

Nikolai Chernov, 1956-2014



Excerpts from CV

1979: MSc, Lomonosov University, Moscow, Advisor: Sinai

1984: PhD, Lomonosov University, Moscow, Advisor: Sinai

1977-1983: Junior Research Scientist, Lomonosov University

1983-1991: Junior/Senior Research Scientist, Dubna, USSR

1991-1994: Visiting Professor/Researcher

UCLA - GeorgiaTech - Princeton

1994-2014: University of Alabama, Birmingham

First paper as still an undergraduate

N. I. Chernov: Kneading invariants for mapping
of an interval with an absolutely continuous
invariant measure,

Russian Math. Surveys 34:4 (1979) 213-214.



Further works (a. o. entropy, billiards)

- Entropy of a gas of hard spheres with respect to the group of space-time translations, Ya. G. Sinai and N. I. Chernov, Trudy Seminara Petrovskogo, 8 (1982) 218–238.
- Construction of transverse fiberings in multi-dimensional semidispersed billiards, N. I. Chernov, Funkts. Analis i Prilozhen, 16:4 (1983) 35-46
- Entropy of infinite-dimensional systems of statistical mechanics with respect to a group of space-time shifts, N. I. Chernov, Uspekhi Mat. Nauk, 38:5 (1983), 213-214.
- Effective algorithms for circle fitting, N. I. Chernov and G. A. Ososkov, Journal of Computer Physics Communications, 33 (1984), 329-333
- Space-time entropy of infinite classical systems, N. Chernov, in: Mathematical Problems of Statistical Mechanics and Dynamics, 125-137. Math. Appl. (Soviet Ser.), 6, Reidel, Dordrecht-Boston, Mass., 1986.

- Ergodic properties of some systems of two-dimensional discs and three-dimensional spheres, Ya. G. Sinai and N. I. Chernov, Uspekhi Mat. Nauk, 42:3 (1987), 153-174
- Efficient estimator of parameters; goodness-of-fit test for multivariate distributions for data presented by 1D histograms, N. I. Chernov, V. S. Kurbatov, G. A. Ososkov, Nuclear Instruments & Methods, A274 (1988), 547-550
- Markov partitions for two-dimensional hyperbolic billiards, L. A. Bunimovich, Ya. G. Sinai, N. I. Chernov, Uspekhi Mat. Nauk, 45:3 (1990), 97-134
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- Statistical properties of two-dimensional hyperbolic billiards, L. A. Bunimovich, Ya. G. Sinai, N. I. Chernov, Uspekhi Mat. Nauk, 46:4 (1991), 43-92
- Steady-state electrical conduction in the periodic Lorentz gas, N. Chernov, G.L. Eyink, J.L. Lebowitz, Ya.G. Sinai Commun. in Math. Physics, 154 (1993), 569-601

Entropy

- Space-time entropy of an infinite system of particles (hard balls!) (Milnor)
- Multidimensional geometry (in particular: collision equations for multidimensional billiards!)
- A new proof of Sinai's formula for entropy of hyperbolic billiards. Its application to Lorentz gas and stadium, N. Chernov, Funkts. Anal. Prilozhen. 25:3 (1991), 50-69
- **N. B. Pesin's identity (1978) for smooth, Katok-Stelcyn (1986) for singular systems.**
- Entropy, Lyapunov exponents and mean-free path for billiards, N. Chernov, Journal of Statistical Physics, 88 (1997), 1-29.

Billiards-1

- Construction of transverse fiberings in multi-dimensional semidispersed billiards, N. I. Chernov, *Funkts. Analis i Prilozhen*, 16:4 (1983) 35-46
Generalization of Sinai's 1970 2D construction to multiD.
- Ergodic properties of some systems of two-dimensional discs and three-dimensional spheres, Ya. G. Sinai and N. I. Chernov, *Uspekhi Mat. Nauk*, 42:3 (1987), 153-174
(cf. my BudWiSer seminar about this topic on 03.03.2014)
Local ergodicity theorem in multiD. Both formulation and proof are ingenious!
Corrolary: Every dispersing billiard is ergodic and K.

Billiards-2

- Markov partitions for two-dimensional hyperbolic billiards, L. A. Bunimovich, Ya. G. Sinai, N. I. Chernov, Uspekhi Mat. Nauk, 45:3 (1990), 97-134
- Statistical properties of two-dimensional hyperbolic billiards, L. A. Bunimovich, Ya. G. Sinai, N. I. Chernov, Uspekhi Mat. Nauk, 46:4 (1991), 43-92

These twin works generalize and rectify some details of Bunimovich-Sinai's 1980/81 twin papers.

Part I constructs Markov grid (!) w. some good properties, Part II uses Part I to prove 1.) stretched exponential mixing for Hölder functions and 2.) convergence of 2D FH periodic Lorentz process to Wiener process.

Interlude: Markov partitions

- 1967, Adler-Weiss: Markov partition for showing isomorphy of toric automorphisms with identical entropies (Kolmogorov (1958), Sinai (1959))
- 1968, Sinai: Markov partition for uniformly hyperbolic maps
- 1970, Sinai: 2D billiards are uniformly hyperbolic w. singularities
- Natural idea was to construct Markov partitions for 2D Sinai billiards
Difficulty: For them the partition is necessarily infinite, consisting of products of Cantor sets (cf. Bu-Sin, 1980)
That is why Markov grid (Bu-Ch-Sin, 1990) was an important and appropriate weakening of the notion

Further fundamental progress: Young's towers (1998) and flows (see Peter).

Billiards-3

Steady-state electrical conduction in the periodic Lorentz gas, N. Chernov, G.L. Eyink, J.L. Lebowitz, Ya.G. Sinai, Commun. in Math. Physics, 154 (1993), 569-601

Nonequilibrium steady states are studied in 2D FH periodic Lorentz gas w. small electric field. The particle kinetic energy is held fixed by a Gaussian 'thermostat'(Moran and Hoover).

Reversible, but dissipative dynamics.

(1) existence of a unique stationary, ergodic measure obtained by forward evolution of initial absolutely continuous distributions (SRB measure on a hyperbolic attractor);

(2) Pesin entropy formula, Young's expression for the fractal dimension, steady-state thermodynamic entropy production; Kawasaki formula;

(3) validity of linear response theory and Ohm's transport law.

Proofs use a theory of small perturbations of hyperbolic dynamical systems and the method of Markov sieves.

Sinai: Reminiscences about Kolya Chernov

"Kolya and I started to work together when Kolya became an undergraduate and later a graduate student of Mathematics Department of Moscow State University. From the very beginning he became interested in the theory of billiards. One of his remarkable property was his ability to penetrate very deeply in any subject in which he was involved."

His arguments have often been immensely delicate.

And, of course, he knew better than anyone else the whole technology, the geometry and the algebra of hyperbolic systems w. singularities.

He was a modest, gentle, most friendly and an exceptionally nice person.





