2004 Steele Prizes

The 2004 Leroy P. Steele Prizes were awarded at the 110th Annual Meeting of the AMS in Phoenix in January 2004.

The Steele Prizes were established in 1970 in honor of George David Birkhoff, William Fogg Osgood, and William Caspar Graustein. Osgood was president of the AMS during 1905–06, and Birkhoff served in that capacity during 1925–26. The prizes are endowed under the terms of a bequest from Leroy P. Steele. Up to three prizes are awarded each year in the following categories: (1) Lifetime Achievement: for the cumulative influence of the total mathematical work of the recipient, high level of research over a period of time, particular influence on the development of a field, and influence on mathematics through Ph.D. students; (2) Mathematical Exposition: for a book or substantial survey or expository-research paper; (3) Seminal Contribution to Research (limited for 2004 to analysis): for a paper, whether recent or not, that has proved to be of fundamental or lasting importance in its field or a model of important research. Each Steele Prize carries a cash award of $5,000.

The Steele Prizes are awarded by the AMS Council acting on the recommendation of a selection committee. For the 2004 prizes the members of the selection committee were: M. Salah Baouendi, Andreas R. Blass, Sun-Yung Alice Chang, Michael G. Crandall (chair), Craig L. Huneke, Daniel J. Kleitman, Tsit-Yuen Lam, Robert D. MacPherson, and Lou P. Van den Dries.

The list of previous recipients of the Steele Prize may be found in the November 2003 issue of the *Notices*, pages 1294–8, or on the World Wide Web, `http://www.ams.org/prizes-awards`.

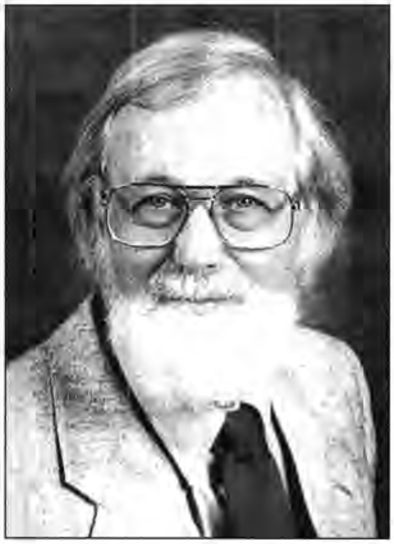
The 2004 Steele Prizes were awarded to John W. Milnor for Mathematical Exposition, to Lawrence C. Evans and Nicolai V. Krylov for a Seminal Contribution to Research, and to Cathleen Synge Morawetz for Lifetime Achievement. The text that follows presents, for each awardee, the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Mathematical Exposition: John W. Milnor

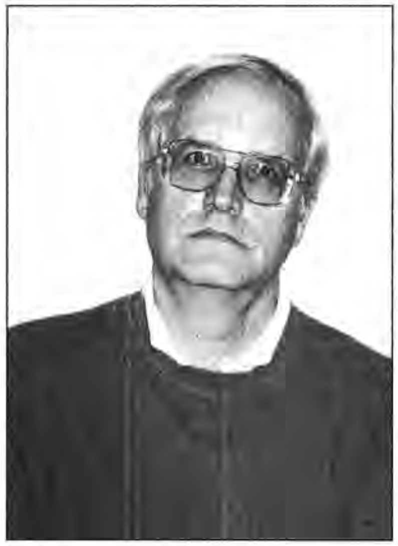
Citation

The Leroy P. Steele Prize for Mathematical Exposition is awarded to John W. Milnor in recognition of a lifetime of expository contributions ranging across a wide spectrum of disciplines including topology, symmetric bilinear forms, characteristic classes, Morse theory, game theory, algebraic K-theory, iterated rational maps...and the list goes on. The phrase "sublime elegance" is rarely associated with mathematical exposition, but it applies to all of Milnor's writings, whether they be research or expository. Reading his books, one is struck with the ease with which the subject is unfolding, and it only becomes apparent after reflection that this ease is the mark of a master. Improvement of Milnor's treatments often seems impossible.

A portion of Kauffman's review of *Symmetric Bilinear Forms* by Milnor and Husemoller conveys the beauty evident in all of Milnor's expository work: "...Appendix 4, where this result is proved, is alone worth the price of the book. It contains Milnor's proof of a Gauss sum formula (due to R. J. Milgram) that uses elegant combinatorics and Fourier analysis to produce an argument whose



John W. Milnor



Lawrence C. Evans

Nicolai V. Krylov

corollaries include the divisibility theorem, the law of quadratic reciprocity and its equivalent in the language of forms over Z: the Weil reciprocity theorem. The proof is short, beautiful, and mysterious."

Milnor's many expository contributions to the mathematical literature have influenced more than one generation of mathematicians. Moreover, the examples that they provide have set a standard of clarity, elegance, and beauty for which every mathematician should strive.

Biographical Sketch

John Milnor was born in Orange, New Jersey, in 1931. He spent his undergraduate and graduate student years at Princeton, working on knot theory under the supervision of Ralph Fox, and also dabbling in game theory with his fellow students John Nash and Lloyd Shapley. However, like his mathematical grandfather, Solomon Lefschetz, he had great difficulty sticking to one subject. Under the inspiration of Norman Steenrod and later John Moore, he branched out into algebraic and differential topology. This led to problems in pure algebra, including algebraic K-theory and the study of quadratic forms. More recently, conversations with William Thurston and Adrien Douady led to studies in real and complex dynamical systems, which have occupied him for the last twenty years. But he is still restless: one current activity is an attempted exposition of problems of complexity in the life sciences.

After many years at Princeton at the university and also at the Institute for Advanced Study, and after shorter stays at the University of California, Los Angeles, and the Massachusetts Institute of Technology, Milnor moved to the State University of New York at Stony Brook, where he has been the director of the Institute for Mathematical Sciences since 1989.

Response

It is a great pleasure to receive this award, and I certainly want to thank the members of the Selection Committee for their consideration. It is of course also a tribute to my many coauthors: let me mention Dale Husemoller, Larry Siebenmann, Jonathan Sondow, Mike Spivak, Jim Stasheff, and Robert Wells.

I have always suspected that the key to the most interesting exposition is the choice of a subject that the author doesn't understand too well. I have the unfortunate difficulty that it is almost impossible for me to understand a complicated argument unless I try to write it down. Over the years I have run into a great many difficult bits of mathematics, and thus I keep finding myself writing things down. (And also rewriting, since I never get things right the first few times. Years ago, I was the despair of secretaries who would produce beautifully typed manuscripts, only to have them repeatedly cut, pasted, and scribbled over. Computers have eliminated this particular problem, but it still makes life difficult for coauthors.)

I am very happy to report that as mathematics keeps growing, there are more and more subjects that I have to fight to understand.

Seminal Contribution to Research: Lawrence C. Evans and Nicolai V. Krylov

Citation

The Steele Prize for Seminal Research is awarded to Lawrence C. Evans and Nicolai V. Krylov for the "Evans-Krylov theorem" as first established in the papers:

Lawrence C. Evans, "Classical solutions of fully nonlinear convex, second order elliptic equations", *Communications in Pure and Applied Mathematics* **35** (1982), no. 3, 333–363; and

N. V. Krylov, "Boundedly inhomogeneous elliptic and parabolic equations", *Izvestiya Akad. Nauk*

SSSR, ser. mat. **46** (1982), no. 3, 487–523; and translated in *Mathematics of the USSR, Izvestiya* **20** (1983), no. 3, 459–492.

Fully nonlinear elliptic equations are of interest in many subjects, including the theory of controlled diffusion processes and differential geometry. It is therefore of great interest to understand when these equations have classical solutions. The first results of any generality exhibiting classical solutions of the subclass of uniformly elliptic equations under suitable convexity conditions are due to the recipients in the cited works. These authors, independently and with different arguments, established the Hölder continuity of second derivatives in the interior, via a priori estimates, a result now known as the Evans-Krylov theorem. The Evans-Krylov theorem was both a capstone on fundamental contributions of the recipients and others and a harbinger of things to follow from the community.

