covered. This phenomenon consists in the formation of a complex magnetic structure in a ferrimagnet at temperatures considerably higher than the Curie point (by a factor of one-and-a-half to two), when the sample is placed in an external magnetic field. Comparison of the experimental data with computations carried out in the framework of the method of constant coupling allowed the determination of the temperature region where the effects of the short-range magnetic order play an important role.

[1]R. V. Pisarev, I. G. Siniĭ, and G. A. Smolenskiĭ, ZhETF Pis. Red. 5, 96 (1967) [JETP Lett. 5, 79 (1967)]; Fiz. Tverd. Tela 9, 3149 (1967) [Sov. Phys.-Solid State 9, 2482 (1968)]; Solid State Comm. 5, 959 (1967); Fiz. Tverd. Tela 10, 2252 (1968) [Sov. Phys.-Solid State 10, 1775 (1969)]; Solid State Comm. 7, 23 (1969); ZhETF Pis. Red. 9, 112, 294 (1969) [JETP Lett. 9, 64, 172 (1969)]; Zh. Eksp. Teor. Fiz. 57, 737 (1969) [Sov. Phys.-JETP 30, 404 (1970)].

[2]G. A. Smolenskiĭ, R. V. Pisarev, M. I. Petrov, V. V. Moskalev, I. G. Siniĭ, and V. M. Yudin, J. Appl. Phys. 39, 568 (1968); Usp. Fiz. Nauk 99, 151 (1969) [Sov. Phys.-Uspekhi 12, 695 (1969)].

[3]G. A. Smolenskiĭ, R. V. Pisarev, N. N. Krainik, and I. G. Siniĭ, Vest. Akad. Nauk SSSR No. 8, 62 (1969).

[4]R. V. Pisarev, Zh. Eksp. Teor. Fiz. 58, 1421 (1970) [Sov. Phys.-JETP 31, 761 (1970)].

[5]G. A. Smolenskiĭ, M. P. Petrov, V. V. Moskalev, V. S. Kasperovich, and E. V. Zhirnova, Phys. Lett. 25A, 519 (1967).

[6]G. A. Smolenskiĭ, M. P. Petrov, V. V. Moskalev, V. S. L'vov, V. S. Kasperovich, and E. V. Zhirnova, Fiz. Tverd. Tela 10, 1305 (1968) [Sov. Phys.-Solid State 10, 1040 (1968)].

[7]M. P. Petrov, V. V. Moskalev, and V. S. Kasperovich, Fiz. Tverd. Tela 12, 1063 (1970) [sic!]

Yu. A. Osip'yan. Interaction of Dislocations with Current Carriers in Crystals

One of the aims of the work, the results of which are discussed below, was to attempt to experimentally investigate the following problem: Does an independent change in the state of the energy spectrum of the electrons in a semiconductor crystal have any effect on the behavior of the dislocations in the crystal and, at the same time, on the shaping of such properties of the crystal as the strength and ductility, which are usually considered as pure "lattice" properties, depending only on the atomic-crystalline and not the electronic structure.

On the other hand, a dislocation, as an array of atoms in nonidentical surroundings, should interact in a particular way with the current carriers in the crystal, and thereby can have a considerable influence on the shaping of many of the electronic properties of the crystal. These effects should show up clearly in semiconductors, where dislocations can influence not only scattering but the concentration of the current carriers as well.

In this connection, the second experimental problem, which was tackled, was to investigate the effect of the presence of dislocations on certain electronic properties of semiconductors (electrical, optical and magneto-optical), i.e., in short, if in semiconductor crystals there is an "electron-dislocation interaction," then the problem was to attempt to experimentally observe the two possible aspects of this interaction; the effects of the state of the electron subsystem on the motion of the dislocations and, coupled with this, on the plastic properties on the one hand, and, on the other, the effects of the presence of dislocations on the characteristics of the state and motion of the electrons.

We give below the experimental results obtained in accordance with the foregoing plan.

