jmm 2023 Joint Mathematics Meetings

Boston • January 4–7

# Prizes and Awards

4:25 PM, Wednesday, January 4, 2023

# Program

**Opening**
Ruth Charney, American Mathematical Society

**Joan & Joseph Birman Research Prize in Topology and Geometry**
Association for Women in Mathematics

**Mary & Alfie Gray Award for Social Justice**
Association for Women in Mathematics

**Dissertation Prize**
Association for Women in Mathematics

**Louise Hay Award for Contribution to Mathematics Education**
Association for Women in Mathematics

**M. Gweneth Humphreys Award for Mentorship of Undergraduate Women in Mathematics**
Association for Women in Mathematics

**Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman**
Association for Women in Mathematics

**Alexanderson Award**
American Institute of Mathematics

**Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student**
American Mathematical Society
Mathematical Association of America
Society for Industrial and Applied Mathematics

**JPBM Communications Award**
Joint Policy Board for Mathematics

**Doug Faires Award**
Consortium for Mathematics and its Applications

**ILAS Invited Address**
International Linear Algebra Society

**Bôcher Memorial Prize**
American Mathematical Society

**Frank Nelson Cole Prize in Number Theory**
American Mathematical Society

**Levi L. Conant Prize**
American Mathematical Society

**Mary P. Dolciani Prize for Excellence in Research**
American Mathematical Society

**Joseph L. Doob Prize**
American Mathematical Society

**Leonard Eisenbud Prize for Mathemaitcs and Physics**
American Mathematical Society

**Award for an Exemplary Program or Achievement in a Mathematics Department**
American Mathematical Society

**Award for Impact on the Teaching and Learning of Mathematics**
American Mathematical Society

**Award for Mathematics Programs that Make a Difference**
American Mathematical Society

**Ruth Lyttle Satter Prize in Mathematics**
American Mathematical Society

**Leroy P. Steele Prize for Mathematical Exposition**
American Mathematical Society

**Leroy P. Steele Prize for Seminal Contribution to Research**
American Mathematical Society

**Leroy P. Steele Prize for Lifetime Achievement**
American Mathematical Society

**Closing**
Kathryn Leonard, AWM

# JOAN & JOSEPH BIRMAN RESEARCH PRIZE IN TOPOLOGY AND GEOMETRY

THE Executive Committee of the Association for Women in Mathematics established the AWM Birman Research Prize in Topology and Geometry in 2013. First presented in 2015, this prize is awarded every other year. The purpose of the award is to highlight exceptional research in topology/geometry by a woman early in her career.

The AWM Joan & Joseph Birman Research Prize in Topology and Geometry serves to highlight to the community outstanding contributions by women in the field and to advance the careers of the prize recipients. The award is made possible by a generous contribution from Joan Birman whose work has been in low dimensional topology and her husband Joseph who is a theoretical physicist whose specialty is applications of group theory to solid state physics.

## CITATION

**Kristen Hendricks**

The 2023 Joan & Joseph Birman Research Prize in Topology and Geometry is awarded to Kristen Hendricks for her highly influential work on equivariant aspects of Floer homology theories.

Professor Kristen Hendricks' work in low-dimensional and symplectic topology has revolutionized the understanding of equivariant aspects of Floer theories, allowing powerful equivariant techniques to be used to solve classical, non-equivariant problems. Hendricks' pioneering work on involutive Heegaard Floer homology has had wide-ranging applications, particularly to questions that straddle the border between 3- and 4-dimensional topology. The impact of her contributions to the understanding of homology cobordism groups, and to the closely related subject of knot concordance, has been profound. Hendricks' work has also opened new doors in the realm of symplectic topology, where her work with collaborators introduced one of the first general constructions of equivariant Floer homology.

Kristen Hendricks received her PhD in 2013 from Columbia University. She was a Hedrick Assistant Adjunct Professor at UCLA from 2013 to 2016, and an Assistant Professor at Michigan State University from 2016 to 2019 before joining

the faculty at Rutgers University, where she is currently an associate professor. Hendricks is the recipient of both an NSF CAREER award and a Sloan Research Fellowship.

***Response from Kristen Hendricks***

I am very honored to be selected for the Birman Prize. Joan Birman was a great inspiration to me while I was fortunate enough to interact with her as a graduate student at Columbia, and my appreciation and respect for her achievements has only increased as my perspective has matured. I'm also delighted to have my name on the same list as the previous prize winners, all of whom I hold in great esteem.

I am greatly indebted to many excellent mentors, most especially my first undergraduate professor Tom Coates, my primary graduate adviser Robert Lipshitz, and my postdoctoral supervisor Ciprian Manolescu. I am also grateful to both my former colleagues at Michigan State and my current colleagues at Rutgers for their unfailing supportiveness. I appreciate deeply the tremendous number of intellectually stimulating relationships I've been fortunate enough to have with my many excellent collaborators and other mathematical friends, far too many to name here; the topology and geometry community has been extremely good to me, and I hope to live up to its high standards of mathematical generosity and collegiality. The past years have been very exciting in our corner of mathematics and I'm enthusiastic to find out what comes next with all of you.

# MARY & ALFIE GRAY AWARD FOR SOCIAL JUSTICE

THE Executive Committee of the Association for Women in Mathematics established the Mary & Alfie Gray Award for Social Justice to reward the vigorous and imaginative application of the mathematical sciences to advancing the cause of social justice, defined as promoting a just society by challenging injustice and valuing diversity. Social justice exists when all people share a common humanity and therefore have a right to equitable treatment, support for their human rights, and a fair allocation of community resources.

## CITATION

**Lily Khadjavi**

The inaugural AWM Mary & Alfie Gray Award for Social Justice is presented to Lily Khadjavi, Professor of Mathematics at Loyola Marymount University. The Award recognizes Khadjavi as a mathematician whose career has been defined by the multifaceted, vigorous, and imaginative pursuit of social justice in her state, classrooms, profession, and beyond. Khadjavi's work has empowered and inspired, changing public policy around racism in policing, equipping students and educators to seek social justice in and beyond the classroom with mathematics, and leading efforts to make mathematics more inclusive and equitable.

Dr. Lily Khadjavi's vigorous and imaginative work for social justice as a mathematician, educator, and activist has made a concrete and significant difference for multiple communities and has played a major role in shaping how mathematicians approach social justice today. Khadjavi's creative and insightful applications of mathematics to social justice have demonstrated how mathematics can serve the causes of justice and equality in our wider societies and how a concern for these values can profoundly enrich mathematics classrooms and the mathematical community.

In 2006, long predating the recent surge in work on data and statistics for racial justice, Khadjavi's article, "Driving While Black in the City of Angels," showed the power of carefully and critically examining the right questions with the right data and right mathematical tools. Tellingly, the article starts with the lived experiences of minoritized people, commonly referred to as "driving while black" to describe racially biased policing. The piece demonstrates how to combine

mathematical methods of data analysis with rich and nuanced engagement with law, sociology, politics, and the varieties of human experience to give a compelling account of an injustice.

Khadjavi's innovative uses of public data related to social justice have been at the core of her long-running interventions in mathematics education. In her own teaching practice, in training educators through Project NExT, and in the rich collections of resources she has made available (including two co-edited books), Khadjavi has helped move project-based social justice mathematics toward the center of the curriculum in many more universities than her own. This has helped to make mathematics more inclusive and relevant, making lessons meaningful to students who might not have seen themselves in mathematics and making all mathematics students aware of how the skills they are learning matter for understanding and improving the world around them.

From her own student days to the present, Khadjavi has been an active contributor and leader in programs and organizations that support minoritized mathematics students and researchers. She was one of the founders of Spectra, an organization that has greatly increased the visibility and inclusion of LGBTQ+ mathematicians, and has had pivotal roles for the Infinite Possibilities Conferences and other activities to support and promote mathematicians of color. These efforts have affirmed the essential connection between mathematics for social justice and justice within the mathematics community.

***Response from Lily Khadjavi***

I am deeply honored to receive the inaugural Mary & Alfie Gray Award for Social Justice. The Grays' commitment to a just society has played an instrumental role both within the profession of mathematics and well beyond it. For me Mary Gray has been an animating force, through her intertwining of statistics and the law and indeed through her spirited determination.

I would like to take this opportunity to thank my department colleagues and institution, Loyola Marymount University, for critical support that allowed me to participate in law conferences and other venues which were not traditional for mathematicians. This broad view of scholarly activity has been tremendously enriching and necessary. I am indebted to legal scholar Kaaryn Gustafson for introducing me to LatCrit. For always stimulating connection, I have been extremely lucky to collaborate with David Greenberg and Gizem Karaali.

Finally, I would especially like to thank those working to broaden participation in the profession. These efforts are of fundamental importance. I am grateful to Tanya Moore and Kimberly Weems who introduced me to the Infinite Possibilities Conference. Collaborating with them continues to inspire me.

# DISSERTATION PRIZE

In January 2016 the Executive Committee of the Association for Women in Mathematics established the AWM Dissertation Prize, an annual award for up to three outstanding PhD dissertations presented by female mathematical scientists and defended during the 24 months preceding the deliberations for the award. The award is intended to be based entirely on the dissertation itself, not on other work of the individual.

## CITATION

**Jia Shi**

Jia Shi received her PhD in 2022 at Princeton University under the direction of Professors Charles Fefferman and Javier Gomez-Serrano. She is currently a C.L.E. Moore instructor at the Massachusetts Institute of Technology.

Shi's interests include Fluid Mechanics and Partial Differential Equations. Her beautiful thesis proves major results on two separate topics in fluid mechanics, a hard classical field. One part of the thesis concerns uniqueness and analyticity of solutions of the Muskat equations describing the interface between two incompressible fluids in a porous medium. She studied the case when the fluids have the same viscosity but different densities. The other part of the extensive thesis deals with the 2D Euler equation. The results in the thesis settle several open questions about spherically-rotating solutions and vortex sheets. The committee was impressed with the new techniques Shi developed to obtain her results. As one of the letter writers said, her work "changed our view of solvability by introducing a new general strategy and applying that strategy with technical virtuosity."

***Response from Jia Shi***

I am very honored to receive the AWM Dissertation Prize. I would like to show my gratitude to those who nominated me and wrote letters for me. I also gratefully appreciate all the help from my advisors Charles Fefferman and Javier Gomez-Serrano during my graduate school years. I feel extremely fortunate as their student and incredibly thankful for their guidance and generosity. I also sincerely thank my wonderful collaborators Yao Yao and Jaemin Park.

## CITATION

**María Soria-Carro**

María Soria-Carro received her PhD in 2022 from the University of Texas at Austin under the direction of Luis Caffarelli and co-direction of Pablo Raúl Stinga. She is currently a Hill Assistant Professor at Rutgers University working with Dennis Kriventsov and Yanyan Li.

Soria-Carro works in the field of elliptic and parabolic partial differential equations. Her dissertation covers two topics. In the first part, she studies the transmission problem for elliptic equations, for example, the Lapacian with interfaces that have minimal regularity. In this, she and collaborators proved optimal regularity of solutions up to the interface via a perturbation method. This is in contrast to the classical theory where the interface is smooth. In the second part of her thesis, she uses tools from convex analysis and symmetrization to study problems related to the nonlocal Monge-Ampere equations. In particular, she shows existence, uniqueness, and regularity of solutions to a particular Poisson problem. The committee was impressed with the enthusiasm of her nomination letter and letter writers, which described her ambition and the creativity of solutions in the thesis.

***Response from María Soria-Carro***

I am very honored and thrilled to receive the AWM Dissertation Prize. I would like to thank the Association of Women in Math for this prestigious award and The University of Texas at Austin, where I had the great opportunity to learn from leading experts in Analysis and PDEs. I am deeply grateful for all the guidance and support I had during Graduate School. I would like to especially thank my advisor, Luis Caffarelli, for being caring, encouraging, and teaching me the beauty of mathematics from a whole new perspective, and my co-advisor, Pablo Raúl Stinga, for all the help and advice, and for sharing with me all of his expertise. Thank you to Irene Gamba and Donatella Danielli for inspiring and supporting me and my work. Finally, I am very thankful to my family and friends for all the love and support.

## CITATION

**Rajula Srivastava**

Rajula Srivastava received her PhD from University of Wisconsin, Madison in 2022, under the supervision of Andreas Seeger. She is currently a Hirzebruch Research Instructor at the University of Bonn and the Max Planck Institute for Mathematics.

Srivastava's research is in harmonic analysis. Her dissertation, "Three Topics in Harmonic Analysis: Maximal Functions on Heisenberg Groups, Cotlar-type Theorems and Wavelets on Sobolev Spaces," as the title suggests, covers a

broad range of topics. Two of the chapters address the problem of establishing optimal Lebesgue space estimates for local maximal averaging operators on Heisenberg groups. In another chapter, Srivastava determines the range of smoothness of Sobolev spaces for which there exists an unconditional basis of orthonormal spline wavelets of a given order. In yet another part of the dissertation she provides $L^p$ bounds for a Cotlar-type maximal operator under minimal smoothness assumptions. The results have led to four publications in research journals, three of which are single-authored.

***Response from Rajula Srivastava***

I am elated to receive the award. I thank the mentors who wrote the letters of nomination and support, and the AWM and the selection committee for this honor. I remain indebted to my advisor, Andreas Seeger, for his unwavering patience and encouragement, and the opportunity to learn from his brilliant mathematical insight. He has been unbelievably generous with his time and resources throughout my PhD. I wish to thank Betsy Stovall for her deep influence; and Sundaram Thangavelu and Varadharajan Muruganandam for their continued investment in my progress. I am thankful to Joris Roos for a stimulating collaboration which forms a part of the thesis, and to the Harmonic Analysis group at UW-Madison for a collegial learning environment. Finally, I wish to thank my family and friends for their support; in particular, I am grateful to Niclas Technau for his constant companionship.

# LOUISE HAY AWARD FOR CONTRIBUTION TO MATHEMATICS EDUCATION

THE Executive Committee of the Association for Women in Mathematics (AWM) established the Louise Hay Award for Contribution to Mathematics Education in 1990. The purpose of this award is to recognize outstanding achievements in any area of mathematics education, to be interpreted in the broadest possible sense. While Louise Hay was widely recognized for her contributions to mathematical logic and for her strong leadership as head of the Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago, her devotion to students and her lifelong commitment to nurturing the talent of young women and men secure her reputation as a consummate educator. The annual presentation of this award is intended to highlight the importance of mathematics education and to evoke the memory of all that Hay exemplified as a teacher, scholar, administrator, and human being.

## CITATION

**Nicole Joseph**

The Association for Women in Mathematics is pleased to announce the 2023 Louise Hay Award to Nicole Joseph, Associate Professor of Mathematics Education at Vanderbilt University. Joseph is being honored for contributions to mathematics education that reflect the values of taking risks and nurturing students' academic talent that are central to Louise Hay's legacy.

Professor Nicole Joseph's research is centered on the experiences and narratives of Black girls and women in STEM. Through an impressive record of publications, in journals such as *Teachers College Record*, *Journal for Research in Mathematics Education* and *the Review of Educational Research*, and a vast number of keynote addresses and invited talks, to national organizations and societies such as the Mathematical Sciences Research Institute (MSRI), and the Clemson University Women in Mathematics Lecture Series, Joseph has elevated the importance of this topic and widened the field's understanding of the complex and intersectional nature of educational inequity, opportunity and access. As one of her recommenders stated, Joseph's research exhibits, "scholarship in action". In other words, Joseph both investigates hard and retracted questions while doing the work necessary to undo these patterns. Joseph is the founder of an interdisciplinary research collective at Vanderbilt, titled "Intersectional Study of

Black Women and Girls in Society." This collective was supported by a $200K internal award and centers Black women's and girls' experiences to interrogate as well as dismantle structural barriers across different sectors of society, including STEM educational contexts. Within this research collective, Joseph organized the March for Black Women in STEM, a space for multiracial and intergenerational solidarity to increase the visibility of racial-gendered oppression and agency among Black women in STEM.

Joseph founded the Joseph Mathematics Education Lab (JMEL). A brain child of Joseph, the Lab meets weekly to support academic and scholarly endeavors as well as the overall well-being of Black girls and women in the field of mathematics. The Lab includes 15 scholars across the undergraduate, graduate, doctoral and postdoctoral trajectories emanating from institutions across the nation. Under her leadership, mentorship and service, members of the lab have themselves applied for and received grants and published their research alongside Joseph. JMEL is an innovative initiative that resists Black women's limited access to research leadership in mathematics and to their silenced voices in the academy.

