2005 Steele Prizes

The 2005 Leroy P. Steele Prizes were awarded at the 111th Annual Meeting of the AMS in Atlanta in January 2005.

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: 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 2005 prizes the members of the selection committee were: Andreas R. Blass (chair), Daniel S. Freed, John B. Garnett, Victor W. Guillemin, Craig L. Huneke, Tsit-Yuen Lam, Robert D. MacPherson, Linda P. Rothschild, and Lou P. Van den Dries.

The list of previous recipients of the Steele Prize may be found on the World Wide Web, `http://www.ams.org/prizes-awards`.

The 2005 Steele Prizes were awarded to Branko Grünbaum for Mathematical Exposition, to Robert P. Langlands for a Seminal Contribution to Research (this year restricted to the field of algebra), and to Israel M. Gelfand 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: Branko Grünbaum

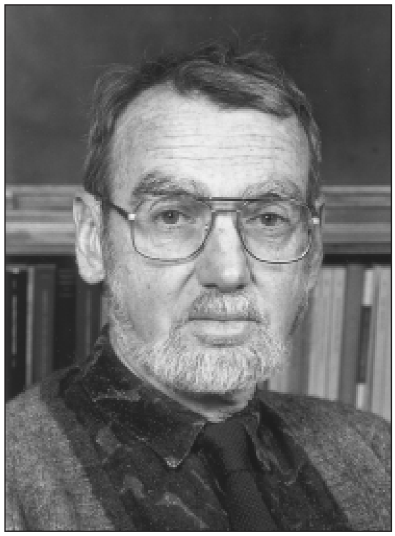
Citation

Branko Grünbaum's book, *Convex Polytopes*, has served both as a standard reference and as an inspiration for three and a half decades of research in the theory of polytopes. That theory is currently very active and enjoys connections with many other areas of mathematics, including optimization, computational algebra, algebraic geometry, and representation theory. Much of the development that led to the present, thriving state of polytope theory owes its existence to this book, which served as a source of information for workers in the field and as a source of inspiration for them to enter the field. Despite the passage of time, *Convex Polytopes* retains its value both as an exposition of the theory and as a reference work. Springer-Verlag's decision to issue a second edition in 2003, consisting of Grünbaum's original text plus notes by Volker Kaibel, Victor Klee, and Günter Ziegler to describe newer developments, will extend the book's influence to future generations of mathematicians.

Biographical Sketch

Branko Grünbaum was born in 1929 in what was then Yugoslavia. In 1948 he started studying mathematics at the University of Zagreb and a year later emigrated to Israel. After receiving his Ph.D. from the Hebrew University in Jerusalem in 1957 under the guidance of Aryeh Dvoretzky, he was a member of the Institute for Advanced Study in Princeton for two years. In 1961 he returned to the Hebrew University. Following a visiting appointment at Michigan State University in 1965, in 1966 he became professor at the University of Washington; he has been in Seattle ever since, from 2000 on as professor emeritus. At various times he had visiting appointments at the University of Kansas, the University of California at Los Angeles, and Michigan State University. His interests cover much of geometry and combinatorics, with the principal activity on convex sets and polytopes, and tilings. In recent

Branko Grünbaum



Robert P. Langlands

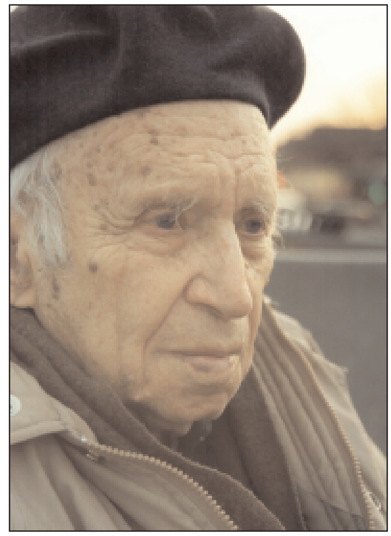


Photo of I. M. Gelfand by Tatiana Gelfand.

I. M. Gelfand

years, most of his efforts were devoted to configurations of points and lines in the Euclidean plane and to nonconvex polygons and polyhedra. He is happy to be able to give courses on these topics and to see that the material has started to attract attention after a long period of quiescence.

