

Mikhail Gordin Prize



This is the inaugural year for the AMS-EMS Mikhail Gordin Prize, which was established to honor the memory of Mikhail Gordin and the tradition of the mathematics of Eastern Europe. It is awarded to a mathematician working in probability or dynamical systems, with preference given to early career mathematicians from or professionally connected to an Eastern European country. The recipient is chosen by a committee appointed by the European Mathematical Society with AMS representation on the committee.



Semyon Dyatlov

Citation

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The 2022 AMS-EMS Mikhail Gordin Prize is awarded to Semyon Dyatlov for his work on quantum chaos, scattering theory, and, in particular, differentiable dynamical systems. This prize is awarded jointly with the European Mathematical Society (EMS).

Mathematical quantum chaos describes the effects of classical dynamics on spectral

properties of quantized systems. Semyon Dyatlov has been the leader in high power collaborations with Jean Bourgain (2018, *Annals of Mathematics* 187), Long Jin (2018, *Acta Mathematica* 220), Stéphane Nonnenmacher (*Journal of the AMS*, to appear), and Joshua Zahl (2016, *Geometric and Functional Analysis* 26), which established the strongest results on mathematical quantum chaos in the last decade: proof that there are *no holes* in support of high frequency eigenfunctions for negatively curved surfaces and the existence of spectral gaps without the Patterson–Sullivan condition for hyperbolic quotients by *thin* groups.

Dyatlov has also contributed to mathematical theory of scattering resonances by providing the most precise results on quasinormal modes of black holes and by writing, with Maciej Zworski, an already influential book, *Mathematical Theory of Scattering Resonances*.

In the last few years, he has been the leading force in applying microlocal methods to the study of classical hyperbolic dynamics. That development started with the work of Frédéric Faure, Nicolas Roy, and Johannes Sjöstrand

(2008–2011, *Open Math Journal* 1, *Communications in Mathematical Physics* 308), who explained how some aspects of Anosov dynamics can be analyzed using microlocal methods originating in scattering theory. Dyatlov went beyond this by adding radial estimates of Richard Melrose (1993) and András Vasy (2013) to this microlocal toolbox and that proved useful in the study of dynamical (Ruelle) zeta functions and Axiom A flows. Ruelle zeta functions were an integral topic of research for hyperbolic flows on compact manifolds in the 1960s, their meromorphic extension being one of the major problems. In particular, in his famous 1967 paper, page 802, Smale asks for the meromorphic extension of a suspension over an Axiom A diffeomorphism.

In 2016, Semyon Dyatlov and Maciej Zworski (*Ann. Sci. Ec. Norm. Supé.* 49) gave a microlocal proof of the 2013 result of Paolo Giulietti, Carlangelo Liverani, and Mark Pollicott (*Annals of Mathematics* 178), who showed meromorphy of Ruelle zeta functions for Anosov flows. That led to his joint work with Colin Guillarmou (2016–2018, *Ann. Henri Poincaré* 17, *Bulletin of the AMS* 55), which answered Smale’s question for general Axiom A flows (to quote Smale: “I must admit that a positive answer would be a little shocking.”). Those works then led to progress on Fried’s conjecture relating behavior of dynamical zeta functions to topological and analytic invariants (Dyatlov–Zworski, 2017, *Inventiones Mathematicae* 210; Dang–Guillarmou–Rivière–Shen, 2020, *Inventiones Mathematicae* 220; Cekić–Dyatlov–Küster–Paternain, 2021, arXiv:2009.08558) and inverse problems (Guillarmou, 2017, *J. of the AMS* 30; Guillarmou–Lefeuvre, 2019, *Annals of Mathematics* 190).

Semyon Dyatlov’s approach to tackle the problems of zeta functions embodies Misha Gordin’s view on mathematics, as quoted by A. M. Vershik in 2016 (*Journal of*

Mathematical Sciences): "(Gordin) was a mathematician with wide interests and broad range of vision he applied to his problems, notions, and approaches from other mathematical fields."

Biographical Note

Semyon Dyatlov was born in Novosibirsk, Russia, in 1987 and received his BS from Novosibirsk State University in 2008 and his PhD from UC Berkeley in 2013, under the guidance of Maciej Zworski. He held a Clay Research Fellowship from 2013 to 2018 and joined the faculty of MIT in 2015. Dyatlov worked at UC Berkeley while on leave from MIT from 2017 to 2019. He is currently an associate professor at MIT.

Dyatlov received a Sloan Research Fellowship in 2017, the IAMP Early Career Award in 2018, and an NSF CAREER grant in 2018. He will be an invited speaker at the ICM in 2022.

Response from Semyon Dyatlov

I am honored and delighted to receive the AMS-EMS Mikhail Gordin Prize. I would like to thank several people who have introduced me to microlocal analysis and hyperbolic dynamics, on the interface of which much of my research has happened: my advisor and longtime collaborator, Maciej Zworski, for mathematical guidance and inspiration; Colin Guillarmou, for our many fruitful collaborations; Richard Melrose, Stéphane Nonnenmacher, and András Vasy for the many insightful discussions that we had over the years; and Kiril Datchev for his mentorship during my days in graduate school.

My recent results in quantum chaos and fractal uncertainty principle would not have been possible without Jean Bourgain. He was a force of nature in mathematics and he tragically left us so early; I was very lucky to co-author two papers with him. I would also like to thank my co-author Long Jin for sharing much of my journey in quantum chaos and Joshua Zahl and Larry Guth for introducing me to the field of additive combinatorics. I am grateful to have had many other excellent collaborators, all of whom I wish to thank here.

Last but not least, I would like to thank my parents and my brother for introducing me to mathematics and to microlocal analysis, and my wife Xuwen and my son for their unconditional support.

Credits

Photo of Semyon Dyatlov is courtesy of the MIT Department of Mathematics.