JMM JOINT MATHEMATICS MEETINGS
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AMERICAN MATHEMATICAL SOCIETY
MATHEMATICAL ASSOCIATION OF AMERICA

JANUARY 2017

PRIZES AND AWARDS

4:25 P.M., THURSDAY,
JANUARY 5, 2017

Program

Opening Remarks
Robert L. Bryant, American Mathematical Society

Beckenbach Book Prize
Mathematical Association of America

Chauvenet Prize
Mathematical Association of America

David P. Robbins Prize
Mathematical Association of America

Euler Book Prize
Mathematical Association of America

The Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching of Mathematics
Mathematical Association of America

Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics
Mathematical Association of America

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

Communications Award
Joint Policy Board for Mathematics

Birman Prize in Geometry and Topology
Association for Women in Mathematics

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

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

Joseph L. Doob Prize
American Mathematical Society

Levi L. Conant Prize
American Mathematical Society

Leonard Eisenbud Prize for Mathematics and Physics
American Mathematical Society

Frank Nelson Cole Prize in Number Theory
American Mathematical Society

Bôcher Memorial Prize
American Mathematical Society

Ruth Lyttle Satter Prize in Mathematics
American Mathematical Society

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

Leroy P. Steele Prize for Mathematical Exposition
American Mathematical Society

Leroy P. Steele Prize for Lifetime Achievement
American Mathematical Society

Closing Remarks
Francis Su, Mathematical Association of America

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

Tim Chartier

When Life is Linear: From Computer Graphics to Bracketology, MAA Press, 2015

Linear algebra is a challenging course to make relevant for today's students. Standard applications in forest management, cryptography, and population modeling, for example, don't seem to stick with our younger generation. Typical student reactions to the course are that it is dull and/or useless. Chartier's book changes this dramatically. The applications are direct, novel, and relevant to today's wired student. They include Google PageRank, image processing, computer modeling of sports cars, sports rankings, and handwriting analysis. The writing is engaging and the examples have a visual component that strengthens the connection between the linear algebra and geometry. Each chapter is motivated by an example that is current and challenges students to think in a more mathematical way about their daily activities. For example, how does Google's PageRank algorithm work, or how does Netflix know which movies to suggest to me? In the preface, Chartier states his two goals: "this book will ignite ideas and fuel innovation in the reader," and "that after reading this book more people will say, 'I really need to remember these ideas. They are so useful!' " Without a doubt, both of these goals have been reached.

Biographical Note

Tim Chartier is professor of mathematics and computer science at Davidson College. He specializes in numerical linear algebra, with his recent work focusing on data analytics. He frequently consults for businesses on data analytics questions, which have included consultation on problems for ESPN's Sport Science program, the National Basketball Association, and NASCAR teams. Tim serves as second Vice President of the Mathematical Association of America and he is also Chief Researcher for Tresata, a predictive analytics software company. Tim is a recipient of the MAA's Henry L. Alder Award. His research and scholarship were recognized with an Alfred P. Sloan Research Fellowship. Tim's book *Math Bytes: Google Bombs, Chocolate-Covered Pi, and Other Cool Bits in Computing*, and his co-authored textbook *Numerical Methods: Design, Analysis, and Computer Implementation of Algorithm*s are both published by Princeton University Press. Through the Teaching Company, Dr. Chartier completed a 24-lecture series entitled *Big Data: How Data Analytics Is Transforming the World*. Tim has also been a resource for a variety of media inquiries, as well as had appearances on NPR, on the CBS Evening News, in *USA Today*, and in *The New York Times*.

Response from Tim Chartier

The MAA bookstore offers delightful treats for the mathematical mind much like Willy Wonka's candy factory does for the sweet tooth. As such, it was quite an honor when Karen Saxe, editor of the Anneli Lax New Mathematics Library, asked me to write for the series. I am grateful for her insight and commitment to my writing throughout the process. To learn that my book is being honored with this award is a celebration of the insights, encouragement, and collaboration of many—from students and colleagues at Davidson College to mathematical colleagues in and beyond the MAA, to family and friends who listened to my creative ponderings.

I want to thank my family as any such commitment is one we make as a unit. One of life's greatest joys is sharing the journey of family life with them. I enjoyed sharing the ups and downs of life's often nonlinear path with my wife Tanya. To my parents, I express my gratitude for your commitment and care throughout the years, especially during college which was a time that I was a student of linear algebra. To my children Noah and Mikayla, I thank you for looking at many of the images of the book and sharing your critiques.

It is impossible to thank everyone who played a role in this book, so I begin by thanking Davidson College and the MAA for fostering environments where sharing even sketchy thoughts can lead to deeper and more robust insight. I also thank those involved with the Davidson College edX MOOC for their commitment and innovative ideas that shared this book in an online format around the world.

For those who have read the book, whether in its entirety or selected portions, I hope the ideas ignited your own notions of how to model or visualize this world with linear algebra. Mathematics is a place where your mind can delve deeply into abstraction and application. My hope is that this book offers keys that unlock your mathematical creativity.

CHAUVENET PRIZE

THE Chauvenet Prize is awarded to the author or authors 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

Mark F. Schilling

"The surprising predictability of long runs," *Mathematics Magazine* **85** (2012), 141–149.

Start flipping a fair coin. What's the longest run (of, say, heads) that you can expect if you flip it 1000 times? What about a million times? Don't bother with the calculations. Certainly the expected length of the longest run will increase as the number of flips increases. However, what happens when we ask the same question about the spread? The subject of probability is full of delightful surprises, and Mark Schilling just uncovered another one. Schilling's paper, "The surprising predictability of long runs," shows us that a 95 percent prediction interval for the longest run is independent of the number of flips and has a tolerance of just three! Thus no matter the number of flips, the length of the longest run is amazingly predictable. Just as impressive, the path to this result is straightforward, elegant, and reads like a good story. The reader is instantly hooked, and the narrative stays engaging and accessible throughout. Applications as diverse as the lottery, batting streaks, and the digits of pi illustrate the utility and the ubiquity of this remarkable result. A rare treat awaits the curious reader; "The surprising predictability of long runs" is a case study in fine mathematical exposition.

Biographical Note

Mark F. Schilling is professor of mathematics at California State University Northridge. He received his B.A. and M.A. degrees in Mathematics at UC San Diego and then earned his Ph.D. in statistics at UC Berkeley in 1979, followed by a National Science Foundation postdoctoral fellowship at UCLA. Dr. Schilling has been professor of mathematics at the University of Southern California and then at CSU Northridge since 1985. His research has spanned a wide variety of areas including statistical methods based on nearest neighbors, optimal confidence intervals for parameters of discrete distributions, experimental design, and long run theory, as well as applications to traffic flow, sports, bias in presidential polls, and medicine. For over ten years Professor Schilling contributed articles involving statistics and probability to the MAA publication *Chance Encounters* through his "Chance Encounters" column. He also served as Associate Editor for *The College Mathematics Journal.* Dr. Schilling enjoys mountain biking in the Santa Monica Mountains where he and his wife Wendy live. They have one grown child Kevin.

Response from Mark F. Schilling

I am extremely grateful to the MAA for this recognition, particularly for having my name in the company of the many great mathematicians that have previously won this award. Communicating the "unreasonable effectiveness of mathematics" in a clear and engaging fashion is something that I have striven to do throughout my career, as there is great enjoyment and satisfaction in stimulating the minds of students and other mathematicians alike. I am deeply indebted to a string of my own instructors and colleagues too numerous to mention who have shown me the way. I'd like to offer a special note of thanks to *Mathematics Magazine* Editor Walter Stromquist, however, whose insightful suggestions and attention to detail were invaluable in making this paper one that could ultimately earn consideration for the Chauvenet prize.

DAVID P. ROBBINS PRIZE

THIS prize was established in memory of David P. Robbins by members of his family. Robbins, who died in 2003, received his Ph.D. in 1970 from MIT. He was a long-time member of the Institute for Defense Analysis Center for Communication Research and a prolific mathematician whose work (much of it classified) was in discrete mathematics. The Prize is for a paper that reports on novel research in algebra, combinatorics, or discrete mathematics, has a significant experimental component, and is on a topic which is broadly accessible. The paper shall provide a simple statement of the problem and clear exposition of the work. This Prize is awarded every three years.

CITATION

Robert D. Hough

"Solution of the minimum modulus problem for covering systems," *Annals of Mathematics* **181** (2015), no. 1, 361–382.

Paul Erdős introduced the concept of a system of covering congruences (SCC) in the 1930s in response to a number theory question of Romanoff. An SCC is simply a finite set of arithmetic progressions $\{m_i n + a_i : n = 0, 1, 2, \dots\}$ for $1 \le i \le r$ with $1 < m_1 < m_2 < \cdots < m_r$ such that every positive integer belongs to at least one of the progressions. For example, it is easily checked that the progressions $\{2n\}$, $\{3n\}$, $\{4n+1\}$, $\{6n+1\}$, and $\{12n+11\}$ form an SCC. Erdős raised the question as to whether there were SCCs with minimum modulus $m_1 \ge M$ for arbitrary M. Over the past fifty years, the value of M increased, with the current record being held by Nielsen with $M = 40$. This latter system has more than 10^{50} progressions! Everyone naturally assumed that the value of M could be made arbitrarily large by taking sufficiently many (carefully chosen) progressions. Thus, it was a complete shock to the community that this is not the case. Bob Hough stunned the field by showing that for any system of covering sequences, the minimum modulus must be less than 10^{16}! The proof involves a very clever application of the so-called Lovász Local Lemma, a powerful combinatorial tool for handling dependent probability in the case where the dependence is local, together with some insightful ideas from elementary number theory. While the proof is not simple, it is completely self-contained, only employing ideas and techniques accessible to undergraduates. Of course, people now believe that the bound of 10^{16} can be lowered to something much smaller, perhaps as small as 100. This still leaves open the old problem as to whether there is an SCC with all the moduli odd. This beautiful paper will certainly stimulate further research on this topic.

Biographical Note

Robert D. Hough was born in Midland, MI in 1985 and completed three degrees from Stanford University, including a Ph.D. in mathematics in 2012 under the supervision of Soundararajan. He spent roughly a year and a half each at Cambridge and Oxford as a post-doc working with Ben Green and was a postdoctoral member of the Institute for Advanced Study, Princeton. He is currently an assistant professor at the State University of New York, Stony Brook. His research interests include quantitative questions in probability, combinatorics, and analytic number theory.

Response from Robert D. Hough

It is a great honor to receive the David P. Robbins Prize for the solution of the minimum modulus problem for covering systems.

The problem, which involves covering the integers with arithmetic progressions to differing steps, is deceptively simple to state. The solution that I found has an almost magical step in which the main tool, the Lovász Local Lemma of Lovász and Erdős, is used in reverse form as a bridge in an inductive argument.

I especially like the problem because it lies in the intersection of two fields which I have studied—probability theory and analytic number theory. There are also fascinating connections to other fields, especially Ramsey theory, as the eventual set of integers not covered by a covering system of sufficiently large initial step is found to be possibly extremely small, but possessing substantial arithmetic structure. I've been enjoying an ongoing collaboration with Pace Nielsen at BYU studying quantitative aspects of covering systems.

I thank Paul Erdős for the beautiful problem, and a number of mathematicians who have influenced my development, including my brother Ben Hough, R. Khetan, Soundararajan, Persi Diaconis, Akshay Venkatesh, Ben Green and Yuval Peres. I also thank my wife Andrea, my parents, and the rest of my family for their loving support.

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

Ian Stewart

In Pursuit of the Unknown: 17 Equations That Changed the World, Basic Books, New York, 2012.

Ian Stewart has been providing insight into the power and beauty of mathematics for decades, in articles and more than two dozen books on topics ranging from probability and game theory (in *Game, Set and Math*) to fair apportionment (in *How to Cut a Cake*). But *In Pursuit of the Unknown* is a truly remarkable read that starts with the Pythagorean theorem and logarithms and progresses to the Black-Scholes equations of finance and the use of Fourier analysis to compress images. Each section simultaneously provides insights into historical aspects and modern applications of mathematical ideas and leaves the reader with the desire to pursue the ideas further—and it provides the means to do so in its footnotes and references.

The style of the writing, as in all of Stewart's books, is conversational, consisting of patient explanations of deep mathematical concepts and complicated applications. Despite occasionally recycling puns and chapter headings from earlier works (but not the essential material, such as in the "Much Ado About Knotting" chapter), Stewart provides powerful insights into classical and modern mathematics that lead to surprising applications and powerful extensions of theoretical investigations.

The book's individual essays can be read independently, but there is a remarkable coherence to the entire volume, such as when the wave equation, which is the subject of chapter 8, resurfaces in a natural way in the chapter about the Maxwell equations of electrodynamics as well as in the chapters on the Fourier transform and quantum mechanics (Schrödinger's equation). The equations themselves sometimes serve as the focus of the chapters, e.g., the chapters on the wave equation and the normal distribution, or serve as avatars of entire subfields of mathematics, as in the case of $i^2 = -1$ and $F - E + V = 2$, which represent the entire fields of complex analysis and algebraic topology, respectively. Finally, the book's endnotes are a trove of additional information and witty commentary, with occasional technical forays such as the derivation from Maxwell's equations of the fact that the electric and magnetic fields satisfy the wave equation, as well as a remarkable amount of detail about the intrigue surrounding the discovery and publication of the formulas for the solution of cubic and quartic polynomials.

In Pursuit of the Unknown provides an impressive panorama of the history and application of mathematics that can be appreciated by students and curious members of the public, either by enjoying it cover-to-cover or by sampling its offerings à la carte. It's a worthy addition to Ian Stewart's oeuvre, as well as to the general mathematics literature.