Joseph pushes on boundaries, seeking to enlighten the field's understanding and responsiveness to an ever-pressing challenge of understanding and improving the opportunities for Black girls and women in mathematics. Joseph's work exemplifies the goals and priorities of the Hay Award.

***Response from Nicole Joseph***

I am deeply honored to join the list of distinguished awardees, including Dr. Virigina Warfield from the University of Washington, who was on my dissertation committee. Throughout my career I have aimed to carry out similar commitments as Louise Hay, specifically related to mentorship, advocacy, and leadership. I started this journey as a young Black girl who found herself in advanced mathematics courses in middle and high school alone…no one else looked like me….and that was a problem. I was young and did not have the words, but I knew as a young person that it was not right to not have other students in mathematics that looked like me.

I am a Black girl cartographer in the field of mathematics education; this means that I care about the well-being, outcomes, and learning experiences of Black girls and women. Through my scholarship, teaching, and service, my goal is to elevate Black women and girls and their stories of mathematics learning because they are worth telling. Few mathematics education researchers focus on the intersectional experiences of Black girls and women—their identities are multiplicative and complex—how they show up in mathematics contexts is different and unique from Black boys and White girls. It is important to me to close the gap between theory and practice…I want to impact real students and

their families. There is so much still to do to support Black girls and women in mathematics. We need more research—both critical quantitative and qualitative studies to better understand their experiences. I include more examples of what mathematics instructors can do to better support Black women and girls in mathematics in my new book, published by Harvard University Press, *Making Black Girls Count in Math: A Black Feminist Vision of Transformative Teaching* (https://www.hepg.org/hep-home/books/making-bla ck-girls-count-in-math-education). It gives me hope that the AMW committee recognized my work in this important way. I am grateful to the selection committee and the AWM for this tremendous honor.

# M. GWENETH HUMPHREYS AWARD FOR MENTORSHIP OF UNDERGRADUATE WOMEN IN MATHEMATICS

THE award is named for M. Gweneth Humphreys (1911–2006). Professor Humphreys graduated with honors in mathematics from the University of British Columbia in 1932, earning the prestigious Governor General's Gold Medal at graduation. After receiving her master's degree from Smith College in 1933, Humphreys earned her Ph.D. at age twenty-three from the University of Chicago in 1935. She taught mathematics to women for her entire career, first at Mount St. Scholastica College, then for several years at Sophie Newcomb College, and finally for over thirty years at Randolph–Macon Woman's College. This award, funded by contributions from her former students and colleagues at Randolph–Macon Woman's College, recognizes her commitment to and her profound influence on undergraduate students of mathematics.

## CITATION

**Erika Tatiana Camacho**

The Association for Women in Mathematics is pleased to announce that the 2023 M. Gweneth Humphreys Award will be presented at the Joint Mathematics Meetings to Erika Tatiana Camacho, Fulbright Research Scholar at the Institut de la Vision-Sorbonne Université and Professor of Mathematical & Statistical Sciences at Arizona State University, for impactful and multidimensional mentoring activities that have enabled the success of generations of talented scientists and mathematicians, regardless of race, ethnicity, socio-economic class, family educational history, or gender.

Dr. Erika Tatiana Camacho's impact through mentoring is multidimensional. She has co-directed two undergraduate summer research programs: the Applied Mathematical Sciences Summer Institute (AMSSI) from 2005 to 2007 which she also co-founded, and the Mathematical and Theoretical Biology Institute (MTBI) from 2011 to 2013. Her efforts at AMSSI and MTBI over the years have contributed to over 80 alumni earning their doctorates, the majority being from underrepresented groups. She incorporates students into her own research—she has refereed publications with fifteen undergraduate co-authors—and spends countless hours mentoring students and faculty one-on-one. Her reach does not end at the University level, as she also finds time to speak to middle school and high school students about their education.

Camacho currently holds positions as a Fulbright Research Scholar at the Institut de la Vision-Sorbonne Université and as Professor in the School of Mathematical & Statistical Sciences at Arizona State University. On July 29, 2022 she ended an impressive three-year rotation at NSF where she created and contributed to impactful initiatives dedicated to equity, diversity, and inclusion as Co-lead of the HSI Program and Program Officer of the ADVANCE, Racial Equity in STEM Education, and HSI Program. She has a PhD in Applied Mathematics from Cornell University and is an accomplished researcher in the field of Mathematical Biology.

In addition to her one-on-one work with students, Dr. Camacho has facilitated changes to the mathematical profession to promote inclusion. As a member of the Society for Industrial and Applied Mathematics (SIAM) Diversity Committee, she co-founded the Workshop Celebrating Diversity that has been held at the SIAM Annual Conference each year since 2008. She has also served as a member of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) Math Task Force and Board of Directors as well as the AMS Council and NIMBioS Advisory Board. Her efforts have led to significant grant support for students, women, early career faculty, and mentees to further their mathematical aspirations.

Erika Tatiana Camacho's efforts have truly enabled the success of generations of talented scientists and mathematicians, regardless of race, ethnicity, socio-economic class, family educational history, or gender. The AWM is pleased to honor Dr. Camacho for her exceptional success in mentoring and her impact on the mathematical profession.

***Response from Erika Tatiana Camacho***

Thank you for this honor that validates the intentional and thoughtful mentoring in mathematics we have received and given over the years. I would like to thank the mentors who have influenced my career path and the hundreds of students and mentees that I have had over the years and who have allowed me to be part of their journey. It has been a true pleasure to get to know my mentees, affect their lives, and see them rise to become great scientists. In the process of mentoring I have transformed the lives of many of them but they all have also greatly transformed my life, as I have learned so much from them.

For me, mentoring is very personal. I have been a benefactor of it but I also did not have good mentoring at many steps along the way. During my career path, there have been so many times that I was ready to walk away and I would have done it if it wasn't for the very few mentors and friends that encouraged me to stay. I went through a prolonged period where a supposed key mentor mentored me selfishly in ways that would promote him at the expense of my success and advancement. It was over these painful years that I realized the importance of

selfless mentoring and that not all mentors do this. When I started to mentor, it was because I wanted to be the mentor at key places and critical stages of an individual's academic path, where I, myself, didn't have a good mentor and felt lost and powerless. Mentoring is an invisible work that often goes unnoticed. Building the scientific capacity to advance science requires developing the human capital and the workforce to carry the scientific enterprise as much as the intellectual aspect of it. Many times we forget that we need to develop the scientists to move forward theories and instead we focus only on the science innovation part and forget that we need a substantial number of scientists ready to undertake complex problems. Most importantly, we need to have all the different perspectives and experiences on the table to be able to tackle a complex problem from every angle and arrive at an optimal solution. I really thank the AWM for recognizing this important work of individuals that work tirelessly and selflessly to mentor. Only through efforts that recognize excellent mentoring are we going to make mentoring and the creation of scientists a key aspect of advancing science.

# ALICE T. SCHAFER PRIZE FOR EXCELLENCE IN MATHEMATICS BY AN UNDERGRADUATE WOMAN

IN 1990, the Executive Committee of the Association for Women in Mathematics (AWM) established the Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman. The prize honors Alice T. Schafer (1915–2009), one of the founders of AWM and its second president, who contributed greatly to women in mathematics throughout her career.

## CITATION

**Faye Jackson**

Faye Jackson is a math major at the University of Michigan. She has made impressive contributions in research, course work and engagement with her community. In Summer 2021 she participated in the SMALL REU at Williams College and played a major role in four different research projects. This work led to one published paper, one accepted paper, three submitted preprints and two papers in preparation. Her mentor praises her creativity, generosity and the clarity of her exposition. In Summer 2022 she participated in the REU at the University of Virginia and co-authored two submitted papers. Her mentor praised the beauty of her work and her impressive contributions to the life of the community.

Faye's instructors are similarly enthusiastic about her abilities and enthusiasm, and they describe her as a delight to have in class who helps spark important discussions. They are particularly excited about her contributions to outreach, and they describe her as a talented teacher for the Math Mondays in Ypsi, Super Saturday and Math Corps programs.

***Response from Faye Jackson***

First of all, it is a great honor to have been selected for the Alice T. Schafer Prize and I would like to thank the Association for Women in Mathematics for sponsoring this award and for supporting women mathematicians.

The mathematical community at the University of Michigan has influenced my understanding of mathematics as well as what it means to be a mathematician more deeply than I can express with words. The vibrancy, inclusivity, and collaborative spirit which characterizes the community there has made my past

four years incredible. This is in no small part due to a few key professors. I am quite blessed to know Professors Sarah Koch and Stephen DeBacker, who have molded that community by pouring their souls into it. Their passion for teaching and outreach is constantly inspiring. They have also been incredible mentors to me in both my finest and my worst moments. I would not be where I am without them. Sarah Koch's dynamism in particular sparks my excitement for mathematics whenever I am around her, and Stephen DeBacker provides me with the space and the resources to pursue whatever idea I have towards improving the department community. I would also like to thank Professor Jenny Wilson, who fostered my love of algebraic topology during an especially difficult academic year over Zoom. Her clear teaching style and love for the subject was not hampered in the slightest by these conditions.

I am deeply grateful for Professor Steven J. Miller, who has been a key mentor for me since I attended the SMALL REU in 2021. He is so deeply dedicated to his students that it astounds me, and he has pushed me to show the same dedication to my students and also to my work. As I constantly tell him, his advice is invaluable. Furthermore, the REU showed me how incredible mathematical research can be, and I would like to thank the entire cohort of the SMALL 2021 REU. I would also like to thank Professor Ken Ono for showing me the beauty of number theory. Through the University of Virginia REU I grew immensely as a researcher, and developed an appreciation for a field of mathematics which had previously been foreign to me. I would like to thank my cohort at the Virginia REU as well. I would specifically like to thank my coauthor Misheel Otgonbayar, whose brilliance and kindness continually astounded me throughout the program, and who made me laugh more times than I could count. I would also like to thank my roommate Catherine Cossaboom, who provided me with invaluable support whenever I was at my wit's end with my research or when I was struggling personally.

Finally, I would like to thank my family for their love and support throughout my college career. Specifically, my mother's sense of service has extended to my passion for outreach, and I would not be who I am without her. Likewise, my father's dedication to his work and to other people always astounds me. I would also like to thank my partner, Cassandra Prokopowicz, for supporting me for the past four years. Whether I am on top of the mountain after conquering a problem or at the bottom of it after falling from the cliffs, she has always been there for me, and that has allowed me to achieve so much.

## CITATION

### Anqi Li

Anqi Li is a math major at Massachusetts Institute of Technology. She has participated in three summer research experiences. The first was the NYC

Discrete Math REU at Baruch College, City University of New York. In that summer she wrote a paper that has been accepted by the *European Journal of Combinatorics*. In Summer 2021 she participated in the MIT Math Summer Program in Undergraduate Research and coauthored a paper her mentor describes as remarkable work. This paper was recognized as the top project from the summer program. In Summer 2022, Anqi participated in the REU at the University of Minnesota Duluth leading to three more papers in preparation. In addition to these summer projects, Anqi has sought out research experiences during the academic year and has two current projects with faculty at MIT.

Anqi's mentors praise her for deeply understanding challenging material, for asking insightful questions and for a willingness to try anything. They describe working with her as like working with an advanced graduate student.

***Response from Anqi Li***

It is an honor to be recognized by the Association for Women in Mathematics for the Alice T. Schafer prize. I would like to thank the Association for their support of early career women researchers and their important work in promoting gender representation in mathematics.

I am deeply grateful for the guidance of my mentors, who have shaped me into the student and researcher I am today. I would like to start by thanking Prof. Yufei Zhao for his unwavering guidance throughout my mathematics journey at MIT and his many insights into academia and beyond. I am also sincerely grateful for the opportunity to work under the patient mentorship of Prof. Lisa Sauermann, who has been one of my biggest role models as a woman mathematician. I also draw deep inspiration from the fruitful conversations I have had with my research collaborators and professors, and in particular thank Prof. Dor Minzer for our many intellectually stimulating discussions and his influence on my current research directions.

I also extend my gratitude to the numerous other faculty I have interacted with over the years, including Prof. Henry Cohn and Prof. Davesh Maulik, as well as my postdoc and graduate student collaborators who constantly inspire me to reach greater heights. I am also thankful for opportunities through the CUNY Baruch Combinatorics REU, MIT Summer Program in Undergraduate Research+ (SPUR+) and University of Minnesota Duluth REU, which were instrumental in shaping my research interests in combinatorics. I would especially like to acknowledge Prof. Adam Sheffer for getting me started on my university research journey.

Last but not least, I would like to express my deepest appreciation to my loved ones, whose unconditional support motivates me every day.

## CITATION

### Ilani Axelrod-Freed

Ilani Axelrod-Freed is a mathematics major at MIT. They have participated in three REUs in Duluth, Minnesota Twin Cities, and New York Discrete Math. The topics of their research projects span combinatorics and discrete geometry. They have an impressive single-author publication stemming from one of these REUs and published in Enumerative Combinatorics and applications, and another joint paper with a mentor accepted in Discrete & Computational Geometry. In one of these REUs, Ilani worked on three different research projects and impressed their mentors with their ability to balance their time between them.

Ilani is also praised as a very active contributor to collaborative meetings, including online ones during the pandemic. Their mentors praised their oral and written mathematical communication skills as demonstrated by their presentations during the REUs as well as their strong coursework.

#### *Response from Ilani Axelrod-Freed*

I would like to thank the AWM for supporting underrepresented genders in mathematics. Thanks to Professor Alexander Postnikov for introducing me to mathematics research at MIT, Professor Joseph Gallian for making Duluth the amazing REU and community that it is, Professor Pablo Soberón for his supportive mentorship and collaboration, and thank you to all my incredible mentors at the Twin Cities REU who made me so excited to do math every day. I would like to thank HCSSiM for sustaining my love of math and introducing me to the mathematics community in high school. I would like to thank all my friends who have worked on math problem sets and research with me and who listen patiently to my excited rambles about my latest proofs. Finally, eternal gratitude to my parents for their endless support, particularly to my dad for giving me exciting math problems ever since I was young that always inspire me to keep learning more.

## CITATION

### Joye Chen

Joye Chen is a senior mathematics major at Princeton University. She participated in the SMALL REU during the summer of 2022 where she worked on hyperbolic knot theory and coauthored three publications (two already on ArXiv and one in preparation). Joye contributed significantly in proving several key results on hyperbolic knotoids and generalized knotoids, in particular giving a complete classification of hyperbolic alternating links in thickened surfaces-with-boundary. Her instructors are impressed by her dedication to conveying these ideas through developing a deep understanding of the material.

As well as conducting research during her time at the SMALL REU, Joye has excelled in becoming familiar with modern topics in topology and has taken several graduate courses, including ones on algebraic topology and Knot Floer and Khovanov homologies. In previous summers, she also worked on reading courses in representation theory, Lie algebras, and grid homology. She is consistently described as working at a graduate student level with impressive initiative to develop her own knowledge and understanding. In addition, Joye previously served as the advising co-chair of the Princeton Math Club and currently serves as a Peer Math Advisor.

***Response from Joye Chen***

It's an honor to be selected as a Schafer Prize Honorable Mention. I am deeply indebted to the many, many people who inspired me and supported me along my mathematical development. In particular, I want to thank Prof. Colin Adams for his mentorship and enthusiasm for hyperbolic 3-manifolds, as well as my collaborators at SMALL for many insightful conversations. I'm also immensely grateful to Prof. David Gabai, Prof. Ian Zemke, and Prof. Ozsváth for their invaluable guidance and encouragement, and to my peers at Princeton for their constant support and presence in the Fine Common Room. Many thanks to the PROMYS program and to my UIL teachers, Mr. John Biros and Ms. Dawn Geshwender, for getting me started. And lastly, thank you to my family for their unconditional love.

## CITATION

**Veronica Lang**

Veronica Lang is a mathematics major at Smith College. She has participated in an REU program at the University of Minnesota–Twin Cities and has engaged in research at Smith College as well. Veronica is interested in a variety of mathematical research topics spanning algebra, combinatorics, and topology. Her research work led to two papers that are in preparation for submission, with potential follow-up results. Her work was described as independent by all of her mentors, and comparable to the level of graduate students and even postdocs.