While the Steele Prize for Seminal Research is explicitly awarded for the named works, it is noted that both recipients have made a variety of distinguished contributions to the theory of nonlinear partial differential equations.

Biographical Sketch: Lawrence C. Evans

Lawrence C. Evans was born November 1, 1949, in Atlanta, Georgia. He received his B.A. from Vanderbilt University in 1971 and his Ph.D. from the University of California, Los Angeles, in 1975; his advisor at UCLA was M. G. Crandall. Evans held positions at the University of Kentucky from 1975 to 1980, at the University of Maryland from 1980 to 1989, and is currently professor of mathematics at the University of California at Berkeley, a position he has held since 1989. He has been a visiting professor at Northwestern University (1977–78) and at the Institute for Advanced Study (1988). Noteworthy publications include *Weak Convergence Methods for Nonlinear Partial Differential Equations* (CBMS Regional Conference Series in Mathematics, volume 74, AMS, 1990), *Measure Theory and Fine Properties of Functions,* coauthored with R. F. Gariepy (Studies in Advanced Mathematics, CRC Press, 1992), and *Partial Differential Equations* (Graduate Studies in Mathematics, volume 19, AMS, 1998).

Response: Lawrence C. Evans

It is a wonderful honor to share with Nick Krylov this year's Steele Prize for a Seminal Contribution to Research. When I was Mike Crandall's graduate student at UCLA and at Wisconsin over thirty years ago, I learned from him the then startling lesson that nonlinear analysis need not be solely based upon linearization, meaning small perturbation theory from linear approximations. Brezis, Browder, Crandall, J.-L. Lions, and many others in the 1970s pioneered the analysis of various sorts of strongly nonlinear operators, a theory in which linearity played little role at all. I think this was why I was not especially afraid to look at so-called "fully nonlinear" elliptic equations in the late 1970s and early 1980s.

These are important PDEs, examples of which are the Monge-Ampère equation and Hamilton-Jacobi-Bellman equations in stochastic optimal control theory. And they are really, really nonlinear. But their solutions satisfy maximum principles, and this was a clue. It turns out that (i) when the nonlinearity is convex, we can get "one-sided" control on second derivatives; and that then (ii) the PDE itself provides a functional relationship among the various second derivatives, yielding thereby "two-sided" control. (Earlier Calabi had derived third derivative bounds for the Monge-Ampère equation, and Brezis and I had treated the very special case of the maximum of two linear elliptic operators.)

All success in mathematics turns largely upon persistence and luck; and while I can take some credit for the persistence, the luck was, well, luck—chiefly in that, quite unknown to me, one N. V. Krylov in the Soviet Union had turned his attention to these same problems at about the same time. And Nick's contributions to the subject have been extraordinary, including not only the interior Hölder second derivative estimates, for which independent discovery we are being honored, but also his previous, and great, work with Mikhail Safonov on Hölder bounds and the Harnack inequality for nondivergence structure second-order elliptic equations with discontinuous coefficients. We needed these to carry out step (i) mentioned above. Nick also later derived boundary second derivative estimates, something at which I completely failed.

So it is really an honor to share this prize with Nick and to have seen over the past twenty years the magnificent work of Caffarelli, Guan, Li, P.-L. Lions, Nirenberg, Spruck, Trudinger, Urbas, Wang, and many other researchers vastly extending these ideas.

Biographical Sketch: Nicolai V. Krylov

Nicolai Vladimirovich Krylov was born in Soudogda, the region of Vladimir, Russia, on June 5, 1941. He received his Ph.D. in 1966 and his doctorate of science in 1973 from Moscow State University; his scientific advisor was E. B. Dynkin. Krylov taught at Moscow State University from 1966 to 1990; he has taught at the University of Minnesota since 1990, and currently holds the position of Samuel G. Ordway Professor of Mathematics. He has supervised the graduate degrees of fifteen students.

Krylov has given invited addresses at the International Congress of Mathematicians in Helsinki (1978) and Berkeley (1986) and has given fifty-eight invited lectures, has written nearly two hundred research articles, and has published five monographs. A member of many journal editorial boards, Krylov was elected a Fellow of the American Academy of Arts and Sciences in 1993, received a Humboldt Research Award for Senior U.S. Scientists in 2001, and has been a recipient of numerous National Science Foundation grants.

Response: Nicolai V. Krylov

It is a great honor to share with Craig Evans this year's Steele Prize for a Seminal Contribution to Research.

In the times when I was an undergraduate student in Moscow State University, all kinds of control theory became popular. My scientific advisor, E. B. Dynkin, became interested in stochastic control theory, and being a brilliant lecturer, he easily attracted many people, including me, into it.

As often happens in probability theory, it was very easy to understand why certain probabilistic quantities should satisfy Bellman equations, but discouragingly for quite a while there were no ideas on how to prove this. Bellman equations are fully nonlinear possibly degenerate second-order partial differential equations with convex nonlinearity, of which the Monge-Ampère equation is the most famous example. When in about 1963 I asked O. A. Oleinik what was known about such equations, the answer was very short: "Nothing." This boosted even further my desire to prove the solvability of Bellman equations by probabilistic means. However, it took seven years before I realized how to prove a basic estimate, and after that the theory was completed in 1971–72.

It took even longer to develop an analytic approach. Working on some very natural questions from stochastic control theory, M. Safonov and I were lucky enough to obtain in 1978 Hölder norm estimates for solutions of linear equations with possibly rough coefficients. These estimates prove, in particular, the continuity of harmonic functions corresponding to diffusion processes with measurable coefficients. An automatic consequence of this fact is the lower semicontinuity of superharmonics. On the other hand, it is trivial to see that the second order directional derivatives of solutions of Bellman equations are superharmonics for certain diffusions. Thus they should be upper semicontinuous. But the equation itself says that a certain function of these directional derivatives is continuous. In addition, the function is monotone, and this yields the continuity of second-order derivatives.

Remarkably, Craig Evans obtained similar results at about the same time. Since then I have become a great admirer of Craig's talent, and I am very honored to share the prize with him.

Our results opened up the area to analytic treatment, and since then very many mathematicians have made amazing contributions. I want to mention only one directly related to our prize. A weak point in Craig's and my argument is that we need to differentiate the equation twice, which led to extra smoothness assumptions on the data. A major step forward in this respect was achieved by M. Safonov in 1984 when he showed that the estimate holds only under "natural" conditions.

Lifetime Achievement: Cathleen Synge Morawetz

Citation

Cathleen Morawetz has greatly influenced mathematics in the broad sense throughout her long and distinguished career. Her fundamental research has resulted in seminal contributions to a number of areas. These contributions include her early work on equations of mixed type, with its striking consequences for the theory of flow around airfoils, her work on local energy decay for waves in the complement of an obstacle, and her results concerning the existence of transonic flow with shocks. Throughout Professor Morawetz's work one finds the theme of deep, creative mathematics used in the treatment of problems selected because of their interest in applied areas. She has not only contributed greatly to mathematics but also to the vitality of the interaction between mathematics and its applications.

Cathleen Morawetz's influence on mathematics extends well beyond her research contributions. In residence at the Courant Institute of Mathematical Sciences for almost all of her career, she provided guidance and inspiration to the stream of visitors and postdoctoral appointees, as well as to her own students. Her works include a number of influential contributions written in collaboration with younger mathematicians.

Beyond these mathematical contributions, commanding in themselves, Cathleen Morawetz has provided strong leadership for and representation of the mathematical community via her remarkable and generous service. The AMS has benefited from her membership on many committees, from her ten years of service as a Trustee of the Society, and her service as President of the Society. She dispatched her duties in these roles with excellence and did not merely serve; she provided leadership. The larger community benefited from her wisdom in positions such as that of a Trustee of Princeton University and a Trustee of the Sloan Foundation; mathematics also benefited from being represented by her in these roles. Among her pioneering "firsts", one notes that she was the first woman to direct an institute of mathematics in the U.S. and she was the first woman to receive the National Medal of Science for work in mathematics.

Thank you, Cathleen, for all you have done.

