SCIENCE SESSION OF DIVISION OF GENERAL PHYSICS AND ASTRONOMY, USSR ACADEMY OF SCIENCES

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A science session of the Division of General Physics and Astronomy and of the Science Council on Complex Problems of "Solid State Physics" of the USSR Academy of Sciences was held in commemoration of the 24th Congress of the C.P.S.U. in the Conference Hall of the Institute of Physical Problems of the USSR Academy of Sciences. The following papers were presented at the session:

1. **G. A. Smolenskiĭ**, Magneto-optical and Radiospectroscopic Investigations of Magnetic and Dielectric Crystals, Carried out at the Institute of Semiconductors.
2. **Yu. A. Osip'yan**, Interaction of Dislocations with Current Carriers in Crystals.
3. **M. A. Krivoglaz**, The Fluctuon States of Electrons in Disordered Systems.
4. **F. F. Voronov**, The Effect of Pressure on the Elastic Moduli of Solids.
5. **S. A. Al'tshuler**, Spin-phonon Interactions and Mandel'shtam-Brillouin Light Scattering in Paramagnets.
6. **A. A. Roĭtburd and A. G. Khachaturyan**, Elastic Domains in Heterophase Systems.
7. **G. I. Distler**, The Electrical Structure of Crystals.

We publish below brief summaries of the papers read at the session.

G. A. Smolenskiĭ. Magneto-optical and Radiospectroscopic Investigations of Magnetic and Dielectric Crystals carried out at the Institute of Semiconductors of the USSR Academy of Sciences.

Optical and magneto-optical investigations allowed us to obtain a wealth of information about the behavior of electronic levels in the internal exchange and external magnetic fields, about the magnetic structure of crystals and the intensity of magnetization of the sublattices, and about the interaction of light with magnetically-ordered crystals.

A phenomenological theory of magneto-optical crystals is developed on the basis of the principles of magnetic symmetry and a number of new effects are predicted.

Extensive spectral, field and thermal investigations into optical phenomena in a number of new transparent magnetic crystals are carried out. The magneto-optical effects, which are quadratic in the magnetization, are found to be of large magnitude, and an exchange mechanism, which explains the magnitude and the temperature dependence of these effects, is proposed.

The anomalies in the optical effects which come into play during magnetic phase transitions (at the Curie, Neél, and Morin points) are investigated. Critical scattering and depolarization of light, as well as anomalous magnetic double refraction are discovered.

A gyro-anisotropy is discovered in the propagation of light in magnetically-ordered media, when the Faraday and Cotton-Mouton effects are simultaneously observed in the crystal. An anisotropy in the quadratic effect is discovered on the example of the cubic rare-earth garnets.

These investigations are also of important practical value for new generations of the electronic computer, and for laser and other fields of technology.

The local magnetic fields at the fluorine nuclei in the ferrimagnetic crystal $RbNiF_3$ are investigated by means of the nuclear magnetic resonance method. A new phenomenon—induced ferrimagnetism—is discovered. 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.

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[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 → n and n → 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-