Veronica has also excelled in advanced courses in different topics and pursued graduate-level coursework through final projects and independent study. Her mentors praised her creativity in research as well as her oral and written mathematical communication skills. She is described as "more of a colleague than a student" by her mentors, and is particularly recognized for being able to work with people from diverse backgrounds and form effective teams.

***Response from Veronica Lang***

Thank you to the AWM for celebrating women in math and to the professors and students who make the Smith math and physics communities so supportive. I am

particularly indebted to Professor Julianna Tymoczko for introducing me to math research, and to Professors Pau Atela, Patricia Cahn and Christophe Golé for their wonderful advice and teaching. I also want to thank the University of Minnesota, Twin Cities REU for an amazing summer research experience. I am especially grateful to my mentors Sarah Brauner and Claire Frechette, TAs Patty Commins and Carolyn Stephen, and student collaborators Ilani Axelrod-Freed and Judy Chiang for being spectacular mathematicians and human beings to work with. Finally, I would like to thank my family and non-mathematician friends for their support and for acting impressed when I say the word “eigenvector”.

# AIM ALEXANDERSON AWARD

THE ALEXANDERSON AWARD recognizes an outstanding scholarly article arising from research activities sponsored by the American Institute of Mathematics and published within the past three years. The award was established in 2018 to honor the contributions of Gerald Alexanderson, Professor of Mathematics at Santa Clara University and founding chair of AIM's Board of Trustees. As its first chair, Jerry provided the stewardship that has distinguished the American Institute of Mathematics as an international center for mathematical research with a commitment to productive and creative collaboration.

## CITATION

**Jan Bruinier, Benjamin Howard, Stephen Kudla, Michael Rapoport, and Tonghai Yang**

The 2022 Alexanderson Award goes to the paper, "Modularity of generating series of divisors on unitary Shimura varieties," by Jan Bruinier, Benjamin Howard, Stephen Kudla, Michael Rapoport, and Tonghai Yang. This collaborative work arose from an AIM SQuaRE and provides a proof of the modularity of a certain generating series whose coefficients are special divisors taking values in an arithmetic Chow group.

Modularity results connect objects from different mathematical areas and allow new techniques to be applied to old problems. The main theorem in this paper has implications for constructing arithmetic theta lifts, and was an essential ingredient in the recently announced proof of the Arithmetic Fundamental Lemma.

### *Biographical Note*

**Jan Bruinier** received his PhD from Heidelberg University (1998) under the supervision of Eberhard Freitag. He held postdoctoral positions at the University of Heidelberg (1998–2000) and the University of Wisconsin at Madison (2000–2001). After that he was a Heisenberg Fellow of the German Research Foundation (2001–2003) in Heidelberg and at the Max Planck Institute for Mathematics in Bonn. He held a professorship at the University of Cologne (2003–2007), and since 2007 he has been a professor at the Technical University of Darmstadt.

***Biographical Note***

**Benjamin Howard** completed his PhD at Stanford University (2002) under the direction of Karl Rubin after finishing his undergraduate studies at the University of Chicago (1997). He held postdoctoral positions at Harvard University (2002–2004) and the University of Chicago (2004–2005), and he was a Clay Liftoff Fellow (2002) and an Alfred P. Sloan Foundation Fellow (2007–2009). He has been a professor at Boston College since 2005.

***Biographical Note***

**Stephen Kudla** finished his undergraduate studies at Harvard in 1971 and completed his PhD at SUNY Stony Brook in 1975 under the direction of Michio Kuga. After spending one year at the IAS in Princeton, he was a member of the Mathematics Department at the University of Maryland for the period 1976–2005. In 2006, he became a Professor at the University of Toronto and held a Canada Research Chair (2006–2020). He was a Sloan Fellow (1981) and was awarded a Max Planck Research Prize (2000) and the Jeffery–William Prize (2009). He was an invited speaker at the 2002 International Congress of Mathematicians. He was elected a Fellow of the Royal Society of Canada in 2011.

***Biographical Note***

**Michael Rapoport** obtained his thèse d'Etat from the Université de Paris-Orsay (1976) under the direction of Pierre Deligne. He held a postdoctoral position at the Humboldt University of Berlin (1976–1980) and positions of professor at the Universities of Heidelberg (1982–1986), Bonn (1986–1990) and (2003–2017), Wuppertal (1990–1997), and Köln (1997–2003). He gave an invited address at the 1994 International Congress of Mathematicians. Other honors include the Leibnizpreis, the Prix Gay-Lussac Humboldt, the Karl Georg Christian von Staudt-Preis, and the Heinz-Hopf-Preis. He has had a number of notable students, among them Ulrich Gortz, Eugen Hellmann, Andreas Mihatsch, Sascha Orlik, Timo Richarz, Peter Scholze, Eva Viehmann, and Torsten Wedhorn.

***Biographical Note***

**Tonghai Yang** became a middle school teacher in rural China in 1980 after two years of education at Hui Zhou Teacher's Academy. He was admitted to a Master's program at Anhui Normal University in 1984. Three years later, he became an assistant professor at University of Science and Technology of China. In 1991, he went to the University of Maryland, earning his PhD in number theory under the supervision of Steve Kudla in 1995. He held positions at IAS (1995–1996, postdoc), University of Michigan (1996–1998, postdoc), SUNY Stony Brook (1998–1999, tenure track), and Harvard (1999–2000, visitor with AMS Centennial Fellowship). He has been a professor at UW-Madison since 2000. He became an AMS Fellow in 2019. He established the Hometown Education Foundation in 2004 to help

poor students in rural China to continue their basic education. It supports 1300+ students annually.

***Response from Jan Bruinier, Benjamin Howard, Stephen Kudla, Michael Rapoport, and Tonghai Yang***

We are enormously honored to be the 2022 recipients of the Alexanderson Award. Our paper, "Modularity of generating series of divisors on unitary Shimura varieties," is the result of several AIM SQuaRE meetings, and we want to thank AIM for making these intense periods of collective work possible. This joint project brought our diverse mathematical backgrounds to interact in such a way that no proper subset of the five of us could have obtained the final result, and AIM's support played a vital role in the collaborative process.

Our main result is a contribution to the venerable subject of theta functions. The subject of theta functions originates in the 19th century, with Jacobi's proof that any integer can be written as a sum of four squares, and has seen an enormous development in the construction of automorphic forms in the last 150 years. We are here concerned with a geometric variant of this fundamental idea. One can perhaps distinguish three variants of geometric theta functions. The first concerns theta series with coefficients in the cohomology of locally symmetric spaces and starts with the papers of Kudla-Millson. The second involves liftings of these cohomological theta series to theta series with coefficients in the Chow groups of locally symmetric algebraic varieties and is concerned with corresponding conjectures of Kudla and results of Borcherds, Bruinier, Kudla, Raum, and Wei Zhang. The third involves theta series with coefficients in arithmetic Chow groups of integral models of Shimura varieties.

In our prize-winning paper we solve the first basic case of the Kudla modularity conjecture in arbitrary dimension, in the case of the codimension one arithmetic Chow group. The result has applications to the conjecture of Colmez on the Faltings height of abelian varieties with complex multiplication, and to the arithmetic fundamental lemma conjecture of Wei Zhang. We hope that further applications can be found, and that our paper can inspire a proof of Kudla's conjecture for higher arithmetic Chow groups, at least in special cases.

# FRANK AND BRENNIE MORGAN PRIZE

THE AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is awarded annually to an undergraduate student (or students for joint work) for outstanding research in mathematics.

The prize recipient's research needn't be confined to a single paper. However, the paper (or papers) to be considered for the prize must be completed while the student is an undergraduate. Publication of research is not required.

The prize was established in 1995 and is entirely endowed by a gift from Mrs. Frank (Brennie) Morgan. The prize is made jointly by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

## CITATION

**Letong (Carina) Hong**

The recipient of the 2023 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is Letong (Carina) Hong of MIT. Hong has solved conjectures and proven important results in combinatorics, number theory, and probability. She has written 9 research papers, 7 of which have already been published or accepted, including in journals such as *Research in Number Theory*, *Combinatorial Theory*, and *Advances in Applied Mathematics*. Hong's level of accomplishment is even more striking, as she graduated from MIT after only three years.

Hong has an extensive collection of impressive results in number theory. With Mertens, Ono, and fellow undergraduate Shengtong Zhang, Hong has proven a conjecture of Căldăraru, He, and Huang, the "Moonshine conjecture at Landau-Ginzburg points," which concerns the elliptic expansion of the $j$-function at certain cusps and the classical rational function defining the hypergeometric inversion formula for the $j$-function. Hong, Ono and Zhang have studied Euler-Kronecker constants for cyclotomic fields, giving strong theoretic evidence for a conjecture on their sizes. Hong and Zhang have proven a conjecture of Ballantine and Merca, giving a detailed analysis of certain congruences for products of theta functions. With Zhang, she also made significant progress towards a conjecture

of Heim and Neuhauser on the unimodality of Nekrasov-Okounkov polynomials, which play an interesting role in the representation theory of the symmetric group. Hong and Amir have proven results for newforms of weight 2 and 3, generalizable to higher odd weights, related to Lehmer's conjecture on the nonvanishing of Ramanujan's $\tau$-function.

Hong has also done outstanding work in combinatorics and related fields. She has proven a conjecture of Defant by showing that a certain generating function defined in terms of the dynamics of the pop-stack sorting operator acting on Tamari lattices is a rational function. Hong and Zhang proved that there are no extremal squarefree words over alphabets of size at least 17, making significant progress towards the conjecture that there are no such words over alphabets of size at least 4. With Miklós she exhibited an irreducible Markov chain on edge $k$-colorings of bipartite graphs with small diameter and large Metropolis-Hastings acceptance ratio, with application in Latin rectangle completions. Hong has worked on additional projects about pattern avoidance in inversion sequences and local limits of high genus planar maps. The committee was very impressed by Hong's ability to work on problems in so many different mathematical areas, and to make progress on conjectures that are of significant interest to the mathematical community.

In addition to her excellent research work, Hong made extensive contributions while at MIT through her work as President of the Undergraduate Math Association, President of the International Students Association, and in executive roles with the First-Generation and/or Low-Income student coalition and the Society of Physics Students. She received the 2022 Alice T. Schafer Mathematics Prize from the AWM. Hong will continue her studies as a graduate student at Oxford as a Rhodes Scholar and then head to Stanford.

***Biographical Note***

**Letong (Carina) Hong** is from Canton, China. For ten years she trained in contest-style problem-solving at her province's Olympiad math team. She fell in love with Legendre/Jacobi symbols and handle theory at the Ross Program and Stanford Math Camp and decided to pursue higher mathematics. With this new goal she self-studied English in order to understand the GTM [Graduate Textbooks in Mathematics] vocabulary but could not access research opportunities until college. Carina received dual bachelor's degrees in math and physics from MIT and has conducted research at the BSM, UVA, and Duluth REUs [Research Experiences for Undergraduates]. Currently, she is at Oxford working with Professor Ben Green FRS.

Growing up, Carina was heavily involved in debate, emceeing, and dance. While at MIT, she could be found stargazing at Wallace Observatory, competing in electronic trading, and chasing her classmates around in live-action mafia. She

also enjoys skiing and competitive cheerleading, though she had to fall down a lot in both.

***Response from Letong (Carina) Hong***

I am beyond grateful to have been selected as the recipient of the 2023 Frank and Brennie Morgan Prize. I would like to extend my deepest gratitude to Mrs. Morgan and the AMS, MAA, and SIAM for encouraging undergraduates pursuing mathematical research.

I would like to especially thank my undergraduate advisor Professor Pavel Etingof whose kindness and support has been defining in my mathematical journey. He believed in me, gave me tremendous invaluable advice, and offered the most generous help during various difficult times.

I am also grateful to Professor Ken Ono for dedicating himself to develop me as a researcher since the UVA REU and throughout my entire undergraduate career. The many elegant number theory problems I was so fortunate to encounter because of him engendered in me an intense fascination in research such that I am not fearful of the problem difficulty. Further I am deeply thankful to Professor Joseph Gallian for the lasting effort, determination, and care he put into running the Duluth REU; into every field trip and into every single student. I feel blessed that I found a community that gave me a sense of security, belonging, and empowerment at Duluth, and in particular I want to thank Dr Colin Defant for leading me on an algebraic combinatorics adventure.

Finally, I want to thank Professor István Miklós, for being an amazing mentor, collaborator, and friend since the BSM; Professor Scott Sheffield, for walking me into the brilliant world of random surfaces with charisma and humor; and Professor Henry Cohn, for teaching me so much about an intricately charming problem and encouraging me especially during setbacks. I profoundly cherish each of these experiences.

Lastly, I thank my family for their unconditional love, and especially my mother who pours her heart into supporting me every step of the way.

## CITATION

**Egor Lappo**

Receiving Honorable Mention for the 2023 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is Egor Lappo. Lappo has received a BS with Honors in Mathematics from Stanford University, where he is currently pursuing a doctorate in Biology. Lappo's work addresses combinatorial and probabilistic problems in the field of mathematical evolutionary biology, within which he has formalized and resolved conjectures and opened new frameworks. This work has resulted in two published co-authored mathematical research papers (and two additional manuscripts under

review) and displays expertise crossing fields including Mathematics, Statistics, Biology, and Computer Science. Furthermore, he has written an honors thesis titled "Concordance of spatial graphs" in the area of modern knot theory. In this research, Lappo generalized Taniyama's work to concordance of arbitrary spatial graphs.

Lappo's work has been described as "creative, independent, voluminous, and diverse in scope and technique". Egor Lappo is recognized with an honorable mention for the 2023 Frank and Brennie Morgan Prize for his outstanding research in combinatorics, knot theory, and mathematical evolutionary biology.

### *Biographical Note*

**Egor Lappo** grew up in Tula, Russia. In high school, he was an active participant in science olympiads, and was awarded a Gold Medal at the 2017 International Biology Olympiad. As an undergraduate at Stanford University, he unexpectedly fell in love with geometric and topological topics, which led him to major in mathematics. This fall, he begins graduate studies in Biology at Stanford University, specializing in population biology and evolutionary genetics. Aside from research, you can always talk to Egor about modernist literature, Marxist political theory, or obscure video games. In his free time, you can often find Egor cycling around Palo Alto, learning jazz guitar, or playing chess.

### *Response from Egor Lappo*

I am incredibly honored to receive an Honorable Mention for the 2023 Morgan Prize. I would like to thank everyone who helped me on my academic journey. I am grateful to my family, especially my mother Natalia, who supported me all these years and gave me opportunities to pursue my interests. I want to thank Noah Rosenberg, to whom I owe most of my progress as a scientist. Ciprian Manolescu introduced me to the field of low-dimensional topology and provided invaluable guidance and encouragement while supervising my thesis, for which I am immensely thankful. I want to honor Yakov Eliashberg and Lenya Ryzhik for their patience with me during our lengthy discussions. I also want to thank Marcus Feldman, who encouraged me to be more independent and ambitious in my research. Finally, I am grateful to Sharon Du for her unwavering support.

## CITATION

### Sophie Kriz

Receiving Honorable Mention for the 2023 Frank and Brennie Morgan Prize for Outstanding Research by an Undergraduate Student is Sophie Kriz of University of Michigan. She has written ten solo-authored research papers in representation theory and category theory, and has also co-authored a textbook, *Introduction to Algebraic Geometry*. Sophie's letter writers emphasized her independence and

one wrote that the "range of subjects tackled and the sheer level of expertise exhibited are truly astonishing."

Sophie has recently given a counterexample to a longstanding conjecture in equivariant stable homotopy theory, the evenness conjecture for homotopical complex bordism. A basic and interesting question is to understand the equivariant analogue of complex cobordism. Computing the coefficient ring of homotopical equivariant complex cobordism for general groups G turns out to be a difficult problem. An old conjecture, which was established over 30 years ago for abelian groups, is that the graded coefficient rings are concentrated in even degrees. Sophie's work provides explicit counterexamples to the conjecture and her method of proof sheds light on the structure of the coefficient ring. Sophie's results establish new completion theorems for a wide class of equivariant cohomology theories and are likely to have a lasting impact in the field. Sophie has also made significant progress in the study of the structure of FI-Modules, and has developed an original generalization of the notion of operads.

Sophie's letter writers were particularly enthusiastic about this recent work and note that her research to date "would be surprising for a graduate student" and that she has "produced a body of work that would be the envy of most post-docs".

