2007 Steele Prizes

The 2007 Leroy P. Steele Prizes were awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

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 1905–1906, and Birkhoff served in that capacity during 1925–1926. 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: 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 US$5,000.

The Steele Prizes are awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prizes, the members of the selection committee were: Rodrigo Banuelos, Daniel S. Freed, John B. Garnett, Victor W. Guillemin, Nicholas M. Katz, Linda P. Rothschild (chair), Donald G. Saari, Julius L. Shaneson, and David A. Vogan.

The list of previous recipients of the Steele Prize may be found on the AMS website at `http://www.ams.org/prizes-awards`.

The 2007 Steele Prizes were awarded to DAVID B. MUMFORD for Mathematical Exposition, to KAREN K. UHLENBECK for a Seminal Contribution to Research, and to HENRY P. MCKEAN 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.

Mathemamatical Exposition: David B. Mumford

Citation

The Leroy P. Steele Prize for Mathematical Exposition is awarded to David Mumford in recognition of his beautiful expository accounts of a host of aspects of algebraic geometry. His *Red Book of Varieties and Schemes*, which began life over forty years ago, introduced successive generations of beginning students to "modern" algebraic geometry and to how the "modern" theory clarifies classical problems. Students could then go on to his 1970 book *Abelian Varieties*, where the whole theory is developed "without the crutch of the Jacobian", and which remains the definitive account of the subject. Here again the classical theory is beautifully intertwined with the modern theory, in a way which sharply illuminates both. Students who wanted to learn about the crutch of the Jacobian had to wait for his 1974 Michigan lectures *Curves and their Jacobians*, now reprinted with the latest reedition of the *Red Book*. Two years later saw the appearance of *Complex Projective Varieties*. And the years 1983–1991 saw the appearance of his three-volume *Tata Lectures on Theta Functions*. In all of these books, there is constant interaction between modern methods and classical problems, leading the reader to a deeper appreciation of both. This modern-classical interaction also underlies, at the more abstruse level, his 1965 book *Geometric Invariant Theory* and his 1966 book *Lectures on Curves on an Algebraic Surface*, a pair of books which provided many advanced readers their baptism by fire into the world of moduli spaces. All of these books are, and will remain for the foreseeable future, classics to which the reader returns over and over.

Biographical Sketch

David Mumford was born in Sussex, England, in 1937, but grew up in the U.S. from 1940 on. He went to Harvard University as a freshman in 1953 and stayed there until 1996, working up through the ranks. He was awarded a Fields Medal in 1974, was chair of the Department of Mathematics in 1981–84, and became also a member of the Division of Applied Sciences in 1985. In 1996, he moved to the Division of Applied Mathematics at Brown University, joining its strong interdisciplinary program. He delivered the AMS Gibbs Lecture entitled "The shape of objects in two and three dimensions" in 2003.

His research was in algebraic geometry from roughly 1960 to 1983. His focus was the construction and analysis of moduli spaces, especially that of curves and abelian varieties. From 1984 to the present, his research has concerned the construction of mathematical models for the understanding of perception, a field called Pattern Theory by its founder Ulf Grenander. Mumford's focus here has been the modeling of vision by computer and in the animal brain, especially statistical models.

Response

I am very honored by receiving this prize and also, as it is many years since I worked in algebraic geometry, very surprised to hear that people still read my books on the subject. The subject has grown in so many exciting and unexpected ways in the last few decades. It may be of some interest to recall what the state of that field was when I was a graduate student in the 1950s. Firstly, it was said that, between them, Zariski and Weil knew everything about the field and, if neither of them knew some fact, it was probably wrong or unimportant. But one thing they were both struggling with was finding a language in which they could express both characteristic p geometry and the arithmetic structures which bound it with characteristic 0, yet retain the geometric intuition which had so often driven the field. When pressed, all of his students had seen Zariski draw a small lemniscate on the corner of the blackboard, away from the mass of algebraic formulas, to revive his geometric intuition. Then Grothendieck arrived on the scene and with a simplicity that was pure genius defined the concept "spec", saying that all prime ideals were to be treated as points. About this time, I was reading, in Klein's history of nineteenth century mathematics, how Kronecker had started on the same road of integrating number theory and geometry—"*Es bietet sich da ein ungeheurer Ausblick auf ein rein theoretisches Gebiet* [It offered an enormous view of a purely theoretical area]". Well, that was what we grad students thought too!

But I loved pictures. I drew cartoons like those in the accompanying figure in my *Red Book* showing how everyone probably thought about schemes. I was amused when a book on *Five Centuries of French Mathematics* asked to include these cartoons with the description: "*Par nature, la notion de schema est trop abstraite pour être reellement 'desinée'. Ces dessins sont dus à l'auteur d'un des rares livres de géométrie algébrique qui osa se lancer dans telle aventure* [By its nature, the notion of scheme is too abstract to really be 'drawn'. These drawings are by an author of one of those rare books of algebraic geometry that dared to fling itself into such an adventure]". After all, it was the French who started impressionist painting and isn't this just an impressionist scheme for rendering geometry?

David B. Mumford

The connections between traditional Italian algebraic geometry and Grothendieck's ideas continued to fascinate me. My book *Lectures on Curves on an Algebraic Surface* was written to show how wonderfully Grothendieck's ideas had completed one of the great quests of the Italian geometers. That was the problem of relating two ways of measuring the "irregularity" of an algebraic surface: could you find algebraic but not linear families of divisors whose dimension was H^1 of the structure sheaf (they called it $p_a - p_g$)? Over the complex numbers, the theory of harmonic forms had come to the rescue and proved this, but they sought an algebraic proof. Grothendieck, by representing functors defined on arbitrary schemes, had, *in passing*, solved this. All you needed at the end was the simple fact that characteristic 0 group schemes were reduced and out it pops. What a triumph for the great abstraction with which he formulated mathematics.

One of the most moving sequels for me was that these books were translated into Russian—several of them by Manin himself—and reached what was then the isolated school of Russian algebraic geometers. I want to thank both Manin and my many co-authors, Ash, Bergman, Fogarty, Kempf, Knudsen, Kirwan, Nori, Norman, Ramanujam, Rapaport, Saint-Donat, and Tai, who have added wonderful material. Writing books is often a team effort and working with all these collaborators has been a major stimulus for me. I am deeply grateful to them all and to the prize committee for this recognition.

Seminal Contribution to Research: Karen K. Uhlenbeck

Citation

The 2007 Steele Prize for a Seminal Contribution to Mathematical Research is awarded to Karen Uhlenbeck for her foundational contributions in analytic aspects of mathematical gauge theory. These results appeared in the two papers:

1) "Removable singularities in Yang-Mills fields", *Comm. Math. Phys.* **83** (1982), 11–29; and

2) "Connections with bounds on curvature", *Comm. Math. Phys.* **83** (1982), 31–42.

Connections are local objects in differential geometry, just as functions are local. But there are two crucial differences. First, connections admit automorphisms, called gauge transformations. Thus there are several different local representations of a connection. Second, the basic elliptic equation on functions—the Laplace equation—is linear whereas its counterpart on connections—the Yang-Mills equation—is nonlinear and not even elliptic as it stands. Its nonellipticity is tied up with the existence of automorphisms. One of Uhlenbeck's fundamental results proves the existence of good local representatives for connections, called Coulomb gauges. The Yang-Mills equations become elliptic when restricted to Coulomb gauges, and so Uhlenbeck deduces many basic theorems: smoothness of solutions, compactness of solutions with bounds on the curvature, etc. Uhlenbeck also proves that solutions to the Yang-Mills equations defined on a punctured ball with suitable boundedness on the curvature extend over the puncture. (Compare the much easier Riemann removable singularities theorem in complex analysis.) These theorems and the techniques Uhlenbeck introduced to prove them are the analytic foundation underlying the many applications of gauge theory to geometry and topology. The most immediate was Donaldson's work in the 1980s on smooth structures on 4-manifolds through invariants of the anti-self-dual equations, a system of first-order partial differential equations closely related to the Yang-Mills equations. Recall that Donaldson proved the existence of topological 4-manifolds which admit no smooth structure and topological 4-manifolds which admit inequivalent smooth structures. These equations have also advanced the theory of stable vector bundles in algebraic geometry. The analysis of various dimensional reductions of the anti-self-dual equations—the monopole and vortex equations and other closely related equations of gauge theory—begins with Uhlenbeck's theorems. More recently, these gauge theoretic ideas have yielded new insights in symplectic and contact geometry.

