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Yasha Sinai (Princeton University)

Citation

For his ground-breaking works concerning dynamical entropy, ergodic theory, chaotic dynamical systems, microscopic theory of phase transitions, and time evolution in statistical mechanics.

Laudatio

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The main fields of interest of Yasha Sinai are ergodic theory, the theory of dynamical systems, probability theory, mathematical, in particular, statistical physics. He has a unique awareness of and sensitivity to the fundamental problems of both mathematics and physics. The problems he raises and attacks with a tremendous proving power if necessary, always lie at the very depth and imply wide and flourishing consequences.

I am more than pleased to challenge here the impossible: to say briefly about the scientific achievements of Yasha, about his contributions to mathematical physics. Let me try nevertheless and start with some of his early accomplishments:

- 1959: Kolmogorov-Sinai entropy
- 1961: dynamical systems with countable Lebesgue spectrum
- 1967: a rigorous theory of phase separation by Minlos and Sinai
- 1968: Markov partitions for uniformly hyperbolic systems
- 1970: Sinai billiard, ergodicity and Kolmogorov-mixing of two hard disks
- 1972: Gibbs measures in ergodic theory

I interrupt this astonishing list here since I, personally, think that these works between 1968 and 1972: the foundations and the basic construction of the highly efficient tool of Markov-partitions for hyperbolic systems, the discovery of the Sinai-Ruelle-Bowen measure and the application of the Gibbs formalism to dynamical systems is the most brilliant example of the width, the depth and also the outflow of Yasha's mathematics. My duty is to continue and do this by only mentioning some of his later, most profound, original and highly influential results:

- proof of existence of Hamiltonian dynamics of infinite particle systems by introducing the idea of „cluster dynamics"
- the far-reaching generalization of Peierls'classical contour method (the well-known Pirogov-Sinai method for describing the phase-diagram in systems with a finite group of symmetry)
- the mathematically rigorous foundations of Kenneth Wilson's renormalization-group-method (for this method, Wilson was awarded the Nobel Prize), this is applicable not only in statistical physics but also in dynamical systems (with Bleher)
- description of the spectrum of the quasi-periodic Schrödinger operator: establishing the localization of the eigenfunctions
- construction of Markov partitions for billiards and the Lorenz-map (with Bunimovich and Chernov)
- for 1-D random walks in a random environment a mathematically rigorous treatment of their subdiffusive behavior (Sinai-diffusion)
- the verification of asymptotic Poisson distribution of energy level gaps for a class of integrable dynamical systems via a very elegant way to treat the related classical and deep number theoretical problems
- the mathematical theory of coupled map lattices (known also as space-time chaos; with Bunimovich and with Pesin)
- hydrodynamics and his theory for the Navier-Stokes equation (with K. Khanin, J. Mattingly and D. Li).

This list obviously demonstrates that Sinai not only solved a number of extremely hard and deep classical problems and built theories. More than that, he is one of those absolutely rare unifying personalities who, by having an overview over a wide spectrum of areas, could initiate directions and theories that connect different fields within mathematics or between mathematics and physics.

Let me mention some personal experiences. Yasha completely revolutionized my interest at least two times. Originally a probabilist, I turned to statistical physics in 1975, and started to regularly visit the seminar of Yasha and that of Dobrushin-Sinai in Moscow. I also invited Yasha to us. His series of lectures held in Budapest in 1976, throughout a whole week, Saturday included, every day until our last breath, actually not his, were composed from the germ of his monograph: Theory of Phase Transitions. Rigorous Results. (He covered among others DLR-equations, theories od Bleher-Sinai, of Pirogov-Sinai and of Dobrushin-Shlosman.) For all of us in Budapest: József Fritz, András Krámli and Péter Major, this became a twist in our interests. Let me also note in brackets that his four lectures held somewhat later on Gelfand's seminars in Moscow on the topics of this monograph eventually meant a turning point in the judgement of Gelfand's school on probability theory and on mathematical statistical physics. In 1979, before our celebrated Random Fields conference in Esztergom, we were taking sunbath with Yasha on the rooftop of Lukács swimming pool in Budapest, a favorite place of Yasha and Lena. He there told me about Markov partitions of the billiard and the CLT for the Lorentz process. Having been interested in dynamical theories of Brownian motion, exactly afterwards I started to study billiards. And I am most glad that quite recently, with Dolgopyat and Varju, we could finally solve a problem, he raised to me 28 years ago, on local perturbation of the Lorentz process. Talking about dynamical theory of Brownian motion, it was, indeed, most exciting to work parallelly with him on the Harris-Spitzer model. I was proud to hear from him that he had learnt much about this model from me. Characteristic to his style is what, during this work, he said to me in 1984 in Tashkent: if you hear the equation I have just found you will jump high up to the ceiling. I would have done if I had been able. All in all, Sinai is not only an exceptional scholar of our time, but the experience of our school in Budapest, and also that of further centers, among others, from Italy, from Poland, from Uzbekistan, etc. shows that his enthusiasm toward problems of science, his energy and his direct and friendly personality always attract many mathematicians from all over the world to beautiful, interesting and fundamental problems of mathematics and physics.