***Biographical Note***

**Sophie Kriz**

Mathematics has been Sophie Kriz's main interest since an early age. She began school as a non-degree student and later became a regular student at the University of Michigan. She is currently finishing her Honors Major in Mathematics this year.

She always enjoyed doing research in mathematics. She has written over 10 research papers, six of which are currently published or accepted for publication. She also co-authored a textbook in algebraic geometry. In addition, she participated in Math Corps at the University of Michigan. She also enjoys playing the piano.

***Response from Sophie Kriz***

My goal is to do good mathematics and I am honored to be recognized for it. I wanted to thank Professor Andrew Snowden for his mentorship and all those who supported my nomination.

JOINT POLICY BOARD FOR MATHEMATICS



# COMMUNICATIONS AWARD

THE Joint Policy Board for Mathematics (JPBM) Communication Award was established by the JPBM in 1988 and is given annually to reward and encourage communicators who, on a sustained basis, bring mathematical ideas and information to non-mathematical audiences. The JPBM is a collaborative effort of the American Mathematical Society, American Statistical Association, Mathematical Association of America, and Society for Industrial and Applied Mathematics.

## CITATION

**Jordan Ellenberg**

Jordan Ellenberg receives the 2023 Joint Policy Board for Mathematics (JPBM) Communications Award for his clear and entertaining prose that brings the power and beauty of mathematics to general audiences. In addition to authoring two bestselling books *How Not to be Wrong: The Power of Mathematical Thinking* and *Shape: The Hidden Geometry of Information, Biology, Strategy, Democracy, and Everything Else*, he also contributes many articles to newspapers and magazines in print and online.

### *Biographical Note*

**Jordan Ellenberg** grew up in Maryland, received his PhD in mathematics from Harvard in 1998, and is now the John D. MacArthur Professor of Mathematics at the University of Wisconsin-Madison. His research centers on arithmetic geometry and especially on Diophantine problems, though his work stretches to touch algebraic geometry, toplogy, and extremal combinatorics. He has held a Sloan Fellowship, an NSF-CAREER award, and a Guggenheim Fellowship; he is a Fellow of the American Mathematical Society and gave a plenary lecture at the 2013 Joint Meetings. He is also the author of numerous articles on mathematical topics in publications including *The New York Times*, *The Washington Post*, *The Wall Street Journal*, and *Slate*; a novel, *The Grasshopper King*, and two general-audience books about mathematics, *How Not To Be Wrong* and *Shape*, which were both *New York Times* best-sellers. Most recently, all these achievements were eclipsed when he became a Jeopardy clue.

### *Response from Jordan Ellenberg*

I feel tremendously honored to be awarded the JPBM Communications Award, especially when the list of previous recipients contains so many of the people whose writing has aided my own, among them Steve Strogatz, Siobhan Roberts, Sylvia Nasar, and of course the light of my childhood, the late Martin Gardner. What Gardner's writing taught me is that making math interesting to people outside the field isn't about looking into their minds and figuring out what sort of thing interests them, but about looking inside our own minds, getting in touch with our own authentic excitement about the material, and figuring out a way to get that out of our heads and onto the page.

I'm also very grateful to my PhD advisor Barry Mazur, who besides helping me become the number theorist I wanted to be, showed me that outward-facing mathematics didn't have to detract from a deep commitment to mathematical research; and to the editors who've taken the risk of putting mathematics in their own pages, like Josh Levin at Slate, Nicholas Thompson and Wired, and most of all Scott Moyers at Penguin Press.

## CITATION

### Grant Sanderson

Grant Sanderson receives the 2023 Joint Policy Board for Mathematics (JPBM) Communications Award for "3blue1brown", his watchable and engaging *YouTube* channel, with over 4 million subscribers, about discovery and creativity in mathematics. Topics range broadly across timely and important mathematical areas, from neural networks to information theory to unexpected appearances of pi in analysis and number theory. Through "3blue1brown" videos and animations, Grant Sanderson presents mathematics both as practically valuable and as an art form, rich with inviting stories and arresting images.

### *Biographical Note*

**Grant Sanderson** is the creator of the "3blue1brown," a *YouTube* channel which explains a wide variety of topics in math using an emphasis on visual intuition and highlighting unexpected connections, reaching over 4.5 million subscribers. He wrote the opensource Python library Manim [An animation engine for explanatory math videos] used to create visuals for the channel, which has since been used by hundreds more in creating expository math material.

After growing up in Park City, Utah, he studied math and computer science at Stanford University. Near the end of his time there he began experimenting with making *YouTube* videos and Manim, and after submitting some of the work to a talent search for online educators run by Khan Academy he was hired by the team there for a fellowship creating multivariable calculus material. Since then, while focusing full time on "3blue1brown," he's collaborated with numerous other

math education and outreach outlets including MIT, Quanta, Numberphile, Udacity, and more.

### *Response from Grant Sanderson*

It's an honor to receive the JPBM Communications award. Many of the past recipients are idols of mine, from James Gleick to Steven Strogatz and countless others. My own love for mathematics is owed, in large part, to the works produced by people in this list, and I know the same is true for many others who have fallen for the subject. I'm grateful that the JPBM recognizes the importance of their efforts in math communication, and to be in any way named in their company is genuinely surreal.

For me, math exposition is a puzzle. How do you keep material as accessible as possible, but without losing the essence of what makes it interesting to mathematicians, and powerful for solving problems? Much of my own work focuses relaying visual intuitions that aid in both goals, but beyond the medium or method used to explain a topic, one thing I've learned from many of the past recipients to this award is the importance of a good story. Never underestimate the power of emotion in drawing people into mathematics, whether it's the thrill of discovery, the excitement of a mathematician's life, or the urge to resolve an unexplained mystery.

## CITATION

### Talithia Williams

Talithia Williams, an associate professor of mathematics at Harvey Mudd College, has won the 2022 Joint Policy Board for Mathematics (JPBM) Communications Award for bringing mathematics and statistics into the homes and hands of millions through her work as a TV host, renowned speaker, and author.

### *Biographical Note*

**Talithia Williams** is a statistician who is an innovative, award-winning college professor, a co-host of the PBS NOVA series *NOVA Wonders* and a speaker whose popular TED Talk, "Own Your Body's Data," extols the value of statistics in quantifying personal health information. She demystifies the mathematical process in amusing and insightful ways to excite students, parents, educators and the larger community about STEM education and its possibilities. In 2015, she won the Mathematical Association of America's Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member, which honors faculty members whose teaching is effective, extraordinary, and extends its influence beyond the classroom.

A current MAA Pólya Lecturer, Williams developed a 24-part college-level lecture series, "Learning Statistics: Concepts and Applications in R," for The Great

Courses, an online platform for lifelong learners. She is the author of *Power in Numbers: The Rebel Women of Mathematics*, a full-color book highlighting the influence of women in the mathematical sciences in the last two millennia, and she has narrated several science documentary films including *Hindenburg: The New Evidence*, *Our Beautiful Planet*, *Secrets in our DNA*, and the upcoming joint BBC and NOVA 5-part series *Universe*.

Williams is currently an associate professor of mathematics at Harvey Mudd College. She is a proud graduate of Spelman College (BA in mathematics), Howard University (MS in mathematics), and Rice University (MA and PhD in statistics). Her research involves developing statistical models that emphasize the spatial and temporal structure of data and applying them to problems in the environment. She has worked at NASA, the National Security Agency, and the Jet Propulsion Laboratory and has partnered with the World Health Organization on research regarding cataract surgical rates in African countries. Faith and family round out a busy life that she shares with her husband and three amazing boys. Through her research and work in the community at large, she is helping change the collective cultural mindset, rebranding STEM as anything but dry, technical, or male-dominated but instead a logical, productive career path that is crucial to the future of the country.

***Response from Talithia Williams***

I recall the day my student, Elly, asked me if I'd consider giving a Claremont Colleges TEDx talk. I very politely declined. Not one to be easily dismayed, however, she kept asking and after about a week, I finally gave in. She later told me the topic: Storytelling. Storytelling?? STORYTELLING?!! What does math have to do with storytelling? I reached out to my colleague, Arthur Benjamin, to get his sage TED advice. Together, we came up with the idea of telling stories with data and "Show Me the Data" was birthed. This local TEDx talk would eventually go on to become a featured TED talk that has been viewed nearly 2 million times and has opened the door to so many other storytelling opportunities.

I am thrilled to be receiving the JPBM Communications Award for 2022. Sharing my enthusiasm for data science and mathematics with broad audiences has become one of the stories I truly enjoy telling. I'd like to thank the JPBM committee, all of my Harvey Mudd College colleagues, especially Arthur Benjamin, and my wonderful husband, Donald and sons, Josiah, Noah, and Micaiah. And my momma, Delores. I can't forget my momma!

# COMAP DOUG FAIRES AWARD

THE DOUG FAIRES AWARD is given by the Consortium for Mathematics and Its Applications (COMAP) to recognize individuals for outstanding contributions to mathematics education in the spirit of Doug Faires. The recipient is acknowledged as emulating Doug, who as a dedicated teacher believed in the power of mathematical modeling to motivate students at all levels and to lead them on a path to life-long learning.

## CITATION

**Kathleen (Kathi) Snook**

The Consortium for Mathematics and Its Applications (COMAP) is pleased to announce Dr. Kathleen (Kathi) Snook as the recipient of the 2022 Doug Faires award. Kathi has been at the heart of COMAP's international mathematical contests in modeling for many years. Starting as a Mathematical Contest in Modeling (MCM)® triage judge, she has triaged and/or final judged in every COMAP contest, written and edited many contest problems, and served as the High School Mathematical Contest in Modeling (HiMCM)® Director as well as the US Regional Senior Judge for the International Mathematical Modeling Challenge ($IM^2C$)®. In 2021, she initiated the Middle Mathematical Contest in Modeling (MidMCM), COMAP's newest contest for middle school/level students, and became its first Director. As COMAP's Director of Operations, Kathi recently oversaw the redesign of COMAP's website and its entry into marketing and social media. Always focused on improving mathematics education, Kathi has coordinated numerous talks, panels, conference sessions, webinars, and workshops focused on applied problem solving and mathematical modeling.

### *Biographical Note*

**Kathleen (Kathi) Snook** is a former U.S. Military Academy mathematics professor and, more recently, math education consultant, curriculum editor, and mathematical modeling contest coordinator. She holds a bachelor's degree in Engineering, a master's degree in Applied Mathematics, and a doctoral degree in Curriculum & Teaching. Kathi's personal and professional passions are education and service. Throughout her mathematics education career, she has focused on teaching & learning, assessment, and professional & curricular development, with specific interest in applied mathematics and mathematical

modeling. Newly retired, Kathi most recently served as the Director of Operations for the Consortium for Mathematics and Its Applications (COMAP).

***Response from Kathleen (Kathi) Snook***

I am honored to receive the COMAP Doug Faires Award.

My mathematics educator journey began as an Army engineer. Engineering is applied mathematics and every Army officer is a teacher. I joined the Mathematical Sciences Department at West Point and met Frank Giordano, who mentored my love of teaching and applied math. Frank and Chris Arney cultivated my understanding of mathematical modeling and the methods to integrate modeling into the curriculum. Rich West, Lida Barrett, and Don Small taught me how to be an educator.

In the early 2000s, Sol Garfunkel invited me to work on COMAP curricular and professional development projects. I enjoyed every chance I had to share the work of COMAP and its contest modeling opportunities through conference presentations, workshops, and webinars. The true purpose of COMAP's modeling contests is to improve mathematics education through supporting the integration of modeling into the curriculum.

As a young girl in high school, I was discouraged from taking math, physics, and chemistry. I hoped to be a math teacher. Through a circuitous journey I did become a math teacher and loved it. I am grateful to those I met along the way for their impact, guidance, support, and friendship.

# ILAS INVITED ADDRESS

THE International Linear Algebra Society (ILAS) is an international organization that strives to highlight the beauty of research in linear algebra and its wide range of applications. Among its activities, ILAS publishes the *Electronic Journal of Linear Algebra*, awards internationally recognized prizes to linear algebra researchers, and organizes conferences across the world.

## CITATION

**Apoorva Khare**

The ILAS is a partner for the 2023 Joint Mathematics Meetings. Apoorva Khare of the Indian Institute of Science gave an ILAS Invited Address, "Analysis applications of Schur polynomials," on Wednesday, January 4, 2023 at 9:00 am ET.

Here is a summary of his talk:

We explain recent results involving Schur polynomials—viewed as functions on the positive orthant—which have led to progress along several classical directions of study:

(1) Understanding functions that preserve positive semidefiniteness when applied entrywise to matrices. This journey takes us from work of Schur, Schoenberg, Rudin, and Loewner (1900s) to modern-day results.

(2) The proofs of these recent results lead to characterizing (weak) majorization of real tuples using Schur polynomials; this has since been generalized to all Weyl groups. Majorization inequalities have been studied since Maclaurin and Newton (1700s).

(3) We also explain how all Schur polynomials are lurking within each smooth function, by completing a 1960s determinantal computation of Loewner. This helps extend determinantal identities by Cauchy and Frobenius (1800s) involving one or two geometric series, to all power series, over all unital commutative rings.

(Partly based on joint works with Alexander Belton, Dominique Guillot, Mihai Putinar, and with Terence Tao.)

### *Biographical Note*

**Apoorva Khare** is Associate Professor of Mathematics at the Indian Institute of Science (IISc), Bangalore and a member of the Analysis & Probability Research Group. After receiving his BStat from the Indian Statistical Institute Kolkata and MS+PhD from the University of Chicago, he worked at the University of California Riverside, Yale, and Stanford before joining IISc as a faculty member. Apoorva is a Ramanujan and SwarnaJayanti Fellow of SERB and DST, and a Fellow of the Indian Academy of Sciences. He was the LAMA Lecturer at ILAS-2019 and an Invited speaker at FPSAC-2022. Apoorva's interests include positivity and analysis (he authored a 2022 book with Cambridge University Press and TRIM), combinatorics and discrete mathematics, and representation theory. He also introduced in 2011 a Quantitative Reasoning course for non-math majors at Yale, and coauthored a textbook for it through Yale University Press in 2015.

### *Response from Apoorva Khare*

It is an honor to represent ILAS at the 2023 Joint Mathematics Meetings, through the ILAS Invited Address. I wouldn't be here without my parents, teachers, and my collaborators, from all of whom I learned so much. It is also a pleasure to acknowledge the support from my excellent colleagues at the Indian Institute of Science. And, of course, I am grateful to ILAS for selecting me to deliver their Invited Address. Finally, I thank my wife and daughter for their constant love and encouragement.

# 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.

## 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 super-critical 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 Supeérieure 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 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 blow-up 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 Raphael 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.

# FRANK NELSON COLE PRIZE IN NUMBER THEORY

THIS prize (and the Frank Nelson Cole Prize in Algebra) was founded in honor of Professor Frank Nelson Cole on the occasion of his retirement as Secretary of the American Mathematical Society after twenty-five years of service and as Editor-in-Chief of the *Bulletin* for twenty-one years. The original endowment was established by the Cole family and Society members, was augmented in 2018 by an anonymous donor, and continues to receive support from the family. The prize is for a notable paper in number theory published during the preceding six years. The work must be published in a recognized, peer-reviewed venue.

## CITATION

**Kaisa Matomäki, James Newton, Maksym Radziwill, and Jack Thorne**

The 2023 AMS Cole Prize in Number Theory is awarded to Kaisa Matomäki, James Newton, Maksym Radziwill, and Jack Thorne.

K. Matomäki and M. Radziwill have received the award for their breakthrough paper, "Multiplicative functions in short intervals," [*Annals of Math.* **183** (2016), 1015–1056], which together with further developments by themselves and their collaborators have led to the solution and advances on long standing difficult problems. By showing that averages of multiplicative functions over short intervals typically behave as averages over long intervals, they were able to show cancellations in sums where the intervals have any length growing with their position, no matter how slowly. Their results are valid for general multiplicative functions, and apply in particular to functions of arithmetic importance. Among the consequences of their work, they were able to show that the Moebius function has a positive proportion of sign changes, the first significant breakthrough towards Chowla's conjecture. Their milestone result is deeply influential, and has led to an explosion of work reshaping the field, and additional applications by themselves and others have led to the solution of some related open problems in number theory and combinatorics.

J. Newton and J. Thorne have also received the award for their astonishing proof of a landmark sought after case of Langlands Conjectures; namely the symmetric power functoriality for holomorphic modular forms. These are achieved in their two papers:

1. “Symmetric power functoriality for holomorphic modular forms, I.,” *Publ. Math. Inst. Hautes Études Sci.* **134** (2021), pp. 1–116.