Karen K. Uhlenbeck

Biographical Sketch

Karen K. Uhlenbeck spent her early years in New Jersey, after which she attended the University of Michigan. She received her Ph.D. in 1968 under the direction of Richard Palais at Brandeis University. She has held posts at the Massachusetts Institute of Technology, the University of California at Berkeley, the University of Illinois in both Champaign-Urbana and Chicago, and the University of Chicago. Since 1988 she has held the Sid W. Richardson Foundation Regents Chair in Mathematics at the University of Texas in Austin.

Uhlenbeck is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. She received a MacArthur Prize Fellowship in 1983, the Commonwealth Award for Science and Technology in 1995, and the National Medal of Science in 2000. Uhlenbeck is a co-founder of the IAS/Park City Mathematics Institute and the program for Women and Mathematics in Princeton.

Response

I thank the American Mathematical Society, its members and the Steele Prize committee for the honor and the award of the Steele Prize.

This honor confirms what I have been suspecting for quite some time. I am becoming an old mathematician, if I am not already there. It gives me cause to look back at my research and teaching. All in all, I have found great delight and pleasure in the pursuit of mathematics. Along the way I have made great friends and worked with a number of creative and interesting people. I have been saved from boredom, dourness, and self-absorption. One cannot ask for more.

My mathematical career has intersected some exciting mathematical changes. My thesis, written under Richard Palais, was written in the thick of the days of "Global Analysis", a period in which the tools and methods of differential topology were applied to analysis problems. This fell into disfavor, but it must be admitted that these ideas are today taken as a matter of course as part of the subject of analysis. During my days as an analyst, I wrote a paper on the regularity of elliptic systems, which I still think is the hardest paper I ever wrote.

The next revolution was single-handedly sponsored and spearheaded by S. T. Yau, who introduced techniques of analysis into the problems of topology, differential geometry, and algebraic geometry. Mind you, S. T. Yau was quite something in his younger days! I am quite proud of the paper I wrote with Jonathan Sachs on minimal spheres. Next we come to the introduction of gauge theory into topology, where I did the work which is cited in the award. I had started work on the analysis of gauge theory after hearing a lecture by Michael Atiyah on gauge theory at the University of Chicago, and was fully prepared to understand the thesis of his student Simon Donaldson, which used the two papers cited in this award. The work of Donaldson and Cliff

Taubes, whom I met when he was still a graduate student, was the start of a new era in four-manifold topology. Finally, due to what was now an addiction to intellectual excitement, I tried to follow the influence of physics on geometry which is associated with the name of Ed Witten. My work in integrable systems grew out of this connection with physics. This part of my career was not entirely successful. The more physics I learned, the less algebraic geometry I seemed to know.

Given that I started my academic career in the late 1960s at the University of California, Berkeley, during the Vietnam War, where protests and tear gas were commonplace, it must be said that I rarely found mathematics and the academic life boring.

The accomplishments of which I am most proud are not exactly mathematical theorems. One does mathematics because one has to, and if it is appreciated, all the better! However, encouraged by my young and enthusiastic colleague Dan Freed, I became involved in educational issues. We were among the founders of the IAS/Park City Mathematics Institute. The original intent was to bring mathematics researchers, students, and high school teachers together. This is now an ongoing institution with a yearly summer school, overseen by the Institute for Advanced Study in Princeton. The Women and Mathematics Program at IAS is an outgrowth of the Park City Institute. Founded by my collaborator Chuu-Lian Terng and me, the original purpose was to encourage and prepare more women to take part in the Park City Summer School. It has now grown to a self-sufficient two-week yearly program sponsored by IAS. I watch with real delight the emergence of our graduates into prominence in the mathematics community.

Another outcome of this involvement with education is our Saturday Morning Math Group at the University of Texas. We started this in conjunction with the beginnings of Park City. It is now an ongoing program which our graduate students organize for local high school students. It is often cited and much boasted of by our university. Finally, I would like to boast further of my department at the University of Texas. During the years that I have held an endowed chair in this department, we have become one of the leading departments of mathematics, admittedly below the top ranked, but still quite respectable. Certainly this is due mostly to my colleagues but I take a little credit. Our primary benefactor is also due some praise. We used to "thank Peter" after a particularly enjoyable colloquium talk and dinner and I do again now.

Starting from my days in Berkeley, the issue of women has never been far from my thoughts. I have undergone wide swings of feeling and opinion on the matter. I remain quite disappointed at the numbers of women doing mathematics and in leadership positions. This is, to my mind, primarily due to the culture of the mathematical community as well as harsh societal pressures from outside. Changing the culture is a momentous task in comparison to the other minor accomplishments I have mentioned.

I want to end by thanking my thesis advisor, Richard Palais, my two present collaborators Chuu-Lian Terng and Andrea Nahmod, my longtime friend and supporter, S. T. Yau, my colleagues, particularly Dan Freed and Lorenzo Sadun as well as all my collaborators, Ph.D. students, and assistants. My husband, Bob Williams, is due a share in this award.

Lifetime Achievement: Henry P. McKean

Citation

McKean launched his rich and magnificent mathematical career as an analytically oriented probabilist. After completing his thesis, which is motivated by, but makes essentially no explicit use of, probability theory, he began his collaboration with K. Itô. Together, he and Itô transformed Feller's analytic theory of one dimensional diffusions into probability theory, a heroic effort that is recorded in their famous treatise *Diffusion Processes and Their Sample Paths* [Die Grundlehren der mathematischen Wissenschaften, Band 125, Springer-Verlag, 1974]. After several years during which he delved into a variety of topics with probabilistic origins, spanning both Gaussian and Markov processes and including the first mathematically sound treatment of "American options", I. M. Singer deflected McKean's attention from probability and persuaded him to turn his powerful computational skills on a problem coming from Riemannian geometry. The resulting paper remains a milestone in the development of index theory.

Henry P. McKean

After moving to the Courant Institute, McKean played a central role in the creation of the analytic ideas which underpin our understanding of the KdV and related nonlinear evolution equations, and here again his computational prowess came to the fore. In recent years, McKean has returned to his probabilistic past, studying measures in pathspace, which are the "Gibbs" state for various nonlinear evolutions.

McKean has had profound influence on his own and succeeding generations of mathematicians. In addition to his papers and his book with Itô, he has authored several books that are simultaneously erudite and gems of mathematical exposition. Of particular importance is the little monograph in which he introduced Itô's theory of stochastic integration to a wide audience. As his long list of students attests, he has also had enormous impact on the careers of people who have been fortunate enough to study under his direction.

Biographical Sketch

Henry McKean was born in Wenham, Massachusetts, in 1930. He graduated from Dartmouth College (A.B. 1952), spent a year at Cambridge University (1952–53), then went to Princeton University (Ph.D. 1955). He worked at the Massachusetts Institute of Technology (1958–66), at Rockefeller University (1966–70), and since then at the Courant Institute, of which he was director (1988–92). In the year 1979–80 he was George Eastman Professor at Balliol College, Oxford. He is a member of the American Academy of Arts and Sciences and of the National Academy of Sciences and received a Doctor Honoris Causa from the University of Paris in 2002.

Introduced to probability by M. Kac (summer school, MIT, 1949), McKean continued in this subject for some twenty-five years with W. Feller (1953–56) and in a long collaboration with K. Itô (1952–65), including a visit to Kyoto (1957–58). In 1974 his interests shifted to Hamiltonian mechanics, in particular, to the application of infinite-genus projective curves to KdV, on which he spoke at the International Congress of Mathematicians in Helsinki in 1978, in parallel to S. P. Novikoff's report on the same topic. Now he alternates between "KdV and all that" and his old affection for Brownian motion.

Response

I have been lucky in my mathematical life. Now comes this new piece of luck, the Steele Prize, something I never imagined I might receive and am very grateful for. In school, I really disliked mathematics with its tiresome triangles and its unintelligible x until I began to learn calculus from the amiable Dr. Conwell. Then I saw that you could do something with it, and that was exciting. Besides, I was better at it than the other kids and I liked that *very* much. Coming to Dartmouth (not so much as to learn anything particular, but to ski) I knew I liked mathematics pretty well but decided on it only little by little, thinking I might be an oceanographer. (A skiing accident helped concentrate my mind.) There I started to read P. Levy on Brownian motion, the first love of my mathematical life, and I worked on that and related things with Kac, Feller, Itô, and Levinson who taught me so much, and not just in mathematics. This went on from 1949 to 1972 or so when I began to look for something else to do.