Biographical Note

Ian Stewart is an Emeritus Mathematics Professor at the University of Warwick and a Fellow of the Royal Society. He is author or co-author of over 180 published papers on pattern formation, chaos, network dynamics, and biomathematics. He has published over 100 books including *Does God Play Dice?, Why Beauty is Truth, Professor Stewart's Cabinet of Mathematical Curiosities, In Pursuit of the Unknown, Calculating the Cosmos*, and the bestselling four-volume *Science of Discworld* series with Terry Pratchett and Jack Cohen. He has also published four science fiction novels including *The Living Labyrinth* with Tim Poston. He has five honorary degrees, and his awards include the Royal Society's Faraday Medal, the IMA Gold Medal, the AAAS Public Understanding of Science Award, the LMS/IMA Zeeman Medal, and the Lewis Thomas Prize.

Response from Ian Stewart

I am honored to receive the Euler Prize. As an undergraduate I studied several of Paul Halmos's books, and I am grateful to the Halmos family for making this award possible. I am also delighted that the chosen book is one of my favorites. The original suggestion came from my English publisher's Dutch translator, and we all liked the idea so much that we rearranged the publishing schedule to make room. I am pleased to discover that others share this view.

The book's main aim is to combat the widespread fear of equations by placing them center stage, explaining what they mean, and showing what the great equations have done for humanity. "If you have a wooden leg, wave it," as they say in show business. When researching the book I was struck by how often the course of human history has been redirected by an equation. Perhaps we should remove the kings and queens and presidents from the history books and replace them with equations. As the opening sentence says: “Equations are the lifeblood of mathematics, science, and technology. Without them, our world would not exist in its present form.”

Unfortunately, this message is not understood as widely as it should be. I have always believed that we in the mathematical community should try to explain the importance and relevance of our subject to the general public. This is to our advantage as much as it is to theirs. We don’t all have to engage in outreach activities, because different people have different talents, but those of us who can do so clearly and effectively should make the effort to communicate the vital importance of all mathematics to everyone.

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

Janet Heine Barnett

A 2017 Haimo Award goes to Janet Barnett for her outstanding successes in the undergraduate classroom, important scholarly and curricular work in the history of mathematics, and for her substantial impact on secondary mathematics education in her native southeastern Colorado. She is known on the Colorado State University–Pueblo campus as a challenging and demanding professor whose classes are in great demand and appreciated by students. Through her interest in the history of mathematics, Janet has become an international leader in efforts to teach mathematics using primary historical sources. She has also led efforts in her region to train mathematics teachers and to get secondary students interested in mathematics.

Strong evaluations from students praise her approachability and helpfulness, saying that she is kind and generous as she works to help the students through the difficult material of her courses. Janet works very hard for her classes, as she provides students with opportunities to revise every homework assignment after giving feedback. She has been willing to try new pedagogical approaches in her classes, and she routinely uses group discussions in class, supervised study groups outside of class, daily reading and study guides, and individual interviews in upper-level courses to assess student understanding. Janet's dedication to her students is recognized by them.

Because of her interests in mathematics pedagogy and the history of mathematics, Janet has become a leader in teaching mathematics using primary historical sources. For more than a decade, Janet has created primary source projects

(PSPs), used by faculty at her own and other institutions, in which students read the works of Euler, Lagrange, or Boole, for example, and discover the mathematics with the help of guiding questions. Janet is now part of a seven-university NSF-funded collaboration, TRIUMPHS (Transforming Instruction in Undergraduate Mathematics via Primary Historical Sources) that is developing additional PSPs and training faculty from around the country on their classroom use.

Additionally, Janet has taken the lead in improving the educational outlook of the residents of southeastern Colorado. A native of Pueblo, CO, Janet recognized the problems in her region and was inspired to do something about them. In addition to everything mentioned above, Janet serves as the PI for the NSF-funded Robert Noyce Scholars Program in southeastern Colorado. The goal of the program is to support and strengthen mathematics achievement in grades 7–12. The program is multi-faceted, as it provides content and training support for teachers, a summer mathematics academy for grades 7–10, teaching opportunities at this academy for undergraduates considering a career in secondary mathematics education, and college scholarships for these undergraduates. Janet is directly involved in every aspect of this program as she even visits the Noyce Scholars in their classrooms and mentors them. The MAA recognizes the great positive impact of Janet Heine Barnett on mathematics students and teachers at her own institution, in her region, and across the country, and is honored to present her with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

Janet Heine Barnett was born and raised in Pueblo,CO, and completed a bachelor's degree with a double major in mathematics and humanities as a first-generation college student at Colorado State University in Fort Collins. She now holds a Ph.D. in set theory from the University of Colorado–Boulder, and is a professor of mathematics at Colorado State University–Pueblo where she has taught since 1990. A 1995–1996 fellow at the MAA Institute for History of Mathematics and Its Use in Teaching (funded by the NSF), her scholarly interests have long included the history of mathematics and its use in promoting mathematical understanding and as a vehicle for promoting teacher reflection on pedagogical issues. An active member of the MAA Rocky Mountain Section, she has served as its Governor, Chair, Secretary/Treasurer, Newsletter Editor, and Book Sales Coordinator; Barnett received the Section Certificate of Meritorious Service Award in 2007. She shares her passions for mathematics and history, as well as dance and yoga, with her husband and traveling companion George Heine, whom she met while serving as a Peace Corps volunteer in the Central African Republic (1982–1984).

Response from Janet Heine Barnett

I am deeply honored—and absolutely thrilled!—to receive the Haimo Award for Distinguished Teaching. I discovered my passion for teaching mathematics while serving as a Peace Corps volunteer in the early 1980s, and have had the blessing of practicing this fascinating craft in my home town since 1990. During this time, I have also had the great good fortune of learning from many of its master practitioners, and am especially indebted to those in the History of Mathematics community who have so generously shared their wisdom with me over the years. I have also benefited, both professionally and personally, from the support and friendship offered by the MAA Rocky Mountain Section mathematical community throughout my teaching career. My thanks go out to all of those who have helped me grow as a teacher, including the many students with whom I have had the opportunity to share in the quest for mathematical understanding over the years. I am especially indebted to the colleagues and students who wrote supporting letters for my nomination; it was their words that caught the attention of the selection committee and made this amazing recognition possible.

CITATION

Caren Diefenderfer

For her work as an outstanding teacher and leader both as a professor at Hollins University and in the larger mathematical community, Caren Diefenderfer is recognized with a 2017 Haimo Award. Her contributions to the teaching of mathematics are deep and broad. She has inspired students at many different levels—high school and college students, math majors and math-averse students, and students in her classroom and students nationwide whom she has never met.

At Hollins University, Caren has distinguished herself as a well-loved professor who teaches a broad range of mathematics courses. In addition to her success with the standard curriculum (students write poems about her linear algebra class), she has designed and taught eight special topics courses in mathematics, and supervised forty-nine senior mathematics projects. She has been an active participant in the Hollins First-Year Seminar program, developing and teaching three interdisciplinary courses, most recently Games, Puzzles, and Logic, designed to help students succeed in college by improving their skill in written and oral communication. Students of many different interests and abilities speak enthusiastically of her influence on their lives.

First at Hollins, and later in the wider community, Caren has been a pioneer in the field of Quantitative Literacy (QL), whose goal is to ensure that all college students become quantitatively "literate" by taking interesting courses at an appropriate level. This movement has had an unquestioned impact on the mathematical education of the current generation of college students. The Hollins QL program served as a model for other colleges and universities, and Caren has traveled around the country giving talks and leading workshops, including an MAA PREP Workshop, on the topic. She was one of the founders of the MAA's SIGMAA QL and has served as its chair and as president of the National Numeracy Network (NNN). In addition to published articles, Caren is a co-author, with Bernie Madison, Stuart Boersma, and Shannon Dingman, of *Case Studies for Quantitative Reasoning* (2009) and a co-PI with these coauthors of an NSF grant to study Quantitative Reasoning in the Contemporary World.

Not content to focus on one area of mathematics education, Caren is also an expert on the teaching of calculus, especially at the high-school level. Starting in 1999 as an Exam Leader at the College Board's Advanced Placement Calculus Reading, she steadily worked her way up to serve as Chief Reader of the exam for four years, and was influential in this role. Based on this work, and on her own experience teaching calculus at the college level, she and Roger Nelsen edited an MAA volume, *The Calculus Collection: A Resource for AP and Beyond* (2010). She also served as a co-PI on a recent NSF Transforming Undergraduate Education in Science grant (to the MAA) on instruction and placement in algebra and precalculus.

Throughout her career, Caren has also been a tireless advocate for young women learning mathematics. She has forged a successful career doing just that in many different ways, culminating in her recent position as the Director of the Tensor/Women and Mathematics program at the MAA. This program provides grants for projects designed to encourage young women to study mathematics—hosting a conference, organizing a club, providing mentors for students—grants that, by design, have had an impact on the lives of many young women. The MAA recognizes the great positive impact of Caren Diefenderfer on mathematics and nonmathematics students, at her own institution and across the country, and is honored to present her with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

Caren Diefenderfer was born and raised in eastern Pennsylvania, where she attended public high school. As an undergraduate, she spent two years at Smith and two years at Dartmouth. She was one of thirty female graduates in Dartmouth's first coed class. Her M.A. and Ph.D. degrees are from the University of California at Santa Barbara. After graduate school, Diefenderfer circled back to the east coast and began her professional career at Hollins College (now University) almost forty years ago. She has been chair of both the MAA's SIGMAA QL and SIGMAA TAHSM. In addition, she worked diligently with the College Board and ETS on AP Calculus programming and served as the Chief Reader for AP Calculus from 2004 through 2007. Diefenderfer won Hollins's Roberta

A. Stewart Service Award and the Herta T. Freitag Faculty Legacy Award in 2011. She also received the MD-VA-DC section's John M. Smith Distinguished College or University teaching award in 2015. She has been a consultant on many campuses for both departmental reviews and workshops on quantitative reasoning workshops. She is an avid reader, knitter, and swimmer. However, discovering the beauty of mathematics is her favorite pastime.

Response from Caren Diefenderfer

I was surprised, delighted, and humbled to receive the e-mail telling me that I would be one of the Haimo awardees at JMM 2017. I extend heartfelt thanks to the students and colleagues who supported my nomination. In addition, I'd like to express gratitude to my family and the many amazing teachers, not just math teachers, who encouraged me along the way. I was privileged to be a student of David Cohen (Smith), Alice Dickinson (Smith), Marjorie Senechal (Smith), Ken Bogart (Dartmouth), Bill Slesnick (Dartmouth), Ernst Snapper (Dartmouth), and David Sprecher (UCSB). As I was attending a Dartmouth alumni event in my first year at Hollins, "Booming Bill" asked me if I was a member of the MAA. I'm embarrassed to tell you that I had to say "No." His reply was, "Go home and join tonight. This is the organization that you will care about for your entire career." I followed his advice and feel very lucky to have received that direct message early in my career. Let's pass it on! Thank you MAA for all that you do to enrich our lives.

CITATION

Tevian Dray

A 2017 Haimo Award goes to Tevian Dray for his record of exemplary mathematics teaching at Oregon State University and distinguished work in college mathematics curriculum development. Over the course of his career, Tevian has created a greater awareness of the need for mathematicians to look at how other fields see mathematics, and his curriculum development work has given the mathematics community a powerful tool to engage students by showing them how the mathematics they are learning will look in their major.

Tevian excels at teaching in the classroom where he creates one that is very interactive and employs nontraditional and alternative teaching methods. In both large and small classroom settings, student questions and other feedback drive the coherent presentation of the subject matter, emphasizing conceptual understanding, and the relationships between different parts of the course. Tevian's success is documented by excellent course evaluations, and student testimonials; students write that Tevian removes barriers between students through open discussions. He invites students to actively explore mathematics and they learn to work as a team to discover the beauty and depth hidden in mathematics. Colleagues write that during student presentations, Tevian has the knack for asking the right question that pushes students, whether presenting or listening, to explore the implications of their argument and to uncover an underlying theory. He has the artful skill to remain quiet, allowing students to lead the discussion by making mistakes and learning from each other.

Tevian has made significant and original contributions to the teaching of mathematics, both at Oregon State and nationwide; he has played a key role in two successful long-term curriculum development projects. Tevian was the PI of the "Vector Calculus Bridge" project, that addressed the divide between how vector calculus is taught by mathematicians and how it is understood by physicists. The Bridge Project developed and classroom tested fifteen small group activities and prepared an accompanying 100-page instructor's guide; materials were presented at ten regional and national workshops, attended by more than 170 faculty members overall. He also co-authored an online multivariable calculus textbook based on this approach. Tevian is the co-PI of the "Paradigms in Physics" project, a nineteen-year NSF-funded effort by the Oregon State physics department to redesign their upper-division physics courses with a strong emphasis on pedagogical reform. Tevian designed a new course on reference frames and an accompanying textbook that presents a geometric approach to relativity.

Tevian has participated extensively in teacher development for the state of Oregon. Through the Oregon Mathematics Leadership Institute (OMLI), he was part of the team that designed an OMLI course in non-Euclidean geometry that encouraged teachers to improve the quality of mathematical discourse in their own classrooms by modeling instruction on an unfamiliar but accessible mathematical topic. Tevian served as a co-PI of the Central Oregon Consortium, a Mathematics and Science Partnership providing professional development to middle-school math teachers in rural Oregon.

