2001 Steele Prizes

The 2001 Leroy P. Steele Prizes were awarded at the 107th Annual Meeting of the AMS in January 2001 in New Orleans.

The 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. The prizes are awarded in three categories: for expository writing, for a research paper of fundamental and lasting importance, and for cumulative influence extending over a career. The current award is $4,000 in each category (in case of multiple recipients, the amount is divided equally).

The recipients of the 2001 Steele Prizes are RICHARD P. STANLEY for Mathematical Exposition, LESLIE GREENGARD and VLADIMIR ROKHLIN for a Seminal Contribution to Research (limited this year to applied mathematics), and HARRY KESTEN for Lifetime Achievement.

The Steele Prizes are awarded by the AMS Council acting through a selection committee whose members at the time of these selections were: Constantine M. Dafermos, Bertram Kostant, Hugh L. Montgomery, Marc A. Rieffel, Jonathan M. Rosenberg, Barry Simon, François Treves (chair), S. R. S. Varadhan, and Herbert S. Wilf. The text that follows contains, for each prize recipient, the committee's citation, a brief biographical sketch, and a response from the recipient upon receiving the prize.

Mathematical Exposition: Richard P. Stanley

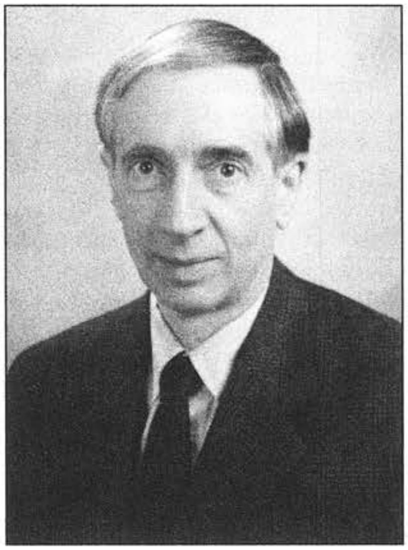
Citation

The Leroy P. Steele Prize for Mathematical Exposition is awarded to Richard P. Stanley of the Massachusetts Institute of Technology in recognition of the completion of his two-volume work *Enumerative Combinatorics*. The first volume appeared in 1986, and, to quote the review of Volume 2 by Ira Gessel, "since then, its readers have eagerly awaited Volume 2. They will not be disappointed. Volume 2 not only lives up to the high standards set by Volume 1, but surpasses them. The text gives an excellent account of the basic topics of enumerative combinatorics not covered in Volume 1, and the exercises cover an enormous amount of additional material."

The field has been expanding and evolving very rapidly, and it is quite remarkable that Stanley has been able to take a still photograph of it, so to speak, that beautifully captures its subject. To appreciate the scholarly qualities of this work, one need look no further than the exercises. There are roughly 250 exercises in each volume, all graded according to difficulty, many being multipart, and all with solutions and/or references to the relevant literature being provided. There are more than 500 bibliographic citations in the two volumes.

The first volume begins with elementary counting methods, such as the sieve method, and works through the theory of partially ordered sets, ending with a beautiful treatment of rational generating functions. Volume 2 begins with an advanced, yet very clear, view of generating functions, with special attention to algebraic and D-finite ones, and concludes with a comprehensive discussion of symmetric functions.

Yet even with all of the information that is being transmitted, we never lose clarity or our view of "the big picture". As a small example, we note that the Catalan numbers seem ubiquitous in combinatorics. Every student of the subject is struck by the large number of questions that they answer and wonders if there are bijections between the various families



Richard P. Stanley

Leslie F. Greengard

Photograph by Michael Marsland, Yale Univ. Office of Public Affairs.

Vladimir Rokhlin

of objects that are counted by these numbers. In a single exercise (ex. 6.19) Stanley has collected 66 such questions and asks the reader to provide the proofs which, in each case, establish the Catalan answer. All 66 of them are worked out in the solution, which is ten pages long, and this is just one of the 500 or so exercises. The author even has time for an occasional smile-generator (e.g., ex. 6.24: "Explain the following sequence: un, dos, tres, quatre, cinc, sis,…." The solution tells us that they are the Catalan numbers.)

This is a masterful work of scholarship which is, at the same time, eminently readable and teachable. It will be the standard work in the field for years to come.

Biographical Sketch

Richard Stanley was born in New York City in 1944. He graduated from Savannah High School in 1962 and Caltech in 1966. He received his Ph.D. from Harvard University in 1971 under the direction of Gian-Carlo Rota. He was a Moore Instructor at Massachusetts Institute of Technology during 1970–71 and a Miller Research Fellow at Berkeley during 1971–73. He then returned to MIT, where he is now a professor of applied mathematics. He is a member of the American Academy of Arts and Sciences and the National Academy of Sciences, and in 1975 he was awarded the Pólya Prize in Applied Combinatorics from the Society for Industrial and Applied Mathematics. His main mathematical interest is combinatorics, especially its connections with such other branches of mathematics as commutative algebra and representation theory.

Response

I have been interested in expository writing since graduate school and have long admired such masters as Donald Knuth, George Pólya, and Jean-Pierre Serre. I think it is wonderful that the AMS awards a prize for mathematical exposition, and I am extremely pleased at having been chosen for this award. It is not just an award for me but for all of combinatorics, for which such recognition would have been unthinkable when I was starting out in the subject. I only regret that it is not possible for me to share the celebration of my prize with Gian-Carlo Rota, who inspired me throughout my career and who wrote the two forewords to *Enumerative Combinatorics*.

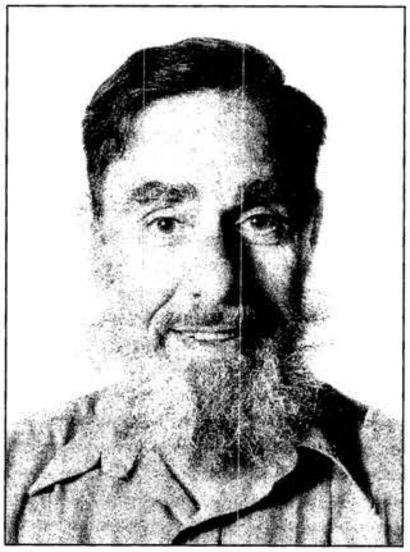
Seminal Contribution to Research: Leslie F. Greengard and Vladimir Rokhlin

Citation

For the paper by L. Greengard and V. Rokhlin "A fast algorithm for particle simulations", *J. Comput. Phys.* **73**, no. 2 (1987), 325–348.

