BECKENBACH BOOK PRIZE

THE BECKENBACH BOOK PRIZE, established in 1986, is the successor to the MAA Book Prize established in 1982. It is named for the late Edwin Beckenbach, a long-time leader in the publications program of the Association and a well-known professor of mathematics at the University of California at Los Angeles. The prize is intended to recognize the author(s) of a distinguished, innovative book published by the MAA and to encourage the writing of such books. The award is not given on a regularly scheduled basis. To be considered for the Beckenbach Prize a book must have been published during the five years preceding the award.

CITATION

Nathan Carter

Bentley University

Introduction to the Mathematics of Computer Graphics, Mathematical Association of America (2016)

The Oxford logician Charles Dodgson via his famed Alice character rhetorically asked, "Of what use is a book without pictures?" And most of us believe that a picture is worth a thousand words. In the same spirit, Nathan Carter in his *Introduction to the Mathematics of Computer Graphics* has given us a how-to book for creating stunning, informative, and insightful imagery.

In an inviting and readable style, Carter leads us through a cornucopia of mathematical tricks and structure, illustrating them step-by-step with the freeware POV-Ray—an acronym for Persistence of Vision Raytracer. Each section of his book starts with a natural question: Why is this fun? Of course, the answer is a striking image or two—to which a reader's impulsive response is, How might I do that? Whereupon, Carter proceeds to demonstrate.

He leads us through vectors, geometrical transformations in two and three dimensions, lines of sight and perspective, the theory of color and lighting techniques; animation, applications of Bernstein polynomials and Bezier curves, and finishes with subdivision algorithms. Nathan Carter's book is a modern-day version of the master wood-cutter Albrecht Dürer's 1525 mathematical and artistic treatise *The Art of Measurement with Compass and Straightedge*.

Danger! Unless you are already an expert, reading this book may prompt you to produce graphics that indeed pop.

Biographical Note

Nathan Carter uses computer science to advance mathematics by writing open-source software for university mathematics education in areas including mathematical logic and abstract algebra visualization. He is a past winner of the Mathematical Association of America's Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member. His major projects have been books, beginning with *Visual Group Theory* (2009), which won the 2012 Beckenbach Book Prize from the MAA. His second text, *Introduction to the Mathematics of Computer Graphics* (2016), will receive that same award in 2020. His most recent book is an edited volume with many contributors, entitled *Data Science for Mathematicians* (2020), intended to help pure mathematicians make the transition into teaching and conducting research in the ever-growing field of data science.

Response from Nathan Carter

Nobody starts life able to write anything, much less write it well. So I must thank the two most significant influences on my life as a writer. I took several English and writing courses from Dan Fraustino as an undergraduate at the University of Scranton, because I knew that he was completely merciless in his requirement that I work and improve, and I hated that and loved it at the same time. Thank you so much, Dan. But long before I met Dan, I worked with an editor; my mother is a copy editor and has been for years, editing my school papers since before I knew that I wanted to study mathematics or write anything. From these two people more than anyone else, I've learned not to stop editing my writing until I can't find anything else to improve, no matter how long that takes.

Several academic friends deserve thanks as well. Andy Hansen of Indiana University first introduced me to computer graphics, Tony DeRose of Pixar and Rasmus Tamstorf of Disney both helped shape the topic list, and Ken Monks and Cornelia Van Cott helped me explain topology concepts correctly. And my friend Ken Crounse of E Ink was an extremely patient correspondent, teaching me what you can and can't say about human color perception. My friend and colleague Charlie Hadlock enthusiastically validated book-writing as a legitimate focus for a mathematical career; my dean Dan Everett supported my taking time to write; and my students patiently worked through many iterations of the text that were far less refined than the final product!

But my primary thanks go to the Mathematical Association of America; I have been very fortunate to work with them when writing books. MAA staff are dedicated and knowledgeable and care about publishing works that, first and foremost, benefit the mathematical community. My great thanks go to them first

for being willing to take up this book project and work with me on seeing it to fruition, then second for being kind enough to consider me for this award. Both have been a pleasure and I am blessed to have had the opportunity.

CHAUVENET PRIZE

THE Chauvenet Prize is awarded to the author of an outstanding expository article on a mathematical topic. First awarded in 1925, the Prize is named for William Chauvenet, a professor of mathematics at the United States Naval Academy. It was established through a gift in 1925 from J. L. Coolidge, then MAA President. Winners of the Chauvenet Prize are among the most distinguished of mathematical expositors.

CITATION

Travis Kowalski

South Dakota School of Mines and Technology

"The Sine of a Single Degree," *The College Mathematics Journal* **47** (2016), no. 5, 322–332, DOI:10.4169/college.math.j.47.5.322.

In a standard trigonometry course, one typically considers the sine of standard angles 30°, 45°, and 60°, but what about sine of 1°? This paper boldly asks if it is possible to find an exact value for sin 1° in terms of ratios of radicals and integers, and then takes the reader on a beautiful mathematical tour involving geometry, algebra, and complex numbers to answer that question.

Kowalski begins his tour in the realm of triangle geometry. Using some standard trigonometric identities, he deduces an exact form for sin 3°. To get closer, the author brings in tools from algebra and obtains sin 1° as a solution to a particular cubic equation. The reader is nicely brought into a discussion of the solvability of cubic equations and the structure of solutions of the depressed cubic, no discussion of which would be complete without the cube roots of unity. From here, we are taken on a brief excursion into the geometry of complex numbers before arriving at multiple exact expressions for sin 1° and ending with one that is "delightfully bizarre and strangely beautiful."

What makes this paper special is how seamlessly the author transitions from one topic to another in the hunt for sin 1°. The tour entices its reader to delve more deeply into geometry, algebra, and complex numbers, and is well designed to appeal to a wide mathematical audience.

Biographical Note

Travis Kowalski went to college to pursue art and ended up with a mathematics degree: "I didn't change my major, only my medium." He earned his undergraduate and graduate degrees from the University of California. He spent two years as a visiting professor at Colorado College, where he was known for his colorful lecture style and equally colorful collection of aloha shirts. He has been a Professor of Mathematics at the South Dakota School of Mines and Technology since 2004 and currently serves as its Interim Head of Mathematics. His mathematical interests include mathematical SOTL, applications of formal power series, and exploring the intersection of mathematics, art, and culture. He also enjoys creating napkin art, playing tabletop games with his family, and panicking at the ever-increasing size of his email inbox.

He is a recipient of the MAA's 2017 George Polya Award and the 2019 Burton W. Jones Award.

Response from Travis Kowalski

I am honored to be recognized with the Chauvenet Prize. Among its laureates are many of the authors who inspired me to see mathematics as much as an expression of artistry and humanity as an exercise in logic and rigor—Hardy, Halmos, Mazur, Krantz, Boas—and I am humbled (and in more than a little disbelief) to be considered among them. This article started as a historical romp of a talk for a departmental Pi Day celebration, an excuse for a bit of mathematical "delight and travel," as Jerome Bruner would say. I am delighted to discover that readers have enjoyed traveling with me through time and technique to admire some gorgeous mathematical gems.

I am grateful to the Mathematical Association of America for fostering this community of mathematical scholars and storytellers, and for their tireless advocacy in sharing the beauty of mathematics with everyone. I am grateful to all my teachers—Jeff Luscher, Albert Stralka, Mihai Putinar, Salah Baoendi—for instilling in me a love of doing and sharing mathematics. I am grateful to my colleagues and students at the South Dakota School of Mines for their patience in listening to this talk over and over, and their feedback in improving it each time. And I am grateful to my family—Bailey, Liliana, and Maia—for their support and love.

EULER BOOK PRIZE

THE Euler Book Prize is awarded annually to the author of an outstanding book about mathematics. The Prize is intended to recognize authors of exceptionally well-written books with a positive impact on the public's view of mathematics and to encourage the writing of such books. The Euler Prize, established in 2005, is given every year at a national meeting of the Association beginning in 2007, the 300th anniversary of the birth of Leonhard Euler. This award also honors Virginia and Paul Halmos, whose generosity made the award possible.

CITATION

Francis Su and Christopher Jackson

Harvey Mudd College

Mathematics for Human Flourishing, with reflections by Christopher Jackson, Yale University Press (2020)

While many authors have presented compelling cases for the beauty and utility of mathematics, *Mathematics for Human Flourishing* takes a different tack, presenting mathematics as a discipline that has the power to transform lives and speak to the very core of what it means to be human.

Su's writing artfully blends personal narrative with scholarly perspectives and mathematical problems that challenge the reader to engage in their own mathematical journey as the book unfolds. As powerful as Su's narrative is, his thesis is driven home in dramatic fashion through the included writings of Christopher Jackson, whose own journey led him to discover the transformative power of mathematics from behind prison walls.

In the conclusion of the book, Su encourages his readers, writing: "I hope you now never feel like saying, 'I'm not a math person,' because you are a human person, and you can see how doing math is tightly bound to being human." He hopes that his readers will "speak about mathematics with others as a vitally human endeavor, grounded in basic desires that we all share, and elevated by virtues to which we can all aspire."

Su and Jackson's book is well-positioned to accomplish these lofty goals. Indeed, if taken to heart, *Mathematics for Human Flourishing* will transform the reader's conception of what it means to do mathematics, to apply mathematics, and to find mathematics beautiful.

Biographical Note

Francis Su writes about the dignity of human beings and the wonder of mathematical teaching. He is the Benediktsson-Karwa Professor of Mathematics at Harvey Mudd College, a former MAA president, and currently serves as an AMS vice-president. His research is in geometric combinatorics and he has co-authored numerous papers with undergraduates. In 2013, he received the MAA Haimo Award for distinguished teaching of mathematics. He authors the popular Math Fun Facts website and is the creator of @mathfeed, a math news aggregator on Twitter. Besides the *'Flourishing'* book, his recent projects include a linear algebra course for the Teaching Company and an IBL topology text with Michael Starbird.

Biographical Note

Christopher Jackson is an avid reader and thinker. Although mistakes as a teen landed him in federal prison 14 years ago, the study of mathematics, politics, and philosophy, among other subjects, helped him turn his life around. Within math, he has worked his way from algebra texts to calculus. Lately, he has been learning linear algebra and topology and is currently reading *Elements of Pure and Applied Mathematics*. His favorite area of math is analysis. He works in the education department at the Coleman federal prison in Florida and has helped over 50 inmates so far learn math to get their GEDs. His hobbies include studying, reading, working out, and keeping current with world events. He has a goal of using his experiences to get people excited about math education in particular and also education in general.

Response from Francis Su

The *'Flourishing'* book had its roots in my own journey of discouragement and wrestling with the fact that what I loved most about math was often absent from the way it is practiced and taught. As math educators, we would love for the public to see math differently, and yet we do little to change an educational system that rewards elitism and discourages those who don't fit a certain mold. We've stripped away the human aspects of math from our evaluation of mathematical potential. Many have helped me see this, most especially my friend Christopher Jackson. Discussing ideas with him has been a real joy, and I have learned so much by seeing math and life through his eyes. I am also more convinced than ever that if we could truly see the dignity and potential in each human being, we would not be locking away teenagers with long sentences over small crimes. I wish to thank the many people who read drafts of the book, my wife Natalie for her steadfast support, and the MAA for valuing mathematical exposition. I feel grateful to have had this opportunity to shape public dialogue about what math is, who it's for, and why everyone should learn it.

Response from Christopher Jackson

Mathematics has always been present in my life (I was told that I was "good" at mathematics from an early age through my early teens until my life took a change in course). After being put into a situation where I could stop and reflect, I found my love for mathematics when I realized that mathematics was a science about ideas and the application of ideas. I would like to thank the MAA for recognizing the ideas of my friend Francis Su and myself with this award. Ideas, when deeply digested, can change perspectives and the actions that come with them. I would like to thank Francis for listening to me and talking to me amongst other things, but especially for encouraging me to stick with and follow my ideas. In a lot of our correspondence and in some used for the book, I usually considered myself "rambling" or saying something half insightful and half off the wall, but he always seemed to convince me otherwise. I have been blessed to have so many people come through my life who have given me insight, pushed me to better myself, or have given me opportunities even if I didn't take advantage of the opportunities at the time. Reflecting on those events allowed me to become better down the line. I'm also appreciative of those who've allowed me to help them, because in attempting to help others, I was ultimately able to help myself, and I am appreciative of all support from every source from which it comes. Thank you.

DEBORAH AND FRANKLIN TEPPER HAIMO AWARDS FOR DISTINGUISHED COLLEGE OR UNIVERSITY TEACHING OF MATHEMATICS

In 1991, the Mathematical Association of America instituted the Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching of Mathematics to honor college or university teachers who have been widely recognized as extraordinarily successful and whose teaching effectiveness has been shown to have had influence beyond their own institutions. Deborah Tepper Haimo was president of the Association, 1991–1992.

CITATION

Dave Kung

St. Mary's College of Maryland

Dave Kung is recognized for outstanding teaching and mentorship, and his leadership in making mathematics more inclusive at St. Mary's College of Maryland (SMCM) and beyond. A belief that every person can meet high standards and achieve greatness guides Dave as he makes mathematics an accessible and joyful experience for all. Inquiry and teamwork are fundamental to Dave's teaching, and he integrates mathematics into life experiences through both the development of innovative and popular courses and diverse collaborations with music, athletics, labor, and many other components of collegiate, public, and private life. His energy is contagious, inspiring passion for mathematics, teaching, fun, fairness, and humanism.

Throughout his career, Dave has worked to build a supportive culture in which students learn from one another, and he has facilitated outstanding experiences for students from groups historically underserved by the mathematics community. He co-founded a departmental emerging scholars program (ESP), which he then helped expand to the other STEM disciplines in his college. He ran MAA PREP workshops to guide other institutions in planning ESP programs of their own. He has served as PI in multiple summer REU programs at SMCM for underrepresented students in mathematics. He also founded the local Southern Maryland Math Circle for 7th–12th graders, focusing on the poorest areas of the community. He affords all of his students a wide variety of opportunities according to

their interests, such as research in mathematics education, training in actuarial science, and participating in the Putnam exam.

In addition to developing his craft on an on-going basis, Dave empowers large numbers of diverse colleagues to embrace evidence-based best practices in teaching. He cultivates fabulous teaching in his department, his college, and around the country, from sitting on 30 hiring committees in his department to initiating college-wide programs like a New Faculty Seminar and a Teaching Excellence Workshop on Culturally Sensitive Teaching, to giving talks all around the country, to organizing meetings, to his work with professional development for new faculty, and to reaching a wide audience with Great Courses video series. He has sparked the creation of programs for graduate student professional development nationally, starting as a co-PI on the project Video Case Studies for Professional Development of Teaching Assistants and now as a consultant on the College Mathematics Instructor Development Source. He has held leadership roles in the Young Mathematicians' Network, various MAA committees, and TPSE-Math. He co-wrote the book *What Could They Possibly Be Thinking!?! Understanding Your College Math Students,* which brings the research of the mathematics education community to college math teachers. Promoting inclusivity in the classroom, he inspired the removal of the name of Moore, a documented racist, from the Inquiry Based Learning conference.

