1985 Steele Prizes Awarded at Summer Meeting in Laramie

Three Leroy P. Steele Prizes were awarded at the Society's Summer Meeting in Laramie, Wyoming.

The Steele Prizes are made possible by a bequest to the Society by Mr. Steele, a graduate of Harvard College, Class of 1923, in memory of George David Birkhoff, William Fogg Osgood and William Caspar Graustein.

Three Steele Prizes are awarded each year: one for expository mathematical writing, one for a research paper of fundamental and lasting importance, and one in recognition of cumulative influence extending over a career, including the education of doctoral students. The current award is $4000 for each of these categories.

The recipients of the Steele Prizes for 1985 are MICHAEL SPIVAK for the expository award; ROBERT STEINBERG for research work of fundamental importance; and HASSLER WHITNEY for the career award.

These prizes were awarded by the Council of the Society (acting through its Executive Committee) on the recommendation of the Committee on Steele Prizes whose members at the time of these selections were Richard W. Beals, Jerry L. Bona, Charles W. Curtis, Harold M. Edwards, Frederick W. Gehring, H. Jerome Keisler, Yiannis N. Moschovakis (Chairman), Lawrence E. Payne, George B. Seligman, Patricia Lilaine Sipe.

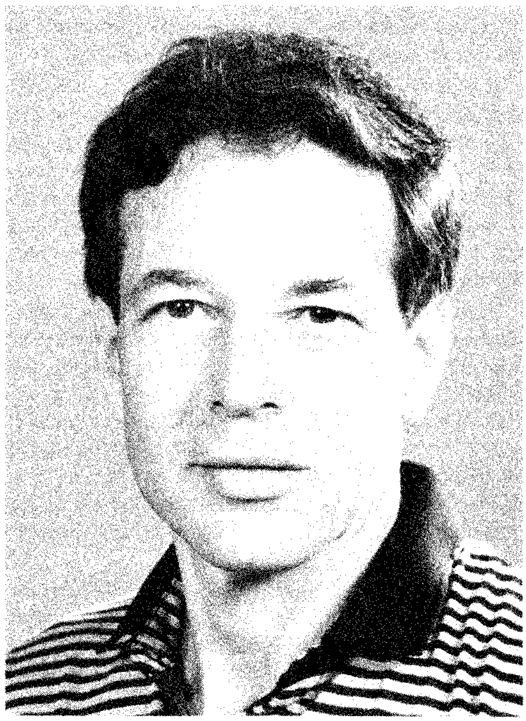
The text which follows contains the Committee's citations for each award, the recipients' responses at the prize session in Laramie, and a brief biographical sketch of each of the recipients.

Expository Writing

Michael Spivak

Citation

The 1985 Steele Prize for expository writing is awarded to MICHAEL SPIVAK for his books in differential geometry. His five-volume set, *A Comprehensive Introduction to Differential Geometry*, accomplishes with style the seemingly impossible tasks announced in the title, presenting a novice to the field with a comprehensive view of the subject, from the classic early works of Gauss and Riemann to the various contemporary approaches of Cartan, Chern, Koszul, and Ehresmann. In the ten years since its completion, this work has become a kind of classic of its own, providing the reader with important insights into the development of the subject, a well-selected set of central topics, and a unique and exhaustive annotative bibliography. Furthermore, it is written in a lucid and informal style that makes reading it a pleasure. An earlier "classic" by Spivak is his *Calculus on Manifolds*, one of the first books to make available to an undergraduate audience the basic concepts and techniques of differentiable manifolds and differential forms.



Michael Spivak

Response

It was as gratifying as it was surprising to learn that I was to receive the Steele Prize for my books on differential geometry. When I made my first intrepid, not to say foolhardy, attempts to fathom the multi-media world of differential geometry, I certainly hadn't anticipated completing a work of such outlandish proportions. I hope this award will encourage others on similar ventures, and show that they can be accomplished even from the periphery of the academic world.

Perhaps it is now appropriate to use $\mathcal{A}_\mathcal{M}\mathcal{S}$-TEX, the next of my imprudent projects, to typeset these books, so that, some time in the distant future, the books can appear in more permanent form—after all, I still do remember, vaguely, what a connection is (I mean are).