This is one of the most important papers in numerical analysis and scientific computing in the last two decades. This paper introduces an algorithm, the fast multipole method (FMM), that speeds up the computation of certain types of sums. It showed that several ideas in harmonic analysis, far field expansions, and multiscale analysis based on dyadic decompositions of space, together with some further innovations, such as so-called "translation operators", could be combined to produce a practical algorithm that would make possible scientific and engineering computations that would have been impossible before. While the paper itself treats a very special case, it contains the fundamental ideas for a vast variety of generalizations and applications. The paper combines both the elegance and originality of the algorithm itself and the "hard" analysis of the proofs. These sums arise in a variety of applications, ranging from computational astronomy (computing the gravitational interaction of stars in a galaxy), to molecular dynamics (the Coulomb interaction of charges in a large molecule), to engineering computations of radar scattering, to

Photograph by Nicola Kountoupes, Cornell University Photography.



Harry Kesten

anything related to solutions of the Laplace equation (vortex methods for incompressible flow). The FMM has been enormously influential not just because of its basic scientific applications, but also because it forms the basis of commercial software for electronic packaging analysis, semiconductor design, and electro-magnetic applications. It has brought previously intractable computational problems within reach.

Biographical Sketch: Leslie F. Greengard

Leslie Greengard was born in London, England, and grew up in New York, Boston, and New Haven. He received his B.A. in mathematics from Wesleyan University in 1979, his Ph.D. in computer science from Yale University in 1987, and his M.D. from Yale University in 1987. From 1987–89 he was a National Science Foundation Postdoctoral Fellow at Yale University in the Department of Computer Science. He is presently a professor of mathematics at the Courant Institute of New York University, where he has been a faculty member since 1989. Much of his work has been in the development of "analysis-based" fast algorithms such as the Fast Multipole Method for gravitation and electromagnetics and the Fast Gauss Transform for diffusion.

Response: Leslie Greengard

I am deeply honored to be the recipient of a 2001 Steele Prize together with Vladimir Rokhlin. The work for which the prize has been awarded lies at the interface of mathematics, physics, and computer science. It is a pleasure to have this kind of interdisciplinary effort recognized by my mathematical colleagues.

As the field of computational mathematics begins to mature, we need a long-term view; short-term results are inadequate, and intermediate results may have no practical application or immediate impact. Mathematics is uniquely positioned as a field to promote this kind of work. There are many open problems, and it's a lot of fun to go after them.

I was fortunate to have met Rokhlin when I was an M.D./Ph.D. student at Yale, working on a tree-based algorithm (a primitive fast multipole method) to evaluate electrostatic interactions in three dimensions. When Rokhlin arrived in 1985, he had already developed an early version of the full fast multipole method for accelerating the solution of boundary integral equations in two dimensions. Martin Schultz, then chair of the department, introduced us. The analytic structure introduced by Rokhlin was richer than that of the simple tree-based codes. He became my thesis advisor, and we have been collaborating ever since.

Biographical Sketch: Vladimir Rokhlin

Vladimir Rokhlin was born in Russia in 1952. He received his M.S. in mathematics in 1973 from the University of Vilnius, Lithuania, and his Ph.D. in applied mathematics from Rice University in 1983. From 1973 to 1976 he worked at the Leningrad Institute of Arctic Geology and from 1976 to 1985, at the Exxon Production Research Company in Houston, Texas. He is currently a professor of mathematics and computer science at Yale University, where he has been working since 1985. He is a member of the National Academy of Sciences.

Response: Vladimir Rokhlin

It is hard to express my delight at being a co-recipient of the 2001 Steele Prize. I have always viewed myself as an applied mathematician, with the emphasis on the "applied". When dealing with a problem, I tend to be interested in its computational aspects; when things work out, the beauty of the resulting mathematics takes me by surprise. It is truly nice to see that this sense of wonder is shared by other mathematicians.

I met Leslie Greengard in 1985. At that point I was convinced that the future belonged to "fast" methods; I had constructed a rudimentary fast scheme for the solution of the Laplace equation in two dimensions and was not quite sure what the next step should be. When I encountered Leslie, he was thinking along very similar lines, but was motivated by biology and chemistry. We have been collaborating ever since.

Steele Prize for Lifetime Achievement: Harry Kesten

Citation

The Leroy P. Steele Prize for Lifetime Achievement is awarded to Harry Kesten, professor of mathematics at Cornell University, for his many and deep contributions to probability theory and its applications. Much of Kesten's work has revolved around random walks on graphs, and his exceptional expertise in this field has led him, and his numerous collaborators, to a wealth of results. To mention only a few of Kesten's achievements: his work on percolation and on first-passage percolation (late 1970s to present), the solution of Chung's problem with the proof of necessary and sufficient conditions for processes with independent increments to hit points with positive probability (late 1960s), the generalization and sharpening of central limit theorems (of Lévy's and Kolmogorov's lineage). Among "applied" areas in which interesting problems have been successfully tackled by Kesten are models for population growth, river networks, and the distinguishing of scenery along a random walk path. Statistical mechanics has been an especially fruitful area of application of the results and methods developed by Kesten: percolation was introduced in the late 1950s by Broadbent and Hammersley as a model for the spread of a fluid or gas through a random medium; it is now viewed by physicists as a prototype of a system with a phase transition. Kesten's analysis near the critical probability p_c provided for the first time rigorous proofs of bounds for significant quantities associated with the percolation and of the equations relating the exponents in those quantities, bounds, and equations that had been-heuristically found by physicists. It gave him the means of completing the proof that $p_c = 1/2$ in two-dimensional percolation; it led him to a mathematical definition of the physicist's "incipient cluster at criticality" and helped him get some hold on this fractal, again by studying random walks on various graphs.

Biographical Sketch

In 1933 when the Nazis came to power, Harry Kesten was one and a half years old. That year his family moved to The Netherlands, where he grew up and received his university education. In 1956 he obtained a fellowship to attend Cornell University, where he earned his Ph.D. under the supervision of Mark Kac. Kesten then held a one-year instructorship at Princeton University and a two-year instructorship at the Hebrew University. He returned to Cornell in 1961 and has been there ever since, except for various leaves.

Kesten has delivered several special lectures during his career: the Mathematical Association of America Earle Raymond Hedrick Lectures in 1970, an Invited Address at the 1971 AMS Winter Meeting, a Rietz Lecture to the Institute of Mathematical Statistics in 1971, a Brouwer Memorial Lecture in 1981, lectures at the International Congress of Mathematicians in Nice (1970) and Warsaw (1983), and the Wald Lectures to the Institute of Mathematical Statistics in 1986. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, is a Correspondent of the Royal Dutch Academy of Sciences, and has served on numerous editorial boards internationally. Kesten has been the recipient of Sloan and Guggenheim Fellowships, as well as of the Brouwer Medal and the George Pólya Prize of the Society for Industrial and Applied Mathematics.

