Expanded session of the executive of the Division of General Physics and Astronomy of the Academy of Sciences of the USSR (16 February 1983)

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An expanded session of the executive of the Division of General Physics and Astronomy was held on February 16, 1983, at the Institute of Solid State Physics, Academy of Sciences of the USSR (Chernogolovka, Moscow District), to celebrate the 20th anniversary of the Institute. The session heard the following reports:

1. An opening speech by Academician A. M. Prokhorov, secretary of the Division of General Physics and Astronomy.

2. *Yu. A. Osip'yan.* Basic research directions in the Institute of Solid State Physics.

3. *V. F. Gantmakher.* Low-temperature kinetics of conduction electrons in metals and semiconductors.

4. *E. G. Ponyatovskiĭ.* High-pressure phases in condensed systems and metal-gas systems.

5. *S. T. Mileĭko.* Fiber composites with metallic and ceramic matrices.

6. *V. A. Tatarchenko.* Profiled crystals: growth and applications.

Four of the reports are summarized below.

V. F. Gantmakher. *Low-temperature kinetics of conduction electrons in metals and semiconductors.* Although the situation in the low-temperature kinetics of solid-state electron-hole plasmas with a long carrier mean free path has calmed down somewhat since the sensational result of the 1960s, which led to the appearance of so-called fermistics, some important changes have still occurred in the past decade and a half. We can distinguish two basic directions in this research.

The first is to study the scattering processes in a solid-state electron-hole plasma. A successful transition has been made from measurements of certain average scattering probabilities to measurements of the probabilities for scattering by a phonon or some specific impurity as functions of the position of the electron on the Fermi surface. A transition has been made from measurements of the total cross sections for the scattering of electrons by dislocations in metals to measurements of differential cross sections. In the reflection of electrons from a surface it has become possible to measure the dependence of the probability for specular reflection of an electron on the angle of incidence and on the position of the electron on the Fermi surface instead of measuring an average diffuseness coefficient over all electrons. All this progress can be credited to the use of kinetic effects on extremal trajectories—the rf size effect, the cyclotron resonance, the de Haas-van Alphen effect, the transverse-focusing effect, etc.—to study scattering. Several new results have been obtained. For example, it has been found that even the exponent in the temperature dependence of the electro-phonon scattering probability depends on the shape of the Fermi surface, so that even when a conduction electron is incident normally on the surface of a metal there is a significant probability for its specular reflection, so that electron–electron scattering can be singled out and measured even in nontransition metals, and so that electrons can be heated to a temperature higher than that of the lattice not only in semiconductors but also in metals. Experimental techniques have been refined to the point at which it is possible to "see" the conversion of an electron into a hole upon reflection from the interface between a normal metal and a superconducting metal. By studying the magnetoresistance of photoelectrons in germanium cooled to liquid-helium temperature it has been found possible to single out and study the inelastic scattering of these electrons by impurity atoms.

A second thrust in the research in the low-temperature kinetics of electron–hole plasmas has been to study new phenomena in electrodynamics. Unfortunately, a brief listing of results in this direction would be far less informative, because each area we would name—the magnetostrictive excitation of sound due to oscillations of the diamagnetic susceptibility of a metal, features of the propagation of helicons at large amplitudes of these oscillations, and the excitation of thermomagnetic and galvonomagnetic waves—is filled with new phenomena which demand explanation. There is, however, a clear trend in this research. Its center of gravity is gradually shifting toward nonlinear electrodynamics. In metals, nonlinearities result from the effect of the magnetic field of currents on electron trajectories and thus on the conductivity. Although this research direction is relatively young, it has already seen much progress and many discoveries. For example, there are current states: macroscopic electromagnetic moments which arise during the bombardment of a metal by an intense electromagnetic wave as a result of rectification effects in a skin layer. These current states are in many ways reminiscent of ferromagnetism: The metal exhibits a hysteresis and is parti-

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tioned into domains. Among the nonlinear effects is the effect of a helicon wave on itself, when the magnetic field of the wave combines with an external field to change the helicon dispersion law. We should also mention the appearance of a soliton-like current distribution in a skin layer at a large amplitude of an alternating field, in which case the skin current is concentrated near a surface at which the alternating magnetic field vanishes, and it moves into the interior along with this plane; the nonlinear cyclotron resonance, caused by the influence of the magnetic field of a wave on the time required for an electron moving in a cyclotron orbit to traverse a skin layer; and the nonlinear resonances involving hopping trajectories, which arise from a focusing of electrons which have left the surface of a metal by the exponentially decaying magnetic microwave field in a skin layer.