1980 WIENER AND STEELE PRIZES AWARDED

On Thursday, August 21, 1980, the 1980 Norbert Wiener Prize and the 1980 Leroy P. Steele Prizes were presented at the Summer Meeting in Ann Arbor.

The third and fourth awards of the Wiener Prize were made to Tosio Kato of the University of California, Berkeley, and to Gerald B. Whitham of the California Institute of Technology. The Wiener Prizes, which are awarded every five years jointly by the AMS and the Society for Industrial and Applied Mathematics, are given for outstanding contributions to "applied mathematics in the highest and broadest sense."

Steele Prizes are awarded annually by the AMS in three categories:

(1) 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) for a book or substantial survey or expository-research paper,

(3) 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.

The recipients of the 1980 Steele Prizes are, respectively,

(1) André Weil of the Institute for Advanced Study (Emeritus),

(2) Harold M. Edwards of the Courant Institute of the Mathematical Sciences, and

(3) Gerhard P. Hochschild of the University of California, Berkeley.

The members of the AMS-SIAM Committee for the 1980 Wiener Prize were George F. Carrier, Ralph S. Phillips (chairman), and Elliot W. Montroll.

The members of the selection committee for the Steele Prize were Robin Hartshorne, Reuben Hersh, Irving Kaplansky, H. Blaine Lawson, Henry O. Pollak, Gian-Carlo Rota, Hans Samelson, Stephen S. Shatz (chairman), Joseph F. Taylor, and Raymond O. Wells, Jr.

The amount of each award is fifteen hundred dollars.

The text following includes the award citations prepared by the selection committees, as well as the responses and biographical sketches of the recipients.

CITATION FOR WIENER PRIZE:

Tosio Kato's work in the perturbation theory of quantum mechanics is truly distinguished. His dominance here is attested to by the fact that his name is associated with almost all of the advances in this field over the past thirty years. Kato has also made outstanding contributions to the study of both linear and nonlinear evolution equations as well as to hydrodynamics. For all this work of great distinction he is eminently deserving of the Wiener Prize.

Tosio Kato

It is a great honor to receive a Wiener prize. It is indeed gratifying to obtain recognition at an advanced age.

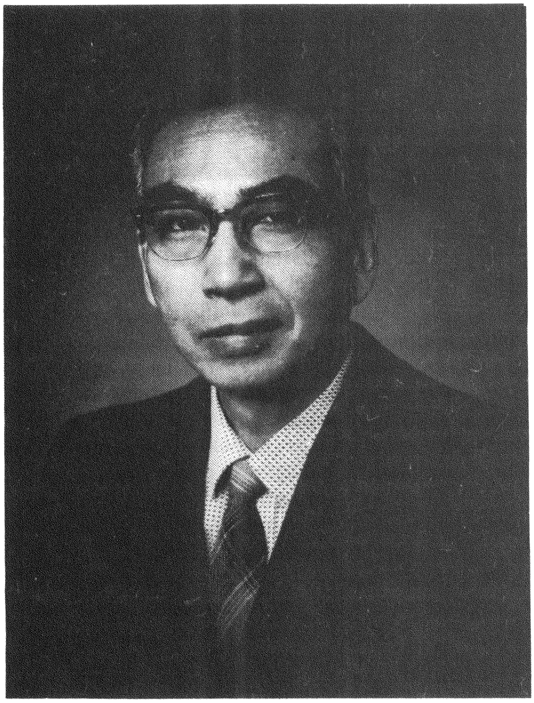
I would like to describe some of my early works and more recent ones, in different fields mentioned in the citation.

During World War II, I was working, in the countryside of Japan, on the spectral theory of Schrödinger operators and perturbation theory. As a physics student I had been led to study these problems on my own, since no one seemed to pay attention to them in spite of the existence of the general principle given by von Neumann. My first efforts were directed toward establishing the essential selfadjointness of Schrödinger operators and laying a mathematical foundation for perturbation theory. (At that time I did not know of Rellich's work.)

Schrödinger operators are formally selfadjoint differential operators. In general such an operator admits infinitely many realizations as selfadjoint operators in the basic Hilbert space. Physics requires that the realization should be unique within a reasonable range. It had been tacitly assumed that the Friedrichs extension, which exists for any semibounded symmetric operator, was the right realization but no proof existed that it was unique. Actually the proof turned out to be rather easy, at least for the N-body problem with the potentials I assumed.