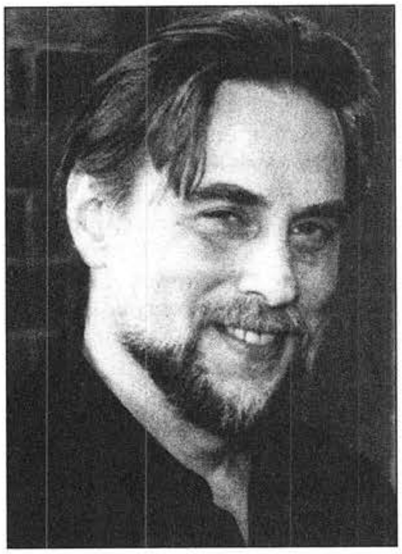
Response

I feel very honored by the award of the Leroy P. Steele Prize for Lifetime Achievement. Of course I accept the prize with great pleasure. I am extremely grateful to the Selection Committee and the AMS for giving me this recognition.

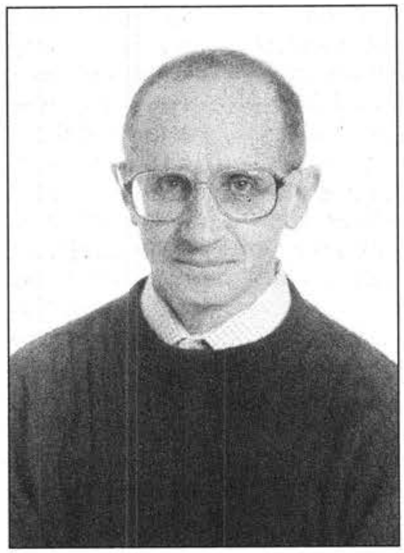
Like most other mathematicians I have had much help and stimulation from teachers and colleagues. My thesis adviser, Mark Kac, started me on random walks on groups, which was virgin territory at that time. Ever since then I have been fascinated by random walks, be they of the classical kind on the integers and real line or on more exotic objects such as trees and percolation clusters. I am amazed that people continue to find interesting new problems and angles in this oldest branch of probability theory. I have profited immensely from working on random walks with Frank Spitzer. The years when he was alive and we were colleagues at Cornell were some of the most exciting and inspiring of my career. It was under Frank's influence that I started my investigations of properties which hold for general random walks on the real line without any moment conditions.

The many contributions of Mark Kac to statistical physics, as well as the work of Frank Spitzer on interacting particle systems and the questions which Mark and Frank raised, attracted me to problems related to statistical mechanics. This led me to work on self-avoiding walks, percolation and first-passage percolation and diffusion-limited aggregation. The beautiful conjectures of physicists in such areas are a rich source of important research problems. I found it somewhat disconcerting to be almost always far behind the physicists. What a mathematician can prove rarely surprises a physicist anymore. Nevertheless, I greatly enjoyed working on such models and only hope that I can continue to work on them for a while longer.

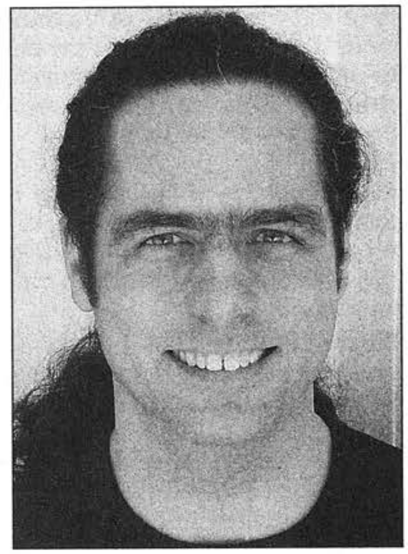
2001 Veblen Prize



Jeff Cheeger



Yakov Eliashberg



Michael J. Hopkins

Oswald Veblen (1880–1960), who served as president of the AMS in 1923 and 1924, was well known for his work in geometry and topology. In 1961 the trustees of the Society established a fund in memory of Veblen, contributed originally by former students and colleagues and later doubled by his widow. Since 1964 the fund has been used for the award of the Oswald Veblen Prize in Geometry. Subsequent awards were made at five-year intervals. The current amount of the prize is \$4,000 (in case of multiple recipients, the amount is divided equally).

At the Joint Mathematics Meetings in New Orleans in January 2001, the 2001 Veblen Prize was presented to JEFF CHEEGER, YAKOV ELIASHBERG, and MICHAEL J. HOPKINS.

Previous recipients of the Veblen Prize are: Christos D. Papakyriakopolous and Raoul H. Bott (1964); Stephen Smale, Morton Brown, and Barry Mazur (1966); Robion C. Kirby and Dennis P. Sullivan (1971); William P. Thurston and James Simons (1976); Mikhael Gromov and Shing-Tung Yau (1981); Michael H. Freedman (1986); Andrew Casson and Clifford H. Taubes (1991); and Richard Hamilton and Gang Tian (1996).

The Veblen Prize is awarded by the AMS Council, acting through a selection committee whose members at the time of this award were Mikhael Gromov (chair), Richard S. Hamilton, Robion C. Kirby, and Gang Tian. The text that follows contains, for each of the three prize recipients, the prize citation, a biographical sketch, and the response of the recipient upon receiving the prize.

Jeff Cheeger

Citation

The 2001 Veblen Prize in Geometry is awarded to Jeff Cheeger for his work in differential geometry. In particular the prize is awarded for:

1. His works on the space of Riemannian metrics with Ricci curvature bounded from below, such as his rigidity theorems for manifolds of nonnegative Ricci curvature and his joint efforts with Colding on the structure of the space of metrics with Ricci curvature bounded from below. These works led to the resolution of various conjectures in Riemannian geometry and provided significant understanding of how singularities form in the degeneration of Einstein metrics on Riemannian manifolds.

J. Cheeger and T. H. Colding, "Lower bounds on the Ricci curvature and the almost rigidity of warped products", *Ann. of Math.* **144** (1996), 189–237.

J. Cheeger and T. H. Colding, "On the structure of spaces with Ricci curvature bounded below. I", *J. Differential Geom.* **45** (1997), 1–75.

2. His works on eta invariants and index theory, e.g.,

J. M. Bismut and J. Cheeger, "The index theorem for families of Dirac operators on manifolds with boundary; superconnections and cones; I, II", *J. Funct. Anal.* **89**, no. 2 (1990), 313–363; and **90**, no. 2 (1990), 306–354.

Biographical Sketch

Jeff Cheeger was born on December 1, 1943, in Brooklyn, New York. He graduated from Harvard University in 1964 and received his Ph.D. from Princeton University in 1967. After one-year stays at the University of California, Berkeley, and the University of Michigan, he joined the mathematics department at the State University of New York, Stony Brook. Since 1989 he has been a member of the Courant Institute of Mathematical Sciences, New York University.

Cheeger has been the recipient of National Science Foundation Postdoctoral, Sloan, and Guggenheim Fellowships, as well as of a Max Planck Research Award from the Alexander von Humboldt Society. He gave the Marston Morse Lectures at the Institute for Advanced Study in Princeton in 1992, and 45-minute invited addresses at the International Congress of Mathematicians in 1974 and in 1986. He is a member of the National Academy of Sciences and a foreign member of the Finnish Academy of Science and Letters.

