Meetings and Conferences

ALL-UNION CONFERENCE ON LOW TEMPERATURE PHYSICS

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THE most recent annual conference on low temperature physics was held in Leningrad, from 26 June through 1 July, 1962. In addition to physicists of the Soviet Union, the participants included guests from the German Democratic Republic, Czechoslovakia, Poland and Hungary. The total number of participants exceeded 400. The range of subjects discussed at the plenary and sectional sessions was extremely broad: superconductivity, electronic spectra of metals and semiconductors, properties of liquid helium, magnetic phenomena at low temperatures, techniques for producing low temperatures, and methods of measuring them.

In the present review it is not possible to provide even a brief summary of each of the 120 papers presented at the conference; the compilers have therefore confined themselves to brief resumés of only a portion of them.

In the introductory address before the first general session, the Chairman of the Scientific Council for Problems in Low Temperature Physics, N. E. Alekseevskiĭ, reported that, in view of the facts that low temperature physics has begun to play an important part in various fields of science and technology, and that the number of institutions and actively working scientists is growing extremely rapidly, the annual low temperature physics conferences will in the future fulfill not only an informational, but a coordinating function. The sections which have been created under the Council must aid in the accomplishment of this complex task.

At the first general session a series of papers was heard dealing with the physical properties of liquid helium.

In a survey paper, V. P. Peshkov discussed the basic directions pursued in research, and the various results obtained, since the time of the preceding conference. The study of solutions of the isotopes He^3 and He^4 has come into prominence. Several papers were devoted to this problem. The surface tension measurements (B. N. Esel'son, V. G. Ivanov) previously conducted for weak solutions of He^3 in He^4 have been extended into the range of large He^3 concentrations (10—50%). The surface tension coefficient falls with increasing He^3 concentration, albeit more rapidly than would be expected from considerations of additivity.

K. N. Zinov'eva described her investigation of the diagram of state for He^3—He^4 solutions at elevated pressures and at temperatures below 1.5°K. In particular, as the pressure is increased, the phase stratification curves retain their form, but are shifted as a whole towards lower temperatures.

In a second paper dealing with the study of the phase diagrams of He^3—He^4 solutions (N. G. Bereznyak, I. V. Bogoyavlenskiĭ, B. N. Esel'son) attention was directed primarily to the process of solidification in mixtures containing up to 76% He^3.

Studies of vortex motion in He II have also been continued. D. S. Tsakadze reported measurements of the coefficient of mutual friction along vortex lines.

A paper by Yu. G. Mamaladze was devoted to a theoretical treatment of critical velocities for vortex formation in He II.

A. F. Andreev has investigated the problem of the influence of conduction electrons upon certain phenomena at the boundary between a metal and liquid helium. The sharp change in the reflection coefficient for phonons in the liquid at the metallic surface, which occurs at specific angles of incidence and is associated with the presence of conduction electrons, has a strong effect upon the Kapitsa temperature discontinuity, and gives rise as well to anomalies in the angular dependence of the sound reflection coefficient.

A paper by I. P. Ipatova and G. M. Éliashberg was devoted to a theoretical study of paramagnetic relaxation in liquid He^3. The order of magnitude and the temperature dependence of the transverse and longitudinal relaxation times were determined for temperatures at which He^3 behaves as a Fermi liquid.

Superconductivity. The efforts of the researchers working in this field have been concentrated in several directions. An extremely powerful tool for the study of the energy gap in the spectra of superconductors (its dependence upon temperature, impurities, etc.) is provided by the tunnel effect. In his paper, N. V. Zavaritskiĭ described an investigation of the tunnel effect between a tin film and monocrystalline samples of varying crystallographic orientation. The temperature dependence of the gap width was determined from the voltage-current characteristics, and certain information was also obtained regarding gap anisotropy.

Of great interest, both in principle and, especially, from the practical standpoint, are the superconducting alloys possessing extremely high critical magnetic fields (in the hundreds of thousands of Oersteds). This property, first discovered for Nb_3Sn, has since been found in other alloys as well. Various problems in the synthesis of such alloys and their use in solenoids for generation of strong magnetic fields formed the subjects of several papers (N. E. Alekseevskiĭ, et al., B. G. Lazarev, et al., V. R. Karasik, S. Sh. Akhmedov). A. M. Kolchin, N. I. Krivko, and N. M. Reĭnov have measured the surface impedance of the alloy Nb—Zr.