The MAA recognizes Dave Kung for the profound impact he has had on his students and for the bridges he has built between the mathematics-education and broader mathematics communities to improve teaching and cultivate diverse participation in mathematics and mathematics teaching. The MAA is honored to present him with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

Dave Kung earned his Bachelors, Masters, and Doctorate from the University of Wisconsin–Madison, studying Harmonic Analysis with Andreas Seeger. In addition to being a professor of mathematics at St. Mary's College of Maryland, where he has taught since 2000, he serves as the director of MAA Project NExT, and as the director of strategy and implementation for Transforming Post-Secondary Education in Mathematics (TPSE-Math).

Dave Kung had nearly every advantage imaginable for someone wishing to make it in the mathematics community. In addition to being a White/Asian cis-gender male, both his parents taught the subject at the post-secondary level. From being marked as gifted early on to being asked to give important addresses around the country, to being nominated for teaching awards based on student evaluations, doors have opened for him in part based on unearned positive assumptions others made about him and his work.

Response from Dave Kung

I am honored to be given this award by the MAA, humbled to join the amazing list of recipients, and excited to see that recent additions to that list have made it more closely resemble the diversity we all claim to value.

I have always strived to inspire students the way my teachers have inspired me. My deepest gratitude goes out to the many teachers who had the patience to deal with a headstrong, brash kid who thought he knew it all, even as he kept learning more. Thanks also to my close friends who have helped me (sometimes reluctantly) gain at least a little more self-awareness.

None of the accomplishments listed in the citation were done alone. Thanks to the many collaborators who worked tirelessly on these projects, including the support staff vital to that work.

Thanks to the activists within the math world who constantly push us all to be better, to be more equitable, to reach populations long forgotten by our community, to see power structures more clearly, and to dismantle those structures that only serve privilege and power. The arc of the moral universe doesn't bend toward justice on its own.

Finally, thanks to my daughter Ellie who inspires me to make the world a better place, and to my parents who have provided more love and support than I could ever have reasonably asked for.

CITATION

David Austin

Grand Valley State University

David Austin is recognized for his record of exemplary mathematics teaching at Grand Valley State University and his support and expansion of programs to build relationships between indigenous communities and the broader mathematical community through mathematical creativity. In and out of the classroom, David brings math alive by showing how it can answer questions of interest to the average person, about topics such as traffic jams or Pixar's animation. In his classes, his writing, and his professional development workshops, he presents math as an active agent in answering socially relevant questions, and technology as a key tool within that mathematical exploration. His engaging columns for AMS, often accessible to a first-year college student, highlight the many ways mathematics appears in everyday life.

David has engaged with and disseminated uses of technology within math, to make "the computer as invisible to the students as possible so that the mathematics stands out more clearly." With his easy-to-use tools, students can explore mathematical ideas without worrying about programming syntax. As a result, students can see math in action and interact with it to discover new

insights. David has played a major role in developing his department's applied mathematics courses and its new applied mathematics major, and has offered annual workshops in teaching linear algebra to Project NExT participants. He has also run multiple summer schools on mathematical graphics and served as a mentor for a local robotics team.

David has made important contributions to the engagement of indigenous students in mathematical inquiry and inclusivity within the mathematical community. In his role as a director for the Alliance for Indigenous Math Circles (AIMC), he has helped to organize and run summer camps for indigenous students and their teachers, as well as nurtured connections between the AIMC and the American Institute of Mathematics, one of the NSF-funded mathematics institutes. He also helped found a chapter of the American Indian Science and Engineering Society at the University of British Columbia.

The MAA recognizes David Austin for his impact on the mathematical community and its pedagogy through technological innovation, lively communication, and engagement in indigenous communities, and is honored to present him with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

David Austin

Growing up in Oklahoma City, David Austin learned to love mathematics at an early age while maintaining the certainty that he never wanted to teach. He received a B.A. in mathematics and physics from Rice University before finishing a Ph.D. at the University of Utah under the supervision of Ron Stern. After a postdoctoral position at the Institute for Advanced Study, David joined the mathematics faculty at the University of British Columbia, where he slowly began to discover his voice as a teacher. After nine years at UBC, he moved to Grand Valley State University and feels grateful every day for colleagues who encourage experimentation, reflection, and collaboration; being part of a department whose default response is "let's find a way to make that happen" is truly a gift. In addition, David is a long-time contributor to the American Mathematical Society's online Feature Column, promotes and authors open educational resources to improve access to higher education, is a director of the Alliance of Indigenous Math Circles; and mentors 7–12th grade students in math and programming within the FIRST robotics program.

Response from David Austin

I'm deeply honored to be selected for this award and accept it with the humility that comes from recognizing the many people who have shaped me into the teacher I've become. My parents continually wove life-long learning and service

to others into our family, and I often think of my aunts, beloved teachers in small Oklahoma towns who touched many lives. One day, my high school algebra teacher, Charlotte Smith, showed our class a proof that an additive identity is unique, and I felt, in a single moment, that a world of possibility had been opened for me. I began my teaching career at the University of British Columbia where I discovered the joy of collaborating with colleagues who continually innovate and question everything. I'm also extremely grateful for my many colleagues at Grand Valley State who continue to nurture a department that lives its mission to support our students and colleagues. Thank you to the MAA for providing this place where we can have discussions about how to improve as teachers and as a community. And, most importantly, thank you to all my students who have shared a part of their mathematical journey with me. Real learning requires vulnerability, and I'm so grateful to all those who have trusted me and helped me understand this deeply human profession.

CITATION

Elaine Kasimatis

California State University, Sacramento

Elaine Kasimatis has a long and exemplary record of accomplishments that attest to her devotion to teaching and student learning. She is the rare mathematician who holds a Ph.D. in pure mathematics as well as an MA in Mathematics Teaching and a teaching credential. Elaine is recognized as a thoughtful and inspiring teacher and a deeply caring mentor whose support builds her students' penchant for persevering to make sense of the mathematics they are exploring. Her broad and deep work through regional, state, and national efforts has profoundly influenced not only students, but also generations of mathematics teachers and, in turn, their students.

Early in her career, Elaine recognized the need for programs to better support future teachers of mathematics. She developed a course to engage future elementary school teachers in genuine mathematical processes—exploration, conjecture, and proof. The course has influenced thousands of teachers as well as the dozens of mathematics faculty members who have taught the course over the past 30 years. Elaine developed a capstone course connecting real analysis and abstract algebra content to high school curricula, revamped the university's curriculum for remedial mathematics, created professional development programs for faculty teaching remedial mathematics, and developed a course to train tutors, among other projects. Much of this work has now appeared in more widely distributed programs and curricula, and in every case, Elaine was years ahead of the trends to create such programs. Elaine played a major role in developing the first program in California to integrate mathematics content with teacher preparation. Since the program's inception in

2001, she has carefully mentored and supervised every student teacher. Teachers from the program are in high demand regionally because of their exceptional preparation. Many teach in communities with large numbers of students from historically underserved groups. Her direct support of K–12 teachers also extends beyond their college and university experience, as she developed the California Math Project, a home for K–12 teachers of mathematics that, for over two decades, has enhanced the professional lives of thousands of teachers.

Elaine has been similarly influential beyond northern California. Her work on the NSF-funded Access to Algebra program increased the success of middle school students in Algebra 1 classes around the country. She is well-known for co-creating College Preparatory Mathematics, an innovative high school and middle school mathematics curriculum now used nationally and internationally. In 1999, it was designated one of three Exemplary Mathematics Programs by the US Department of Education. Elaine's international efforts include her work to create a new school in Rwanda and to develop the teacher preparation program there.

For her inspiration of students, her creation of programs to develop future teachers and support current teachers, and her influential curriculum and program development, the MAA is honored to recognize Elaine Kasimatis with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

Elaine Kasimatis earned a handful of degrees and credentials from the University of California, Davis—her hometown university—culminating in 1986 with a Ph.D. in discrete geometry under the guidance of Sherman K. Stein, who advised her to "let the problem speak to you" and introduced her to the idea of posing questions that engage students in the "tri-ex process." She immediately joined the faculty at California State University, Sacramento, eager to work with a diverse student body in a department that emphasized the mathematical preparation of teachers. She was fortunate to have grown up in a small community that supported its public schools and attracted highly-qualified teachers who challenged students to think and welcomed students to ask probing questions and wonder "Why?" Her love of mathematical reasoning was kindled by her Grade 4 teacher, Mrs. Briley, who unveiled the whys of fraction arithmetic. Not entirely home-grown, Elaine also spent a year of high school in Sydney, Australia, and her junior year of university at Georg August University in Goettingen, Germany, two experiences that broadened her perspective on studying mathematics. Elaine's interest in teaching mathematics grew naturally out of her observations of classmates' struggles and successes together with teachers' practices that fostered confusion or understanding, and her reflections on what she did to make sense of problems. Her aspiration to effect changes

in the way mathematics was taught was ignited by Postman and Weingartner's Teaching as a Subversive Activity (1969) and sustained by the philosophical underpinnings and Socratic method she acquired through Project S.E.E.D. Elaine's teaching experience spans Grade 2 through the university level, and throughout her career she has continued to ponder teacher-student-curriculum interactions that influence understanding and to seek ways to nurture sense-making in the classroom. Her favorite days are when she is with students, either working on mathematics or observing student teachers. She also enjoys spending time with her daughter, working in her yard, and learning about different cultures.

Response from Elaine Kasimatis

I am deeply honored and genuinely delighted to receive the MAA Haimo Award in recognition of my contributions to the teaching of mathematics. I am truly grateful to my friend and colleague Kathy Zhong for nominating me, and to the many colleagues and former students who supported my nomination. I would never have been able to achieve any of my goals were it not for the inspiration and guidance of several outstanding mentors, the patience and spark of a multitude of students and teachers, and the on-going support of talented colleagues. The steadfast mentoring of Cal Crabill, Don Chakerian, and Sherman Stein challenged my thinking, fueled my imagination, and renewed my spirits. So, too, did my students, who trusted me to ask questions that would help them construct their understanding of mathematics, and the teachers who welcomed me and student teachers into their classrooms. Long time collaborations with Edward Bradley, Scott Farrand, Wally Etterbeek, and Warren Furumoto were instrumental in the development and fruition of new courses and experimental projects. Over the years I also received encouragement and ideas from Marjorie Enneking, Roberta Gehrmann, Tom Lester, Bill Raski, Tom Sallee, and Bob Stringall. My life has been richly blessed by all of these dedicated teachers and many more.

I am also thankful for the lack of support and the discouraging "you don't really belong" messages that I encountered throughout my career. Rather than turn me away from my goals, this opposition triggered deeper perseverance. Bumpy paths have helped me to slow down, examine surroundings more carefully, and be more uplifting of others—so defeats are also blessings. Looking ahead, I hope that mathematics departments will renew their commitment to the preparation of mathematics teachers, encouraging outstanding students to pursue careers in teaching. I hope mathematics departments will recognize the immensely positive impact that mathematicians working on-site in on-going collaboration with teachers in elementary and secondary classrooms can have on students.

Lastly, I would like to acknowledge the inspiration and joy that my daughter Katja continues to bring to my life. She grew up attending classes, conferences,

workshops, and institutes, progressing from being an infant in a sling while I led all-day professional development meetings to assist with workshops. I am proud of her and grateful for her patience, inquisitiveness, and, most of all, being herself.

YUEH-GIN GUNG AND DR. CHARLES Y. HU AWARD FOR DISTINGUISHED SERVICE TO MATHEMATICS

THE Gung and Hu Award for Distinguished Service to Mathematics, first presented in 1990, is the endowed successor to the Association's Award for Distinguished Service to Mathematics, first presented in 1962. This award is intended to be the most prestigious award for service offered by the Association. It honors distinguished contributions to mathematics and mathematical education—in one particular aspect or many, and in a short period or over a career. The initial endowment was contributed by husband and wife, Dr. Charles Y. Hu and Yueh-Gin Gung. It is worth noting that Dr. Hu and Yueh-Gin Gung were not mathematicians, but rather a professor of geography at the University of Maryland and a librarian at the University of Chicago, respectively. They contributed generously to our discipline, writing, "We always have high regard and great respect for the intellectual agility and high quality of mind of mathematicians and consider mathematics as the most vital field of study in the technological age we are living in."

CITATION

Deanna Haunsperger

Carleton College

The Gung and Hu Award Committee recommends that the 2021 award go to Deanna Haunsperger for her prolific service to mathematics, including with the Mathematical Association of America; for her influential leadership of women in mathematics; for her long focus on inclusion and on building inclusive mathematical communities; and for a laudable career that has been rich in mathematical research, mathematical education, and mathematical exposition.

There are many ways one might influence the course of our discipline in Gung Hu-worthy ways. The main theme of Deanna's way is inclusion, in the sense of working to make learning and doing mathematics, from elementary to advanced levels, interesting and viable for many and various people. Deanna's deep interest in welcoming and helping a broad range of students to the study of mathematics is clear and evident. Both the goal of building a mathematical community and Deanna's efforts to this end are about as thoroughly MAA-centered as one could imagine. Deanna Haunsperger was MAA president (2017–2018) and is a professor of Mathematics at Carleton College, where she has been teaching for over

twenty-five years. She earned her BA in mathematics and computer science from Simpson College and her Ph.D. in mathematics from Northwestern University, focusing on voting theory applications to decision making.

As a faculty member at Carleton College, co-editor of *Math Horizons*, co-founder and co-director of the NSF-funded Summer Mathematics Program for Women Undergraduates [SMP], the second vice president and president of the MAA, chair of the Strategic Planning Group on Students, chair of the Council on Outreach Programs, co-chair of the Centennial Planning Committee, a member of many more MAA committees, and a member of the Mathematics Community as a whole, Deanna has done a tremendous job of encouraging, mentoring, and envisioning programs to help undergraduates pursue graduate study and careers in the mathematical sciences.

Carleton's Summer Math Program for women (SMP) was recognized by the AMS as a 2014 Program That Makes a Difference. As the co-founders and co-directors from 1995 through 2014, Deanna and fellow mathematician and husband Stephen Kennedy created a community of several hundred female mathematicians who support, encourage, and inspire one another, and who mentor younger women who are thinking of going into mathematics. The impact of this group of female mathematicians can be felt throughout the country. The community of women built by this program, whose members started as undergraduates, now boasts over 110 Ph.D.s in mathematics or a mathematical science, with over 30 members currently in graduate school in mathematics. These women will invariably tell you how grateful they were to SMP and Deanna and Stephen for helping them get where they are now in mathematics.