Biographical Sketch

Cathleen Synge Morawetz was born in Toronto, Canada, on May 5, 1923. She received a B.A. in applied mathematics from the University of Toronto in 1945, an M.Sc. from the Massachusetts Institute of Technology in 1946, and a Ph.D. from New York University in 1951. From 1950 to 1951 she was a research associate at MIT working on hydrodynamic stability with C. C. Lin. From 1951 on she worked with the group at NYU that became the Courant Institute, mainly at first with L. Bers, K. O. Friedrichs, and H. Grad.

Bers and Friedrichs introduced her to the fascinating problems of transonic flow; Harold Grad introduced her to problems in magnetohydrodynamics, especially the mathematical problem associated with very thin plasmas; and from Joe Keller she learned the open problems of wave propagation.

She became an assistant professor at the institute in 1958. Always involved in some administration, she eventually served as director of the Courant Institute from 1984 to 1988. She retired in 1993.

Cathleen Morawetz gave the AMS Gibbs Lecture in 1981. During much of her career she received support from the Office of Naval Research.

She served the Society as a member of the Council from 1973 to 1975, as a member of the Executive Committee in 1975 and from 1994 to 1998, as a trustee from 1975 to 1985, and was the second woman president of the Society from 1995 to 1997. She is still a member of two committees. She received the National Medal of Science in 1998.

Cathleen Morawetz was a trustee of Princeton University, a trustee of the Sloan Foundation, a member of the board of NCR, and a founding director of JSTOR (1995–98). In addition, she served on the board of the Mathematical Sciences Research Institute and chaired the board for theoretical physics of the Dublin Institute for Advanced Studies. She has received numerous honorary degrees.

She first studied the nonlinear wave propagation of shock wave theory as a student and later, at the suggestion of I. Segal, of semilinear equations. This resulted in fundamental work with Walter Strauss. Both her transonic theories and her work in wave propagation involved finding special identities and inequalities for the relevant equations.

Response

Receiving the Steele Prize for Lifetime Achievement is not only a huge honor but a stunning surprise for which I am very grateful. But I can never be quite as grateful as I am to those people who mentored and encouraged me in a lifetime of mathematics which, somewhat to my surprise, still goes on. The person to whom I am most grateful is Richard Courant, who steadfastly employed me in real research as I struggled to get a Ph.D. and to bear and raise four children between 1946 and 1958. He claimed it was Kurt Friedrichs who constantly recommended me to him, but Courant was surely the only person with the authority to follow this nonstandard path. Before that time I wavered a great deal in my career ideas, working as a chronographer during World War II, seriously contemplating teaching in India (a chance meeting with Cecilia Krieger sent me off to graduate school instead), trying out and failing at electrical engineering at MIT. There was also a considerable amount of external social pressure to abandon my career, but such ideas did not enter the minds of Courant and his colleagues—nor for that matter of my husband, Herbert.

Cathleen Synge Morawetz

Among the many people at the Courant Institute who educated, mentored, and helped me in the vast literature of mathematics (I have a bad memory) were not only Friedrichs but Lipman Bers, Joe Keller, Harold Grad, Fritz John, Paul Garabedian, Peter Lax, and Louis Nirenberg. Let me add the names of my collaborators who taught me so much: Walter Strauss, Jim Ralston, and Ralph Phillips.

Lastly, and by no means least, I am forever indebted to my mother for instilling in me the idea of ambition (then very unladylike) and to my father for the idea of intellectual achievement (not to mention the introduction to Courant).

2004 Veblen Prize

David Gabai

The 2004 Oswald Veblen Prize in Geometry was awarded at the 110th Annual Meeting of the AMS in Phoenix in January 2004.

The Veblen Prize is awarded every three years for a notable research memoir in geometry or topology that has appeared during the previous five years in a recognized North American journal (until 2001 the prize was usually awarded every five years). Established in 1964, the prize honors the memory of Oswald Veblen (1880–1960), who served as president of the AMS during 1923–24. It carries a cash award of \$5,000.

The Veblen Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2004 prize the members of the selection committee were: Andrew J. Casson, Yakov Eliashberg, and John W. Morgan (chair).

Previous recipients of the Veblen Prize are: Christos D. Papakyriakopoulos (1964), Raoul H. Bott (1964), Stephen Smale (1966), Morton Brown and Barry Mazur (1966), Robion C. Kirby (1971), Dennis P. Sullivan (1971), William P. Thurston (1976), James Simons (1976), Mikhael Gromov (1981), Shing-Tung Yau (1981), Michael H. Freedman (1986), Andrew J. Casson (1991), Clifford H. Taubes (1991), Richard Hamilton (1996), Gang Tian (1996), Jeff Cheeger (2001), Yakov Eliashberg (2001), and Michael J. Hopkins (2001).

The 2004 Veblen Prize was awarded to David Gabai. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

The 2004 Veblen Prize in Geometry is awarded to David Gabai of Princeton University in recognition of his work in geometric topology, in particular, the topology of 3-dimensional manifolds.

Since its beginnings in the early twentieth century, 3-dimensional topology has occupied a central role in geometric topology. It is tantalizingly close to what we can directly visualize, yet with its knotting phenomena it is an incredibly complex and difficult subject. For the last twenty years, Gabai has been one of the leading figures in this field. He has led many of the main avenues of development, developing tools in order to solve some of its most important problems himself, tools that have turned out to be central to the further development of the subject.

One aspect of 3-dimensional topology greatly influenced by Gabai is the study of surfaces inside a 3-manifold and the intersection patterns of two or more of these. His introduction of the notion of thin position, which he used to resolve the question known as "Property R" about when surgery on a knot in the 3-sphere can yield a 3-manifold homeomorphic to the product of the 2-sphere and a circle, has found application far beyond Gabai's original use, for example, in the proof that knots are determined by their complements. Gabai's study of surfaces is achieved in large part through the study of more general objects, codimension-one laminations, in a 3-manifold. In a sequence of papers beginning in the 1980s and summarized in his talk at the 1990 International Congress of Mathematicians in Kyoto entitled "Foliations and 3-manifolds", Gabai developed the theory of these objects. In Gabai's hands, they have served to help unlock some of the topological mysteries of 3-dimensional topology. This theory of these laminations has now grown to the extent that it is a subdomain of 3-dimensional topology in its own right.

More recently, Gabai has investigated 3-dimensional hyperbolic manifolds. Hyperbolic 3-manifolds are a rich and much studied class. Conjecturally at least, they are by far the richest and most interesting class. One of the central problems in 3-manifold topology is how to tell when a 3-manifold is hyperbolic, i.e., has a hyperbolic structure. By strikingly original arguments in a series of papers [listed below], Gabai has answered this question in a special case, by showing that every irreducible 3-manifold with the homotopy type of a hyperbolic manifold has a hyperbolic structure. Further developments of his methods led to a proof by Gabai of the Smale Conjecture for hyperbolic 3-manifolds—describing the homotopy type of the space of self-diffeomorphisms—and also to new estimates for the volumes of hyperbolic 3-manifolds.

"Homotopy hyperbolic 3-manifolds are virtually hyperbolic", *J. Amer. Math. Soc.* **7** (1994), no. 1, 193–8.

"On the geometric and topological rigidity of hyperbolic 3-manifolds", *J. Amer. Math. Soc.* **10** (1997), no. 1, 37–74.

(jointly with Robert Meyerhoff and Nathaniel Thurston) "Homotopy hyperbolic 3-manifolds are hyperbolic", *Ann. of Math.* (2) **157** (2003), no. 2, 335–431.

Biographical Sketch

David Gabai received his B.S. from the Massachusetts Institute of Technology (1976), his M.A. from Princeton University (1977), and his Ph.D. from Princeton (1980) under the direction of William Thurston. After positions at Harvard and the University of Pennsylvania, he spent most of the years 1986–2001 at the California Institute of Technology and has been at Princeton University since 2001. He held visiting positions at the Institute for Advanced Study, Princeton (1982–83, fall 1989); the Mathematical Sciences Research Institute, Berkeley (1984–85, 1996–97); and the Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France (1985–86). He has received a National Science Foundation Postdoctoral Fellowship, a Sloan Fellowship, and an AMS Centennial Fellowship. He gave a 45-minute invited talk at the 1990 International Congress of Mathematicians in Kyoto and an hour invited talk at the 1995 joint meeting of the AMS and the Mexican Mathematical Society in Guanajuato, Mexico. He also gave the 1996 Porter Lectures (Rice University), the 2001 Marston Morse memorial lectures (IAS), and the 2002 Unni Namboodiri memorial lectures (University of Chicago).

