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PERSONALIA

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In memory of Boris Valerianovich Chirikov

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The Russian scientific community lost one of its brightest and most original thinkers — Professor Boris Valerianovich Chirikov, Full Member of the Russian Academy of Sciences, DSc in physics and mathematics. He died on February 12, 2008.

Boris Valerianovich is widely known to scientists all the world over as one of the creators of the physical theory of dynamic chaos — the science that lies on the borderline of classical and quantum mechanics, where they merge with statistical physics and information theory. The importance of this theory goes far beyond specific aspects of the dynamics of nonlinear systems; indeed, it reveals the nature of relations between the deterministic and the random, establishes the mechanism and conditions under which statistical laws are generated, and gives these laws a complete dynamic foundation. The results obtained by Boris Valerianovich Chirikov have already influenced international science in important ways and continue to do so. Science journals annually publish an enormous number of papers that are connected directly or indirectly to the problem of dynamic chaos. Numerous international conferences are regularly devoted to this range of problems.

Boris Valerianovich Chirikov was born in the city of Orel on June 6, 1928. From 1933 to early 1942 he and his mother lived in Leningrad, from which he was evacuated during the siege of Leningrad to the North Caucasus. There his mother died in 1944 and he began working to earn his livelihood, as did most of his peers in those hard times. Despite these difficulties, he successfully graduated from school in 1946 and enrolled in the V I Lenin Moscow Pedagogical Institute. Boris Valerianovich took his first steps in physics in 1947 when, after his freshman year at the Pedagogical Institute, he transferred in his sophomore year to the Physico-Technical Department (Fiztekh) of Moscow State University (MGU). He graduated with the very first group of the most talented students who were selected for the new department from among students of the best institutes and universities of the Soviet Union. He worked on practical projects at the Thermotechnical Laboratory (TTL), later renamed to the Institute of Theoretical and Experimental Physics (ITEP) where he continued to work after graduation from the university in 1952. Two years later, however, in 1954 he was invited by the future Academician Andrei Mikhailovich Budker (who knew B V Chirikov well from seminar sessions at Fiztekh) to transfer to LIPAN (nowadays the Russian Research Centre 'Kurchatov Institute') where he started working on pressing problems of accelerator physics and plasma physics. B V Chirikov became one of the first research scientists of the Institute of Nuclear Physics (IYaF) that A M Budker began to organize and whose director-organizer he was made in 1958. These two outstanding personalities quickly established mutual respect and liking; alas this tragically came to an end upon Andrei Mikhailovich's untimely death. Despite A M Budker's somewhat sceptical attitude regarding B V Chirikov's passion for the problem of stochastic instability of nonlinear dynamics, Boris Valerianovich would proudly continue to call himself a disciple of A M Budker.

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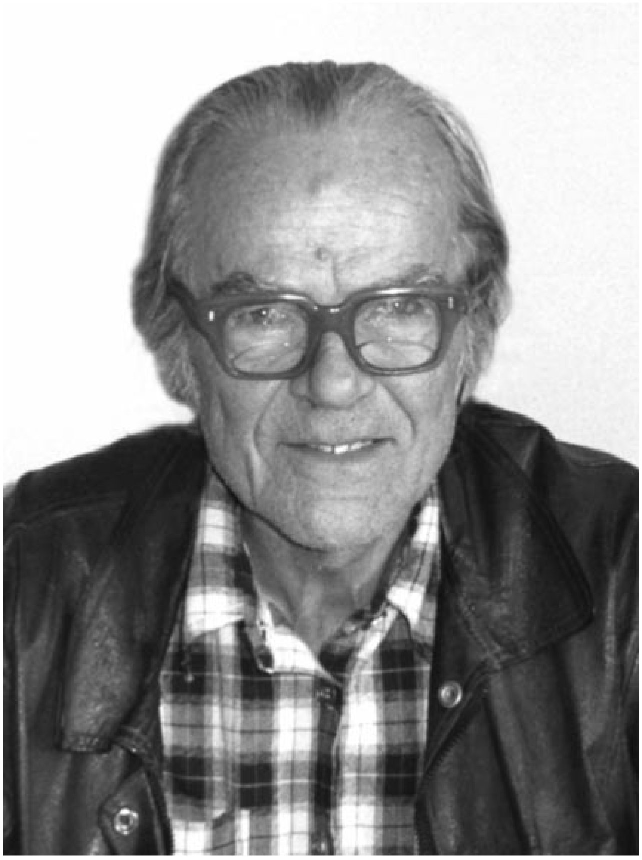
Translated by V I Kisin



Boris Valerianovich Chirikov
(06.06.1928 – 12.02.2008)

The early period of B V Chirikov's life in research was connected with seeking a solution to two problems formulated by A M Budker. The first of them concerned the study of the process of ion compensation in an intense relativistic electron beam; this work ended in the creation of the B-3 betatron with record-breaking parameters. And in 1968 B V Chirikov published his first, later to become classic, paper in which he extended A M Budker's theory of coherent transverse instability of an annular ion-compensated electron beam. The second of the problems formulated by Budker — the influence of nonlinear resonances on the accuracy of sustaining the adiabatic invariant in open-ended traps — brought B V Chirikov face-to-face with the problem of the chaotic behavior of deterministic systems.

Already in one of his first papers on this subject (published in 1959), Boris Valerianovich formulated his famous criterion of overlapping resonances as a condition for the inception of the chaotic behavior of totally deterministic nonlinear systems. Using this criterion, it was possible to explain the seemingly mysterious results of experiments at Budker's laboratory on electron confinement in open-ended traps. This was the first successful application of the theory of dynamic chaos to a physics experiment. In the 1960s, B V Chirikov made theoretical predictions based on analyzing the interaction between nonlinear resonances revealed; a serious experimental confirmation of them was produced in the studies of electron dynamics in storage rings at IYaF.