In addition to the leadership and mentoring that Deanna and Stephen provided to students during SMP, they have continued to foster the community of former SMPers long after the NSF stopped funding summer programs for women. Every year, they organize an SMP reunion at the Joint Mathematics Meetings, which now brings together approximately 40–50 alumnae at various stages in their mathematical careers. While SMP still had some NSF funding, they would help organize a JMM workshop, the Graduate Education Mentoring Workshop (GEM), to offer continued mentoring and networking for former SMPers who were pursuing graduate studies. This workshop was run by former SMPers who had tenure-track jobs themselves, but Deanna and Stephen's ideas, enthusiasm, and encouragement would be felt every step of the way.

Deanna was recognized in 2012 by the AWM with the M. Gweneth Humphreys Award for Mentorship of Undergraduate Women in Mathematics. She won, with Stephen Kennedy, the MAA Meritorious Service Award in 2016. She is also on the Board of Directors of Pro Mathematica Arte, which oversees the Budapest Semesters in Mathematics, and she was co-chair of the Human Resources Advisory Committee of the Mathematical Sciences Research Institute.

Deanna co-edited the books *The Edge of the Universe* and *A Century of Advancing Mathematics* and is working on a new book on mathematical communities. Deanna's co-editorship of the fourth edition of the MAA's popular *101 Careers in Mathematics* is yet another example of Deanna's MAA-related community effort. This one nicely combines Deanna's editorial skills with an explicitly broad outreach mission: to encourage students and other young mathematicians to see mathematical careers as possible and viable for themselves. The 125 people featured in this edition are notably diverse in every sense of the word.

As MAA president and past-president, Deanna helped launch a new MAA Award and then served as the first chair of the Committee on the Inclusivity Prize. And if that were not enough, she and Stephen financially support the MAA and are members of the MAA Icosahedron Society.

As an Association, MAA is stronger and a model for others because of Deanna Haunsperger's insistence that we be fair, inclusive, and welcoming, which has expanded our community with mathematicians who respect and include all. This is distinguished service from which the MAA and the profession will long benefit.

Biographical Note

Deanna Haunsperger, a first-generation college student from central Iowa, earned her BA (1986) in mathematics and computer science from Simpson College and her Ph.D. (1991) from Northwestern University in mathematics under Donald Saari in voting theory applications to decision making. She married fellow mathematician Stephen Kennedy in 1990. From 1991–94, they worked at St. Olaf College alongside past MAA president Lynn Steen and future MAA president Paul Zorn. Since 1994, they have worked at Carleton College, where Deanna chaired the Department of Mathematics, 2011–14. Together they edited *Math Horizons*, 1999–2004 and have nurtured the award-winning NSF-funded Carleton Summer Mathematics Program since 1995. Deanna is a former president of the MAA, an inaugural AWM fellow, and a winner of the AWM's M. Gweneth Humphreys Award for Mentorship of Undergraduate Women. Deanna and Stephen have two adult children, Sam and Maggie.

Response from Deanna Haunsperger

The work that I do for the Association and mathematics is very fulfilling; it brings me great happiness. To be recognized by my friends and by our Association for that work is an incredible honor.

When I was in graduate school, one of my colleagues asked what I wanted to do with my Ph.D. when I finished, and I explained that my goal was to teach at a liberal arts college. He told me that I should belong to the MAA—the organization that supports professors and their students, embraces research-based pedagogy,

promotes research by faculty and students, publishes exceptional exposition, and creates a community where all are welcomed and encouraged to contribute. He was absolutely right, so I joined the MAA, and I married him.

Many of the accomplishments listed above wouldn't have been possible, or at least not nearly as fun, without Stephen Kennedy by my side. We have been on many adventures together, mathematical and otherwise, and I thank him for his support. I would also like to thank my colleagues at Carleton and my kids Sam and Maggie for always supporting me when I say yes to new responsibilities. Finally, I would like to thank all the MAA friends I have made along the way for being my mathematical family.

Together, I hope we will continue to welcome all people and voices into our community and give them opportunities to contribute. We will be richer for it.

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 field will be broadly interpreted to include topology, geometry, geometric group theory, and related areas. Candidates should be women, based at U.S. institutions who are within 10 years of receiving their Ph.D. or having not yet received tenure, at the nomination deadline.

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

Emily Riehl

The 2021 Joan & Joseph Birman Research Prize in Topology and Geometry is awarded to Emily Riehl for her deep and foundational work in category theory and homotopy theory.

Riehl has proved many fundamental theorems in category theory and its relations to homotopy theory and has produced a large body of exceptional research as well as expository and pedagogical work. Her work is transforming the ways we work with higher categorical objects, drawing on classical category-theory tools and constructions to illustrate and simplify higher categorical constructions. Riehl's theorems and machinery beautifully showcase how these higher categorical constructions can often be viewed as intuitive generalizations of the ordinary ones. Her books on category theory and on homotopical category theory have become the standard references, and her draft book on ∞-categories is already finding immediate use by researchers.

Riehl is an internationally recognized scholar for her important research works in category theory and her innovative ideas about mentorship and communication of mathematics.

Riehl received her Ph.D. in 2011 from the University of Chicago and was a Benjamin Peirce Postdoctoral Fellow and an NSF Postdoctoral Fellow at Harvard University from 2011 to 2015. Riehl is currently an associate professor at Johns Hopkins University and spent the spring term of 2020 as a Chern Professor at the Mathematical Sciences Research Institute in Berkeley where she was the lead organizer of a semester-long program on Higher Categories and Categorification.

Response from Emily Riehl

I am deeply honored to have been selected for the 2021 Joan & Joseph Birman Research Prize in Topology and Geometry and acutely grateful to the selection committee for recognizing higher category theory and abstract homotopy theory as topology metamorphosed.

I am lucky to have fallen in love with mathematics at an early age and even more fortunate to have received such fantastic mentorship at every step along the way. I am particularly grateful to Benedict Gross, who inspired and then catalyzed my undergraduate forays into teaching; Martin Hyland, who roused my aspirations to think categorically; Peter May, my Ph.D. advisor and preeminent editor, who showed me what it takes to write well; Mike Hopkins, who initiated me into the profession and moves me with the kindness he shows to so many who look up to him; and especially to my colleagues at Johns Hopkins who have gone above and beyond time and time again to support me in every conceivable way: Nitu Kitchloo, Jack Morava, David Savitt, and Steve Wilson. Finally, I'd like to acknowledge the generosity of the algebraic topology community, who have drawn me in from the periphery and made me feel as if we were all a part of a common enterprise. For instance, through the wonderful Women in Topology network, I and many others can count the senior luminaries in the field—Kathryn Hess, Brooke Shipley, Kristine Bauer, and Brenda Johnson—among my treasured collaborators and friends.

I am excited to be one of many contributors to a field of mathematics that is undergoing a rapid evolution. I like to daydream about what infinite-dimensional category theory will look like from the other side, perhaps where a univalent foundation system allows us to treat equivalence as equality and recognize sets as one layer of an infinite hierarchy of homotopy types, recording the higher structures that may be borne by these equivalences.

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

Dr. Lynda R. Wiest

In recognition of her outstanding contributions to math education, the Association of Women in Mathematics (AWM) presents the 2021 Louise Hay Award to Dr. Lynda R. Wiest from the University of Nevada, Reno. Dr. Wiest has contributed impactfully to advancing mathematics education in K–12 across a variety of school settings. She has created innovative courses and summer programs, addressing gender equity and diversity issues.

Dr. Wiest is the founder and the director of the highly influential Northern Nevada Girls Math and Technology Program (NNGMTP) since 1998. Every summer for more than two decades, the program hosts girls entering the seventh and eighth grades from Nevada's rural and urban areas at the University of Nevada, Reno. The summer camp boosts the girls' interest in mathematics, advances their mathematics education and problem-solving skills, and it presents participants with university campus experience. As one nominator wrote, "Dr. Wiest's mentorship and guidance reached all levels of this program. This was clear by the number of return instructors, assistants, volunteers, and girls who wished to continue participating in the NNGMTP." Many of these students have chosen to pursue degrees in Math and Engineering.

Response from Dr. Lynda R. Wiest

I am deeply honored to be among the individuals chosen over the years for the Louise Hay Award. In the same way that Louise Hay paved a path for us, for several decades I have sought to continue a tradition of encouraging and supporting girls and young women in mathematics. Some ways I have done this are through my research and writing; girls mathematics programs I have conducted (e.g., the Northern Nevada Girls Math & Technology Program I started in 1998); education to teachers, parents, and others about girls/women and mathematics; and individual mentoring and encouragement to young girls through adult women. I am very grateful to have received this award for my work, which I will continue to perform as long as I can, with confidence that this chain of "sources of inspiration and opportunities" (in Louise's words) that started long before me will continue with future generations.

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

Raegan Higgins

The Association for Women in Mathematics is pleased to present the 2021 M. Gweneth Humphreys Award to Raegan Higgins, Associate Professor of Mathematics in the Department of Mathematics and Statistics at Texas Tech University. Reagan Higgins has a Ph.D. in Mathematics from the University of Nebraska and her research interests revolve around time scales—particularly oscillation criteria for certain linear and nonlinear second order dynamic equations. She has also studied the impact of professional development on the self-efficacy of middle-school mathematics teachers.

At Texas Tech University, Higgins' excellence in teaching and mentoring and her commitment to diversity have consistently shined through. In addition to her formal role as academic advisor for both female and male graduate students, she co-founded the *Young Women in Mathematics: Fostering Success* program in 2013. This initiative led to the formation of an AWM Student Chapter in 2018 which Higgins co-advises. She is also a member of the organizing committee of the Emmy Noether High School Mathematics Day and over the years has given numerous talks, organized workshops, and served as Career Panelist for the female high school and undergraduate students who participate in this annual event. Since 2009, Raegan Higgins has served as Faculty Advisor for the

Eta Lambda Chapter of Delta Sigma Theta Sorority and as Faculty Mentor and Mentor Cluster Leader for Mentor Tech (formally known as The Lauro Cavazos & Ophelia Powell-Malone Mentoring Program), a program for students from diverse backgrounds at Texas Tech. In 2014, Higgins received a *Women in STEAM Award* from the Center for the Integration of STEM Education and Research and in 2020 she was recognized as an *Integrated Scholar* for her synergistic activities at the intersection of teaching, service and research.

An alumna of the Enhancing Diversity in Graduate Education (EDGE) program, and one to always give back, Higgins served as EDGE Instructor in the years 2014 to 2017 and since 2017 serves as co-director of the program. Founded in 1998, the EDGE program has had a marked success at helping female undergraduate mathematics students transition into and thrive in graduate school. Raegan Higgins is a co-founder of the Network of Minorities in Mathematical Sciences. Through its website *Mathematically Gifted and Black*, the network highlights the contributions and accomplishments of blacks in the mathematical sciences.

Raegan Higgins has positively impacted the academic trajectory of many women, particularly women of color, within and outside of her institution and the AWM is pleased to honor her for her genuine and sustained commitment to the recruitment, mentoring, and retention of women in mathematics.

Response from Raegan Higgins

I was surprised to learn that I had been selected as a recipient of the M. Gweneth Humphreys Award for Mentoring. I am deeply honored to receive this award. I extend my sincerest thanks to my department chair, Magdalena Toda who nominated me, to those who supported my nomination, and to the award selection committee.

It is refreshing to be reminded that we are positively impacting students' lives through the seemingly small things. Listening and providing encouragement contribute endlessly to students' outlook and persistence. Several of us are beneficiaries of those small deeds. I will continue to show my women students that they have a place in mathematics and help them find their entry point.

This recognition is for all the women who inspired me to pursue math and who continue to inspire me to do the work—the hard work, the good work, the needed work.

AMS MAA siam

American Mathematical Society
Mathematical Association of America
Society for Industrial and Applied Mathematics

Frank and Brennie Morgan Prize for Outstanding research in Mathematics by an undergraduate Student

The Morgan Prize is awarded each year to an undergraduate student (or students for joint work) for outstanding research in mathematics. Any student who was enrolled as an undergraduate in December at a college or university in the United States or its possessions, Canada, or Mexico is eligible for the prize. The prize recipient's research need not be confined to a single paper; it may be contained in several papers. 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. It is entirely endowed by a gift from Mrs. Frank (Brennie) Morgan. It is made jointly by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

Citation

Ashwin Sah and Mehtaab Sawhney

The recipient of the 2021 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is the team of Ashwin Sah and Mehtaab Sawhney, both of the Massachusetts Institute of Technology. The award recognizes the duo's groundbreaking results across a broad range of topics in combinatorics, discrete geometry, and probability. Working alongside one another, Sah and Sawhney settled longstanding conjectures and improved results by established mathematicians. They have "solved several significant open problems and developed new techniques while working on exciting and central areas in the field." Combined, they have authored 30 papers (11 of these together), and published in top journals including *Inventiones Mathematicae*, *Advances in Mathematics*, *Mathematical Proceedings of the Cambridge Philosophical Society*, the *Journal of Combinatorial Theory Series B*, and *Combinatorica*. This is the first award to coauthors of joint work in the Morgan Prize history. The two were chosen from an especially strong slate of candidates due to the "quality and quantity [of their] collective work." The committee considered that, while each

independently would be top contenders for the prize, as a team they have contributed significantly more to mathematical scholarship, which should be lauded. Their expansive list of coauthors, including many other impressive young mathematicians, is an excellent example of the enormous benefit of collaboration in mathematics.

The pair were recognized with Honorable Mention last year (along with D. Stoner). Since then, they have produced numerous additional significant results, including the "recent improvement of Sah of the best known upper bound for the diagonal Ramsey numbers", making progress on what is "arguably the most famous problem in extremal combinatorics." Their joint work on "local limit theorems for subgraph counts" extends the previous results of Gilmer, Kopparty and Berkowitz and provides counterexamples to the conjectures of Fox, Kwan, and Sauermann. This is an "important and technically challenging problem, which was not even solved [in the simplest case] until about five years ago." In a joint paper with Zhao on "Cayley graphs without a bounded eigenbasis," they extend a result from Naor in spectral graph theory from abelian groups to "not necessarily abelian" groups. In the study of graph limits (with Tidor and Zhao), they found a counterexample to several conjectures of Bollobs and Riordan aimed towards extending the theory of graph limits to the sparse regime. These "appealing conjectures had stood open for more than ten years, but their short, elegant counterexample had escaped many of the leading researchers in the area". The research of Sah and Sawhney is both deep and broad, "tackling questions at the very forefront of current research, yet extending across the entire gamut of modern combinatorics", with significant contributions to extremal graph theory, graph limits, additive combinatorics, Ramsey theory, algebraic combinatorics, combinatorial geometry, random graphs and random matrix theory. They have demonstrated a "significant amount of ingenuity, originality and technical ability" resulting in a research record which is "extremely rare for undergraduate students".