Response

I have been incredibly lucky all my life. As a graduate student at Princeton, Bill Thurston suggested an area of mathematics, foliations on 3-manifolds, which matched my talents. Being in a field then considered by many experts to be either finished or peripheral, I could slowly and happily build my intuition and technical skills without the distraction of noise or the danger of being trampled. It turned out my constructions of foliations were useful and of contemporary interest, so I got a great job at Caltech. In 1991 I attempted to teach a topics course on the hyperbolic geometry that I should have learned as a graduate student. I started with Chapter 1 of Thurston's 1977–78 lecture notes but could not get past Chapter 5. There he discussed why Mostow's rigidity theorem implies that a manifold finitely covered by a hyperbolic 3-manifold is homotopy equivalent to a hyperbolic 3-manifold. I got stuck trying to prove the converse. Ultimately, the converse became the start of work cited here.

It is a great pleasure to thank Ulrich Oertel, with whom I introduced essential laminations in 1986, and Rob Meyerhoff and Nathaniel Thurston, who worked with me on the homotopy hyperbolic project. I also thank my long-time collaborator Will Kazez and my collaborators Peter Milley and Valentin Poenaru. Victor Guillemin's beautiful differential topology course during my last semester at MIT kept me from opting out of mathematics for medical school. Bill Thurston's influence has been immense. I am in debt to my teachers, and I count my students among them. I very much appreciate the many mathematicians who have encouraged me over the years. Finally, I thank my many hosts in China, England, France, Israel, and Japan for providing quiet environments during short visits so that I could hide out and nurture my thoughts.

Much of what I know was done or inspired by former prizewinners. It is humbling to be the recipient of the 2004 Veblen Prize.

2004 Wiener Prize

James A. Sethian

The 2004 AMS-SIAM Norbert Wiener Prize in Applied Mathematics was awarded at the 110th Annual Meeting of the AMS in Phoenix in January 2004.

The Wiener Prize is awarded every three years to recognize outstanding contributions to applied mathematics in the highest and broadest sense (until 2001 the prize was awarded every five years). Established in 1967 in honor of Norbert Wiener (1894–1964), the prize was endowed by the Department of Mathematics of the Massachusetts Institute of Technology. The prize is given jointly by the AMS and the Society for Industrial and Applied Mathematics (SIAM). The recipient must be a member of one of these societies and a resident of the United States, Canada, or Mexico. The prize carries a cash award of $5,000.

The recipient of the Wiener Prize is chosen by a joint AMS-SIAM selection committee. For the 2004 prize the members of the selection committee were: Alexandre J. Chorin (chair), Martin Grötschel, and Philip J. Holmes.

The previous recipients of the Wiener Prize are: Richard E. Bellman (1970), Peter D. Lax (1975), Tosio Kato (1980), Gerald B. Whitham (1980), Clifford S. Gardner (1985), Michael Aizenman (1990), Jerrold E. Marsden (1990), Hermann Flaschka (1995), Ciprian Foias (1995), Alexandre J. Chorin (2000), and Arthur T. Winfree (2000).

The 2004 Wiener Prize was awarded to JAMES SETHIAN. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

The Norbert Wiener Prize in Applied Mathematics is awarded to James A. Sethian of the University of California at Berkeley for his seminal work on the computer representation of the motion of curves, surfaces, interfaces, and wave fronts, and for his brilliant applications of mathematical and computational ideas to problems in science and engineering.

His earliest work included an analysis of the motion of flame fronts and of the singularities they develop; he found important new links between the motion of fronts and partial differential equations, and in particular found that the correct extension of front motion beyond a singularity follows from an entropy condition as in the theory of nonlinear hyperbolic equations. These connections made possible the development of advanced numerical methods to describe front propagation through the solution of regularized equations on fixed grids.

In a subsequent work (with S. Osher) Sethian extended this work through an implicit formulation. The resulting methodology has come to be known as the "level set method", because it represents a front propagating in n dimensions as a level set of an object in $(n + 1)$ dimensions. Next, Sethian tamed the cost of working in higher dimensions by reducing the problem back down to its original dimensionality. This set of ideas makes possible the solution of practical problems of increasing importance and sophistication and constitutes a major mathematical development as well as an exceptionally useful computational tool with numerous applications.

Among the practical problems solved by Sethian are: the tracking of interfaces and drops in fluid mechanics with applications to inkjet design for high-speed printers; the analysis of crystal growth (with J. Strain); motion under mean curvature, construction of minimal surfaces, and knot recognition in computational geometry; design of optimal structures under loads (with A. Wiegmann); and the analysis of anisotropic front propagation and mixed discrete-continuous control. Each of these applications required extensions and modifications of the basic tools as well as new understanding of the problems under investigation.

Sethian's mathematical description of etching and deposition in the manufacture of computer chips has illuminated processes such as ion-milling, visibility, resputter, and material-dependent etch rates; the resulting algorithms are now an indispensable part of industrial semiconductor fabrication simulations throughout the world. His models of implicit surface motion together with fast Eikonal solvers are standard fare in medical and biomedical shape extraction and in fields such as shape-based image interpolation, shape-from-shading, stereoscopic vision, and texture segmentation; they are used in hospital electron beam scanners to quantify cardiac motion and efficiency. Recently, Sethian (with S. Fomel) developed efficient numerical methods for simulating multiple-arrival wavefront propagation by solving Liouville-type equations; this work has direct applications in seismic imaging and geophysical inverse problems and has already been put to use by the petroleum industry.

A particularly noteworthy aspect of Sethian's work is that he pursues his ideas from a first formulation of a mathematical model all the way to concrete applications in national laboratory and industrial settings; his algorithms are currently distributed in widely available packages. Sethian's work is a shining example of what applied mathematics can accomplish to benefit science as a whole.

Biographical Sketch

James A. Sethian was born on May 10, 1954, in Washington, DC. He received a B.A. in mathematics from Princeton University in 1976 and a Ph.D. in applied mathematics from the University of California, Berkeley, in 1982. After a National Science Foundation Postdoctoral Fellowship at the Courant Institute of Mathematical Sciences, he joined the faculty at UC Berkeley, where he is now professor of mathematics as well as head of the mathematics department at the Lawrence Berkeley National Laboratory. He has been a plenary speaker at the International Congress of Industrial and Applied Mathematicians, has been an invited speaker at the International Congress of Mathematicians, and has received SIAM's I. E. Block Community Lecture Prize.

He is an associate editor of *SIAM Review*, the *Journal of Mathematical Imaging and Vision*, and the *Journal on Interfaces and Free Boundaries*.

Response

In the course of a normal day, a letter from the AMS appears and jolts one out of a busy routine. I am grateful for this unexpected shock: It is a wonderful honor to be the recipient of the Norbert Wiener Prize.

My interest in front propagation began with the suggestions of Alexandre Chorin at Berkeley. Starting with his cell fraction-based Huyghens propagation algorithm, he artfully led me toward unanswered questions about interface evolution, the Landau instability, and ill-posedness. The appeal of alternative approaches stemmed from the sheer frustration of attempting to elevate existing numerical front propagation schemes beyond simple two-dimensional problems. I have a fond memory of buying building blocks in 1978 from a local toy store in an optimistic attempt to visualize the various cases involved in a three-dimensional version of the Volume-of-Fluid algorithm. The visual aids were not enough, and my thesis instead focused on developing and analyzing a mathematical model of flame and front propagation.

A Danforth Fellowship at Berkeley, followed by a National Science Foundation [NSF] Postdoctoral Fellowship at the Courant Institute, and then a Sloan Foundation Fellowship back at Berkeley, coupled to support from the U.S. Department of Energy [DOE], generously allowed me time for subsequent work on entropy conditions for front propagation, as well as links between the regularizing effects of curvature on Hamilton-Jacobi equations for front propagation and viscosity in conservation laws, and opened up the strategy of applying shock schemes to interface problems.