B V Chirikov's virtuosity in applying the idea of overlapping nonlinear resonances allowed him to solve subsequently a large number of interesting and important physical problems. For instance, in 1979, by using this approach, he was able to solve the famous Poincaré problem, formulated in the 19th century, on the structure and size of the domain of the exponentially unstable motion (the stochastic layer) in the neighborhood of the separatrix of nonlinear resonance. This result served as a basis for constructing an effective evaluation of the Arnold diffusion rate (a mechanism of universal instability of multidimensional nonlinear oscillations that V I Arnold had predicted in 1964 already). This phenomenon plays the key role in such dissimilar processes as, on the one hand, solar system dynamics (including asteroids, comets, and even planets) and, on the other hand, proton confinement in storage rings of modern colliders. Another impressive example of the application of Chirikov's ideas and methods of the dynamic chaos theory to astronomy is the calculation of the parameters of motion of Halley's comet and the proof that its motion is chaotic in nature. The proof was based on the dates of twenty eight appearances of this comet known to us from historical chronicles.

In 1979, B V Chirikov summarized his preliminary research results in a large review paper in *Physics Reports*, where he presented the foundations of the theory of dynamic chaos in classical Hamiltonian systems developed by himself along with his colleagues and students, and described its many applications. This publication rapidly became widely known internationally and is now referred to as the 'Chaos Bible'. The number of references to the Chaos Bible has by now reached several thousand.

Beginning in the mid-1970s, Boris Valerianovich published together with his coworkers a number of pioneering papers devoted to manifestations of dynamic chaos in the behavior of quantum systems. These papers built the foundation of a new research area — 'quantum chaos' — and attracted widespread attention. They formulated and analyzed a number of questions of fundamental importance in connection with the principle of correspondence between the quantum and classical theories, and discovered the phenomenon of quantum suppression of diffusion, which has much in common with the widely known Anderson localization in quasi-one-dimensional disordered structures. A nontrivial relation was thus established between dynamic quantum chaos and the physics of disordered systems. The effects of dynamic localization of quantum chaos are clearly pronounced in the peculiarities of the diffusion photoeffect in a microwave field on the Rydberg states of the hydrogen atom; B V Chirikov and his coworkers studied these peculiarities in detail. The phenomena they predicted were later confirmed in experiments.

B V Chirikov then published a series of papers devoted to expanding the concept of quantum chaos; one can find there a discussion of applications of the theory to such fundamental aspects as the nature of irreversibility of statistical laws and the role of quantum measurement.

A specific feature of Boris Valerianovich's research style was a combination of rigorous analytical methods and approximate qualitative estimates based on the simplest possible models that were adequate to the problem at hand. Hardly anyone was B V Chirikov's equal in this ability to arrive at the simplest possible tools for solving very nontrivial problems. It was no accident that Chirikov's model of a plane rotator excited by periodical instantaneous kicks deserved the name 'standard' for its universality and rich content. Using it, Boris Valerianovich succeeded in clearly demonstrating all the main features of the physics of classical and quantum dynamic chaos. A huge number of papers by other authors have been devoted to his model; it is still attractive to physicists and mathematicians who are continuing to develop the theory of dynamic quantum chaos.

An extremely important component of Chirikov's approach was his wide utilization of numerical simulation, which at present is very nearly the main technique for solving problems arising in connection with dynamic chaos; it did not, in fact, enjoy popularity in the years when Boris Valerianovich started his research. It is fair to say that B V Chirikov created the foundation of the integrated approach in which the 'numerical experiment' plays a decisive role, dictating the direction of theoretical studies of novel phenomena and types of behavior.

Boris Valerianovich Chirikov related to the kind of scientist who prefers working alone and does not attempt to widen the circle of students and coworkers. Despite this, Chirikov's school of science did grow around him and it continues to work successfully. It includes, in addition to physicists in Novosibirsk, scientists from the USA, Italy, and France who worked directly with Boris Valerianovich for a number of years. Research absorbed Boris Valerianovich's attention almost completely. He was usually deeply immersed in his thoughts and appeared to be hardly bothered by external attributes of success. He seemed to be quite happy in a small modestly furnished office that he occupied for a long time in his capacity as Head of the Theoretical Department at the Institute of Nuclear Physics, and quite satisfied with an old PC that he used for years. Did he know his own true worth? No doubt he did, but he disliked talking about it or showing off. He shied away from any advertising of his name and even expressed his disapproval when an international conference on chaos was convened in 2003 in Novosibirsk to coincide with his 75th birthday. The conference did take place after all, causing much interest all over the world, and many outstanding physicists from many places — from the USA to Europe and Japan — took part in it. The organizers of this conference all hope that, despite all that, it gave Boris Valerianovich many a pleasant moment.

An important point to emphasize is that Boris Valerianovich combined his intense research program with teaching and educating the public. He played an enormous role in the creation and development of Novosibirsk State University (NGU). His brilliant, original physics courses and textbooks, manuals and training aids helped many generations of NGU students to find their way into science. His ability to present the most complicated problems of nonlinear dynamics in a simple and engaging manner attracted wide and varied audience to his lectures.

His talents as Scientist and Educator were combined in him with a wonderful personality which made him a Teacher not only of science but also of life — and a brilliant one at that.

Undoubtedly, not only we who have known him personally but also the next generations of physicists will remember and have a profound respect for the father of dynamic chaos — Boris Valerianovich Chirikov.

L M Barkov, A E Bondar', N S Dikanskii,
G I Dimov, E P Kruglyakov, G N Kulipanov,
I N Meshkov, V V Parkhomchuk, A N Skrinsky,
V V Sokolov, V S Fadin, I B Khriplovich