1. The photoplastic effect. A new phenomenon, which manifests itself as a sharp change in the resistance to plastic deformation under the action of visible light[1,2], was observed in the investigation into the mechanical properties of semiconductors (CdS, ZnSe, ZnO). The magnitude of the maximum effect was +25% for CdS and 100% for ZnSe and ZnO of the initial stress.

In the range from 50 to 100°C, the effect decreases with increase in temperature, and is not observed above 250°C. The dependence on the light intensity is given by a curve with saturation. The spectral dependence is given by a curve with a sharp peak lying in the region of the fundamental absorption edge. The effect is explained by the interaction between moving dislocations and the local centers produced during the redistribution of the current carriers (electrons and holes) under the action of light.

2. Deformation luminescence. A peculiar luminescence is observed in alkali-halide crystals containing color centers when the crystals are subjected to small stresses which cause the dislocations in the crystals to move. The crystallographic anisotropy, and the spectral and kinetic characteristics of the observed luminescence have been investigated[3]. The assumption that moving dislocations interact with localized centers again underlies the explanation of this effect.

3. Dislocations and a conductivity-type of inversion. Following introduction of dislocations of different polarity (α, comprising of indium atoms, and β-of antimony atoms) into InSb crystals, the author observed a sharp change in the concentration and mobility of the current carriers right up to a conductivity-type inversion.

Thus, $p \rightarrow n$ and $n \rightarrow p$ transitions could be realized only on account of a law-governed introduction of dislocations, without doping, into indium antmonide.

4. Electron paramagnetic resonance on dislocations. A dislocation line with an edge component in a covalent crystal can be represented as a linear array of uncompensated spins. Electron paramagnetic resonance (EPR) has been observed on the dislocations in direct experiments with plastically deformed silicon. The anisotropy in the EPR spectrum, the nature of the fine structure, the temperature dependence of the intensity, as well as the parameters of the spin-spin and spin-lattice relaxation have been investigated[6,7]. The donor action of dislocations has been observed by the EPR method in silicon doped with phosphorus.

Thus, a number of new phenomena, due to "electron-dislocation" interaction in crystals, has been experimentally successfully observed.

[1] Yu. A. Osip'yan and I. B. Savchenko, ZhETF Pis. Red. 7, 130 (1968) [JETP Lett. 7, 100 (1968)].
[2] L. Carlsson and Ch. Svensson, J. Appl. Phys. 41 (4), 1652 (1970).
[3] S. Z. Shmurak, Fiz. Tverd. Tela 10, 1934 (1968) [Sov. Phys.-Solid State 10, 1526 (1969)].
[4] Yu. A. Osip'yan, Yu. I. Fedyaev, and S. A. Shevchenko, Zh. Eksp. Teor. Fiz. 54, 1706 (1968)].
[5] Yu. A. Osip'yan and Yu. I. Fedyaev, ZhETF Pis. Red. 9, 37 (1969) [JETP Lett. 9, 21 (1969)].
[6] V. A. Grazhulis and Yu. A. Osip'yan, Zh. Eksp. Teor. Fiz. 58, 1259 (1970) [Sov. Phys.-JETP 31, 677 (1970)].
[7] V. A. Grazhulis and Yu. A. Osip'yan, Zh. Eksp. Teor. Fiz. 60, 1148 (1971) [Sov. Phys.-JETP 33, 623 (1971)].

M. A. Krivoglaz. The Fluctuon States of Electrons in Disordered Systems

The interaction of electrons with the fluctuations of some internal parameter of a nonmetallic medium is considered. If the variation of this parameter leads to the appearance of a sufficiently deep and wide potential well, then the electron localizes in it. The decrease in the energy of the electron on localization may turn out to be larger than the increase in the thermodynamic potential of the medium connected with the fluctuation and, then, the appearance of the fluctuation, in the vicinity of which the electron localizes, will be thermodynamically favorable. Under definite conditions the radius of the electron state turns out to be fairly large, considerably exceeding the interatomic distance.