Response

I am very honored to be named, along with Yasha Eliashberg and Michael Hopkins, as a recipient of the Veblen Prize. It is especially gratifying to be recognized for work on subjects that have been central to my research throughout my career. My work on these subjects includes joint efforts with a number of wonderful collaborators: Mike Anderson, Jean-Michel Bismut, Toby Colding, and Detlef Gromoll.

A unifying theme is the key role played by spaces possessing a simple canonical geometric structure, spaces which split off lines as isometric factors and metric cones.

Rigidity theorems for Ricci curvature assert that geometric conditions that cannot be realized if the Ricci curvature has a particular strict lower bound are realized only in the presence of special structure if "strict" is relaxed to "weak". In almost rigidity theorems both the hypotheses and conclusions hold up to a specified error. If the Ricci curvature has a definite lower bound, then on a small but definite scale, after rescaling, the hypotheses of certain almost rigidity theorems for nonnegative Ricci curvature—the splitting theorem and volume cone imply the metric cone theorem—are satisfied "generically". So these theorems govern the small-scale structure of such manifolds and, in limiting cases, the structure of the singular set.

Gromoll and I proved the splitting theorem for nonnegative Ricci curvature in 1970. Colding's and my almost rigid version took another twenty-five years. Precursors of our work include Bochner's formula (1946), Toponogov's splitting theorem for nonnegative sectional curvature (1959), Bishop's inequality (1963), Cheng-Yau's gradient estimate (1975), Gromov's compactness theorem for the Gromov-Hausdorff distance (1981), Anderson's convergence theorems (1989), Abresch-Gromoll's inequality (1990), and the new techniques introduced by Colding (1994) in proving conjectures of Anderson's and mine.

A point that came up in my study of analytic torsion suggested that one could do index theory L_2-cohomology on singular spaces (circa 1975). The most basic case was that in which a metric cone was attached to the boundary of a manifold with boundary. The resulting index formula for the signature operator was identical to that of Atiyah-Patodi-Singer, but rather than being associated to the boundary, the η-invariant term arose from the singularity. Much later this turned out to be of technical importance in Bismut's and my proof of the families index theorem for manifolds with boundary. There the Bismut superconnection was also crucial.

I want to express my gratitude to my father, Thomas Cheeger, who first aroused my passion for mathematics; to my teachers, Salomon Bochner, Raoul Bott, Jim Simons, and Shlomo Sternberg; to S. S. Chern and Is Singer; and to my collaborators. All have helped me immeasurably.

Yakov Eliashberg

Citation

The 2001 Veblen Prize in Geometry is awarded to Yakov Eliashberg for his work in symplectic and contact topology. In particular the prize is awarded for:

1. His proof of the symplectic rigidity, presented in his ICM talk:

"Combinatorial methods in symplectic geometry", *Proceedings of the International Congress of Mathematicians*, Vols. 1, 2 (Berkeley, California, 1986), Amer. Math. Soc., Providence, RI, 1987, pp. 531–539.

2. The development of 3-dimensional contact topology, presented in the papers:

"Classification of overtwisted contact structures on 3-manifolds", *Invent. Math.* **98**, no. 3 (1989), 623–637; and "Invariants in contact topology", *Proceedings of the International Congress of Mathematicians*, Vol. II (Berlin, 1998).

Biographical Sketch

Yakov Eliashberg was born in December 1946 in Leningrad, USSR. He received his Ph.D. from Leningrad University in 1972 under the direction of V. A. Rokhlin. From 1972 to 1979 he taught at the Syktyvkar University of Komi Republic of Russia and from 1980 to 1987 worked in industry as the head of a computer software group. In 1988 Eliashberg moved to the United States, and since 1989 he has been a professor of mathematics at Stanford University. Eliashberg received the Leningrad Mathematical Society Prize in 1972. In 1986 and in 1998 he was an invited speaker at the

International Congress of Mathematicians. He delivered the Porter Lectures at Rice University (1992), the Rademacher Lectures at the University of Pennsylvania (1996), the Marston Morse Lectures at the Institute for Advanced Study (1996), the Frontiers in Mathematics Lectures at Texas A&M University (1997), and the Marker Lectures at Pennsylvania State University (2000). In 1995 Eliashberg was a recipient of the Guggenheim Fellowship.

Response

I am greatly honored to be a corecipient of the Oswald Veblen Prize of the AMS along with such outstanding mathematicians as Jeff Cheeger and Mike Hopkins. Symplectic geometry and topology has flourished during the last two decades, and I am happy that I was able to contribute to its success. I want first to thank my wife, Ada, for her lifelong support. I am also grateful to N. M. Mitrofanova, who converted me to mathematics from music when I was in school, and to Professor V. A. Rokhlin, who shared with me his topological insights when I was a student in Leningrad University. I was greatly influenced by my friend and colleague Misha Gromov. From him I learned about symplectic structures; then I struggled to find a balance between the apparent flexibility and hidden rigidity of the symplectic world. I am grateful to Misha for sharing his vision with me. My gratitude also goes to V. I. Arnold for many stimulating and critical discussions, and to D. B. Fuchs, who invested a lot of time to help me clarify the proof of my first result in symplectic geometry, the Arnold conjecture for surfaces. I owe a lot to all my coauthors: R. Brooks, M. Fraser, A. Givental, M. Gromov, H. Hofer, C. McMullen, N. M. Mishachev, L. Polterovich, T. Ratiu, D. Salamon, and W. P. Thurston. Finally, I thank my colleagues and students at the Stanford mathematics department for creating a stimulating environment for geometric research.

Michael J. Hopkins

Citation

The 2001 Veblen Prize in Geometry is awarded to Michael J. Hopkins for his work in homotopy theory. In particular the prize is awarded for:

1. His work on nilpotence and periodicity, beginning with his work with coauthors Ethan Devinatz and Jeff Smith, "Nilpotence and stable homotopy theory, I and II", *Ann. of Math.* **128** (1988), 207–241; and **148** (1998), 1–49.

2. His work on rigid analytic geometry and its application to homotopy theory, represented in his papers with Dick Gross, "Equivariant vector bundles on the Lubin-Tate moduli space", *Contemp. Math.* **158** (1994), 23–88; and "The rigid analytic period mapping, Lubin-Tate space, and stable homotopy theory", *Bull. Amer. Math. Soc. (N.S.)* **30** (1994), 76–86.

3. His work on elliptic spectra, represented in part in the paper with Matthew Ando and Neil Strickland, "Elliptic spectra, the Witten genus, and the theorem of the cube".

Biographical Sketch

Michael Hopkins was born on April 18, 1958, in Alexandria, Virginia. He received his Ph.D. from Northwestern University in 1984 under the direction of Mark Mahowald. In 1984 he also received his D.Phil. from the University of Oxford under the supervision of Ioan James.

