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Boris Chirikov, a pioneer in Classical and Quantum Chaos

This special issue of the Annales de l'Institut Henri Poincaré on "Classical and Quantum Chaos", is dedicated to Boris Chirikov —a pioneer in this area of research— on the occasion of his 70th birthday on June 6th, 1998.

As early as 1959, in a seminal article, Chirikov proposed a criterion for the emergence of classical chaos in Hamiltonian systems, now known as the *Chirikov resonance-overlap criterion* (B. V. Chirikov, *At. Energ.* **6**, p. 630 (1959)). In the same paper, he applied such criterion to explain some puzzling experimental results on plasma confinement in open mirror traps, that had just been obtained at the Kurchatov Institute for Atomic Energy. This was the very first physical theory of chaos, which succeeded in explaining a concrete experiment, and which was developed long before computers made the icons of chaos familiar to everyone.

The 1959 paper was to become a landmark. In the years that followed, Chirikov's criterion found extensive applications in plasma physics, in the physics of particle accelerators, in astronomy, in the microwave ionization of Rydberg atoms and in mesoscopic physics. To this day, this criterion is still regarded as a very effective practical method for the analytical estimate of the chaos border in Hamiltonian systems.

The name of Boris Chirikov is associated with an impressive list of fundamental results in this field. Among them we mention: the determination of the strong chaos border and the explanation of the Fermi-Pasta-Ulam problem; the derivation of the chaos border for the Fermi acceleration model; the numerical computation of the Kolmogorov-Sinai entropy in area-preserving maps; the investigations of weak instabilities in many-dimensional Hamiltonian systems (Arnold diffusion and modulational diffusion); the demonstration that the homogeneous models of classical Yang-Mills field have positive Kolmogorov-Sinai entropy, and therefore are generally not integrable; the discovery of the power law decay of

Poincaré recurrences in Hamiltonian systems with divided phase space; the demonstration that the dynamics of the Halley comet is chaotic, and is described by a simple map. The physical theory of classical chaos developed by Chirikov was confirmed in experiments with relativistic electrons accelerators, carried out at the Institute of Nuclear Physics in Novosibirsk, where Chirikov worked from the first days of its foundation by Budker in 1958.

In 1977, Chirikov and his collaborators proposed the kicked rotator as a quantum model for Hamiltonian chaos, and showed that quantum effects limit the classical chaotic diffusion. After the demonstration (by Fishman, Grempel and Prange in 1982) of an analogy with the theory of Anderson localization in solid state physics, Chirikov's work led to the development of a quantum theory of dynamical localization of systems which are classically chaotic. The predictions of this theory were subsequently confirmed in experiments on microwave ionization of highly excited atoms, and on the spreading of cold atoms in a modulated laser field.

The influence of Chirikov's ideas on the field of chaos can also be gauged by the abundance of terms of common use, which were originally coined by him: the Kolmogorov-Arnold-Moser (KAM) theory, the Kolmogorov-Sinai (KS) entropy, the Arnold diffusion, the standard map, the kicked rotator, dynamical localization.

Chirikov's achievements, like those of many twentieth-century mathematicians, are part of the legacy of Henri Poincaré, who discovered the first manifestations of what is now called deterministic chaos. It is therefore appropriate to honor Boris Chirikov with a special issue of the Annales de l'Institut Henri Poincaré. With great pleasure we dedicate this volume to Boris, thanking all authors who accepted enthusiastically the invitation to write an original contribution.

J. BELISSARD and D. L. SHEPELYANSKI

Toulouse, February 27, 1998