Indeed, this work on casting front propagation in the language of differential geometry and partial differential equations benefitted from a collection of disparate ideas and tools that were bubbling together in the late 1970s and early 1980s. The work of M. Crandall and P.-L. Lions, and then L. C. Evans, on viscosity solutions for Hamilton-Jacobi equations, G. Barles' analysis of that Berkeley flame model, the maturation of numerical schemes for hyperbolic conservation laws, and fresh ideas about curve evolution by M. Gage and M. Grayson all formed part of the landscape in those early years.

These ideas have led to several algorithms based on a partial differential equations view of evolving fronts. The first such algorithm, which relied on embedding the front as a particular level set of a higher-dimensional function and employed high-order schemes for the underlying Hamilton-Jacobi equation, became known as the "Level Set Method". The work is joint with Stanley Osher at UCLA, whose enthusiasm is a force unto itself, and I have warm memories of that collaboration.

As first laid out, that version of the Level Set Method was mathematically appealing, numerically robust, and unnecessarily slow. I was fortunate to have D. Chopp, now at Northwestern, as my first Ph.D. student, with whom the ideas of reinitialization and adaptivity were developed, pointing the way towards making these methods practical and efficient. The resulting Narrow Band Level Set Methods were honed with an equally talented Ph.D. student, D. Adalsteinsson, now at the University of North Carolina, Chapel Hill, who helped put these methods on a competitive footing with other methods of the day.

In this short space I cannot do justice to the large amount of work done on level set methods and the surprising areas to which they have been applied. Many efforts, including large-scale projects at the DOE National Laboratories, in particular at the Lawrence Berkeley National Laboratory, semester-long programs at IPAM [Institute for Mathematics and its Applications] at UCLA, and focused teams such as those in the semiconductor industry, have all contributed to pushing these techniques forward.

I would like to make mention of a few of my most recent collaborators. R. Malladi developed groundbreaking work while at the University of Florida, applying these algorithmic ideas to image segmentation, and I was fortunate that he chose to take his NSF Computational Sciences Postdoctoral Fellowship at Berkeley. He continues to be a leader in applying PDE-based techniques for medical and biomedical applications, and I am grateful for the ongoing collaboration. A. Vladimirsky, a former student now at Cornell, was instrumental in extending PDE-based front propagation techniques to produce extraordinarily fast methods for optimal control and anisotropic front propagation. S. Fomel, a former postdoc now at Texas, was pivotal in devising PDE front schemes for multiple "nonviscosity" arrivals with the same computational efficiency. And J. Wilkening, a former student now at Courant, tackled the difficult problem of front propagation and void motion in the context of electromigration. It is a joy to work with such able talents.

Two other endeavors deserve mention, in part because of the extensive work done long after I left the scene. The work with A. Majda on zero Mach number combustion has been honed and melded into complex combustion calculations by J. Bell and P. Colella. And the work on mathematical botany, anisogamy, and chemotaxis continues to be pioneered by P. Cox, director of the National Tropical Botanical Garden.

I have been lucky to have had pivotal teachers who stood as "transformers" along the way, investing their own energy to raise the voltage and then graciously passing it on. At a public junior high school in Virginia, W. Taylor was the first to tell me to study mathematics. A high school teacher offered similar encouragement, adding that I was almost as good as the kid sitting next to me. I don't feel too bad, since that kid, Eric Schmidt, is now CEO of Google. W. K Allard, then at Princeton, brought me to PDEs. O. Hald at Berkeley introduced me to numerics. A. Chorin is a wise and skilled thesis advisor; I am fortunate to be in the large community of his former students.

Finally, I am grateful to the Department of Energy for its long-term support of these efforts, the National Science Foundation, and the ongoing opportunity to interact at Berkeley and the Lawrence Berkeley National Laboratory with people of singular talent, warmth, and support, including G. I. Barenblatt, A. Grunbaum, O. Hald, and R. Malladi.

2004 Moore Prize

The 2004 E. H. Moore Research Article Prize was awarded at the 110th Annual Meeting of the AMS in Phoenix in January 2004. This was the first time the prize was awarded.

The Moore Prize will be awarded every three years for an outstanding research article that appeared in one of the AMS primary research journals: *Journal of the AMS, Proceedings of the AMS, Transactions of the AMS, AMS Memoirs, Mathematics of Computation, Electronic Journal of Conformal Geometry and Dynamics,* and *Electronic Journal of Representation Theory.* The article must have appeared during the six calendar years ending a full year before the meeting at which the prize is awarded. The prize carries a cash award of $5,000.

The prize honors the extensive contributions of E. H. Moore (1862–1932) to the AMS. Moore founded the Chicago section of the AMS, served as the Society's sixth president (1901–02), delivered the Colloquium Lectures in 1906, and founded and nurtured the *Transactions of the AMS.*

The Moore Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2004 prize the members of the selection committee were: Béla Bollobás, Lawrence Craig Evans (chair), Grigorii A. Margulis, George C. Papanicolaou, and Andrew J. Wiles.

The 2004 Moore Prize was awarded to Mark Haiman. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

Mark Haiman

"Hilbert schemes, polygraphs, and the Macdonald positivity conjecture", *Journal of the AMS* **14** (2001), 941–1006.

Mark Haiman's groundbreaking paper proves both the $n!$ conjecture and Macdonald's positivity conjecture, both long-standing open problems in algebraic combinatorics, through the development of remarkable new notions in algebraic geometry and a tour-de-force derivation in commutative algebra.

The last step concerns the defining equations of the polygraph, an arrangement of linear subspaces connected with the geometry of the Hilbert scheme of n points in the plane. This is then shown to coincide with the Hilbert scheme of regular orbits of the symmetric group acting on labeled configurations of n points. The key result states that the isospectral Hilbert scheme is normal, Cohen-Macaulay, and Gorenstein.

Haiman's paper has within the last two years already led to numerous other new developments at the interface of combinatorics, algebraic geometry, and representation theory.

These include: M. Haiman, "Vanishing theorems and character formulas for the Hilbert scheme of points in the plane", *Invent. Math.* **149**, no. 2 (2002), 371–407; I. Gordon, "On the quotient ring by diagonal invariants", *Invent. Math.* **153** (2003), 503–518; and J. Haglund, "A proof of the q,t-Schröder conjecture", *Internat. Math. Res. Notices* (2004).

Biographical Sketch

Mark Haiman received the Ph.D. in 1984 from the Massachusetts Institute of Technology, under the direction of Gian-Carlo Rota. He continued at MIT as an applied mathematics instructor and then assistant professor until 1991, when he moved to the University of California, San Diego, becoming full professor in 1997.

Haiman is presently professor of mathematics at the University of California, Berkeley, where he moved in 2001 following a semester there as a visiting Miller professor in fall 2000. He serves on the editorial board of *Algebra Universalis* and on the scientific advisory board of the Centre de Recherches Mathématiques in Montreal, Canada.

Haiman's research interests encompass a mix of combinatorics, algebraic geometry, and representation theory, with an additional occasional interest in lattice theory.

Response

It is an honor and a special pleasure to be chosen as the first recipient of the E. H. Moore Research Article Prize. The publication activity of the AMS is, I think, the most important of all its contributions to mathematical life. Since the *Journal of the AMS* was started in 1988, I have always thought first of submitting there on those occasions when I believed a paper I had just completed to be one of my best. It's a bit of good fortune that by doing so I became eligible for a prize which did not yet exist.

The cited work bears the name of a sole author, but it was not done alone. The conjectures that started it all came out of a long and rewarding collaboration with Adriano Garsia, which we began in 1991 and have never finished. Adriano taught me a lot of mathematics and even more about how to do mathematics. In 1992 Adriano introduced me to Claudio Procesi, and we told him about our discoveries. The insight that the geometry of the Hilbert scheme should contain the solution to our problems was his. In those days my knowledge of algebraic geometry was rudimentary, and I had never heard of Hilbert schemes. I have Claudio's impetus to thank for whatever more I might know about those subjects today.

