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PERSONALIA

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Aleksandr Grigor'evich Litvak (on his 80th birthday)

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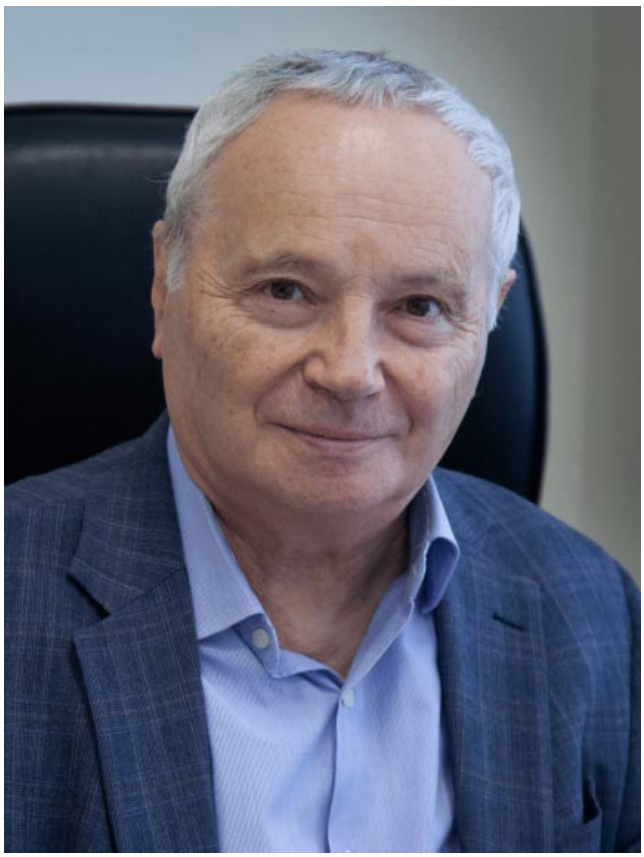
November 17, 2020 was the 80th birthday of Professor Aleksandr Grigor'evich Litvak, the outstanding physicist, academician of the Russian Academy of Sciences (RAS), member of RAS Presidium, member of the bureau of the Division of Physical Sciences of RAS, research supervisor of the Federal Research Center of the Institute of Applied Physics of RAS (IAP RAS), and doctor of physico-mathematical sciences.

In 1962, A G Litvak graduated from the Radiophysical Faculty of Lobachevsky Gorky State University and entered the postgraduate course headed by Professor M A Miller. In 1967, A G Litvak defended his candidate thesis, ''Some problems with the theory of nonlinear electromagnetic phenomena in plasma,'' and in 1977 his doctoral thesis, ''Self-action and interaction of electromagnetic waves in plasma.'' From 1977, at the newly organized Institute of Applied Physics of the USSR Academy of Sciences, A G Litvak headed in turn the Sector, the Laboratory, and the Department of Plasma Physics. In 1988, A G Litvak became head of the Division of the Plasma Physics and High-Power Electronics, and from 2003, he was director of the Institute of Applied Physics of RAS for 12 years. In the period from 2008 to 2015, he was also the founder and chair of the RAS Research Center of Nizhny Novgorod. Since May of 2015, he has been research supervisor of the Federal Research Center of the Institute of Applied Physics of RAS.

A G Litvak is a prominent and widely recognized scientist in plasma physics, physical electronics, and radiophysics. His scientific activities cover an extensive range of problems, such as the interaction of high-power electromagnetic radiation with matter, the development and creation of dense plasma sources, working out RF methods of plasma heating in setups of controlled thermonuclear fusion, and the development of high-power sources of microwave radiation and their use to create new technologies and also to increase the defense capacity of the country.

Already at the first stage of his scientific activity, A G Litvak performed fundamental studies of nonlinear electrodynamics of plasma and condensed matter. He formulated the average dynamic equations for plasma and fields that made it possible to investigate from a unified standpoint the processes of self-focusing and stimulated scattering of electromagnetic waves in isotropic and magnetoactive plasma, formulated the theory of self-channeling of intense electromagnetic waves in an opaque supercritical plasma, and considered for the first time the self-action of relativistically strong waves associated with the dependence of the electron mass on the oscillation energy in the wave field. These effects determine the character of interaction of extreme intensity laser pulses with plasma in modern experiments aimed at the development of new methods of particle acceleration and the investigation of extreme states of matter.



