# Boris Valerianovich Chirikov (on his sixtieth birthday)

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Boris Valerianovich Chirikov, Corresponding Member of the Academy of Sciences of the USSR and Director of the Theoretical Division of the Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences, celebrated his sixtieth birthday on June 6.

B. V. Chirikov was born in Orel. During the war he was evacuated to the northern Caucasus, where, as did most of his peers during those difficult years, he started his career.

B. V. Chirikov started his path in physics in 1947, transferring, upon completing the first year at the V. I. Lenin Moscow Pedagogical Institute, as a second year student to the physicotechnical department of Moscow State University (now the Moscow Physicotechnical Institute). Soon thereafter he went to work as a student-apprentice in the Heat Engineering Laboratory (HEL, now the Institute of Theoretical and Experimental Physics).

The first serious physical apparatus with which the student Chirikov had to work was a Wilson cloud chamber. He performed his thesis work on this apparatus, and he was invited to work at HEL together with other young physicists in the first graduating class of the Physicotechnical Institute.

The experimental investigations in meson physics on the Dubna phasotron, which occupied Boris Valerianovich during the first few years of his independent scientific work, apparently did not excite his interest, and in 1954 he accepted without hesitation the invitation by Andreĭ Mikhaĭlovich Budker, then a young theoretical physicist, to transfer to LIPAN (now the I. V. Kurchatov Institute of Atomic Energy). This invitation was not accidental: A. M. Budker, who taught in the Physicotechnical Institute, knew Boris Chirikov well as a student. From this moment Boris Valerianovich started a new life, filled with the scientific search for solutions to the most interesting physical problems.

The first problem was one of the limiting current of an electron beam. In a series of elegant experiments, performed together with V. I. Volosov, he convincingly demonstrated the formation of a virtual cathode and the development of instability in a compensated beam—effects that are now classic, but at that time they had not been experimentally confirmed for proton beams. Boris Valerianovich's main interests started to form back then—nonlinear and stochastic processes.

In 1958 the Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences was formed based on the Laboratory of New Methods of Acceleration directed by A. M. Budker, at the Institute of Atomic Energy, and two years later Boris Valerianovich moved together with Budkev's earliest scientific colleagues to Novosibirsk. Here he started experimental studies in two directions simultaneously.

The first area of research was the relativistic, stabilized electron beam, theoretically predicted by A. M. Budker. Five years of intense work gave encouraging results: a circulating electron beam with a current of 300 A and $3 \cdot 10^{13}$ particles, which today remains unsurpassed for accelerators of this class, was achieved in a betatron of a novel design.

BORIS VALERIANOVICH CHIRIKOV

Boris Valerianovich analyzed the stability of such an electron beam, loaded with ions. This work of B. V. Chirikov is now classic in the physics of charged-particle beams.

The second direction of research was very directly related to the problem of stability and stochasticity of the motion of particles in a force field. Accurate experiments, in which the lifetime of an electron in a magnetic mirror configuration was measured, demonstrated the existence of a new mechanism for escape of particles into the "loss cone"—stochastic instability not previously observed experimentally. These results were theoretically generalized by Boris Valerianovich in his monograph "Investigations in the Theory of Nonlinear Resonance and Stochasticity," presented in 1969 as a doctoral dissertation.

It is appropriate to emphasize here one of the most striking characteristics of Chirikov as a researcher—the ability to generalize widely. Thus the "particular" results of experiments with electrons in a mirror machine made it possible to construct a general theory of the stochastic behavior of a nonlinear oscillator, which was soon brilliantly confirmed in experiments on a beam of electrons circulating in

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an accumulator. A particle in such an accumulator is the analog of an oscillator with an extremely high (of the order of $10^{10}$) $Q$-factor, which makes it possible to study very fine nonlinear effects in its dynamics. In particular, the stochastic instability accompanying the overlapping of regions of autophasing of nonlinear resonances, theoretically predicted by Boris Valerianovich, was first observed in these experiments, performed at the Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences in 1968–1969. The experimental results were in complete agreement with "Chirikov's criterion"—a now well-known relation describing the condition for the development of stochastic instability. It is these works that served as an impetus for the development of an entirely new direction in the physics of accelerators with colliding beams—nonlinear "effects of the collision," whose understanding is necessary in practice in order to achieve the maximum luminosity in such accelerators. The second, no less important result of B. V. Chirikov's work on nonlinear resonance and stochasticity is the problem of magnetic confinement of particles in a thermonuclear reactor, where such effects must be taken into account in order to shape correctly the magnetic field of the reactor.

At the end of the 1960s Boris Valerianovich made his final choice between theory and experiment, as a method of investigation, and he turned to numerical simulation. He explains this decision by the very large technical costs and large amount of time involved in modern experiments ("One has to wait too long for the result!").

The talent and irreplaceable individuality of Chirikov as a scientist is no less evident even here. In a short time he became the leading specialist on the methods of numerical modeling of nonlinear processes in the dynamics of physical systems.

The range of systems that he studied is extremely large—from particles in accelerators and thermonuclear traps to astrophysical objects. Thanks to his great authority among specialists in different countries, he was able to organize an international collaboration using modern computer technology, which enabled him to simulate the most complicated many-body and prolonged stochastic processes.

The crowning achievement of this work was the construction of a theory of physical chaos (classical and quantum) and the formulation of the principle of stochastic instability of a dynamic system.

Boris Valerianovich belongs to the class of scientists who prefer to work by themselves, without striving to expand their circle of students and colleagues. A Chirikov school has nonetheless formed and operates fruitfully. It includes, in addition to physicists from Novosibirsk, groups of scientists in the USA and Italy, who for many years have worked with Boris Valerianovich.

There is another group of Chirikov students, whose number is difficult to count: all students in the physics department of Novosibirsk University, where Boris Valerianovich has lectured since the organization of the university, have passed "through his hands." He was one of the initiators of the modern unified course in physics, in which the artificial separation of physics into "general" and "theoretical" was eliminated, at Novosibirsk State University.

Boris Valerianovich celebrates his sixtieth birthday at the peak of his power, full of creative plans and ideas. His friends and colleagues wish him a happy birthday, good health, continued optimism so characteristic of him, and successful, fruitful work.

Translated by M. E. Alferieff