

## Sergei Nikolaevich Bagayev (on his 80th birthday)

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September 9, 2021 was the 80th birthday of academician Sergei Nikolaevich Bagayev — a prominent scientist in the field of quantum electronics and laser physics, talented science organizer, research supervisor of the Federal State Budget Scientific Institution the Institute of Laser Physics of the Siberian Branch of the Russian Academy of Sciences (ILP SB RAS).

Sergei Nikolaevich Bagayev (Bagaev) was born in Novosibirsk, where he graduated from Novosibirsk State University (NSU) in 1964. The scientific biography of S N Bagayev began in 1964 at the Institute of Radiophysics and Electronics (IRE) of SB of the USSR Academy of Sciences with the outstanding physicist Yurii Borisovich Rumer as director. At IRE, S N Bagayev got acquainted with the future academician and the first director of ILP SB RAS Veniamin Pavlovich Chebotaev, with whom he was bound by friendship and fruitful scientific collaboration for many years.

After a reorganization of IRE, from 1965 to 1978, S N Bagayev was in turn an apprentice-researcher, a junior research fellow, a senior research fellow, and head of the laboratory at the Institute of Semiconductor Physics (ISP) SB of the USSR Academy of Sciences. From 1978 to 1991, S N Bagayev was head of laboratory, head of department, deputy director of the Institute of Thermophysics SB of the USSR Academy of Sciences; from 1991 to 1992, he was deputy director, from 1992 to 2016, director, and from 2016, research supervisor of ILP SB RAS. In 1975, S N Bagayev defended his candidate thesis under the scientific guidance of V P Chebotaev, and, in 1983, he defended his thesis for the academic degree of doctor of physical and mathematical sciences. In 1990, S N Bagayev was elected a corresponding member and, in 1994, a full member of the Russian Academy of Sciences.

The main lines of S N Bagayev's research are superhigh-resolution laser spectroscopy, optical frequency and time standards, optical clocks, the generation of stable ultrashort laser pulses of extreme intensity, precision femtosecond spectroscopy, and the application of lasers in various areas.

S N Bagayev was the first to observe and investigate the recoil effect, an anomalous Zeeman effect in vibrational-rotational transitions of molecules. The method of obtaining ultra-narrow optical resonances of saturated absorption using the optical selection of slow molecules in their interaction with a resonant laser field was experimentally developed. Obtained and examined were ultra-narrow non-linear optical resonances in the IR range with an absolute width of 50 Hz, which is a record result for molecular transitions. A new scientific discipline appeared, namely, high-resolution optical spectroscopy without the quadratic



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Doppler effect; the basis of light scattering spectroscopy with a resolution of 0.1 Hz was developed for the study of the dynamics of moving forms of microorganisms.

S N Bagayev and his colleagues created the most monochromatic sources of coherent radiation in the IR range, namely, lasers with a radiation line width of 0.07 Hz and a long-time frequency instability at the level of  $10^{-15}$ , which became the basis of the first optical clocks in the world. The physical principles of femtosecond ( $1 \text{ fs} = 10^{-15} \text{ s}$ ) optical clocks (a femtosecond time and frequency scale with the use of high-stability ultra-short optical pulses) were proposed and developed under the guidance of S N Bagayev. This was a revolutionary breakthrough in high-precision optical measurements. The fundamental possibility of heightening the precision of absolute frequency measurements to  $10^{-17} - 10^{-18}$  was shown.

S N Bagayev and his colleagues worked out the physical bases for the creation of multichannel femtosecond laser complexes with exawatt-level ( $10^{18} \text{ W}$ ) peak power based on coherent summation of channel fields in phase synchronization of their radiation according to an optical clock.

The first optical frequency standard at a quadrupole transition of a unit ytterbium-171 ion ( $^{171}\text{Yb}$ ) with a long-time frequency instability of  $\sim 10^{-17}$  was created in Russia under the guidance of S N Bagayev. In totality of parameters,



Veniamin Pavlovich Chebotaev (left) and Sergei Nikolaevich Bagayev at the research site of ILP SB of RAS (village of Kaitanak, Altai Mountains, early 1980). Preparation of an experiment with a laser meter of slight displacements.