2. “Symmetric power functoriality for holomorphic modular forms, II.,” *Publ. Math. Inst. Hautes Études Sci.* **134** (2021), pp. 117–152.

This case of functoriality has been a central case put forth by Langlands in earliest formulation in the late 1960s. The brilliant strategy of Newton and Thorne synthesizes many of the developments in proving modularity of Galois representations arising out of Wiles’s proof of Fermat’s Last Theorem. Their proof uses a beautiful and general connectivity argument (relying on their paper, “Adjoint Selmer groups of automorphic Galois representations of unitary type” in *Journal of the EMS*), along with an adroit use of facts (which are almost like pieces of good fortune) that are particular to small primes (like $p = 2$). Their papers sparkle with insights and a deceptive ease with which they extend techniques of modularity lifting so that they apply in the trickiest, and most degenerate cases.

### *Biographical Note*

**Kaisa Matomäki** was born in Nakkila, Finland, in 1985. She received her masters degree at University of Turku, Finland, in 2005, and her PhD at Royal Holloway, University of London, in 2009. Since 2008 she has worked at University of Turku in different positions. Currently she is an Academy Research Fellow there. Matomäki received an EMS Prize in 2020 and the Ruth Lyttle Satter Prize in 2021, and together with Maksym Radziwill she has received the Sastra-Ramanujan prize in 2016 and the New Horizons Prize in Mathematics in 2019, and they were jointly invited speakers at ICM in 2018.

### *Response from Kaisa Matomäki*

I am very honoured and delighted to receive the Frank Nelson Cole Prize in Number Theory together with my collaborator Maksym Radziwill. Our collaboration has once again proved that together one can do much more than alone and that the mathematical community works together advancing mathematical knowledge—our original ideas and results have already been utilized and extended by us and many other people.

I am very grateful to all my mentors throughout the way; In early years my teachers Harri Ketamo and Merikki and Esa Lappi, as well as math contest trainers made me excited about mathematics. My PhD supervisor Glyn Harman helped me to get a good start in my research career. Andrew Granville has helped and advised me in various ways. Also, I have been able to benefit from discussing and collaborating with and learning from several other mathematicians.

Finally, I would like to thank my family, in particular my husband Pekka for all the love and support, and my children Touko, Lotta and Ilmari for all the joy they bring to my life.

### *Biographical Note*

**Maksym Radziwill** holds the University Chair in Mathematics at UT Austin. He grew up in Poland, obtained his BSc from McGill University, and his PhD from Stanford advised by Soundararajan. He did a postdoc at IAS, Rutgers and the Centre de recherches mathématiques, and was subsequently an assistant professor at McGill, professor at Caltech, and finally University Chair in Mathematics at UT Austin. He is interested in analysis. Most of his work has been in analytic number theory and related areas.

Radziwill is the recipient of the SASTRA Ramanujan Prize, New Horizons Prize and was an invited speaker at the ICM in 2018 (all joint with Matomäki). He was also the recipient of a Sloan fellowship, the Coxeter-James prize, Ribenboim prize and Stefan Banach prize.

### *Response from Maksym Radziwill*

It is a great honour and pleasure for me to receive the Frank Nelson Cole Prize. I would like to express my gratitude to all of my long-term collaborators (obviously among them, Kaisa!) for their friendship over the years and to all the people who advised me early on in my career. On a side note it gives me some satisfaction to recall that during my undergraduate years I did encounter Chowla's conjecture and thought that it was obviously "too impossible to make any progress on".

### *Biographical Note*

**James Newton** is an associate professor of number theory at the University of Oxford, and a fellow of Merton College, Oxford. He did his undergraduate studies at the University of Cambridge, and received his PhD from Imperial College London, supervised by Kevin Buzzard, in 2011. After a term at the IAS, Princeton, he did postdoctoral work in Cambridge and Imperial, and was a lecturer at King's College London for five years before moving to Oxford in 2021. His work has been supported by an EPSRC postdoctoral fellowship (2011–2014) and a UKRI future leaders fellowship (2021–). He grew up in a village near Cambridge, and currently lives in northwest London with his partner Andy and their cat Balthazar.

### *Biographical Note*

**Jack Thorne** was born in Hereford, England in 1987. He studied at the University of Cambridge before obtaining his PhD at Harvard University in 2012 under the supervision of Benedict Gross and Richard Taylor. He was a Clay Research Fellow during the years 2012–2017 and is now a Professor at the University of Cambridge and a Fellow of Trinity College. In 2020, he was elected a Fellow of the Royal Society.

### *Response from James Newton and Jack Thorne*

We are honoured to receive the Cole Prize in Number Theory and thank the

selection committee and the AMS for their decision to recognise our work on functoriality for holomorphic modular forms. The symmetric power $L$-functions associated to Ramanujan's $\delta$ function were first written down explicitly in the 1960's by Serre, who predicted their analytic continuation. Around the same time, Langlands proposed a general definition of $L$-function of an automorphic representation of a reductive group and formulated his functoriality principle, which ultimately implies Serre's prediction. We feel very lucky to be able to contribute to this circle of ideas.

Our work would not have been possible without the great progress that has taken place in the Langlands program in the last 50 years, including foundational works by Kottwitz, Clozel, Harris, and Taylor on the cohomology of higher-dimensional Shimura varieties and the first modularity lifting theorems proved by Wiles and Taylor. Our arguments take place in the world of $p$-adic modular forms, as developed by Serre, Hida, Coleman, Mazur, Emerton, and Kisin. We owe an especially large intellectual debt to Bellaïche and Chenevier, who wrote a foundational book on the $p$-adic Hodge theory of overconvergent modular forms and emphasised the importance of pseudocharacters in this context. A supporting paper of ours relies on ideas introduced by Pan in his PhD thesis. We would like to offer special thanks both to him and to our co-authors Allen and Anastassiades.

***Response from James Newton***

Our collaboration on this work was a great delight, bringing together a lot of the mathematics I've been thinking about since I was a student with Kevin Buzzard. I'd like to thank my former colleagues at King's College London, together with Ana Caraiani, Toby Gee and Christian Johansson for their collaboration and friendship over the years. Finally, thanks to my family and to my partner Andy for his love and support.

***Response from Jack Thorne***

I came to these questions after my earlier joint work with Laurent Clozel. I am deeply grateful to Laurent for sharing his ideas and point of view on mathematics.

Thanks are due to the institutions that have placed their trust in me, including the Clay Mathematics Institute and the University of Cambridge. Finally, special thanks to my wife Arti and family for all their love and support!

# LEVI L. CONANT PRIZE

THIS PRIZE was established in 2000 in honor of Levi L. Conant to recognize the best expository paper published in either the *Notices of the AMS* or the *Bulletin of the AMS* in the preceding five years. Levi L. Conant (1857–1916) was a mathematician who taught at Dakota School of Mines for three years and at Worcester Polytechnic Institute for twenty-five years. His will included a bequest to the AMS effective upon his wife's death, which occurred sixty years after his own demise.

## CITATION

**Joshua Evan Greene**

The 2023 Levi L. Conant Prize is awarded to Joshua Evan Greene for his article "Heegaard Floer homology", which was published in the *Notices of the American Mathematical Society*, **68** (2021), No. 1, pp. 19–33.

Greene's article is a survey of the emerging field of Heegaard Floer homology, starting from its historical antecedents and going on to describe a wide variety of results and applications of this theory. This is a substantial undertaking, and the paper is a serious read which requires a dedicated effort to understand. However, for any student or researcher with some knowledge of the underlying mathematical ingredients, this paper provides a compelling account of how the field evolved. It describes key issues and questions motivating this development, and presents some of the beautiful results and applications it has made possible. This area is challenging to enter inasmuch as it requires facility with several different parts of mathematics, including combinatorial methods in low dimensional topology, symplectic techniques, and an appreciation for the analytic subtleties of gauge theory. Greene's paper provides an excellent roadmap for any serious study of this field by illuminating a path through this long chain of ideas and results; it motivates the logical progression that has led to the current state of knowledge, and suggests some promising directions for future investigation.

He starts by recalling Heegaard's long-ago ideas to study three manifolds and Witten's more recent innovations in Morse theory, and explains how these inspired Floer to develop a dramatic new approach to Lagrangian intersection theory. Later, motivated by the new spectacular applications of gauge theory to four-manifold topology, Floer generalized these ideas to an infinite dimensional

setting to obtain instanton homology, an exemplar of Atiyah's definition of a topological quantum field theory. A link between this and Floer's earlier Lagrangian intersection theory inspired what is now known as the Atiyah-Floer conjecture. The next big step was the introduction of the introduction of the Seiberg-Witten equations, which subsequently led to the constructions of monopole Floer and Heegaard Floer homology. Greene explains some finer points of this theory and how it has turned out to be a very well adapted tool to attack, and in some cases solve, some old problems in knot theory.

### *Biographical Note*

**Joshua Evan Greene** grew up in Columbia, Maryland. He got a BS from Harvey Mudd College (2002), was an Americorps volunteer with Habitat for Humanity in Kentucky, got an MSc from the University of Chicago (2004), got a PhD from Princeton University (2009), did a postdoc at Columbia University, and has been on the faculty at Boston College since then (2011). His research is in low-dimensional topology, drawing influence from combinatorics, symplectic geometry, and (Heegaard) Floer homology. He has maintained a close involvement with the Hampshire College Summer Studies in Mathematics since he was a student there at age 17, and more recently with the programs of Mathematical Staircase, Inc., where he sits on the board of directors; mathematics is never more fun for him than it is in those environments. He plays hockey on Tuesday nights with Team Black in Somerville, although he is on loan this season to The Hansons (A) in Oakland, CA. He notched a garbage goal on the power play in a 4-2 loss to the Grey Bears about an hour before writing this sketch.

### *Response from Joshua Evan Greene*

I am very proud to win the 2023 Levi L. Conant Prize.

I have greatly enjoyed reading the *Notices* and the *Bulletin* from the time I entered graduate school. I am grateful to the AMS for publishing and promoting high-quality exposition through these journals, as well as to the countless contributors to these journals whose articles I have read and who have set such a high bar for quality. Thanks especially to Erica Flapan from the AMS for soliciting me to write this article, and to her, Dorothy Buck, and Eli Grigsby for encouraging me at a time when I thought I would give up on it.

Heegaard Floer homology is a vibrant area whose emergence was personally very well-timed with my entering graduate school. It draws together many different strands of mathematics, so has been able to pull in scores of mathematicians of different talents and persuasions. I am grateful to my many mentors, peers, and students, whose work and writing have educated me and helped me compose this survey. Amongst them, let me single out the field's creators, Peter Ozsváth and Zoltán Szabó, whom I was fortunate to study under as a graduate student

and postdoc. Thanks in large part to their influence, the area has been a reliably positive and supportive environment.

Thanks to the many mathematicians whose writing style has left an imprint on me; to name a handful: Noga Alon, for his elegance and clarity; Cameron Gordon, for his concision; Larry Guth, for supplying context and revealing thought processes; David C. Kelly, for his wit and whimsy; and Paul Seymour, for his energy and enthusiasm.

Finally, thanks to my English teachers from Oakland Mills High School, Ms. Curtis, Mr. Wright, and Mrs. Hermann. They gave me a rigorous training in composition which has been vital to my life and career, even though I certainly did not appreciate it at the time. They would be astonished to learn that I have won an award for my writing.

# AMS MARY P. DOLCIANI PRIZE FOR EXCELLENCE IN RESEARCH

THE AMS Mary P. Dolciani Prize for Excellence in Research recognizes a mathematician from a department that does not grant a Ph.D. who has an active research program in mathematics and a distinguished record of scholarship. The primary criterion for the prize is an active research program as evidenced by a strong record of peer-reviewed publications.
This prize is funded by a grant from the Mary P. Dolciani Halloran Foundation. Mary P. Dolciani Halloran (1923–1985) was a gifted mathematician, educator, and author. She devoted her life to developing excellence in mathematics education and was a leading author in the field of mathematical textbooks at the college and secondary school levels. The prize is awarded every other year for five award cycles.

## CITATION

**Diana M. Thomas**

Diana M. Thomas will receive the 2023 Mary P. Dolciani Prize for Excellence in Research from the American Mathematical Society (AMS). Thomas is currently a Professor of Mathematics at the United States Military Academy, an Adjunct Professor at the Pennington Biomedical Research Center, and a Research Associate at the New York Obesity Research Center at Columbia University. She was awarded the prize for her outstanding research at the interface of mathematics with nutrition and obesity as well as her work in number theory, combinatorics, and dynamical systems, and for her impressive work with undergraduates.

Thomas has an extensive publication record with over 150 articles, book chapters, and conference proceedings. Much of her research is interdisciplinary and has been published in a diverse set of journals including those specializing in nutrition, obesity, behavioral science, biology, and pure mathematics. Her work on obesity and metabolism has been particularly impactful. Her nominators write that “she has published a remarkable series of highly original and imaginative papers that display creativity and quantitative rigor, and more recently, on the dynamics of energy exchange and weight gain in pregnancy. Each of these areas suffered substantial quantitative assessment gaps. The reports by Dr. Thomas provide not only important new biological insights, but also

important clinical advances and assessment tools. She is rapidly filling the gap between classical mathematics and biological processes. In so doing, she adds a new dimension to the study of human obesity that is so pervasive across adults and children." Her work has led to the design of innovative software that assists users with weight related health issues, and has been covered by several media outlets. The work of Thomas and her colleagues has been funded by numerous grants, including six funded by the National Institutes of Health. She received an American Heart Association Most Impactful Publications Award in 2014, and The Obesity Society George Bray Founders Award in 2017.

Thomas has advised undergraduate research in both pure and applied mathematics, and has coauthored more than fifty publications with undergraduates, including first-generation college students. She inspires undergraduates with informal discussions inside and outside of the classroom, and masterfully draws them into research projects that are appropriate for their background and interests. The undergraduates she has mentored have pursued many different professions, including enrollment into doctoral programs, and careers in education and medicine.

Thomas is passionate about transforming mathematics education, and she has served in several important leadership roles in this regard. She directed the MAA's undergraduate research poster session competition, and while serving as Director of the Center for Quantitative Obesity Research at Montclair State University, grouped together STEM students engaged in quantitative research, medicine, and nutrition, to develop and integrate their knowledge across disciplines. In addition, Thomas teaches an annual short course on the Mathematical Science in Obesity Research, and she recently served as a Remote Teaching Dean's Fellow at the United States Military Academy. As her nominators write, "Her leadership, collegiality, and results oriented focus are three strengths that drive any program that she takes on to use science to answer hard questions. She has inspired, educated, and mentored generations of mathematics and nutrition researchers to choose fact and science to make policy decisions."

***Biographical Note***

**Diana M. Thomas** received her PhD from the Georgia Institute of Technology in 1996 and is currently a professor of mathematical sciences at the United States Military Academy at West Point. Dr. Thomas has been an active research mathematician for over 25 years with a focus on nutrition and obesity related modeling. She co-invented the remote weight loss program, SmartLoss™, which has been clinically applied world-wide to guide and improve individual patient weight loss adherence through smartphone technology. Dr. Thomas has published over 150 peer-reviewed articles and book chapters which include over 50 articles with undergraduates. Her work has been covered by the *New York Times*, *Wall Street Journal*, *Fitness Magazine*, *Good Housekeeping*, *CBS News*, and

*ABC News*. Dr. Thomas holds the 2012 Mathematical Association of America of New Jersey Distinguished Teaching Award and the 2015 Obesity Society George Bray Founder's Award.

***Response from Diana M. Thomas***

To be nominated for this award by my colleagues is the ultimate recognition and reflects the level of support that I experience daily. My continued intellectual and personal development have been made possible by my relationships with the nominating team which include, COLs Hartley, Scioletti, Lindquist and Gist, LTCs Bluman and Wallen, Drs. Misiurewicz, Calkin, Heymsfield and Allison. What we, as professors, live for is the opportunity to play a role in the lives of our students and our mentees. The former students and early career faculty who have reached out because of this award have warmed my heart and remind me of the impact we make. Finally, I would like to thank my mother, Mary Thomas. No career is without obstacles. Every time I hit the big ones, she's the person I turned to. As the tears and the heartache flooded, she would hold my hands and tell me to be patient and continue to work hard. She was confident that as long as I stuck to this work ethic, I would be successful. It is my hope she will be at the JMM awards ceremony this year to know that her words are why I persevered.