Aleksandr Grigor'evich Litvak

In the 1960s, A G Litvak analyzed a number of important effects in nonlinear optics. He predicted the effect of thermal self-focusing and constructed its theory, formulated, together with V I Talanov, an equation like the nonlinear Schrödinger equation for the description of self-action of three-dimensional wave packets in nonlinear media that underlay the theory of modulation instability of non-one-dimensional wave packets, and showed the existence of nonlinear surface polaritons, i.e., electromagnetic surface waves nonexistent in a linear case.

A G Litvak was the first to put complex experimental research into the interaction of high-power microwave radiation with plasma. He and his colleagues experimentally discovered and investigated the effects of wave self-focusing in plasma and nonlinear transparency of dense 'supercritical' plasma, the modulation instability of Langmuir oscillations, and the dynamics of the Langmuir caviton. Their studies of the nonlinear dynamics of freely localized gas discharge in microwave beams laid the basis of a new field of physics of low-temperature plasma, fairly rich in various applications, from the production of multicharge ion beams for high-

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energy accelerators to purification of the upper atmosphere from ecologically harmful admixtures and ozone regeneration.

In the area of controlled thermonuclear fusion, A G Litvak and colleagues developed the basic elements of the theory of electron-cyclotron resonance plasma heating (EC) by quasi-optical electromagnetic wave beams and showed the possibility of plasma heating in toroidal devices upon radiation input from the side of a weak magnetic field. These proposals, confirmed by tokamak T-10 experiments at the Kurchatov Institute of Atomic Energy (IAE), underlay the wide application of EC heating and noninductive current generation in modern toroidal controlled nuclear fusion devices.

Under the guidance of A G Litvak, a team of highly qualified theoreticians and experimentalists was formed that reached noticeable success in creating high-power microwave sources and in developing their application in radars, plasma physics, nuclear physics, and technologies for obtaining new materials. Among the most important results in this field, noteworthy is the development and commissioning of quasi-continuous megawatt gyrotrons. A scientific-production enterprise, Gycom, that involved tens of scientists and engineers from several large Russian institutes was formed on the initiative of A G Litvak and under his guidance took the position of the world leader in the production of gyrotrons and gyrotron facilities. The organization of high-technology production made it possible to equip about 15 Russian and foreign tokamaks and stellarators with effective systems of EC plasma heating and to retain the leadership of Russian science in this area. At the present time, A G Litvak and his colleagues are constructing a complex of eight systems based on continuous megawatt gyrotrons at a frequency of 170 GHz for the large international ITER project. Considerable success has been reached in developing dense nonequilibrium plasma sources on the basis of a new generation of gyrotrons, the technology of sintering of nanoceramic materials, and high-velocity growth of polycrystal diamond films, plates, and single crystals.

In recent years, A G Litvak and his colleagues have been carrying out studies on the creation and application of terahertz radiation sources associated both with the extension of the traditional methods of high-power vacuum electronics to a region of higher frequencies and with the use of detecting femtosecond laser pulses in nonlinear media. Possessing wide scientific erudition, A G Litvak always keeps up with the trends in world science and skillfully draws the attention of the scientific collective to new promising ideas. Research on high-gradient particle acceleration was started at IAP RAS on his initiative, and the design of new magnetic systems for vacuum electronics using high-temperature superconductivity are being discussed. He and his colleagues are conducting theoretical and experimental studies aimed at creating multifiber laser systems competing with solid-state lasers with regard to the level of peak and average power; in particular, determined are arrays of multicore active lightguide structures, in which the radiation coherence necessary for a subsequent summation of intense wave beams is preserved owing to the formation of nonlinear eigenmodes of the system. Versions of an effective self-compression of laser pulses and the formation of light bullets in such systems were proposed. Studies in the field of quantum technologies aimed at creating the basic elements of quantum communications and computations on the basis of impurity color centers in a solid body are successfully being developed. Qubits, quantum memory on a spectral grating of rare-earth metal ions embedded in an inorganic crystal, have been developed, and the possibility of three-qubit operations has been demonstrated. Work was started on the realization of monochromatic quantum memory and entanglement of spatially separated memory cells needed for the creation of quantum followers determining the possibility of scale expansion of quantum communication lines.