Response

The beginning of *Convex Polytopes* was in notes and explanations I prepared for students in my seminar at the Hebrew University in 1963. The main topic concerned the material of Klee's seminal preprints about the face vectors of convex polytopes and Steinitz's characterization of graphs of convex 3-polytopes. In time, the notes expanded and formed the core of the book. I was fortunate to have M. A. Perles contribute to the book his path-breaking results dealing with Gale diagrams and to receive the cooperation of Vic Klee and G. C. Shephard for other parts of the book. After the book went out of print, there were several attempts to publish an updated version; they foundered on the sheer quantity of the relevant new material. It took the mathematical depth and organizational ability of Günter Ziegler and the help of Volker Kaibel and Vic Klee to complete the task. I am greatly indebted to all of them. Naturally, I am deeply appreciative of the Steele Prize and greatly honored by it.

Seminal Contribution to Research: Robert P. Langlands

Citation

The Steele Prize for a Seminal Contribution to Mathematical Research is awarded to Robert Langlands for the paper "Problems in the theory of automorphic forms", Springer Lecture Notes in Math., vol. 170, 1970, pp. 18–86. This is the paper that introduced the Langlands conjectures.

The Langlands conjectures asserted deep relations among modular forms that encompassed as special cases class field theory, the Artin conjectures, and Eichler-Shimura theory, which they extended to higher dimensional varieties. The conjectures provided a unifying principle for the theory of automorphic forms, and in particular a relatively clear guide to their relation with L-functions. As a result of this paper, the systematic relation between global and local theory and the systematic use of adele groups became fixtures in the subject.

The Langlands conjectures had their origin in Langlands' theory of Eisenstein series, which was itself a major mathematical advance. The conjectures are still unproved, but many difficult cases have been established recently. It's hard to think of any other instance in the history of mathematics where conjectures gave so accurate a road map of what would turn out to be true in so many different situations. And few other conjectures have generated so much research of such high quality.

Biographical Sketch

Robert P. Langlands was born October 6, 1936, in New Westminster, British Columbia, Canada. He received his A.B. and M.A. degrees at the University of British Columbia in 1957 and 1958 respectively and his Ph.D. from Yale University in 1960. His principal speciality is the theory of automorphic forms. He is best known for the Langlands Program, which proposes deep links between algebra and analysis, having significant ramifications for number theory. Langlands held positions at Princeton University (1960–67) and at Yale University (1967– 72), and since 1972 he has been at the Institute for Advanced Study. He is the recipient of numerous honorary doctorates and awards, including the AMS Cole Prize in Number Theory in 1982, the Commonwealth Award in 1984, the National Academy of Sciences Award in Mathematics in 1988, the Wolf Prize in Mathematics (1995– 96), and La Grande Médaille d'or de l'Académie des Sciences in 2000. He is a fellow of the Royal Society of Canada (1972) and the Royal Society of London (1981); he is also a member of the American Academy of Arts and Sciences (1990), the National Academy of Sciences (1993), the American Philosophical Society (2004), the American Mathematical Society, and the Canadian Mathematical Society. Langlands is the author of numerous research papers.

Response

The pleasure of learning that one is to be awarded a Steele Prize or perhaps almost any prize in mathematics is, for anyone with a sense of proportion, soon followed by the uneasy sentiment that there are others more deserving and, at least if the prize is coveted, that they are quite aware of it. There is little to be done with the unease but to live with it and to be grateful to those unknown members of the selection committee who appreciated what you have tried to do and made an effort to persuade the other members of the committee of its merits.

The unease is, in any case, soon followed by a more troubling impulse, the desire to supplement the citation and to explain what one really had in mind. I shan't do that now, except to mention that in the paper "Problems in the theory of automorphic forms", dedicated, I recall, to Salomon Bochner, the emphasis was on what I later came to call functoriality, thus, in particular, on the Artin conjecture and a possible nonabelian class-field theory. Hasse-Weil L-functions were mentioned only in passing as a more or less obvious—once I had learned of the Taniyama-Shimura-Weil conjecture—afterthought. By the time the paper was published, I had reflected for two or three years on the "working hypotheses", as I called them, contained in it, and I no longer had any serious doubts.

In the following years various mathematicians, myself included, were able to do something with them, even some things quite striking, as with, say, base change and the Artin conjecture in the tetrahedral and octahedral case or with various general forms of the Ramanujan conjecture. Nevertheless, for lack of courage and historical perspective, I did not, as I now believe, appreciate until quite recently the real import of the suggestions and the depth one would have to attain to solve the problems posed. Unfortunately, it may now, at least for me, be too late for boldness. On the other hand, until serious inroads had been made on what the experts call the fundamental lemma, the time was not ripe for it.