Biographical Sketch

MICHAEL DAVID SPIVAK was born May 25, 1940, in Queens, New York. He received an A.B. degree from Harvard University in 1960, and a Ph.D. from Princeton University in 1964. Between 1964 and 1970 he was a member of the department of mathematics at Brandeis University (lecturer, 1964–1967, and assistant professor, 1968–1970). In 1967-1968 he was a National Science Foundation Fellow at the Institute for Advanced Study in Princeton. From 1970 on, he visited and lectured at several universities, including Bonn and the University of California, Berkeley, pursued his career as a publisher of mathematical books, and developed an interest in computer composition of mathematical text.

His book *Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus* was published by Benjamin in 1965 [MR **35** #309], and subsequently translated into Polish, Spanish, Japanese and Russian. Another text, *Calculus,* was published originally by Benjamin and translated into Spanish; it is now in a second edition published by Publish or Perish, Inc.

The five volumes of *A Comprehensive Introduction to Differential Geometry* were published originally in 1970 (volumes 1 and 2) [MR **42** #2369, #6726] and in 1975 (volumes 3, 4, 5) [MR **51** #8962, **52** #15254a, #15254b]; a second edition, of all five volumes, was issued in 1979 by Publish or Perish, Inc. See also the *Bulletin of the American Mathematical Society,* volume **84** (1978), pages 27–32, for a more extensive review of the differential geometry series.

Dr. Spivak is the creator of the $\mathcal{A}_\mathcal{M}\mathcal{S}$-TEX macro package (see the *Notices,* February 1981, page 176), and the author of *The Joy of TEX,* a book describing $\mathcal{A}_\mathcal{M}\mathcal{S}$-TEX and its use, published by the American Mathematical Society. He is also the principal of Publish or Perish, Inc., a mathematical publishing house.

Fundamental Paper

Robert Steinberg

Citation

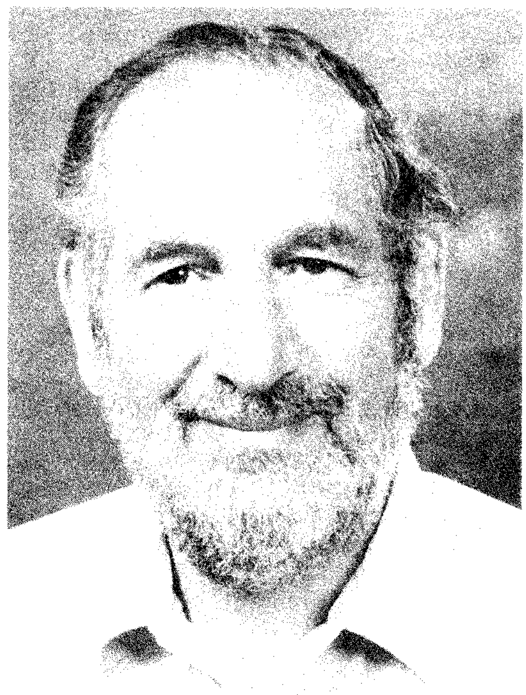
The 1985 award for a paper, whether recent or not, which has proved to be of fundamental or lasting importance in its field, or a model of important research, is made to ROBERT STEINBERG for the following series of papers on various aspects of the theory of algebraic groups:

Representations of algebraic groups, Nagoya Mathematical Journal, volume **22** (1963), pages 33-56. [MR **31** #4788]

Regular elements of semisimple algebraic groups, Institut des Hautes Études Scientifiques. Publications Mathématiques, volume **25** (1965), pages 49-80. [MR **31** #4788]

Endomorphisms of linear algebraic groups, Memoirs of the American Mathematical Society, volume **80** (1968), 108 pages. [MR **37** #6288]

The results and methods contained in these papers have contributed to progress on a wide range of deep and important problems in the theory of finite simple groups, representation theory, and cohomology, as well as in the theory of algebraic groups. This work has helped open the way to the establishment of the theory of algebraic groups as a strong and versatile method for the solution of problems, many of which had long appeared inaccessible.