The MAA recognizes the impact Tevian Dray has had on numerous student and faculty lives through his excellent teaching and curricular work, and is honored to present him with the Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics.

Biographical Note

Tevian Dray earned his B.S. in mathematics from MIT in 1976 and his Ph.D. in mathematics from Berkeley in 1981. Following physics postdoctoral positions in Germany, the Netherlands, and India, and mathematics postdoctoral positions in England and at Princeton, he accepted a faculty position at Oregon State University, where he has been ever since.

Tevian was a Fulbright Scholar to Australia, is a Fellow of the American Physical Society, and is currently a member of CRAFTY, the MAA subcommittee on Curriculum Reform Across the First Two Years. He remains active in mathematical physics, with two recently published textbooks on relativity, and a third on his latest interest, the octonions and their applications to physics. But the hardest thing he has ever done was to teach calculus jointly with his wife, physicist Corinne Manogue, leading to nearly twenty years of deep conversations about student learning of mathematics, as well as active involvement in both the MAA SIGMAA RUME (Research in Undergraduate Mathematics Education) and PER (Physics Education Research) communities.

Response from Tevian Dray

What an honor! As I look through the list of past recipients, I am both delighted and humbled by this award. First and foremost, I thank my wife, Corinne Manogue, a physicist who has repeatedly challenged me to reexamine my own assumptions about what it means to learn mathematics, especially for those who will not themselves become mathematicians. My own slow transition from traditional researcher to curriculum developer has come about in large part while trying to keep up with her efforts to revise the upper-division physics curriculum. I have been fortunate that my institution supports discipline-based education research, with a strong presence in both the mathematics and physics departments. And I have been blessed with a series of graduate students who were also excellent teachers. But I am most grateful to my many students over the years at all levels, who embraced my unorthodox methods and helped me refine them.

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

Martha J. Siegel

The 2017 Gung and Hu Award goes to Martha J. Siegel for her remarkable leadership in guiding the national conversation on undergraduate mathematics curriculum, particularly as it is affected by fields in applied mathematics, and especially from the perspective of the Mathematical Association of America and its mission.

Supported by a 1981 NSF grant, Martha founded the Towson University Applied Mathematics Laboratory (AML), one of the first undergraduate courses in the U.S. featuring student teams working on applied mathematics projects for business, industry, or government clients. The AML has been in continuous operation at Towson for thirty-five years.

Martha's support of a multitude of MAA initiatives has been far reaching. She was a member of the MAA Executive Committee from 1991 to 2010, serving first in the role of editor of *Mathematics Magazine*, and subsequently as Secretary of the Association for more than fourteen years. In the latter capacity, in particular, she not only shaped the agenda of the Association for many years, but she influenced a generation of MAA leaders (including eight MAA presidents and two executive directors) through her model leadership, stewardship, and commitment to the profession.

Upon leaving her long-time post as Secretary, rather than settle into a much-deserved quieter life, Martha took on the role of chair of the high-profile Committee on the Undergraduate Program in Mathematics as that committee began the process of updating the MAA Curriculum Guide to Undergraduate Majors in the Mathematical Sciences for 2015. This work involves coordination of a large number of stakeholders and requires great leadership to get them working toward a common goal. In many ways, Martha is ideally suited to this role. Her deep understanding of mathematics curriculum and pedagogy, and her ability to connect people of common interests have not only brought the most recent CUPM project to a successful conclusion, but have also had a profound influence on the greater MAA and the mathematics community, in general.

Martha's decades of work with curriculum development has been both intensive and extensive. She has been a consistent advocate for the role of applied mathematics, active learning, and real world experiences for students in mathematics courses, and the past thirty years have witnessed her far-reaching influence on the evolution of the undergraduate mathematics curriculum. In the early 1980s, she was PI for the MAA project, "Discrete Mathematics in the First Two Years," funded by the Alfred P. Sloan Foundation. Her textbook, *Finite Mathematics and Its Applications* (with Larry Goldstein and David Schneider) is now in its eleventh edition, and she is co-author with Sheldon Gordon, Florence Gordon, and Alan Tucker of the pre-calculus text, *Functioning in the Real World*. More recently, Martha was co-PI (with Michael Pearson and Carol Schumacher), on the NSF DUE grant project, "2015 Curriculum Guide to Undergraduate Majors in the Mathematical Sciences," supporting the complex work of the CUPM. In addition, Martha has served in the capacity of external reviewer for many mathematics programs, making significant contributions to MAA efforts to provide programs and evaluators with resources for this important activity. While at Towson, Martha received the College of Natural and Mathematical Sciences Outstanding Faculty Award (1989) as well as the President's Award for Outstanding Service to the University (1991). She has been a member of the Towson University Senate during most of her time at the school, and for more than a decade Martha was a representative of Towson to the Council of University System Faculty of the University System of Maryland, serving as the chairperson twice. For a decade Martha led the Towson University CoSMiC Scholars Program, an NSF S-STEM scholarship program (totaling more than $1 million over its lifetime) focused on enabling economically disadvantaged students to obtain a B.S. in a STEM discipline before entering the workforce or continuing their professional education. While of immediate benefit to Towson University students, these awards also shape the national discussion of what it means to train mathematicians and the importance of providing opportunity to traditionally underrepresented groups. In addition to service to the MAA and at Towson University, Martha has made many contributions to other projects, particularly as they involve curriculum development and teaching resources in applied mathematics, including "Project Intermath," a consortium based at the United States Military Academy at West Point, "COMAP National Science Foundation Project on Applications," and "West Point Project on ILAPS." Martha is also a founder of the Maryland Mathematics and Science Coalition. Martha Siegel has had a tremendous influence on the national conversation about mathematics curriculum, particularly with respect to the growing importance of applied mathematics. Her leadership within the MAA has shaped a generation of leaders, influencing not just the national agenda but also the sense of support and common purpose within the greater mathematics community.

Biographical Note

Martha Siegel spent her formative years in Brooklyn, NY, about three blocks from Ebbets Field, and gained an early appreciation of numbers from calculating statistics for her beloved Brooklyn Dodgers. A tenth-grade honors geometry class at Midwood High School provided challenge problems that intrigued her and her father, Nat Jochnowitz, a civil engineer. They ignited her passion for mathematics. After graduating high school in Dobbs Ferry, NY, she went to Russell Sage College in Troy and, in a cooperative program, attended RPI as a special undergraduate, some years before RPI was coed. Graduate school at the University of Rochester with doctoral work in stochastic processes followed. Martha taught at Goucher College from 1966 to 1971, when she joined the faculty at Towson University; she retired in 2015. In 1977–78, she spent a sabbatical year working in operations research at the Johns Hopkins University School of Hygiene and Public Health. Appointed by Dorothy Bernstein to her first MAA committee in the late 1970s, Martha began many years of involvement with the MAA. Her five-year term as Editor of *Mathematics Magazine* was followed by more than fourteen years as MAA Secretary. She has served as chair of CUPM since February of 2011 and has participated in re-writing the MAA Bylaws at least three times. Her interest in meaningful mathematics for students led to two co-authored textbooks, Sloan Foundation and NSF grants, and work with several applied math projects on and beyond the Towson campus.

Response from Martha J. Siegel

I am very surprised, humbled, and grateful to have been chosen for the Gung and Hu Award. My service to the profession and particularly to the MAA has given me tremendous rewards. I have made many friends among the wonderful and dedicated members of the MAA and its Sections. I owe a great deal to my late husband, Charles Siegel, who always encouraged me through my graduate years and in my career. Rochester faculty members Len Gillman, Ken Ross, Sanford Segal and my advisor, Joop Kemperman, urged me to finish the doctorate after my children were born. They gave me opportunities for leadership and were themselves outstanding examples of service to the profession. Doris Schattschneider, Jerry Alexanderson, Lida Barrett, Jerry Porter, Marcia Sward, and Tina Straley provided me with their considerable knowledge and friendship. I thank my students for enriching my life and for their many accomplishments. I am grateful to my children, Rachel and Norman, for their independence and forbearance. My reliable car pool gave me much needed freedom by helping to ferry the children to after-school activities for more than eight years. I thank the committee that nominated me for this honor. I acknowledge the continual support of my dear friend, Herb Berkow, and note that none of my service would have been possible without the flexibility and cooperation of my department and the administrators of Towson University. Thank you.

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

Frank and Brennie Morgan Prize

The Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student recognizes and encourages outstanding mathematical research by undergraduate students. It was endowed by Mrs. Frank Morgan of Allentown, PA.

Citation

David H. Yang

The recipient of the 2017 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student is David H. Yang for his outstanding research in algebraic geometry. Yang is an author of five papers, with two more in preparation. Three of his papers have appeared or will appear in the *Memoirs of the American Mathematical Society, Journal für die reine und angewandte Mathematik*, and *Research in the Mathematical Sciences*. His letters of support describe his work as truly exceptional. His joint paper with senior collaborators Ein and Lazarsfeld builds on David's earlier single author work. Starting in his freshman year at MIT, Yang's research was guided by Professors Joe Harris at Harvard and Roman Bezrukavnikov at MIT. Yang has also excelled in contest math. He was a Putnam Competition Fellow for the last three consecutive years. He also won two gold medals in the International Mathematics Olympiad.

Biographical Note

David Yang was born in California, where he spent most of his early childhood. He moved to New Hampshire to attend Phillips Exeter Academy, where he was first exposed to algebraic geometry. After graduating, David matriculated at the Massachusetts Institute of Technology, where he is currently a senior. It was at MIT that David started pursuing research in algebraic geometry. He plans to continue his research after graduating from MIT.

Response from David H. Yang

It is a great honor for me to receive the 2017 Frank and Brennie Morgan

Prize. First, I would like to thank my research advisors, Roman Bezrukavnikov and Joe Harris, who have deeply influenced how I view mathematics. I have been fortunate to spend much of my undergraduate career in mathematically stimulating environments, including the vibrant departments of MIT and Harvard and the REU at Emory University, and I am very grateful for the atmosphere that they provided. I would also like to thank many mathematicians who took the time to impart their wisdom to me, including Clark Barwick, Lawrence Ein, Pavel Etingof, Dennis Gaitsgory, Rob Lazarsfeld, Ivan Losev, Davesh Maulik, Bjorn Poonen, and Jason Starr. Finally, I would like to thank my friends and family, whose support has always been vital to my work.

CITATION

Aaron Landesman

Aaron Landesman is recognized with an Honorable Mention for the 2017 Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student. He has authored eight papers in algebraic geometry, number theory, and combinatorics. Three of his papers were accepted in *Annales de l'Insitut Fourier, Research in Number Theory,* and *Order*. His work on interpolation of varieties is an important contribution to the area, proving fundamental theorems while introducing new specialization techniques which are expected to be of further use for algebraic geometers. He already received the Mumford prize, Hoopes prize, and Friends prize from Harvard for his undergraduate research. Landesman conducted further research at the Emory and Minnesota Twin Cities REUs. He is currently a Ph.D. student at Stanford, where he enjoys an NSF Graduate Fellowship.

Biographical Note

Aaron Landesman, raised in New York City, is a graduate of Hunter College High School and Harvard University. Aaron is currently pursuing a Ph.D. at Stanford University, focusing on algebraic and arithmetic geometry. His interest in math was piqued at a young age by his father, and together they wrote a book of three-dimensional mazes. In high school, Aaron's passion for mathematics grew through attending MathCamp, math team, and courses at Columbia. In college, he concentrated in mathematics, with a secondary in computer science. During his summers, Aaron conducted math research at the Minnesota Twin-Cities REU and the Emory REU. He also enjoys playing chess, solving puzzlehunts, and public speaking.

Response from Aaron Landesman

It is an incredible honor to receive the Honorable Mention for the 2017 AMS, MAA, and SIAM Morgan Prize. I would like to thank Mrs. Morgan and the AMS, MAA, and SIAM for awarding this prize and supporting undergraduate research. Many past Morgan Prize winners have had a profound impact on my development, so it is a privilege to be counted among them. I would like to thank my mentors, including Joe Harris and Anand Patel, who advised my senior thesis, David Zureick-Brown and Ken Ono, who advised my research at the Emory REU, and Vic Reiner and Gregg Musiker, who advised me at the Minnesota Twin-Cities REU. I extend thanks to all my professors and teachers, particularly Dennis Gaitsgory, Curtis McMullen, Wilfried Schmid, Michael Thaddeus, and Eliza Kuberska. Finally, I would like to thank my friends and family for their support and inspiration.

Joint Policy Board for Mathematics

Communications Award

The Joint Policy Board for Mathematics (JPBM) established its Communications Award in 1988 to reward and encourage journalists and mathematicians who, on a sustained basis, bring mathematical ideas and information to nonmathematical audiences. The award recognizes a significant contribution or accumulated contributions to the public understanding of mathematics, and it is meant to reward lifetime achievement. JPBM represents the American Mathematical Society, the American Statistical Association, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

Citation

Arthur Benjamin

2017 JPBM Communications Award for Public Outreach

The 2017 JPBM Communications Award for Public Outreach is given to Art Benjamin, for his books aimed at general audiences, his Ted Talk on “mathemagic,” and his popular “Great Courses” for the Teaching Company. Arthur Benjamin’s work demonstrates his ability and commitment to share the joy of mathematics, and excites and engages audiences at all levels.

Biographical Note

Arthur Benjamin earned his B.S. in applied mathematics from Carnegie Mellon and his Ph.D. in mathematical sciences from Johns Hopkins University. Since 1989, he has taught at Harvey Mudd College, where he is the Smallwood Family Professor of Mathematics and past chair. In 2000, he received the Haimo Award for Distinguished Teaching by the Mathematical Association of America, and served as the MAA’s Pólya Lecturer from 2006 to 2008.

