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Sergei Nikolaevich Bagaev (on his 70th birthday)

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Academician Sergei Nikolaevich Bagaev celebrated his 70th birthday on September 9, 2011. Sergei Nikolaevich is an outstanding scientist in quantum electronics and laser physics and in their fundamental applications, a talented science organizer, and Director of the Institute of Laser Physics of the Siberian Branch of the Russian Academy of Sciences (ILP SB RAS).

S N Bagaev's entire life has been inseparable from Siberia, where he was born, graduated from the Physics Department of Novosibirsk State University, and in 1963 began his career in research at the Institute of Radiophysics and Electronics of the Siberian Branch of the USSR Academy of Sciences. In 1964, he transferred to the Institute of Semiconductor Physics of the Siberian Branch of the USSR Academy of Sciences.

In 1975, Sergei Nikolaevich submitted and defended his PhD thesis under the auspices of the future Academician Veniamin Pavlovich Chebotaev, whose closest supporter and friend he remained for many years. They co-authored numerous priority studies in nonlinear laser spectroscopy, optical frequency standards, etc. and brought together a team out of which in 1991 they formed the base of the Institute of Laser Physics (ILP) of the Siberian Branch of the USSR Academy of Sciences. After Academician V P Chebotaev's premature death, Sergei Nikolaevich continued and developed the fields of research launched by Chebotaev.

In 1978 S N Bagaev, along with the Department of Laser Physics, transferred to the Institute of Thermo Physics of the Siberian Branch of the USSR Academy of Sciences, where he completed his work on his DSc thesis, which he submitted and defended in 1983. His thesis presented pioneering results which remain significant and important even today. This work discovered nonlinear dependences of broadening and shift of optical resonance on gas pressure. It was caused by the effect of elastic scattering of excited particles to small angles without dephasing. Also discovered was the anomalous decrease in the shift of the resonance in the low-pressure range; this made it possible to achieve high reproducibility of frequency in gas lasers. Another achievement was the observation of narrowing of nonlinear resonance due to the increased contribution of slow molecules, when the mean free path of particles becomes longer than the transverse dimension of the light beam. A method for recording ultranarrow resonances in the spectra of lasers with nonlinear absorption was suggested and implemented. The observation of coherent radiation in spatially separated optical fields was reported for the first time. Also achieved for the first time was the observation and study of the recoil effect and the anomalous Zeeman effect in vibrational–rotational transitions of molecules.

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Sergei Nikolaevich Bagaev

In 1990, Sergei Nikolaevich was elected Corresponding Member of the USSR Academy of Sciences, in 1991 he rose to the position of Deputy Director, and in 1992 entered the ILP SB RAS directorship. In 1994, S N Bagaev was elected Full Member of the Russian Academy of Sciences. He continued to work productively, to constantly widen the span of his scientific interests, and to retain the leading positions in a number of fields of laser physics. S N Bagaev's activity and persistence played an important role in sustaining and invigorating the creative team of the ILP SB RAS despite the situation of sciences and research, which worsened dramatically in the 1990s. Sergei Nikolaevich launched an initiative to create the State-supported Scientific & Technical Program on fundamental metrology, and headed the program council. He succeeded in setting up efficient collaboration with a number of leading foreign laboratories and with CIS countries. International programs on high-precision spectroscopy of hydrogen and muonium atoms and indium ions were implemented in order to improve the accuracy of fundamental physical constants and for laser detection of gravitational waves in collaboration with laboratories in Germany, Great Britain, France, the USA, and other countries. In 1995, the Irkutsk Affiliate of the ILP SB RAS was created on S N Bagaev's initiative.

In the field of optical frequency standards, S N Bagaev and his colleagues created lasers with the emission line width equal to a hundredth of one Hertz and with long-term frequency stability at the level of 10^{-15}, which became the basis for developing the first optical clock in the world and for conducting absolute measurements of transition frequencies of different atoms, ions, and molecules with an accuracy of 10^{-13}.

In the field of nonlinear laser spectroscopy, S N Bagaev obtained and studied the narrowest ever optical resonances in the IR range of the optical spectrum with the absolute width of 50 Hz, which in relative units corresponded to 5×10^{-13}. S N Bagaev pioneered the observation and carrying out of spectroscopic studies of nonlinear optical resonances in a gas using cold molecules with an effective temperature of $\sim 10^{-2}$ K, which formed the foundation of a new avenue in laser spectroscopy research — optical spectroscopy free of the quadratic Doppler effect. The foundation of light scattering spectroscopy with a resolution of 0.1 Hz was developed for the study of the dynamics of mobile forms of microorganisms; a new fundamental research field was created and is successfully progressing in the biomechanics of blood flow, studying the physical mechanisms of the transport function of the cardiovascular system.

