

2020 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student



Nina Zubrilina was awarded the 2020 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student at the 126th Annual Meeting of the AMS in Denver, Colorado, in January 2020.



Nina Zubrilina

Citation

The recipient of the 2020 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is Nina Zubrilina, for “her research in the areas of analysis and analytic number theory... characterized by her independent vision, her creativity, and her technical abilities.” She was selected from a list of nominees with stellar accomplishments to their credits. Zubrilina is described as a researcher with unusually mature vision, who has obtained beautiful and surprising results that shocked leading experts in the field. Zubrilina has written six papers and preprints (with more forthcoming), all solo authored, which makes her early contributions to several areas of mathematics all the more impressive. Her published papers appear in *Discussiones Mathematicae* and *Discrete Mathematics*, with further papers under revision at the *International Journal of Number Theory* and the *International Mathematics Research Notices*.

In her earlier works, Zubrilina studied the number of connected components of ranges of divisor functions, and

gave lower and upper bounds for the number of such, for a subclass of divisor-zeta functions with a real parameter. This work has prompted C. Defant to introduce the term “Zubrilina numbers” and to conjecture the infinitude of such. She also addressed part of a conjecture of Grimmer–Strizaker regarding the expected value of maximal bets in the Labouchere system; classified all the pairs of elements of $SL(\mathbb{N}_0)$ whose corresponding Möbius transformations map the right upper half plane into disjoint sets, answering a question of Nathanson; answered two open questions of Kalanc, Tretnik, and Yero concerning the edge dimension of a graph; and found an asymptotic formula for the edge metric dimension of the Erdős–Rényi graph with constant p .

In her most recent work, Zubrilina contributed substantially to the theory of sphere packings. Viazovska’s breakthrough results in dimensions 8 and 24 were based on the properties of the zero sets of the optimal Cohn–Elkies function. Zubrilina focused on properties of the zero sets of optimal Cohn–Elkies functions in other dimensions. In her work, she has proved—under a very plausible regularity hypothesis—a fifteen-year-old conjecture of H. Cohn and N. Elkies regarding the relationship between best known bounds for packing density of spheres in high dimensions and an uncertainty principle for signs of functions. As an expert writes, “This [regularity] hypothesis seems difficult to remove, but Nina’s argument amounts to greater progress than anyone else has made in the last fifteen years, and it

gives the first conceptual reason why the conjecture should be true." The committee felt that Zubrilina's contributions to active research areas were original, numerous, and impactful. Her development as an independent thinker and mathematician shines through her work, which will undoubtedly continue to produce results appreciated by leading experts.

Zubrilina graduated from Stanford University with departmental honors and is now a PhD student in mathematics at Princeton University. She has been awarded the Barry M. Goldwater Scholarship, the Paul and Daisy Soros Fellowships for New Americans, the Hertz Foundation Graduate Fellowship, the NSF Graduate Fellowship, the Princeton Centennial Fellowship, and an honorable mention for the Alice T. Schafer Mathematics Prize.

Biographical Sketch: Nina Zubrilina

Nina Zubrilina grew up in Moscow, Russia. She became interested in mathematics and started participating in math olympiads at an early age, and later attended the math magnet Moscow State High School #57. Nina earned her undergraduate honors math degree at Stanford University. As an undergrad, she participated in the Duluth REU twice and spent a summer at Microsoft Research New England. Nina is currently pursuing a PhD in mathematics at Princeton University. Apart from mathematical research, she enjoys playing music, making films and writing film scores, lifting, and reading.

Response from Nina Zubrilina

It is a great honor and a privilege to receive the 2020 Frank and Brennie Morgan Prize. I want to thank Mrs. Morgan as well as the AMS, MAA, and SIAM for supporting and encouraging undergraduate mathematical education.

I am incredibly grateful to Professor Thomas Church for the colossal work he has done to support me and other underrepresented undergraduates in the Stanford math department. Learning and working with Professor Church was the most rewarding part of my undergraduate career, and his unwavering support and mentorship gave me the desire and confidence to continue doing math in graduate school.

I am very thankful to Joe Gallian for the two wonderful and prolific summers in the Duluth REU, and his continued mentorship over the years. I would like to thank Henry Cohn for a very productive summer at Microsoft Research, and for contaminating me with his deep scientific curiosity about the world. Summer research experience was foundational to my decision to pursue a research career, and I am very thankful to Professor Gallian and Professor Cohn for creating such superb environments to try it out.