# JOSEPH L. DOOB PRIZE

THIS prize was established in 2003 by the American Mathematical Society to recognize a single, relatively recent, outstanding research book that makes a seminal contribution to the research literature, reflects the highest standards of research exposition, and promises to have a deep and long-term impact in its area. The book must have been published within the six calendar years preceding the year in which it is nominated. The prize (originally called the Book Prize) was endowed in 2005 by Paul and Virginia Halmos and renamed in honor of Joseph L. Doob. Paul Halmos (1916–2006) was Doob's first Ph.D. student. Doob received his Ph.D. from Harvard in 1932 and three years later joined the faculty at the University of Illinois, where he remained until his retirement in 1978. He worked in probability theory and measure theory, served as AMS president in 1963–1964, and received the AMS Steele Prize in 1984 "for his fundamental work in establishing probability as a branch of mathematics." Doob passed away on June 7, 2004, at the age of ninety-four.

## CITATION

**Bjorn Poonen**

The 2023 Joseph L. Doob Prize is awarded to the book *Rational Points on Varieties*, written by Bjorn Poonen and published by the American Mathematical Society in 2017 in the series Graduate Studies in Mathematics.

The subject "rational points on varieties", also known as "arithmetic algebraic geometry", is a modern incarnation of what used to be called "Diophantine equations": a venerable area, which literally goes back to Diophantus (3rd century AD). It is one of those attractive branches of mathematics in which the results obtained are intelligible to everybody, while the proofs require much more sophistication. This contrast could already be seen in the work of Diophantus himself, who spent considerable ingenuity in producing rational solutions to given polynomial equations, and in the techniques that Fermat developed in the 17th century for showing the non-existence of solutions. In the 20th century, when, starting with the work of Weil, techniques from modern algebraic geometry were brought into play, this contrast became more visible than ever. Algebraic geometry has, in the latter half of the 20th century, developed into a massive subject with an aura of inaccessibility, and much of it applies to the subject at hand.

The area abounds in open problems that are as attractive as they are challenging. How should someone with the ambition to solve one of these get started digesting all the advanced foundational material just mentioned? Until recently, the answer was not so obvious, but now there is Bjorn Poonen's book *Rational Points on Varieties*. The prerequisites, although by no means negligible, are relatively modest, and the efforts required in acquiring them are well-spent anyway. The reader should be mature enough to realize that precise definitions and statements, together with examples and exercises, go a long way towards developing the proper intuition for a subject, and that reading detailed proofs can in many cases best wait until the bigger picture has become familiar. And this is the way Poonen's book has been organized, presenting the basic concepts and their properties in a coherent and friendly manner. There are many illuminating and instructive examples, many sketches of proofs, and copious references to the literature for the details that have been omitted.

*Rational Points on Varieties* is an essential and indispensable resource for anybody who wishes to do cutting-edge research in arithmetic geometry. While the emphasis of the book is not on new results, all readers who make their way through even half of all the material presented are ready to prove new theorems of their own.

### *Biographical Note*

**Bjorn Poonen** is the current Distinguished Professor in Science at MIT. Before arriving at MIT in 2008, he received an AB from Harvard and PhD from the University of California at Berkeley and then held academic positions at MSRI, Princeton, and Berkeley. Poonen's research lies principally in number theory and algebraic geometry. He is a Simons Investigator, Fellow of the AMS, and member of the American Academy of Arts and Sciences. His awards include the Chauvenet Prize for exposition, the MIT School of Science Prize in Undergraduate Teaching, a Miller Professorship, and the Guggenheim, Packard, Rosenbaum, Simons, and Sloan Fellowships. He is a principal investigator in the Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation, and he served for 14 years as founding managing editor of *Algebra & Number Theory*. Twenty-six mathematicians have received a PhD under his supervision.

### *Response from Bjorn Poonen*

Any prize such as this is also recognizing the interest of the subject it covers, whose historical and ongoing significance is summarized well in the citation. So surely I am indebted to the many researchers who, motivated by classical Diophantine equations, developed this beautiful subject connecting number theory and algebraic geometry. I have been lucky enough to have a few of these researchers as my teachers, and to pass on the knowledge to my students, many

of whom have helped improve my book over the years 2003–2017 during which it was written.

On a personal level, I find it very rewarding to be honored for this, the single mathematical project that I have devoted more of my life to developing than any other. I thank the National Science Foundation, Simons Foundation, Packard Foundation, and Guggenheim Foundation for having faith in me, for their long-term support during the writing of my book. I am happy that I published my book with the AMS, and I thank the AMS staff for their assistance with it. Finally, I would like to honor Paul and Virginia Halmos for their vision to endow a prize that reminds us all of the value of good writing.

# LEONARD EISENBUD PRIZE FOR MATHEMATICS AND PHYSICS

THIS prize was established in 2006 in memory of the mathematical physicist Leonard Eisenbud (1913–2004) by his son and daughter-in-law, David and Monika Eisenbud. Leonard Eisenbud was a student of Eugene Wigner. He was particularly known for the book *Nuclear Structure* (1958), which he coauthored with Wigner. A friend of Paul Erdős, he once threatened to write a dictionary of English to Erdős and Erdős to English. He was one of the founders of the physics department at Stony Brook University, where he taught from 1957 until his retirement in 1983. In later years he became interested in the foundations of quantum mechanics and in the interaction of physics with culture and politics, teaching courses on the anti-science movement. His son, David, was President of the American Mathematical Society (2003–2004).

The prize is awarded every three years for a work or group of works, published in the preceding six years, that brings mathematics and physics closer together. Thus, for example, the prize might be given for a contribution to mathematics inspired by modern developments in physics or for the development of a physical theory exploiting modern mathematics in a novel way.

## CITATION

**Jason P. Miller and Scott Sheffield**

Jason Miller and Scott Sheffield are awarded the 2023 Leonard Eisenbud Prize of the AMS for their monumental series of papers on Liouville Quantum Gravity. This body of work provides a novel and deep understanding of ideas and concepts that had been first developed and used in the theoretical physics community (and called quantum gravity there) and opened the door to a number of new mathematical results and research directions.

For mathematicians, "Quantum Gravity" in two dimensions can be broadly viewed as encapsulating ways to define and study random planar geometries. This can encompass quite different perspectives—one can define random distances in a planar domain, random area measures in a planar domain, random metric spaces. The wide-ranging survey, *What is a random surface?*, written in colloquial style by Scott Sheffield for the proceedings of this year's ICM can be a good way for newcomers to learn about this area, which has become a cornerstone of contemporary mathematical physics.

These questions originated from physics, as the following quote by A.M. Polyakov from 1981 shows: "*In my opinion at the present time we have to develop an art of handling sums over random surfaces. These sums replace the old-fashioned (and extremely useful) sums over random paths.*" This is what led Polyakov and others to introduce what are now called the *Polyakov* and *Liouville actions* and ignited a number of spectacular developments related to Conformal Field Theory and Quantum Gravity in the theoretical physics community.

The following two ways of trying to define the canonical random planar geometries mathematically are directly relevant to the work of Miller and Sheffield:

(a) Scaling limits of discrete planar maps: One starts from a discrete combinatorial model that defines a probability measure on discrete finite planar maps (which are equivalence classes of embedded discrete finite planar graphs in the plane or in the sphere, modulo diffeomorphisms). These graphs come automatically equipped with their graph distance and with the counting measure on the vertices. One can try to see what happens to this law when one lets the number of vertices in the planar map tend to infinity for a given model. If one renormalizes distances and counts measures appropriately, one might get in the limit a random metric space equipped with a measure $\nu$ on it. This program has been successfully carried out in the last decade by Le Gall, Miermont and others for one particular class of planar maps that can be heuristically described as "uniformly" chosen—the limit is then the so-called Brownian map. It should be emphasized that the Brownian map is a random metric space which is "planar" but does not come with a "canonical" way to be embedded in the plane.

(b) Directly in the continuum, using the Gaussian Free Field (GFF): Here, one starts with a given planar domain, say the unit disc $D$, and defines in it a random area measure $\mu$ using an instance of the GFF $h$ in $D$ following some of Polyakov's ideas. Recall that the GFF can be heuristically thought of as the *natural real-valued function in $D$*, but that it is in fact not a proper function (it is only a generalized function), so that well-posedness issues do arise in a number of directions in all the constructions involving the GFF. Heuristically, for some constant $\gamma$, the intensity of $\mu$ with respect to the Lebesgue measure can be understood as some multiple of $\exp(\gamma h)$, and this heuristic can be made rigorous via a renormalizing procedure. This construction works when $\gamma$ is small enough, i.e., when $\gamma < 2$. So in this second approach, one constructs directly in the continuum a random area measure in every given simply connected planar domain. This measure is quite rough—it has no atoms but it is carried by a fractal dense set of point in the plane (heuristically, points where $h$ is exceptionally large).

For rather deep reasons that can be traced back to Polyakov's work and to the idea that conformal invariance should play a role, it has been conjectured that

these two constructions should give rise to closely related objects, in the sense that:

(*) There should exist an embedding in $D$ of the random metric spaces appearing in procedure (a) in such a way that the law of the embedding of $\nu$ (which is the rescaled limit of the counting measure on discrete maps) is exactly that of an LQG area measure $\mu$ constructed in (b) for some $\gamma$ that depends on the class of planar maps that was used in (a).

(**) For each $\gamma < 2$, there should be a way to associate directly to $\mu$ constructed in (b) a "compatible" metric $d$ in $D$, so that $(D, d, \mu)$ is distributed exactly as one of the random metric measure space (conjecturally) appearing in (a).

If this holds, the continuum objects constructed in (b) should possess some striking properties that reflect some combinatorial features of discrete planar maps—one can, for instance, naturally glue two independent discrete planar maps along their outer boundaries and obtain another planar map decorated by a curve drawn on it (the place where the gluing took place).

The belief in the connection between these two approaches was exploited in the physics community in the 1980's and 1990's: The combinatorial identities (both enumerative features and the gluing operations) made it possible to identify a number of critical exponents for models of statistical physics drawn on these random graphs. Then, using the so-called KPZ formulas (KPZ stands here for Knizhnik, Polyakov and Zamolodchikov—there are two KPZs in this mathematical physics world), whose origins and justifications lie more in the second continuum approach, they could infer the critical exponents for the same models of statistical physics, but when drawn on Euclidean lattices. All this appeared like black magic from a mathematician's perspective! Things are now very different thanks to this body of work by Miller and Sheffield.

Here are some of the numerous contributions by Miller and Sheffield that are being recognized with this prize:

Miller and Sheffield (with also one joint long paper with Duplantier) showed how it was possible to define properly these random area measures in the plane and variants thereof, to define the right notion of *equivalence classes of domains equipped with a random area measure, modulo conformal invariance* that in some sense provides a *semi-embedded* version of these objects (which they call LQG surfaces), to then glue (i.e., conformally weld) together independent LQG surfaces along their boundaries, in such a way that the random "boundary lengths" coincide on both sides. This gluing gives rise to a new LQG surface with a curve drawn on it (the place where the surgery took place), and they proved that if things are set up in the appropriate way, this surgery curve is a fractal Schramm-Loewner-Evolution type curve that is *independent* of the obtained LQG surface. This remarkable result can be viewed as a continuum

analog of the combinatorial gluing operations mentioned above. All this is of course technically very subtle due to the roughness and fractal nature of all the objects involved.

For the case of the Brownian map and the value $\gamma = \sqrt{8/3}$, Miller and Sheffield showed that (*) and (**) as stated above do indeed hold. In a further series of papers with Gwynne, they actually provided a concrete embedding in the plane of some discrete planar maps (for which the scaling limit was known to be the Brownian map) and showed that its limit is indeed an embedded LQG surface with $\gamma = \sqrt{8/3}$. Along the way, they had to establish novel and deep results about the scaling limits of random walks on discrete random graphs.

These results have opened the door to many further developments by Miller and Sheffield, as well as by Gwynne, Holden, Sun, Ding and many others. This includes constructions of the LQG metric for general $\gamma$. Let us also highlight the recent work of Kupiainen, Rhodes and Vargas (also with F. David or Guillermou) which makes rigorous (and builds upon) many aspects of the conformal field theory approach initiated in the physics literature.

### *Biographical Note*

**Jason P. Miller** received his undergraduate degree from the University of Michigan in 2006 and his PhD from Stanford in 2011 under the supervision of Amir Dembo. He was a postdoc at Microsoft Research and then at MIT before becoming a faculty member at the University of Cambridge and a fellow of Trinity College in 2015. He previously received the Rollo Davidson Prize, the Clay Research Award (with Scott Sheffield), and the Doeblin Prize. He was an invited speaker at the 2018 ICM.

### *Response from Jason P. Miller*

It is a great pleasure to receive this prize together with Scott Sheffield. I was introduced to this area by my PhD supervisor Amir Dembo when he gave me a copy of Greg Lawler's book, *Conformally Invariant Processes in the Plane*, as well as an early draft of Bertrand Duplantier and Scott Sheffield's paper, "Liouville quantum gravity and KPZ," which played a major role in kicking off this subject. I never guessed at the time that I would still be working intensively on it 15 years later. I would also like to thank Scott Sheffield, who I first met in 2008 at a conference in CRM in Montreal where he gave a talk on his work with Duplantier. Scott was later my postdoctoral advisor at MIT and research mentor for many years. Finally, I would like to thank my other research collaborators. Indeed, all of them have played an incredibly important part in driving the subject forward.

I would also like to thank the nominators, the selection committee, the Eisenbud family and the AMS.

### *Biographical Note*

**Scott Sheffield** received his undergraduate and master's degrees from Harvard University in 1998 and a PhD from Stanford in 2003 under the supervision of Amir Dembo. He worked at Microsoft Research, UC Berkeley and IAS Princeton (as a postdoc) and at NYU (as faculty) before joining MIT in 2008. Other awards include the Clay Research Award (also joint with Jason Miller), the Loéve Prize, the Rollo Davidson Prize, the Presidential Early Career Award for Scientists and Engineers, and the Sloan Research Fellowship. He was an invited speaker at the 2010 ICM and a plenary speaker at the 2022 ICM.

### *Response from Scott Sheffield*

I am tremendously honored by this award, and especially honored to be sharing it with my long-time collaborator Jason Miller. I started working in this general area some 15 or 20 years ago, and at the time had no idea how far it would develop, or how exciting it would turn out to be. I'd like to thank my earliest close collaborators in the subject (including Bertrand Duplantier, Oded Schramm, and Wendelin Werner) as well as the many wonderful collaborators and inspirational colleagues who have helped us so much since then.

I would also like to thank the nominators, the selection committee, the Eisenbud family and the AMS.

# AWARD FOR AN EXEMPLARY PROGRAM OR ACHIEVEMENT IN A MATHEMATICS DEPARTMENT

THE annual AMS Award for an Exemplary Program or Achievement in a Mathematics Department was established in 2004, first awarded in 2006, and fully funded by a gift to the AMS's permanent endowment by an anonymous donor in 2009. This award recognizes a department which has distinguished itself by undertaking an unusual or particularly effective program of value to the mathematics community, internally or in relation to the rest of society. Departments of mathematical sciences in North America that offer at least a bachelor's degree in mathematical sciences are eligible.

## CITATION

**Smith College**

The Postbaccalaureate Program at the Center for Women in Mathematics at Smith College is highly effective at preparing women mathematically and professionally for graduate school in the mathematical sciences. Students in the program come from backgrounds that do not fit the typical mold of graduate school applicants, for instance graduating from undergraduate institutions with limited mathematics coursework, or having discovered mathematics late in their college experience or indeed after spending years in the workforce, or wanting to pivot from sciences and social sciences into mathematics or statistics. Postbacc cohorts are notably diverse in race, ethnicity, socioeconomic status, age and employment background. During the program at Smith College, students develop mathematical talent and confidence through intensive coursework and research projects and also receive mentoring and coaching about graduate school issues such as applications, qualifying exams, time management, choosing advisors, and more.