Hopkins has held the position of professor of mathematics at the Massachusetts Institute of Technology since 1990 after a few years of teaching at Princeton University, a one-year position with the University of Chicago, and a visiting lecturer position at Lehigh University. He gave invited addresses at the 1990 Winter Meeting of the American Mathematical Society in Louisville, Kentucky, and at the the 1994 International Congress of Mathematicians in Zurich. He presented the 1994 Everett Pitcher Lectures at Lehigh University, the 2000 Namboodiri Lectures at the University of Chicago, and the 2000 Marston Morse Memorial Lectures at the Institute for Advanced Study, Princeton. At the 2001 Joint Mathematics Meetings, where he received the Veblen Prize, he presented an AMS Invited Address. Hopkins received postdoctoral fellowships from the National Science Foundation and the Sloan Foundation, a Rhodes Scholarship, and a Presidential Young Investigator award.

Response

It is a great pleasure to receive the Oswald Veblen Prize for my work in homotopy theory. The mathematical world would be very different had it not been for the efforts of Oswald Veblen, and I feel both humbled and honored to be given the prize that bears his name.

One of the things that enchants me the most about mathematics is its capacity for sudden and profound transformations of context. I have been lucky to take part in this many times. Homotopy theory meets geometry in both its geometric and function theoretic aspects, cannily straddling our most fundamental metaphor. It has taken me on a remarkable journey, and I am excited by the prospects for its future.

I am indebted to many teachers, friends, and collaborators, but I would especially like to thank Mark Mahowald, Ib Madsen, and Is Singer for all that they have given me. I would also like to thank the selection committee. It is an honor to receive this award and to share it with Jeff Cheeger and Yakov Eliashberg, both of whom have my admiration.

2001 Satter Prize

The Ruth Lyttle Satter Prize was established in 1990 using funds donated by Joan S. Birman in memory of her sister, Ruth Lyttle Satter. Professor Satter earned a bachelor's degree in mathematics and then joined the research staff at AT&T Bell Laboratories during World War II. After raising a family she received a Ph.D. in botany at the age of forty-three from the University of Connecticut at Storrs, where she later became a faculty member. Her research on the biological clocks in plants earned her recognition in the U.S. and abroad. Birman requested that the prize be established to honor her sister's commitment to research and to encouraging women in science. The prize is awarded every two years to recognize an outstanding contribution to mathematics research by a woman in the previous five years. The current amount of the prize is $1,200 (in case of multiple recipients, the amount is divided equally).

At the 107th Annual Meeting of the AMS in January 2001 in New Orleans, the 2001 Satter Prize was awarded to KAREN E. SMITH and SIJUE WU.

Previous recipients of the Satter Prize are: Dusa McDuff (1991), Lai-Sang Young (1993), Sun-Yung Alice Chang (1995), Ingrid Daubechies (1997), and Bernadette Perrin-Riou (1999).

The prize was awarded by the AMS Council on the recommendation of a selection committee consisting of Alexandra Bellow, Sun-Yung Alice Chang, and Bhama Srinivasan. The text that follows contains the committee's prize citations, brief biographical sketches of the prize winners, and responses from them upon receiving the prize.

Karen E. Smith photo ©U-M Photo Services, Martin Vloet.

Karen E. Smith

Sijue Wu

Karen E. Smith

Citation

The Ruth Lyttle Satter Prize in Mathematics is awarded to Karen E. Smith of the University of Michigan for her outstanding work in commutative algebra, which has established her as a world leader in the study of tight closure, an important tool in the subject introduced by Hochster and Huneke. It is also awarded for her more recent work, which builds new bridges between commutative algebra and algebraic geometry via the concept of tight closure. In particular, the prize is awarded for her papers (1) "Tight closure of parameter ideals", *Invent. Math.* **115** (1994), 41–60; (2) "F-rational rings have rational singularities", *Amer. J. Math.* **119** (1997), 159–180; and (3) (with Gennady Lyubeznik) "Weak and strong F-regularity are equivalent in graded rings", *Amer. J. Math.* **121** (1999), 1279–1290.

Biographical Sketch

Karen E. Smith was born in Red Bank, New Jersey, near the Jersey shore. Although she always loved mathematics and wanted to be a mathematician from a young age, she did not realize that one could have a career as a mathematician until college, when her freshman calculus teacher, Charles Fefferman, suggested it. She graduated from Princeton University in 1987 with a major in mathematics and certification to teach high school mathematics in New Jersey public schools. After teaching high school mathematics for a year, she looked into the possibilities of graduate school and learned that one could actually get full support to work on a Ph.D. At this point she decided to make a big change, and went off to the Midwest for graduate school.

At the University of Michigan, Smith wrote a thesis in commutative algebra under the direction of Melvin Hochster, finishing in 1993. After spending one year working with Craig Huneke at Purdue University on a National Science Foundation postdoctoral fellowship, she became a Moore Instructor at the Massachusetts Institute of Technology. Although she enjoyed Boston and was promoted to assistant professor at MIT, she and her husband moved back to Ann Arbor in 1997, where they had met nine years earlier. Smith is now teaching and doing research in algebraic geometry and commutative algebra at the University of Michigan. She has a three-year-old daughter, Sanelma, with whom she very much enjoys discussing mathematics.

Response

It is a great honor to be awarded the Ruth Lyttle Satter Prize, and it is truly encouraging to be recognized in this way. I would like to use this opportunity to publicly thank the many teachers, mentors, and collaborators who have guided and inspired me. In particular, my former advisor, Mel Hochster, first introduced me to tight closure and encouraged me; his influence on the cited papers above is strong. In fact, Mel Hochster has encouraged many women in mathematics to succeed at the very highest level and has supervised many female graduate students and postdocs who have gone on to become highly visible researchers in commutative algebra. Special thanks are also due to my coauthor, Gennady Lyubeznik, with whom it has been a pleasure to work on the above-cited paper.

I am also grateful to the AMS and to the prize committee for selecting me from among the many deserving researchers who were considered, and to Professor Joan Birman for her generosity and vision in supporting a prize that recognizes women mathematicians. My congratulations also to Professor Sijue Wu, with whom I am happy to share this honor.

Sijue Wu

Citation

The Ruth Lyttle Satter Prize in Mathematics is awarded to Sijue Wu for her work on a long-standing problem in the water wave equation, in particular for the results in her papers (1) "Well-posedness in Sobolev spaces of the full water wave problem in 2-D", *Invent. Math.* **130** (1997), 39–72; and (2) "Well-posedness in Sobolev spaces of the full water wave problem in 3-D", *J. Amer. Math. Soc.* **12,** no. 2 (1999), 445–495. By applying tools from harmonic analysis (singular integrals and Clifford algebra), she proves that the Taylor sign condition always holds and that there exists a unique solution to the water wave equations for a finite time interval when the initial wave profile is a Jordan surface.

