Mikhail Fedorovich Deĭgen (Obituary)

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Soviet science has suffered a heavy loss. Mikhail Fedorovich Deĭgen, a leading figure in solid state physics, died November 10, 1977, after a long illness. Professor Deĭgen was a doctor of physicomathematical sciences and a corresponding member of the Academy of Sciences of the Ukrainian SSR.

Deĭgen was born in 1918 in the Ukrainian city of Khmel'nitskiĭ in the family of a communications engineer. He moved to Kiev in 1932, completed work at the ten-year secondary school, and entered the Physics Faculty of the T. G. Shevchenko Kiev State University. After completing work at the University in 1940, he remained as a graduate student in the department of theoretical physics. War interrupted his studies; in 1941–1944, he worked at a defense establishment. Then he was sent back to Kiev by the Central Committee of the Communist Party of the Ukraine to continue his scientific work. In 1947 he defended his candidate's dissertation on the electronic theory of crystals. From 1947 to 1960, he was a senior scientist at the Institute of Physics, Academy of Sciences of the Ukrainian SSR.

Deĭgen's first papers presented new ideas and new research directions in solid state physics. Let us review a few of the results from the period 1945–1957.

The concept of strain energy was introduced to describe the interaction of an electron with acoustic lattice vibrations. The possible formation of self-consistent electronic states ("condensons") due to the strain energy was discussed. This "condenson" effect was also introduced into the theory of polarons and local electronic centers. The properties of the quantum states and the optical transitions at color-center clusters in ionic crystals were calculated. The application of the theory of polarons and local electronic centers to metal–ammonium solutions yielded an explanation of the magnetic and optical properties of these solutions and led to the prediction of new optical effects which were subsequently observed experimentally. A theory was developed for the local centers and excitons at the surface of a semiconductor.

Starting in 1957, Deĭgen concentrated his efforts on the development of rf spectroscopy of nonmetallic crystals. This work was purely theoretical at first. Along with the work carried out in 1947–1957, it constituted the material of his doctoral dissertation (1959). In 1960 Deĭgen founded a department of rf spectroscopy in the Institute of Semiconductors, Academy of Sciences of the Ukrainian SSR, and the work carried out there under his guidance has always been distinguished by a close relationship between theory and experiment. For example, theoretical work on the method of the electron–nuclear double resonance (ENDOR) showed this resonance to be unusually informative and promising for study.

MIKHAIL FEDOROVICH DEĬGEN (1918–1977)

The first Soviet apparatus for ENDOR experiments was developed in the department at Deĭgen's initiative. The experimental results revealed the distribution of the ψ cloud of the local electronic centers in several crystals. He proposed a method for determining energy–band structures from ENDOR data. In order to explain the fine details of the corresponding spectra it was necessary to refine the theory for the ENDOR frequencies, intensities, and line shapes. Deĭgen headed this effort. Also at that time he proposed a double resonance in which the transitions between the nuclear sublevels would be caused by ultrasound; the electron–nuclear double magnetoacoustic resonance. This resonance was detected experimentally two years later.

In a series of studies on the effect of external agents (electric fields, pressure, and temperature) on ESR and ENDOR spectra, Deĭgen defined a fundamental new field of physics: the study of the local properties of a medium near a defect by the methods of rf spectroscopy. A comparison of the theory and spectra of ESR and ENDOR for several crystals led to conclusions regarding the nature of the changes which occur near a defect in a crystal (conclusions regarding the local electric fields, atomic displacements, and the local elastic moduli). In the course of this work a correlation was discovered between the angular variation of the ESR line width and the magnitude of the line splitting in an

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external electric field. To explain this effect, Deĭgen proposed fundamentally new broadening mechanisms for ESR lines, and these mechanisms subsequently proved to be the dominant mechanisms in many crystals.

Over the years, Deĭgen predicted several effective mechanisms for spin relaxation: modulation of the exchange interaction by lattice vibrations in the presence of a hyperfine interaction, electric-field scattering of current carriers by paramagnetic centers, etc.

Deĭgen had a keen sense for what was new and was eager to support and develop a promising new idea. After the first reports of the noncentral nature of certain ions in cubic crystals, Deĭgen developed a theory of paraelectric-resonance which included an explanation for the frequencies, intensities, and shapes of the lines; the origin of the noncentral position of the ions; and the effect of external agents on the paraelectric resonance. He proposed new types of acoustic paraelectric resonances.

Deĭgen devoted his last years to studying the interaction of the electron plasma of a solid with paramagnetic centers. He studied the interaction of the centers with current carriers based on the electric-field in magnetic resonances, and he identified the role played by this effect in paramagnetic relaxation and the indirect coupling of magnetic ions in crystals. Particularly important is the theory of a new relaxation process in which the magnetic energy of a center is transferred to collective excitations of the current-carrier plasma in a semiconductor. This group of effects is important in itself for rf spectroscopy, and it can also serve as a "paramagnetic probe" for studying solid-state plasmas.

Deĭgen guided the development of all the research on rf spectroscopy in the Ukraine. He devoted much time and energy to work in the national councils on the problems of solid-state theory, the physics of semiconductors, and rf spectroscopy. He also devoted much effort to lecturing at Kiev State University and to editing the journal Ukrainskiĭ Fizicheskiĭ Zhurnal.

Deĭgen was extremely talented in organizing scientific teams and in arranging favorable working conditions. Without ever "pulling rank," he was able to elicit interest and enthusiasm from the people on his team. It was amazing how the problem proposed by Deĭgen would precisely match the interests and capabilities of the particular individual. Deĭgen trained six doctors of science and about thirty candidates of science, who went on to form the core of the widely acclaimed Kiev school of physicists and rf spectroscopists. An untiring worker and a communist, Deĭgen set an example of honest and selfless service to science. He was always surrounded by youth, with whom he generously shared his talent, knowledge, and ideas. Most of his published papers (of which there were about 200) were written in collaboration with his students. And for many years to come publications will appear on various projects begun or conceived by Deĭgen.

Deĭgen left us at the height of his creativity and interest in life. For all those who knew him he remains a talented scientist, a thorough and demanding teacher, a kind and sensitive comrade, a man of principle, and a genuine patriot.

Translated by Dave Parsons