Such type of large-radius formations in which an electron is localized near a change (fluctuation) in some internal parameter of a medium and maintains by means of its own field the stationarity of this fluctuation (the bound electron-fluctuation states) have been called fluctuons. They have been theoretically considered in[1-6]. Fluctuons should move in an external electric field, so that if fluctuons are thermodynamically favorable, they can play the role of current carriers. In order that a significant number of electrons will go over into fluctuon states, it is necessary that the characteristic relation time of the internal parameter be small compared with the life time of the electron in the potential well.

Fluctuons may be connected with fluctuations of the composition of solutions[1,3,4] (producing regions with sharply increased concentration of one of the components), with fluctuations of the magnetization in elementary magnets[2,4] (producing ferromagnetic regions in paramagnets or regions of enhanced magnetization in ferromagnets), with fluctuations of the long-range order in ordered crystals[4], with the fluctuations of the density in gases[4,5], etc. In systems which are close to a first-order phase transition point, an electron may localize at a heterophase fluctuation of the second phase, stabilizing the fluctuation and producing a phason—a particular type of fluctuon[1], which is characterized by the existence of a discontinuity in the variation of the internal parameter.

For the appearance of fluctuons of large radius, it is necessary that the energy of interaction of an electron with the internal parameter, A, be small compared with the width of the conduction band, but large compared with kT and the characteristic energy kT_c of the direct interatomic interaction (T_c is the Curie or critical temperature). It is significant then that in the considered examples, the formation of fluctuons turned out to be thermodynamically favorable only in a definite temperature range $T_1^* < T < T^*$, which includes the temperature T_c (but not $T = 0$), the transition to the fluctuon states occurring, for the majority of electrons, in a comparatively small temperature interval $\delta T \ll T^*$ and having the character of a diffuse phase transition. In this respect, fluctuons greatly differ from polarons[7] (with which, conceptually, they have much in common). The macroscopic nature of fluctuons is connected with the nonlinear dependence of the change in the internal parameter on the force exerted by the electron, and not with a long-range interaction as in the case of polarons.

The direct interatomic interaction can facilitate the formation of fluctuons. The effect manifests itself especially sharply in the vicinity of the critical points on a decay curve, on a gas-liquid curve, or in the vicinity of the Curie points[4]. Fluctuons are produced in this region at substantially smaller $|A|$ and have unique properties. In particular, no free-energy barrier is surmounted in their formation as is the case at points far from the critical region.

The formation of the fluctuons, perceived as a smeared phase transition in the electron subsystem, should lead to a qualitative change in all the electronic properties of the system—the electrical conductivity, the galvanomagnetic and thermoelectric effects, the optical properties (a new absorption band may appear owing to optical transitions in the fluctuon), the magnetic properties (because of the anomalously large magnetic moment of a fluctuon in an elementary magnet), etc. Certain atomic properties also change (fluctuons may strongly influence the kinetics of phase transitions, the scattering of x-rays, neutrons and light, the density of gases, etc.).

In particular, the mechanism underlying the mobility of the current carriers should qualitatively change when fluctuons are formed. This problem was investigated, using as an example, fluctuons in solutions and paramagnets, as well as phasons[6]. It turns out that fluctuons have no mean free path (its effective value is much less than the radius of a fluctuon) and their motion is connected with diffusion or with viscous flow in a medium. Therefore, a "hydrodynamic" approach, in which the energy dissipated in the medium during the motion of a fluction is calculated, was used to calculate the mobility u of fluctuons. In solutions u is proportional to the atomic coefficient of diffusion D and is n times smaller than the mobility of the ions (n is the effective number of atoms in the volume of a fluctuon). The effective mass of fluctuons M which determines the inertial force during their motion in high-frequency fields was also found. It is inversely proportional to D^2 and usually exceeds substantially the mass of the atoms.

The interaction of electrons with the inhomogeneities of internal parameters may qualitatively change the