Veniamin Pavlovich Chebotaev (Obituary)

E. B. Aleksandrov, A. F. Andreev, S. N. Bagaev, N. G. Basov, F. I. Bunkin, A. V. Gaponov-Grekhov, N. V. Karlov, L. V. Keldysh, V. S. Letokhov, G. A. Mesyats, A. M. Prokhorov, and I. I. Sobel'man

Usp. Fiz. Nauk **163**, 105–106 (February 1993)

On September 2, 1992 Veniamin Pavlovich Chebotaev departed from life. He was an outstanding physicist and the recipient of the Lenin Prize, the Townes Prize of the American Optical Society, and the Humboldt Prize, and director of the Laser Physics Institute of the Siberian Division of the Russian Academy of Sciences. Until the last day Veniamin Pavlovich was full of energy an new ideas. His sudden death cut off the activity of this extraordinary individual.

Chebotaev was born on August 27, 1938 in Kuibyshev on the Volga. In 1960 he graduated from the Novosibirsk Institute of Electrical Engineering. His scientific activity and development are associated with the Institute of Radio Physics and Electronics of the Siberian Division of the USSR Academy of Sciences, where he received his bachelor's degree and then worked as a research associate. His first scientific publication in a journal was the undergraduate work on "Theory of a generator with a decelerating field." The director of the Institute, the well-known theoretical physicist Yuriĭ Borisovich Rumer, had a great influence on the development of Chebotaev's world view. Already in his first independent work Veniamin Pavlovich showed his talent as an experimental physicist and his tenacity in solving the most difficult problems of quantum electronics.

V. P. Chebotaev is one of the founders of the new, extremely fruitful, developments in spectroscopy: nonlinear laser spectroscopy with superhigh resolution. He proposed and implemented its basic techniques, such as the method of saturated absorption, the method of two-photon absorption without electron recoil, the method of separated optical fields, etc., which permitted the resolution of conventional spectroscopy to be increased by 6–7 orders of magnitude. The method of saturated absorption (1967) allowed narrow optical resonances to be produced in a gas with a homogeneous line width. The principal reason for line broadening in gases, inhomogeneous Doppler broadening, was eliminated, and this allows one to speak of spectroscopy without Doppler broadening. Using this technique, V. P. Chebotaev was the first to observe the effect of electron recoil in connection with absorption and emission of a photon in the optical region, and a relativistic effect, the quadratic Doppler level shift, etc.

In the 1970s, work was carried out under the direction of V. P. Chebotaev on using narrow optical resonances to stabilize the frequency of a laser. The basic results in this area were obtained using the method of saturated absorption, by means of which lasers were created with the highest in the world stability and frequency reproducibility. These stability levels put lasers in the same rank with the best frequency standards in the microwave range, and the frequency stability of the best lasers over short time scales is significantly higher than in masers.

The 1980s were met with a new success, the creation of an optical time scale. The unit of time, the second, was synchronized with the period of the optical oscillations of a stable laser by dividing the laser frequency without loss of accuracy. The first optical clocks were made, in which the period of the optical vibrations of a highly stable laser was used as the time scale.

V. P. Chebotaev made many original suggestions in quantum electronics. The majority of these were implemented under his direction and were accorded theoretical and experimental study. He carried out a long series of

Veniamin Pavlovich Chebotaev
(1938–1992)

 1063-7869/93/020100-02$10.00

studies in the theory of resonance interaction of optical fields with a gas. The role of level saturation and of coherent effects in strong laser radiation fields were explained. Interesting results were obtained in the area of atomic collisions: the elastic scattering cross section was measured in low-pressure gases using laser spectroscopy methods. The method of separated optical fields, the optical analog of the Ramsey method in the radio range, was proposed and implemented. Coherent emission in separated optical fields was experimentally demonstrated, which laid the foundations for a new area of physics, atomic optical interferometry.

Special mention should be made of the method of two-photon absorption in the field of a standing wave, proposed by Chebotaev and his co-workers. The most impressive results using this method were obtained by Prof. Hensche in the Max Planck Institute (Garching) in measuring the $1S$–$2S$ transition frequency of the hydrogen atom. The accuracy with which the Rydberg constant was measured in this experiment is the highest of all the fundamental constants of physics. It should be noted that the unique measurement facility used included a stable laser manufactured in the Laser Physics Institute of the Siberian Division of the Russian Academy of Sciences.

The breadth of V. P. Chebotaev's scientific interests is astonishing—they range from the problem of observing gravitational waves to using lasers in medicine. Under his direction, optical methods for detecting small shifts ($\sim 10^{-16}$ cm) were developed using high-stability lasers, which served as the basis for the development of optical sensors for detecting gravitational waves. He predicted the formation of crystalline ion structures when ions are cooled in a magnetic trap. He expressed ideas about the possibility of creating a γ-ray laser using stimulated Raman scattering from nuclear transitions. This is far from a complete list of the work performed by V. P. Chebotaev and his colleagues.

In recent years Chebotaev worked on the problems of nonlinear spectroscopy using femtosecond pulses, the solution of which will open up new possibilities for physics and physical and applied studies in the area of superfast processes; and he proposed a new type of laser, which he called a stabilitron, with a noise level below the quantum level, using the bistable properties of a resonance nonlinear absorber.

Veniamin Pavlovich was a major figure in science management. He was a member of the organization committees of all the All-Union conferences on nonlinear and coherent optics, the Vavilov conferences, and many international conferences. He was a member of the scientific councils of the Russian Academy of Sciences in the areas of "Coherent and nonlinear optics," "Atomic and molecular spectroscopy," the committee on quantum electronics of the Internation Union of Theoretical and Applied Physics, associate editor of the journals *Applied Physics*, *Metrologia*, *Soviet Journal of Quantum Electronics*, etc.

V. P. Chebotaev created a school of the area of superhigh-resolution spectroscopy and quantum metrology which is renowned throughout the world. His students include many Ph.D.'s and D.Sc.'s. Many will retain in their memory the clear presentations and discussions of Chebotaev at scientific conferences and seminars. He was the author of the widely known books *Principles of Nonlinear Laser Spectroscopy* (1975), *Nonlinear Laser Spectroscopy* (1977), *Nonlinear Laser Spectroscopy* (2nd ed.) (1990), and *Superhigh Resolution Spectroscopy* (in the *Laser Handbook*, 1985).

Veniamin Pavlovich had an extraordinary gift for generating ideas, which he generously shared. He was good at convincing people, and he infected them with his energy and his confidence in success. It is difficult to believe that he is no longer with us. Veniamin Pavlovich and his achievements will always be remembered in the hearts of his friends, colleagues, and students.

Translated by D. L. Book