



Bôcher Memorial Prize

This prize, the first to be offered by the American Mathematical Society, was founded in memory of Professor Maxime Bôcher, who served as president of the AMS (1909–1910). The original endowment was contributed by members of the Society and was augmented by a generous donor in 2008. It is awarded for a notable paper in analysis published during the preceding six years. The work must be published in a recognized, peer-reviewed venue.



Frank Merle



Pierre Raphaël



Igor Rodnianski



Jérémie Szeftel

Citation

[Frank Merle](#), [Pierre Raphaël](#),
[Igor Rodnianski](#), and [Jérémie Szeftel](#)

The 2023 Bôcher Memorial Prize is awarded to Frank Merle, Pierre Raphaël, Igor Rodnianski, and Jérémie Szeftel for their groundbreaking work establishing the existence of blow-up solutions to the defocusing NLS equation in some supercritical regimes and to the compressible Euler and Navier-Stokes equations. This breathtaking achievement, which greatly enhances our understanding of dispersive

PDEs and of fluid dynamics is exposed in a monumental series of three articles: “On the implosion of a compressible fluid II: singularity formation,” *Annals of Mathematics* 196 (2022), “On the implosion of a compressible fluid I: smooth self-similar inviscid profiles,” *Annals of Mathematics* 196 (2022), and “On blow up for the energy super critical defocusing nonlinear Schrödinger equations,” *Inventiones Mathematicae* 227 (2022).

Biographical Note

Frank Merle was born on November 22, 1962. He received his PhD at the École Normale Supérieure in 1987 and held a position at the CNRS from 1988 to 1991. Since 1991, he has been a professor at the Université de Cergy-Pontoise. In the last twenty years, he has held a joint position between the Université de Cergy-Pontoise and l’Institut des Hautes Etudes Scientifiques, and has been a regular visitor at the University of Chicago.

He has held various visiting positions including at the IAS, the Courant Institute, Rutgers University, Stanford University, MSRI and Tokyo University.

Merle’s recent awards and honors include Speaker at the International Congress of Mathematicians (1998), The Bôcher Memorial Prize 2005 of the American Mathematical Society, the Médaille d’argent du CNRS (2005), the ERC Advanced Grant (2011), Speaker at the European Congress of Mathematics (2012), Plenary Speaker at the International Congress of Mathematicians (2014), Prix Ampère de l’Académie des Sciences (2018), Member of The Academia Europaea (2020).

Response from Frank Merle

It is a great honor to be awarded the Bôcher Memorial Prize together with my collaborators and friends Pierre Raphaël, Igor Rodnianski, and Jérémie Szeftel. I am deeply grateful to the Prize Committee and to the American Mathematical Society for their recognition of this research. This award has special meaning for me.

I would like to thank the people who influenced me early in my career, specifically: Henri Berestycki, Haim Brezis, Louis Nirenberg, Hiroshi Matano, George Papanicolaou, Robert V. Kohn, Abbas Bahri, Jean Ginibre. I am also deeply grateful to Jean Bourgain and to Carlos Kenig for their constant support and early recognition since the mid 1990's. I am also indebted to my close collaborators and friends who have helped me mature my mathematics. They are Hatem Zaag, Yvan Martel, Carlos Kenig, Thomas Duyckaerts, Luis Vega, Hiroshi Matano, Charles Collot and of course Pierre Raphaël, Igor Rodnianski, and Jérémie Szeftel.

The results mentioned in the citation stem from a long collaboration and mathematical exploration with my coauthors Pierre, Igor and Jérémie. Each of us brought our own expertise, sharing a common enthusiasm which enabled our success. I feel very lucky to have such collaborators.

These papers are the result of a seemingly chaotic process of exploration and creation related to supercritical problems with a lot of back and forth that started around ten years ago. In the process we became interested in fluid dynamics. It took a long time to realize that this could and would lead to blow-up in the defocusing situation, disproving the expected conjecture that blow-up would not occur in the supercritical case stated by Jean Bourgain, a giant of mathematics. This counterintuitive result and new ideology lead to the construction of blowup solutions for the 3 Dimensional Compressible Navier-Stokes Equation.

Again, I wish to thank the Prize Committee for honoring these lines of research, and I look forward to continuing to work on them.

Finally, I wish to thank my family for their constant support and love: my wife Rebecca, my children Jascha and Maxim, my parents Myriam and Norbert, my parents-in-law Beverly and Hy, and my friends.

