MYKHAILO PAVLOVYCH LISITSA (to the 90-th Anniversary of His Birthday)

On January 15, 2011, Academician of the National Academy of Sciences of Ukraine Mykhailo Pavlovych Lisitsa, an outstanding Ukrainian scientist, who is known to a wide community of researchers owing to his fundamental results obtained in optics, spectroscopy, nonlinear optics, quantum electronics, solid state physics, and physics of semiconductors, is 90 years of age.

M.P. Lisitsa was born in the village of Vysoke (the Zhytomyr region) in a peasant family. In 1938, he graduated from Kyiv pedagogical secondary school and, in 1939, became a student of the Physico-Mathematical Faculty of Taras Shevchenko Kyiv State University. However, in two months, M.P. Lisitsa was called up for the military service till October 1945. He participated in the military actions during the Great Patriotic War, being awarded three orders, a medal "For Courage", and other medals. In 1945, he continued his study at Taras Shevchenko Kyiv State University. Being awarded a diploma in 1950, Mykhailo Pavlovych became the post-graduate student at the Chair of Optics of the Faculty of Physics that was separated from the Physico-Mathematical Faculty in 1949. In 1954, M.P. Lisitsa defended the Ph.D. thesis. His dissertation was based on the studies, first over the world, of the vibration spectra of molecular microcrystals in a polarized light. To this end, it was necessary to fabricate microobjectives with mirror optics and multilayer polarizers transparent for IR-emission that were earlier unknown and were not produced at any scientific institution over the world. Since such systems did not ensure the 100-it was necessary to develop a theory that would give a possibility to calculate the polarization degree as a function of the incidence angle. M.P. Lisitsa had developed such a theory. It allows one to describe any layered system including a polarizer and an efficient light reflector or the antireflecting system of an optical objective.

Since 1954 and for 10 years, Mykhailo Pavlovych together with his post-graduate students studied the problem dealing with the temperature dependences of the spectra of normal vibrations of molecular compounds in the gaseous, liquid, and solid states. The relevant cycle of scientific publications became a basis for his thesis for the Doctor's degree, which M.P. Lisitsa defended in 1961. The dissertation started a wide circle of experimental and theoretical researches of the intramolecular Fermi and intermolecular Davydov resonances, which enabled M.P. Lisitsa to discover and to substantiate the existence of a new phenomenon, the combined Fermi–Davydov resonance. This discovery gained him the recognition by spectroscopists throughout the whole world. In addition to the scientific work, Mykhailo Pavlovych lectured a six-term course of general physics and, periodically, one- or two-term courses of the spectroscopy of complex molecules and crystals, history of physics, the quantum mechanics of two-atom molecules, optics of semiconductors, and nonlinear optics. The Lisitsa's substantial lectures were very popular among students and scientists.

In 1961, the scientist obtained a permanent position at a just organized academic Institute of Semiconductor Physics and held the post of the Head of the Department of Optics. Simultaneously, he continued the double jobbing at the Faculty of Physics of the Taras Shevchenko Kyiv State University holding the position of Professor.

The talent of M.P. Lisitsa as a scientist with a wide outlook stimulated and ensured a successful development for optical research methods not only at the department headed by him, but also at the whole Institute, as well as at a number of high-school institutions in Ukraine. It was so, because, in due time, his disciples headed some other departments and laboratories of the Institute, and the chairs at many educational institutions. Among Mykhailo Pavlovych's disciples, there are two Corresponding Members of the NAS of Ukraine, more than 20 Doctors of Science and 50 Candidates of Science. The scientific directions of his scientific school in optics and spectroscopy include the absorption optics of various elementary and collective excitations in semiconductors, luminescence researches, Raman scattering in solids, and new polarization phenomena.