One morning in 1974 Pierre Van Moerbeke came and told me that KdV could be solved by an elliptic function, and being an amateur of these, I sat up, took notice, and made a 90-degree turn into Hamiltonian mechanics and the (to me) very surprising use of infinite-genus projective curves for solving mechanical problems with an infinite number of commuting constants of motion. This led to delightful collaborations with van Moerbeke, Trubowitz, Moser and Airault, Ercolani, and others, building on Peter Lax's deep understanding of the question and paralleling the work of S. P. Novikoff and his school. At the beginning, we knew nothing of algebraic geometry. I remember a private seminar with Sarnak, Trubowitz, Varadhan, and others: how we would get the giggles at how little we understood—except for Sarnak, who was way ahead. Anyhow, a beautiful picture slowly emerged, though it is still a mystery to me what projective curves have to do with all those constants of motion. I mean, why is complex structure hidden there? I suppose it must come from the fact that the "n choose 2" system of vanishing brackets for n constants of motion is vastly over-determined. But that is just one of the queer things about "KdV and all that".

Well then: I have been lucky in my teachers, in my collaborations, and in my students. A few of those last are named above. The others know who they are. My thanks to them all: to those still present and to those present only to memory, of whom I count myself merely the representative in the receipt of this generous prize.

2007 Conant Prize

The 2007 Levi L. Conant Prize was awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

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 US$1,000.

The Conant Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prize, the members of the selection committee were: Noam D. Elkies, Carl R. Riehm, and Mary Beth Ruskai.

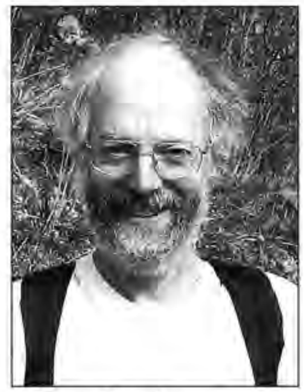
Previous recipients of the Conant Prize are: Carl Pomerance (2001), Elliott Lieb and Jakob Yngvason (2002), Nicholas Katz and Peter Sarnak (2003), Noam D. Elkies (2004), Allen Knutson and Terence Tao (2005), and Ronald M. Solomon (2006).

The 2007 Conant Prize was awarded to JEFFREY WEEKS. The text that follows presents the committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

The Conant prize in 2007 is awarded to Jeffrey Weeks for his article "The Poincaré Dodecahedral Space and the Mystery of the Missing Fluctuations" [*Notices*, June/July 2004]. In this article, together with an earlier one "Measuring the Shape of the Universe" [*Notices*, December 1998], co-authored with Neil Cornish, Weeks explains how extremely sensitive measurements of microwave radiation across the sky provide information about the origins and shape of the universe.

After giving some physical background, Weeks summarizes the evidence for and against a universe that locally looks like a spherical, Euclidean, or hyperbolic 3-manifold. He then considers spherical universes in more detail, emphasizing the role of symmetry groups and making a case for a model based on the Poincaré dodecahedral space. Throughout the paper, he makes this material accessible by using analogies with more familiar structures in one and two dimensions. He gives a particularly elegant exposition of the free symmetry groups of the 3-sphere via an extension of rotation groups of the 2-sphere.



Jeffrey Weeks

Most accounts of the development of physical theories are presented after the dust has settled and the experimental evidence has convinced most scientists. Weeks has explained the mathematics behind models whose validity cosmologists debate while waiting for more experimental evidence. Whether or not the dodecahedral model turns out to be consistent with future observations remains to be seen. In either case, Weeks has given a rare glimpse into the role of mathematics in the development and testing of physical theories.

Biographical Sketch

Jeff Weeks fell in love with geometry in the 12th grade when he read *Flatland*. While an undergraduate at Dartmouth College he bounced back and forth between math and physics, eventually settling on math. He went on to study 3-manifolds under Bill Thurston at Princeton but maintained his interest in physics on the sly. After a few years teaching at Stockton State College and Ithaca College, Weeks resigned to be a full-time dad for a few years. From there he fell into the life of a freelance mathematician, at first part-time, then full-time. He has enjoyed extensive work with the Geometry Center and the National Science Foundation as well as smaller gigs for science museums and teaching at Middlebury College. In 1999 a telephone call from the MacArthur Foundation brought five years of work with zero administrative overhead. The timing could not have been better: 1999–2004 was an intense period for cosmic topology, as well as the time to finish the unit Exploring the Shape of Space for middle schools and high schools. Weeks currently splits his time between puzzling over the microwave background and writing Macintosh versions of his geometry and topology software.

Response

Mathematics, physics, and astronomy share a deep common history. It's been a pleasure working in this tradition, and I'm particularly pleased that *Notices* readers enjoyed hearing one small piece of the ongoing story.

As for the cosmic microwave background, new satellite data (WMAP 2006) and more detailed analysis (carefully excluding a neighborhood of the galactic plane) find the large-scale fluctuations to be even weaker than previously thought, implying that we're seeing something real and not just a statistical fluke. Nontrivial cosmic topology could account for the weakness, but so far no rigorous evidence exists for this or any other explanation. Mother Nature is keeping us guessing.

2007 Morgan Prize

The 2007 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 New Orleans in January 2007.

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 of Allentown, Pennsylvania, 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 US$1,000.

Recipients of the Morgan Prize are chosen by a joint AMS-MAA-SIAM selection committee. For the 2007 prize, the members of the selection committee were: Kelly J. Black, James H. Curry, Herbert A. Medina (chair), Karen E. Smith, Judy L. Walker, and Paul Zorn.

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), Joshua Greene (2002), Melanie Wood (2003), Reid Barton (2005), and Jacob Fox (2006).

The 2007 Morgan Prize was awarded to Daniel Kane. The text that follows presents the selection committee's citation, a brief biographical sketch, and the awardee's response upon receiving the prize.

Citation

Daniel Kane is majoring in both mathematics and physics at the Massachusetts Institute of Technology (MIT) and expects to receive his bachelor's degree in June 2007. At this early stage of his mathematical career, Daniel has already established a research record that would be the envy of many professional mathematicians. Indeed, he has authored or co-authored ten articles that have appeared or will soon appear (have been accepted) in research journals including the *Proceedings of the American Mathematical Society, The Ramanujan Journal, The Journal of Number Theory, Foundations of Computer Science,* and *Integers: Electronic Journal of Combinatorial Number Theory.* In addition, he has six other research papers that have been submitted or are in preparation for a total of sixteen research papers! The specifics of his research are too long to detail, but we mention that it has been in fields as diverse as number theory, computer science, ergodic theory, combinatorics, computational geometry, and game theory.

Daniel Kane

Mr. Kane's mathematical talent is captured well in some of the comments/summaries contained in the letters supporting his nomination for the prize:

- "Daniel's first paper improves on a famous *Annals of Mathematics* paper by Paul Erdős."
- "He proved an open conjecture stated by a well-known number theorist several years before. It [Kane's paper] was written while Daniel was in 12th grade."
- "He is by far the sharpest and most productive math undergraduate I have come in contact with in my five years [at MIT]."

In addition to all of his mathematical research, Daniel is also a three-time Putnam Fellow and two-time International Mathematical Olympiad (IMO) Gold Medalist.

Biographical Sketch

Daniel Kane was born in Madison, Wisconsin, to professors of mathematics and of biochemistry. His schooling began at Wingra, a private school unusual in its noncompetitive policies and open classrooms. When it became clear (in about the third grade) that he was ready for high school math, he was allowed to do more advanced math assigned by his parents. Due to this head start, he was ready to begin taking university classes at the beginning of high school. After graduating, Kane went to MIT to study mathematics and physics.

Kane first learned about mathematical problem solving through the University of Wisconsin's Van Vleck Talent search. This training helped immensely when he took the USA Mathematical Olympiad in the 7th grade, qualifying for the Mathematical Olympiad Program (MOP), which he continued to attend for the duration of high school, earning two IMO gold medals.

Kane became interested in research near the end of high school, when he did work on modular forms under the supervision of Ken Ono. In college his opportunities for research expanded greatly, including the summer programs at Williams College and University of Minnesota-Duluth, class projects, and competitions.

