorphic transformations were reported. This metal, with a body-centered cubic lattice at room temperature, is partially transformed into a hexagonal close-packed form upon being cooled below 84°K, and may by plastic deformation at 140°K and below be altered into a face-centered cubic modification. The mechanical properties of Li (of 99.3% purity) under tension as well as its microstructure were studied over a broad range of temperatures from 1.5 to 300°K. A number of peculiarities were found, associated with the presence of a variety of modifications in the deformed sample: an increase in ductility with reduction in temperature, a jump in micro-hardness at 74°K, etc. **P. L. Kapitza**, **N. E. Alekseevskiĭ**, **N. V. Zavaritskiĭ**, and **M. S. Svirskiĭ** took part in the discussion, dealing principally with the question of the feasibility of producing pure low temperature phases.

A paper by **O. N. Trapeznikova** and **I. A. Sagava** (Leningrad State University), devoted to an investigation of the specific heat of chain structures at low temperatures, was read by O. N. Trapeznikova, **I. M. Lifshitz** spoke during the discussion, indicating possible reasons for the difference between these results and those predicted theoretically for crystals.

Yu. S. Karimov and **I. F. Shchegolev** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) reported on an investigation of proton resonance in the free radical of diphenylpicrylhydrazyl over a range in temperature from 1.5 to 300°K, and in field from 500 to 3000 oersteds. At low temperatures a splitting of the proton line into four components is observed. These four lines cannot be related to the various proton groups occurring in the molecule.

The greatest difficulty is encountered in the explanation of one of these lines, which remains at the position of the undisplaced proton line and contains at times 65 — 80% of the total intensity. **I. V. Obreimov**, **B. N. Samoĭlov**, and others, took part in the discussion.

D. A. Kichigin (Institute of Radio Engineering and Electronics, Acad. Sci. Ukr. S.S.R.) presented the results of a study of electron resonance in samples of coal (anthracite, etc.) adsorbing oxygen. The latter becomes bound to the free radicals in the coal, leading to a change in the magnetic susceptibility, and in the form of the resonance spectrum. The resonance peak vanishes completely for an O_2 concentration of about 1%. On the basis of the data obtained, the author has designed an analyzer for air as an impurity in gaseous helium and hydrogen.

A. A. Galkin and **I. V. Matyash** (Physico-Technical Institute, Acad. Sci., Ukr. S.S.R., Institute of Radio Engineering and Electronics, Acad. Sci., Ukr. S.S.R., Khar'kov) described studies of nuclear magnetic resonance in adsorbed hydrogen. The measurements were performed by the spin echo method, at a frequency of 14 Mc/sec. The hydrogen was adsorbed onto charcoal and silica gel. The spin-spin and lattice relaxation times were measured, and the diffusion coefficient and activation energy were evaluated. It was found that the adsorbed hydrogen is in a strongly-bound state (especially in charcoal), and diffusion is sharply restricted.

A paper by **N. G. Koloskova** and **U. Kh. Kopvillem** (Kazan' University) was devoted to a theoretical investigation of ultrasonic nuclear induction at low temperatures. The phenomenon of nuclear resonance in ultrasonics was predicted by Al'tshuler. The authors have shown that a pulsed ultrasonic wave, by exciting the system of nuclear spins, gives rise to an electromagnetic signal which may be detected by the spin echo method. Experimental study of this effect can yield a value for the matrix element $\langle k | H | k \rangle$ of the spin-lattice interaction. According to the authors' computations, the effect may be observed in the Br^{79} nucleus in a crystal of KBr at 1.4°K, in a field of ~10 kilooersteds. **I. V. Obreimov** and **N. E. Alekseevskiĭ** took part in the discussion.

D. Kh. Amirkhanova described two studies of galvanomagnetic and thermomagnetic effects in semiconductors at low temperatures. Both were carried out at the Physics Institute of the Dagestan branch of the Acad. Sci. U.S.S.R. (Makhachkala). D. Kh. Amirkhanova and R. I. Bashirov, studying n-InSb at 20 – 120°K, observed the effect of quantization of the electron energy spectrum in a magnetic field. Phonon entrainment (the Gurevich effect) has been detected, the authors have concluded, in a number of effects in p-InSb and GaSb for T < 100°K. Two types of holes (light and heavy) have been found in p-InSb. Kh. I. Amirkhanov, R. I. Bashirov, and Yu. D. Zakiev have studied resistance variation and the Hall effect in n-InSb at 77°K. The measurements were made in pulsed fields H of strengths (according to the authors' estimates) up to 600,000 oersteds. The Hall constant is independent of H for H > 150,000 oersteds.

A. V. Kogan, V. D. Kul'kov, L. P. Nikitin, N. M. Reĭnov, I. A. Sokolov, and **M. F. Stel'makh** (Physico-Technical Institute, Acad. Sci. U.S.S.R., Leningrad) reported on studies which they have made of radiation from nuclei oriented at ultra-low temperatures. Measurements were made of γ-radiation anisotropy in Sc^{46}, V^{48}, Au^{199}, Tb^{160}, and Ir^{192}. Since the orientation was produced by an external field, cooling was achieved by an indirect method (from another medium). The temperature was determined from the γ-ray anisotropy of Co^{60}. From the data thus obtained, an evaluation was made of the internal fields and the nuclear magnetic moments, and a more accurate decay scheme for Ir^{192} was obtained. **N. E. Alekseevskiĭ** and **B. N. Samoĭlov** took part in the discussion.