The organization of the department of optics concurred in time with one of the major events in the development of optics in the twentieth century, the invention of lasers. M.P. Lisitsa immediately evaluated the historical significance and the prospects of this discovery; so that the directions of researches indicated above were appended with works devoted to optical quantum electronics and nonlinear optics. Following the suggestion of the President of the Academy of Sciences of Ukraine B.E. Paton, Mykhailo Pavlovych became his deputy for managing the Commission on quantum electronics; the task of the Commission was to promote the rapid development of researches in this new scientific branch. Later on, Mykhailo Pavlovych became the Editor-in-Chief of a new periodic collection of scientific transactions "Kvantovaya Elektronika" ("Quantum Electronics"), one of the earliest periodicals that appeared in such a direction in the world. In the Department of Optics headed by M.P. Lisitsa, working examples of solid-state lasers were created, and the researches of the generation mechanisms of coherent radiation emission and nonlinear optical phenomena were started.

Quantum electronics became an extra stimulus for making the works in semiconductor physics more active in the 1960s. The data available at that time on the optics and the photoelectricity of semiconductors left no doubt concerning their prospects as active media for the generation, control, and registration of laser radiation. Under the direction of M.P. Lisitsa, the Department of Optics had been carrying out the precise spectral researches of the refractive index dispersion and the birefringence in A^2B^6 crystals, necessary for the creation of electro-optical modulators. On M.P. Lisitsa's initiative, those researches were appended with fundamental dispersion researches of excitonic phenomena with the use of the classical optical method of Rozhdestvenskii hooks. The uniqueness of the latter studies consisted in that the experiments were carried out on a DFS-13 spectrograph characterized by the best linear dispersion, which allowed the behavior of refractive index in the bands of excitonic transitions to be traced in detail at various intensities of laser radiation. As a result, the effect of exciton disappearance at a high concentration of photo-induced charge carriers and the emergence of an electron-hole plasma were clearly demonstrated.

It was not a unique transformation effect of optical properties in semiconductors at high levels of optical excitation that was revealed and examined. Of large importance was the effect of interband absorption saturation and sharp switching to the induced-transparency mode that took place in color glass filters at laser irradiation and which was discovered at the department and studied there in the 1960s and 1970s. This simple efficient method of passive Q-switching has got a wide popularity in nonlinear optical researches. Moreover, those studies predated a boom in the researches of the optics of zero-dimensional semiconducting systems by more than 20 years. The matter is that the indicated filters are glass matrices with incorporated microcrystallites of A^2B^6 semiconductors (CdSe–CdS). The average size of microcrystallites can be a few nanometers, which is comparable with a typical radius of excitons in A^2B^6 semiconductors. For this reason, it was those objects that served as a basis for carrying out – later on, in the 1980s – a known series of works at Ioffe Physico-Technical Institute (Leningrad, now St. Petersburg, Russia), which started wide-range studies of the excitonic phenomena under the conditions of quantum-size confinement throughout the whole world. Similar researches were also carried out successfully at the department headed by M.P. Lisitsa.

The mastering of various techniques for the generation of giant laser pulses allowed works aimed at elucidating the nature and dominating mechanisms of light-induced destruction of the surface and the bulk of transparent insulators and semiconductors to be started at the department at that time – in the second half of the 1960s. The destruction thresholds for alkali halide crystals and semiconductors of A^2B^6-, A^2B^5-, and A^5B^6-types were determined. In the glowing spectra of torches that arise, when the surfaces are damaged, the lines corresponding to the radiation emission by neutral and once-ionized elements of damaged bodies dominate. On this basis, a laser-based method of spectral emission analysis was proposed. The application of passive Q-switching of a laser resonator at introducing a nonlinear optical element into it allowed one to isoformically elongate the generated pulses by more than an order of magnitude, which was of importance for optical communication facilities. A method, which was proposed on the basis of researches of two-photon absorption and polarization effects in various crystals and consisted in that nonlinearly absorbing and optically active semiconducting plates were used to confine the power of laser beams and to stabilize and correct their space-time intensity distributions, was also of practical value.