Robert Steinberg

Response

I want to thank the Steele Prize committee for this award. The news, when I first learned about it, came as a total surprise. To have my name added to the list of distinguished mathematicians who have received this award is indeed an honor. I view the award as a tribute, not just to me, but to all of the people, before and after, who have worked in this field and continue to make it such a vital area of mathematics. Those that preceded me made my own work possible and those that followed are responsible for any lasting value that it may have. It is not possible to name all of the people involved, but I would like to mention two of them, Professors Claude Chevalley and Richard Brauer, both unfortunately now dead. They were primarily responsible for the renewed interest and great surges in the theory of algebraic groups and the theory of finite groups just before the papers cited in the award were written. Brauer was also my main teacher and my indebtedness to him can not be measured. It pleases me a great deal that the first of the three papers chosen by the committee is dedicated to Brauer and has as its takeoff a theorem of his. The main result of that paper is a "tensor product theorem" that simplifies the representation theory of the finite and the algebraic simple groups. The second paper contains the construction of a cross section of the set of regular elements of a semisimple algebraic group similar to the Jordan normal form for matrices and, as a consequence, the theorem that the Galois cohomology of connected algebraic groups defined over fields of dimension at most 1 is trivial. The latter result has been used in the study of groups over local fields and vector bundles over Riemann surfaces. The third paper introduces the notion of affine root system, but one of its main purposes is the development of a connection between the simple algebraic groups and the simple finite groups. The point is that, with some exceptions, each of the latter is the set of fixed points of a suitable endomorphism of one of the former. The first paper and a companion paper on central extensions of algebraic groups were written while I was a visitor at the Institute for Advanced Study in 1961-1962, while the second paper and a preliminary version of the third were written in Paris in 1963-1964. Thus, leaves away from home and the resulting contacts with other mathematicians have been of great benefit to me. Since a number of talented younger mathematicians are now working in the area in which my papers were written, I expect it to remain an active one.

Biographical Sketch

ROBERT STEINBERG was born May 25, 1922, in Stykon, Rumania. His undergraduate and graduate studies were done at the University of Toronto, where he received a B.A. in 1944 and a Ph.D. in mathematics in 1948 and was a lecturer in mathematics in 1947-1948. Since 1948 he has been a member of the department of mathematics at the University of California, Los Angeles, as an instructor, assistant professor, associate professor, and (since 1962) a full professor. He has visited the Institute for Advanced Study (1955-1956, 1961-1962, 1969), Yale University (1967-1968), M.I.T. (1968-1969), Tata Institute (1972), and (informally) the University of Paris (1963-1964, 1973) and Queen Mary College (1979-1980). This year he was elected to the National Academy of Sciences.

He has given invited addresses at the AMS meeting in Las Cruces, New Mexico (April 1963), at the International Congress of Mathematicians in Moscow (August 1966), and at the Annual Meeting of the MAA in Las Vegas, Nevada, January 1972. The ICM lecture, *Classes of elements of semisimple algebraic groups* was published in the Proceedings of the International Congress of Mathematicians (Moscow, 1966), pages 277-284 [MR **39** #216].

He is a member of the American Mathematical Society and the Mathematical Association of America.

Career Award

Hassler Whitney

Citation

The 1985 Steele Prize for cumulative influence is awarded to HASSLER WHITNEY for his fundamental work on geometric problems. Whitney combined unusual but fruitful viewpoints with great technical prowess in his research. The ideas and methods he pioneered in the general theory of manifolds, in the study of differentiable functions on closed sets, in geometric integration theory, in the geometry of the tangents to a singular analytic space, and elsewhere, have become a part of the very fabric of these subjects and have had a profound influence on later work in these areas.

Hassler Whitney

Response

It appears to me a little strange, after eighteen years of concentrated work in mathematics education, to be given an award in mathematics. However, I appreciate this highly, and would like to say a few words about the present state of mathematics in relation to education.

I can start with my own experience. My schooling was rather informal, which suited me well. I built with erector sets and had mechanical projects which did not work well. There was just one clue to my future (about age nine). I figured out why the formula for divisibility by nine worked, then thought the basic reason was because nine was next to ten; but so was eleven, so I found the formula for eleven. I had little mathematics in school, and none in college. For advanced physics, I studied calculus by myself, and enjoyed it for a while. After graduating, on reviewing my notes for a physics course, I found that I had forgotten most of it. In physics it seems you have to remember facts, so I gave it up and moved into mathematics.

My mathematical career consisted basically of searching out interesting problems of a simple variety; then I would plunge in. I had lots of luck in finding things to work on; but with graduate students who wanted a thesis topic, I did not manage to help them much. In my work I would begin getting some results; other mathematicians would move in also and the field would expand; on its getting too big and complex, I would move out and look for new things.