Biographical Note

Ashwin Sah was born and raised in Portland, Oregon. In high school, he won a gold medal at the 2016 International Mathematical Olympiad as a member of the winning US team. Ashwin is currently a graduate student studying mathematics at the Massachusetts Institute of Technology. Other than combinatorics, Ashwin is also interested in pursuing analytic number theory, Fourier analysis, and random matrix theory. Beyond math, Ashwin spends his time helping organize math contests and participating in the effective altruism community. He is also interested in economics, game theory, and artificial intelligence.

Biographical Note

Mehtaab Sawhney grew up in Commack, New York. Mehtaab is currently a graduate student studying mathematics at the Massachusetts Institute of Technology. In addition to combinatorics, Mehtaab is interested in statistics, probability, and random matrix theory. Outside of math, Mehtaab enjoys playing table tennis, playing Texas hold 'em and Pot Limit Omaha, and watching classical movies. He is also interested in economics, theoretical machine learning, and finance.

Response from Ashwin Sah and Mehtaab Sawhney

It is a tremendous honor to receive the 2021 Frank and Brennie Morgan Prize. We extend our deepest gratitude towards Mrs. Morgan and the AMS, MAA, and SIAM for promoting and supporting undergraduate mathematical research.

We would also like to sincerely thank two of our research mentors, Professor Yufei Zhao from the MIT math department and Professor Joseph Gallian from the Duluth REU, who have each been instrumental in our mathematical endeavors. Professor Yufei Zhao has been an exceptionally kind and generous mentor for both of us for the past three years and it has truly been a pleasure to interact with him closely over this time period. In particular, he has spent a great deal of time teaching us how to become better mathematicians and how to communicate our results. Professor Gallian introduced us to an amazing community of peers and mentors, informally known as "Duluthians", and the summers we each spent at the Duluth REU were incredibly enjoyable due in large part to his passion and expert guidance.

We would further like to thank a number of joint collaborators including David Stoner, Vishesh Jain, and Ross Berkowitz.

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

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

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

CITATION

Noah Kravitz

Noah Kravitz of Yale University is recognized with an Honorable Mention for the 2021 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. He has nine papers published, many single authored, in top journals such as the *Journal of Number Theory*, *Discrete Mathematics*, *The Journal of Fourier Analysis and Applications*, and *Integers*. He has made significant progress on "very central and well-studied problems", including the Small Ball Inequality—where he improved upon the current understanding of the problem by leading experts in the field—and the Lonely Runner Conjecture—where he "discovered an unexpected rigidity in the problem". Additionally, he has developed an asymptotic theory of difference bases and shown that the problem is completely equivalent to a problem in Real Analysis using a "very sophisticated mixture of combinatorial, probabilistic and analytical arguments".

Biographical Note

Noah Kravitz was born and raised in Washington, DC, where he attended Georgetown Day School. In 2020, he graduated from Yale College summa cum laude and junior Phi Beta Kappa with Exceptional Distinction in both of his majors, Mathematics and Near Eastern Languages and Civilizations. His two senior theses treated the Lonely Runner Problem and the development of medieval Arabic number theory, respectively. Noah is now pursuing a Ph.D. in mathematics at Princeton University. He has broad interests in combinatorics and adjacent fields, and recently he has been particularly drawn to combinatorial problems with an additive or number-theoretic flavor.

Noah was interested in mathematics from a young age and participated in local mathematics competitions in high school. His first foray into mathematical research came during his freshman year at Yale, and he learned more about the research process when he attended the Research Experiences for Undergraduates (REU) program at the University of Minnesota, Duluth in the summer after his sophomore year. At Yale, Noah was an organizer and the chief problem writer for the Math Majors of America Tournament for High Schools and Girls in Math at Yale annual competitions for high-school students. Noah is a U.S. Presidential Scholar, a Goldwater Scholar, a National Science Foundation Graduate Research Fellow, and the winner of Yale's Warren Prize (for high scholarship in the humanities). His non-mathematical academic interests include languages, philology, philosophy, literary translation, and the history of science. Outside of academics, Noah plays the piano and the carillon and enjoys long-distance running.

Response from Noah Kravitz

It is a great privilege to receive an Honorable Mention for the Morgan Prize. I would like to thank a few (but necessarily not all) of the many people who helped me reach this point: Andy Lipps, my high-school calculus teacher, for teaching me about the possibilities of math beyond the classroom and taking the time to challenge me with a near-constant stream of interesting problems; Stefan Steinerberger, my adviser at Yale, for introducing me to mathematical research and providing sage advice, steady encouragement, and insightful ideas for research projects; Joe Gallian, for running a wonderful REU program and supporting me through my subsequent endeavors; Gil Kalai, for giving me the confidence to try my hand at hard open problems; my parents, for patiently listening to me talk about math, even at inopportune times; and my peers and research collaborators, for spending hours poring over problems and attempted solutions.

JOINT POLICY BOARD FOR MATHEMATICS

COMMUNICATIONS AWARD

THIS award is given each year to reward and encourage communicators who, on a sustained basis, bring mathematical ideas and information to non-mathematical audiences. This award was established by the Joint Policy Board for Mathematics (JPBM) in 1988. JPBM is a collaborative effort of the American Mathematical Society, the Mathematical Association of America, the Society for Industrial and Applied Mathematics, and the American Statistical Association. Up to two awards are made annually. Both mathematicians and non-mathematicians are eligible.

CITATION

John Bailer, Richard Campbell, and Rosemary Pennington

The 2021 JPBM Communications Award is presented to John Bailer, Richard Campbell, and Rosemary Pennington for their engaging, entertaining, and enlightening *Stats+Stories* podcast that for over six years has brought "the statistics behind the stories and the stories behind the statistics" to public radio and a broad podcast audience.

Biographical Note

John Bailer is university distinguished professor and founding chair of the department of statistics at Miami University in Oxford, Ohio. He is also an affiliate member of the Departments of Biology, Media, Journalism and Film, Sociology and Gerontology and the Institute for the Environment and Sustainability. He received undergraduate degrees in mathematics and statistics and in psychology from Miami University and pursued his graduate studies at North Carolina where he received a Ph.D. in Biostatistics from the University of North Carolina at Chapel Hill. He was a staff fellow at the National Institute of Environmental Health Sciences before joining the faculty at Miami University in 1988.

He is President of the International Statistical Institute (2019-2021), and he previously served on the Board of Directors of the American Statistical Association. He is a Fellow of the American Statistical Association, the Society for Risk Analysis, and the American Association for the Advancement of Science. His research has focused on quantitative risk estimation, but he has also collaborated on research addressing problems in toxicology, environmental

health, and occupational safety. Promoting quantitative literacy and enhancing connections between statistics and journalism are more recent passions. The *Stats+Stories* podcast he developed with journalism colleagues grew out of that interest.

Bailer has taught 26 different courses since arriving at Miami including a few that he designed. Team-teaching a course with a journalism colleague ("news and numbers") and another with a graphic design colleague ("advanced data visualization") are two of his favorite teaching experiences, and he is happiest when connecting his students to problems posed by external clients and helping his students effectively communicate work to clients and the public.

He enjoys hanging out with his family and kids, walking his dog, reading fun fiction, traveling internationally or working on his Butler County donut trail passport.

Response from John Bailer

I am deeply honored and delighted to be a recipient of this award. The notification was a complete surprise. It is truly humbling to have our work in the company of outstanding communicators who previously won this prize including John Allen Paulos whose books *A Mathematician Reads the Newspaper* and *Innumeracy* influenced my thinking about communicating mathematical and statistical concepts to a general audience. Joint Policy Board for Mathematics—thank you for recognizing the *Stats+Stories* team with this tremendous honor.

One of my first reactions to hearing about this award was the recognition of the importance of partnering with good people. I've been blessed to collaborate with Richard Campbell for more than a decade and with Rosemary Pennington during the last six years. These colleagues are tremendous professionals, and I've learned much from our work together. It really isn't accurate to refer to this as 'work'—the podcast has been a vocational avocation.

Co-teaching a course on News and Numbers with Richard in 2009 provided a connection with an amazing journalism colleague, and provided the proof-of-concept that viewing ideas through the lens of statistics and the lens of journalism was a worthwhile endeavor. The emergence of the podcast from this connection seemed natural and the addition of a moderator, first Bob Long and then Rosemary Pennington, completed our panel for the podcast. Thanks are due to the many colleagues who helped make the 'on air' panel sound and look good (sound and recording engineers, web page support, and podcast/show production) and to the College of Arts and Science at Miami University for facilities and other resources contributing to the podcast. Sponsorship and other support from the *American Statistical Association* allowed the podcast to go to a weekly release schedule, and the connection with *Significance* magazine

provided a means to connect to a larger pool of potential guests with interesting stories.

During times when allegations of false news are common and trust in science varies, there continues to be a call for a forum to consider the statistics behind the stories and the stories behind the statistics, and I hope that our podcast can continue in this role.

Biographical Note

Richard Campbell is professor emeritus and founding chair of the Department of Media, Journalism and Film at Miami University. He is the author of *60 Minutes and the News: A Mythology for Middle America* and co-author of *Cracked Coverage: Television News, the Anti-Cocaine Crusade and the Reagan Legacy*. For Bedford/St.Martin's Press, he is the lead author of three textbooks, including *Media and Culture: Mass Communication in a Digital Age*, now in its 12th edition. Campbell earned his B.A. in English from Marquette University and his Ph.D. from Northwestern University in the Radio-Television-Film department. He also worked as a print reporter and broadcast news writer in Milwaukee. In his 48-year teaching career, he has also worked at Mount Mary College, UW-Milwaukee, Middle Tennessee State University, and the University of Michigan. In addition to the *Stats+Stories* podcast, his most recent projects include the digital Oxford Observer and Report for Ohio—initiatives aimed at getting more young journalists real-world experience and hired to cover under-reported areas in both rural and urban communities. He is also the executive producer of *Training for Freedom: How Ordinary People in an Unusual Time & Unlikely Place Made Extraordinary History*, a 2019 documentary on Oxford's role in the historic events of Freedom Summer in 1964. A former high school English teacher and girls' basketball coach in the Milwaukee Public School system, Campbell grew up in Dayton, Ohio, where in 2015 he served on the city's planning committee for the 20th anniversary of Dayton Peace Accords. In 2019, Campbell received Miami's Benjamin Harrison Medallion Award "For Outstanding Contribution to the Education of the Nation."

Response from Richard Campbell

I am stunned. I thought my numerical literacy prowess had peeked during my Dayton, Ohio, high school days when I served as president of the sophomore math club. But to the point: It has been an absolute pleasure working with our team on *Stats+Stories*. So much so that I keep doing it in retirement, still learning from the terrific guests we have had on the podcast over the years. At Miami, John Bailer and I had worked together to get a quantitative literacy requirement into our college's curriculum. As part of that initiative, we team taught an honors class called "News and Numbers" in 2009 and developed the podcast in 2013. As a one-time reporter and long-time journalism educator (with some math

phobia issues), I remember how nervous I was in that first class with John. But when he put up a data graph culled from a national newspaper and asked the students, "What's the story here?", I relaxed. Storytelling is something I knew about and to realize this renowned statistician expected a good data chart to tell a story put me at ease. John and I had common ground. I do recommend that every journalism student take statistics courses and that every math and stats major take journalism courses (plus, all our high schools should be requiring quantitative literacy classes). The ability for a mathematician or scientist to translate the complexities of her work into a story for a general audience is key to challenging the anti-science and anti-evidence strains running through our mediated culture. John, Rosemary and I grateful are for this prestigious award ... and proud of our *S+S* work. Thank you, MAA.

Biographical Note

Rosemary Pennington is an assistant professor of journalism in Miami University's Department of Media, Journalism & Film. Her research focuses on media representations of marginalized groups, with a specific focus on the representations of Muslims. She's the co-editor of the books *The Media World of ISIS* and *On Islam: Muslims and the Media* from Indiana University Press. Pennington received her Ph.D. in mass communication from Indiana University in 2015. In her pre-academic life, she worked as a broadcast journalist in the newsrooms of public broadcasters WOUB and WBHM. While working at WBHM, Pennington's science and medical reporting helped her win the Alabama Associated Press's Best Specialized Reporter award two years in a row and the Douglas L. Cannon Broadcast Award for Excellence in Medical Reporting three years in a row.

Response from Rosemary Pennington

This is perhaps the most surprising thing to have happened to me in my professional life! Thank you, Joint Policy Board for Mathematics, for this honor and for the recognition of our work. I once counted myself among those who professed to hate math—born more out of frustration with how it was taught than any real feelings about the subject itself. As a working journalist I carved out a niche as a science and medical reporter which helped me develop a deep appreciation for all that math can help us understand about our world; it was an appreciation that only grew during my graduate studies. Sometimes, all it takes is the right story, or the right storyteller, to unlock the beauty of math for someone who may have struggled with it in the past. (That was certainly the case for me.) One of the things I have loved about my work with *Stats+Stories* is that I learn so much with each interview. Hearing our guests tell the stories of their research, field, or methodology has made a subject that, in my youth, felt very abstract feel very accessible. It's really been a privilege to be part of this program and I am truly honored that our work on *Stats+Stories* has been recognized in this way.

CITATION

Erica Klarreich

The 2021 JPBM Communications Award is presented to Erica Klarreich for her work as a writer and popularizer of mathematics and science. She writes about mathematics and theoretical computer science, and her writing has been chosen for and reprinted in *Best Writing on Mathematics* in four different years. Her works have appeared in *Quanta*, *The Atlantic*, *New Scientist*, *Science News*, *Wired* and other publications for a general audience. Erica Klarreich received a Ph.D. in mathematics in 1997.

Biographical Note

Erica Klarreich has been writing about mathematics and science for a popular audience for more than twenty years. She has a Ph.D. in mathematics from Stony Brook University and was a postdoc at the University of Michigan for three years. She is a graduate of the science communication program at the University of California, Santa Cruz.

As a freelance journalist based in Berkeley, California, she has written hundreds of articles for a wide range of publications, including *Quanta Magazine*, *Nature*, *New Scientist*, *Science News* and *Nautilus*. Her articles for *Quanta* have been syndicated in *Wired*, *The Atlantic* and *Scientific American* and have been translated into many languages. Her work has been reprinted in the 2010, 2011, 2016 and 2020 volumes of *The Best Writing on Mathematics* and in the *Quanta Magazine* anthology "The Prime Number Conspiracy."