These works were more or less completed by the end of the war, but I was not very lucky with their publication. A couple of years later I submitted two papers on the subject to *Physical Review.* They were soon forwarded to the *Transactions of the American Mathematical Society,* where the manuscripts were passed from one referee to another without success, eventually to be lost. I had to resubmit new manuscripts. After three years from initial submission, the papers were finally saved by the last referee.

In the following three decades, these preliminary results on Schrödinger operators were to be followed by more detailed study of their spectral properties, the main part of which belongs to scattering theory. A tremendous development has set in, due to the participation of a host of brilliant mathematical physicists of the new generation. It has been my great pleasure to watch the N-body problem in quantum mechanics nearing a com-



Tosio Kato

plete solution, though I feel myself now too far behind to make any active contribution.

I have been fascinated by the Hille-Yosida-Phillips theory of operator semigroups, and continually have tried to apply it to solving various evolution equations, linear and nonlinear. The simplest, and in many cases most powerful, method for solving nonlinear equations is successive approximation. Here one has to solve a sequence of linearized evolution equations, which are temporally inhomogeneous even if the original equation is homogeneous. Once a satisfactory theory of linear equations is established, the process of successive approximation can be converted into a general algorithm, with which one can handle a large number of partial differential equations and integro-differential equations, as long as local (in time) solutions are concerned. One of my recent papers deals with the Korteweg-de Vries equation by this method, supplemented with the conservation laws to extend the solutions globally. Here I have found the semigroup theory especially powerful for constructing a completely smooth solution for positive time, starting from any square-integrable initial function with compact support. It is very interesting to observe that the formally time-reversible equation exhibits a highly irreversible and smoothing behavior.

Biographical Sketch

Tosio Kato was born August 25, 1917, in Kanuma, Japan. He received a B.S. in 1941 and a D.Sc. in 1951, both from the University of Tokyo. Between 1943 and 1962 he advanced from assistant to professor of physics at the University of Tokyo. He has been professor of mathematics at the University of California, Berkeley, since 1962.

Professor Kato served on the AMS Committee for the Symposium on Nonlinear Functional Analysis, April 16–19, 1968, in Chicago, Illinois. He has given addresses at several AMS meetings, including the Symposium on Applications of Nonlinear Partial Differential Equations (New York, April 1964), the Special Session on Partial Differential Equations (Annual Meeting, Chicago, January 1966), the Symposium on Nonlinear Functional Analysis (Chicago, April 1968), the Special Session on Operator Theory (San Luis Obispo, November 1977), and the Special Session on Nonlinear Analysis (San Francisco, April 1978); other invited addresses were presented at the Conference in honor of Professor Marshall Stone (Chicago, May 1968), the International Conference on Functional Analysis and Related Topics (Tokyo, April 1969), the International Congress of Mathematicians (Nice, September 1970), the International Symposium "50 Years Schrödinger Equation" (Vienna, June 1976), and the Conference on Functional Analysis and its Applications (M.I.T., October 1979). He also gave an invited hour address at the AMS meeting in Pasadena, California, in November 1970.

Professor Kato was the recipient of the Asahi Award in 1960 and is a member of the Mathematical Society of Japan. His major research interests are functional analysis and applications and mathematical physics.

CITATION FOR WIENER PRIZE:

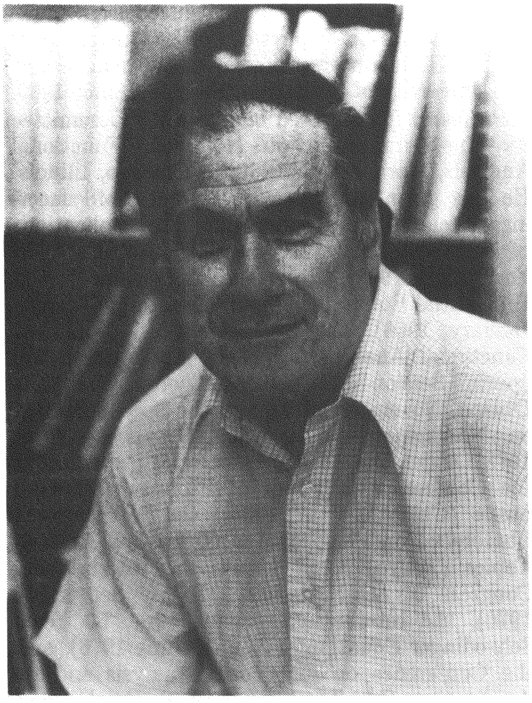
G. B. Whitham's qualifications for the Wiener Prize rest on his remarkably broad set of contributions to the understanding of fluid dynamical phenomena and on his equally remarkable innovative contributions to the methodology through which that understanding can be constructed. Either of these would suffice, in our opinion, but with both he is a formidable candidate indeed!