Biographical Sketch

Sijue Wu was born on May 15, 1964, in China. She received her B.S. (1983) and M.S. (1986) from Beijing University, Beijing, China, and her Ph.D. (1990) from Yale University. Since then she has held the following positions: Courant Instructor at Courant Institute, New York University (2 years); assistant professor at Northwestern University (4 years); and assistant, then associate professor at the University of Iowa (2 years). She was also a member at the Institute for Advanced Study in the fall of 1992 and during the year 1996–97. She has been an associate professor at the University of Maryland, College Park, since 1998.

Response

It is a great honor for me to receive the Satter Prize. I am very happy about this and very happy to share this prize with Professor Karen E. Smith. I would like to thank the AMS and the selection committee for awarding this prize to me. I am very grateful to my teachers, friends, and colleagues, especially Ronald R. Coifman for his constant support and Lihe Wang for his friendship and his help.

2000 Morgan Prize

Today undergraduate students are working on problems of current research interest, proving theorems, writing up results for publication, and giving talks on their work. There is undergraduate research at the highest level of professional excellence.

The AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student recognizes and encourages high-caliber mathematical research by undergraduate students. Sponsored by the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics, the prize was endowed by Mrs. Frank Morgan and carries the name of her late husband.

At the Joint Mathematics Meetings in New Orleans in January 2001, the 2000 Morgan Prize was awarded to Jacob Lurie. Wai Ling Yee received an Honorable Mention.

The prize selection committee consisted of George E. Andrews, Kelly J. Black, Robert O. Robson (chair), Martha J. Siegel, and Robert Strichartz.

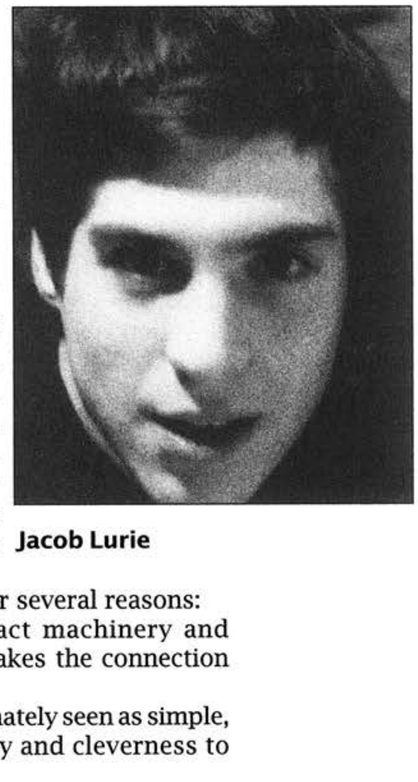
The following text contains the committee's citation, a brief biographical sketch of Jacob Lurie, and his response upon receiving the award. The same information is presented for Wai Ling Yee.

Jacob Lurie

Citation

Jacob Lurie is cited for his paper "On simply laced Lie algebras and their miniscule representations", an original and penetrating work that may well become a standard reference in the subject, according to the nominating letter of Benedict Gross.

Simply laced Lie algebras include some of the classical families, but also some of the exceptional Lie algebras that are not as well understood. Lurie began with the problem of understanding a certain 27-dimensional representation of the exceptional Lie algebra E_6, in particular identifying explicitly the invariant cubic polynomial for the representation. After solving this problem, Lurie went on to build a coherent theory that contains and generalizes his solution. He constructs the Lie algebra, its miniscule representations (those whose weight vectors lie in a single orbit of the Weyl group), and natural multilinear maps between miniscule representations, working over the integers, all using initial data consisting of a double cover of the root lattice of the Lie algebra. He further applies his constructions to the exceptional Lie algebra E_7 and its 56-dimensional representations, giving an explicit expression for its invariant quartic polynomial.



Jacob Lurie

This work is impressive for several reasons:

- It involves both abstract machinery and concrete examples, and it makes the connection between them.
- It uses ideas that are ultimately seen as simple, but required great originality and cleverness to discover and implement.
- It makes an important contribution to an area of active interest.
- It was independent work conceived and carried out by the author.

For any mathematician this would be an outstanding work. For an undergraduate it is truly exceptional.

Biographical Sketch

Jacob Lurie is a first-year graduate student at Princeton University. His primary mathematical interests are algebraic geometry, representation theory, and mathematical logic.

Response

I would like to thank Dick Gross and Joe Harris for all the help they have given me with my thesis and throughout my (undergraduate) time at Harvard.

Honorable Mention: Wai Ling Yee

Citation

The members of the 2000 Morgan Prize committee are pleased to award Wai Ling Yee with an Honorable Mention. Ms. Yee's application focused on her extension of the theory developed by D. Ragozin on the properties of the convolution on compact Lie groups of continuous measures that are invariant under conjugations (central measures). Ragozin showed that a convolution product of sufficiently many such measures yields an absolutely continuous measure. Ms. Yee improved the result, showing that absolutely continuous measure can be made to have an L^2 density function, and she gave sharp estimates for the minimum number of factors required, depending on the particular group. Her work was based on precise pointwise estimates on the characters of the groups, which in itself is an important contribution.

Ms. Yee is a student at the University of Waterloo, and her work is the result of a summer research program with her advisor. As part of her research program she first had to familiarize herself with and understand the basic theory of Lie algebras and representation theory. Not only was she able to master the necessary material but was able to simplify an earlier result of her advisor as well as extend those results to all classical Lie algebras. Ms. Yee's joint work with Kathryn Hare, her advisor, and David Wilson has been accepted for publication in the *Journal of the Australian Mathematics Society*, and a second paper on their work has been submitted to *Studia Mathematica*.

The 2000 Morgan Prize committee recognizes that Wai Ling Yee is not only an outstanding undergraduate student but has also contributed to the profession. It is our great pleasure to name Ms. Yee as this year's Honorable Mention.

Biographical Sketch

Wai Ling Yee is presently a first-year graduate student at the Massachusetts Institute of Technology. Her primary mathematical interests are analysis and representation theory.

Response

It is a remarkable honor to be awarded Honorable Mention for the 2000 Morgan Prize. I am indebted to the Natural Sciences and Engineering Research Council of Canada and the faculty of mathematics of the University of Waterloo for providing opportunities to work as an undergraduate research assistant. I am also very grateful to the many people, especially Professors Davidson, Forrest, Hare, and Nica of the University of Waterloo's analysis research group, who supported me in my endeavors. In particular, I would like to thank my advisor, Professor Kathryn Hare, who deserves the highest praise for her dedication, encouragement, and guidance.

2001 Frank and Brennie Morgan AMS-MAA-SIAM Prize for Outstanding Research in Mathematics by an Undergraduate Student

The prize is awarded each year to an undergraduate student (or students having submitted joint work) for outstanding research in mathematics. Any student who is an undergraduate in a college or university in the United States or its possessions, or Canada or Mexico, is eligible to be considered for this prize.