2004 Conant Prize

The 2004 Levi L. Conant Prize was awarded at the 110th Annual Meeting of the AMS in Phoenix in January 2004.

The Conant Prize is awarded annually to recognize an outstanding expository paper published in either the *Notices of the AMS* or the *Bulletin of the AMS* in the preceding five years. Established in 2001, the prize honors the memory of Levi L. Conant (1857–1916), who was a mathematician at Worcester Polytechnic University. The prize carries a cash award of $1,000.

The Conant Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2004 prize the members of the selection committee were: Anthony W. Knapp, Brian J. Parshall (chair), and Carl Pomerance.

Previous recipients of the Conant Prize are: Carl Pomerance (2001), Elliott Lieb and Jakob Yngvason (2002), and Nicholas Katz and Peter Sarnak (2003).

The 2004 Conant Prize was awarded to NOAM D. ELKIES. The text that follows presents the committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

The Levi L. Conant Prize in 2004 is granted to Noam D. Elkies for his enlightening two-part article "Lattices, Linear Codes, and Invariants", *Notices of the AMS* **47**, nos. 10–11 (2000): Part I, 1238–45; Part II, 1382–91.

Part I, which is of prize-winning quality by itself, begins with the problem of finding the densest packing of 24-dimensional marbles whose centers are placed at the points of a lattice. It carries the reader effortlessly along a journey through the space of lattices, through the subject of theta functions and modular forms, through classical number-theoretic identities, through sporadic finite simple groups, and finally to some hints of an exceptional 24-dimensional lattice known as the Leech lattice. Elkies keeps the reader's attention throughout, judging well which points to expand upon and which points to skip over. It is hard to put the article down as it takes unexpected turns and weaves together different areas of pure mathematics.

Noam D. Elkies

In Part II, Elkies avoids the temptation to expand this development further, in a way that might tire the reader, and instead he develops an ostensibly different topic, stressing a detailed analogy with the material in Part I. Here the topic is one in applied mathematics, specifically that of linear error-correcting codes. He introduces "Hamming space" as the space of ordered n-tuples from a finite alphabet, especially from the elements of a finite field. Error-correcting codes become the analog of sphere packings. Linear error-correcting codes become the analog of sphere packings with centers at the points of a lattice. "Weight enumerators" play the role of theta functions, and he pursues the topic through the same kinds of twists and turns as in Part I. Eventually he arrives again at the Leech lattice, and this time he constructs the lattice and examines some of its remarkable properties.

The article leaves the reader with a good feeling about the unity of mathematics, and its underlying beauty. It is a masterful exposition.

Biographical Sketch

Noam D. Elkies is a number theorist whose work mostly concerns Diophantine geometry, computational number theory, and connections with other fields such as sphere packing and error-correcting codes. He also publishes occasionally in enumerative combinatorics and combinatorial games. He twice represented the United States at the International Mathematical Olympiad, winning gold medals both times, and was a Putnam Fellow in each of the three years he took the Putnam examination. He has been at Harvard since coming there as a graduate student in 1985; after earning his Ph.D. there under Barry Mazur and Benedict Gross, he was a junior fellow, then associate professor, and was granted tenure in 1993 at age twenty-six, the youngest in Harvard's history. His work has also been recognized by awards such as a Packard Fellowship and the Prix Peccot of the Collège de France.

Elkies's main interest outside mathematics is music, mainly classical piano and composition. Recently performed works include a full-length opera, *Yossele Solovey*; Brandenburg Concerto no. 7, commissioned and performed by the Metamorphosen Chamber Orchestra; and several other orchestral compositions, one of which had Elkies playing the solo piano part in Boston's Symphony Hall. He still has some time for chess, where he specializes in composing and solving problems; he won the world championship for solving chess problems in 1996 and earned the Solving Grandmaster title in 2001.

Response

I am honored and grateful to receive the 2004 L. L. Conant Prize for my article "Lattices, Linear Codes, and Invariants" in the *Notices of the AMS*. I also thank Tony Knapp for soliciting the article and for working with me on the mathematical writing. It was already gratifying to have the opportunity to introduce the *Notices* readership to a beautiful circle of mathematical ideas whose continuing vitality is exemplified by such recent work as the unified treatment by Nebe, Rains, and Sloane of various generalizations of the MacWilliams identity and Gleason's theorems, and the proof by Cohn and Kumar that the Leech lattice yields the densest lattice packing of spheres in dimension 24. I am delighted that my exposition was selected for the Conant Prize and hope that this additional exposure will entice more mathematicians to learn about the invariants associated with lattices and codes.

2004 Award for Distinguished Public Service

The 2004 Award for Distinguished Public Service was presented at the 110th Annual Meeting of the AMS in Phoenix in January 2004.

The Award for Distinguished Public Service is presented every two years to a research mathematician who has made a distinguished contribution to the mathematics profession during the preceding five years. The purpose of the award is to encourage and recognize those individuals who contribute their time to public service activities in support of mathematics. The award carries a cash prize of $4,000.

The Award for Distinguished Public Service is made by the AMS Council, acting on the recommendation of a selection committee. For the 2004 award the members of the selection committee were: D. J. Lewis (chair), William James Lewis, Calvin C. Moore, William Y. Velez, and Margaret H. Wright.

Previous recipients of the award are: Kenneth M. Hoffman (1990), Harvey B. Keynes (1992), I. M. Singer (1993), D. J. Lewis (1995), Kenneth C. Millett (1998), Paul J. Sally Jr. (2000), and Margaret H. Wright (2002).

The 2004 Award for Distinguished Public Service was presented to Richard Tapia. The text that follows presents the selection committee's citation, a brief biographical sketch, and the recipient's response upon receiving the award.

Citation

The award for Distinguished Public Service is given to Richard A. Tapia for inspiring and teaching thousands of people (from elementary school students to senior citizens) to study and appreciate the mathematical sciences. His dedication to opening doors for underrepresented minorities and women is legendary, as is his determination to reach students who would otherwise be discouraged or overlooked. Educational and outreach programs that he has founded and leads, such as the Rice University Center for Excellence and Equity in Education, represent a continuing tribute to his energy and perseverance. More than half of Richard's Ph.D. students have been women, and more than a third have been underrepresented minorities. In addition, his life has been filled with many other forms of public service: he was a member of the National Science Board from 1996–2002; in 1996 he was one of the first recipients of a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring; and he is a founding member of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS).

Biographical Sketch

Richard Tapia is a mathematician and professor in the Department of Computational and Applied Mathematics at Rice University in Houston, Texas. He is internationally known for his research in the computational and mathematical sciences and is a national leader in education and outreach programs.

Tapia's current Rice positions are Noah Harding Professor of Computational and Applied Mathematics; associate director of Graduate Studies, Office of Research and Graduate Studies; and director of the Center for Excellence and Equity in Education.

Tapia was born in Los Angeles to parents who separately immigrated from Mexico as teenagers in search of educational opportunities for themselves and for future generations. Tapia was the first in his family to attend college. He received B.A., M.A., and Ph.D. degrees in mathematics from the University of California, Los Angeles. In 1967 he joined the Department of Mathematics at UCLA and then spent two years on the faculty at the University of Wisconsin. In 1970 he moved to Rice University, where he was promoted to associate professor in

Richard Tapia

1972 and full professor in 1976. He chaired the department from 1978 to 1983. He is currently an adjunct faculty member of Baylor College of Medicine and the University of Houston.

Tapia has authored or coauthored two books and over eighty mathematical research papers. He has delivered numerous invited addresses at national and international mathematical conferences and serves on several national advisory boards.

Due to Tapia's efforts, Rice has received national recognition for its educational outreach programs, and the Rice Computational and Applied Mathematics Department has become a national leader in producing women and underrepresented minority Ph.D. recipients in the mathematical sciences. Thirty-five mathematics students have received, or are currently working on, the Ph.D. degree under his direction or codirection. Of these thirty-five students, fifteen have been women and eight have been underrepresented minorities.

As associate director of Graduate Studies at Rice University, Tapia supervises a group of graduate students from all areas. He meets with the group regularly to monitor their progress, and many of these students are involved in community and educational outreach.