I want to thank my advisor Kannan Soundararajan and all my excellent undergraduate professors and mentors, including but certainly not limited to Brian Conrad, Jacob Fox, Persi Diaconis, Daniel Bump, Lenya Ryzhik, Ravi Vakil,

and Simon Rubinstein-Salzedo, as well as my mathematical friends and peers Ann Dmitrieva, Ben Gunby, Colin Defant, Tony Feng, and Levent Alpoge.

I would also like to thank all my educators at the Moscow High School #57, especially to Professors Sergeev, Gordin, and Timashev. The world-class mathematical education I got in this excellent school cemented my fascination with research mathematics.

Lastly, I want to give special thanks to my family. My parents have supported and advised me every step of the way, and I am so very grateful to have them.

Citation for Honorable Mention: Ashwin Sah, Mehtaab Sawhney, and David Stoner

The team of Ashwin Sah, Mehtaab Sawhney, and David Stoner is recognized with an Honorable Mention for the 2020 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by Undergraduate Students for their prolific research collaborations on a wide range of topics in discrete mathematics, ranging from extremal graph theory to combinatorial number theory and discrete geometry. Among the three of them, they have worked on eighteen papers, four of which include all three students as coauthors, and five others have two of the trio as coauthors. Papers have appeared in the *SIAM Journal of Discrete Mathematics*, the *Mathematical Proceedings of the Cambridge Philosophical Society*, and the *Journal of Combinatorial Theory, Series B*, among many others.

In joint work, they found an elegant inequality on the number of independent sets of a graph in terms of the degrees of the vertices of the graph. Using some of the ideas of that paper, they solved several open problems in the area of extremal problems for bounded degree graphs, including maximizing the number of proper q -colorings of a d -regular graph.

Sah and Sawhney are currently undergraduates at the Massachusetts Institute of Technology, expected to graduate in 2020. Stoner graduated from Harvard University and is currently in the PhD program in mathematics at Stanford. Sah has been awarded a Goldwater Scholarship and was a Putnam Fellow, and Stoner was a two-time Putnam Fellow and received the Friends Prize from Harvard and an NSF graduate fellowship.

Biographical Sketch: Ashwin Sah

Ashwin Sah was born and raised in Portland, Oregon. In high school, he won a gold medal at the 2016 International Mathematical Olympiad as a member of the winning US team. Ashwin is currently an undergraduate studying mathematics at the Massachusetts Institute of Technology. Other than combinatorics, Ashwin is also interested in pursuing analytic number theory and Fourier analysis.

Beyond math, Ashwin spends his time helping organize math contests and participating in the effective altruism

community. He is also interested in economics, game theory, and artificial intelligence.

Biographical Sketch: Mehtaab Sawhney

Mehtaab Sawhney grew up in Commack, New York. He is currently an undergraduate studying mathematics at the Massachusetts Institute of Technology. In addition to combinatorics, Mehtaab is interested in statistics and probability.

Outside of math, Mehtaab enjoys playing table tennis, playing poker, and watching classic Hollywood movies. He is also interested in economics, theoretical machine learning, and finance.

Biographical Sketch: David Stoner

David Stoner grew up in suburban Aiken, South Carolina. As a high schooler, he won a gold medal at the 2015 International Math Olympiad as part of the winning US team. David received his AB in mathematics and SM in computer science from Harvard University, where he graduated summa cum laude and Phi Beta Kappa. During his undergraduate years, David published joint papers in combinatorics at the Cornell and Duluth REUs.

Currently, David is enrolled in the math PhD program at Stanford University. He plans to continue his studies in combinatorics there. Outside of mathematics, David also enjoys puzzles, competitive gaming, and graphical art.

Response from Ashwin Sah, Mehtaab Sawhney, and David Stoner

It is a tremendous honor to receive Honorable Mention for the 2020 Frank and Brennie Morgan Prize. We extend our deepest gratitude towards Mrs. Morgan and the AMS, MAA, and SIAM for promoting and supporting undergraduate mathematical research. We would also like to sincerely thank two of our research mentors, Professor Yufei Zhao from the MIT math department and Professor Joseph Gallian from the Duluth REU, who have each been instrumental in our mathematical endeavors.

Ashwin Sah would like to thank his older brother Varun for support in all his pursuits and to thank Dr. John Gorman for playing a key role in guiding him towards higher mathematics. He also thanks Professor Ken Ono and Professor Jesse Thorner for their mentorship and support at the 2019 Emory REU.

Mehtaab Sawhney would like to thank Mr. Robert Minott, Mrs. Barbara Gerson, and Mr. Richard Kurtz for helping cultivate an interest in mathematics and research more broadly. He also thanks Dr. Per Alexandersson and Professor Jonathan Weed for their mentorship in his initial steps into research, especially in their guidance regarding how to broadly approach mathematical research.

