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## History

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### **To 100th anniversary of birthday of Professor Mykhailo Fedorovich Deigen**

On June 18, 2018, it is carried out the 100th anniversary of the birth of Mykhailo Fedorovich Deigen, a prominent scientist in the field of solid state physics, physics of semiconductors and radio-spectroscopy of

solids. Bright, extraordinary man, he left a notable mark in science and in the life of his native institution. The name of Professor Deigen is widely known both in our country and abroad.

In his student years at the Kyiv university in 1938, Mykhailo Fedorovich began his scientific work and during his student practice under the leadership of the outstanding scientist Ya.I. Frenkel in the theoretical department of the Leningrad Physics and Technology Institute performed his first scientific work on asymmetry of condensation of vapor on ions of various signs, which was important to develop the Wilson camera theory.

In 1940, he graduated from the University with honor and was invited to postgraduate courses, where he continued his research work under the guidance of prominent scientist in the nuclear physics D.D. Ivanenko at the Department of Theoretical Physics, Kyiv State University. His postgraduate courses were interrupted by war. In 1941-1944, Mykhailo Fedorovich worked on one of the defensive enterprises of the USSR. In 1944, he returned to Kyiv where he continued his scientific work under the direction of S. I. Pekar at the Institute of Physics of the Academy of Sciences of the USSR. The scientific works of this period comprised the content of the candidate's thesis "Absorption of light by polarons and F-centers" in 1947. From 1947 up to 1960, he worked as a senior researcher at the Institute of Physics of the Academy of Sciences of the USSR. Already in his first works, Mykhailo Fedorovich introduced new concepts and directions of researches in physics of solids. So, for the period from 1945 to 1957, in cooperation with S.I. Pekar, they introduced the concept of deformation potential to describe interaction of electrons with acoustic oscillations, which made it possible to prove formation of self-consistent electron-deformation states, the so-called "condensons", in crystals. The condensation effect was also introduced into the theory of polarons and local electron centers. In addition, Mykhailo Fedorovich performed calculations of parameters describing quantum states and optical transitions for aggregate color centers in ionic crystals. Using the theory of polarons and local electron centers for metal-ammonia solutions gave him the opportunity to explain their magnetic and optical

properties, to predict new optical effects in these solutions, which were discovered later experimentally. Then, Mykhailo Fedorovich developed the theory of local electron centers and excitons on the surface of semiconductors, which for many years attracted attention of domestic and foreign scientists.

Since 1957, in the walls of the Institute of Physics of the Academy of Sciences of Ukraine, Mykhailo Fedorovich was focused on the development of radiospectroscopy of non-metallic media.

In 1960, the Institute of Semiconductors of the Academy of Sciences of the USSR was founded on the basis of one of the departments of the Institute of Physics. M.F. Deigen became one of the founders of this institute and created a department for radiospectroscopy, which united qualified theorists and experimenters into a team that originally had less than 10 persons. Since then, the close relation between theory and experiment became an inescapable feature of research carried out under his leadership. Their theoretical investigations of the electron-nuclear double resonance (ENDOR) showed this method to be extremely informative and promising. Under the leadership of Mykhailo Fedorovich, his disciple M.O. Ruban created the first in the USSR ENDOR spectrometer with much better characteristics than those of world analogues. Using this spectrometer, unique investigations of ENDOR were carried out on nuclei distant from the paramagnetic center, and also dynamic and electro-field effects. The wide possibilities of the spectrometer and developed theoretical basis of the method allowed determining the distribution of wave functions of local electron centers at the distances corresponding to the 13<sup>th</sup> coordination sphere of ions in crystals. Being based on the obtained results, M.F. Deigen together with S.I. Pekar and V.G. Grachev (now a doctor of physical and mathematical sciences, working in the USA) developed a new method for calculating the structure of energy bands in crystals according to the ENDOR data. At the same time, Deigen proposed the conception of double electron-nuclear magneto-acoustic resonance, in which resonant transitions between energy levels of nuclei were caused by ultrasound. Two years later this resonance was observed experimentally.

Active work on organization of researches was performed in his department. Scientific workshops were held every week, and at the same time, no one had a sense of a time loss. Each seminar began with a review of fresh scientific literature by young colleagues and graduate students – the subject of review was not limited. The main purpose of these seminars was to enhance the skill of young scientists with the necessary knowledge and to enrich their erudition. After the review, it was obligatory to have a scientific report on the work completed by the colleagues, or analysis of a new