His research interests include combinatorics and number theory, with a special fondness for Fibonacci numbers. Many of these ideas appear in his book (co-authored with Jennifer Quinn), *Proofs That Really Count: The Art of Combinatorial Proof,* published by MAA. In 2006, that book received the Beckenbach Book Prize by the MAA. Professors Benjamin and Quinn were the editors of *Math Horizons* magazine from 2004 through 2008.

Benjamin is also a magician who performs his mixture of math and magic to audiences all over the world, including the Magic Castle in Hollywood. He has demonstrated and explained his calculating talents in his book and DVD course, *Secrets of Mental Math*, and on numerous television programs, including the Today Show, CNN, and the Colbert Report. He has been featured in *Scientific American, Omni, Discover, People, Esquire, The New York Times, The Los Angeles Times*, and *Reader's Digest*. He has given three TED talks, which have been viewed over twelve million times. Princeton Review recently profiled him in their book, *The Best 300 Professors. Reader's Digest* calls him "America's Best Math Whiz." His newest book is called *The Magic of Math: Solving for X and Figuring out WhY.*

Response from Arthur Benjamin

I am deeply humbled to be selected for this prize. Nearly all of the previous recipients of this award are heros of mine and it is truly an honor to be recognized among such a distinguished group.

I have loved numbers all of my life. As a kid, I marveled at the fact that you could do an arithmetic problem many different ways and, if you were careful, you would always get the same answer. I found that consistency of math to be absolutely beautiful then, and I still do today. As a professor, I encourage my students to solve problems or prove theorems in multiple ways to build a deeper understanding of the subject.

In my classes, my writing, and my public appearances, I try to emphasize the fun and magical side of mathematics, and I would love to see more of this appear in the pre-college curriculum. Since students have such easy access to powerful computational tools, we can and should replace some of the more laborious parts of our curriculum with math that is more relevant or elegant.

I would not have received this award without the support and inspiration of many people. I would like to thank my parents for encouraging me to pursue my mathematical and magical passions. I owe a debt of gratitude to Martin Gardner for setting such a high standard. Thanks to the MAA for spreading the joy of mathematics through its publications and activities. I will always cherish my work with Jennifer Quinn for our collaboration on articles and books and for being my co-editor of *Math Horizons*. I am so grateful to my students and colleagues at Harvey Mudd College who make it a joy to come to work every day. Last but not least, I thank my wife Deena and daughters Laurel and Ariel for their love, for their support, and for adding so much magic to my life.

CITATION

Siobhan Roberts

2017 JPBM Communications Award for Expository and Popular Books

The 2017 JPBM Communications Award for Expository and Popular Books is presented to Siobhan Roberts for her engaging biographies of eminent mathematicians and articles about mathematics that are appreciated by the general public and scientific audiences alike. The acclaimed biographies *King of Infinite Space* (about H. S. M. Coxeter) and *Genius at Play* (about John Horton Conway) bring her subjects to life and make the importance of their mathematical accomplishments accessible to all.

Biographical Note

Siobhan Roberts is an award-winning science journalist and biographer, based in Toronto.

Siobhan writes for *The New Yorker's* "Elements," *Nautilus*, and *Quanta*, and at various times has contributed to *The Guardian, Smithsonian, The New York Times Science Times, The Globe and Mail*, and *The Walrus*, among other publications. She is an occasional Director's Visitor at the Institute for Advanced Study in Princeton.

While writing her latest book, *Genius at Play: The Curious Mind of John Horton Conway*, she was a Fellow at the Leon Levy Center for Biography, at the CUNY Graduate Center in New York City. Her first book, *King of Infinite Space: Donald Coxeter, The Man Who Saved Geometry*, won the Euler Prize for expanding the public's view of mathematics. She also wrote and produced a documentary film about Coxeter, *The Man Who Saved Geometry*, for TV Ontario's *The View From Here*.

Response from Siobhan Roberts

Writing, like mathematics, is about discovery: following one's curiosity; questioning; persevering through the "stuckedness" with an iterative process of trial and error to reach a desired (or altogether unexpected) destination. Writing about mathematics and science is double the fun, especially since my background is predominantly in the arts. It's a serious enterprise with a steep learning curve, especially in these beleaguered times, when the Oxford English Dictionary declares "post-truth" the word of the year. "Tell all the truth but tell it slant..." wrote Emily Dickinson—it's a gradual, circuitous process finding "the Truth's superb surprise." Now we need to persevere in our efforts to tell it straight. I am honored to receive the JPBM Communications Award, and I look forward to many more mathematical adventures.

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 ten 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

Emmy Murphy

The 2017 Joan & Joseph Birman Research Prize in Topology and Geometry is awarded to Emmy Murphy, Massachusetts Institute of Technology (MIT), for major breakthroughs in symplectic geometry.

Murphy has developed new techniques for the study of symplectic and contact structures on manifolds, uncovering a startling degree of flexibility in a branch of geometry that is ordinarily distinguished by rigidity. As a result, some geometric problems can now be reduced to homotopy theory; for example Murphy's methods have yielded answers to long-standing questions concerning the existence of contact structures on high-dimensional manifolds. She has shown great creativity in the delicate work of inventing powerful new h-principle techniques. She has also masterfully combined these new tools with other tools, such as the method of pseudo-holomorphic curves, to explore the boundary between flexibility and rigidity.

Murphy is a highly original thinker, and leading geometers will not be surprised if she goes on to make breakthroughs in very different areas of mathematics.

Response from Emmy Murphy

I am very honored to be a recipient of the Joan & Joseph Birman Prize. My work would never have been possible without my many mentors, particularly Chris Herald, Alex Kumjian, Tom Mrowka, and Paul Seidel. I would also like to thank my collaborators for stimulating and inspiring ideas, particularly Strom Borman, Roger Casals, Baptiste Chantraine, Mike Freedman, and Fran Presas. Yasha Eliashberg deserves special mention, as a wonderful advisor, collaborator, and friend. I'd like to thank Joan and Joseph Birman for being so generous and supportive of the women in the mathematics community. Joan is certainly an inspiration to me. There are many people in mathematics who deserve my warmest thanks, but cannot be listed here. And of course, I'd like to thank my family and friends for their love and support.

Finally, I'm grateful to the selection committee for the recognition of my work, and the kind words. I have always had an appreciation for highly visual and geometric questions, and I'm very happy to find places where this kind of thinking is useful. Symplectic and contact geometry, though very fashionable, are still very young fields. And though we've developed a lot of machinery in recent years, there are still many basic questions we don't know the answer to, and I believe many deep theorems can still be proven from first principles. I'm very excited to see where the field will go in upcoming years.

LOUISE HAY AWARD FOR CONTRIBUTION TO MATHEMATICS EDUCATION

IN 1990, the Executive Committee of the Association for Women in Mathematics (AWM) established the Louise Hay Award for Contribution to Mathematics Education. 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

Catherine Kessel

The AWM presents the 2017 Louise Hay Award to Catherine Kessel, senior editor at Illustrative Mathematics. Catherine Kessel's clear, crisp scholarship has shaped the reports of investigations ranging from studies of mathematics curricula in East Asia to characterizations of East Asian teachers' shared knowledge of mathematics teaching (with implications for the professional development of U.S. mathematics teachers) to the design and development of mathematics standards in the U.S. As a mathematician who possesses a unique ability for editing text, Catherine Kessel transforms what mathematicians write into a form readable by mathematics educators and the general public, without sacrificing precision. She also transforms what mathematics education researchers write into a form readable by mathematicians unfamiliar with the education literature.

Just as critically, Catherine Kessel's contributions span the domains of school mathematics curricula, expectations defining the development of prospective and practicing teachers of mathematics, and mathematics assessment. She fosters productive interactions between often noncommunicating communities.

Her public writings have been “a source of scholarship, evidence, and intellectual accountability in the debate” surrounding the Common Core State Standards for Mathematics.

Catherine Kessel has amassed a rich record of service, frequently addressing equity in education in general and women and mathematics in particular, based partly on her own work in the field of gender and mathematics. Through her mentoring, she has influenced the professional lives of aspiring and practicing mathematicians and mathematics educators.

A mathematician and educator fully reflective of the tradition of Louise Hay, Cathy Kessel is richly deserving of the 2017 Louise Hay Award.

Response from Catherine Kessel

Receiving this honor makes me very conscious of how many people have helped to improve my scholarship, writing, and editing, and deepen my knowledge of mathematics.

Although all my degrees are in mathematics, I’ve come to know education research and researchers, thanks to many at the School of Education at Berkeley, particularly Alan Schoenfeld. In learning about research on gender I’ve been fortunate to have the guidance of Marcia Linn.

Although I flunked my undergraduate writing exam, I’ve become an editor. Editing begins with reading and writing, and helping someone to improve these can be amazingly labor-intensive. Thanks to the University of Chicago writing program and all who took time to criticize my reading and writing (in, about, and outside of mathematics): teachers, co-authors, friends, colleagues, reviewers.

Helping someone learn to edit is also labor-intensive. Thanks to Alan Schoenfeld for an entrée, and many others for editing opportunities and advice. I’ve been fortunate to work with many writers who have graciously responded to questions, helping me better understand their thinking.

Although most of my life has been in the U.S. and I speak no Asian language, I’ve been able to learn about East Asian mathematics education from Catherine Lewis, Global Education Resources, Myong-Hi Kim, and many years of work with Liping Ma.

Although I’ve been a solitary consultant much of my life, I’ve benefited from interaction with the mathematical community, thanks to several organizations, including Mathematicians and Education Reform (and Naomi Fisher), and especially the Association for Women in Mathematics.

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 23 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

Helen G. Grundman

The Association for Women in Mathematics is pleased to present its seventh annual M. Gweneth Humphreys Award to Helen G. Grundman, Professor Emeritus of Mathematics at Bryn Mawr College and inaugural Director of Education and Diversity at the American Mathematical Society.

At Bryn Mawr, Dr. Grundman has an impressive record of mentoring female undergraduate students, many of whom have now earned graduate degrees in mathematics, physics, computer science, or other professional programs. Not only has she mentored students from her classes, but her guidance has extended to students of all levels seeking advice on coursework, summer research programs, senior theses, and careers. In recent years, three of her mentees have received NSF Graduate Research Fellowships to continue their studies in Mathematics. While at Bryn Mawr, she has served as a research advisor for over twenty-five senior undergraduate theses, Master's theses, and Ph.D. dissertations. The undergraduate research has resulted in at least eight published papers co-authored with her students.

She has received high praise for her work with undergraduates in the "Distressing Math Collective," a weekly informal math seminar/club that she created with some students almost twenty years ago. Students gather to give and to listen to math talks in a friendly, gregarious atmosphere, in which interruptions (and jokes) are encouraged. The students learn math, develop their public speaking skills, (get some mentoring,) and find comradery in an environment where it is normal to enjoy math.

Setting Helen Grundman apart from other professors is her beautifully sincere and long-lasting support of students beyond graduation. One student comments that "her support is the more remarkable because there was no formal relationship between us—she had never taught me in a course or been assigned as my major advisor," while another student states "that kind of unwavering and unconditional support, which is so rare to find in mathematics, allowed me to reach out to her for help during the times I needed it most in graduate school."

Response from Helen G. Grundman

I am deeply honored to receive the AWM's M. Gweneth Humphreys Award. I am also extremely humbled by the many notes and letters that former students of mine wrote in support of this nomination and were kind enough to share with me. My sincere thanks to all of them and, of course, to the award selection committee.

It is wonderful to be reminded how the seemingly little things that we do can have such major positive impacts on our students' lives. As I move into my new career, I hope to continue to pay attention to the small things that I can do for individuals, even while I work on larger projects for the mathematics community.

Joseph L. Doob Prize

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

Citation

John Friedlander and Henryk Iwaniec

The Joseph L. Doob Prize is awarded to John Friedlander and Henryk Iwaniec for their book *Opera de Cribro*, published in 2010 as volume 57 of the American Mathematical Society Colloquium Publications.

This monograph by two top masters of the subject is dedicated to the study of sieves in number theory and to their applications. Its Latin title could be translated literally as "A Laborious Work Around the Sieve," but the Latin has a conciseness easily missed in any translation.

The Eratosthenes sieve, going back to the 3rd Century BCE, was a simple but efficient method to produce a table of prime numbers and for a long time it was the only way to study the mysterious sequence of primes, at least experimentally. It was only in 1919 that the Norwegian mathematician Viggo Brun obtained the first quantitative results of the correct order of magnitude for the density of sifted sequences, by combining the sieve with ideas from combinatorics. From another direction, the introduction of complex variable methods by Hardy, Ramanujan, and Littlewood, and of techniques of harmonic analysis by Vinogradov, helped to obtain the correct conjectures about the distribution of prime numbers of special type and of their fine distribution, such as the study of the sequence of gaps between prime numbers.

For a long time Brun's method and its refinements by Buchstab and many others were the only tools at the mathematician's disposal for obtaining unconditional results on the arithmetical structure of sequences of integers, until in 1950 Selberg put forward a new, simple, elegant method to study such questions. Selberg's method and Brun's combinatorial method were independent of each other and gave rise to new deep results on the arithmetic structure of special sequences. In the 1950s and early 1960s the new ideas of Linnik and Rényi gave origin to the so-called Large Sieve, particularly apt to the study of the distribution of sequences of integers in arithmetic progressions.