Under Tapia's direction Rice's Alliances for Graduate Education and the Professoriate (AGEP) Program, funded by the National Science Foundation, provides opportunities for undergraduate and graduate students in science, mathematics, and engineering to participate in university activities and work for the summer under the guidance of researchers at Rice. Over the years Tapia has impacted hundreds of teachers through two summer programs: the Mathematical and Computational Sciences Awareness workshop and GirlTECH.

Among his many honors:

• The National Atomic Museum Foundation of Hispanics in Science and Engineering named Tapia Exhibit Honoree in Albuquerque, New Mexico, in October 2003.

• In January 2002 Tapia was inducted into the Texas Science Hall of Fame. The Texas Science Hall of Fame is a tribute to the "giants" who shape the world through their innovative use of science.

• In October 2001 Tapia was honored with the Reginald H. Jones Distinguished Service Award by NACME, Inc., in Baltimore, Maryland.

• Tapia's work at improving the representation of underrepresented groups was celebrated with a symposium entitled "The Richard Tapia Celebration of Diversity in Computing". It is the first in a series of events designed to celebrate the technical contributions and career interests of diverse people in computing fields. The symposium, sponsored by the Association for Computing Machinery and IEEE-Computer Society, took place in Houston, Texas.

• In May 2000 Cornell University established a lecture series to honor Tapia and David Blackwell, professor at the University of California, Berkeley. The lecture series provides a forum for the research of African-American, Latino, and American Indian scientists working in the fields of mathematical and statistical sciences.

• In September Tapia received a 2000 Peace Award for Education from the Spiritual Assembly of the Baha'is of Houston. With unity of humanity as a guiding principle, the Baha'is of Houston present three awards—for education, for humanitarianism, and for peace—each year to individuals or organizations for their work in serving the community and breaking down barriers of culture, race, class, and creed. The awards are presented in association with the International Day of Peace, a day designated by the United Nations "to commemorating and strengthening the ideas of peace both within and among all nations and peoples."

• The Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) honored Tapia with the 2000 SACNAS Distinguished Scientist Award at their annual national meeting in Atlanta, Georgia, on October 14, 2000. Tapia was selected for his ongoing commitment to educational opportunities for women and minority students and in honor of a lifetime of achievement in his field and for dedication to the future of young scientists.

• In 1999 Tapia was awarded the Giants in Science Award by the Quality Education for Minorities (QEM) Network.

• Tapia received the 1997 Lifetime Mentor Award from the American Association for the Advancement of Science.

• In 1997 Tapia was inducted into the Hispanic Engineer National Achievement Awards Conference Hall of Fame.

• President Clinton appointed Tapia to the National Science Board (NSB), the governing body of the National Science Foundation in 1996. Tapia also received the 1996 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. Later that year he was named the Hispanic Engineer of the Year by *Hispanic Engineer* magazine, the first academic to receive this honor.

• Tapia was awarded the inaugural A. Nico Habermann Award by the Computer Research Association in 1994 for outstanding contributions in aiding members of underrepresented groups within the computing research community.

• In the same year Tapia was selected Professor of the Year by the Association of Hispanic School Administrators of the Houston Independent School District.

• In 1992 Tapia was elected to the National Academy of Engineering, the first native-born Hispanic to receive this honor.

• Students at Rice University voted Tapia the 1991 winner of the George R. Brown Award for superior teaching.

• Tapia was given the College Level Educator of the Year Award by *Hispanic Engineer* magazine and named one of the twenty most influential leaders in minority math education by the National Research Council in 1990.

• Tapia was asked to serve as chair of the National Research Council's Board on Higher Education and Workforce, as cochair of all educational outreach and training activities for both the University of Illinois Supercomputer Center (NCSA) and the San Diego Supercomputer Center, and as cochair of the Research Board for Building Engineering and Science Talent (BEST).

Response

It is a great honor to be recognized by the American Mathematical Society. No recognition can be more cherished than recognition conferred by one's peers and colleagues. I thank the selection committee for choosing me for this prestigious award. Even more, I thank the AMS for establishing this award, which formally recognizes the importance of outreach and public service.

Throughout my formative years my parents instilled in me the value of education, community, and outreach to others. As a result, in my professional life I have valued not only academic scholarship but also teaching and mentoring, public service, and outreach to the general community. I never thought that these activities detracted from each other—I grew up thinking that they went hand in hand, each influencing and supporting the others. For example, credibility in scholarly research facilitates credibility in public service, while outreach activities broaden one's perspective, revealing that different people learn and understand mathematics in different ways.

This award is especially satisfying, because formal recognition by prestigious organizations validates the importance of public service and outreach activities. In turn, this validation promotes public service within the mathematics community. I want young mathematicians to see that there are many dimensions to mathematical scholarship. In addition to scholarly research, the activities of teaching and mentoring, expository writing, increasing awareness and understanding of mathematics in a broader community, and other public service activities are both valuable and necessary for the scientific health of our nation.

My own development benefitted enormously from the guidance and support of others. My mother and my father came separately from Mexico to the United States as young teenagers in search of educational opportunities. Times were difficult when they arrived. My parents were not able to achieve their own educational goals, but their dreams were realized for their five children, each of whom graduated from college.

My siblings and I were born and raised in Los Angeles. I am a product of public education, from my primary education in the Los Angeles public schools through my doctoral degree from UCLA. I strongly believe that quality public education is essential to the educational health and scientific competitiveness of our nation.

As a graduate student at UCLA, I was greatly influenced by my professors. In particular, David Sanchez gave me direction at a time when I greatly needed guidance, while Magnus Hestenes shaped how I think about mathematics.

My first faculty position was at the Mathematics Research Center at the University of Wisconsin. My experiences at MRC, where I learned so much in so many ways from so many people, were crucial to my professional development. I particularly thank Michael Golomb, Barkley Rosser, I. J. Schoenberg, and Hans Weinberger for mentoring me and for showing me that excellence and graciousness need not be mutually exclusive.

Rice University has been my home for more than three decades. The students I have taught and known, and from whom I have learned, have played an essential role in shaping my vision of what is important. The Rice administration, especially Ken Kennedy as director of the Center on Parallel Computation and current Rice president Malcolm Gillis, have strongly supported that vision and allowed me to pursue it.

Recently, my six years on the National Science Board further expanded my horizons, allowing me to discern critical national needs in science and mathematics, including representation by all members of our society. I thank the National Science Foundation for this extraordinary opportunity to learn and to serve.

Finally, I thank my family. My wife, Jean, has been a wise advisor and an enthusiastic supporter of my activities. And I have learned so much from my children: my daughter, Becky; my son, Richard; and my late daughter, Circee, to whose memory I dedicate this award.

2003 Morgan Prize

Melanie Wood

The 2003 AMS-MAA-SIAM Frank and Brennie Morgan Prize for Outstanding Research in Mathematics by an Undergraduate Student was awarded at the Joint Mathematics Meetings in Phoenix in January 2004.

The Morgan Prize is awarded annually for outstanding research in mathematics by an undergraduate student (or students having submitted joint work). Students in Canada, Mexico, or the United States or its possessions are eligible for consideration for the prize. Established in 1995, the prize was endowed by Mrs. Frank Morgan and carries the name of her late husband. The prize is given jointly by the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) and carries a cash award of $1,000.

Recipients of the Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2003 prize the members of the selection committee were: Kelly J. Black, Fan Chung Graham, Thomas C. Hales (chair), Svetlana R. Katok, Kris Stewart, and Philippe M. Tondeur.

Previous recipients of the Morgan Prize are: Kannan Soundararajan (1995), Manjul Bhargava (1996), Jade Vinson (1997), Daniel Biss (1998), Sean McLaughlin (1999), Jacob Lurie (2000), Ciprian Manolescu (2001), and Joshua Greene (2002).

The 2003 Morgan Prize was awarded to Melanie Wood. Receiving an honorable mention was Karen Yeats. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize. The same information is provided for the honorable mention.

Melanie Wood

Citation

The winner of the 2003 Morgan Prize for Outstanding Research by an Undergraduate is Melanie Wood. The award is based on research on two different topics: Belyi-extending maps and P-orderings.