***Response from Smith College***

*History of the Program*

The Postbaccalaureate Program at Smith College was founded 15 years ago by Ruth Haas and Jim Henle, and is now directed by Patricia Cahn, Candice Price, and Julianna Tymoczko. The program was the first of its kind in 2007 and remains the national gold-standard, serving as a blueprint for the other postbaccalaureate and bridge-to-PhD programs that have started in the last few

years. Each year, the program admits a cohort of students interested in graduate school in the mathematical sciences but who for whatever reason are not yet prepared (changed majors late, small undergraduate math program, illness during college, etc.). Without an on-ramp like the postbaccalaureate program, many would not be able to (re)enter the graduate pipeline in math. Since 2016, 50 postbaccalaureate alums have entered graduate programs like Dartmouth, Cornell, Duke, Rice, Michigan State, University of Minnesota, and Vanderbilt, and 2 are current NSF graduate fellows.

*Response from the Program*

We are honored and delighted to receive the AMS Exemplary Program Prize for the Postbaccalaureate Program at the Center for Women in Mathematics at Smith College, and to carry on the tradition that Ruth Haas and Jim Henle started.

This program is their vision, based on the students they saw who left Smith College—and math—but who never stopped loving math. Haas and Henle reasoned that with a path back, some of those students could not just re-enter the field but thrive in it. They received the first of two NSF grants to fund the program in 2007.

For most of us, loving math is not enough to propel us to a PhD—we also need an environment that allows us to enjoy the experience of doing math. The core of the Postbaccalaureate Program is the warm and welcoming environment of the Smith College Department of Mathematical Sciences. Postbaccs and undergraduates support each other in their coursework and research. Faculty provide intensive, individualized mentoring to help students identify their own interests as well as graduate programs that fit their mathematical backgrounds and strengths. Alums frequently return to campus to connect with current students, particularly through our annual Women in Mathematics in the Northeast (WIMIN) Conference. One former postbacc said:

> Smith's postbacc program made it possible for me to pursue graduate school in math. There is no way I could've gotten here without it. I've found my time as a graduate student really fulfilling, and I hope that I can continue on to work as a professor and give similar opportunities to my students. Smith's program boosted my love of math to new heights and gave me the inspiration to keep learning.

The on-ramp and support provided by the Postbaccalaureate Program have only become more important since the pandemic. Students found their coursework interrupted and lost social connections that keep mathematics fun. Across the country, ties between faculty and students have become attenuated. As faculty, we underestimate the impact of small actions—suggesting an REU, a grant application, graduate study—but our students have felt their absence.

We have found that diversifying mathematics starts when people are in an environment where they feel comfortable enough to experience the joy and wonder of mathematics. We hope that graduate programs and other academic institutions can carry on this work, training students not just with technical tools, but also cultivating an atmosphere that helps students thrive and prepares them for the broad range of careers represented in the AMS community.

# AWARD FOR IMPACT ON THE TEACHING AND LEARNING OF MATHEMATICS

THE Award for Impact on the Teaching and Learning of Mathematics was established by the AMS Committee on Education (COE) in 2013. The endowment fund that supports the award was established in 2012 by a contribution from Kenneth I. and Mary Lou Gross in honor of their daughters Laura and Karen. The award is given annually to a mathematician (or group of mathematicians) who has made significant contributions of lasting value to mathematics education.

## CITATION

**Ulrica Wilson**

Dr. Ulrica Wilson, Associate Professor of Mathematics at Morehouse College, has led many initiatives on the teaching and learning of mathematics for many different segments of the mathematics community. She has done so with an unwavering commitment to equity and mentorship.

Dr. Wilson has been key to Morehouse Mathematics' successes and to its recognition by the AMS as the 2016 recipient of its Mathematics Programs that Make a Difference honor. She has worked with research teams of first-year students. She uses set theory to introduce early mathematics students to proof-based coursework. Through these and other efforts, she establishes relationships with her students early on, helping them grow and find opportunities. The college celebrated her impact with the 2017 Vulcan Teaching Excellence Award.

Dr. Wilson improves the education of Morehouse students in her administrative and service capacities as well. She is the founding director of the James King Jr. Initiative for Student and Faculty Engagement, which initiates and supports extensive efforts that improve students' mathematical experience. One example of this is the Communicating by Thinking Effectively in and About Mathematics program, which develops abilities of older students to communicate mathematics to freshmen, in turn strengthening the success of general education mathematics. Dr. Wilson is also director of the RISE to Excellence program. Starting at the sophomore year, this program accepts math and science students and provides them scholarship support, promotes research experience, and develops them professionally through individual mentoring and program workshops.

Dr. Wilson has played a long-term integral role within the Enhancing Diversity in Graduate Education (EDGE) Program, a program that prepares a cohort of new PhD students, all women, to succeed in their graduate programs. Starting first as a graduate student mentor, Dr. Wilson returned to the program as an algebra instructor, then Co-Director, and now Vice President of the Sylvia Bozeman and Rhonda Hughes EDGE Foundation, which received a 2015 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM). Throughout her more than 20-year involvement with EDGE, Dr. Wilson has mentored dozens of young women mathematicians. Dr. Wilson's mentorship has empowered early career teachers to recognize their role and ownership in their mathematical community, and to excel in their work as educators.

Dr. Wilson has served as vice president of the National Association of Mathematicians (NAM). Dr. Wilson deserves considerable credit for securing funding for the continuation of NAM's Undergraduate MathFest, which annually attracts mathematics majors, mostly Black, at all levels to inform them about and inspire them to consider graduate study and careers in the mathematical sciences.

She is a 2019 Fellow of the Association of Women in Mathematics (AWM), and serves on the AWM Scientific Advisory Committee.

At the Institute for Computational and Experimental Research in Mathematics (ICERM), Dr. Wilson has helped increase faculty involvement in student research broadly. She has been the PI on numerous grants for Research Experiences for Undergraduate Faculty, for workshops equipping mathematics faculty to conduct undergraduate research at their own institutions across the country. At ICERM Dr. Wilson also coordinates diversity initiatives and co-chairs the Mathematical Sciences Initiatives Diversity Committee. For example, she is a member of a small organizing committee for Girls Get Math at ICERM, a summer program for high school students.

Dr. Wilson was co-organizer for the 2018 Infinite Possibilities Conference and two-time co-organizer of the Blackwell-Tapia Conference.

In recognition of her many contributions impacting nearly every segment of the mathematics community, from K-12 students to mathematics faculty, and her steadfast commitment to equity and excellence in mathematics teaching, the AMS awards Ulrica Wilson the 2023 Award for Impact on the Teaching and Learning of Mathematics.

### *Biographical Note*

**Ulrica Wilson** was born in Massachusetts while her father was in graduate school and raised in Birmingham, AL. She is an alumna of Spelman College and it was the mathematics faculty and her classmates at Spelman who informed her choice to pursue mathematics and increase opportunities for women in mathematics. Undaunted by a roadblock or two herself at several critical stages of her career, Ulrica is committed to breaking down barriers that obstruct diverse paths to careers and opportunities in the mathematical sciences. Since the recent loss of her father, who was a Geography professor, she's had the pleasure of hearing from many of his former students and colleagues and now more than ever she recognizes the impact that teaching and learning can have long past the initial professor-student or mentor-mentee interaction.

### *Response from Ulrica Wilson*

Thanks to AMS for recognizing efforts that impact teaching and learning as part of the overall mission to advance mathematics. I am honored to receive this prize. Inspired by many of my own mentors, including Etta Falconer, I am proud to say that throughout my career, I've had the support of Morehouse College, EDGE, and ICERM to create and contribute to programs that respond to specific needs that arise in the mathematics community. I have the privilege to work at an institution dedicated to educating black men—a population often overlooked and discounted. At Morehouse, I see firsthand the impact that such programs have on my current and past students.

I am also thankful for the environment I entered in 2007 when I joined the Morehouse College faculty. Because of a dean that strongly supported my ideas and initiatives, a chair that was creative and unwavering in his commitment, and peers that fueled my motivation, I've been able to design a broad array of opportunities that expand pathways for those that are regularly underrepresented in our community. Lastly, I am immensely grateful for the community of EDGErs that have become both colleagues and friends in the past 15 years. I've learned so much from working with you all.

# MATHEMATICS PROGRAMS THAT MAKE A DIFFERENCE AWARD

IN 2005, the American Mathematical Society, acting upon the recommendation of its Committee on the Profession, established the Mathematics Programs that Make a Difference Award. The award, provided by the Mark Green and Kathryn Kert Green Fund for Inclusion and Diversity, highlights programs that are succeeding and could serve as a model for others in addressing the issues of underrepresented groups in mathematics.

## CITATION

**University of Texas Arlington (UTA)**

The AMS is pleased to recognize the Math Bridge to Doctorate Program at the University of Texas, Arlington (UTA) Mathematics Department with the 2023 Mathematics Programs That Make a Difference Award.

The Math Bridge to Doctorate Program at UTA began in 2016 and works with the National Alliance for Doctoral Studies in the Mathematical Sciences to identify potential applicants. The Math Alliance's Facilitated Graduate Application Program (F-GAP) is designed to provide resources for minority students to gain access to admission in graduate mathematical sciences programs. The Math Alliance can thereby identify students who do not have the appropriate background to be competitive for graduate school and UTA has used these contacts effectively to recruit and prepare many of these students for graduate studies in mathematical sciences. UTA's Bridge to Doctorate meets all three criteria for the Mathematics Programs That Make a Difference Award: It contributes to an increase of students from historically underrepresented groups that receive advanced mathematical degrees, has documented success, and is a replicable model.

The Bridge Program provides a vibrant and immersive learning environment within a PhD program, where Bridge fellows collaborate not only among themselves but also work side by side with other PhD students. This ensures academic success, learning about an entire doctoral program, and peer support. The Bridge Program is built on two cornerstones: (a) A Bridge-to-Math Doctorate curriculum training program through the BS-MS fast track, which provides a smooth transition from undergraduate to graduate programs through coursework in two-semester Analysis, Linear Algebra, Advanced Linear Algebra,

and other graduate courses; (b) A comprehensive system of strong faculty and peer mentoring, aggressive recruitment at annual Gulf States Math Alliance (GSMath) conferences and other GSMath activities, direct involvement of external faculty mentors from other GSMath institutions, with whom the Bridge Program has built trust and strong relationships so that they actively recommend their students to the program. The Bridge fellows are usually supported for one year. Upon completing the program successfully, they transition to a doctoral program.

UTA's Bridge to Doctorate Program closely collaborates with faculty mentors at various underserved institutions, particularly HBCUs, HSIs, and URM faculty mentors within GSMath. Those mentors function as excellent recruiters for the Bridge Program and recommend their own students. The GSMath has been growing as a regional alliance, from a dozen institutions in 2013 to currently over 40 mathematics departments. The start of the Bridge Program in 2016 and the annual GSMath conferences since 2017 have been instrumental to this phenomenal growth. The Bridge Program has been sponsoring the annual GSMath conferences since 2017, where a typical attendance is over 200 students and faculty. At those annual conferences the Bridge Program faculty interact with many prospective Bridge fellows. The current data indicates that the Bridge Program is successful in attracting URM students and prepare them for doctoral studies in the mathematical sciences with effective academic preparation and strong mentoring. The Bridge Program works closely with the National Math Alliance through active engagement in the annual Field of Dreams conferences and the FGAP (Facilitated Graduate Applications Process). The Bridge Program also plays a leadership role in the Gulf States Math Alliance. The Bridge Program is now developing collaborative relationships with the NAM (National Association of Mathematicians) and other organizations such as the Mathematical Association of America–Texas section.

UTA's Bridge to Doctorate Program, with its vibrant and immersive learning environment and annual GSMath conferences, has had a significant impact on its alumni's career choices and trajectories. Alumni comments (from the nomination) include "The program offers more flexible course plan to strengthen my foundation in analysis and linear algebra. With the strong mathematical foundation, I was able to move smoothly through my doctoral program. ... One thing that impressed me is the support of the professors and from other graduate students that advocate for the success of students as they matriculate through the program.... I believe that UTA, more specifically, the Bridge-to-Math doctorate program truly brought me success and provided me with the skillset necessary as I advance further through my academia career path."

The AMS commends UTA's Bridge to Doctorate Program for its success in bringing more persons from historically underrepresented and underserved groups to doctoral studies in mathematical sciences.

**About the Program.** The Bridge to Doctorate Program at UTA has been running since 2016 as an NSF-supported project (#1620630). Students participate in the Bridge Program for an entire academic year. The cohort size may vary each year (originally designed for 3 cohorts of 10 students each year, but resulted in a total of 42 students during 2016–2022). The program focuses on URM (underrepresented minority) and other underserved students, especially from HBCUs (Historical Black Colleges and Universities) and HSIs (Hispanic Serving Institutions). It is different from a typical post-bac program in that it offers individualized curriculum and advising based on students' needs and strengths, and it helps the participants move forward without delay in progression towards doctoral studies. The Bridge to Doctorate Program at UTA has been running since the fall of 2016. The program is directed by a faculty team consisting at present of Prof. Jianzhong Su (Bridge Project Director/PI, Math Department Chair), Prof. Tuncay Aktosun (Bridge Program Director), and Profs. David Jorgensen, Ren-cang Li, Theresa Jorgensen, and Hristo Kojouharov (Math Graduate Director).

***Response from University of Texas Arlington (UTA)***

The Mathematics Department at University of Texas at Arlington is honored to receive this AMS award. The Bridge Program aims at transforming the participating students into strong candidates for standard PhD programs in the mathematical sciences with graduate assistantships. The targeted students are those with potential, talent, and commitment to achieve a doctoral degree, but not yet ready to succeed in a standard PhD program for reasons such as coming from an underserved institution, where advanced mathematics courses may not be available. The success in the Bridge Program is reflected not only in the high number of students who have matriculated at a PhD program, but also evidenced by students in early cohorts who have successfully completed PhD studies and begun their professional careers. It has strong positive effects on the UTA Mathematics Department itself, by creating a better academic environment for graduate students, for their retention, career preparation, involvement in outreach, and functioning as mentors/peer-mentors. We thank our collaborators, faculty mentors at over 40 institutions, mostly HBCUs and HSIs, in the Gulf States Math Alliance covering Texas, Louisiana, and Mississippi, and colleagues from the National Alliance for Doctoral Studies in the Mathematical Sciences, for their tremendous support.

# THE RUTH LYTTLE SATTER PRIZE IN MATHEMATICS

THE Satter Prize recognizes an outstanding contribution to mathematics research by a woman in the previous six years. This prize was established in 1990 using funds donated by Joan S. Birman in memory of her sister, Ruth Lyttle Satter. Professor Birman requested that the prize be established to honor her sister's commitment to research and to encourage women in science. An anonymous benefactor added to the endowment in 2008. The prize is awarded every two years.

## CITATION

**Panagiota Daskalopoulos and Nataša Šešum**

The 2023 Ruth Lyttle Satter prize is awarded to Panagiota Daskalopoulos and Nataša Šešum for groundbreaking work in the study of ancient solutions to geometric evolution equations.

Ancient solutions are crucial to the understanding of singularities of geometric flows and are of major interest in the theory of renormalization group flows in theoretical physics. Daskalapoulos and Šešum launched a systematic investigation of ancient solutions in 2010 in foundational work with Richard Hamilton. Their deep and influential work over the past decade culminated in the exciting breakthroughs for which this prize is being awarded.

In a 2020 paper in the *Annals of Mathematics*, preceded by a 2019 article in *Journal of Differential Geometry*, Daskalopoulos and Šešum, along with Sigurd Angenent, completely classiffed ancient compact solutions of the mean curvature flow that are uniformly two-convex, a condition that has played a pivotal role in allowing surgery constructions for general solutions of the flow. The proof developed highly original techniques to estimate the various asymptotic growth rates in different parts of the surfaces backward in time, enabling them to establish rotational symmetry of solutions. The ideas developed here helped pave the way for the remarkable results we describe next.

Two decades ago Perelman established the existence of a non-collapsed compact ancient solution of the three-dimensional Ricci flow that is not a soliton. Daskalopoulos and Šešum, in joint work with Angenent and Simon Brendle (*Comm. Pure and Appl. Math.* 2022, online version 2021), provided a complete asymptotic description of Perelman's ancient solution, in fact of

all rotationally symmetric, non-collapsed compact ancient solutions that are not flat. Subsequently, Brendle, Daskalopoulos and Šešum (*Invent. Math* 2021) proved the longstanding conjecture that the only non-collapsed, non-flat, compact ancient solutions of the three-dimensional Ricci flow are Perelman's solution and shrinking spheres.