Biographical Note

Pierre Raphaël graduated from Ecole Polytechnique and received his doctorate from the University of Cergy Pontoise in 2004. Professor Raphaël then held appointments as Junior CNRS researcher in Orsay, Assistant Professor in Princeton, Professor at the University of Toulouse and the University of Nice. He is currently the Herchel Smith Professor of Pure Mathematics at the University of Cambridge. His research on the mathematical description of singularities for nonlinear waves has been supported by three ERC grants as Principal Investigator. He received the Grand Prix Alexandre Joannides from the French Academy of Sciences in 2014, and has been invited to give the Riviere–Fabes lectures (Minneapolis 2007), the Nachdiplom lectures (ETH Zurich 2001), the Weyl lectures (IAS Princeton 2021) and the Zygmund–Calderon lectures (Chicago 2022).

Response from Pierre Raphaël

Receiving the Bôcher Prize is an immense honor. Many of the names of those who transformed so deeply analysis in the last century belong to the list of awardees. Receiving this prize jointly with my collaborators Frank Merle, Igor Rodnianski and Jérémie Szeftel is such a pleasure! The work which has been recognized by the committee is the accomplishment of two decades of intense collaboration. This long journey started with the breakthrough work by Miguel Herrero and Juan Velasquez (1994) on singularity formation for super critical parabolic problems, and has constantly been influenced by our interaction with Yvan Martel and Hatem Zaag whose works on singularity formation started nothing but a revolution.

Biographical Note

Igor Rodnianski was born in Kyiv, Ukraine. After receiving his PhD from Kansas State University under the direction of Lev Kapitanski in 1999, he came to Princeton as an Instructor and has been there since, with the exception of 2 enjoyable years as a Professor at MIT in 2011–2013. He is currently a Professor and the Department Chair at Princeton.

Rodnianski's research interests lie broadly in the subjects of partial differential equations and mathematical physics and, more specifically, in the areas of hyperbolic and dispersive equations and general relativity. He was a recipient of the Clay Fellowship, the Fermat Prize and a Simons Investigator Award.

Response from Igor Rodnianski

It is an incredible honor to join the company of the great mathematicians who have previously won the Bôcher Prize. This is felt even stronger with a realization that this year marks the 100th anniversary of the prize. I am very happy and grateful to share it with my collaborators. I have been very lucky to have worked on and solved, with Frank, Jérémie and Pierre, the two problems mentioned in the citation. One of them, the supercritical Schrödinger problem, is of particular personal significance. I have heard about this problem already in graduate school. Its resolution also became a solution (in the negative) of a conjecture of Jean Bourgain, who had been an inspiring, titan-like figure in the field. The second result on strong singularities in compressible fluids was a major surprise, at least to me, and had given me a delightful experience in the wonderful world of fluids.

I have been very fortunate in my career to enjoy collaborations with many fantastic mathematicians who have had a lasting impact on me and my work. Among those influences was a great tradition in mathematical physics and spectral theory in Saint-Petersburg where I received my undergraduate degree. The work recognized by the prize has the footprints of all of those influences. Finally, I want

to express my appreciation of the Princeton Mathematics Department for its unparalleled scientific environment and also mention Mihalis Dafermos, Lev Kapitanski and Pierre Raphaël, who have not only taught me a tremendous amount but also have been good friends for many years.

Biographical Note

Jérémie Szeftel is currently a senior CNRS researcher at the Laboratoire Jacques-Louis Lions of Sorbonne Université. Following a postdoctoral position at Princeton University and a junior CNRS position at Ecole Normale Supérieure, he joined the Laboratoire Jacques-Louis Lions in 2013. His current research interests concern nonlinear partial differential equations, general relativity, and finite time singularity formation.

Response from Jérémie Szeftel

I am honored to receive the 2023 Bôcher Prize, and delighted to share it with my long-term collaborators Frank Merle, Pierre Raphaël and Igor Rodnianski. I am particularly happy to see Sergiu Klainerman among the impressive list of prestigious previous recipients of the prize, as he has played such an important role in my career from the time I spent as a postdoc in Princeton until today.

I would like to end by thanking my wife Emilie and my two kids Joshua and Elias for bringing joy in my life and for keeping me reasonably balanced.

Credits

Photo of Frank Merle is courtesy of Madame Marie Liesse.
Photo of Jérémie Szeftel is courtesy of Anca Niculin.