publication in the scientific journals of the recent month, which was of general interest. The seminar quickly turned into the common for Kyiv one. It was visited by scientists from other institutes, and they together discussed the most new scientific achievements. Very close relations took place between the Kyiv and Kazan scientific schools of the electron paramagnetic resonance. First, Kazan was the place where Ye. K. Zavoisky experimentally discovered EPR phenomenon in 1944; and second, friendly relations united M.F. Deigen with S.A. Altshuller, who was the author of the textbook "Electronic Paramagnetic Resonance", the first in the Soviet Union. This manual was a desktop book of all Soviet radiospectroscopists, and Deigen was the editor of the second edition of this book. An important area of his researches was the cycle of works on the influence of external actions (electric fields, pressure, temperature, *etc.*) on the spectra of EPR and ENDOR, and the study of the structure of solids in the immediate environment of defects by using the methods of radiospectroscopy. A comparison of the theory with the EPR and ENDOR spectra for many crystals enabled to draw conclusions about the nature of changes in the crystalline structure near the paramagnetic defect: local electric fields, atomic displacements, and local modulus of elasticity. It was discovered the effect of correlation between the angular dependence of the EPR line width and the magnitude of its splitting in external electric fields. To explain the nature of this phenomenon, M.F. Deigen proposed new mechanisms that provide broadening the EPR lines. In the next cycle of researches, Deigen considered interaction of paramagnetic centers with the collective states of conduction electrons, with plasma. New mechanisms of spin relaxation were proposed, namely: collective excitation of electron plasma in semiconductors caused by scattering of current carriers in the electric field near paramagnetic centers, as well as modulation of exchange interaction by oscillations of crystal lattice atoms. International relations with physicists of other countries were definitely confined to the interference of the political leadership of the Soviet Union; nevertheless, scientific writing, the invitation of famous scientists to make a report at the seminar of the department and participation in international conferences contributed to the wide acquaintance of foreign scientists with the scientific work of the radiospectroscopy department at the ISP of the Academy of Sciences of Ukraine. As a result, the research subject of department was always modern and sometimes went ahead of foreign studies. M.F. Deigen had a keen sense of research innovation and spent a lot of energy for supporting and developing the promising ideas. After the first reports at international conferences about observation of non-centrality of some ions in cubic lattices, M.F. Deigen developed a new theory of paraelectric resonance, which included description of the frequencies, intensity and shape of the paraelectric resonance lines, explanation of the nature of non-central ions, influence of external forces on this resonance, and proposed new types of

acoustic paraelectric resonance. Due to the width of views, the richness of ideas and spiritual generosity, on the basis of his department No 8 at the IS of Academy of Sciences of Ukraine (new titled as ISP), M.F. Deigen created a scientific school that includes more than 20 doctors and several dozen candidates of sciences, who successfully work in founding fields. Most of his scientific works (just over 200) were performed by him together with his students and disciples. The Academy of Sciences of the Ukrainian SSR appreciated the scientific achievements of M.F. Deigen, choosing him as a corresponding member in 1968. M.F. Deigen also paid considerable attention to scientific-organizational and pedagogical activity. He was a member of the scientific councils of the USSR Academy of Sciences on solid-state radiospectroscopy, on solid-state theory, on semiconductor physics; worked for many years as Deputy Chief Editor of the Ukrainian Physical Journal; for a long time he lectured the course of radiospectroscopy at the Kyiv State University. A scientific seminar at the Institute of Semiconductor Physics under the direction of Mykhailo Fedorovich became the core of the Kyiv school for radiospectroscopy. Easy and easy, with a constant sense of humor, he solved everyday issues, but was mindful and far-sighted when it concerned serious decisions. Not relying on his authority, he could prepossess with a new idea any coworker, and it often turned out that this task was exactly in line with the interests and capabilities of this person. Domestic and foreign physicists knew Mykhailo Fedorovich Deigen as a talented scientist, a careful teacher, a man with a bright sense of humor, and in the circle of friends - as a simple, modest, attractive and friendly person. He was an exciting, tireless interlocutor and he could listen for hours. Sociable, instantly responsive, he has always been aware of all the significant events in physics, politics, literature.

Mykhailo Fedorovich died in the heyday of creative forces and vital energy. In our memory, he remains a fully gifted man, talented scientist and teacher, principal and responsible citizen.

#### **The main dates of M.F. Deigen's life**

1918, 18 June – born in Khmelnytskyi, Ukraine;  
 1928– moved to Kyiv with parents;  
 1935 – entered the physical department of Kyiv university;  
 1940 – completed his studies at Kyiv university;  
 1940 – was offered a postgraduate course at Kyiv university;  
 1944 – joined to the Institute of Physics, Academy of Sciences of UkrSSR;  
 1947 – defended the doctor thesis “Light absorption by polarons and F-centers” ;  
 1956 – created the concept of a deformation potential in collaboration with S.I. Pekar;  
 1957 – created the theory of condensons;  
 1959– was conferred with the doctor's degree of habilitation (Phys&Math);

1957-1960—created the theory of the electron–nuclear double resonance (ENDOR);  
 1960 – began to work at the newly-created Institute of Semiconductors, Academy of Sciences of UkrSSR;  
 1960-1964 – headed creation of the ENDOR spectrometer in collaboration with M.A. Ruban;  
 1962– professor;  
 1968 – was elected as a corresponding member of Academy of Sciences of UkrSSR;  
 1977, 10 November – died in Kyiv.

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Colleagues and disciples of Mykhailo Fedorovich Deigen

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