A whole series of papers dealt with the investigation of the effect of pressure upon the properties of superconductors. Of especial interest are studies of this sort for bismuth, whose electronic spectrum is subject to substantial changes under deformation. N. B. Brandt and N. I. Ginzburg have found a large difference in the properties of the two superconducting modifications of bismuth.

B. G. Lazarev, L. S. Lazareva (Kan), and V. I. Makarov have continued their previous studies of the pressure dependence of the critical temperature for tin and thallium. In particular, the non-linear character of this dependence has been established. Measurements of the pressure dependence of the critical temperature for Nb_3Sn (B. G. Lazarev, L. S. Lazareva (Kan), O. N. Ovcharenko, and A. A. Matsakova) clearly indicate the small specific volume of the superconducting regions in this alloy.

The quenching of superconductivity by current and the distribution of phases in the intermediate state have been investigated by N. E. Alekseevskiĭ and E. A. Troĭnar by the ferromagnetic powder technique. The results obtained correspond to the picture of the intermediate state proposed by Landau. A study has also been undertaken of the kinetics of the quenching of superconductivity by current (A. P. Smirnov, A. V. Rumyantseva, and V. N. Totubalin).

Of great interest was a theoretical paper by I. A. Privorotskiĭ, who demonstrated that the absence of an isotope effect for ruthenium may be explained on the hypothesis that the reason for the formation of Cooper pairs in this antiferromagnet lies in the exchange of spin waves between electrons.

As in previous conferences, a large number of papers were devoted to the electronic spectra of metals; especially to the determination by various means of the form of Fermi surfaces of metals. Besides the galvanomagnetic measurements, whose fruitfulness has already been demonstrated, high-frequency radiospectroscopic and ultrasonic methods were presented which appear to assure the highest accuracy and completeness for studies of Fermi surface topology.

Great interest was aroused by a paper by M. S. Khaĭkin and colleagues - R. T. Mina and V. S. Édel'man - on a cyclotron resonance study of tin, lead and bismuth. The method, proposed by M. S. Khaĭkin, of intercepting the cyclotron orbit by the surface of the metal in thin specimens, and the supplementary method of intercepting non-resonant orbits, permit one to determine directly the momentum of the electrons at the Fermi surface, and thus to construct specific cross-sections of the Fermi surface. Measurement of effective masses in various crystalline directions provides a substantial addition to the results obtained by the method of intercepted orbits and a fuller clarification of the picture of the Fermi surface. In this way a study was made of the hole Fermi surfaces in the third and fourth Brillouin zones for tin, of the electron Fermi surface in the third Brillouin zone for lead, and of the electron Fermi surface for bismuth, which, in accordance with the viewpoint set forth above, turned out to consist of three Schoenberg ellipsoids. The results for the fourth Brillouin zone of tin also revealed details of the extremely complex Fermi surface which could not be obtained by de Haas—van Alphen effect measurements, which are less sensitive to the form of the surface. Oscillations in the surface impedance were found to occur in stronger magnetic fields, which the authors ascribe to the high-frequency Shubnikov - de Haas effect, as well as oscillations of the quantum cyclotron resonance type having a period which is not constant in $1/H$.

The studies of V. F. Gantmakher and E. P. Vol'skiĭ are closely related to the work of Khaĭkin and his colleagues.

V. F. Gantmakher has found a new dimensional effect in thin specimens of tin while making measurements of the surface impedance of the samples at frequencies of 1—5 Mc (i.e., far from the conditions for cyclotron resonance). The effect consists of the appearance of singularities ("splashes") in the curve showing the magnetic field dependence of the impedance, due to interception of the electron orbit by the sample surface when the thickness of the specimen is equal to the diameter of the orbit; impedance splashes are observed due to local enhancement of the electromagnetic field at depths in the specimen to which the high-frequency field does not normally penetrate (anomalous skin effect conditions), at values of the magnetic field which are multiples of some fundamental. As a result, it is found possible to determine the momentum of an electron at the Fermi surface from the magnetic field at which the orbit is intercepted and from the thickness of the sample, and to construct the cross-section of the Fermi surface under study.