The first topic is concerned with finite coverings of the projective line that are ramified only at three points of the projective line. The absolute Galois group of the field of rational numbers acts on these coverings and on diagrams (that Grothendieck named *dessins d'enfants*) associated with the coverings. Melanie Wood's research gives a way to generate genuinely new Galois invariants of dessins from old ones. Her work yields important insights into the actions of the Galois group on fundamental groups. This research has attracted the attention and admiration of the specialists working in this field. The paper has been submitted for publication.

In a separate project, Melanie Wood studies P-orderings in Dedekind rings. These P-orderings were introduced by Bhargava in 1995 to generalize the usual factorial function. It is well known that a polynomial with rational coefficients takes integer values at the integers if and only if it is an integer linear combination of binomial coefficient polynomials ${}_xC_k$. One of her results in this area implies that, in imaginary quadratic fields, the integer-valued polynomials cannot possess a basis of this same general form. Melanie began this work during the 2000 Duluth Summer Research Program (directed by Joseph Gallian), and her paper on P-orderings has recently appeared in the *Journal of Number Theory*.

Richard Hain (with help from Makoto Matsumoto) mentored her work at Duke.

Melanie Wood's research has been described in glowing terms by her mentors and by other experts in her field. The work is deep and original. The committee commends her for the mature mathematical perspective in her writings. The AMS, the MAA, and SIAM are pleased to award the 2003 Frank and Brennie Morgan Prize to Melanie Wood.

Biographical Sketch

Melanie Wood graduated from Duke University in May 2003 with highest distinction in mathematics. Her math competition honors include top place finishes in the USA Mathematical Olympiad and the Asian Pacific Mathematical Olympiad, and the designation of Putnam Fellow. She won both a Gates Cambridge Scholarship and a Fulbright to study at the University of Cambridge, where she is currently doing a one-year math program. This fall she will enter the math Ph.D. program at Princeton on a National Science Foundation Graduate Fellowship. Her current research interests are in algebraic number theory and arithmetic algebraic geometry. Melanie also enjoys acting, especially classical acting and voice work; directing; dancing; and philosophy.

Response

I am extremely honored to be awarded this prize. My experiences doing math research have been tremendously rewarding and the critical factor in my decision to continue on to graduate work in mathematics. That I had these experiences at all is due to two institutions that enable and encourage undergraduate math research: Duke University and the REU [Research Experiences for Undergraduates] at the University of Minnesota, Duluth. At Duke, I wish to thank Richard Hain, who supervised my research on the absolute Galois group, and Robert Bryant, who was available for many helpful conversations. I wish to thank Makoto Matsumoto for quick and helpful responses to technical questions. I also wish to thank Joe Gallian, director of the Duluth REU, for his support of my research, and all those affiliated with the Duluth REU who gave me feedback on my *P*-orderings paper.

Honorable Mention: Karen Yeats

Citation

The Morgan Prize Committee is pleased to award honorable mention for the 2003 Morgan Prize for Undergraduate Research to Karen Yeats for a series of outstanding contributions on topics ranging from asymptotics and number theory to mathematical logic. A few examples indicate the broad versatility of her research.

One of Karen Yeats's research projects is motivated by a precise analogy between results in additive number theory and results in multiplicative number theory. Based on this analogy, Karen Yeats has proved a multiplicative version for Dirichlet series of a classical estimate of Schur on the size of the coefficients of a product of two power series.

In her second paper Yeats determines bounds on the size of values of a character, expressed as a function of the degree of the character, for exceptional compact Lie groups. This research completes the work of other researchers, who had previously obtained results for classical compact Lie groups.

In a third paper she makes a model-theoretic investigation of exotic identities of the positive integers. An exotic identity is one involving addition, multiplication, and exponentiation that is not a consequence of eleven basic arithmetic identities, articulated by Dedekind in 1888.

The committee was impressed by the quality of the papers, the enthusiastic letters from her mentors, and the speed and independence of her research. The committee is proud to honor Karen Yeats with this award.

Biographical Sketch

Karen Yeats is a native of Halifax, NS, Canada. She began enjoying mathematics through regional, national (Canadian), and foreign contests. She entered the University of Waterloo in September 1998 and graduated with an honors BMath in Pure Math and a Governor General's Silver Medal in 2003. During that time she had the opportunity to spend three summers as an NSERC (Natural Sciences and Engineering Research Council of Canada) undergraduate research assistant and benefited greatly from the strong faculty and program in pure mathematics at Waterloo. She is now pursuing a Ph.D. in mathematics at Boston University. Karen is an accomplished recorder player and also enjoys playing clarinet and singing in choirs, as well as the occasional foray into making teddy animals and working on free software.

Response

I am truly honored to have been named honorable mention for this year's Morgan Prize. Great thanks to the creators and organizers to whom the prize owes its existence. I also owe great thanks to NSERC, Kathryn Hare, Frank Zorzitto, and especially Stan Burris for my summer research terms, which have made all this possible. At the University of Waterloo I also want to thank everyone in Math and Pure Math for making it clear to me that I was in the right place from the very beginning, and in Halifax to everyone who encouraged me on the contests.

Mathematics People

Dawson Awarded CRM-Fields Prize

Donald Dawson, professor emeritus at Carleton University, has been awarded the 2004 CRM-Fields Prize. The prize, awarded annually by the Centre de Recherches Mathématiques in Montreal and The Fields Institute for Research in Mathematical Sciences in Toronto, recognizes exceptional contributions by a mathematician working in Canada. The prize carries a cash award of 5,000 Canadian dollars (approximately US$3,850), and the recipient is expected to present a lecture at the CRM and at The Fields Institute.

Donald Dawson

Dawson was recognized for exceptional achievement in the field of probability. He has made seminal contributions to the study of spatially distributed stochastic processes and infinite-dimensional branching systems, including the Dawson-Watanabe superprocess.

Dawson received his B.Sc. from McGill in 1958 and his doctorate from the Massachusetts Institute of Technology in 1963. He taught at both McGill University and Carleton University, where he is now professor emeritus. His leadership within the Canadian mathematical community includes a term as director of The Fields Institute from 1996 to 2000.

Dawson is a fellow of the Royal Society of Canada, the International Statistical Institute, and the Institute of Mathematical Statistics. Other honors include the 1991 Gold Medal Lecture of the Statistical Society of Canada, the 1994 Jeffery-Williams lecture of the Canadian Mathematical Society (CMS), an invited lecture at the 1994 International Congress of Mathematicians, and The Fields Institute's Distinguished Lecture Series in the Statistical Sciences. His numerous editorial contributions include serving as co-editor-in-chief of the *Canadian Journal of Mathematics*. He has served his profession through numerous committees of the CMS and of the National Science and Engineering Research Council. He is currently president-elect of the Bernoulli Society for Mathematical Statistics and Probability.

Previous recipients of the CRM-Fields Prize are H. S. M. (Donald) Coxeter, George A. Elliot, James G. Arthur, Robert V. Moody, Stephen A. Cook, Israel Michael Sigal, William T. Tutte, John B. Friedlander, John McKay, and Edwin Perkins.

—From a CRM announcement

AWM Essay Contest Winners Announced

The Association for Women in Mathematics (AWM) has announced the winners of its 2003 essay contest, "Biographies of Contemporary Women in Mathematics". The Grand Prize went to Esther Feldblum, Maimonides School, Sharon, Massachusetts, for her essay "Dr. Harpreet Chowdhary: The Mathematician As Executive". This essay won first place in the grade 9-12 category, and as grand prizewinner it will be published in the *AWM Newsletter*. The first-place winner in the college category was Jessica John of Willamette University, Salem, Oregon, for "Elizabeth Stanhope: Overcoming Silent Barriers". In the middle school category the first-place winner was Sergei Shubin of Joaquin Miller Middle School, San Jose, California, for "I Seek an Answer to the Question 'Why?'—Dr. Helen Moore". A complete list of the winners, as well as copies of their essays, may be found on the AWM website at `http://www.awm-math.org/biographies/contest/2003.html`.

—From an AWM announcement