Gerald B. Whitham

I am greatly honored to be awarded a Norbert Wiener Prize in Applied Mathematics. It is most encouraging to have one's work recognized in this way and I thank the members of SIAM and AMS very sincerely. In view of this award, I am particularly glad that my two years at M.I.T. overlapped with Professor Wiener and that I had some opportunity to talk with him. I am happy to receive an award associated with his name.

Biographical Sketch

Gerald B. Whitham was born on December 13, 1927, in Halifax, England. He received his Ph.D. from Manchester University in 1953, and was Lecturer in Applied Mathematics, 1953–1956.



Gerald B. Whitham

From 1951 to 1953 he was Research Associate at the Institute of Mathematical Sciences at New York University and returned there in 1956 as Associate Professor; from 1959 to 1962 he was Professor of Mathematics at the Massachusetts Institute of Technology. After a year's visit to the California Institute of Technology, he moved there permanently in 1962, first as Professor of Aeronautics and Mathematics, and since 1967 as Professor of Applied Mathematics.

Professor Whitham is a Fellow of the Royal Society and a Fellow of the American Academy of Arts and Sciences. He has given invited lectures at the AMS Summer Seminar in Potsdam, New York, 1972, the British Theoretical Mechanics Colloquium 1975 and the Canadian Congress of Applied Mechanics 1977.

His research interests are in fluid mechanics and wave propagation. This has included formulas for the strength of sonic booms, theories of shock wave propagation and diffraction, variational methods for the general study of wave phenomena, and the introduction of nonlinear group velocity and related concepts for dispersive waves. Much of this work is presented in his book *Linear and nonlinear waves.*

CITATION FOR THE STEELE PRIZE FOR CUMULATIVE INFLUENCE:

The Steele Prize for *cumulative effect on mathematics, or very high level of work over a long period of time* is awarded to André Weil of the Institute for Advanced Study (Emeritus), for the total effect of his work on the general course of twentieth century mathematics, especially in the many areas in which he has made fundamental contributions.

Some highlights of his career in approximate chronological order are:

a) Proof of the correct generalization of Mordell's theorem: The points on an abelian variety (complex torus with enough meromorphic functions) whose coordinates lie in a fixed algebraic number field form a *finitely* generated group (this is the Mordell-Weil theorem).

b) New treatment of Haar measure and the recognition that the spectral theory of compact operators is at the heart of the Peter-Weyl theorem—strong emphasis on Fourier analysis on locally compact groups (in his book *L'Intégration dans les Groups Topologiques et ses applications*).

c) Proof of the Riemann hypothesis for algebraic curves, entailing (i) Foundations of intersection theory on algebraic varieties (this appears in his book *Foundations of algebraic geometry* which was extremely influential and contained the first mention of a notion of algebraic variety, constructed by patching like manifolds), (ii) *Creation* of the theory of abelian varieties over fields of all characteristics, including almost all the fundamental results, (iii) Use of the inverse limit of the l^r-torsion points on the Jacobian of a curve (l a prime, not equal to the characteristic of the base field) as the analog of a one-dimensional cohomology group for the curve, and recognition that the Frobenius operator and its action on this "cohomology group" are crucial for the Riemann hypothesis.

d) Generalization of the ideas above to algebraic varieties of dimension two or more resulting in his celebrated conjectures of Diophantine Geometry. These "Weil Conjectures" were *the* prime movers behind the enormous flowering of algebraic geometry and algebraic number theory in the twenty-five years 1947–1974. The conjectures were proved by Dwork, Artin-Grothendieck, Lubkin, and Deligne (Riemann hypothesis).

e) Recognition that the Riemann hypothesis gives the best estimate for important number-theoretic sums (Kloosterman, Jacobi sums) and the proof of these estimates in the one-variable case.

f) The resurrection and considerable deepening of Poincaré's theory of θ-functions on abelian varieties and the shaping of a renewed theory of Kähler varieties by his influential book *Introduction a l'Étude des Varieties Kählériennes.*

g) Fundamental work in the representation theory of certain locally compact groups and the demonstration of unexpected connections with number theory and class field theory (the papers on the "metaplectic" group).

h) His several other books (among which are *Basic number theory* and *Elliptic functions according to Eisenstein and Kronecker*) which stress the crucial connections between abstract analysis and number theory—a point of view so common today that we forget it took great insight to see it.