E. P. Vol'skiĭ has measured the quantum oscillations in the quasistatic conductivity of bismuth in a magnetic field (the Shubnikov - de Haas effect) at frequencies of 3—5 Mc. In this experiment, high sensitivity in the measurements was assured by the use of a modulation technique. The results are found to be in accordance with the hypothesis of ellipsoidal electronic Fermi surfaces: since it is the mean cross-section of the ellipses which is measured, departures from ellipsoidality were not observed.

Papers by V. P. Naberezhnykh, A. A. Galkin and V. L. Mel'nik, and by P. A. Bezuglyĭ, A. A. Galkin and A. I. Pushkin dealt with investigations of cyclotron resonance and magnetoacoustic resonance in the same samples of aluminum, which made possible the direct comparison of results and simplified the reconstruction of the topology of the Fermi surface. The angular dependence of the effective mass in the vicinity of the principal crystalline directions was obtained. For the third Brillouin zone of aluminum the results agree with the de Haas-van Alphen effect data, but provide clarification of the details of the Fermi surface; there are difficulties in the interpretation of the data for the second Brillouin zone.

N. E. Alekseevskiĭ reported on galvanomagnetic investigations of the transition metals (N. E. Alekseevskiĭ, V. Egorov, B. N. Kazak, and G. É. Karstens) in strong magnetic fields (constant to 35 kOe and pulsed to 200 kOe). These studies have shown that while palladium and rhenium possess open Fermi surfaces, that for molybdenum is evidently closed. The principal accomplishment in this experiment was to obtain reproducible results by preparation of pure specimens, since (as the authors show) impurities in these metals, especially in palladium, play an extremely prominent role. N. E. Alekseevskiĭ also noted the applicability of galvanomagnetic measurements to the study of the Fermi surfaces of the transition metals, since the purity achieved in specimens of these metals is as yet far from that required by such methods as cyclotron resonance.

N. E. Alekseevskiĭ and Yu. P. Gaĭdukov have measured the anisotropy of the electrical resistance and of the Hall effect in cadmium, zinc and thallium; open Fermi surfaces were found for all of these metals. It was further established that for Zn open trajectories are found both in the (0001) plane and parallel to the principal axis; for Tl they lie only in the (0001) plane, while Cd has open trajectories only along the principal axis.

In concluding this summary of the principal experimental papers concerned with Fermi surface topology, it should be pointed out that the interpretation of the experimental results in all of the work described above was carried out using the Harrison free electron model. It has been found that in many cases this, at first glance, crude model yields surprisingly good results when compared with experiment (the data of M. S. Khaĭkin, et al., V. F. Gantmakher, E. P. Vol'skiĭ, A. A. Galkin and his colleagues, N. E. Alekseevskiĭ et al.), and may therefore serve as a sort of compass for the development of a working model of the Fermi surface (of course, its details near the points of intersection with the boundaries of the Brillouin zone, or the intersection points of various portions of the Fermi surface, require more accurate definition). This "universality" of the Harrison model was commented on by many of those who spoke during the discussion.

V. G. Volotskaya and N. Ya. Fogel' have investigated galvanomagnetic phenomena in very pure aluminum (resistivity ratio $\rho_{300°}/\rho_{4°} \sim 2500-2000$ as compared with previous values not exceeding 2000). These measurements confirm the previously hypothesized existence of open Fermi surfaces in aluminum; in addition, however, various anomalies were observed in samples of varying impurity content.

B. N. Aleksandrov reported on a study of dimensional effects in a longitudinal magnetic field for high-purity tin, zinc, and aluminum.

Two additional theoretical papers, devoted to effects facilitating the investigation of the Fermi surfaces of metals, were presented at the conference.

In the first of these, É. A. Kaner described a theory which he has developed for acoustic cyclotron resonance (a phenomenon already observed in gallium by Roberts). In contrast to other resonance effects associated with the absorption of sound, such as magnetoacoustic resonance, or the oscillations produced by open periodic trajectories of the electrons at the Fermi surface, acoustic cyclotron resonance occurs at higher acoustical frequencies ($\omega\tau \gg 1$) for which the electrons circulating in their orbits in the magnetic field always lie in a plane of constant phase in the sound wave, and strongly attenuate the acoustical energy. Resonance occurs not only at the fundamental cyclotron frequency, but also at even multiples $\omega = n\Omega$ thereof (where $\Omega = eH/mc$, and ω is the acoustical frequency). The resonance is sharpest for $\mathbf{k} \perp \mathbf{H}$ (where $\mathbf{k}$ is the wave vector and $\mathbf{H}$ is the magnetic field) and for a quadratic dispersion law, but may also be observed for $\mathbf{k}$ non-perpendicular to $\mathbf{H}$ and for various (not merely the extremal) cross sections of the Fermi surface. An especially valuable aspect of this new effect is the possibility it provides for determining not only the extremal diameters and the effective masses for the extremal cross-sections of the Fermi surface, but also the effective masses and mean velocities for any arbitrary cross-section, together with the directions of open trajectories.