Response

In receiving this award I would like to extend my thanks to all of those who helped make it possible. Most importantly, I would like to thank my parents for giving me such a good environment to grow up in and in particular my dad for teaching me and helping me to develop my love of mathematics. Thanks are also due to those who helped me get started learning mathematical problem solving skills such as Marty Isaacs, who ran the Van Vleck Talent Search, and Titu Andreescu and the other MOP instructors. I would like to thank those who helped supervise parts of my research, namely, Ken Ono, Joe Gallian, Cesar Silva, and Erik Demaine. Lastly, I would like to thank my many teachers over the years who have provided me with the knowledge base to be able to conduct interesting research in so many areas.

2007 Satter Prize

The 2007 Ruth Lyttle Satter Prize in Mathematics was awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

The Satter Prize is awarded every two years to recognize an outstanding contribution to mathematics research by a woman in the previous five years. Established in 1990 with funds donated by Joan S. Birman, the prize honors the memory of Birman's sister, Ruth Lyttle Satter. 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 carries a cash award of US$5,000.

The Satter Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prize, the members of the selection committee were: Benedict H. Gross, Karen E. Smith, and Chuu-Lian Terng (chair).

Previous recipients of the Satter Prize are: Dusa McDuff (1991), Lai-Sang Young (1993), Sun-Yung Alice Chang (1995), Ingrid Daubechies (1997), Bernadette Perrin-Riou (1999), Karen E. Smith (2001), Sijue Wu (2001), Abigail Thompson (2003), and Svetlana Jitomirskaya (2005).

The 2007 Satter Prize was awarded to CLAIRE VOISIN. 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 Ruth Lyttle Satter Prize is awarded to Claire Voisin of the Institut de Mathématiques de Jussieu for her deep contributions to algebraic geometry, and in particular for her recent solutions to two long-standing open problems. Voisin solved the Kodaira problem in her paper "On the homotopy types of compact Kähler and complex projective manifolds", *Invent. Math.* **157** (2004), no. 2, 329–343. There she shows that in every dimension greater than three, there exist compact Kähler manifolds not homotopy equivalent to any smooth projective variety. This problem has been open since the 1950s when Kodaira proved that every compact Kähler surface is diffeomorphic to (and hence homotopy equivalent to) some projective algebraic variety. Her idea is to start with the fact that certain endomorphisms can prevent a complex torus from being realized as a projective variety, and then to construct Kähler manifolds whose Albanese tori must carry such endomorphisms for homological reasons. In a completely different direction, Voisin also solves Green's Conjecture in her papers "Green's canonical syzygy conjecture for generic curves of odd genus", *Compos. Math.* **141** (2005), no. 5, 1163–1190, and "Green's generic syzygy conjecture for curves of even genus lying on a K3 surface", *J. Eur. Math. Soc.* **4** (2002), no. 4, 363–404.

Claire Voisin

A century ago, Hilbert saw that syzygies (relations among relations) were important invariants of varieties in projective space, and in the early 1980s, Mark Green conjectured that the syzygies of a general curve canonically embedded in projective space should be as simple as possible. This conjecture attracted a huge amount of effort by algebraic geometers over twenty years before finally being settled by Voisin. Her idea is to work with curves on a suitable K3 surface, where she executes deep calculations with vector bundles (at least in even genus) that lead to the required vanishing theorems.

Biographical Sketch

Claire Voisin defended her thesis in 1986 under the supervision of Arnaud Beauville. She began employment in the Centre National de la Recherche Scientifique as *chargée de recherche* in 1986 and since then pursued her career in this institution. She occasionally taught graduate courses but mainly does research and advises students. Her honors include the European Mathematical Society Prize (1992), the Servant Prize (1996) and the Sophie Germain Prize (2003) of the Académie des Sciences de Paris, and the silver medal of the CNRS (2006). She was an invited speaker at the International Congress of Mathematicians in 1994 in Zurich.

Response

I am deeply honored to have been chosen to receive the 2007 Ruth Lyttle Satter Prize. I feel of course very encouraged by this recognition of my work. I would like to thank the members of the prize committee for selecting me. I am also very grateful to my institution, the CNRS, which made it possible for me to do research in the best conditions.

2007 Wiener Prize

The 2007 AMS-SIAM Norbert Wiener Prize in Applied Mathematics was awarded at the Joint Mathematics Meetings in New Orleans in January 2007.

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 US$5,000.

The recipient of the Wiener Prize is chosen by a joint AMS-SIAM selection committee. For the 2007 prize, the members of the selection committee were: Percy A. Deift (chair), David B. Mumford, and Stanley J. Osher.

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), Arthur T. Winfree (2000), and James Sethian (2004).

The 2007 Wiener Prize was awarded to Craig Tracy and Harold Widom. The text that follows presents the selection committee's citation, a brief biographical sketch of each awardee, and their response upon receiving the prize.

Craig Tracy

Harold Widom

Citation

Craig Tracy and Harold Widom have done deep and original work on Random Matrix Theory, a subject which has remarkable applications across the scientific spectrum, from the scattering of neutrons off large nuclei to the behavior of the zeros of the Riemann zeta-function.

The contributions of Tracy and Widom center around a connection between a class of Fredholm determinants associated with random matrix ensembles on the one hand, and Painlevé functions on the other. Most notably, they have introduced a new class of distributions, the so-called Tracy-Widom distributions, which have a universal character and which have applications, in particular, to Ulam's longest increasing subsequence problem in combinatorics, tiling problems, the airline boarding problem of Bachmat et al., various random walker and statistical mechanical growth models in the KPZ class, and principal component analysis in statistics when the number of variables is comparable to the sample size.

The committee also recognizes the earlier work of Craig Tracy with Wu, McCoy, and Barouch, in which Painlevé functions appeared for the first time in exactly solvable statistical mechanical models. In addition, the committee recognizes the seminal contributions of Harold Widom to the asymptotic analysis of Toeplitz determinants and their various operator theoretic generalizations.

Biographical Sketch: Craig Tracy

Craig Arnold Tracy was born in England on September 9, 1945, the son of Eileen Arnold, a British subject, and Robert C. Tracy, an American serving in the U.S. Army. After immigrating to the United States as an infant, Tracy grew up in Missouri where he attended the University of Missouri at Columbia, graduating in 1967 as an O. M. Stewart Fellow with a B.S. degree in physics. He began his graduate studies as a Woodrow Wilson Fellow at the State University of New York at Stony Brook, where he wrote his doctoral dissertation under the supervision of Barry M. McCoy. After postdoctoral positions at the University of Rochester (1973–75) and the C. N. Yang Institute for Theoretical Physics (1975–78), Tracy was at Dartmouth College for six years before joining the University of California, Davis, in 1984. He is currently Distinguished Professor of Mathematics at UC Davis. In 2002 Tracy was awarded, jointly with Harold Widom, the SIAM George Pólya Prize. He is a member of the American Academy of Arts and Sciences. Tracy has two daughters and three grandchildren. He is married to Barbara Nelson, and they reside in Sonoma, California.

Biographical Sketch: Harold Widom

Harold Widom is professor emeritus at the University of California, Santa Cruz. He grew up in New York City, where he attended Stuyvesant High School and the City College of New York. He did his graduate work at the University of Chicago, receiving his Ph.D. under the supervision of Irving Kaplansky. His first academic position was at Cornell University where, inspired by Mark Kac, he turned his attention to the study of Toeplitz and Wiener-Hopf operators. This influenced much of his subsequent research and led ultimately to his work (largely in collaboration with Craig Tracy) in integrable systems and random matrix theory.

He is a member of the American Academy of Arts and Sciences and in 2002 received, jointly with Tracy, the SIAM George Pólya Prize. He is an associate editor of *Asymptotic Analysis; Journal of Integral Equations and Applications*; and *Mathematical Physics, Analysis and Geometry*. He is an honorary editor of *Integral Equations and Operator Theory*.

Response

We are honored to be named the recipients of the 2007 AMS-SIAM Norbert Wiener Prize in Applied Mathematics. We thank the members of the Selection Committee for their consideration and in particular for their recognition of our field of random matrix theory and integrable systems. Underlying much of our own research have been Wiener-Hopf operators and Wiener processes, so it is especially gratifying to receive this prize, named for Norbert Wiener. We thank AMS and SIAM for this honor.

One of us (Tracy) would like to acknowledge the support, early in his career, from Barry M. McCoy, J. Laurie Snell, Tai Tsun Wu, and Chen Ning Yang. We both express our appreciation of Estelle L. Basor, with whom we wrote our first joint paper on random matrices.

And we thank the diverse group of researchers in random matrix theory and integrable systems for making this an exciting field in which to work.