She was the journalist in residence at the Mathematical Sciences Research Institute in Berkeley in 2002 and at the Simons Institute for the Theory of Computing at the University of California, Berkeley in 2016. She has appeared on the Numberphile YouTube series and was the narrator for two mathematics documentaries by ZALA Films: *Secrets of the Surface*, about the life and work of Maryam Mirzakhani, and *Counting from Infinity*, about Yitang Zhang's work on the twin primes conjecture.

Response from Erica Klarreich

It is a great honor to join the ranks of the previous recipients of this prize, whom I deeply admire. It has been my privilege to tell the stories of mathematics over the past two decades, and I look forward to the stories the coming years will bring.

Many people helped me reach the point where I could share these stories, and I'd like to mention a few: my parents, Emily and Paul Klarreich, both math teachers, who taught me the family trade from my earliest days; my Ph.D. adviser, Yair Minsky, who introduced me to one of the most beautiful areas of mathematics, three-dimensional hyperbolic geometry; my professors at UC Santa Cruz (especially Robert Irion), who helped turn me from a mathematician

into a journalist; and my editor at *Quanta Magazine*, Thomas Lin. When he feels that one of my drafts needs improvement, he sends me a list of suggestions that always contains at least three impossible tasks. Then I figure out how to do them, and my article is immeasurably better.

It's been more than 20 years since I did any mathematics research of my own. But I am in constant conversation with research mathematicians, and sharing in their excitement about their work is one of the most delightful parts of my job.

I have found over the years that the stories that resonate the most with readers are those with a powerful human element. My readers want to understand mathematics, but they also want to understand you: the people who have dedicated your lives to the pursuit of mathematical beauty and discovery. They want to know about your struggles and your triumphs, your disappointments and your flashes of joy.

I believe that even those readers who found their own math education mind-numbing or traumatic still feel, on some level, that mathematics is an inextricable component of the human experience. And when the human element in a story is compelling, my readers are willing to dive into the hardest research areas at the frontiers of modern mathematics.

Many of my most successful stories have come about because some mathematician told me about something amazing that was happening in their field. So I'd like to end with an invitation: When you hear about a beautiful new advance, please share it with me or other mathematics communicators, so that we can share it in turn with the broader public. Reading about your stories gives people an opportunity to see the world through your eyes, catch a glimpse of the mathematical beauty that motivates you, and emerge with an enlarged sense of human potential.

GEORGE DAVID BIRKHOFF PRIZE IN APPLIED MATHEMATICS

THE Birkhoff Prize is awarded for an outstanding contribution to applied mathematics in the highest and broadest sense. The prize was established in 1967 in honor of Professor George David Birkhoff, with an initial endowment contributed by the Birkhoff family and subsequent additions by others. The American Mathematical Society (AMS) and the Society for Industrial and Applied Mathematics (SIAM) award the Birkhoff Prize jointly. The prize is awarded every three years to a member of AMS or SIAM.

CITATION

Gunther Uhlmann

The 2021 George David Birkhoff Prize in Applied Mathematics is awarded to Gunther Uhlmann for his fundamental and insightful contributions to inverse problems and partial differential equations, as well as for his incisive work on boundary rigidity, microlocal analysis and cloaking. Gunther's work is distinguished by its mathematical beauty and relevance to many significant applications, especially in medical imaging, seismic prospecting and general inverse problems.

Biographical Note

Gunther Uhlmann was born in Quillota, Chile, in 1952. He studied mathematics as an undergraduate at the Universidad de Chile in Santiago, gaining his Licenciatura degree in 1973. He continued his studies at MIT, where he received a Ph.D. in 1976 under the direction of Victor Guillemin. He held postdoctoral positions at MIT, Harvard, and the Courant Institute. In 1980 he became assistant professor at MIT and then moved in 1985 to the University of Washington, where he was appointed Walker Family Endowed Professor in 2006. From 2010–2012 he also held the Endowed Excellence in Teaching Chair at the University of California, and was appointed the Si-Yuan Professor at IAS, HKUST in 2014. Uhlmann received a Sloan Research Fellowship in 1984 and a Guggenheim Fellowship in 2001. Also in 2001 he was elected a corresponding member of the Chilean Academy of Sciences and in 2013 a Foreign Member of the Finnish Academy of Sciences. He was elected to the American Academy of Arts and Sciences in 2009 and as SIAM Fellow in 2010. He was an invited speaker at ICM

in Berlin in 1998 and a plenary speaker at ICIAM in Zurich in 2007. He gave the AMS Einstein Lecture in 2012, a plenary lecture at the International Congress of Mathematical Physics in 2015 and a plenary lecture at the 2016 Latin American Congress of Mathematics. He was Clay Senior Scholar at MSRI in 2010 and 2019 and Chancellor Professor at UC Berkeley in 2010. Uhlmann was awarded the AMS Bocher Prize in 2011, the Kleinman Prize by SIAM in 2011 and the Solomon Lefschetz Medal by the Mathematical Council of the Americas in 2017.

Response from Gunther Uhlmann

I would like to thank the AMS and SIAM for the great honor of being named the recipient of the 2021 George Birkhoff Prize in Applied Mathematics. Several of the previous recipients of the award are some of my mathematical heroes. I would like to also thank my collaborators and my graduate students and postdocs who have enriched my life both professionally and personally. Many people were very influential early in my career and I can mention only a few. Nicolas Yus was my undergraduate mentor in Chile and I owe him my thanks for his great support and teaching. Warren Ambrose made it possible for me to go to graduate school at MIT, and he was a continuous source of support and encouragement, especially in my early years in the United States. Herbert Clemens also helped me to come to the United States, and he has been an example to emulate in my life. My Ph.D. advisor Victor Guillemin taught me so much—he has a contagious enthusiasm for mathematics. Richard Melrose shared with me many times his great insight, and he has been a true friend. I met Alberto Calderón during my graduate studies at MIT; he is one of my mathematical heroes, such an original mathematician. Norberto Kerzman was also very supportive and encouraging during my graduate studies and we became friends. The year I was at Courant, I had the great fortune of meeting Louis Nirenberg. He taught me many things in mathematics and is one of the kindest people I have ever met—a wonderful role model for anybody to follow. I also treasured the friendship I started with Cathleen Morawetz during my stay at Courant. Most of all I have had the unwavering support of my family, my late wife Carolina, my daughter Anita, and my son Eric. Without them this would not have been possible. Carolina would have been so proud. This prize is dedicated to our five grandchildren Thomas, Eli, Louis, Charlie and little Carolina. They are my joy.

BERTRAND RUSSELL PRIZE OF THE AMS

THE Bertrand Russell Prize of the AMS was established in 2016 by Thomas Hales. The prize looks beyond the confines of the profession to research or service contributions of mathematicians or related professionals to promoting good in the world. It recognizes the various ways that mathematics furthers fundamental human values. Mathematical contributions that further world health, our understanding of climate change, digital privacy, or education in developing countries, are some examples of the type of work that might be considered for the prize. The prize is awarded every three years.

CITATION

Michel Waldschmidt

The 2021 Bertrand Russell Prize is awarded to Michel Waldschmidt in recognition of his outstanding contribution to graduate schools and mathematical research in developing countries in all continents and of his sustained commitment to building bridges between mathematical communities around the world. Throughout his career, Michel Waldschmidt has worked tirelessly to the development of graduate schools in tens of countries, both through lecturing and on advisory committees.

Michel Waldschmidt studied at Lycée Henri Poincaré and then at the University of Nancy until 1968. He defended his habilitation thesis at University of Bordeaux in 1972. Since 1973, he has been professor at Université Paris VI and Emeritus since 2012. Michel Waldschmidt is a world expert in transcendental number theory and Diophantine approximation. He was awarded the silver medal from CNRS in 1978, the Marquet Prize of the French Academy of Science in 1980, the Distinguished Award from the Hardy-Ramanujan Society in 1986 of which he is honorary fellow since 2006. He has over 190 research papers and advised 21 Ph.D. students. Michel Waldschmidt was president of Société mathématique de France for 2001–2004 and Deputy President of CIMPA for 2005–2008. He was also a member of many scientific committees and of the Committee of Developing Countries of the European Mathematical Society. He is presently a member of the Commission of Developing Countries of the International Mathematical Union.

The Centre International de Mathématiques Pures et Appliquées (CIMPA), founded in France in 1978, is a nonprofit organization that promotes research in mathematics in developing countries. Located in Nice, it is a UNESCO

Category 2 center. It organizes schools, courses and funds fellowships for young researchers. This is exactly the mission to which Michel Waldschmidt devoted an impressive portion of his time and professional life. Michel Waldschmidt is an inspiring lecturer and he mixes well with students and researchers wherever he goes. He understands very well the daily problems faced by researchers in developing countries and is able to deal with delicate situations in a positive and human way. Michel Waldschmidt is very helpful and very dedicated. He is able to push and help local mathematical communities improve their research environment. As an example, he played an important role in having IMSP (Institut de Mathématiques et de Sciences Physiques) in Benin become an Emerging Regional Centre of Excellence (ERCE).

The endless list of countries where Michel Waldschmidt made service in the form of courses, series of lectures, organization of events, and work on advisory committees is truly impressive and the best testimony of his dedication:

- Africa: Algeria (2013, 2015), Benin (2014, 2016), Cabo Verde (2015), Congo (2011, 2018), Ethiopia (2019), Ghana (2018), Ivory Coast (2009, 2017), Kenya (2005), Mali (2005, 2010), Mauritania (2014, 2016), Morocco (2008, 2009, 2015), Senegal (2016), South Africa (2018).
- America: Brazil (2010).
- Asia: Bangladesh (4 times between 2014 and 2019), Bhutan (2008), Cambodia (eight times between 2005 and 2016), India (25 times between 2006 and 2019), Indonesia (2013, 2020), Iran (2003, 2005, 2008, 2019), Iraq (eight times between 2000 and 2019), Korea (2014), Laos (2012), Malaysia (2014), Mongolia (2015), Myanmar (2013, 2017), Nepal (seven times between 2010 and 2019), Pakistan: (6 times between 2009 and 2015), Philippines (2013, 2017), Taiwan (2001), Thailand (2012), Vietnam (eight times between 2006 and 2016).
- Middle East: Saudi Arabia (2019), Syria (2002), Turkey (2010, 2011, 2017).
- Oceania: Papua New Guinea (2013 and 2014).

Biographical Note

Michel Waldschmidt was born in 1946 in Nancy where he studied until 1968. He was Assistant in Bordeaux from 1968 until 1972 when he submitted his doctoral dissertation (thèse d'état) under the supervision of Jean Fresnel. He was appointed at University Paris Sud for the academic year 1972–73 and he started to teach in 1972 in University Pierre et Marie Curie (Paris 6, now Sorbonne University) until he became Emeritus in 2012. He gave the Cours Peccot (1976–77) at the Collège de France. He is Doctor Honoris Causa from Ottawa University.

He served as President of the Société Mathématique de France from 2001 to 2004 and as Deputy President of the Centre International de Mathématiques Pures et Appliquées (CIMPA) from 2005 to 2009. He was a member of the Committee for

Developing Countries of the European Mathematical Society (2011–2015), and Chair in 2013–2015; he is still an associate member of CDC EMS. He is currently a member of the Commission for Developing Countries of the International Mathematical Union, and Chair of the GRAID Committee (Graduate Research Assistantships in Developing Countries).

His main field is number theory, especially transcendental number theory and Diophantine problems. He had 21 Ph.D. students. During the last 15 years he has been very active promoting the development of mathematics in many countries, especially in Asia, and also in Africa.

Response from Michel Waldschmidt

To succeed Christiane Rousseau, who received the inaugural 2018 Bertrand Russell prize of the AMS, is an honor and a privilege for me. Among the various ways which are recognized with this prize are our understanding of climate change, which was the topic of the first prize related with Mathematics of Planet Earth, and education in developing countries, which is the topic of the second one. I am very grateful to the AMS for attracting attention to this issue.

As a member of the CIMPA (Centre International de Mathématiques Pures et Appliquées), of the EMS CDC (Committee for Developing Countries of the European Mathematical Society) and of the IMU CDC (Commission for Developing Countries of the International Mathematical Union), I meet many colleagues who are committed to the improvement of mathematics in the least developed regions of the world. This price is an encouragement for all of us to pursue.

There were mathematicians in ancient civilisations in many places. There are talents all over the world. It is unfair that, because of the location of their birth, so many bright young people are not able to develop their skills. Even if programs like the IMU Program for Graduate Research Assistantships in Developing Countries (GRAID) may be a drop of water to put out the fire, like in the Legend of the Hummingbird, let us do our bit.

FRANK NELSON COLE PRIZE IN ALGEBRA

THE Cole Prize in Algebra recognizes a notable research work that has appeared in the last six years. The work must be published in a recognized, peer-reviewed venue. This prize (and the Frank Nelson Cole Prize in Number Theory) was founded in honor of Professor Frank Nelson Cole upon his retirement after twenty-five years as Secretary of the American Mathematical Society. Cole also served as Editor-in-Chief of the *Bulletin* for twenty-one years. The original fund was donated by Professor Cole from moneys presented to him on his retirement, and was augmented by contributions from members of the Society. The fund was later doubled by his son, Charles A. Cole, and supported by family members. It has been further supplemented by George Lusztig and by an anonymous donor. The prize is awarded every three years.

CITATION

Chenyang Xu

The 2021 Frank Nelson Cole Prize in Algebra is awarded to Chenyang Xu. Xu is the leader of a group developing an algebraic theory of moduli for K-stable Fano varieties and working out a radically new approach to the singularities of the minimal model program using K-stability.

His (single authored) paper *A minimizing valuation is quasi-monomial* proves a conjecture of Jonsson and Mustată on log canonical thresholds and also a conjecture of Li on normalized volumes. In a series of papers with many different co-authors (in particular, the papers *Boundedness of moduli of varieties of general type* with Hacon and McKernan and *Uniqueness of K-polystable degenerations of Fano varieties* with Blum), new powerful methods were introduced and they established a general framework for moduli of K-stable Fano varieties and give detailed descriptions in many cases. This opens up a completely new area of moduli theory, which earlier was assumed to apply only to general type and Calabi-Yau varieties. This can be viewed as a vast expansion of the minimal model program initiated by Mori.

The particular papers that the prize is awarded for are the following:

References

[1] C. Hacon, J. McKernan and C. Xu, *Boundedness of moduli of varieties of general type*, J. Euro. Math. Soc. **20** (2018), Issue 4, 865–901.