The second paper (V. G. Bar'yakhtar and V. I. Makarov) was devoted to the presentation of a theory for the quantum oscillations in the tunnelling current through the contact between two metals, in a magnetic field perpendicular to the plane of the contact. Two types of oscillations should be observed: one depending upon the magnetic field and having a period determined by the extremal cross-sections of the Fermi surfaces, and the other depending upon the pressure applied to the contact; the period of the second type of oscillation is governed by the effective mass of the electrons corresponding to the extremal cross-section of the Fermi surface. The advantage offered by this phenomenon lies in the possibility of studying the extremal cross sections of the Fermi surface as well as the effective masses, in a single experiment; the ratio of the oscillatory component to the total current is, however, on the order of 10^{-6}—10^{-7}, which makes it very difficult to observe the effect.

This same phenomenon, with the problem somewhat differently stated, has been investigated by I. O. Kulik and G. A. Gogadze, who have reached similar conclusions. They state that oscillations of only one type, associated with oscillations in the chemical potential, may be observed in pulsed magnetic fields; the condition for their appearance is $\tau \ll RC$, where τ is the duration of the magnetic field pulse, and R and C are, respectively, the resistance and capacitance of the contact.

N. B. Brandt, N. N. Stupochenko and T. F. Dolgolenko have investigated the fine structure of the quantum oscillations in the magnetic susceptibility of bismuth in various crystalline directions at ultra-low temperatures. In addition to a complex magnetic field dependence of the amplitude of the fundamental oscillations on the hole portion of the Fermi surface, the authors have observed high-frequency oscillations of double and sometimes even tripled frequency over a specific range of angles of the trigonal axis relative to the magnetic field. Speaking during the discussion, A. A. Abrikosov stated that comparison of the experiment with theory is hindered by the large non-ellipsoidality of the Fermi hole surface of bismuth and by the difficulty in calculating its cross sections.

The interesting phenomenon of the amplification of ultrasound in semi-metals has been treated by R. F. Kazarinov and V. G. Skobov. This amplification takes place when the sound is absorbed in an electric field via Čerenkov radiation from the phonons, when the drift velocity of the electrons is directed antiparallel to the acoustic wave vector and exceeds in magnitude the phase velocity of the sound.

In a strong magnetic field ($\Omega\tau \gg 1$, where Ω is the cyclotron frequency and τ is the relaxation time) the ultrasonic amplification coefficient increases by a factor v_F/S (where v_F is the Fermi velocity of the electron and S is the sound velocity). For **E** perpendicular both to **H** and to the direction of sound propagation, cyclotron resonance absorption of the sound can take place both at the fundamental cyclotron frequency and at harmonics thereof.

During the discussion, Yu. M. Kagan pointed out that the frequency of the phonons arising from this process may be measured with the aid of the Mössbauer effect, and that a similar phenomenon yielding amplification of spin waves may also be observed.

Two additional theoretical papers were devoted to problems involving the electronic spectra of metals.

L. A. Fal'kovskiĭ and A. A. Abrikosov have computed the energy spectrum of the "bad" metals of the fifth group (bismuth, arsenic, antimony) by group theory methods, utilizing qualitative ideas concerning the structure of the bismuth type of lattice and the nature of the transition from "good" metals to dielectrics under deformation. The bismuth type of lattice possesses a weakly-deformed cubic structure, but even this small degree of deformation reduces the unit cell of the reciprocal lattice by a factor of two; as a consequence, bismuth is transformed from the good metal which it would be for zero deformation of the cubic lattice, into a "dielectric" (since the Brillouin zone is entirely filled), or, more specifically, into a bad metal with a low electron concentration. As R. G. Arkhipov has shown (cf. his paper cited below), this transition from a good metal into a dielectric must take place discontinuously; consequently, in every state, for various degrees of deformation, two phases must exist - dielectric and metallic - one of which is stable and the other metastable. Evidently, the dielectric phase is the stable phase in the presence of a finite amount of deformation (as in the normal bismuth lattice), while the metallic phase is stable for the corresponding undeformed cubic lattice. These hypotheses are verified when the energy of deformation for the dielectric phase is calculated and minimized, to determine the equilibrium deformation; unfortunately, the energy of the metallic phase cannot simply be computed and compared with the dielectric phase energy. On the basis of these considerations the carrier dispersion law was calculated near the most symmetrical points of the bismuth reciprocal lattice by solving the second order secular equations. Taking the spin-orbit interaction into account, closed Fermi surfaces are obtained for both electrons and holes, in accordance with the experimental data; the dispersion law departs from the quadratic form at a reasonable distance from the energy extrema.