In the next thirty years many very deep results on classical questions, previously considered to be inaccessible, were obtained. Suffice it here to mention the asymptotic formula for the number of primes representable as the sum of a square and of a fourth power, obtained by Friedlander and Iwaniec in 1998, and a similar result by Heath-Brown in 2001 for the number of primes which are the sum of a cube and of twice a cube. So it was time for a new book dealing not only with the sieves per se, but in fact with the very deep new techniques needed for the applications. The first nine chapters of this monograph deal with the sieves, followed by three chapters dedicated to the optimization of parameters. The next ten chapters are dedicated to specific problems, including several milestone results. The last three chapters, which are a most original contribution to this monograph, deal with the future by raising new questions, giving partial answers, and indicating new ways of approaching the problems. Two long appendices deal with technical results of general application. The bibliography with 161 entries is a major complement to this work. Everything is well written, the motivations of the arguments are well explained, and the numerous examples help the student to understand the subject in depth. These features distinguish this unique monograph from anything that had been written before on the subject and lift it to the level of a true masterpiece.

The selection committee thanks Professor E. Bombieri for writing the citation.

Biographical Note

John Friedlander was born in Toronto, less than a mile from his current office. Following a B.Sc. in Toronto and an M.A. in Waterloo, he received his Ph.D. at Penn State in 1972 working under the supervision of S. Chowla. His first position was that of Assistant to A. Selberg at the Institute for Advanced Study. After further positions at IAS, MIT, Scuola Normale Superiore (Pisa), and the

University of Illinois (Urbana), he returned to the University of Toronto in 1980 where he was Mathematics Department Chair from 1987 to 1991 and, since 2002, has been University Professor of Mathematics. He was awarded the Jeffery-Williams Prize of the Canadian Mathematical Society (1999) and the CRM-Fields (currently CRM-Fields-PIMS) Prize, given by the Canadian Mathematical Institutes (2002). He has given an invited lecture at the ICM in Zurich in 1994, been a Research Professor at MSRI Berkeley in 2001–2002, and was a Killam Research Fellow during the period 2003–2005. He is a Fellow of the Royal Society of Canada, a Founding Fellow of the Fields Institute, and a Fellow of the American Mathematical Society. His best friend Cherry has been sharing her life with him and, amongst many other things, has been largely responsible for creating the space-time during which he has found a chance to think about mathematics.

Biographical Note

Henryk Iwaniec was born on October 9, 1947, in Elblag, Poland. He graduated from Warsaw University in 1971, and he received his Ph.D. in 1972. In 1976 he defended his habilitation thesis at the Institute of Mathematics of the Polish Academy of Sciences where he held various positions from 1971 until 1983. In 1983 he was promoted to extraordinary professor (which is one step below the ordinary professor) and was elected to member correspondent of the Polish Academy of Sciences. Henryk Iwaniec spent the year 1976–77 at the Scuola Normale Superiore di Pisa and the year 1979–80 at the University of Bordeaux I. He left Poland in 1983 to take visiting positions in the United States; at the Institute for Advanced Study in Princeton (1983–84), at the University of Michigan in Ann Arbor (summer 1984), Ulam Distinguished Visiting Professor at Boulder University (fall 1984), and again at IAS in Princeton (January 1985–December 1986). Henryk Iwaniec was appointed as New Jersey State professor of mathematics at Rutgers University, where he has held this position from January 1987 until present. Henryk Iwaniec was elected to the American Academy of Arts and Sciences in 1995, to the National Academy in 2006, and to the Polska Akademia Umiejetnosci in 2006 (foreign member). He received the Docteur Honoris Causa of Bordeaux University in 2006. Henryk Iwaniec twice received first prizes in the Marcinkiewicz contest for student works in the academic years 1968–69 and 1969–70. Among several other prizes he received are: Alfred Jurzykowski Award (New York, 1991); Wacław Sierpiński Medal (Warsaw, 1996); Ostrowski Prize (Basel, 2001, shared with Richard Taylor and Peter Sarnak); Frank Nelson Cole Prize in Number Theory (AMS, 2002, shared with Richard Taylor); Leroy P. Steele Prize for Mathematical Exposition (AMS, 2011); Stefan Banach Medal (Polish Academy of Sciences, 2015); and the Shaw Prize in Mathematical Sciences (Hong Kong, 2015, shared with Gerd Faltings). Henryk Iwaniec was an invited speaker at the International Congress of Mathematicians in Helsinki 1978, Berkeley 1986, and Madrid 2006.

Response from John Friedlander and Henryk Iwaniec

We are grateful to the American Mathematical Society and to the Joseph L. Doob Prize Selection Committee for having chosen our book *Opera de Cribro* for this award.

We are, in particular, gratified by the recognition that this prize brings to the (beloved by us) subject of our book. The study of sieve methods in number theory began its modern history with the works of Viggo Brun just about one hundred years ago. Brun's works were of an elementary (though not at all easy) combinatorial nature, yet led to theorems about prime numbers that still today have found no other source of proof. The first few following decades saw further development of the sieve mechanisms themselves, given by many people, most notably Atle Selberg. Beginning in the 1970s, the subject entered into a new period during which it has become possible to incorporate into the sieve structure deep results coming from several of the main sources which power modern analytic number theory more generally. These include, most frequently, harmonic analysis both classical and automorphic, algebraic tools of various types, and arithmetic geometry. But anything is fair game. Basically, the modern sieve takes from mathematics anything it can use and, the more surprising the source, the more intensely the beauty shines through.

We also greatly appreciate the timing of the Joseph L. Doob Prize. Although we spent five years working intensively on our *Opera*, it of course actually incorporates works of the authors dating back over a considerably longer period of time. This prize represents to us a milestone of our collaboration, almost precisely forty years after it began in Pisa, reading the preprint of *The Asymptotic Sieve*, written by Enrico Bombieri.

LEVI L. CONANT PRIZE

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

CITATION

David Bailey, Jonathan Borwein, Andrew Mattingly, and Glenn Wightwick

The 2017 Levi L. Conant Prize is awarded to David Bailey, Jonathan Borwein, Andrew Mattingly, and Glenn Wightwick for their article "The computation of previously inaccessible digits of π^2 and Catalan's constant," published in the *Notices of the American Mathematical Society* in 2013.

This fascinating article will delight any mathematician who has ever been intrigued by the mysteries of the digits of π. The reader is first taken on a historical journey from Archimedes to the computer age with many interesting anecdotes along the way. For example, "Isaac Newton devised an arcsine-like scheme to compute digits of π and... sheepishly acknowledged 'I am ashamed to tell you to how many figures I carried these computations, having no other business at the time.' Newton wrote these words during the plague year 1666, when, ensconced in a country estate, he devised the fundamentals of calculus and the laws of motion and gravitation."

The remarkable "BBP" formula, discovered by the first author along with Peter Borwein and Simon Plouffe, allows one to calculate binary or hexadecimal digits of π beginning with the nth digit without first calculating any of the preceding $n-1$ digits. We are led through an elementary proof of the BBP formula but also learn about the nonconventional search that originally led to this formula, along with similar formulas for Catalan's constant and π^2.

Most intriguing are the insights into the age-old question of whether the digits of π are truly randomly distributed. A real number α is said to be b-normal, where b is a positive integer, if every string of base-b digits appears in the base

b expansion of α with the expected limiting frequency. The first two authors and Richard Crandall observed that the normality of real numbers such as π that admit BBP formulas can be reduced to proving the equidistribution in $(0,1)$ of a related recursively defined sequence. In particular, we are shown an explicit sequence $\{x_n\}$ in $(0,1)$ such that $\lfloor 16x_n \rfloor$ appears to produce exactly the hexadecimal expansion of π, with an explicit miniscule bound on any possible errors. If this sequence can be proven to be randomly distributed, it will follow that π is 16-normal.

Computations of digits of π have practical applications: running paired computations of π provides a strenuous integrity test of computer hardware and software. Well beyond such applications, however, few mathematical objects have piqued the public interest as powerfully as π. Next π Day, we can amaze our friends by reciting the sequence of ten digits of π starting from position 17,387,594,880, namely 0123456789!

We are saddened that the second author, a frequent contributor to the *Notices*, did not live to receive this prize. Borwein's creative work and beautiful expositions will be sorely missed.

Biographical Note

David H. Bailey received his Ph.D. in mathematics from Stanford University in 1976, and in his subsequent career worked at the NASA Ames Research Center and then at the Lawrence Berkeley National Laboratory. He recently retired from the Berkeley Lab but continues as a Research Associate with the University of California, Davis, Department of Computer Science. His published work includes over 200 papers in experimental mathematics, computational number theory, parallel computing, high-precision computing, fast Fourier transforms, and mathematical finance. Perhaps his best-known paper, co-authored with Peter Borwein and Simon Plouffe, describes a new formula for π, discovered by a computer program, that permits one to directly calculate binary digits of π, beginning at an arbitrary starting position, without needing to calculate any of the preceding digits. Bailey operates several blogs and writes articles on mathematics, computing, and science for the Huffington Post and the Conversation. He has previously received the Chauvenet and Merten Hesse Prizes from the Mathematical Association of America, the Sidney Fernbach Award from the IEEE Computer Society, and the Gordon Bell Prize from the Association of Computing Machinery.

Response from David H. Bailey

I am truly honored to be a corecipient of this year's Levi L. Conant Prize. It is remarkable how the number π, after more than two millennia, continues to amaze, delight, and inspire the general public and professional mathematicians alike. We have learned so much, and yet there is so much more that we still do not know, such as the age-old question of whether and why the digits of π are normal—whether given a positive integer b, every m-long string of base-b digits appears in the base-b expansion of π with the limiting frequency $1/b^m$. We do not know the answer to this question even for $b = 2$ and $m = 1$, let alone for all m or all b. Computationally exploring questions such as this is a delight, and opens an avenue for mathematicians to work hand-in-hand with computer scientists, such as our co-authors Andrew Mattingly and Glenn Wightwick, to make significant contributions. With new theoretical results, combined with ever-more-powerful computer tools, we can look forward to uncovering additional interesting facts about π in the years to come.

This article was the brainchild of our co-author Jonathan M. Borwein, who sadly passed away on August 2, 2016, in what can only be described as a monumental loss to the world mathematical community. My own career was deeply intertwined with Jon's, dating back to 1985 when I read a paper by Jon and his brother Peter on their new nth order convergent algorithms for π. Since then Jon and I have collaborated on five books and more than eighty papers, encompassing a large fraction of my career, and so I owe him a deep debt of gratitude for his inspiration and support. Jon's fascination with π, as well as his delight in bringing the excitement of new findings on π to the general public, was matched only by his indefatigable energy in pursuing a wide range of mathematical research, ranging from optimization and experimental mathematics to biomedical imaging and mathematical finance, using state-of-the-art computer tools to discover and understand new results. For decades to come we will be mining his enormous published corpus (over 500 papers and twenty-eight books) for insights and inspiration.

Biographical Note

Andrew Mattingly holds a Bachelor of Science degree with Honours in Applied Mathematics and Meteorology from Monash University (Melbourne, Australia) and a Master of Science in Astronomy from Swinburne University (Melbourne, Australia). He is employed as a software architect with IBM Australia. While he specializes in IBM's mainframe systems, he has experience with distributed and supercomputing environments, in particular, IBM's Blue Gene supercomputer. Andrew also operates a remote optical observatory in outback Australia, for the benefit of astronomy students at Wheaton College, MA.

Response from Andrew Mattingly

I am very honoured to receive the Levi L. Conant prize, in the company of my esteemed co-authors. I am grateful to Glenn Wightwick for inviting me to participate in the "Pi Day" project that led to our winning paper. This collaboration with Glenn, David Bailey, and the late Jon Borwein led to many subsequent collaborations in experimental mathematics, awakening my enthusiasm for mathematics that, apart from brief encounters in the course of my astronomical pursuits, had lain dormant for decades while I pursued a career in computer software. I very much appreciate the guidance and patience offered by Jon and David during the preparation of this paper, as we wrangled the IBM Blue Gene into producing the desired numerical results.

Biographical Note

Glenn Wightwick is the deputy vice-chancellor and vice-president (Research) at the University of Technology Sydney (UTS) where he is responsible for research activity and research policy development, postgraduate education, industry liaison, intellectual property, and commercialization. Prior to joining UTS, he worked for IBM for over twenty-seven years in a number of roles related to high-performance and scientific computing. He led the establishment of IBM research and development laboratories in Australia, as director of IBM Research-Australia and director of IBM Australia Development Laboratory, and also held the position of chief technologist for IBM Australia. He was appointed an IBM distinguished engineer in 2003 and elected to the IBM Academy of Technology in 2000.

Glenn Wightwick is recognized as a leader in developing Australia's information technology industrial research and development base and a significant contributor to innovation across the nation. He has a distinguished industrial research and development track record. A fellow of the Australian Academy of Technological Sciences and Engineering, Glenn Wightwick has also served on the Australian Research Council (ARC) College of Experts, the Board of National ICT Australia, and has led national bodies and committees such as the NSW Digital Economy Industry Taskforce. He has a bachelor of science from Monash University.

Response from Glenn Wightwick

I am absolutely delighted and deeply honoured to receive the 2017 Levi L. Conant prize along with my collaborators David Bailey, Jonathan Borwein, and Andrew Mattingly for our paper in the *Notices of the AMS*. The computations associated with this research work were undertaken on an IBM BlueGene supercomputer and was partly motivated by a public event at the University of Technology Sydney (where I now work) to celebrate international π Day in 2011. Even though I am not a practicing mathematician, the opportunity to contribute to a large computation involving π connects me back to some of my first interactions with computers at school in 1976. I was fortunate then to have access to DEC PDP-11/750 and an Apple and used them to compute π using various algorithms including a Monte Carlo method which revealed (rather painfully!) fundamental limitations in the underlying pseudo-random number generator. This began a life-long love of computation and I have been very fortunate to work on numerical weather models, seismic processing algorithms, computational

chemistry problems, and bioinformatics. I would very much like to acknowledge my co-authors on this paper and the many colleagues over the years who I have interacted with. In particular, I would like to acknowledge Lance Leslie who taught me everything I know about numeric weather prediction. Finally, I was deeply saddened by the passing of Jonathan Borwein in August 2016. He was one of the world's experts in π and he will be sadly missed by many inside and outside the mathematical community.

