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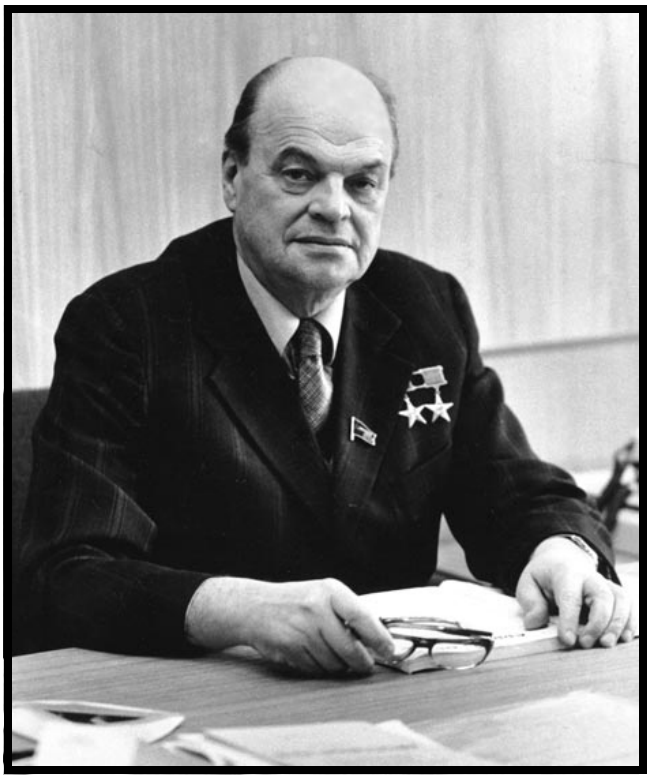
In Memory of Nikolai Gennadievich Basov



Nikolai Gennadievich Basov, a leading light of Russian and world science, died on 1 July 2001. He was one of the founders of quantum electronics which ranks among the great achievements of the 20th century, together with atomic energy, space exploration, semiconductor technology, and computers.

In 1952 Nikolai Basov and Aleksandr Prokhorov were the first to demonstrate, on the basis of theoretical analysis, the feasibility of constructing amplifiers and generators of electromagnetic fields based on induced radiation by quantum systems in an inverse-population state. In 1955 these two scientists proposed an effective method for generating an inverse population by selective pumping of a three-level system – a method which is now widely used in lasers and quantum amplifiers. The same period saw the construction of fundamentally new devices – quantum oscillators (masers) and low-noise radio-frequency amplifiers. In 1959 Basov and Prokhorov were awarded the Lenin Prize for discovering this new principle of generation and amplification of electromagnetic radiation by quantum systems, and in 1964 they were awarded, jointly with Charles Townes, the Nobel Prize for physics for fundamental studies in the field of quantum electronics which have led to the creation of masers and lasers.

Kvantovaya Elektronika **31** (8) 751 – 752 (2001)

After developing in 1956 the first quantum-electronic devices – masers – and successfully applying them to frequency standards, Basov came up with an initiative of constructing quantum light generators – lasers. For the first time ever the use was suggested of semiconductors as active media, with various excitation methods, including injection across the p – n junction (1961). This method led to the creation of injection (diode) lasers, now most widespread and extensively used in science and technology, the annual world production of which now amounts to several hundred million.

In the 1960s Basov carried out a wide range of investigations of laser frequency standards. To a large extent thanks to the work of Basov and his students the precision of measurement of the frequencies and wavelengths of atomic and molecular transitions was increased by several orders of magnitude. Laser standards of time and frequency were created in the Department of Quantum Radiophysics of the Physics Institute of the Academy of Sciences [FIAN, more widely known as the Lebedev Physics Institute] which had unrivalled parameters, and which are now being introduced into the State time-keeping service.

Basov was always a true patriot, never separating his interests in developing science and using its achievements from the interests of the State. He was the initiator of the first and many subsequent decrees of the Government of the USSR on the development of quantum electronics in our country. In the early 1960s, together with his team, he identified and solved various scientific and technical problems related to practical applications of lasers, including those designed to improve the defence capacity of our country.

Regarding the problem of creating a powerful laser as the most important one for quantum electronics, Basov started in 1962, and subsequently headed, a wide range of investigations which led to the creation of a broad family of new powerful photodissociation, excimer, electron-beam-controlled, and chemical lasers.

The most important in this family of powerful high-energy lasers developed under the leadership of Basov are iodine photodissociation lasers in which a shock wave is used for the excitation of the active medium. The scientific basis of such lasers was worked out at the Lebedev Physics Institute, and they were jointly produced by teams from the Lebedev Physics Institute and the All-Union Scientific Research Institute for Experimental Physics. Already in 1968 our country had explosion-type iodine photodissociation lasers capable of generating megajoule pulses.