R. G. Arkhipov has derived a criterion for the occurrence of metals with small electron concentrations. For small carrier concentrations the formation of pairs of electrons and holes becomes profitable, due to poor screening of the Coulomb interaction, as a consequence of which there will be no current-conducting states. Therefore, the specific criterion for metallic properties (i.e., the presence of free carriers) will consist of order-of-magnitude equality between the mean electron separation and the Debye screening radius. It is then found that for good metals (with large electron concentrations) the effective mass of the carriers may be large, while "bad" metals must necessarily possess carriers of small effective mass. If a dielectric is deformed in such a way that the energy gap between the empty and filled states decreases, then its transition into a metal as the bands begin to overlap will be retarded by the process of electron-hole pair formation, which increases as the number of carriers grows with decreasing energy gap. When the number of carriers has increased sufficiently that effective screening of the Coulomb interaction begins, there occurs a sharp transition of the dielectric into a metal (a transition of the first order). It follows from these considerations that a bad metal will represent a substance in which the bands are in contact or overlap as a result of high lattice symmetry. The removal of degeneracy resulting from a weak deformation leads to the appearance of a small number of carriers of low effective mass (this is borne out by the examples of bismuth and graphite).

M. I. Kaganov and V. G. Peschanskiĭ analyzed various mechanisms for the absorption of ultrasound in metals.

The number of papers dealing with semiconductors was significantly smaller. The greatest interest was attracted during the sectional session by two papers presented by the laboratory of S. M. Ryvkin (FTI, Leningrad).

V. P. Dobrego and S. M. Ryvkin have studied conductivity in germanium alloyed with Group V or III impurities and having carrier concentrations of 10^{15} -10^{16} cm^{-3}, in the presence of compensating impurities. Under these conditions, carrier movement takes place by "jumps" to free spaces at the donors (acceptors); negative photoconductivity was observed, due to the absorption of light by fundamental absorption bands, and explained by an increase in the filling of the free donor states by electrons excited into the conduction band. A study was made of the dependence of the photoconductivity upon the degree of compensation in the samples and the intensity of the light, and a mechanism was proposed for the reduction in the photoconductivity observed when the samples were illuminated with pulsed light.

S. M. Ryvkin, V. P. Dobrego, B. M. Konovalenko, and I. D. Yaroshetskiĭ have observed the appearance of the so-called induced impurity breakdown in germanium samples of the same degree of purity, but fully compensated. In this case, carriers are completely absent at the shallow donor levels lying below the conduction band, but illumination of the germanium with light in the fundamental absorption band can cause a transition of the electrons, first into the conduction band, and then to the donor levels, and application of an electric field can induce breakdown. Under certain conditions, current oscillations arise in the measuring circuit which are associated with shock ionization of the impurities, with subsequent recombination of the electrons with holes located at the compensating acceptor levels. The conditions for the appearance of such current oscillations were investigated.

M. I. Kaganov proposed that attempts be made to observe additional exciton waves in a crystal due to the presence of space dispersion, using the deceleration of fast particles in a dielectric. In this case the braking energy losses are composed of polarization losses and Čerenkov radiation; the polarization losses are governed by the generation of exciton waves, space dispersion being taken into account. Upon emerging from the crystal, the exciton waves are transformed into electromagnetic waves, in accordance with the boundary conditions. This electromagnetic radiation may be distinguished from the Čerenkov radiation, since it is emitted in a different direction; it is comparable with the Čerenkov radiation in intensity.