2007 Veblen Prize

The 2007 Oswald Veblen Prize in Geometry was awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

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 1923–1924. It carries a cash award of US$5,000.

The Veblen Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prize, the members of the selection committee were: Cameron M. Gordon, Michael J. Hopkins (chair), and Ronald J. Stern.

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 Casson (1991), Clifford H. Taubes (1991), Richard Hamilton (1996), Gang Tian (1996), Jeff Cheeger (2001), Yakov Eliashberg (2001), Michael J. Hopkins (2001), and David Gabai (2004).

The 2007 Veblen Prize was awarded to two pairs of collaborators: to PETER KRONHEIMER and TOMASZ MROWKA, and to PETER OZSVÁTH and ZOLTÁN SZABÓ. The text that follows presents the selection committee's citations, brief biographical sketches, and the awardees' responses upon receiving the prize.

Citation: Peter Kronheimer and Tomasz Mrowka

The 2007 Veblen Prize in Geometry is awarded to Peter Kronheimer and Tomasz Mrowka for their joint contributions to both three- and four-dimensional topology through the development of deep analytical techniques and applications. In particular the prize is awarded for their seminal papers:

Peter Kronheimer

Tomasz Mrowka

"Embedded surfaces and the structure of Donaldson's polynomial invariants", *J. Differential Geom.* **41** (1995), no. 3, 573–734.

Since 1982, most of the progress in four-dimensional differential topology has arisen from the applications of gauge theory pioneered by S. K. Donaldson. In particular, Donaldson's polynomial invariants have been used to prove a variety of results about the topology and geometry of four-manifolds. This paper is one of the pinnacles of this development. It gives a conceptual framework and an organizing principle for some of the disparate observations and calculations of Donaldson invariants that had been made earlier, it reveals a deep structure encoded in the Donaldson invariants which is related to embedded surfaces in four-manifolds, and it has been the point of departure and the motivating example for important further developments, most spectacularly for Witten's introduction of the so-called Seiberg-Witten invariants.

"The genus of embedded surfaces in the projective plane", *Math. Res. Lett.* **1** (1994), no. 6, 797–808.

This paper proves the Thom conjecture, which claims that if C is a smooth holomorphic curve in $\mathbf{C}P^2$, and C' is a smoothly embedded oriented two-manifold representing the same homology class as C, then the genus of C' satisfies $g(C') \geq g(C)$.

"Witten's conjecture and property P", *Geometry and Topology* **8** (2004), 295–310.

Here the authors use their earlier development of Seiberg-Witten monopole Floer homology to prove the Property P conjecture for knots. In other words, if $K \subset S^3$ is a nontrivial knot, and $K_{p/q}$ is the three-manifold obtained by p/q Dehn surgery along K with $q \neq 0$, then $\pi_1(K_{p/q})$ must be nontrivial. The proof is a beautiful work of synthesis which draws upon advances made in the fields of gauge theory, symplectic and contact geometry, and foliations over the past twenty years.

Biographical Sketch: Peter Kronheimer

Born in London, Peter Kronheimer was educated at the City of London School and Merton College, Oxford. He obtained his B.A. in 1984 and his D.Phil. in 1987 under the supervision of Michael Atiyah. After a year as a Junior Research Fellow at Balliol and two years at the Institute for Advanced Study, he returned to Merton as Fellow and Tutor in Mathematics. In 1995 he moved to Harvard University, where he is now William Caspar Graustein Professor of Mathematics. A recipient of the Förderpreis from the Mathematisches Forschungsinstitut Oberwolfach, and a Whitehead Prize from the London Mathematical Society, he was elected a Fellow of the Royal Society in 1997.

Next to mathematics, his main pastime has often been music—the horn in particular, which he studied as a pupil of Ifor James. Peter Kronheimer lives in Newton, Massachusetts, with his wife Jenny and two sons, Matthew and Jonathan.

Biographical Sketch: Tomasz Mrowka

Tom Mrowka is a professor at the Massachusetts Institute of Technology. He received his undergraduate degree from MIT in 1983 and attended graduate school at the University of California at Berkeley, receiving his Ph.D. under the direction of Clifford H. Taubes in 1989. After graduate school he held postdoctoral positions at the Mathematical Sciences Research Institute in Berkeley (1988–89), Stanford (1989–91) and Caltech (1991–92). He held a professorship at Caltech from 1992 until 1996 and was a visiting professor at Harvard (spring of 1995) and at MIT (fall of 1995) before returning to MIT permanently in the fall of 1996.

He received the National Young Investigator Grant of the NSF in 1993 and was a Sloan Foundation Fellow from 1993 to 1995. He gave an invited lecture in the topology section of the 1994 International Congress of Mathematicians in Zurich, the Marston Morse lectures at the Institute for Advanced Study in Princeton in 1999, the Stanford Distinguished Visiting Lecture Series in 2000, the Joseph Fels Ritt Lectures at Columbia University in 2004, and the 23rd Friends of Mathematics Lecture at Kansas State University in 2005.

He works mainly on the analytic aspects of gauge theories and applications of gauge theory to problems in low-dimensional topology.

Response: Peter Kronheimer and Tomasz Mrowka

We are honored, surprised, and delighted to be selected, together with Peter Ozsváth and Zoltán Szabó, as recipients of the Oswald Veblen Prize in Geometry.

The Thom conjecture, and other related questions concerning the genus of embedded 2-manifolds in 4-manifolds, are natural and central questions in 4-dimensional differential topology. After Simon Donaldson's work in gauge theory opened up this field, these problems became tempting targets for the newly available techniques. In the summer of 1989, we were both at MSRI and discussed the idea of using "singular instantons" to prove such conjectures. But it was not until two years later, when we spent a month together at Oberwolfach, that a proof began to emerge of a version of the Thom conjecture for embedded 2-manifolds in *K3* surfaces. This theorem and its proof filled our first two joint papers, and provided the first truly sharp results for the genus problem.

In March 1993, we met at Columbia, at the invitation of John Morgan. We understood that the singular instanton techniques that we had used for the genus problem should lead to universal relations among the values of Donaldson's polynomial invariants for 4-manifolds. At the time, calculating Donaldson's invariants in special cases was a challenging occupation. Although we could see how to prove relations, no coherent picture was emerging; and at the end of this visit, Peter headed to LaGuardia with the forest still not visible for the trees. New York's "Blizzard of the Century" closed the airport, and we worked together for another day, during which we noticed that our relations implied a simple linear recurrence relation for certain values of Donaldson's invariants. This soon led to a beautiful structure theorem for the polynomial invariants in terms of "basic classes", intricately entwined with the genus question through an "adjunction inequality". These developments provided a proof of the Thom conjecture for a large class of algebraic surfaces, though the original version for the complex projective plane had to wait until 1994 and the introduction of the Seiberg-Witten equations.

While techniques from gauge theory revolutionized the field of 4-manifolds, providing answers to many important questions, these ideas had no comparable impact in 3-dimensional topology, where the questions and tools remained very different. Around 1986, Andreas Floer used Yang-Mills gauge theory to define his "instanton homology" groups for 3-manifolds. The Euler number of these homology groups recaptured an integer invariant introduced by Andrew Casson which had already been seen to imply results about surgery on 3-manifolds, including partial results in the direction of the "Property P" conjecture. It seems likely that Floer himself foresaw the possibility of using his homology theory to prove stronger results in the same direction; in particular, he established an "exact triangle" relating the Floer homology groups of the 3-manifolds obtained by three different surgeries on a knot. But a missing ingredient at this time was any very general result stating that these homology groups were not trivial. In 1995 Yasha Eliashberg visited Harvard and lectured on his work with Bill Thurston on foliations and contact structures. It was apparent that these results could be combined with work of Cliff Taubes and Dave Gabai to give a non-vanishing theorem for a version of Floer's homology groups defined using the Seiberg-Witten equations, and to show, for example, that these versions of Floer homology encode sharp information about the genus of embedded surfaces in 3-manifolds. This was the first strong indication that, by combining non-vanishing theorems with surgery exact triangles, one would be able to use Floer groups to obtain significant new results about Dehn surgery. This hope was eventually realized in our joint paper with the other co-recipients of this prize, Peter Ozsváth and Zoltán Szabó, on lens space surgeries, and in the eventual resolution of the Property P conjecture using instanton homology. In the meantime, Ozsváth and Szabó's "Heegaard Floer theory" has transformed the field once again: it has led to a wealth of new results, and open problems to attract a new generation of researchers.