David Stoner would first like to thank his older brothers Ben and Michael for being his earliest math teachers and

for motivating him to pursue his passions at an early age. He also thanks Richard Rusczyk for his helpful guidance when David was first learning about research, and Professor Florian Frick for his mentorship at the 2016 Cornell REU. Mehtaab and David both thank Richard Moy for his assistance in their collaboration at Duluth.

Finally, and most importantly, we would each individually like to thank our parents for their incredible support and encouragement all along our mathematical adventures.

Citation for Honorable Mention: Murilo Corato Zanarella

Murilo Corato Zanarella is recognized with an Honorable Mention for the 2020 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. He has made important contributions to difficult problems in number theory, specifically to the Iwasawa theory of elliptic curves and to the theory of Kolyvagin systems for conjugate self-dual Galois representations. Zanarella proved Howard's Main Conjecture for many elliptic curves, and showed that the primitivity of the Heegner point Kolyvagin system is equivalent to Howard's Main Conjecture and the p -indivisibility of the Tamagawa numbers. In his work, he "found something in the well-mined theory of Euler and Kolyvagin systems that had been missed by all the 'experts.'" Zanarella is commended for "his willingness to think deeply about an important problem, to probe the boundaries and the technical details of prior work, and to grapple with obstacles over an extended period of time."

On the basis of this research, Zanarella was awarded the Middleton Miller Prize at Princeton University for the best independent work. He also received the Class of 1861 Special Prize from Princeton University. He graduated from Princeton with highest honors in mathematics and is currently a PhD student at MIT.

Biographical Sketch: Murilo Corato Zanarella

Murilo Corato Zanarella was born in Brazil and raised in the countryside of São Paulo. During middle and high school, he represented his country in several international mathematics olympiads. He then attended Princeton University, where he received an AB in mathematics, graduating with highest honors. His undergraduate studies motivated him to further pursue research in mathematics, and he is currently a PhD student at MIT. His interests are in number theory and arithmetic geometry, and especially in the study of the arithmetic of elliptic curves and abelian varieties.

Besides research, Murilo is also passionate about teaching. He was recognized by Princeton's computer science department for his service as a course assistant and consistently helps with the preparation of Brazil's team for the International Mathematics Olympiad.

Response from Murilo Corato Zanarella

It is an honor and privilege to receive Honorable Mention for the 2020 AMS-MAA-SIAM Frank and Brennie Morgan Prize. I am grateful to Mrs. Morgan, the AMS, MAA, and SIAM for promoting undergraduate research in mathematics.

I am extremely thankful to Professor Chris Skinner for the countless hours of advisement throughout my undergraduate years. He was exceedingly kind and caring, and his commitment to promoting undergraduate research at Princeton is remarkable. I would also like to thank Professor Francesc Castella for advising my junior paper and for all his generosity. They both played pivotal roles in my undergraduate [program], and have been great sources of inspiration. I extend thanks to my Princeton professors and the mathematical community there, and in particular to Daniel Kriz for his patience on answering many of my questions. Finally, I thank my family and friends for their enduring support.

About the Prize

The Morgan Prize is awarded annually for outstanding research in mathematics by an undergraduate student (or students having submitted joint work). Students in Canada, Mexico, or the United States or its possessions are eligible for consideration for the prize. Established in 1995, the prize was endowed by Mrs. Frank (Brennie) Morgan of Allentown, Pennsylvania, and carries the name of her late husband. The prize is given jointly by the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) and carries a cash award of US\$1,200.

Recipients of the Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2020 prize, the members of the selection committee were:

- Giuliana P. Davidoff
- Tamas Forgacs
- Nathan Louis Gibson
- Wei Ho (Chair)
- V. Kumar Murty
- Catherine Sulem

A list of previous recipients of the Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student may be found on the AMS website at <https://www.ams.org/morgan-prize>.

Credits

Photo of Nina Zubrilina is courtesy of Nina Zubrilina.

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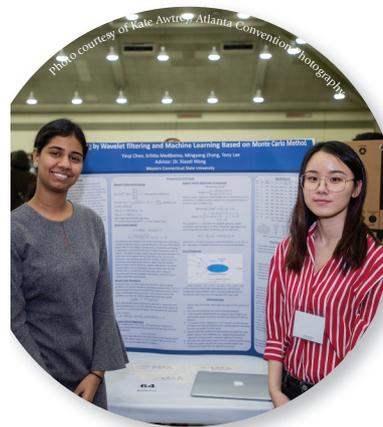
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