[2] C. Li, X. Wang and C. Xu, *On the proper moduli spaces of smoothable Kähler-Einstein Fano varieties*, Duke Math. J. **168** (2019), 1387–1459.

[3] H. Blum and C. Xu, *Uniqueness of K-polystable degenerations of Fano varieties*, Annals of Math. **190** (2019), 609–656.

[4] C. Xu, *A minimizing valuation is quasi-monomial*, Annals of Math. **191** (2020), 1003–1030.

[5] J. Alper, H. Blum, D. Halpern-Leistner and C. Xu, *Reductivity of the automorphism group of K-polystable Fano varieties*, Invent. Math., to appear.

Biographical Note

Chenyang Xu was born in Chongqing, China, in 1981. He did his undergraduate studies at Peking University and his graduate studies at Princeton with János Kollár. He held a postdoctoral position at the Massachusetts Institute of Technology. Chenyang Xu was hired as a junior faculty of University of Utah in 2011. Then he joined the Beijing International Center for Mathematical Research at Peking University in 2012 and was promoted to a professor there in 2013. In 2018, he moved to the Massachusetts Institute of Technology and in 2020 he became a professor at Princeton University. Chenyang Xu's main research area is the birational geometry of higher dimensional algebraic varieties, and he also likes to explore its connections to other fields.

Response from Chenyang Xu

Constructing moduli spaces to parametrize objects has always been one of the most powerful tools in algebraic geometry. D. Mumford settled the case in dimension one for curves. This was later vastly generalized to higher dimension to parametrize varieties with a negative Chern class, via the Kollár-Shepherd-Barron program, which has been an intellectual engine in higher dimensional geometry since the late 80s, whose development intertwines with the minimal model program started by S. Mori.

It has been mysterious to algebraic geometers for a very long time how to construct a moduli space for varieties with a positive Chern class. Such varieties are called Fano varieties, named after the Italian mathematician G. Fano. After a period of experimental searching, it has eventually become clear that one can investigate the notion of K-stability defined by G. Tian and S. Donaldson

to capture the existence of Kähler-Einstein metric, using the machinery from higher dimensional geometry, and build up a new field—the algebraic K-stability theory of Fano varieties. Then the moduli space of Fano varieties comes out of the theory, as the best reward. Under the local-to-global philosophy, one could expect a local K-stability theory for singularities, and such expectation is fulfilled by studying the geometry of the minimizer of the normalized volume function on the valuation space of a singularity, a picture far outside the scope of the traditional higher dimensional geometry.

I'm very glad that the committee recognized the field and I feel profoundly honored that they chose me to represent the area. It is still a relatively new area and I am very happy to see that there have been a number of young brilliant mathematicians working on it. I hope that the recognition by the Frank Nelson Cole Prize will spur further activities.

The Cole Prize gives me the precious opportunity to acknowledge the invaluable aid I have received from others. I would like to thank my advisor J. Kollár, who shaped my thinking of the moduli of higher dimensional varieties. I would like to thank C. Hacon and J. McKernan, through our collaborations I learned tremendously about the minimal model program. I also want to thank all my collaborators on this topic whom the recognition should also be associated with, especially C. Li and X. Wang, for suffering the pain together earlier when it was not clear to which direction the subject would move; as well as J. Alper, H. Blum, D. Halpern-Leistner, Y. Liu and Z. Zhuang, for their energy and ideas in our joint works. I want to thank Peking University, MIT and Princeton University for providing me a wonderful environment to accomplish the research. Finally, I want to thank my family, especially my wife Xiaoyu, for her constant 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 was a mathematician and educator who spent most of his career as a faculty member at Worcester Polytechnic Institute. He was head of the mathematics department from 1908 until his death and served as interim president of WPI from 1911 to 1913. Conant was noted as an outstanding teacher and an active scholar. He published a number of articles in scientific journals and wrote four textbooks. His will provided for funds to be donated to the AMS upon his wife's death. Prize winners are invited to present a public lecture at Worcester Polytechnic Institute as part of their Levi L. Conant Lecture Series, which was established in 2006. The Conant Prize is awarded annually.

CITATION

Dan Margalit

The 2021 Levi. L. Conant prize is awarded to Dan Margalit for the article "The Mathematics of Joan Birman", *Notices of the AMS*, **66** (2019), 341–353.

Joan Birman's work spans several interconnected areas of algebra, low-dimensional geometry, topology and dynamics. She has made key contributions and opened up new areas of research in many directions, from braid groups to geometrization and Lorenz attractors. Her work underpinned two Fields medals (Jones and Mirzakhani), and set the stage for the acclaimed work of Johnson (on Torelli groups) and Ghys (on Lorenz knots). Her work continues to be hugely influential to this day.

Margalit's article, in just ten pages, conveys the breadth and depth of her mathematics. It starts with basic objects in low-dimensional topology (knots, braids, surfaces and 3-manifolds), introducing them in an accessible manner and using elementary motivating problems (how to distinguish two knots) as a vehicle for introducing larger questions and more advanced areas of research (e.g., the subtleties of the conjugacy problem for braid groups). The author identifies the common themes and interconnections amongst these objects. Birman's best known and most cited works are included here, along with interesting yet often overlooked details about them, such as the fact that her classic text *Braids, Links, and Mapping Class Groups* contains the first complete

proof of what is known as Markov's Theorem. The article also highlights some of Birman's key contributions that are perhaps less widely known, such as her work with Williams on Lorenz attractors and its connections with Thurston's theory of 3-manifolds. The illustrations (by David Dumas, Shane Scott, and Thierry Dugnolle) are well chosen, helpful and intuitive.

Margalit's portrait of Birman shows a visionary mathematician who was often ahead of her time, forged her own paths, and followed "her own vision, interests, and curiosity" while simultaneously building bridges across disciplines through highly productive collaborations. The author takes a long view, highlighting the significance of Birman's work in ways that are only possible in a major retrospective. He chooses to provide an overview of Birman's career that focuses exclusively and deservedly on her mathematics rather than on her nontraditional career trajectory. He tells a coherent and engaging mathematical story, offering a broad perspective on these topics, but also bringing a highly detailed knowledge of them to the front as needed. Readability and accessibility is never compromised, so that the article could also serve as an excellent introduction to a wide variety of topics in these areas of mathematics.

Biographical Note

Dan Margalit grew up in Flanders, NJ, the son of two Israeli immigrants. He received his Sc.B. in Mathematics from Brown University in 1998 and his Ph.D. in Mathematics from the University of Chicago in 2003 under the direction of Benson Farb. He was on the faculty at the University of Utah and Tufts University before coming to Georgia Institute of Technology, where he became Professor in 2016. Margalit's mathematical interests generally fall under the heading of geometric group theory, with particular focus on surfaces, braids, and complex dynamics.

Margalit is on the editorial boards at *Algebraic & Geometric Topology* and *Advances in Mathematics*. He has written a book, *A Primer on Mapping Class Groups*, with Benson Farb, has co-edited a book, *Office Hours with a Geometric Group Theorist*, with Matt Clay, and has written an online textbook, *Interactive Linear Algebra*, with Joe Rabinoff.

Margalit received a Sloan Research Fellowship in 2009 and a National Science Foundation CAREER Award in 2010. In 2016, he was the inaugural recipient of the Leddy Family Faculty Fellowship in the Georgia Tech College of Sciences. Margalit was elected as a Fellow of the American Mathematical Society in 2019, "for contributions to low-dimensional topology and geometric group theory, exposition, and mentoring."

Margalit's interests outside of mathematics include guitar, hiking, and juggling. He is married to Kathleen Margalit and they have two children, Lily and Simon.

Response from Dan Margalit

I am honored to receive the 2021 Levi L. Conant Prize. I would like to thank the AMS for recognizing my article with this award. I would also like to thank Dorothy Buck and Erica Flapan for inviting me to write the article for the *Notices*. I am grateful to David Dumas and Shane Scott for the illustrations that they made. I would also like to thank Tara Brendle, Benson Farb, Justin Lanier, and Kevin Wortman for their invaluable feedback and suggestions, which greatly improved the quality of the article.

I first met Joan Birman in March 2002 at an AMS Special Session at the University of Michigan. She introduced herself and told me that she had missed my talk. She said that she heard it was good, and so she wanted to know if I would like to visit her at Columbia to speak in their topology seminar. This was a pivotal moment in my career. That such an esteemed mathematician took interest in my work gave me confidence and hope that I did not have before.

I met Joan at many conferences afterwards, and often I spotted her encouraging another young mathematician during the breaks between talks. While my article was about the impact of Joan's mathematical work, her humanity towards the younger generations of mathematicians has had an equally important and far ranging impact.

Eventually, Joan and I became close colleagues and frequent travel partners, sharing a train to Aarhus, an airport shuttle to Banff, a car ride to the University of Georgia, and on and on. Through our conversations about family, politics, our careers, our shared religion, and (of course) mathematics, we developed a deep kinship. As a close friend, I am especially honored and grateful to have been able to shed more light on her remarkable career.

I have been lucky to have had mentor/friends like Joan throughout my journey as a mathematician. Thomas Banchoff, my undergraduate mentor, showed me the beauty and wonder of mathematics. Benson Farb, my graduate advisor, is a constant source of inspiration, mathematical and otherwise. Mladen Bestvina, my postdoc advisor, expanded my abilities and horizons in many ways. I am grateful to all of my mentors for believing in me, caring for me, and investing in me.

To close, I would like to thank my family. My parents, Batya and Zamir, sacrificed endlessly so their children could realize their dreams. My brother, Ron, and my sister, Thalia, are constant sources of love, support, and direction. Finally, my wonderful wife, Kathleen, and our two beautiful children, Lily and Simon, support me with love and provide me with purpose. I love you and am grateful to you all.

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

Amanda L. Folsom

The Mary P. Dolciani Prize for Excellence in Research is awarded to Amanda L. Folsom, Professor of Mathematics at Amherst College, for her outstanding record of research in analytic and algebraic number theory, with applications to combinatorics and Lie theory, for her work with undergraduate students and for her service to the profession, including her work to promote success of women in mathematics.

Folsom received her Ph.D. in Mathematics in 2006 from the University of California at Los Angeles under the supervision of William Duke. She has published over 40 research articles on different aspects of the theory of modular forms, most notably on harmonic Maass forms, mock modular forms, and quantum modular and Jacobi forms. These papers have appeared in some of the most important international journals in number theory, including *Compositio Mathematica*, *Acta Arithmetica*, *Crelle's Journal*, and the *Journal of Number Theory*. Her book *Harmonic Maass Forms and Mock Modular Forms: Theory and Applications*, written with Kathrin Bringmann, Ken Ono, and Larry Rolen, won the PROSE Award from the Association of American Publishers as the Best Scholarly Book in Mathematics of 2018. She serves on the Editorial Boards of the *Proceedings of the American Mathematical Society*, the *Journal of Number Theory*, and *Research in Number Theory*. She has twice been a von Neumann Fellow at the

Institute for Advanced Study in Princeton, received a Simons Fellowship, and has received multiple NSF individual investigator awards including a CAREER award.

Folsom's research centers around the theory of mock modular forms and their relatives. Classical modular forms are complex functions on the upper half plane that have an invariance property under the action of the modular group; it was a profound study of their relationship to number theory that led to the proof of Fermat's Last Theorem. Mock modular forms have their roots in the work of Ramanujan, who proposed a number of functions that were "almost" invariant like a "real" modular form, but not quite. While Ramanujan didn't formally define 'mock modular forms', over the past few decades, the work of many mathematicians has clarified the relationship of mock modular forms to more classical objects while at the same time generalizing them and highlighting the important combinatorial implications of the theory. Folsom has played a key role in this program, showing, with a variety of collaborators, how the theory of mock modular forms and their generalizations yields insights in situations as diverse as the representation theory of vertex algebras and Lie superalgebras, convex geometry, and a variety of combinatorial problems such as counting unimodal sequences of integers.

Folsom is an active collaborator with undergraduates, successfully bringing students into her research field, and has co authored five papers with thirteen undergraduate co-authors. Folsom is also a dedicated expositor, working to explain her research field as well as aspects of the mathematical profession to a more general audience through articles in journals such as the *Notices of the American Mathematical Society* and *Philosophical Transactions of the Royal Society A*. She has twice been a research advisor and co-edited a volume for the Women in Numbers workshops at Banff. She currently serves as Department Chair of Mathematics and Statistics at Amherst.

Biographical Note

Amanda L. Folsom is a professor of mathematics at Amherst College, specializing in number theory. She received her B.A. degree in mathematics from the University of Chicago in 2001, and her Ph.D. degree in mathematics from the University of California, Los Angeles in 2006. Folsom held postdoctoral positions at the Max Planck Institute for Mathematics and the University of Wisconsin-Madison between 2007–2010, and joined the mathematics faculty at Yale University in 2010. Folsom has been a mathematics faculty member at Amherst College since 2014. She has held temporary visiting positions at the Max Planck Institute for Mathematics, and the Institute for Advanced Study. Folsom was the recipient of an NSF Career Award from 2013–2019, and in 2018–19, she was named a Simons Fellow in Mathematics.

Response from Amanda L. Folsom

I am truly honored and grateful to receive the 2021 Mary P. Dolciani Prize for Excellence in Research. Thank you to the American Mathematical Society and to the Mary P. Dolciani Halloran Foundation for establishing this prize, and for recognizing mathematics research at non-Ph.D.-granting institutions. There are many mathematicians deserving of this recognition. I sincerely thank all of my wonderful colleagues in the Mathematics and Statistics Department at Amherst College. I am very grateful to work both at a college and in a department that are supportive in general, and of research specifically. There are many people in the profession who have helped me throughout my career, and I am thankful to all of them. In particular, I would like to thank my Ph.D. advisor Bill Duke and my postdoctoral mentor Ken Ono, for years of mentorship, teaching, support, and advice. Thank you to all of my co-authors, including my student co-authors, who I am always learning from. I am also grateful for support provided by the National Science Foundation during my career. Finally, thank you to my family, for their constant support.

2021 ULF GRENANDER PRIZE IN STOCHASTIC THEORY AND MODELING

THE Grenander prize, established in 2017 in honor of Ulf Grenander (1923–2016), recognizes exceptional theoretical and applied contributions in stochastic theory and modeling. It is awarded for seminal work, theoretical or applied, in the areas of probabilistic modeling, statistical inference, or related computational algorithms, especially for the analysis of complex or high-dimensional systems. Grenander was an influential scholar in stochastic processes, abstract inference, and pattern theory. He published landmark works throughout his career, notably his 1950 dissertation, *Stochastic Processes and Statistical Interference* at Stockholm University, *Abstract Inference*, his seminal *Pattern Theory: From representation to inference* and *General Pattern Theory*. A long-time faculty member of Brown University's Division of Applied Mathematics, Grenander was a fellow of the American Academy of Arts and Sciences, the National Academy of Sciences and was a member of the Royal Swedish Academy of Sciences.