Peter would like to thank his wife Jenny and all his family for their love and support; and his mathematical mentors, Michael Atiyah, Simon Donaldson, and Dominic Welsh, for their guidance.

Tom thanks Gigliola, Mario, and Sofia for the joy they bring. Tom also thanks his teachers Victor Guillemin, Richard Melrose, Raoul Bott, Stephen Smale, John Stallings, and Rob Kirby for lighting up very different directions and ways of thinking at the beginning of his mathematical journey. Special thanks to his advisor Cliff Taubes and to John Morgan whose confidence and interest at the beginning of his career were crucial.

Finally we would both like to thank the American Mathematical Society for recognizing the field of gauge theory and low-dimensional topology with this year's Veblen Prize. We feel privileged to be chosen, together with our co-recipients, as representatives for an area of research that has seen so many exciting developments.

Peter Ozsváth

Zoltán Szabó

Citation: Peter Ozsváth and Zoltán Szabó

The 2007 Veblen Prize is awarded to Peter Ozsváth and Zoltán Szabó in recognition of the contributions they have made to 3- and 4-dimensional topology through their Heegaard Floer homology theory.

Ozsváth and Szabó have developed this theory in a highly influential series of over twenty papers produced in the last five years, and in doing so have generated a remarkable amount of activity in 3- and 4-dimensional topology. Specifically, they are cited for their papers

"Holomorphic disks and topological invariants for closed three-manifolds", *Ann. of Math.* (2) **159** (2004), 1027-1158;

"Holomorphic disks and three-manifold invariants: properties and applications", *Ann. of Math.* (2) **159** (2004), 1159-1245;

"Holomorphic disks and genus bounds", *Geometry and Topology* **8** (2004), 311-334.

The Heegaard Floer homology of a 3-manifold plays a role, in the context of the Seiberg-Witten invariants of 4-manifolds, analogous to that played by Lagrangian Floer homology in the context of the Donaldson invariants. There is also a version for knots, whose Euler characteristic is the Alexander polynomial. It detects the genus of a knot and also whether or not a knot is fibered. The combinatorial nature of these invariants has led to many deep applications in 3-dimensional topology. Among these are results about Dehn surgery on knots, such as the Dehn surgery characterization of the unknot, strong restrictions on lens space and other Seifert fiber space surgeries, and dramatic new results on unknotting numbers. Ozsváth and Szabó have used Heegaard Floer homology to define a contact structure invariant, which has led to new results in 3-dimensional contact topology. They have also defined a new concordance invariant of knots, which gives a lower bound on the 4-ball genus. The 4-dimensional version of Heegaard Floer homology has enabled them to give gauge-theory-free proofs of many of the results in 4-dimensional topology obtained in the last decade using Donaldson and Seiberg-Witten theory, such as the Thom Conjecture on the minimal genus of a smooth representative of the homology class of a curve of degree d in CP^2, and the Milnor Conjecture on the unknotting number of a torus knot.

Biographical Sketch: Peter Ozsváth

Peter Ozsváth was born on October 20, 1967, in Dallas, Texas. He received his B.S. from Stanford University (1989) and his Ph.D. from Princeton University (1994) under the direction of John W. Morgan. He held postdoctoral positions at Caltech, the Max-Planck-Institut in Bonn, the Mathematical Sciences Research Institute in Berkeley, and the Institute for Advanced Study in Princeton. He held faculty positions at Princeton University, Michigan State University, and the University of California, Berkeley. He has been on the faculty at Columbia University since 2002.

Ozsváth received a National Science Foundation Postdoctoral Fellowship and an Alfred P. Sloan Research Fellowship. His invited lectures include an Abraham Robinson Lecture at Yale University (2003), a William H. Roever Lecture at Washington University St. Louis (2004), a Kuwait Foundation Lecture at Cambridge University (2006), and a lecture in the topology section of the International Congress of Mathematicians (2006).

Response: Peter Ozsváth

I am greatly honored to be a co-recipient of of the Oswald Veblen Prize, along with my long-time collaborator Zoltán Szabó, and also Peter Kronheimer and Tomasz Mrowka, whose work has always been a profound source of inspiration for me.

Heegaard Floer homology grew out of our efforts at understanding gauge theory from a more combinatorial point of view. The mathematical starting point was Yang-Mills theory and then Seiberg-Witten theory, which started with the work of S. K. Donaldson, A. Floer, and C. H. Taubes. But we have also been fortunate to be able to draw on the work of many interlocking neighboring fields, including contact and symplectic geometry, where at various times the work of Y. Eliashberg and E. Giroux provided answers to fundamental questions, and also three-manifold topology, where the questions raised by C. Gordon serve as a guiding light and the work of D. Gabai provides powerful tools which fit very neatly into the context of Floer homology.

I would like to thank my family and friends for their support throughout the years, and I also owe a great debt of gratitude to my teachers, coauthors, and students. In particular, I thank Zoltán for those many caffeinated mathematical sessions. I also thank my thesis advisor J. W. Morgan for introducing me to gauge theory and T. S. Mrowka, to whom I have turned many times for insight and advice. I would also like to thank R. Fintushel, R. Kirby, and R. Stern for helping to make the field so pleasant socially and so rich mathematically. I am deeply grateful to my undergraduate teachers P. J. Cohen, R. L. Cohen, R. J. Milgram, and fellow student D. B. Karagueuzian, for introducing me to mathematics. I would also like to thank my more recent collaborators C. Manolescu, S. Sarkar, A. Stipsicz, D. P. Thurston, and my former students E. Grigsby, M. Hedden, P. Sepanski, and the many additional members of the Columbia mathematics department who are constantly bringing new insights to an exciting and ever-developing field.

Biographical Sketch: Zoltán Szabó

Zoltán Szabó was born in Budapest, Hungary, in 1965. He did his undergraduate studies at Eötvös Loránd University in Budapest, and then his graduate studies at Rutgers University with John Morgan and Ted Petrie. He has worked at Princeton University since graduating in 1994. He also spent a year at the University of Michigan in 1999–2000. He has been a professor at Princeton University since 2002. He received a Sloan Research Fellowship and a Packard Fellowship. He was an invited lecturer at the 2006 International Congress of Mathematicians in Madrid, and a plenary speaker at the 2004 European Congress of Mathematics in Stockholm. Szabó's main research interests are smooth 4-manifolds, 3-manifolds, knots, Heegaard Floer homology, symplectic geometry, and gauge theory.

Response: Zoltán Szabó

I am greatly honored to be named, along with Peter Kronheimer, Tom Mrowka, and Peter Ozsváth, as a recipient of the Oswald Veblen Prize. The joint work with Peter Ozsváth which is noted here grew out of our attempts to understand Seiberg-Witten moduli spaces over three-manifolds where the metric degenerates along a surface. This led to the construction of Heegaard Floer homology that involved both topological tools, such as Heegaard diagrams, and tools from symplectic geometry, such as holomorphic disks with Lagrangian boundary constraints. The time spent on investigating Heegaard Floer homology and its relationship with problems in low-dimensional topology was rather interesting. I am very glad that this effort was rewarded by the prize committee.

First of all I would like to thank my wife, Piroska, for her support over the years. I also owe a lot to my co-author Peter Ozsváth whose boundless energy made this work possible, and to my thesis advisor, John Morgan, who introduced me to the world of gauge theory.

2007 E. H. Moore Prize

The 2007 E. H. Moore Research Article Prize was awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

The prize is awarded every three years for an outstanding research article that appeared in one of the primary AMS 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,* or *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 US$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 (1901–1902), delivered the Colloquium Lectures in 1906, and founded and nurtured the *Transactions of the AMS.*

The previous recipient of the Moore Prize is Mark Haiman (2004).

The Moore Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prize, the members of the selection committee were: Lawrence Craig Evans, Carolyn S. Gordon (chair), Grigorii A. Margulis, George C. Papanicolaou, and Efim I. Zelmanov.

The 2007 Moore Prize was awarded to IVAN SHESTAKOV and UALBAI UMIRBAEV. The text that follows presents the selection committee's citation, brief biographical sketches, and the awardees' responses upon receiving the prize.

Citation

In two groundbreaking papers published in the *Journal of the American Mathematical Society* ("The tame and the wild automorphisms of polynomial rings in three variables", **17** (2004), no. 1, 197–227; and "Poisson brackets and two-generated subalgebras of rings of polynomials", **17** (2004), no. 1, 181–196), Ivan Shestakov and Ualbai Umirbaev develop powerful new techniques to address the structure of automorphism groups of polynomial algebras. Their dramatic results include a proof of the longstanding Nagata Conjecture, establishing the existence of a wild automorphism of a polynomial algebra in three variables.