Lifetime Achievement: Israel M. Gelfand

Citation

The broad and lasting impact of I. M. Gelfand on mathematics is difficult to convey in a short space. He has had a profound influence on many fields of research through his own work and through his interactions with other mathematicians, including students. Here we can only touch on a few highlights.

Gelfand's first major achievement is the theory of commutative normed rings, which he developed in the late 1930s in his thesis. His use of maximal ideals was crucial not only in harmonic analysis, but also in the subsequent development of algebraic geometry. Next, in collaboration with Naimark, he proved that noncommutative normed rings with involution may be represented as operators in Hilbert space, a cornerstone of the modern theory of C^*-algebras. In the 1940s Gelfand turned to representation theory and the theory of generalized functions. There are also foundational papers from this period on integral geometry, geodesic flows on surfaces of negative curvature, and generalized random processes.

Beginning in the mid-1940s Gelfand led many investigations on partial differential equations, and in a well-known paper published in 1960 asked for a topological classification of elliptic operators, based on the observation that the index is a homotopy invariant of the leading symbol. This led to the Atiyah-Singer index theorem, with its many profound implications and applications. We also mention his work with, among others, Levitan and Dickii on inverse spectral problems and scattering theory.

Gelfand, in collaboration with Fuks in the late 1960s, investigated the cohomology of infinite-dimensional Lie algebras, particularly those associated with a manifold. Even for the algebra of vector fields on the circle there is nontrivial and interesting cohomology. This work led to characteristic classes of foliations.

This brief account omits many fundamental results—the Bernstein-Gelfand-Gelfand resolution of representations, work on integral geometry and the Radon transform, combinatorial characteristic classes, etc.—as well as recent work on such topics as determinants, noncommutative polynomials, etc. Gelfand has also had a parallel career working on applied problems, ranging from computation to biology.

Gelfand's mathematical influence has spread not only through his many research papers, but also through his books, lectures, and seminars. His series of five books (with various coauthors) on *Generalized Functions* dates from the late 1950s and has been a classic for 50 years. A recent book with Kapranov and Zelevinski entitled *Discriminants, Resultants, and Multidimensional Determinants* is also a major work. In between are monographs on many other topics. Gelfand's seminar, which began in Moscow and continues in Piscataway, has long been a training ground for participants and speakers. His educational activities extend to younger mathematicians as well, including a correspondence school in both Russia and the United States as well as many books on elementary mathematics.

Biographical Sketch

Israel M. Gelfand was born on September 2, 1913, in Krasnye Okny, Ukraine; he received his Ph.D. and D.Sc. in mathematics from Moscow State University in 1935 and 1940 respectively. For almost fifty years (1941–90) Gelfand served as professor of mathematics at Moscow State University; he has held visiting professor positions at Harvard University and the Massachusetts Institute of Technology (1989–90). Since 1990 he has served as professor of mathematics at Rutgers University. Gelfand is the author of more than 800 articles and 30 books in mathematics, applied mathematics, and theoretical biology. He has worked chiefly in the area of functional analysis and representation, but he has significantly contributed to many other areas of mathematics as well.

Gelfand is the recipient of many awards and honors, including the State Prize of the U.S.S.R. (1953), the Lenin Prize (1956), the Wolf Foundation Prize (1978), the Kyoto Prize (1989), and a MacArthur Foundation Fellowship (1994). He was elected a member of the American Academy of Arts and Sciences (1964), the Royal Irish Academy (1970), the National Academy of Sciences (1970), the Royal Swedish Academy (1974), the Académie des Sciences of France (1976), the Royal Society of Britain (1977), the Academia dei Lincei of Italy (1988), the Japan Academy of Sciences (1989), and the European Academy of Sciences (2004). In 2000 he was made a Lifetime Member of the New York Academy of Sciences. A corresponding member of the U.S.S.R. Academy of Sciences since 1953, Gelfand was elected to full membership in 1984. He is also the recipient of many honorary degrees.

Response

I am very touched to receive this award from the American Mathematical Society. For me it is a confirmation that everything that I have worked for through my entire life was not in vain. This recognition of my work from my peers, colleagues, and friends from the American Mathematical Society is especially meaningful for me. Mathematics for me is a universal and adequate language of sciences, and it is an example of how people of different cultures and backgrounds can communicate and work together. This is extremely important in our times.