AMERICAN MATHEMATICAL SOCIETY

LEONARD EISENBUD PRIZE FOR MATHEMATICS AND PHYSICS

THIS prize was established in 2006 in memory of the mathematical physicist Leonard Eisenbud (1913–2004) by his son and daughter-in-law, David and Monika Eisenbud. Leonard Eisenbud was a student of Eugene Wigner. He was particularly known for the book *Nuclear Structure* (1958), which he co-authored with Wigner. A friend of Paul Erdős, he once threatened to write a dictionary of English to Erdős and Erdős to English. He was one of the founders of the physics department at Stony Brook University, where he taught from 1957 until his retirement in 1983. In later years he became interested in the foundations of quantum mechanics and in the interaction of physics with culture and politics, teaching courses on the anti-science movement. His son, David, was President of the American Mathematical Society 2003–2004. The prize will honor a work or group of works that brings mathematics and physics closer together. Thus, for example, the prize might be given for a contribution to mathematics inspired by modern developments in physics or for the development of a physical theory exploiting modern mathematics in a novel way. The prize will be awarded every three years for a work published in the preceding six years.

CITATION

László Erdős and Horng-Tzer Yau

The 2017 Leonard Eisenbud Prize is awarded to László Erdős and Horng-Tzer Yau for proving the universality of eigenvalue statistics of Wigner random matrices. In the 1950s, Eugene Wigner, motivated by the study of the complex spectra of highly excited nuclei, initiated an investigation of random matrices of a seemingly simple form: $N \times N$ symmetric, Hermitian, or quaternion self-dual random matrices with independent, identically distributed entries. Lacking a truly microscopic theory, Wigner proposed randomly selecting a quantum Hamiltonian. Since then, modeling through random matrices has been surprisingly useful: in determining the distribution of the zeros of the Riemann ζ-function; in characterizing the spectra of quantum Hamiltonians whose classical limit generates a chaotic dynamics; in developing lattice gauge theories; and in carrying out statistical analysis on large data sets. By browsing *The Oxford*

Handbook of Random Matrix Theory, one gains an appreciation of how much the subject has flourished.

A quantity of prime interest is the gap probability, i.e., the distribution of the distance between neighboring eigenvalues. For matrices whose entries have a Gaussian distribution, F. Dyson computed the gap probability in the limit of large N. In fact, he determined the entire local spectrum of eigenvalues and found a structure now known as Pfaffian, or determinantal, point processes with a specific defining kernel. At the time, pioneering numerical simulations suggested that the eigenvalue statistics are *universal*, in the sense that for large N there is no longer a dependence on the particular distribution of the matrix entries. In applications, this kind of robustness is a crucial assumption. The true Hamiltonian will not resemble a particular Wigner matrix. But for the purpose of predicting universal features, such a model may suffice.

A proof of the universality conjecture remained as an unsolved, challenging problem for many years. K. Johansson established the desired result for complex Hermitian matrices under the assumption that the distribution of the entries has a Gaussian component. László Erdős and Horng-Tzer Yau, jointly with collaborators, introduced and perfected the technique of using Dyson's Brownian motion as an interpolating scheme. The dynamics start with the eigenvalues of A and reach the eigenvalues of a Gaussian random matrix as time $t \to \infty$.

To summarize their amazing result: Let $\{A_{ij}\}_{1 \le i,j \le N}$ be a collection of either real or complex random variables, independent up to symmetry, such that $\mathbb{E}(A_{ij}) = 0$, $\mathbb{E}(|A_{ij}|^2) = N^{-1}$, and $\mathbb{E}(|\sqrt{N} A_{ij}|^{4+\epsilon}) < C$ for some constants C and $\epsilon > 0$. Then the typical distance between eigenvalues is of the order N^{-1}. We focus at a point $E \in \mathbb{R}$ at which the average density of eigenvalues is strictly positive and consider the eigenvalues lying in the interval $[E - \ell N^{-1}, E + \ell N^{-1}]$ with arbitrary $\ell > 0$. Shift these eigenvalues by E and rescale by N. Then we arrive at the collection of eigenvalues $\{\lambda_j^{(N)}\}_{j=1,\dots,n}$, with random n, located in the interval $[-\ell, \ell]$. The assertion of the theorem is that in the limit $N \to \infty$, the point process $\{\lambda_j^{(N)}\}_{j=1,\dots,n}$ converges to the limiting point process for the eigenvalues of the Gaussian Wigner random matrix $\{\lambda_j^{(G)}\}_{j=1,\dots,n}$.

A complete formulation can be found in Erdős and Yau's review "Universality of local spectral statistics of random matrices," published in the *Bulletin of the AMS* in 2012, where the notion used for the convergence of point processes is specified.

The initial breakthrough was published in 2010 in "Bulk universality for Wigner matrices," *Communications on Pure and Applied Mathematics* (with S. Péché, J. Ramírez, and B. Schlein), with important subsequent improvements in "Universality of random matrices and local relaxation flow," *Inventiones*

Mathematicae (2011, with B. Schlein), "Bulk universality for generalized Wigner matrices," *Probability Theory and Related Fields* (2012, with J. Yin), "Gap Universality of Generalized Wigner and β-ensembles," *Journal of European Mathematical Society* (2015), and "Fixed energy universality for generalized Wigner matrices," *Communications on Pure and Applied Mathematics* (2016, with P. Bourgade and J. Yin).

Biographical Note

László Erdős was born in Budapest in 1966 and completed university education in mathematics at the Lorand Eötvös University in 1990. He received his Ph.D. at Princeton University in 1994 under the supervision of Elliott H. Lieb. After postdoc positions in Zürich and New York he first became a faculty member at Georgia Tech in Atlanta, then obtained a chair professorship at the Ludwig-Maximilian University in Munich, Germany. Since 2013 he is professor at the Institute of Science and Technology Austria, near Vienna. He was an invited speaker at ICM 2014. He is a corresponding member of the Austrian Academy of Sciences, an external member of the Hungarian Academy of Sciences, and member of the Academia Europaea. Erdős's research focuses on mathematical physics, in particular many-body quantum mechanics, disordered quantum systems and random matrices.

Response from László Erdős

It is a great pleasure and honor to be selected as a corecipient of the 2017 Leonard Eisenbud prize. I am grateful to the committee for this recognition of our work.

I am very fortunate to have learned the importance to combine physical motivations with sharp analysis from the very beginning of my career, starting in the Budapest dynamical system school led by Doma Szász and continuing at Princeton under the guidance of Elliott Lieb whose infallible scientific taste and mathematical mastery have shaped my research ever since. Finally, I owe most of my research aptitude to my former postdoctoral advisor and long-term collaborator, Horng-Tzer Yau, with whom sharing this prize is a great distinction.

A very special acknowledgment goes to our younger collaborators with whom we shared many parts of this long journey toward the solution of the Wigner-Dyson-Mehta conjecture. The results would not have been possible without the multitude of ideas and indefatigable engagement by Paul Bourgade, Antti Knowles, Benjamin Schlein, and Jun Yin, together with shorter but essential collaborations with Jose Ramirez and Sandrine Peche. I thank all of them.

Biographical Note

Horng-Tzer Yau received his B.Sc. from National Taiwan University in 1981 and his Ph.D. degree from Princeton University in 1987, under the supervision of Elliott Lieb. He has held faculty positions at the Courant Institute and

Stanford University, and since 2005 he has been a professor of mathematics at Harvard University. H. T. Yau received the Henri Poincaré Prize in 2000 and was the Distinguished Visiting Professor at the Institute for Advanced Study from 2013 to 2014. He has received fellowships from the Sloan Foundation, Packard Foundation, and MacArthur Foundation, and has been a member of the American Academy of Arts and Sciences since 2001 and the National Academy of Sciences since 2013. Currently, H. T. Yau is a Simons Investigator and the Editor-in-Chief of *Communications in Mathematical Physics.* His work focuses on quantum many-body systems, interacting particle systems, and random matrix theory.

Response from Horng-Tzer Yau

It is a great pleasure and honor to receive this prize. As a student, I saw E. Wigner many times in the colloquium at Princeton. During those years, it never occurred to me that one day I would work on a problem in his area of interest. My coworker, László Erdős, and I came to the universality problem accidentally after many years of working on random Schrödinger equations, which were believed to exhibit random matrix statistics. At the time, study of the universality of random matrices was under the reign of integrable methods. It was fortunate for us that the Green's function method and probabilistic tools were mature enough by then to be applied to this problem. These tools allowed us to understand the universality problem through analytic methods and to make the connection with Dyson's work.

I would like to take this opportunity to thank my thesis adviser, E. Lieb, who taught me to believe in the simplicity of mathematics and physics. I also would like to thank Raghu Varadhan, from whom I learned probability theory during my postdoctoral time at the Courant Institute. In addition to Erdős, I am also indebted to my other coworkers. Among them, Paul Bourgade, Benjamin Schlein and Jun Yin collaborated with Erdős and me on several papers and generated many key ideas in this project. I also would like to thank the committee for selecting this work for the Leonard Eisenbud Prize. Finally, I would like to thank my wife, Chuan-Chuan, for her patience and care through my career.

AMERICAN MATHEMATICAL SOCIETY

FRANK NELSON COLE PRIZE IN NUMBER THEORY

THE Frank Nelson Cole Prize in Number Theory (and the Frank Nelson Cole Prize in Algebra) was founded in honor of Professor Frank Nelson Cole on the occasion of his retirement as secretary of the American Mathematical Society after twenty-five years of service and as editor-in-chief of the *Bulletin* for twenty-one years. The endowment was made by Cole, contributions from Society members, and his son, Charles A. Cole. The prize is for a notable paper in number theory published during the preceding six years. To be eligible, the author should be a member of the AMS or the paper should have been published in a recognized North American journal. This prize is awarded every three years.

CITATION

Henri Darmon

Henri Darmon, of McGill University, is awarded the Cole Prize in Number Theory for his contributions to the arithmetic of elliptic curves and modular forms. The prize recognizes, in particular, the papers "Generalized Heegner cycles and p-adic Rankin L-series" (with Massimo Bertolini and Kartik Prasanna and with an appendix by Brian Conrad) published in 2013 in the *Duke Mathematical Journal* and "Diagonal cycles and Euler systems, II: The Birch and Swinnerton-Dyer Conjecture for Hasse-Weil-Artin L-functions" (with Victor Rotger) published in 2016 in the *Journal of the American Mathematical Society*. These works, which are themselves only high points of a long sequence of influential papers, prove p-adic analogues of the Gross-Zagier formula, thus relating the value of a p-adic L-function to a cohomology class constructed from the geometry of modular curves. In certain situations, these cohomology classes can be used to control the Mordell-Weil group of an elliptic curve, thus establishing new cases of the conjecture of Birch and Swinnerton-Dyer.

Biographical Note

Henri Darmon was born in Paris, France, in 1965, before moving to Canada in 1968, first to Quebec City and then to Montreal at the age of 11. He earned a Bachelor of Science degree with Joint Honours in Mathematics and Computer Science at McGill University in 1987, and a Ph.D. in Mathematics from Harvard University in 1991, under the supervision of Benedict Gross. After a postdoctoral

Instructorship at Princeton University under the mentorship of Andrew Wiles, he returned to his undergraduate alma mater in 1994, where he is currently a James McGill Professor in the Department of Mathematics and Statistics. He has delivered an invited lecture in the number theory section of the 2006 ICM in Madrid, the Earle Raymond Hedrick lectures of the MAA in 2003, and two plenary AMS lectures, at the annual joint meetings in Orlando (1996) and San Antonio (2015).

Response from Henri Darmon

I am tremendously honored to receive the Frank Nelson Cole Prize of the American Mathematical Society, as well as humbled by the thought of the many close friends, towering influences, and fortuitous events that were instrumental for the articles mentioned in the prize citation (referred to henceforth as [BDP] and [DR]).