Of particular importance is their novel use of Poisson structures and their universal quantizations to obtain a criterion of tameness. This innovation is already resulting in further major applications.

Biographical Sketch: Ivan Shestakov

Ivan Shestakov was born on August 13, 1947, in the Irkutsk region in Russia. After graduating from the Physical-Mathematical School in Novosibirsk, he entered Novosibirsk University in 1965. There he obtained his first results in algebra, under the guidance of professors K. Zhevlakov and A. Shirshov. His master's thesis "On a Class of Non-commutative Jordan Rings" was awarded the Medal of the Academy of Sciences of USSR for students.

In 1970 Shestakov graduated from Novosibirsk University and entered the Sobolev Institute of Mathematics as a researcher. In 1973 he received his Ph.D. from Novosibirsk University, and in 1978 he earned the Doctor of Sciences from the Sobolev Institute of Mathematics for the work "Free Alternative Algebras". The book *Rings That Are Nearly Associative,* written by Shestakov jointly with K. Zhevlakov, A. Slinko, and A. Shirshov, was published in 1978.

In 1974 Shestakov became a professor of the Novosibirk State University. Since 1999 he has held the position of full professor at the University of São Paulo.

Shestakov's interests lie in ring theory and combinatorial algebra. He has focused on the structure and representations of nonassociative algebras and superalgebras, PI-algebras, free algebras and their automorphisms.

Response: Ivan Shestakov

It is a great honor for me to receive the E. H. Moore Research Article Prize, and I would like to thank the AMS and the selection committee for awarding this prize. I am especially happy to share it with my former student Ualbai Umirbaev. During my mathematical career, I experienced help and support from my friends and colleagues in different countries. I would also like to use this opportunity to thank all of them, especially my colleagues from the Sobolev Institute of Mathematics, where I grew up as a mathematician, and from the University of São Paulo, where I have been working during the last several years.

Biographical Sketch: Ualbai Umirbaev

Ualbai Umirbaev was born in Turtkul, Shymkent region, Kazakhstan, in 1960. He studied mathematics at Novosibirsk State University. He got his Ph.D. in mathematics from the Sobolev Institute of Mathematics of the Siberian branch of the Soviet Academy of Sciences with Ivan Shestakov in 1986, and from the same Institute he got his Doctor of Science degree in 1995.

During 1986–1995 Umirbaev taught at the Kazakh State University, Almaty, first as an assistant professor, then as a senior lecturer and then as an associate professor. In 1995 he moved to the South-Kazakhstan State University in Shymkent as a full professor and Chair of Informatics. In 2001 Umirbaev moved to the Eurasian National University in the new capital Astana, where he became a professor and Chair of Algebra and Geometry. His main research interests are in the areas of combinatorial algebra, subalgebras and automorphisms of free algebras, and affine algebraic geometry.

Response: Ualbai Umirbaev

I am deeply honored to have been chosen to receive the 2007 E. H. Moore Research Article Prize together with Ivan Shestakov.

It is very interesting to recall that I met the Nagata automorphism for the first time in a survey by Vladimir Popov in 1989. It was really an amazing and a concrete problem! Later I studied two very interesting papers related to the Nagata automorphism: by Hyman Bass in 1984 on non-triangular actions and by Martha Smith in 1989 on stably tame automorphisms. I was studying

Ivan Shestakov

Ualbai Umirbaev

subalgebras of free algebras with a view towards to algorithmic problems. Since then I related these investigations with the study of automorphisms of free algebras.

I am very glad that the two cited papers were published in the *Journal of the American Mathematical Society*. I am very glad that the committee recognized the significance of these results. Many challenging problems of affine algebraic geometry and combinatorial algebra are still open. I hope that the recognition by the Moore Prize will spur further activity in this area.

I would like to thank my friends, colleagues, and collaborators with whom discussions of mathematics were very important and useful. Also I would like to thank my father Utmakhanbet Umirbaev (1922–2001), who was a teacher of mathematics, thanks to whom I started to study math.

2007 Robbins Prize

The David P. Robbins Prize prize was awarded at the 113th Annual Meeting of the AMS in New Orleans in January 2007.

The Robbins Prize was established in 2005 in memory of David P. Robbins by members of his family. Robbins, who died in 2003, received his Ph.D. in 1970 from the Massachusetts Institute of Technology. He was a long-time member of the Institute for Defense Analysis Center for Communications Research and a prolific mathematician whose work (much of it classified) was in discrete mathematics. The prize is given for a paper that (1) reports on novel research in algebra, combinatorics, or discrete mathematics, (2) has a significant experimental component, (3) is on a topic broadly accessible, and (4) provides a simple statement of the problem and clear exposition of the work. The US$5,000 prize is awarded every three years. This is the first time the prize was awarded.

The Robbins Prize is awarded by the AMS Council acting on the recommendation of a selection committee. For the 2007 prize, the members of the selection committee were: Jonathan M. Borwein, Jeffrey C. Lagarias (chair), David I. Lieberman, Richard P. Stanley, and Robin Thomas.

The 2007 Robbins Prize was awarded to SAMUEL P. FERGUSON and THOMAS C. HALES. The text that follows presents the selection committee's citation, brief biographical sketches, and the awardees' responses upon receiving the prize.

Citation

This Robbins Prize is presented to Thomas C. Hales and Samuel P. Ferguson for the paper: Thomas C. Hales, "A proof of the Kepler conjecture", *Ann. Math.* **162** (2005), 1065–1185. Section 5 of this paper is jointly authored with Samuel P. Ferguson.

The Kepler conjecture asserts that the densest three-dimensional sphere packing is attained by the cannonball packing. This 400-year-old problem, going back to Kepler in 1611, was mentioned as part of Hilbert's eighteenth problem. The proof of this result is a landmark achievement.

These two authors used experimental methods to formulate a local density inequality that would both establish the result and be provable by a computation of feasible length. Laszlo Fejes Tóth suggested in the 1950s that it might be possible to prove Kepler's conjecture by establishing a local inequality that would simultaneously be maximized at every sphere center in the cannonball packing. Local inequalities at a single sphere center can in principle be proved by maximizing a nonlinear function over a compact set, but in practice the resulting problems are too large to be computationally feasible. One of the contributions of this work was to find a way to obtain a computationally feasible problem. In the early 1990s Hales began an approach to formulating suitable local density inequalities that combined information from both the Voronoi and Delaunay triangulations associated to the sphere centers. A very delicate balance is needed between their contributions to obtain a suitable inequality, which was arrived at by computer experiments. Although Samuel Ferguson is credited only with one section of the cited paper, he made essential contributions on the theoretical and experimental side, in formulating the local density inequality used and in proving the most difficult special case of it.

The cited paper elegantly describes the main theoretical structure of the proof. It formulates a novel and complicated local density inequality and shows that its proof would establish Kepler's conjecture. The proof of the local inequality reduces to a very large nonlinear optimization problem of minimizing a function over a compact region consisting of many connected components of high dimension. The authors introduce decomposition methods that simplify the optimization. The optimization is checked analytically in neighborhoods of the two global minima, and after many reductions the remainder is checked by computer; there are thousands of cases. The cited paper presents an extensive road map of this proof and includes motivation for the truth of the given local inequality. A more detailed version appears in six papers published in *Discrete and Computational Geometry* **36** (2006), 5–265, four authored by T. C. Hales, one by S. P. Ferguson alone, and one joint paper which formulates the precise local inequality.

Some controversy has surrounded this proof, with its large computer component, concerning its reliable checkability by humans. Addressing this issue, Hales has an ongoing project, called the "Flyspeck" project, whose object is to construct a "second-generation" proof which is entirely checkable by computer in a formal logic system.

Thomas C. Hales

Samuel Ferguson

Biographical Sketch: Thomas C. Hales

Thomas C. Hales received his master's degree from Stanford University in the School of Engineering and his Ph.D. from Princeton University in mathematics in 1986 under Robert Langlands. He has held positions at Harvard University, the University of Chicago, and the University of Michigan. He is currently the Andrew Mellon Professor of Mathematics at the University of Pittsburgh. His honors include the Chauvenet Prize (2003) of the Mathematical Association of America and the R. E. Moore Prize (2004) for applications of interval analysis. His research interests include representation theory, motivic integration, discrete geometry, and formal proof theory.