The advances in A G Litvak's research are published in more than 300 scientific papers and are realized in numerous unique device and apparatus facilities. For their scientific achievements, A G Litvak and his colleagues were awarded the USSR State Prize in science and engineering for the series of studies "Basic elements of nonlinear dynamics of high-frequency wave processes in completely ionized plasma" (1987), the Prize of the RF Government in the field of science and technique "for elaboration and industrial production of megawatt gyrotrons for electron-cyclotron plasma heating in large-scale devices of controlled thermonuclear fusion" (2012), the prestigious international Kenneth Batton Prize "for the outstanding contribution to science of electromagnetic spectrum" (2008), and the Innovation Prize of the Plasma Physics Division of the European Physical Society (2011).

A G Litvak focuses a great deal of attention on the education and training of young scientists. More than twenty doctors and candidates of sciences are among his disciples, including a full member of the Russian Academy of Sciences. A G Litvak is the founder and the head of a widely known and one of the largest Russian leading scientific schools in plasma physics, enlisting nearly 30 actively working doctors and candidates of sciences and many young scientists. He is founder and the first dean of the basic faculty of IAP RAS named "Higher School of General and Applied Physics" at Nizhny Novgorod State University. He founded the research educational center of IAP RAS, putting together an effective continuous system of training for young scientists for work in physics. The center contains specialized senior classes of the physics and mathematics lyceum, the above-mentioned faculty of Nizhny Novgorod State University, and the postgraduate course of IAP.

A G Litvak is carrying out high-level research and organizational work. He played a decisive role in the formation of the largest division of IAP — the Division of Plasma Physics and High-Power Electronics. As director of IAP, A G Litvak successfully resolved economic, staff, and scientific provision issues and the development of the institute, which retained, in spite of the hard years of reforms, its leading world science in the radio physics and electronics. He initiated transformation of IAP into the Federal Research Center that united institutes of Nizhny Novgorod and became one of the largest Russian scientific research broad-spectrum centers. As research supervisor of the center, he performs serious work on the coordination of research and the establishment of efficient research-and-production relations of the center with leading scientific organizations and industrial enterprises in Russia.

A G Litvak is a world-renowned scientist. He is chair and a member of program committees of a whole number of international scientific conferences and meetings, including the traditional IAP RAS conferences Frontiers of Nonlinear Physics and High-Power Microwaves: Sources and Applications, having a high international rating. He is also a member of the editorial boards of a number of international and

Russian scientific journals. Recognition of A G Litvak's achievements was his decoration with the 2004 Order of Friendship and the 2010 Order for Merits Before the Motherland of IVth degree, and in 2006 he was given the title Honored Citizen of the Nizhny Novgorod region.

A G Litvak's high scientific and personal authority in the professional community allows him to secure and advocate on solid grounds his positions concerning many questions in the life of the country directly related to the development of science and education. In recent years, when the Russian Academy of Sciences has suffered unprecedented pressure from state authorities and consequent radical transformations, A G Litvak has taken an active part in discussions with his 'academic guild' colleagues of a possible way out from the current situation proceeding from his rigid beliefs in the necessity to retain the independence of scientific search and those principles of science self-organization that had historically underlain the activities of the RAS.

It is a pleasure to note that an inexhaustible scientific and social temperament allows A G Litvak to be highly productive in scientific research, in spite of the wide range of his social and scientific duties.

Litvak's friends and colleagues, his numerous disciples and followers wish him all the best on this jubilee and wish him sound health and many long years of life and new creative advances in all spheres of his versatile activity.

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V V Zheleznyakov, L M Zelenyi, R I Ilkaev,
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