Above all, I thank my collaborators, Massimo Bertolini, Kartik Prasanna, and Victor Rotger, who deserve this recognition as much as I do. Massimo and I have known each other since our graduate student days almost thirty years ago, and since then have shared many mathematical dreams and written twenty-five papers together. Without Massimo's friendship my career would have been very different: less successful for sure, and also far less enjoyable. We started working with Kartik in 2006, at a time when our earlier ideas had largely played themselves out and we were eager for fresh perspectives. We learned a great deal from Kartik, who made us venture outside our comfort zone and expand our horizons. Our collaboration lasted roughly four years and culminated in the p-adic Gross-Zagier formula described in [BDP]. Over a memorable summer in Barcelona in 2010, Victor encouraged me to extend this formula to the setting, originally explored by Gross, Kudla, and Schoen in the early 1990s, of diagonal cycles in the triple product of modular curves. I was a bit reluctant at first to embark on this project, fearing it would interfere with my two main preoccupations at the time: questions surrounding elliptic curves and the Birch and Swinnerton-Dyer conjecture, and the search for a counterpart of the theory of complex multiplication for real quadratic fields. It is fortunate that Victor prevailed, because a few months later we discovered close connections with both topics, thanks to the extra "miracle ingredient" of p-adic variation of modular forms and associated cohomology classes. One of the contributions of [DR] is a proof of the weak Birch and Swinnerton-Dyer conjecture in analytic rank zero for elliptic curves over Q twisted by ring class characters of real quadratic fields. Although this is hardly a mainstream result, proving it had become something of a personal obsession since the late 1990s, when I realised it would follow from a conjectural extension of Heegner points to the setting of real quadratic fields that I proposed back then and on which I was—and continue to be—quite stuck. I can hardly do justice in a short paragraph to all the mathematical giants on whose shoulders Massimo, Kartik, Victor and I have stood, but let me at least try. Much of my work with Massimo over the years has been guided by Barry Mazur's grand vision of the Iwasawa theory of elliptic curves. Some p-adic variants of the influential results of Benedict Gross, Don Zagier, and Jean-Loup Waldspurger, in the spirit of Leopoldt's p-adic analogue of Dirichlet's analytic class number formula, are explored in [BDP]. The seminal ideas of John Coates and Andrew Wiles originally used to study the arithmetic of elliptic curves with complex multiplication, along with the spectacular refinements and variations that arose in the work of Victor Kolyvagin, Francisco Thaine, Karl Rubin, and Kazuya Kato, are a cornerstone of [DR]. Both [BDP] and [DR] exploit the notion of p-adic families of modular forms pioneered by Haruzo Hida and his school, and rest on an approach towards p-adic L-functions that grew out of the work of Coates-Wiles, as systematized and vastly extended by Robert Coleman, Kazuyo Kato, and Bernadette Perrin-Riou. Out of such excellent ingredients, even a mediocre cook can make a good stew!

Lady luck has played an inordinate role in my career and deserves a paragraph of her own. I was fortunate to be the Ph.D. student of Dick Gross from 1987 to 1991, in the heady days when the Gross-Zagier formula was still fresh but starting to assert its profound and lasting influence on number theory, through its role in such breakthroughs as the 1989 work of Kolyvagin on the Birch and Swinnerton-Dyer conjecture. As a postdoc in Princeton from 1991 to 1994, I had the privilege of witnessing first hand Andrew Wiles's momentous announcement of his proof of Fermat's Last Theorem and the Shimura-Taniyama conjecture. If there is one merit I can claim with some confidence, it is the knack for being at the right place at the right time, which served me well in my formative years. I also thank my family, most of all my parents, my wife, and my daughter for their love and support, and my colleagues at McGill University, Concordia University, and the Centre de Recherches Mathématiques in Montréal for providing the most pleasant, stimulating, and supportive environment, bar none, that a research mathematician could ask for.

AMERICAN MATHEMATICAL SOCIETY

BÔCHER MEMORIAL PRIZE

THIS prize, the first to be offered by the American Mathematical Society, was founded in memory of Professor Maxime Bôcher, who served as president of the AMS 1909–10. The original endowment was contributed by members of the Society. It is awarded for a notable paper in analysis published during the preceding six years. To be eligible, the author should be a member of the AMS or the paper should have been published in a recognized North American journal. Currently, this prize is awarded every three years.

CITATION

András Vasy

The 2017 Bôcher Memorial Prize is awarded to András Vasy for his fundamental paper "Microlocal analysis of asymptotically hyperbolic and Kerr-de Sitter spaces," *Inventiones Mathematicae* **194** (2013), 381–513. This paper resolved a thirty-five year old conundrum in geometric scattering theory, regarding an effective meromorphic continuation of Green functions in these settings. In so doing, it developed a systematic microlocal framework for the Fredholm analysis of nonelliptic problems. This paper was seminal for numerous subsequent works, including two by Vasy in collaboration with P. Hintz: "Semilinear wave equations on asymptotically de Sitter, Kerr-de Sitter, and Minkowski spacetimes," *Analysis & PDE* **8** (2015), 1807–1890, and the recently posted paper, "The global nonlinear stability of the Kerr-de Sitter family of black holes." The committee also recognizes Vasy's outstanding contributions to multibody scattering and to propagation of singularities for solutions to wave equations on regions with singular boundaries.

Biographical Note

András Vasy was born and grew up in Budapest, Hungary. He attended the Apáczai Csere János Gimnázium (high school) in Budapest and the United World College of the Atlantic in Llantwit Major, Wales, before undergraduate studies at Stanford University in mathematics and physics. He received his Ph.D. in mathematics from the Massachusetts Institute of Technology under the supervision of Richard Melrose in 1997. Subsequently he held positions at the University of California, Berkeley, the Massachusetts Institute of Technology, and

Northwestern University before joining Stanford University in 2005, where he is currently Professor of Mathematics. He received a Sloan Research Fellowship, a Clay Research Fellowship, and was a speaker in the partial differential equations section of the 2014 ICM in Seoul.

Response from András Vasy

It is a great honor to receive the 2017 Bôcher Memorial Prize. I am very grateful that the prize recognizes the development of microlocal analysis, along with the role I played in it. Microlocal analysis is a powerful unified approach dealing with many problems in analysis, from partial differential equations to integral geometry and inverse problems. It is this unified aspect that appeals to me particularly, and I very much hope that future generations of mathematicians will derive as much joy from working on and with it as I do.

The work leading to this prize could not have happened without the support of many people. My parents, Margit and Géza, my siblings, Benedek and Júlia, as well as my wife, Sara, and my daughter, Marguerite, supported me in this endeavor in a multitude of ways, including forgiving me for spending so much time thinking about mathematics and for creating such a happy environment for my life.

I am also grateful to my teachers throughout the years who led me to the delights of mathematics and physics: my Budapest Apáczai Gimnázium (high school) math and physics teachers, Péter Pósfai and Ferenc Zsigri, and my Stanford undergraduate and MIT graduate instructors, especially Steven Chu, Leon Simon, and Victor Guillemin; it is thanks to Leon's inspiring lectures that I ended up doing mathematics. I also learnt a lot from my collaborators; I am very grateful for all the discussions that undoubtedly played a role in how I approach the area. But most of all I am extremely grateful to my Ph.D. advisor Richard Melrose. My view of the subject was fundamentally shaped by what I learned from him as a student, a collaborator, and a colleague; I believe that the insights I acquired through interactions with him was the key part of the work that is now being recognized by the AMS.

AMERICAN MATHEMATICAL SOCIETY

THE RUTH LYTTLE SATTER PRIZE IN MATHEMATICS

THE Satter Prize was established in 1990 using funds donated by Joan S. Birman in memory of her sister, Ruth Lyttle Satter, to honor Satter's commitment to research and to encourage women in science. The prize is awarded every two years to recognize an outstanding contribution to mathematics research by a woman in the previous six years.

CITATION

Laura DeMarco

The 2017 Ruth Lyttle Satter Prize in Mathematics is awarded to Laura DeMarco of Northwestern University for her fundamental contributions to complex dynamics, potential theory, and the emerging field of arithmetic dynamics.

In her early work, DeMarco introduced the bifurcation current to study the stable locus in moduli spaces of rational maps, and she constructed a dynamically natural compactification of the moduli spaces with tools from algebraic geometry, potential theory, and geometric topology. Both ideas were groundbreaking, opening new directions of research in complex dynamics. In recent joint work with M. Baker, she formulated a far-reaching conjecture about arithmetically special points in these moduli spaces, analogous to (and containing overlap with) the André-Oort and related conjectures in arithmetic geometry. They proved cases of the conjecture with methods involving a remarkable confluence of ideas from complex dynamics and disparate fields such as logic, number theory, and analysis on Berkovich spaces. With K. Pilgrim, she has constructed new invariants of polynomial maps in terms of metric trees and additional planar topological information. This led to two striking results, one on the algorithmic enumeration of cusps for certain curves in the space of cubic polynomials, addressing a problem first formulated and studied by J. Milnor, and the other a generalization of the well-known theorem that the Mandelbrot set is connected. Finally, in her most recent work, she has established direct connections between the theory of bifurcations in complex dynamics and the study of rational points on elliptic curves.

Biographical Note

Laura DeMarco is a professor at Northwestern University. She earned her Ph.D. in 2002 from Harvard, where she studied with Curtis McMullen. Her undergraduate degree is in mathematics and physics from the University of Virginia, and she obtained an MA at the University of California in Berkeley. DeMarco held an NSF Postdoctoral Fellowship and Dickson Instructorship at the University of Chicago. She became an assistant professor at the University of Chicago, before moving to (and subsequently being tenured and promoted to professor at) the University of Illinois at Chicago. While there, DeMarco received the NSF Career Award and a Sloan Fellowship. She also became a fellow of the American Mathematical Society. During the academic year 2013–14, DeMarco was the Kreeger-Wolf Distinguished Visiting Professor in the mathematics department at Northwestern University. She moved to Northwestern in 2014. Laura DeMarco was awarded a Simons Fellowship in 2015.

AMERICAN MATHEMATICAL SOCIETY

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

Leon Simon

The Steele Prize for Seminal Contribution to Research is awarded to Leon Simon for his fundamental contributions to Geometric Analysis and in particular for his 1983 paper "Asymptotics for a class of nonlinear evolution equations, with applications to geometric problems", published in the *Annals of Mathematics*.

In this groundbreaking paper Simon addressed the basic question of what a minimal variety must look like near a singularity. This is a question of fundamental importance since singularities in minimal varieties (as well as solutions to many other nonlinear problems) are generally unavoidable. Once one knows that singularities occur, one naturally wonders what they are like. The first answer, already known to Federer and Fleming in 1959, is that they weakly resemble cones. Unfortunately, the simple proof leaves open the possibility that a minimal variety looked at under a microscope will resemble one blowup, but under higher magnification, it might (as far as anyone knows) resemble a completely different blowup. Whether this ever happens is one of the most fundamental questions about singularities.

Simon recasts this as a question of long-time behavior of solutions to gradient flows. He then uses this formulation to prove the uniqueness of the tangent cone at a singularity where there is a tangent cone with an isolated singularity at the vertex. Simon also obtains, in the same paper, a similar uniqueness result for other variational problems. A couple of years earlier, in a landmark paper, Allard and Almgren had proven uniqueness under an additional integrability assumption on the cross-section by entirely different methods.

In the 1960s Łojasiewicz showed that, for an analytic function on Euclidean space, any limit point of its gradient flow is in fact a limit. Simon realized in a brilliant way that many fundamental problems in analysis and geometry can be recast as infinite-dimensional Łojasiewicz theorems and, by ingenious analytic arguments, deduced from the finite-dimensional Łojasiewicz theorem.

The significance of Simon's pioneering paper extends well beyond these results. In fact, Simon obtained these results as an application of a strikingly original and general method that he developed in the paper, based on the Łojasiewicz inequality in Real Algebraic Geometry, known now as the Łojasiewicz-Simon inequality. The basic analytic ingredient that Simon developed to carry out this method has proven to be an extraordinarily powerful tool of far-reaching impact. It has since been applied or adapted in uniqueness and related questions in a very large number of contexts, ranging from differential geometry to fluid dynamics and superconductivity.

Simon himself subsequently used this inequality, together with a host of further new ideas, to show regularity of the singular set of a minimal variety.

Leon Simon's paper has had extraordinary impact on analysis, geometry, and applied mathematics. Hundreds of papers have been written either directly applying the Łojasiewicz-Simon inequality or based upon the insights contained in this paper. Without a doubt Simon's ideas will continue to be applied and further developed in future work.

Biographical Note

Leon Simon is Emeritus Professor of Mathematics at Stanford University. Born July 6, 1945, in Adelaide, South Australia, he received his bachelor's degree at the University of Adelaide in 1967, and his Ph.D., written under the direction of James Michael, from the same institution in 1971. After briefly holding a lectureship at Flinders University in Adelaide, he took a postdoctoral Assistant Professorship at Stanford University from 1973–76. After holding professorships at Minneapolis, Melbourne University, and the Australian National University in Canberra, he returned to Stanford as Professor of Mathematics in 1986. He was Chair of Mathematics at Stanford for the period 1998–2001.

Simon's main research interests are in Geometric Measure Theory and Partial Differential Equations, in particular the theory of minimal surfaces and related problems in the geometric calculus of variations.

He was elected fellow of the Australian Academy of Sciences in 1983, the American Academy of Arts and Sciences in 1994, and the Royal Society in 2003. He was awarded a Sloan Fellowship in 1975, an Australian Mathematical Society Medal in 1983, the Bôcher Prize of the American Mathematical Society in 1994, and a Humboldt Award in 2005. He gave an invited talk at the ICM in 1983 and is an AMS Fellow. In the course of his career, he has supervised the thesis work of eighteen graduate students.

Response from Leon Simon

I am very honored to be chosen for this award. The cited work was carried out during my time at the Australian National University in Canberra, and I owe a great debt to a number of people, including Robert Bartnik, John Hutchinson, Peter Price, and Neil Trudinger, who were responsible for the congenial and very active research environment during that time. I am of course also indebted to those who provided me with inspiration and support in the period prior to that, including James Michael (1920–2001), who was an inspiring undergraduate teacher and who supervised my Ph.D. work, and David Gilbarg (1918–2001), Rick Schoen, and S.-T. Yau during my postdoctoral period at Stanford. I'm also greatly indebted to Robert Hardt who acquainted me with many of the finer points of Geometric Measure Theory during our collaborations at the University of Minnesota and the University of Melbourne in 1977–79.

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

Dusa McDuff and Dietmar Salamon

Dusa McDuff and Dietmar Salamon are awarded the Steele Prize for Mathematical Exposition for their book *J-Holomorphic Curves and Symplectic Topology*, American Mathematical Society Colloquium Publications, 52, 2004.