With the object of maximising laser energy concentration Basov initiated studies aimed at increasing the brightness of laser beams by frequency conversion and coherent integration through stimulated light scattering – Raman (SRS) and Mandel'shtam – Brillouin (SMBS). This led to the construction of powerful SRS lasers – coherent beam combiners – and successful application of phase conjunction by SMBS discovered in the Department of Quantum Radiophysics of the Lebedev Physics Institute with the aim of increasing the brightness of multichannel lasers.

The scope of Basov's interests was always very broad. He pioneered the application of laser science and technology to the solution of global problems facing humanity in energetics, industry, health, etc. In 1962 at a meeting of the Presidium of the Academy of Sciences of the USSR, and then in 1963 at the International Conference on Quantum Electronics in Paris he put forward (jointly with O N Krokhin) the idea of producing thermonuclear reactions by laser irradiation of targets. In 1968 the first thermonuclear neutrons were generated in Basov's laboratory by laser irradiation of a lithium deuteride target, which provided a powerful stimulus throughout the world for investigations aimed at developing laser thermonuclear fusion (LTF).

In 1971 a multichannel facility capable of spherical irradiation of targets with a power density of 10^{14} W cm^{-2} was constructed at the Lebedev Physics Institute under the leadership of Basov. This facility was used to demonstrate the feasibility of efficient coupling of laser energy to a target; the target was spherically compressed to the density of a solid, and neutrons generated by thermonuclear DD reactions and secondary DT reactions were detected. To reduce the laser energy needed to produce positive energy outputs, Basov and his collaborators developed thin-shell targets which are now used in all countries in which experimental studies on LTF are being carried out.

Basov and his coworkers have formulated the concept and have been working on the construction of a laser thermonuclear reactor. They considered not only a purely thermonuclear reactor, but also a hybrid one (using fissionable materials). Until his last days Basov supervised a programme directed at the construction of a hybrid fission–fusion atomic power station as the basis of future safe nuclear power.

Basov gave much attention to the application of achievements of basic and applied science in the national economy. On his initiative a Special Design Bureau was set up in 1962 in Troitsk, close to Moscow, which for many years successfully fulfilled the technical requirements of experimental work at the Lebedev Physics Institute and constructed a whole range of remarkable instruments. In 1980 a branch of the Lebedev Physics Institute was established by Basov in Samara, which has since become a major independent institute successfully introducing latest attainments of quantum electronics to industry.

Also on Basov's suggestion in 1982 an interdepartmental laboratory on the application of lasers in surgery was set up in the Lebedev Physics Institute. Lasers are at present successfully used in heart operations.

Basov gave much attention to the recruitment and training of young scientists. He held a chair at the Moscow Engineering–Physics Institute and was a founder and head of the Higher Physics School attached to it and to the Lebedev Physics Institute. Many of Basov's students have been awarded Doctor of Science degrees and have become members of the Russian Academy of Science. Basov and his school received one Nobel Prize, three Lenin Prizes, and seventeen State Prizes.

Basov's activity in science organisation was broad and wide-ranging: he was a member of the Presidium of the Russian Academy of Sciences, for many years he was Director of the Lebedev Physics Institute, Chairman of the 'Znanie' (Knowledge) Society and Editor-in-Chief of the journal *Priroda* (Nature). In 1971 he founded the journal *Kvantovaya Elektronika* (Quantum Electronics) and for 30 years was its Editor-in-Chief.

Basov's services to our country's and world science are recognised everywhere. He became twice a Hero of Socialist Labour, was a Laureate of the Nobel, Lenin, and State Prizes, and received the Lomonosov Gold Medal of the Academy of Sciences of the USSR. He became a Corresponding Member of this Academy in 1962 and a full Academician in 1966. He was also a member of many foreign academies.

Basov devoted all his strength, knowledge, and enormous talents to the development of science in our country. He had exceptional feeling for the new, was capable of generating continuously a multitude of fruitful ideas, had amazing intuition, was creatively generous, enjoyed work enormously, and was very kind. All this attracted and held scientists around him, many of whom were his students from the university bench.

The death of Nikolai Gennadievich Basov is an irreplaceable loss to science in our country and throughout the world.

A M Prokhorov, L V Keldysh, O N Krokhin, M A Vasil'ev, N S Kardashev, Yu V Kopaev, A N Lebedev, I I Sobel'man, A N Starodub, N A Borisevich, M D Galanin, A I Isakov, V S Letokhov, S I Nikol'skii, V P Silin, V Ya Fainberg, L P Feoktistov, V A Isakov, R V Ambartsumyan, Yu V Afanas'ev, A V Vinogradov, A Z Grasyuk, M A Gubin, I G Zubarev, V S Zuev, A D Klementov, Yu L Kokurin, I B Kovsh, P G Kryukov, V V Nikitin, A N Oraevskii, A L Petrov, Yu M Popov, V B Rozanov, A S Semenov, G V Sklizkov