S N Bagaev and his team suggested and formulated physical principles, and then built the first femtosecond optical clock — the femtosecond time and frequency scale using highly stable ultrashort optical pulses. This constituted a revolutionary breakthrough in high-precision optical measurements. The conceptual possibility of improving the accuracy of the absolute frequency measurements to 10^{-17} – 10^{-18} was demonstrated.

In recent years, S N Bagaev has been supervising successful work on improving the accuracy and stability of the frequency of femtosecond optical clocks, whose operation is based on the development of a new generation of laser frequency standards with record-high stability ($10^{-17} - 10^{-18}$) using ultracold ($T \leqslant 10^{-6} - 10^{-8}$ K) Mg atoms and Yb^+ and In^+ ions. At the same time, the team is conducting research on developing compact fiber laser clocks, including systems aboard space vehicles. S N Bagaev and his group devised the first magneto-optical trap in Russia for alkaline-earth atoms and performed spectroscopic studies of magnesium atoms using the clock transition $^1S_0 \rightarrow {}^3P_1$ with a spectral resolution of about 1 kHz; they conducted the first experiments measuring the frequency of the $^1S_0 \rightarrow {}^3P_1$ transition in the magnesium atom. These results constitute important steps on the way to a new generation of optical standards of frequency and time for ultracold atoms, with stability at the level of 10^{-17} required to improve the measurement accuracy by one or two orders of magnitude in fundamental fields of physics and in physics applications (tests of quantum electrodynamics, detection of gravitation waves, improvement and further development of the GLONASS system, etc.).

S N Bagaev and his colleagues used a new principle — the coherent summation of femtosecond optical fields based on the phase synchronization of their radiation with the optical clock — to work out the physical principles and create the foundation for building multichannel exawatt femtosecond laser systems with intensity exceeding the ultrarelativistic level of 10^{25} W cm^{-2}. Achieving this level of intensity signifies launching a new stage in the development of modern laser physics, in which an essential role is played by effects of quantum electrodynamics.

S N Bagaev has paid great attention to implementing scientific discoveries in practical fields. Under his guidance, laser equipment was designed and found applications in medical areas, ecology, navigation, communications, etc. S N Bagaev and co-workers developed the basis for implementing highly productive laser-plasma techniques (some of which do not need a vacuum environment) for wear-resistant nanostructured modification of the surface of metals and alloys, for synthesizing protective (wear- and corrosion-resistant) and functional (ultrahard, impact-resistant, emitting) coatings for metals, for the plasma-chemical synthesis of nanoparticles of semiconducting metal oxides used on ceramics, in gas sensors, and in catalysis; these techniques have no counterparts in world industries.

Sergei Nikolaevich is very active in training the next generations of researchers, holding chairs at Novosibirsk State University and the Moscow Institute of Physics and Technology. S N Bagaev's scientific school, Ultrahigh Resolution Laser Spectroscopy and Its Applications, enjoys a high international reputation. Among his students, eight hold DSc degrees and 27 have received PhD degrees.

S N Bagaev combines his research work with a huge amount of science management. He is a member of the Presidium of the Russian Academy of Sciences and its Siberian Branch, a member of the Bureau of the RAS Physical Sciences Division, chairman or a member of a number of research councils and commissions of the RAS, a member of editorial boards of Russian and foreign scientific journals, Deputy Chairman of the RAS Council on Defense Research, Deputy Chairman of the United Physical Society of the Russian Federation, Honorary President of the Russian Society 'Knowledge', a member of the International Commission on Quantum Electronics, chairman of organizational and program committees of many international conferences and seminars, a member of the Optical Society of America (OSA), and Chairman of the DSc Thesis Council of the ILF SB RAS.

S N Bagaev's service to his country and to science has brought him high state awards: the State Prize of the Russian Federation (1998), Order of Friendship (1999), Order For Merit for the Fatherland of the 4th Class (2006), V A Koptyug Prize of the SB RAS and Belarus National Academy of Sciences (1999), P N Lebedev Gold Medal of the Russian Academy of Sciences (2006), and Chevalier of the Order of the Legion of Honor (2004, France).

We congratulate Sergei Nikolaevich from the bottom of our hearts on his birthday, and wish him good health, creativity, longevity, and much success for the benefit of science!

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