***Biographical Note***

**Panagiota Daskalopoulos** is a native of Greece and has been a Professor at Columbia University since 2001. Her primary research interest lies at the interface of Partial Differential Equations and Differential Geometry. She earned her PhD from the University of Chicago under the supervision of Carlos Kenig and received her BS from the University of Athens, Greece. Previously, she was a visiting member at the Institute of Advanced Study and taught at the University of Minnesota, and the University of California, Irvine. Her honors and awards include a Guggenheim Fellowship, Sloan Fellowship, Simon's Fellowship, and the Distinguished Award for Research from University of California, Irvine. In 2014 she was an invited speaker at the Special Section in PDE, at the ICM in Seoul, and in 2016 she gave an AMS Invited Address at the Joint Meetings in Seattle. In 2022 she was elected a member of the American Academy of Arts and Sciences.

***Biographical Note***

**Nataša Šešum** is a native of Serbia and has been a Professor at Rutgers University since 2010. Her primary research interest lies at the interface of Partial Differential Equations and Differential Geometry. She earned her PhD from the Massachusetts Institute of Technology under the supervision of Gang Tian and received her BS from the University of Belgrade, Serbia. Previous academic appointments include MSRI (visiting member), New York University, Columbia University and University of Pennsylvania (UPenn).

Her honors and awards include being selected as an AMS fellow and Simon's Fellowship. In 2011 she gave an AMS Invited Address at the Joint Meetings at the College of the Holy Cross in Worcester, MA, and in 2014 she was an invited speaker at the Special Section in Geometry, at the ICM in Seoul.

***Response from Panagiota Daskalopoulos and Nataša Šešum***

We are deeply honored and happy to receive the Ruth Lyttle Satter Prize. We are extremely grateful to those who nominated us, to those colleagues who wrote letters to support our nomination, and to the selection committee. We would like to thank Joan Birman who established the prize in memory of her sister Ruth Little Satter to encourage women in science. Joan Birman'a deep contributions to mathematics have been an inspiration for the younger generations of women mathematicians.

We are very happy that the mathematics community has recognized our work on ancient solutions in geometric flows, which would not be possible without the support of our collaborators. We would like to thank Richard Hamilton who shared with us the importance of classification of ancient solutions in geometric flows and collaborated with us on works that marked the beginning of our project on ancient solutions. We also want to thank Sigurd Angenent, our collaborator of several years now, with whom we developed methods for classifying ancient solutions that played an essential role in the development of the subject, and have been widely used since then, even in more general settings. It has been very inspiring and gratifying working with him all these years and we have learned a lot from him. We also want to thank Simon Brendle for sharing with us, since early on, his ideas on establishing the rotational symmetry of solutions and collaborating with us in proving the compact case of Perelman's conjecture in dimension three. Finally, we would like to thank all of our colleagues at Columbia University and Rutgers University for their support all these years, and without whose support all of our accomplishments in this citation would be impossible.

# LEROY P STEELE PRIZE FOR MATHEMATICAL EXPOSITION

THE Leroy P. Steele Prizes were established in 1970 in honor of George David Birkhoff, William Fogg Osgood, and William Caspar Graustein and are endowed under the terms of a bequest from Leroy P. Steele. Prizes are awarded in up to three categories.

The AMS Leroy P. Steele Prize for Mathematical Exposition is awarded annually for a book or substantial survey or expository research paper.

## CITATION

**Lawrence C. Evans**

Lawrence C. Evans is honored for his book, *Partial Differential Equations*, published by the American Mathematical Society, Providence, RI, 1998 (first edition) and 2010 (second edition). This unparalleled text has become the primary reference for every graduate student in the field and many experts. It achieves the near impossible task of giving coherence to the very extensive classical and modern theory of linear and nonlinear partial differential equations, through a masterful choice of material. A pleasure to read, it combines insight and clear technical descriptions in an attractive and economical style, making a complex area accessible to numerous young and established researchers.

### *Biographical Note*

**Lawrence C. Evans** received his PhD in mathematics in 1975 from UCLA, where he worked under the direction of Michael Crandall. Evans has been a math faculty member at the University of Kentucky, the University of Maryland and finally the University of California, Berkeley, from which he retired last year. His field of research is nonlinear partial differential equations, especially regularity theory, viscosity solutions and weak convergence issues.

Evans is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, and is an AMS Fellow.

### *Response from Lawrence C. Evans*

My deepest thanks to the American Math Society for this honor. And, coincidentally, I also thank the AMS for publishing this book 25 years ago. I

have received spectacular support from Sergei Gelfand and many others at AMS publishing, as the text has gone through many revised printings and a new edition.

My thanks also to the vast numbers of readers who over the years have located typos and errors, some quite stunning. Removing all the mistakes from a really long math book turns out to be impossible, at least for me, but the current version seems pretty good.

Finally, let me acknowledge also my many friends and colleagues who contributed their technical help, for various topics about which I am not so expert. Tai-Ping Liu in particular helped me immensely. It is surely true that the writing of mathematics books is deeply collaborative, even if only one name appears on the title page.

# LEROY P. STEELE PRIZE FOR SEMINAL CONTRIBUTION TO RESEARCH

THE Leroy P. Steele Prizes were established in 1970 in honor of George David Birkhoff, William Fogg Osgood, and William Caspar Graustein and are endowed under the terms of a bequest from Leroy P. Steele. Prizes are awarded in up to three categories.

The Steele Prize for Seminal Contribution to Research is awarded for a paper, whether recent or not, that has proved to be of fundamental or lasting importance in its field, or a model of important research. The prize is awarded according to the following six-year rotation of subject areas: Open, Analysis/Probability, Algebra/Number Theory, Applied Mathematics, Geometry/Topology, and Discrete Mathematics/Logic.

## CITATION

**Peter B. Kronheimer and Tomasz S. Mrowka**

The 2023 Steele Prize for Seminal Contribution to Research is awarded to Peter B. Kronheimer and Tomasz S. Mrowka for their paper, "Gauge theory for embedded surfaces. I," published in 1993 in *Topology* **32**, 773–826. This paper introduced new notions and developed sophisticated new technology that has played and continues to play a central role in gauge theory and low dimensional topology. The first application of the new methods (given in the cited paper) was to settle a 25-year-old conjecture of Milnor, concerning the minimality of the genus of algebraic surfaces among all embedded surfaces in the four-ball spanning the same boundary curve in the three-sphere. This marks the starting point of a long development which has revolutionized our understanding of the four-ball genus (for a recent example, see Piccirillo's proof that the Conway knot does not bound a disk). Kronheimer-Mrowka's argument is a consequence of a general adjunction inequality obtained in the paper.

Two years after the cited paper was published, Kronheimer and Mrowka used the same technology of singular instantons to describe the structure of the mysterious Donaldson invariants for closed four-manifolds, in terms of a finite number of "basic" degree two cohomology classes. This structure theorem led Edward Witten to his conjectural relationship between Seiberg-Witten invariants and Donaldson invariants.

Later, Kronheimer and Mrowka defined a new version of Floer homology for knots, again based on singular instantons. Using that, they proved that the (purely algebraically defined) Khovanov homology detects whether a knot is trivial. This led to a flowering of such detection results; for instance, concerning the trefoil knot, by Baldwin and Sivek. The authors, as well as many other researchers, continue to develop the ideas in the cited paper to define new invariants in low-dimensional topology, and the subject has grown to include relations with a wide array of topics (such as sheaf theory, in Côté's and Manolescu's recent work).

***Biographical Note***

**Peter B. Kronheimer** was born in London and educated at the City of London School and Merton College, Oxford. He obtained his BA in 1984 and his DPhil in 1987 under the supervision of Michael Atiyah. After a year as a Junior Research Fellow at Balliol and two years at the Institute for Advanced Study, he returned to Merton as Fellow and Tutor in Mathematics. In 1995 he moved to Harvard, where he is now William Caspar Graustein Professor of Mathematics. He is a recipient of the Förderpreis from the Mathematisches Forschungsinstitut, Oberwolfach, and the Whitehead Prize from the London Mathematical Society. He is a co-recipient of the Oswald Veblen Prize and the Joseph L. Doob Prize, both from the American Mathematical Society, and was elected a Fellow of the Royal Society in 1997. Outside of mathematics he enjoys playing the horn, often joined by his wife Jenny on piano.

***Biographical Note***

**Tomasz S. Mrowka** was born in State College, Pennsylvania in 1961. He received a SB in mathematics from MIT in 1983. His 1988 PhD is from UC Berkeley advised by Clifford Taubes. After postdoctoral positions at the MSRI and Stanford, he was appointed as a professor at Caltech in 1992 and moved to MIT in 1994. At MIT, Mrowka has served as chair of graduate studies, chair of the pure mathematics committee and head of the department.

Mrowka was awarded the NSF Young Investigator Grant in 1993. He has been a fellow of the Sloan Foundation, Radcliffe Institute, Guggenheim Foundation and Simons Foundation. Mrowka is a member of the American Academy of Arts and Sciences and the National Academy of Sciences. He is a joint recipient of the Oswald Veblen Prize and the Joseph L. Doob Prize of the AMS. In 2018, with Kronheimer, they delivered a plenary lecture at the ICM.

***Response from Peter B. Kronheimer and Tomasz S. Mrowka***

We are honored and delighted to hear that we have been awarded the Leroy P. Steele Prize for Seminal Contribution to Research.

Our paper, “Gauge theory for embedded surfaces, I” and its later companions had their origin in a collaboration which was forged at Oberwolfach in the summer of 1991. There we had the opportunity to work together for several weeks at the Mathematisches Forshungsinstitut, with this project in mind. By the end of that stay, the key results that we had been aiming for, concerning singular Yang-Mills instantons, were in place, and applications such as Milnor’s conjecture on the unknotting number of torus knots soon followed.

Our mathematical research since then has taken several directions, but has often returned to the singular instanton story. It has been a constant source of excitement, not only to see new applications of these ideas in the work of many mathematicians, but also to see quite new tools being developed over the intervening decades, greatly increasing the state of knowledge around questions which might have seemed out of reach in 1991.

We would like to thank our families for their love and support. Our sincere thanks also to the community of mathematicians whose ideas formed the background for our own work and whose contributions have led to such vigorous and unexpected growth in this field. We thank the Oberwolfach Foundation for the opportunity afforded by the Oberwolfach Prize in 1991. Finally, we thank the American Mathematical Society and the selection committee for recognizing our work in this way.

# LEROY P. STEELE PRIZE FOR LIFETIME ACHIEVEMENT

THE Leroy P. Steele Prizes were established in 1970 in honor of George David Birkhoff, William Fogg Osgood, and William Caspar Graustein and are endowed under the terms of a bequest from Leroy P. Steele. Prizes are awarded in up to three categories.

Presented annually, the AMS Leroy P. Steele Prize for Lifetime Achievement is awarded for the cumulative influence of the total mathematical work of the recipient, high level of research over a period of time, particular influence on the development of a field, and influence on mathematics through PhD students.

## CITATION

**Nicholas M. Katz**

The Steele Prize for Lifetime Achievement is awarded to Nicholas M. Katz for his landmark contributions to number theory and arithmetic geometry.

Katz' fundamental articles and monographs have benefited the mathematical community by opening up new directions of research, and illuminating large areas of mathematics. His best-known works include his long Antwerp article on $p$-adic modular forms; his *Astérisque* volume on exponential sums; the *Annals of Mathematics Studies* volume on moduli of elliptic curves by Katz and Mazur; and the AMS volume *Random matrices, Frobenius eigenvalues, and monodromy* by Katz and Sarnak.

A continuing theme in Katz's work is his pathbreaking and influential study of the connection between exponential sums and lisse $l$-adic sheaves on open curves over finite fields. By viewing such sums as traces of Frobenius at the closed points of the curve and applying the fundamental results of Deligne, he obtained powerful distribution results for exponential sums, through a study of the global monodromy groups of the sheaves.

Throughout his career, Katz has been generous in sharing his enthusiasm and farreaching insights with students and colleagues at all levels. His mentorship of generations of mathematicians has been of inestimable value.

### *Biographical Note*

**Nicholas M. Katz** attended Johns Hopkins as an undergraduate, and received his PhD from Princeton in 1966 as a student of Bernard Dwork. His work focuses on

the $p$-adic and $l$-adic aspects of life over finite fields, and its relation to life in characteristic zero. He is a professor at Princeton.

He visited IHES for many sabbaticals and for many many summers, and twice was a visiting professor at Orsay. He has held a NATO Postdoctoral Fellowship, a Sloan Fellowship, a Guggenheim Fellowship twice, a JSPS Fellowship, a Visiting Miller Professorship, a Simons Fellowship, and was several times an Ordway Visiting Professor at the University of Minnesota.

He served as Deparment Chair in 2002–2005. He and Peter Sarnak were jointly awarded the Levi L. Conant prize in 2003. He is a member of the National Academy of Sciences. He is an editor of *Annals of Mathematics*.

***Response from Nicholas M. Katz***

I am delighted and honored to receive the Leroy P. Steele Prize for Lifetime Achievement. I have had astoundingly good luck in my career. When I graduated from high school in 1960, calculus was not standardly taught in high school, and the usual first semester college math course was "Analytic Geometry". But when I arrived at Johns Hopkins, that course had just been scrapped completely, in favor of a revolutionary course designed by Mostow, Meyer, and Sampson, with the idea that genuine "abstract" mathematics could and should be taught to everyone. Mostow taught the course that year, and it was transformational for me. I also fell under the charismatic spell of Ken Ireland, then a graduate student of Dwork, and when I was taught Galois theory by Dwork there was no going back. Another transformational event was Dwork arranging my attending Woods Hole in 1964, where I saw giants at work and at play. I then had the good fortune to visit IHES and learn from and be inspired by both Deligne and Grothendieck, and later by Gabber. Having Laumon, Mazur, Messing, Oda, Sarnak, and Tiep as co-authors, each with amazing breadth of knowledge and interest and enthusiasm, has been an inspiration to me.

# Summary of Awards

**For AWM**

**Joan & Joseph Birman Research Prize in Topology and Geometry**: Kristen Hendricks
**Mary & Alfie gray Award for Social Justice**: Lily Khadjavi
**Dissertation Prize**: Jia Shi, María Soria-Carro, Rajula Srivastava
**Louise Hay Award for Contribution to Mathematics Education**: Nicole Joseph
**M. Gweneth Humphreys Award for Mentorship of Undergraduate Women in Mathematics**: Erika Tatiana Camacho
**Alice T. Schafer Prize for Excellence in Mathematics by an Undergraduate Woman**: Faye Jackson; runner-up: Anqi Li; honorable mention: Ilani Axelrod-Freed, Joye Chen, and Veronica Lang

**For AIM**

**AIM Alexanderson Award**: Jan Bruinier, Benjamin Howard, Stephen Kudla, Michael Rapoport, and Tonghai Yang

**For AMS-MAA-SIAM**

**Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student**: Letong (Carina) Hong; Honorable mention: Egor Lappo and Sophie Kriz

**For JPBM**

**JPBM Communications Award (2023)**: Jordan Ellenberg and Grant Sanderson
**JPBM Communications Award (2022)**: Talithia Williams

**For COMAP**

**COMAP Doug Faires Award**: Kathleen (Kathi) Snook

**For ILAS**

**ILAS Invited Address**: Apoorva Khare

**For AMS**

**Bôcher Memorial Prize**: Frank Merle, Pierre Raphaël, Igor Rodnianski, and Jérémie Szeftel
**Frank Nelson Cole Prize in Algebra**: Kaisa Matomäki, James Newton, Maksym Radziwill, and Jack Thorne
**Levi L. Conant Prize**: Joshua Evan Greene
**Mary P. Dolciani Prize**: Diana M. Thomas
**Joseph L. Doob Prize**: Bjorn Poonen
**Leonard Eisenbud Prize for Mathematics and Physics**: Jason P. Miller and Scott Sheffield
**Award for an Exemplary Program or Achievement in a Mathematics Department**: Smith College
**Award for Impact on the Teaching and Learning of Mathematics**: Ulrica Wilson
**Mathematics Programs that Make a Difference Award**: University of Texas, Arlington
**Ruth Lyttle Satter Prize**: Panagiota Daskalopoulos and Nataša Šešum
**Leroy P. Steele Prize for Mathematical Exposition**: Lawrence C. Evans
**Leroy P. Steele Prize for Seminal Contribution to Research**: Peter B. Kronheimer and Tomasz S.Mrowka
**Leroy P. Steele Prize for Lifetime Achievement**: Nicholas M. Katz

# Index of Award Recipients