L. S. Kukushkin spoke on his theory of non-radiative transition processes in molecular crystals.

A paper by A. R. Kessel' and U. Kh. Kopvillem presented a calculation of the sensitivity of a quantum phonon counter which, in contradistinction to the quantum phonon amplifiers already investigated, utilizes atoms in the ground state rather than in an excited state, which permits a substantial reduction in the noise level.

A paper was also presented at the sectional meeting by A. A. Kaplyanskiĭ on the influence of uniaxial deformations upon the optical spectra of crystals of the type of CaF_2, LiF, etc., containing various impurities, as well as upon the exciton spectrum of cuprous oxide. The measurements allow a conclusion to be drawn regarding the structure of the local centers and the band symmetry in cuprous oxide. Uniaxial deformation appears to be an especially effective approach for cubic crystals, since they possess the highest degree of symmetry.

Several additional papers on semiconductors were presented at the general sessions.

Yu. N. Obraztsov has developed a theory for thermomagnetic effects in semiconductors in quantized magnetic fields.

A paper by I. I. Boĭko, É. I. Rashba and V. I. Sheka analyzed the conditions leading to the possible observation of a new resonance effect in semiconductors, due to spin-orbit coupling.

M. I. Kaganov and I. M. Lifshitz have computed the absorption of light in a metal whose Fermi surfaces contain degenerate points (evidently this is characteristic only of graphite). In such a case there may be observed a unique internal photo-effect differing from the usual photo-effect in that the absorption begins at low frequencies, since there is a meeting of zones. For $\omega\tau \gg 1$, the absorption coefficient is proportional to ω^3.

The Shubnikov-de Haas effect in $A^{III}B^{IV}$ compounds of electronic type has been investigated in pulsed fields of up to 400 kOe by Kh. I. Amirkhanov, R. I. Bashirov, Yu. É. Zakiev, and A. Yu. Mollaev. For InSb the magnetoresistance and Hall effect data were found to be in good agreement, and the electron effective mass was determined. The results are in accordance with the theory of Adams and Holstein. The transverse magnetoresistance of GaAs and InAs exhibits anomalies.

O. V. Emel'yanenko and D. N. Nasledov have studied the electrical properties of gallium arsenide having a carrier concentration of $5 \times 10^{15} - 5 \times 10^{16}$ cm^{-3}, but with varying total impurity concentrations, as could be judged from the varying mobility in samples having the same carrier concentration. The presence of an impurity band was inferred from the occurrence of a maximum in the temperature dependence of the Hall constant; the mobility in the impurity band showed an exponential temperature dependence. The lower the mobility at room temperature, the lower was its value in the impurity band as well, from which the authors conclude that the scattering of the carriers takes place at the same centers. A negative magnetoresistance, linear with field, was found in the region of impurity band conduction. Since the Hall constant is independent of the magnetic field, this effect is not associated with a change in carrier concentration in the magnetic field.

In recent years low temperature methods in the realm of purely nuclear studies have assumed great significance.

N. E. Alekseevskiĭ, Pham Zuy Hien, V. G. Shapiro and V. S. Shpinel' have measured the resonance absorption probability for 28.3 keV γ-quanta in slices of crystalline tin cut along various crystal planes. A variation in the form of the Mössbauer line was observed, arising from the interaction of the quadrupole moment of the excited Sn^{118} nucleus with the internal electric field. This effect is strongly anisotropic, and differences are observed in both the locations and the amplitudes of the absorption maxima. The results of these experiments make it possible to determine the sign of the quadrupole interaction constant and, in principle, the value of the component of the electric field gradient. In the case of tin, however, the effect is too small to yield quantitative results.

Resonance absorption of 35 keV γ-quanta in Te^{125} formed the subject of a paper by V. V. Sklyarevskiĭ, B. N. Samoĭlov, E. P. Stepanov, I. I. Lukashevich, and R. A. Manakhov. The authors have observed splitting of the resonance absorption lines, which they also ascribe to the quadrupole interaction. It is extremely interesting that the magnitude of the splitting is constant for chemical compounds of tellurium having a variety of crystal structures.

As was remarked by Yu. M. Kagan, the electric field gradient may be associated with the crystal lattice, with the effect of the crystal field on the ionic envelope, and with the field of the envelope itself. Up to now, it has been assumed that the fundamental role in the establishment of a non-uniform electric field near the nucleus is played by the first two mechanisms. The results of the present work, however, indicate that in the case of tellurium the field is primarily determined by its own electron shells.