CITATION

Michael I. Jordan

The Ulf Grenander Prize in Stochastic Theory and Modeling is awarded to Michael I. Jordan for foundational contributions to machine learning, especially unsupervised learning, probabilistic computation, and core theory for balancing statistical fidelity with computation.

Machine learning (ML) has emerged as one of the highest-impact areas of computer science in the 21st century, and it has become nearly synonymous with modern artificial intelligence (AI). Michael I. Jordan has played a significant role in bringing ML from infancy to where it is today. Since the 1990's, he has been one of the foremost intellectual leaders of the field, developing numerous important new theories and methods that link AI, statistics, optimization, and computation. His work has provided the foundational building blocks for modern machine learning and has paved the way for both its current successes and its future.

One of Prof. Jordan's core contribution to ML is the development of the field of unsupervised learning. In his hands it has moved from a collection of unrelated algorithms to an intellectually coherent field—one largely based on probabilistic

inference—that can be used to solve real-world problems. Unsupervised learning dispenses with the labels and reinforcement signals of the other main branches of machine learning, developing algorithms that reason backwards from data to the patterns that underlie its generative mechanisms. Working from the general perspective of stochastic modeling and Bayesian inference, Jordan augmented the classical analytical distributions of Bayesian statistics with computational entities having graphical, combinatorial, temporal and spectral structure. Furthermore, making use of ideas from convex analysis and statistical physics, he developed new methods for approximate inference that exploited these structures. The resulting algorithms, which are called variational inference, are now a major area of ML and the principal engine behind scalable unsupervised learning. Prof. Jordan's general approach to unsupervised learning gave birth to latent Dirichlet allocation, hierarchical Dirichlet processes, kernel independent component analysis, factorial hidden Markov models, multiple kernel learning, DP-means and distance metric learning—all topics developed by Jordan and his students, and all topics which have become textbook material in unsupervised learning, with thousands of applications in science and technology.

Prof. Jordan has also made significant contributions to many of the other important methodologies of ML, such as neural networks, reinforcement learning, and dimensionality reduction. He is known for prescient early work on recurrent neural networks, for the first rigorous theory of convergence of Q-learning (the core dynamic-programming-based framework that underlies reinforcement learning) and for his work on "classification-calibrated loss functions," which provides a general theory of classification that encompasses boosting and the support vector machine. In more recent years, Jordan has turned his attention to optimization theory and Monte Carlo sampling, focusing on nonconvex optimization and sampling in high-dimensional spaces. Overall, the research accomplishments of Prof. Jordan have been broader than any specific technique; rather, they go to the core of what it means for a real-world system to learn, and they herald the emergence of machine learning as a science.

Michael Jordan has been an intellectual leader in machine learning for more than 20 years. Throughout his career, he has pursued a general agenda of reworking core statistical theory to encompass computational concepts, reworking core computational theory to encompass statistics, and bringing both these concepts to bear on the study of the foundations of machine learning. We are delighted to bestow on him the Ulf Grenander Prize in Stochastic Theory and Modeling.

Biographical Note

Michael I. Jordan is the Pehong Chen Distinguished Professor in the Department of Electrical Engineering and Computer Science and the Department of Statistics at the University of California, Berkeley. His research interests

bridge the computational, statistical, cognitive and biological sciences. He is known for his work on variational inference, topic models, Bayesian nonparametrics, reinforcement learning, convex and nonconvex optimization, distributed computing systems, and game-theoretic learning. Prof. Jordan is a member of the National Academy of Sciences and a member of the National Academy of Engineering. He has been named a Neyman Lecturer and a Medallion Lecturer by the Institute of Mathematical Statistics, and he has given a Plenary Lecture at the International Congress of Mathematicians. He received the IEEE John von Neumann Medal in 2020, the IJCAI Research Excellence Award in 2016, the David E. Rumelhart Prize in 2015, and the ACM/AAAI Allen Newell Award in 2009.

Response from Michael I. Jordan

My career had its origins in the fields of cognitive psychology and philosophy, where, inspired by logicians such as Bertrand Russell, I was drawn to the problem of finding mathematical expression for aspects of human intelligence, including reasoning and learning. Eventually my work began to take mathematical shape in the study of relationships between computation and inference, where again I found myself in debt to pioneers of the past century, including von Neumann, Kolmogorov, Neyman, Wald, Turing, Blackwell, and Wiener. The problems that have fascinated me have revolved around how humans and machines can make good decisions based on uncertain data, and do so in a computationally-efficient, real-time manner. In studying such problems I've made use of a wide range of mathematics, including convex analysis, variational analysis, stochastic differential equations, symplectic integration, partial differential equations, graph theory, and random measures. It's been exciting to uncover some of the algorithmic consequences of the mathematical structures studied in these fields, while working within the overall framework of inferential statistics.

My first decade as a professor took place at MIT, and I was well aware of the nearby presence at Brown of Ulf Grenander and his "pattern theory" school, including the friendly and stimulating welcome to be found in that school from mathematicians such as Stuart Geman and David Mumford. In accepting this award I wish to indicate my delight and honor to be associated with such individuals and with the intellectual tradition of Grenander's pattern theory.

ALBERT LEON WHITEMAN MEMORIAL PRIZE

THIS prize was established in 1998 using funds donated by Mrs. Sally Whiteman in memory of her husband, the late Albert Leon Whiteman. Mrs. Whiteman requested that the prize be established for notable exposition on the history of mathematics. Ideas expressed and new understandings embodied in the exposition awarded the Whiteman Prize will be expected to reflect exceptional mathematical scholarship. The prize is awarded every three years at the Joint Mathematics Meetings.

CITATION

Judith Victor Grabiner

The 2021 Albert Leon Whiteman Memorial Prize is awarded to Judith Grabiner for her outstanding contributions to the history of mathematics, in particular her works on Cauchy, Lagrange, and MacLaurin; her widely-recognized gift for expository writing; and a distinguished career of teaching, lecturing, and numerous publications promoting a better understanding of mathematics and the significant roles it plays in culture generally.

Biographical Note

Judith Victor Grabiner got her B.S. in Mathematics in 1960 at the University of Chicago, where she discovered that history, philosophy, and literature could be just as interesting and intellectually challenging as science. A chance look at a Harvard catalogue revealed the existence of an interdisciplinary field called History of Science, so she decided to study it. She received her M.A. in 1962 from Radcliffe and Ph.D. in the History of Science in 1966 from Harvard, with thesis advisors I. Bernard Cohen and Dirk Struik. Her thesis was the beginning of her research program on eighteenth-century analysis. She focused on the use of algebraic inequalities in bounding approximations that revealed the key properties of the derivative, especially in the mean-value theorem, the theory of maxima and minima, power series, and the fundamental theorem of calculus.

After one-year jobs at UC Santa Barbara and Cal State LA, she became a professor of history at California State University, Dominguez Hills, where she received the Outstanding Professor award in 1975. She was co-president of the West Coast History of Science Society (1973–1975), Book Review Editor of *Historia Mathematica* (1976–1988), and Chair of the Southern California Section of the

MAA (1982–1983). In 1985 she joined the mathematics faculty at Pitzer College in Claremont, California, where she held the Flora Sanborn Pitzer Chair in Mathematics until retiring in 2016. She has been a Visiting Scholar at the University of Leeds, the University of Edinburgh, Cambridge University, the Australian National University, and the University of Copenhagen. In 2013 she became a Fellow of the American Mathematical Society.

Grabiner's publications include three books: *The Origins of Cauchy's Rigorous Calculus*, 1981; *The Calculus as Algebra*, 1990; and *A Historian Looks Back: The Calculus as Algebra and Selected Writings*, 2010, which won the Beckenbach Book Prize from the MAA in 2014. She has also published over forty refereed articles, three of which have won Carl Allendoerfer awards for articles of expository excellence in the *Mathematics* Magazine: "The Changing Concept of Change" (1984); "The Centrality of Mathematics in the History of Western Thought" (1988); and "Descartes and Problem-Solving" (1990). Four of her papers have won the MAA's Paul R. Halmos–Lester R. Ford award for articles of expository excellence in the *American Mathematical Monthly*: "Who Gave You the Epsilon? Cauchy and the Origins of Rigorous Calculus" (1984); "Was Newton's Calculus a Dead End?" (1998); "Newton, Maclaurin, and the Authority of Mathematics" (2005); and "How Did Lagrange 'Prove' the Parallel Postulate?" (2010). Her other articles include "Computers and the Nature of Man: A Historian's Perspective on Controversies about Artificial Intelligence" (1986); "'Some Disputes of Consequence': Maclaurin among the Molasses Barrels" (1998); and "The Role of Mathematics in Liberal Arts Education" (2014).

She has given invited talks about her work in many international and national meetings, and has been both a Sigma Xi National Lecturer and an MAA National Lecturer. She is also the author of a highly-rated course, "Mathematics, Philosophy, and the 'Real World,' " in the Teaching Company's Great Courses series. And she received the national Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching from the MAA in 2003.

Since retiring, she has been tutoring at-risk elementary school students in mathematics, working in voter outreach, still doing research though at a slower pace, and reading far too many detective novels than is good for her.

Response from Judith Victor Grabiner

A response is a way to say thank you, and I shall do so. It is also the place to reflect on how extraordinarily lucky I've been to get where I've gotten, and therefore on how important it is for the mathematics profession, for education in general, and for society as a whole to enhance opportunities for all to learn mathematics, regardless of wealth, ethnicity, religion, gender, sexual orientation, or disability.

So thanks to so many. My parents and high school teachers got me started. A National Merit Scholarship made it possible for me to attend the University of

Chicago. At Chicago, Professor Saunders Mac Lane was the best mathematics teacher I ever had, and Humanities Professor Herman Sinaiko opened my eyes to the intellectual rigor of the humanities.

My fellow graduate students from different backgrounds at Harvard taught me about their worlds. Uta Merzbach was a great female role model for me at a crucial time. Dirk Struik of MIT taught me that a mathematician is a social being even when thinking about lines in hypercones in 7-dimensional space, and my mentor I. Bernard Cohen taught me to think like a historian.

The experimental college at Cal State Dominguez Hills gave me the freedom to design my own courses. The Association for Women in Mathematics provided a supportive community. The MAA has not only given me personal honors, it has been crucial to advancing the teaching of university-level mathematics. Barbara Beechler, the founder of Pitzer College's math program, figured out that I would be a good fit there and encouraged me to apply for their job. My Pitzer colleagues were willing to listen to my ideas about teaching mathematics and about the role of mathematics in liberal arts education.

My husband, Sandy Grabiner, has supported me in my career from the beginning, since our first date when he enjoyed learning that Descartes, Newton, Maclaurin, Cauchy, and Weierstrass were more than just the names of theorems. And my students taught me how to teach and how to always be open to questions. They also gave me insights from their differing backgrounds, both into history and into the variety of ways people think about mathematics.

Above all, I thank the AMS and the Whiteman prize committee for admitting me to the august company of past recipients Tom Hawkins, Harold Edwards, Jeremy Gray, Joe Dauben, Umberto Bottazzini, and Karen Parshall, and for giving me this chance to say how important it is to open more doors for more people to enter the world of mathematics.

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

Kaisa Matomäki

The 2021 Ruth Lyttle Satter Prize is awarded to Kaisa Matomäki for her work (much of it joint with Maksym Radziwiłł) opening up the field of multiplicative functions in short intervals in a completely unexpected and very fruitful way, and in particular in their breakthrough paper, "Multiplicative functions in short intervals," (*Annals of Math.* **183** (2016), 1015–1056).

The Möbius function μ is a function from positive integers to $\{0, \pm 1\}$ which sends n to $(-1)^k$ where k the number of prime factors of n if n is square free, and to 0 otherwise. It is a basic example of a multiplicative function, i.e., a function f on the positive integers satisfying $f(ab) = f(a)f(b)$ whenever a and b are coprime. The Möbius function is intimately connected to the Riemann zeta function and to the distribution of prime numbers. For example the prime number theorem (giving the asymptotic distribution of prime numbers) is equivalent to the non-vanishing of the Riemann zeta function on the line $\mathrm{Re}(s) = 1$ which in turn is equivalent to the fact that the Möbius function asymptotically has mean zero on intervals of the form $[x, 2x]$. It is important to understand whether this mean zero behaviour remains true on shorter intervals $[x, x + h(x)]$, even for "most x". In their 2016 *Annals* paper, described as a "stunning surprise" going well beyond what was commonly thought to be currently possible, Matomäki and Radziwiłł showed that for most x this was true as long as $h(x)$ grew with x, however slowly. (Moreover they proved a general result that holds for any real-valued bounded multiplicative function, not only for the Möbius function.) Previously, even assuming the Riemann hypothesis, such a result was only known for h growing like a power of $\log x$. Their result has had a transformative effect on analytic number theory opening up new lines of research and leading for instance to

important progress on the Chowla conjecture and to Tao's resolution of the Erdős discrepancy problem.

Biographical Note

Kaisa Matomäki was born in Nakkila, Finland, in 1985. She received her master's degree at University of Turku, Finland, in 2005, and her Ph.D. 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 together with her collaborator Maksym Radziwiłł 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 Ruth Lyttle Satter Prize. It would not have been possible without my mentors and collaborators to whom I am extremely grateful; In early years my teachers Harri Ketamo and Merikki and Esa Lappi, as well as math contest trainers made me excited about mathematics. My Ph.D. supervisor Glyn Harman helped me to get a good start in my research career. Andrew Granville has helped and adviced me in various ways.

I want to thank all my collaborators—together one can do much more than alone. Special thanks go to Maksym Radziwiłł with whom we have had several succesful projects. 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.

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 following citation describes the award for Mathematical Exposition.

CITATION

Noga Alon and Joel Spencer

The Steele Prize for Mathematical Exposition is awarded to Noga Alon and Joel Spencer for the book *The Probabilistic Method*, published by Wiley & Sons Inc. in 1992.

Now in its fourth edition, *The Probabilistic Method* is an invaluable toolbox for both the beginner and the experienced researcher in discrete probability. It brings together through one unifying perspective a head-spinning variety of results and methods, linked to applications in graph theory, combinatorics, number theory, and geometry.

This enduring book has been used around the world. Much-cited by important papers in leading journals, it functions as both onramp and toolbox. *The Probabilistic Method* has its roots in the work of Paul Erdős, and this volume brought together a dizzying array of ideas, methods and applications, using them to prove deterministic properties of combinatorial systems and typical properties of random discrete systems.