L. P. Zverev, M. M. Noskov, and **M. Ya. Shur** (Ural State University, Sverdlovsk) presented a paper on the contour of the exciton absorption bands in cuprous sulfate. The measurements were performed on polycrystalline samples 9 to 110μ in thickness, at temperatures of 20 to 190°K. The form of the contour of the second band in the yellow exciton series, and the temperature dependence of its half-width, agree closely with Toyozawa's non-localized exciton theory. In particular, it was found that below 55°K the half-width is independent of temperature; this the authors attribute to interaction between the excitons and the zero-point vibrations of the lattice.

As **V. V. Eremenko** and **L. I. Chuĭko** (Physics Institute, Acad. Sci. Ukr. S.S.R., Kiev) reported in their paper, they have investigated the variation in the absorption spectrum of Cu_2O under monaxial compression (T = 20°K). It is well known that in this absorption spectrum there are found two "hydrogen-like" series of bands, a fact which has not as yet received any concrete explanation. The authors have discovered that under compression the bands are displaced, while only for the series of shorter wavelength do the intervals between the bands become narrower (representing an increase in the effective mass of the carriers). From this the conclusion is drawn that the two series are due to the complex electronic structure, and not to a combination of exciton transitions with lattice oscillations. **I. V. Obreimov, A. F. Prikhod'ko, I. M. Lifshitz,** and others, spoke during the discussion of the last two papers.

The production of pulsed magnetic fields up to H_{max} = 200,000 – 300,000 oersteds in coils cooled by liquid hydrogen was described in a paper by **E. S. Borovik** and **A. G. Limar'** (Physico-Technical Institute, Acad. Sci. Ukr. S.S.R.). Lowering the starting temperature makes it possible to increase by several times the value attainable for $H^2_{max}\tau$ (τ being the duration of the pulse up to the maximum). Fields of 100,000 – 150,000 oersteds were obtained for $\tau \sim 0.2 - 0.1$ sec. The current pulses were produced by discharging a condenser. It was demonstrated that, as a material for the windings, aluminum would evidently have advantages over the copper employed, due to its smaller resistance increase in the field. **N. E. Alekseevskiĭ** and **I. Obreimov** participated in the discussion.

E. S. Borovik went on to describe three other projects carried out at the Physico-Technical Institute, Acad. Sci. Ukr. S.S.R., and related to low temperature technique. The speaker, B. G. Lazarev, and I. F. Mikhaĭlov have developed a high-vacuum hydrogen condensation pump. Liquid hydrogen is produced by a liquefier built into the pump. The gas being pumped is condensed onto a surface cooled to 20°K. The capacity of the pump is 40,000 liters per second, and the ultimate vacuum is $10^{-8} - 10^{-9}$ mm Hg. B. G. Lazarev and M. F. Fedorova have constructed new types of low temperature high-vacuum adsorption pumps, in which the gas being pumped is condensed onto charcoal cooled with liquid nitrogen or (for pumping hydrogen) liquid hydrogen. The capacity of these pumps reaches tens and hundreds of liters per second, and the ultimate vacuum (with hydrogen cooling) reaches 10^{-8} mm Hg. B. N. Esel'son and A. D. Shvets have used a charcoal adsorption pump to produce temperatures below 1°K by pumping off the vapor over a helium bath. The pump is placed directly within the cryostat and, although its pumping speed is estimated to be but 1 liter/sec, it replaces a diffusion pump of 300 liter/sec capacity situated outside the cryostat. The apparatus is initially cooled to $T \sim 1.5$°K, the charcoal pump is then connected, and within 10 – 15 minutes the temperature of the helium bath falls to 0.7°K. If a He^3 bath is used in this way, according to the authors' estimates, a temperature of 0.4°K may be attained. Speaking during the discussion, N. E. **Alekseevskiĭ** and I. V. **Obreimov** noted the great practical value of work in this direction.

N. N. **Mikhaĭlov** (Institute for Physics Problems, Acad. Sci. U.S.S.R.) described carbon resistance thermometers for low temperatures developed by himself and A. Ya. Kaganovskiĭ. The thermometers are produced by partial graphitization of a mixture of coke and petroleum pitch (75 : 25) by firing at high temperature. The firing was carried out at a pressure of 10 Ton/cm^2 (T_{firing} = 790 to 810°C). Thermometers may be produced which are suitable for work in the helium and in the hydrogen temperature regions. The thermometers were calibrated at three points. One hundred cycles of cooling to liquid nitrogen temperature and reheating to room temperature displaced the calibration by but 0.01° in all. The thermometers have low thermal inertia. The properties of the thermometers may be described, if one proceeds from the assumption that they are semiconductors having an internal resistance such that $R \sim \exp(Q/kT)$. The character of the dependence of the activation energy Q upon the conditions of the heat treatment are explained. Approximately 100 of these resistors have been distributed to various laboratories. B. G. **Lazarev** reported that a large number of these thermometers are in use at the Ukrainian Physico-Technical Institute. These are very good thermometers, yielding nothing in sensitivity nor reproducibility to the best examples of thermometers of this type. I. G. **Fakidov**, B. N. **Samoĭlov**, and A. I. **Sudovtsov** also spoke during the discussion.

Academician I. V. **Obreimov** summarized the conference, and, in the name of the participants in the conference, expressed their thanks to their colleagues of the Physico-Technical Institute, Acad. Sci. Ukr. S.S.R., and to all parties who contributed to its success. The next conference, the eighth, will take place in the summer of 1961.

Translated by S. D. Elliott