V. S. Shpinel' also noted that the constancy of the electric field gradient in crystals of varying symmetry is difficult to explain from the standpoint of our present ideas.

In his paper "Toward a Theory for the Redward Thermal Displacement of the Mössbauer Line", Yu. M. Kagan reported a new approach to the theory of this effect. Recoil of the nucleus during γ-emission leads to the generation of a broad spectrum of thermal oscillations in the lattice. If a specific form for the phonon spectrum of the crystal is considered, the lines then appear both broadened and displaced toward longer wavelengths. The form of the expression derived by the author depends upon whether the lattice is a regular one, or whether the radiating atom represents an impurity. The line displacement has a strong temperature dependence when the radiating atom is heavy, and is practically independent of temperature for a light impurity. In many cases the broadening of the Mössbauer line plays an extremely important role, and even in the case of the well-known γ transition in zinc it is approximately equal to the shift and almost completely determines the line width.

Speaking during the discussion, N. E. Alekseevskiĭ noted that the papers on the Mössbauer effect presented at the conference illustrate the broad possibilities offered by this method for investigations in solid state physics.

The papers "Assymetry of β-radiation in Certain Nuclei, Polarized in an Alloy with Iron", and "Nuclear Specific Heats of Certain Elements Alloyed with Iron" (A. V. Kogan, V. D. Kul'kov, L. P. Nikitin, N. M. Reĭnov, M. F. Stel'makh, M. Shott) were devoted to a study of the effective magnetic field (H_{eff}) acting on impurity nuclei in iron alloys.

Study of β-ray asymmetry in In^{114}, Re^{186}, and Ir^{192} has shown that for these elements the internal field is directed oppositely to the magnetizing field. An analogous result has already been found by other authors for iron and for alloys of gold, cobalt, and tin with iron. It has proven possible to estimate a lower limit for the nuclear spin relaxation time for In^{114} and to obtain information on the matrix elements for the β-transition $Ir^{192}-Pt^{192}$.

Improvement in techniques for determination of specific heat have permitted measurement of the nuclear specific heats of alloys of rhenium and iridium with iron, determination of H_{eff}, and calculation of the nuclear magnetic moments of the radioactive isotopes In^{114}, Re^{186}, and Ir^{192}.

Comments concerning these papers were made by N. E. Alekseevskiĭ, Yu. M. Kagan, B. N. Samoĭlov, and M. I. Kaganov.

Experiments on dynamic polarization of protons in various hydrogenic compounds were reported in the paper "Dynamic Polarization of Protons in Lanthanum-Magnesium Double Nitrate," by V. I. Lushchikov, A. A. Manenkov, and Yu. V. Taran. These experiments were undertaken with the object of producing polarized samples. In lanthanum-magnesium double nitrate, with a small admixture of paramagnetic cerium ions, the authors succeeded in obtaining an approximately 170-fold increase in the polarization, as compared with the amount of static polarization under the same conditions. With irradiated polyethylene the enhancement did not exceed a factor of 10—15.

The results thus obtained were compared with the theory of spin diffusion.

A large number of papers concerned with the investigation of the properties of ferro- and antiferromagnetic substances were presented at the conference. Of great interest were the results from measurements of the specific heats of a group of isomorphic antiferromagnets, which permit a qualitative test to be made of the spin wave theory. Papers were also heard which dealt with the theory of certain relaxation phenomena in antiferromagnets, with the study of magnetic transformations in chromium, with the investigation of a new threshold absorption effect for electromagnetic waves in antiferromagnets, associated with spin wave transitions from one branch of the spectrum to the other, and with the measurement of susceptibility and electrical conductivity in various magnetic materials.

A special session was devoted to techniques for the production of low temperatures and to methods for making various low temperature measurements.

A number of papers dealt with problems concerning the mechanical properties and optics of crystals at low temperatures, and concerning techniques for producing high pressures and strong pulsed magnetic fields for low temperature research.

On the last day of the conference, summaries of the papers presented at the various sectional sessions were presented by their respective chairmen.

As the conference chairman, N. E. Alekseevskiĭ, remarked in conclusion, only the practice of combining plenary sessions with concurrent sessions of individual sections can, in the opinion of the Scientific Council, make it possible to "boil down" to reasonable dimensions the annually increasing flood of papers on low temperature physics.

Translated by S. D. Elliott