I do feel that the essence of fine mathematics is its pure limpid simplicity, branching out into a myriad of patterns and interconnections that defy imagination. I can dive into these patterns for a while; then it is too much. The hardest nice theorem I accomplished was the duality (product) theorem in sphere (now vector) bundles. Later it became part of a definition. And one of my more trivial papers was on linear dependence; it became a basis of a large new branch of combinatorial theory, which I do not attempt to understand. I can't describe my feelings.

Like many others, I have had a lifelong teaching urge (in mathematics, mountain climbing, skating, string quartet playing ...). A course at Harvard to help incoming graduate students understand what mathematics was about developed into a book, completed in 1964, but unpublished because I did not see it actually *helping* high school teachers. They were trying to work under teacher-power, not their own power. This I now see as a basic problem throughout math (and other) teaching. I am still learning to *let others do their thing. Presenting* material puts the focus on the *teacher's* thoughts instead of the student's; and hence the students get *patterns* of thought without the reasoning from which they came. We know pretty well that this occurs in school, but hide from the fact that it is mostly true in college also. In Brazil I was asked: "They understand $y = ax + b$, but not $x = x_0 + vt$. What can we do?" The principal trouble is that "understand" means (for the students) simply knowing certain things you are asked to do, like "where does it cut the x-axis?"

My success came simply from continuing my preschool habit of exploring situations. We can all do this, if allowed. (For example, Beth, with a lifetime of mathematics anxiety and almost no math, essentially constructed the exponential function and found its derivative, in answer to a question about children getting a sense of a large range of numbers.)

Our teaching of calculus, in particular, is being recognized as missing most students badly. I now see the troubles as essentially identical on all levels. A principal cure is to give them things to explore; *after* this, through class discussions (you join in), underlying principles start coming out.

For an example, let s be the side length and A the area of a square. Make the square a little bigger, by Δs and ΔA; how do these relate? Putting the little square on the bigger one, one corner on a corner, we *see* the extra area ΔA, and easily find its value, $2s\Delta s$ plus a tiny bit, $(\Delta s)^2$. This is the essence of the relationship. With more study and play, we can introduce definitions of derivative, inverse functions, etc. Now our formula easily takes on the familiar forms for the derivatives of x^2 and of $\sqrt{y}$. But teaching the final results only leaves a lifeless jewel, not a part of the student's world, without connections with anything outside or with the student's experience. It removes all the pleasure of discovery and denigrates human powers.

Thus this underlying trouble, an essential part of the failure in school, continues into college; so engineering students and others drop out in droves. We claim to serve them, but do not. It is pleasure to work up exploration situations! Let's do it. Let us cooperate and transform mathematics teaching at *all* levels, bringing back the real beauties which we can all appreciate to everyone's benefit.

Biographical Sketch

HASSLER WHITNEY was born March 23, 1907, in New York City. He received his Ph.D. from Harvard University in 1932 and was awarded an honorary D.Sc. degree by Yale University in 1947. He was a member of the Harvard faculty from 1933 to 1952; in 1952 he moved to the Institute for Advanced Study as a professor, and in 1977 he retired as professor emeritus. He was elected to the National Academy of Sciences in 1945. He delivered the Colloquium Lectures at the AMS Summer Meeting in August 1946 and he served as vice president of the American Mathematical Society in 1948 and 1949. He was a member of the *Transactions* editorial committee from 1942 to 1949 and the *Mathematical Reviews* editorial committee from 1949 to 1954. He was awarded the

National Medal of Science in 1977 by President Carter.

The 1982 Wolf Foundation Prize in mathematics ($100,000) was awarded jointly to Hassler Whitney and Mark Grigor′evich Krein of the Ukrainian S.S.R. Academy of Sciences, Odessa. (See the February 1983 *Notices*, page 145.) The Wolf foundation citation for Whitney's work read as follows:

His innovative ideas have been the seed from which contemporary work in combinatorics, topology and differential geometry have grown to maturity. Matroids, differential manifolds, fiber bundles, characteristic classes, classifying spaces, stratifications, rational homotopy are only some of the concepts that trace their parentage to Whitney. His work inaugurated the style of geometric and combinatorial reasoning that has become the standard for the second half of the twentieth century.