The researches in quantum electronics and dealing with the interaction of laser radiation with semiconductors, which were cited as examples above, composed only one direction in the scientific activity of the department. The largest part of the department staff were engaged in studying the optics and the spectroscopy of semiconductors and insulators. The main purpose of this team was to determine the features in the energy structure of those objects, which might be associated with various types of elementary and collective excitations. It was quite natural that the previous scientific experience of the Head of the department could not but affecting the statement of those researches and their orientation. The studies of the radiation absorption by free current carriers in silicon and germanium, which M.P. Lisitsa and his post-graduate students had begun as early as he worked at the Kyiv University, were extended not only upon A^3B^5 and A^2B^6 compounds, but were appended by the measurements of the infra-red plasma reflection by free charge carriers. The obtained experimental results turned out a nice basis for a detailed testing of the theory developed by Japanese authors and the confirmation of its adequacy.

A large-scale direction of researches started by M.P. Lisitsa and his disciple, Corresponding Member of the NAS of Ukraine M.Ya. Valakh, was aimed at studying the vibrational phonon excitations in semiconductor crystals. This issue became the subject of ones of the earliest experiments in Ukraine using the laser Raman scattering. Various mechanisms of resonance interaction, where phonon excitations are engaged, were found to be substantially responsible for the peculiarities in the spectra of pure, doped, and mixed semiconductors. A new approach to the interpretation of phonon spectra in crystals with the layered structure was proposed, as well as methods capable to substantially increase the sensitivity of optical diagnostics of semiconductor parameters with the use of Raman scattering.

A significant response among experts was induced by the experimental discovery of two new nonlinear optical polarization phenomena, made by M.P. Lisitsa and his disciples: an extra nonlinear optical activity in gyrotropic crystals earlier predicted theoretically by the physicists of M.V. Lomonosov Moscow University and an essentially new huge optical activity in non-gyrotropic cubic crystals with impurity tunnel centers. Those phenomena allow new methods to control the characteristics of light beams to be implemented.

As early as at the beginning of his scientific and pedagogic activity, M.P. Lisitsa began experiments with nano-sized structures, namely, superthin layers of atomic semiconductors and metals. Therefore, it is not of surprise that, in the last decade, he and his disciples participated very productively in every scientific program aimed at the development of semiconductor nanophysics and nanoelectronics.

The scope of Mykhailo Pavlovych's interests also includes the problems of the physics of alive. He substantiated the resonance character of the interaction between electromagnetic waves in the millimeter range and alive organisms, in particular, with the human body. He determined those quantum transitions of the vibration, rotation, inversion, and spin origins, which result in medical consequences, provided that the waves concerned are used to irradiate the acupuncture points located along the meridian associated with a sick organ.

The international recognition of M.P. Lisitsa's scientific authority is confirmed by awarding him, as an outstanding spectroscopist, a Johannes Marcus Marci Memorial Medal by the Czechoslovak Academy of Sciences. He is a winner of two State Prizes of Ukraine in science and engineering.

The Honor Worker in Science and Technique of Ukraine Academician M.P. Lisitsa is the author of more than 500 scientific works and about 40 author's certificates of invention. In the co-authorship with his disciples, he published 6 monographies, among which there is the first-ever book "Volokonnaya optika" ("Fiber optics"), published also abroad in English, as well as a 4-volume edition of "Zanimatel'naya Optika" ("Entertaining Optics").

For many years, M.P. Lisitsa had been actively working as a member of the Editorial board of Ukrain'skyi Fizychnyi Zhurnal (Ukrainian Journal of Physics), being the Deputy Editor-in-Chief.

The scientific community sincerely congratulates Mykhailo Pavlovych on his anniversary and wishes him strong health and long life.

A.G. Naumovets, V.M. Loktev, M.S. Brodyn, V.F. Machulin, M.G. Nakhodkin, O.E. Belyaev, M.Ya. Valakh, V.G. Lytovchenko, F.F. Syzov, G.G. Tarasov, A.M. Yaremko

 ISSN 2071-0194. Ukr. J. Phys. 2011. Vol. 56, No. 1