Response: Thomas C. Hales

It is an honor to be a recipient of the David P. Robbins Prize. Without the fundamental contributions of my collaborator, Samuel P. Ferguson, the Kepler conjecture would still be unsolved. He made essential contributions to the formulation of the local density inequality and to the computer algorithms that were used. He solved the most difficult case that arises in the proof. I am proud to share the prize with him.

The solution to the Kepler conjecture relies on fundamental advances by many researchers in several domains. It is a pleasure to acknowledge the many researchers who developed algorithms that permit the rapid solution of largescale linear programs, those who developed the tools of interval computations, and L. Fejes Tóth, who had the original vision about how the Kepler conjecture might be solved by computer. Finally, I wish to thank my colleagues in the formal theorem-proving community for elevating computer proofs to unprecedented levels of mathematical rigor.

Biographical Sketch: Samuel Ferguson

Samuel Ferguson earned a B.S. in mathematics at Brigham Young University in 1991. A Research Experience for Undergraduates program at the College of William and Mary provided support for his interest in pursuing graduate studies in mathematics. He earned his Ph.D. in 1997 at the University of Michigan, working with Tom Hales. He is currently employed by the National Security Agency.

Response: Samuel Ferguson

I am honored to have been selected for this award. Having met David Robbins and being familiar with some of his remarkable work makes this award all the more meaningful. I wish to express my gratitude to everyone who has helped me along the way, from my parents and siblings, to teachers, mentors, and friends. Thank you.

Mathematics People

Feldman Awarded CRM-Fields-PIMS Prize

JOEL S. FELDMAN of the University of British Columbia has been awarded the 2007 CRM-Fields-PIMS Prize. The prize, awarded annually by the Centre de Recherches Mathématiques (CRM), the Fields Institute, and the Pacific Institute for the Mathematical Sciences (PIMS), recognizes exceptional contributions by a mathematician working in Canada. The prize carries a cash award of CA$10,000 (approximately US$8,500) and an invitation to give a lecture at each institute.

Feldman was chosen "in recognition of his exceptional achievement and work in mathematical physics." According to the prize citation, he "has risen to a position of international prominence in the world of mathematical physics, with a thirty-year record of sustained output of the highest caliber. He has made important contributions to quantum field theory, many-body theory, Schrödinger operator theory, and the theory of infinite genus Riemann surfaces. Many of Professor Feldman's recent results on quantum many-body systems at positive densities and on Fermi liquids and superconductivity have been classed as some of the best research in mathematical physics in the last decade."

Feldman received his bachelor's degree from the University of Toronto in 1970 and his master's (1971) and Ph.D. (1974) degrees from Harvard University. He was a research fellow at Harvard University from 1974 to 1975 and C. L. E. Moore Instructor at the Massachusetts Institute of Technology (MIT) from 1975 to 1977. He has been teaching at the University of British Columbia since 1977. He was an invited speaker at the International Congress of Mathematicians in Kyoto in 1990. He was a plenary speaker at the International Congress on Mathematical Physics in Brisbane in 1997 and an invited speaker at the International Congress on Mathematical Physics in Lisbon in 2003. He is a fellow of the Royal Society of Canada (RSC) and was awarded the 1996 John L. Synge Award of the RSC, the Aisenstadt Chair Lectureship of the CRM (1999–2000), and the 2004 Jeffery-Williams Prize of the Canadian Mathematical Society (CMS) for outstanding contributions to mathematical research.

The CRM and the Fields Institute established the CRM-Fields prize in 1994 to recognize exceptional research in the mathematical sciences. In 2005 PIMS became an equal partner, and the name was changed to the CRM-Fields-PIMS prize. Previous recipients of the prize are H. S. M. (Donald) Coxeter, George A. Elliott, James Arthur, Robert V. Moody, Stephen A. Cook, Israel Michael Sigal, William T. Tutte, John B. Friedlander, John McKay, Edwin Perkins, Donald A. Dawson, David Boyd, and Nicole Tomczak-Jaegermann.

—From a Fields Institute announcement

Smith and Holroyd Awarded Aisenstadt Prize

GREGORY D. SMITH of Queen's University and ALEXANDER E. HOLROYD of the University of British Columbia are the recipients of the 2007 André Aisenstadt Prize of the Centre de Recherches Mathématiques (CRM) of the University of Montreal. Smith was honored for his work in algebraic geometry and computational algebra, and Holroyd was chosen for his work in probability theory, with emphasis on discrete spatial models, including cellular automata, percolation, matching, and coupling.

The André Aisenstadt Mathematics Prize consists of CA$3,000 (approximately US$2,500) and a medal. The prize recognizes talented young Canadian mathematicians in pure and applied mathematics who have held a Ph.D. for no longer than seven years.

—From a CRM announcement

Viale Awarded ASL Sacks Prize

MATTEO VIALE of the University of Torino and the University of Paris 7 is the recipient of the 2006 Sacks Prize of the Association for Symbolic Logic (ASL). The prize is awarded for the most outstanding doctoral dissertation in mathematical logic. Viale received his Ph.D. in 2006 from the University of Torino and the University of Paris 7. According to the prize citation, his thesis "makes fundamental contributions to our understanding of the consequences of forcing axioms in the combinatorics of singular cardinals. In particular, it solves a well-known problem, by showing that the proper forcing axiom implies the singular cardinals hypothesis."

The Sacks Prize was established in honor of Gerald Sacks for his unique contribution to mathematical logic. It consists of a cash award and five years' free membership in the ASL.

—From an ASL announcement

Mustata Receives Packard Fellowship

The David and Lucile Packard Foundation has awarded twenty Fellowships for Science and Engineering for the year 2006. MIRCEA MUSTATA, a mathematician at the University of Michigan, has received an unrestricted research grant of US$625,000 over five consecutive years. He will pursue research in algebraic geometry, particularly on singularities of algebraic varieties.

The fellowships are awarded to researchers in mathematics, natural sciences, computer science, and engineering who are in the first three years of a faculty appointment.

—From a Packard Foundation announcement

AWM Essay Contest Winners Announced

The Association for Women in Mathematics (AWM) has announced the winners of its 2006 essay contest, "Biographies of Contemporary Women in Mathematics". The grand prizes were awarded to ANNIE DAVIS of the Solomon Schechter Day School of Greater Boston, Newton, Massachusetts, for her essay, "Margo Levine, Mathematician"; and to STEPHANIE HIGGINS of Bates College for her essay, "Dr. Bonnie Shulman: A Different Kind of Story". Davis's essay won first place in the middle school (grades 6–8) category, and Higgins's essay won first place in the college category. As grand prize winners, these essays will be published in the *AWM Newsletter*. The first-place winner in the grade 9–12 category was MARGARITE BECHIS of Mount Saint Joseph Academy, Flourtown, Pennsylvania, for an essay titled "Splendor of the Heavens: Dr. Knapp's Astronomical Odyssey". A complete list of the winners and copies of their essays can be found on the AWM website, `http://www.awm-math.org/biographies/contest/2006.html`.

—From an AWM announcement

Correction

The February 2007 issue of the *Notices* carried a list of doctoral degrees conferred in 2005–2006. Because of incorrect information supplied by his institution, David S. Torain II was listed as having received a doctorate in mathematics. His degree is in systems science, with a specialization in mathematics.

—Allyn Jackson

About the Cover *(continued from page 502)*

whereas nonexperts use only short-term memory. Episodic memory is used to store memory of our own life's events, and is one of several types of long-term memory recognized by neuroscientists. As Pesenti writes in a survey article in the *Handbook of Mathematical Cognition*, the work supports the suggestion that "high-level expertise is not only accounted for by an acceleration of existing processes and by local modulation of activations, but" …"also involves new processes involving new brain areas." Of course mental arithmetic is not the same as higher mathematics, but sometime in the not too distant future it should be possible to analyze what is involved in discovering and proving theorems!

The important role of long-term memory should make us wary of referring disparagingly to "mere memorization". But neither should it make us pessimistic about the value of attempting to teach our students how to reason. In a brief note by Brian Butterworth about this work (in the January 2001, issue of *nature neuroscience* at `http://neuroscience.nature.com`), Gamm is quoted as saying that at school he was "very bad at arithmetic" because the teachers never explained the concepts in a way he could understand. It was only later in life that he worked these things out for himself.

Pesenti's home page is at `http://www.nesc.ucl.ac.be/mp/pesentiHomepage.htm`.

—Bill Casselman, Graphics Editor
(`notices-covers@ams.org`)