

In Memory of Aleksander Mikhailovich Prokhorov



Russian scientists were struck by an enormous sense of grief on 8 January, 2002 when Academician Aleksander Mikhailovich Prokhorov, a world-renowned prominent physicist and one of the founders of the most important branch of modern physics – quantum electronics, a great organiser of science, a prominent citizen of Russia and a patriot, passed away suddenly after a bout of acute double pneumonia. Aleksander Mikhailovich lived a bright and exceptionally dynamic life, and worked actively until his last days for the welfare of our Fatherland.

Aleksander Mikhailovich Prokhorov was born on 11 July 1916 in Atherton, Australia, in the family of a Russian revolutionary worker who was forced to emigrate in order to escape from persecution by the Czarist regime. The Prokhorov family returned to Russia in 1923. In 1939, Aleksander Mikhailovich graduated from the Leningrad University and joined the Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow as a postgraduate student. His scientific career was interrupted by the second World War. He joined active army service in 1941 and was wounded in action twice. After demobilisation in 1944, he resumed his scientific activity at the Lebedev Physics Institute. Displaying a profound sense of diligence and

perseverance, he completed for a very short period of time his research in the field of radioelectronics. The most important results of this research were the development of the theory of stabilisation of an vacuum-tube oscillator and the establishment of coherence of microwave radiation emitted by electrons in a synchrotron-type accelerator. The material of this research formed the basis of his Ph.D. (1945) and D.Sc. (1951) dissertations.

Subsequent scientific activity of Aleksander Mikhailovich, which covered a span of over half a century, was devoted to the creation and development of quantum electronics and its various scientific and practical applications. His interest in this field was stimulated by his research work in the fields of radiospectroscopy of gases (1952–1955) and EPR spectroscopy of solids (1953–1958). Together with Academician N.G. Basov, Aleksander Mikhailovich developed the basic ideas and studies that laid the foundations of quantum electronics based on a new so-called laser–maser principle of generation and amplification of electromagnetic radiation by using stimulated emission during quantum transitions in atomic and molecular systems. They formulated the very principle of quantum generation and amplification, and proposed the most efficient method of electromagnetic pumping for creating quantum states with inverse population. Aleksander Mikhailovich proposed and theoretically substantiated a new type of resonator, called the open resonator, which subsequently received experimental verification. He also proposed and studied many efficient active media for quantum amplifiers and generators, and suggested new methods of their realisation.

It is appropriate to mention here the idea of using ruby as an active material for microwave quantum amplifiers. This idea played an exceptionally important role in realisation and development of quantum electronics: ruby was used as the material in the most efficient microwave quantum amplifiers (masers), and also in the first optical quantum generator (laser).

Aleksander Mikhailovich devoted considerable attention to the development of physical and technical foundations of the materials used in quantum electronics. Under the guidance and active participation of Aleksander Mikhailovich, a strong experimental and industrial foundation was laid quickly for the growth of optical high-perfection single crystals of different types for solid state lasers in IR, visible and UV ranges, including active laser crystals, nonlinear elements for radiation frequency conversion and control of their space–time parameters (modulators, etc.). Many new types of laser materials were obtained, and our country was widely acclaimed as the pioneer in the production of such materials.

Aleksander Mikhailovich proposed and realised a new method for producing the population inversion of molecules in gases, the so-called adiabatic expansion of a gaseous mixture. High-power gas-dynamic IR lasers were designed using this method.

The name of Aleksander Mikhailovich is closely linked with the creation and development of many new trends in modern optics and laser physics, including nonlinear optics, fibre optics, and the physics of interaction of powerful laser radiation with matter.

A number of ideas and results in these fields having great fundamental and practical significance belong to Aleksander Mikhailovich. These include the development of the theory and experimental verification of the multifocal structure of self-focusing of wave beams in a nonlinear medium, the theory of propagation of optical solitons in optical fibres, the measurement of laser plasma characteristics in various excitation regimes, and the determination of the basic mechanisms of destruction of transparent solids irradiated by high-power lasers. These studies have a tremendous significance in laser physics and its applications in technology (for building high-power laser systems, developing fibreoptic communication lines, thermonuclear investigations, etc.).

Quantum electronics is a spectacular demonstration of the triumph of quantum mechanics – one of the greatest scientific achievements of the XX century. In its turn, the development of quantum electronics had a profound influence on the subsequent scientific and technical progress. New trends appeared in atomic physics, optics, electronics and other fields, which resulted in outstanding scientific discoveries and technical applications. These include the physics of ultralow temperatures (ultracold atoms), quantum optics, nanoelectronics, quantum informatics, and quantum computers. New horizons of scientific and technical progress in the XXI century are emerging as a result of developments in these fields.

A distinguishing feature of the personality of Aleksander Mikhailovich was his endeavour to use the results of scientific achievements to the maximum possible extent in practice. He exerted a profound influence on the studies devoted to the creation of highly efficient masers and their application in long-range space communications and astronomy, to the commercial production of lasers and their applications in technology, medicine, and other fields of national economy and defence.

The range of scientific interests of Aleksander Mikhailovich was exceptionally wide. He had a profound erudition in many fields of physics and related disciplines, which drew many scientists and specialists from various fields in science and engineering to him. This explains the profound influence exerted by him on the development of quantum electronics and its diverse practical applications in our country.

A large number of pupils of Aleksander Mikhailovich became leading scientists. Among them are Academicians, Corresponding members of the Academy of Sciences, and doctors of sciences.

Aleksander Mikhailovich paid considerable attention to the organisation of scientific research. He was the Head of the General Physics and Astronomy Division of the Academy of Sciences of the USSR for twenty years. He was a member, and later a consultant, of the Presidium of the Russian Academy of Sciences. Aleksander Mikhailovich was the founder of the General Physics Institute of the Russian Academy of Sciences, and was its Director for many years.

The enormous research and organisational activities of Aleksander Mikhailovich Prokhorov, as well as his entire

life, were devoted to the service of his Motherland. He was a great citizen and a patriot, and took great pride in the progress made in the field of scientific research in our country and the leading contribution made by it to the world science.

At the same time, Aleksander Mikhailovich was deeply concerned about the fate of Russian science during the years of reforms, when the State paid little attention to the scientific activity. He spoke persistently against such an attitude, emphasising that the future of our country, as of the entire civilisation on the planet, depends on the scientific and technical progress.

The immense services of Aleksander Mikhailovich Prokhorov were highly appreciated by the State and by the international scientific community. He was a laureate of the Lenin and State awards, and was twice honoured with the title 'Hero of Socialist Labour'. He was an honorary fellow of numerous scientific associations and universities, winner of a large number of awards and medals, including the Lomonosov Gold Medal of the Russian Academy of Sciences. In 1964, Aleksander Mikhailovich together with N.G.Basov and Ch.Townes was awarded the most prestigious scientific prize in the world, the Nobel Prize in Physics. Aleksander Mikhailovich always took special pride in the medal 'For Courage' awarded to him for the courage displayed during the Second World War.

The name of Aleksander Mikhailovich Prokhorov, a great scientist, citizen and patriot, will remain forever inscribed in the history of our country and the world civilisation.

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