The field of symplectic topology went through a rapid phase of development following Gromov's 1985 paper that introduced J-holomorphic curves into symplectic topology and intertwined this field with algebraic geometry and string theory. Techniques revolving around J-holomorphic curves have been a basic ingredient in the solution of many classical and crucial questions in symplectic topology as well as in the discovery of new structures. More than thirty years after its publication the influence of Gromov's paper in the rapidly developing field of symplectic topology is as strong as in the beginning and many of the most exciting research topics in the field (like, for example, mirror symmetry) involve in one way or another the notion of a J-holomorphic map.

The book *J-Holomorphic Curves and Symplectic Topology* is a comprehensive introduction to Gromov's theory of J-holomorphic curves explaining from the beginning and in detail the essential notions and results as well as many of its spectacular applications in symplectic topology. While being among the main contributors to this development, McDuff and Salamon spent nearly a decade assembling the foundations of this subject into a mammoth 700-page book. It has since served as the most standard and undisputed reference in the field and as the main textbook for graduate students and others entering the field. The use of the abbreviation M-S in the context of J-holomorphic curves and symplectic topology has now become routine and causes no confusion.

This book begins with a sixteen-page overview of the subject of symplectic topology, the theory of J-holomorphic curves, and its applications to symplectic topology, algebraic geometry, and mirror symmetry. This overview is informative to those outside the field who are just curious and serves as a guide to the book. Each chapter begins with its own very informative introduction. The chapters and sections are structured so that the main statements are formulated as early as possible while their proofs are delayed.

In some ways, the McDuff and Salamon book on J-holomorphic curves is the symplectic analogue of Lazarsfeld's *Positivity in Algebraic Geometry* and Griffths and Harris's *Principles of Algebraic Geometry*. This book, together with McDuff and Salamon's *Introduction to Symplectic Topology* and their many other contributions, has been a great help to both junior and senior symplectic geometers.

Biographical Note

Dusa McDuff was born in London in 1945, grew up in Edinburgh, and in 1971 received her Ph.D. from Cambridge University under the direction of George Reid. She spent six months in 1969–70 as a student of I. M. Gelfand in Moscow, who had a profound influence on her mathematics. After working on topics in topology and foliation theory (often in collaboration with Graeme Segal), she was moving into the area of symplectic geometry just as Gromov published his pioneering paper, and has remained there ever since. After holding positions at York, Warwick, and Stony Brook Universities, she is currently Helen Lyttle Kimmel '42 Professor of Mathematics at Barnard College, Columbia University. She received the Ruth Lyttle Satter prize (1991), gave a plenary address to the ICM (1998), was AWM Noether Lecturer (1998), and AMS Colloquium Lecturer (2014). She is a Fellow of the Royal Society of London (1994), a member of the US Academy of Sciences (1999) and of the American Philosophical Society (2013), and has Honorary degrees from the universities of York, Edinburgh, St. Andrews, Strasbourg, and Pierre and Marie Curie, Paris.

Biographical Note

Dietmar Salamon was born in Bremen in 1953 and completed his Ph.D. at the University of Bremen in 1982 under the direction of Diederich Hinrichsen. After postdoctoral positions at the University Madison–Wisconsin and at ETH Zurich, he took up a lectureship at the University of Warwick in 1986 where he became professor in 1994. In 1998 he moved to ETH Zurich to take up a professorship. His field of research is symplectic topology and related subjects.

He was an invited speaker at the ECM 1992 in Paris, at the ICM 1994 in Zurich, and at the ECM 2000 in Barcelona. He delivered the Andrejewski Lectures in Goettingen (1998) and at the Humboldt University Berlin (2005), and the Xth

Lisbon Summer Lectures in Geometry (2009). He is a member of the Academia Europaea and a fellow of the AMS.

He is the author of several books, including the joint monographs *Introduction to Symplectic Topology* and *J-Holomorphic Curves and Symplectic Topology* with Dusa McDuff, and of over seventy research papers. He has supervised twenty Ph.D. students.

Response from Dusa McDuff and Dietmar Salamon

It is a great honor to receive the Leroy P. Steele Prize for Mathematical Exposition for our book on *J-Holomorphic Curves and Symplectic Topology*.

Our collaboration started in 1990, at a conference at the University of Warwick. During the preceding year we had both given lecture courses on symplectic topology, and decided to put our acts together to write a monograph about that newly emerging subject, not imagining how much effort would go into this in the course of the following quarter of a century. In December 1993 at a conference in Tel Aviv—coincidentally in honor of Misha Gromov's fiftieth birthday—we decided that the theory of J-holomorphic curves together with the vast amount of introductory material would be too much for a single volume.

So one book turned into two, and the one on J-holomorphic curves "bubbled off." It was initially conceived as a fairly brief introduction together with a proof of the gluing theorem, and appeared less than a year later, even before our *Introduction to Symplectic Topology*, in the AMS University Lecture Series under the title *J-Holomorphic Curves and Quantum Cohomology*. About a decade later we decided to correct errors and include more details and applications, after which the manuscript tripled in size to almost 700 pages and was published in 2004 under the title *J-Holomorphic Curves and Symplectic Topology* in the AMS Colloquium Publications. An updated and corrected Second Edition appeared in 2012.

Our work on both manuscripts required a certain amount of compromise, as well as extensive arguing, as often we were approaching the subject from rather different points of view, which one might characterize as more geometric (Dusa) versus more analytic (Dietmar). However, we both found this process stimulating, and in the end it led to a much better result than either of us could have achieved on our own.

We learnt a great deal from each other, as well as from many other researchers in the field, to whom we wish to express our deep gratitude. We are very happy that our books helped many others to study this beautiful subject, and also are deeply honored that our efforts have been recognized with the award of this prize.

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

James Arthur

The 2017 Steele Prize for Lifetime Achievement is awarded to James Arthur for his fundamental contributions to number theory and harmonic analysis, and in particular for his proof of the Arthur-Selberg trace formula.

Introduction of L-functions into the theory of automorphic forms began with a conjecture of Ramanujan, its proof by Mordell, and the exploitation of Mordell's ideas by Hecke, who had already had experience with Euler products in the context of Dedekind ζ-functions and related L-functions.

Later Selberg introduced methods from the spectral theory of second-order differential equations on a half-line, as well as a form of the Frobenius reciprocity theorem, familiar from the representation theory of finite groups. In the context of discrete subgroups of Lie groups it became known as the Selberg trace formula. For groups with compact quotient it is hardly more difficult than the Frobenius theorem itself. For groups with quotients of finite volume but not compact, not only its formulation but also its proof required ingenuity and a good deal of skill in the use of the spectral theory.

The first trace formula for general groups was established by Arthur in the 1970's in a series of three papers. Starting from the particular case of SL(2) which had been established by Selberg in 1956, Arthur has built a whole mathematical framework and introduced many major tools in noncommutative harmonic analysis in order to prove the trace formula for a general reductive group. The final result is now called the Arthur-Selberg trace formula. The proof in itself takes 16 long and difficult papers that Arthur published between 1974 and 1988. This is considered to be a major achievement in mathematics.

As Langlands suggested at the end of the 1960s, the trace formula is a powerful tool for proving the Langlands principle of functoriality, especially in the so-called endoscopic case. For this purpose, one first needs to stabilize the Arthur-Selberg trace formula. Arthur published eight papers between 1997 and 2003 on the stabilization process. Using the stable trace formula and the Fundamental Lemma proved in 2008 by Ngô Bảo Châu, Arthur has recently been able to establish the Langlands functoriality for the standard representations of the classical groups (symplectic, orthogonal, and unitary).

As a consequence, he has obtained explicit formulas for the multiplicities in the automorphic discrete spectrum for those classical groups. The Arthur-Selberg trace formula is a central tool in Lafforgue's proof of the Langlands correspondence for function fields.

Arthur's contribution to mathematics is fundamental. His work already has had, is having, and will have an enormous impact on several branches of mathematics. But his service to the mathematical community is also very impressive. Arthur played an important role in shaping the work of several important national and international committees and organizations. All this culminated when he served as President of the American Mathematical Society.

In 1992 Arthur was elected a Fellow of the Royal Society. He was elected a Foreign Honorary Member of the American Academy of Arts and Sciences in 2003 and a foreign member of the National Academy of Sciences in 2014. In 2015 he was awarded the Wolf Prize in Mathematics.

Biographical Note

James Arthur is a university professor and holds the Ted Mossman Chair in Mathematics at the University of Toronto. He was born in Hamilton, Ontario, in 1944, and received a B.Sc. from the University of Toronto in 1966, an M.Sc. from the University of Toronto in 1967, and a Ph.D. from Yale University in 1970. He then held positions in mathematics at Princeton University, Yale University, and Duke University before returning to the University of Toronto in 1979.

Arthur is a fellow of the Royal Society of Canada, a fellow of the Royal Society of London, a Foreign Honorary Member of the American Academy of Arts and Sciences and a Foreign Associate of the National Academy of Sciences. His various honors and awards include an Honorary Doctorate at the University of Ottawa in 2002, the Canada Gold Medal in Science and Engineering in 1999, and the Wolf Prize in Mathematics in 2015. He has given several addresses at International Congresses of Mathematicians, including a Plenary Lecture at the Congress in Seoul, Korea, in 2014, and he gave a Plenary Lecture at the first Mathematical Congress of the Americas in Guanajuato, Mexico, in 2013. He is presently working on Beyond Endoscopy, a proposal by Robert Langlands for using the trace formula to study the general Principle of Functoriality.

Arthur has served mathematics in several senior administrative roles. He was a member of the Executive Committee of the International Mathematics Union from 1991–1998, and the Academic Trustee for Mathematics on the Board of Trustees of the Institute for Advanced Study from 1997–2007. He also served as president of the AMS from 2005–2007. He lives in Toronto with his spouse Penny. They have two sons, James, a poet in the creative writing program at Johns Hopkins University, and David, a computer engineer at Google, in Mountain View, CA.

Response from James Arthur

I am thrilled and honored to receive the Steele Prize for Lifetime Achievement. It is a cliche, but true nonetheless, for me to say that I feel humbled to look down the list of past winners. I would like to thank the Steele Prize Committee for selecting me. I would also like to thank the AMS, and the many mathematical colleagues in particular, who donate their time to serve on prize committees and to participate in the many other activities that do so much to help our subject thrive.

I was not a prodigy in mathematics as a child. As a matter of fact, I am quite happy that my record for the Putnam exams was not available to the Prize Committee. But I do remember being fascinated even as a child by what was said to be the magic and power of mathematics. These feelings have remained with me throughout my professional life, and they have motivated me more than any specific theorem or result.

I am very grateful to Robert Langlands for his encouragement, both during my time as a graduate student and since then. I am also grateful to him, personally and as a member of the larger community, for what he has given to mathematics. His mathematical discoveries truly are magical and powerful. They are becoming more widely known among mathematicians today, and I have no doubt that they will bring pleasure and inspiration to many generations of mathematicians to come.

Much of my mathematical life has been connected in one way or another with what has become known as the Arthur-Selberg trace formula. It is now a very general identity that, like other things in mathematics, links geometric objects (such as closed geodesics) with spectral objects (such as eigenvalues of a Laplacian). The trace formula has many different terms. But as we are beginning to understand them now, each of these sometimes arcane quantities (either geometric or spectral) seems to have its own particular role in the larger scheme of things. I have been fortunate that the trace formula has assumed a more central role than might have been imagined earlier. I am excited to think that there is now a well-defined (if also rather imposing) strategy for using the trace formula to attack what is known as the principle of functoriality, the central tenet of the Langlands program.

Summary of Awards

For MAA

- **Beckenbach Book Prize**: Tim Chartier
- **Chauvenet Prize**: Mark F. Schilling
- **David P. Robbins Prize**: Robert D. Hough
- **Euler Book Prize**: Ian Stewart
- **Deborah and Franklin Tepper Haimo Awards for Distinguished College or University Teaching of Mathematics**: Janet Heine Barnett, Caren Diefenderfer, and Tevian Dray
- **Yueh-Gin Gung and Dr. Charles Y. Hu Award for Distinguished Service to Mathematics**: Martha J. Siegel

For AWM

- **Joan and Joseph Birman Prize in Geometry and Topology**: Emmy Murphy
- **Louise Hay Award for Contribution to Mathematics Education**: Catherine Kessel
- **M. Gweneth Humphreys Award for Mentorship of Undergraduate Women in Mathematics**: Helen G. Grundman

For AMS

- **Joseph L. Doob Prize**: John Friedlander and Henryk Iwaniec
- **Levi L. Conant Prize**: David Bailey, Jonathan Borwein, Andrew Mattingly, and Glenn Wightwick
- **Leonard Eisenbud Prize for Mathematics and Physics**: László Erdős and Horng-Tzer Yau
- **Frank Nelson Cole Prize in Number Theory**: Henri Darmon
- **Bôcher Memorial Prize**: András Vasy
- **Ruth Lyttle Satter Prize in Mathematics**: Laura DeMarco
- **Leroy P. Steele Prize for Seminal Contribution to Research**: Leon Simon
- **Leroy P. Steele Prize for Mathematical Exposition**: Dusa McDuff and Dietmar Salamon
- **Leroy P. Steele Prize for Lifetime Achievement**: James Arthur

For AMS-MAA-SIAM

- **Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student**: David H. Yang and Aaron Landesman

For JPBM

- **Communications Award**: Arthur Benjamin and Siobhan Roberts

Index of Award Recipients