Ninth international symposium, Modern Problems of Laser Physics (MPLP-2021), Russian Federation, Novosibirsk, August 22–28, 2021. Plenary meeting of August 22, 2021. From left to right: doctor of physical and mathematical sciences O N Prudnikov—secretary of symposium, academician S N Bagayev—chairman of symposium, Leuchs Gerhard—director of Max Planck Institute for the Science of Light (Erlangen, Germany), foreign member of RAS (online conference).

the frequency standard has no Russian equivalent and finds itself among the best samples in the world. Experimental models of on-board optical clocks with a frequency instability of  $10^{-16}$ – $10^{-17}$  for the new GLONASS generation are being worked out.

S N Bagayev and members of a research team received a science and technology award—the 2019 Prize of the Government of the Russian Federation—for the design of a high-precision complex of time and frequency quantum standards for promising navigation, geodesic, and digital technologies.

S N Bagayev pays great attention to introducing scientific achievements into practice. He and his colleagues designed a unique laser-plasma facility, which has no equivalent in the world, for the nonvacuum synthesis of protective and functional coverings of metals. Together with the A V Nikolaev Institute of Inorganic Chemistry of SB RAS, they were the first to show experimentally the promising nature of creating a number of high-performance laser-plasma nanotechnologies, including those for the development of the Arctic.

Laser equipment for medical purposes, ecology, navigation, communication, etc. was created in ILP SB RAS under the guidance of S N Bagayev.

In 2014, S N Bagayev and his co-authors were awarded the State Prize of Novosibirsk region for the development of high-efficiency and safe laser medical technologies, for the creation of test samples of pulsed ultraviolet laser medical equipment, and for introducing them into medical practice for treating herpes and open-angle glaucoma.

S N Bagayev is the author and co-author of over 800 scientific works, including 28 patents. He takes an active part in training researchers and is professor and head of the Department of Quantum Electronics at Novosibirsk State University. The scientific school of academician S N Bagayev related to superhigh-resolution laser spectroscopy has gained wide recognition. Ten doctors and over 30 candidates of science were prepared under his guidance.

Sergei Nikolaevich Bagayev acquired rich experience in scientific organizational work. Together with academician V P Chebotaev, S N Bagayev made a great contribution to the organization in 1991 of the Institute of Laser Physics SB RAS. In the difficult 1990s, S N Bagayev's total dedication to

science, inexhaustible energy, incredible efficiency, and stable character played a great role in the maintenance of the creative staff of ILP SB RAS.

S N Bagayev initiated the development of the State Scientific and Technical Program concerning fundamental metrology and became head of the Program Council. The Irkutsk affiliate of ILP SB RAS was founded in 1995 on S N Bagayev's initiative. He established an efficient collaboration of ILP SB RAS with several leading scientific organizations abroad and in the CIS. International programs concerning precision spectroscopy of hydrogen and muonium atoms and the indium ion were developed at ILP SB RAS together with laboratories in Germany, England, France, Italy, the USA, and other countries.

S N Bagayev is a member of RAS and SB RAS Presidiums and the Bureau of the Division of Physical Sciences of RAS, chair and member of several academic councils and committees of RAS and editorial boards of Russian and foreign scientific journals, vice-chair of the RAS Council for Defense Research, a member of the Advisory Council for the Military Industrial Commission, chair of the organizational and program committees of many international conferences and seminars, and chair of the doctoral dissertation council of ILP SB RAS.

For his scientific and organizational achievements, S N Bagayev has received high state and international awards: the 1998 RF State Prize for science and technology, the 1999 Order of Friendship, the 1999 and 2017 V A Kopt'yuga awards of SB RAS and the Belarusian National Academy of Sciences, the 2004 Order of the Legion of Honor of France, the 2006 P N Lebedev Gold Medal of RAS, Orders of Merit for the Fatherland, 4th degree (2006) and 3rd degree (2012), the 2013 Prize of the European Physical Society, and the 2019 award of the RF Government.

Sergei Nikolaevich's colleagues and friends heartily extend their best wishes to him on this jubilee and wish him sound health and further creative achievements!

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