The prize recipient's research need not be confined to a single paper; it may be contained in several papers. However, the paper (or papers) to be considered for the prize must be submitted while the student is an undergraduate; they cannot be submitted after the student's graduation. The research paper (or papers) may be submitted for consideration by the student or a nominator. All submissions for the prize must include at least one letter of support from a person, usually a faculty member, familiar with the student's research. Publication of research is not required.

The recipients of the prize are to be selected by a standing joint committee of the AMS, MAA, and SIAM. The decisions of this committee are final. The 2001 prize will be awarded for papers submitted for consideration no later than **June 30, 2001,** by (or on behalf of) students who were undergraduates in December 2000.

Nominations and submissions should be sent to:

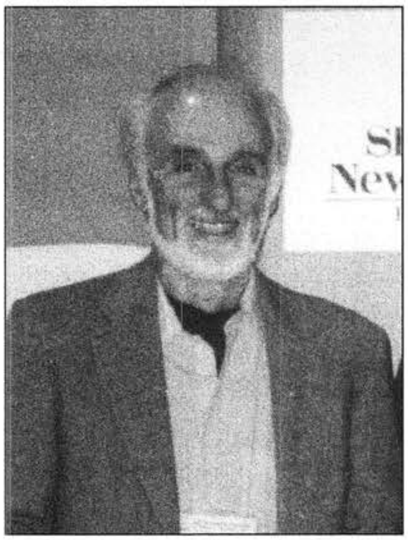
Morgan Prize Committee
c/o Robert J. Daverman, Secretary
American Mathematical Society
Department of Mathematics
University of Tennessee
Knoxville, TN 37996-1330

Questions may be directed to the chairperson of the Morgan Prize Committee:

Dr. Martha J. Siegel, Chair
Department of Mathematics
Towson University
Towson, MD 21252-0001
telephone: 410-704-4379
e-mail: siegel@towson.edu

AMERICAN MATHEMATICAL SOCIETY

2001 Whiteman Prize



Thomas Hawkins

The Albert Leon Whiteman Prize was established in 1998 using funds donated by Mrs. Sally Whiteman, in memory of her husband, the late Albert Leon Whiteman. Mrs. Whiteman requested that the prize be established for notable exposition on the history of mathematics. The ideas expressed and the new understandings embodied in the exposition recognized by the Whiteman Prize should reflect exceptional mathematical scholarship. The $4,000 prize is awarded every four years.

The first Whiteman Prize was awarded at the Joint Mathematics Meetings in New Orleans in January 2001 to Thomas Hawkins.

The Whiteman Prize is awarded by the AMS Council acting through a selection committee whose members at the time of this award were Joseph W. Dauben, Jeremy J. Gray (chair), and Karen Hunger Parshall. The text that follows contains the committee's citation, a biographical sketch, and a response from Thomas Hawkins upon receiving the prize.

Citation

In awarding the first Albert Leon Whiteman Prize to Thomas Hawkins, professor of mathematics at Boston University, the American Mathematical Society recognizes an outstanding historian of mathematics whose current research and numerous publications display the highest standards of mathematical and historical sophistication.

Hawkins began his career in the history of mathematics with the publication of a groundbreaking book on *Lebesgue's Theory of Integration: Its Origins and Development* (Madison and London: University of Wisconsin Press, 1970). Now a recognized classic in the field, this work, like all of Hawkins's subsequent research, is characterized by its historical depth and mathematical perceptiveness.

After 1970, however, Hawkins gradually shifted his research from the history of nineteenth- and early twentieth-century analysis to the development of group representation theory and Lie groups. This new line of inquiry began with papers on the representation theory of finite groups, which culminated with the paper "New light on Frobenius' creation of the theory of group characters" (1974). By that time this work had led to research on the history of matrix theory, as can be seen from the first of his presentations to an International Congress of Mathematicians (ICM) in 1974. In Vancouver he discussed the theory of matrices in the nineteenth century and showed that more is owed to Weierstrass, and less to Cayley, than then-standard texts would have it. This insight led him, via his paper "Wilhelm Killing and the structure of Lie algebras" (1982), to investigate the tangled history of the theory of linear representations of semi-simple Lie groups, the subject of his second ICM address at Berkeley in 1986. Since then he has written extensively on the history of Lie groups. In particular, he has traced their origins to work in the 1870s on differential equations and contact transformations in which Lie applied both Poisson brackets and the Jacobi identity to study the integration of partial differential equations. In "Jacobi and the birth of Lie's theory of groups" (1991), Hawkins argued convincingly that the *idée fixe* guiding Lie's work was the development of a Galois theory of differential equations. Another paper, "Hesse's principle of transfer and the representation of Lie algebras" (1988), found the roots of Élie

Cartan's 1913 paper on the construction of all irreducible representations of a complex semisimple Lie algebra in nineteenth-century algebra and geometry. Hawkins has also studied Killing's work in detail, debunking, in particular, the inflated claims as to the influence of Klein's Erlanger Program at the time of its appearance. In drawing his historical conclusions, Hawkins has relied not only on the published mathematical record but also on collections of letters and other archival sources. His reading of these varied sources has, moreover, been guided by a sure sense of the mathematical connections involved, even when, as has often been the case, these have been lost and forgotten as a result of the subsequent growth of the subject.

All of this work has culminated most fruitfully in the publication of his long-awaited book *The Emergence of the Theory of Lie Groups: An Essay in the History of Mathematics 1869–1926* (New York: Springer-Verlag, 2000). This study treats in great depth the work of Sophus Lie, Wilhelm Killing, Élie Cartan, and Hermann Weyl as it highlights the fascinating interaction of geometry, analysis, mathematical physics, algebra, and topology in the late nineteenth and early twentieth centuries. It displays to the full Hawkins's deeply held belief that mathematical understanding grows when the underlying motivations and the original, informal, intuitive conceptions are uncovered and illuminated. It also interweaves the critical human dimension into the story through extensive quotation of the mathematicians' private correspondence.

Hawkins's many contributions to the history of mathematics have already won him much deserved recognition. In addition to twice addressing the International Congress of Mathematicians, he received the Chauvenet Prize for mathematical exposition from the Mathematical Association of America in 1997. In presenting the first Albert Leon Whiteman Memorial Prize to Thomas Hawkins, we acknowledge a body of scholarship characterized by breadth and coherence, clarity and sensitivity to historical detail, and depth of insight. Hawkins's work has truly transformed our understanding of how modern mathematics has evolved.