Applications presented are frequently state-of-the-art bounds, and Alon-Spencer have synthesized their various proofs and at times offer alternative proofs of their own. As is often the case for books that help to seed a field, the material brought together here into a unified fabric was previously unavailable in one place. The style of the book is both crystalline and engaging.

Biographical Note

Noga Alon is a Professor of Mathematics at Princeton University and a Professor Emeritus of Mathematics and Computer Science at Tel Aviv University, Israel. He received his Ph.D. in Mathematics at the Hebrew University of Jerusalem in 1983 and had visiting and part time positions in various research institutes

including MIT, Harvard, the Institute for Advanced Study in Princeton, IBM Almaden Research Center, Bell Laboratories, Bellcore and Microsoft Research (Redmond and Israel). He joined Tel Aviv University in 1985, served as the head of the School of Mathematical Sciences in 1999–2001, and moved to Princeton in 2018. He supervised more than 20 Ph.D. students. He serves on the editorial boards of more than a dozen international technical journals and has given invited lectures in numerous conferences, including plenary addresses in the 1996 European Congress of Mathematics and in the 2002 International Congress of Mathematicians. He published one book and more than five hundred research papers.

His research interests are mainly in Combinatorics, Graph Theory and their applications in Theoretical Computer Science. His main contributions include the study of expander graphs and their applications, the investigation of derandomization techniques, the foundation of streaming algorithms, the development and applications of algebraic and probabilistic methods in Discrete Mathematics and the study of problems in Information Theory, Combinatorial Geometry and Combinatorial Number Theory.

He is an ACM Fellow and an AMS Fellow, a member of the Israel Academy of Sciences and Humanities, of the Academia Europaea, and of the Hungarian Academy of Sciences. He received the Erdős Prize, the Feher Prize, the Polya Prize, the Bruno Memorial Award, the Landau Prize, the Gödel Prize, the Israel Prize, the EMET Prize, the Dijkstra Prize, the Nerode Prize, the Kanellakis Prize, and Honorary Doctorates from ETH Zürich and from the University of Waterloo.

Biographical Note

Joel Spencer is Silver Professor of Mathematics and Computer Science at the Courant Institute, New York University. He works in the fecund intersection of Discrete Mathematics, Probability and Logic. He is co-founder of the journal *Random Structures and Algorithms*. He has served on the AMS Executive Committee, chaired the Meeting and Conference Committee and, most proudly, helped found and chaired the Epsilon Fund for High School Math Camps. He is a Fellow of the AMS and SIAM. He has over 200 research publications and 7 books. His latest book, *Asymptopia*, was published by the AMS. His Erdős number is one.

Response from Noga Alon and Joel Spencer

We are delighted and honored to receive the Steele Prize for Mathematical Exposition. Already when we had started writing the first edition of the book, there had been a substantial number of known impressive applications of the Probabilistic Method in the study of problems in Discrete Mathematics as well as in other areas including Information Theory, Number Theory, Geometry and theoretical Computer Science. Three decades later, after four editions of the book have been published, it is now clear that the method is one of the most powerful

and widely used tools in Combinatorics and its applications. We believe and hope that our book contributed to the success and popularity of the subject.

I [Noga] personally first learned about the probabilistic method when I was still in high school. I read a version of one of the earliest results established using it: the proof of the lower bound for Ramsey numbers discovered in 1947 by Paul Erdős, the founder of the method. I still recall the admiration I felt going through the concise and elegant argument, an admiration that only increased when I kept following the profound impact of other applications of the method on the development of Discrete Mathematics.

I [Joel] began working with Paul Erdős while still a graduate student. Uncle Paul, as we all called him, was, is, and forever will be the center of my professional life. He combined brilliance with a powerful personality—pushing us always to new heights with his admonition "Prove and Conjecture." Erdős's style was to prove specific individual results. A mathematician once said "Erdős only gives us corollaries of the great metatheorems which remain unformulated in the back of his mind." It was my hubris that the theorems could be made into a theory, that the methods could be made into a methodology. I was so fortunate to find Noga, who shared my passion and surpassed my abilities. To my great joy, the Probabilistic Method is now a basic element of combinatorial and probabilistic thinking. This award is surely icing on the cake.

Our book was never meant to be an encyclopedic treatment of the subject. Even in the late 80s it looked difficult to try to cover all the significant applications of the method, and with all the beautiful results and techniques developed since then this is a totally impossible task now. The emphasis in the book is on methodology and ideas, with an attempt to explain those in a precise and yet intuitive and readable manner. As is often the case, the work often led us to find new arguments and proofs, and this has been one of the main satisfying aspects of the project.

The book, and the Probabilistic method itself, would not exist without the immense contributions of the superb researchers working in the area, starting with the fundamental contributions of the giant founders, and continuing with the beautiful results of numerous others. We are indebted to all of them including our many colleagues, collaborators and students. It is rewarding to see that the resulting text is used extensively by researchers and students, and it is a great honor to thank the prize committee and the American Mathematical Society for the recognition.

Finally, it is a special pleasure to thank our wives Nurit and MaryAnn. Their understanding and encouragement have been crucial in the successful writing enterprise.

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 following citation describes the award for Seminal Contribution to Research.

CITATION

Murray Gerstenhaber

The Steele Prize for Seminal Contribution to Research is awarded to Murray Gerstenhaber for "The cohomology structure of an associative ring," *Ann. Math.* **78** (1963), 267–288 and "On the deformation of rings and algebras," *Ann. Math.* **79** (1964), 59–103. These two remarkable *Annals of Mathematics* papers established the foundations of algebraic deformation theory, developing a rich structure on the Hochschild cohomology. These papers have had and continue to have a huge impact on many areas of mathematics and physics, including "higher algebra" and deformation quantization.

In these two seminal and much-cited papers, Gerstenhaber laid the foundation of algebraic deformation theory, discovering that formal deformations of an algebraic structure are governed by an appropriate cohomology theory, and the existence and classification of such deformations by a graded Lie algebra structure on the cohomology. The ideas initiated in these papers have permeated a multiplicity of subjects. Gerstenhaber's theory of deformations of associative algebras has been extended to commutative Lie, Hopf, Poisson, Leibniz, and other classes of algebras. Algebras carrying a structure like the one introduced by Gerstenhaber are now called Gerstenhaber algebras, with examples the exterior algebra of a Lie algebra, the multivector fields on a manifold using the Schouten-Nijenhuis bracket, and differential forms on a Poisson manifold.

Gerstenhaber's homological approach to deformation theory has been taken up by the physics community, beginning with looking at special relativity as a deformation of Newtonian mechanics. Work of Bayen, Flato, Fronsdal, Lichnerowicz, and Sternheimer studied quantization in terms of a deformation of the algebra of functions on a Poisson manifold, initiating the subject of deformation quantization. This led to applications to particle physics, string

theory and gauge theory, including remarkable work of Kontsevich that settled the deformation quantization of Poisson manifolds. The continued use of the methods pioneered in these two papers is testimony to their enduring influence.

Biographical Note

Murray Gerstenhaber was born in May, 1927, in Brooklyn, to a family that lost much during the Great Depression, including their brownstone home. They survived on the earnings of his hard working seamstress mother. Gerstenhaber attended the Speyer School, and the Bronx High School of Science. A scholarship allowed him to enter Yale in March, 1944. There, his encounter with student and institutional anti-Semitism, was considerably mitigated by Einar Hille and Deane Montgomery, both later presidents of the AMS. Gerstenhaber was drafted in May, 1945. In February, 1946, he was sent to OMGUS, the Office of Military Government, U.S., in Berlin for 10 months. There he was assigned first to the Transportation Division and then to a small Army university run for soldiers on leave.

With the support of the GI Bill, Gerstenhaber returned in March, 1947, to a Yale transformed by war veterans, matured by their experiences and driven to make up for time lost during the war. Gerstenhaber graduated in June, 1948 and then entered the University of Chicago. Gerstenhaber received the Ph.D. in 1951 with A. Adrian Albert; his mentor at Chicago was André Weil. With Frank B. Jewett Fellowships from Bell Laboratories, Gerstenhaber engaged in postdoctoral study at Harvard in 1951–1952, and at the Institute for Advanced Study in 1952–1953, where he was an assistant to Hermann Weyl.

In 1953, Gerstenhaber joined the faculty of the University of Pennsylvania from which he retired in 2011. At Penn, Gerstenhaber served as chair of the Mathematics Department, and subsequently as chair of the Faculty Senate. He earned a J.D. in 1973 at Penn's Law School, and was admitted to the Pennsylvania bar. At the Law School he taught a course on Statistics for Law, using Supreme Court cases as illustrations—a first for this country.

At the American Mathematical Society Gerstenhaber served on the Committee on Human Rights, the Committee on Academic Freedom and Tenure, and the Council of the Society. He helped draft the Code of Ethics of the Society. As a Regional Secretary of the Society, Gerstenhaber reconnected the AMS with the American Association for the Advancement of Science by instituting a series of Annual Symposia on "Some Mathematical Questions in Biology", whose proceedings were published by the Society until those symposia were discontinued.

Gerstenhaber served as an editor of the *Bulletin of the AMS* from 1966 to 1971, and as Managing Editor from 1968 to 1971. As first chair of the Steele Prize committee, he nominated Lefschetz for the first Award, given in 1970.

Gerstenhaber is a Fellow of the American Association for the Advancement of Science, and an Inaugural Fellow of the American Mathematical Society. He was also one of the founders of the Association of Members of the Institute for Advanced Study (AMIAS), its alumni organization, which he served for many years as treasurer. As a member of an advisory committee of the National Science Foundation, Gerstenhaber moved to fund the Mathematical Sciences Research Institute at Berkeley and the Institute for Mathematical Analysis at Minnesota.

Response from Murray Gerstenhaber

Thank you for this honor.

It has been a wonderful journey learning of Riemann surfaces from Weyl's *Die Idee der Riemannschen Fläche*, to Teichmüllers attempt to define their infinitesimal deformations, to the correct definition by Frölicher and Nijenhuis of infinitesimal deformations of complex manifolds of arbitrary dimension, to seeing Kodaira and Spencer develop the deformation theory of complex manifolds. My own *Annals of Mathematics* papers of 1963 and 1964, creating algebraic deformation theory for which you are now honoring me, were but the next step.

Even more wonderful has been seeing later the work of Bayen, Flato, Fronsdal, Lichnerowicz, and Sternheimer who, with algebraic deformation theory, were able to deduce the spectrum of hydrogen without using either Schrödinger or wave mechanics. They also recognized that Einstein's special relativity can be viewed as a deformation of Newtonian mechanics, with the speed of light (more precisely, its inverse) as the deformation parameter. A polynomial algebra in two variables can deform, with Planck's constant as deformation parameter, to the first Weyl algebra, which expresses the quantum relationship between position and momentum. Weyl algebras allow no further deformations; they are "rigid" or "stable", which may suggest that physical laws deform towards stability, but the laws themselves do not change; only our understanding of them continues to evolve.

Acknowledging with gratitude those before who brought us to our present level of understanding, and with the firm belief that those who come after us will see much farther than we have, I gratefully accept this honor you have given me.

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. The following citation describes the award for Lifetime Achievement.

CITATION

Spencer Bloch

The Steele Prize for Lifetime Achievement is awarded to Spencer Bloch for his seminal contributions linking algebraic geometry, algebraic K-theory, arithmetic and Hodge theory. Bloch's ideas pervade modern thinking on these subjects and laid the groundwork in both techniques and framework for many of the most exciting developments in these subjects.

A striking feature of Bloch's work is its combination of extraordinary results with its seminal nature. Starting with his remarkable work linking algebraic K-theory and algebraic cycles, leading to the Bloch-Quillen formula, a body of visionary work emerged. Bloch's conjecture on rational equivalence on surfaces, the Bloch-Beilinson conjectures, the Bloch-Kato conjecture, the Bloch-Srinivas theorem on decomposition of the diagonal, Bloch's recasting of the Birch-Swinnerton-Dyer conjecture as a volume computation, Bloch's work on motivic cohomology, his development of higher Chow groups and the Bloch-Suslin theorem, Bloch's work on the link between K_2 and the dilogarithm function, have energized entire fields and been remarkably productive of great mathematics.

More recently, his work with a variety of collaborators on "irregular differential equations," on Feynmann motives and mathematical physics continue to reflect the innovative nature of Bloch's mathematical work. It is difficult to imagine algebraic geometry, algebraic K-theory, arithmetic and Hodge theory without Bloch's contributions.

Biographical Note

Spencer Bloch was born in 1944 in New York City. He grew up in Ossining, N.Y., a suburb of New York. He was educated at Scarborough school and Deerfield academy, graduating from high school in 1962. He attended Harvard University, graduating in 1966, and got a Ph.D. in Mathematics from Columbia University

under the direction of Steve Kleiman in 1971. He held non-tenured positions at Princeton and the University of Michigan, moving to a tenured post at the University of Chicago in 1976.

Bloch was an ICM speaker in Helsinki, Finland in 1978 and an ICM plenary speaker in Kyoto, Japan in 1990. He was elected to the National Academy of Science in 1994. Over the years he has held temporary research positions in England, France, Germany, India, Japan and China.

Response from Spencer Bloch

I am honored (humbled, actually) to have been awarded the Steele Prize for Lifetime Achievement from the AMS. Surely, if the committee had asked me, I could have come up with any number of more suitable candidates. Some thoughts on 50+ years in Mathematics:

1. As a math teacher. I am moved to cry out "Behold, the infinite variety of human intelligence!" For are we math people not the best placed to observe? All the modern emphasis on STEM. Surely it is for naught. What will happen to the LEAVES and FLOWERS and ROOTS and the other 22 letters, constituting acronyms we cannot even imagine? And STEM seems such a rigid thing. We must avoid rigidity at all costs. Science is expensive, and it changes rapidly. People find themselves stuck in an outdated technology. By good fortune, I was able to focus on excellence. We should insure that many students have that chance. I was also blessed with an extremely supportive intellectual atmosphere at the University of Chicago. If the current political environment is allowed to fester, we risk losing such support.

2. How has math changed over the years? I am fascinated by the Jujutsu wrestling match currently playing out between math and physics. Modern ideas like string theory and mirror symmetry were introduced in physics. People thought they would lead to mathematical domination of physics. In fact, it is the reverse. Mathematicians are confronted with amazing conjectures, sometimes admitting mathematical proofs, but totally lacking in mathematical motivation or intuition.

3. Is it possible for a 76 year old to continue to do math? Yes but... It is difficult to "multi-task", and one has to acknowledge there are ideas out there one will never grasp.