Biographical Sketch

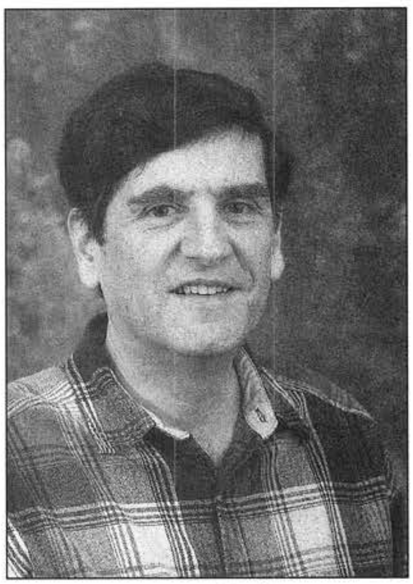
Thomas Hawkins received a Ph.D. degree with a joint concentration in mathematics and history of science from the University of Wisconsin-Madison in 1968. After passing the Ph.D. qualifying examinations of both departments, he wrote a dissertation on the origins of the theory of Lebesgue integration, which was published as a book in 1970. After a few years teaching at Swarthmore College, he accepted a position in the mathematics department at Boston University, where he has remained. Over the years his work on the history of mathematics has been supported by both historical and mathematical institutions. With the financial support of the American Council of Learned Societies, he spent 1969–70 as a guest of the Forschungsinstitut für Mathematik at the Eidgenössische Technische Hochschule (ETH) in Zürich. During 1980–81 he was a visiting scholar in the Department of History of Science at Harvard University, with financial support provided by the National Science Foundation program in history and philosophy of science. The School of Mathematics of the Institute for Advanced Study in Princeton provided him with support as a visiting member during 1988–89, and the Dibner Institute for History of Science and Technology at the Massachusetts Institute of Technology did the same during 1996–97, when most of his book on the history of Lie groups was written. In 1997 he was awarded the Chauvenet Prize of the Mathematical Association of America for his paper "The birth of Lie's theory of groups" (*Math. Intelligencer* **16** (1994), no. 2, 6–17).

Response

As one who has been researching the history of mathematics for more than thirty years, it is a great honor for me to become the first recipient of the Whiteman Prize. The creation of this prize is particularly meaningful to me as a further manifestation of the importance the AMS attaches to the historical study of mathematics.

Thirty-five years ago, however, when I committed myself to a career in history of mathematics, there was in this country no such recognition of historical work by professional mathematical societies. In deciding to pursue a career in this area, I realized I was facing the prospect of a lonely and not quite respectable existence within the community of mathematicians, the professional group to which I felt the closest affinity. I am happy to report that my dire expectations proved to be unfounded. After leaving Wisconsin I was encouraged by the growing interest a number of distinguished mathematics departments showed in my work through their unsolicited invitations to speak about it. Among the many such departments, I want to mention in particular those at the University of Chicago and Yale University, where I have been invited back many times to talk about my latest discoveries. In addition, over the years many first-rate mathematicians have respectfully encouraged me in my work or have assisted me by reading over preliminary drafts of papers and by sharing their expertise, thereby helping me to avoid countless pitfalls as well as to explore connections I would have otherwise missed. To all the mathematicians who in one or more of the above-mentioned ways have supported and assisted my work, I hereby extend my heartfelt thanks.

2001 Conant Prize



Carl Pomerance

The Levi L. Conant Prize recognizes 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 at Worcester Polytechnic Institute. His will provided for funds to be donated to the AMS upon his wife's death. When she passed away in 1976, the AMS received $9,500, which it used to establish the Levi L. Conant Fund. Income from the fund was used to supplement other AMS prizes. Because the fund has grown substantially over the years, the Society has decided to use it to establish a new prize in Conant's honor. At its meeting in January 2000 the AMS Council approved the establishment of the prize. The current amount of the prize is $1,000.

At the Joint Mathematics Meetings in New Orleans in January 2001, the 2001 Conant Prize was awarded to Carl Pomerance.

The Conant Prize is awarded by the AMS Council, acting through a selection committee whose members at the time of this award were Brian J. Parshall, Anthony V. Phillips (chair), and Joseph H. Silverman. The text that follows contains the committee's citation, a brief biographical sketch, and a response from Carl Pomerance upon receiving the prize.

Citation

The Levi L. Conant Award in 2001 is granted to Carl Pomerance of Bell Laboratories for his paper "A Tale of Two Sieves", *Notices of the AMS* **43**, no. 12 (1996), 1473–1485. The paper gives an elegant and attractive introduction to factorization methods in modern number theory, starting from elementary examples and leading to the state-of-the-art method, the number field sieve, used at the time of writing to crack a 130-digit RSA challenge number.

This paper is remarkable among expository papers for the care with which Pomerance motivates and explains each step forward in his argument. He begins with a personal anecdote, describing a problem he faced in a high school competition. He missed the problem, but it sparked his interest in algorithms for factoring. This episode gives an engaging lead-in to what in less careful hands could be a very dry topic. He continues the human side of the story in describing the interplay between the "pure" teams working on the theory of factoring and the "applied" interests who were more motivated toward actual factorizations. The pace and explicitness of his explanations are also effective in keeping the nonexpert reader engaged and satisfied. He is never afraid to take a small numerical example: "Say we try this with $p = 7$" occurs in the thick of his description of the number field algorithm, well toward the end of the article.

Carl Pomerance's paper on "The Tale of Two Sieves", with its witty first sentence ("It is the best of times for the game of factoring large numbers into their prime factors"), can be held up as a standard for good expository writing in mathematics. It has charm, it has substantial and important content, and every line is written with the nonexpert reader in mind.

Biographical Sketch

Carl Pomerance was born in Joplin, Missouri, in 1944. He received his B.A. from Brown University in 1966 and his Ph.D. from Harvard University in 1972 under the direction of John Tate. During the period 1972–99 he was a professor at the University of Georgia, with visiting positions at the University of Illinois at Urbana-Champaign, the University of Limoges, Bell Communications Research, and the Institute for Advanced Study. Currently, he is a member of the technical staff at Bell Laboratories and a research professor emeritus at the University of Georgia.

A number theorist, Pomerance specializes in analytic, combinatorial, and computational number theory. He considers the late Paul Erdős as his greatest influence.

Pomerance was an invited speaker at the 1994 International Congress of Mathematicians, the Mathematical Association of America Pólya Lecturer in 1993–95, and the Hedrick Lecturer in 1999. He has been honored by the MAA with the Chauvenet Prize (1985) and the Haimo Award for Distinguished Teaching (1997).

Response

I am thrilled and honored to be the first recipient of the Levi L. Conant Award. Writing does not always come easily to me, but "A Tale of Two Sieves" was a labor of love. The paper grew out of a talk I gave at Lehigh University in 1996, and I thank the Lehigh mathematics department for suggesting I write an expository article based on the lecture. The *Notices* editorial staff were very supportive. In particular, I thank Susan Landau for urging me to submit the article to the *Notices* and for her constructive critique, and Hugo Rossi for his likewise constructive critique and for his suggestion of the cover artwork theme. It is amusing to me, rereading the article now, that I predicted my book with Richard Crandall (which was suggested for further reading) would be published in 1997. It is just a little late; it will be published early this year, I promise.