André Weil

A message of thanks was received from Professor Weil, expressing his regrets about his inability to receive the award in person, and his deep appreciation of the honor conferred upon him by the AMS.

Biographical Sketch

André Weil was born May 6, 1906, in Paris, France, and received his D. Sc. degree from the University of Paris in 1928. He was professor at Aligarh Muslim University in India (1930–1932) and at the University of Strasbourg (1933–1940). He served as lecturer at Haverford College and Swarthmore College in 1941-1942, and as professor of mathematics at the University of São Paulo, Brazil, from 1945 to 1947. From 1947 to 1958 he was professor at the University of Chicago. He was a professor at the School of Mathematics of the Institute for Advanced Study from 1958 until his retirement in 1976.

Professor Weil has been AMS representative to the Board of Editors of the *American Journal of Mathematics* (1955–1958). He has given invited addresses at AMS meetings in New York (April 1944) and Chicago (February 1948). He also gave addresses at International Congresses of Mathematicians in 1950, 1954, and 1978. He is a member of the Mathematical Society of France and the Indian Mathematical Society. His major areas of research interest are theory of numbers, algebraic geometry, group theory, and the history of mathematics.

CITATION FOR THE STEELE PRIZE FOR MATHEMATICAL EXPOSITION:

The Steele Prize for a book or research-expository article in the category of *Mathematical Exposition* is awarded to Professor Harold M. Edwards of New York University for his two books:

a)*Riemann's zeta function* (Pure and Applied Mathematics, Number 58) Academic Press, New York and London, 1974

b) *Fermat's last theorem* (Graduate Texts in Mathematics, Number 50) Springer-Verlag, New York and Berlin, 1977

These books are very well written summaries of the main results on these two research-provoking problems. They give valuable historical information and provide a needed contribution to the history of ideas of the past three centuries. Moreover, they are mathematically lucid and enable mathematicians of all specialties to understand the mathematics of these important questions and their potential for stimulating further mathematical discoveries. In placing before the mathematically literate public the important ideas and results of investigations involving the tangled skeins of diophantine equations, algebraic number theory, elementary number theory, and complex analysis, Edwards has rendered an important service to the mathematical community.

Harold M. Edwards

Harold M. Edwards

In 1969, when I began the work for which this prize is being given, I did not imagine, even in my most exhuberant fantasies, that work of this kind would ever be commended by the American Mathematical Society. I had become interested in the Riemann hypothesis (a fact which will enable any mathematician to guess what form my most exhuberant fantasies *did* take) and I simply found it natural to look into the history of the problem and, in particular, to study the brief memoir in which Riemann first advanced his "hypothesis."

My inclination to the study of history is doubtless something I learned from my father, who was fascinated by American history and whose everyday life and thought were suffused with his appreciation of the importance of history. Certainly nothing in my graduate education, which was otherwise excellent, contributed to my interest in the history of mathematics; it was only after I received my Ph.D. that I began looking into the works of Hilbert, Riemann, Poincaré, and others, more for pleasure and interest than as a serious part of my mathematical work.

In any case, I read Riemann's eight page memoir on the zeta function so many times I could practically recite it, and each time I read it I felt I understood something I hadn't understood before. It seemed to me it would be worthwhile to write an explication of the memoir in order to make it accessible to others who might be put off by Riemann's difficult and very condensed style. However, I hesitated because I didn't know of any journal that might publish such an article. Fortunately, my friend and colleague Bruce Chandler convinced me that if it was good it would find an audience, and that I should go ahead and try to write it.

As I worked on it, the project expanded, more or less of its own accord, into a book-length exposition, not only of the contents of Riemann's memoir, but also of other aspects of the theory of the zeta function. The approach remained historical, and I dealt with the original works of the major contributors to the theory. I learned from the inspiring introduction to Otto Toeplitz's book on the development of the calculus to call this method of exposition the *genetic method*, defined by the dictionary as "the explanation or evaluation of a thing or event in terms of its origin and development." My book is not a history, then; it is an exposition of the theory of the zeta function using the genetic method.

Once the article had become a book, the problem of finding an appropriate journal no longer existed, but it was replaced by what I thought might be the more difficult problem of finding a publisher. I am grateful to Wilhelm Magnus for encouraging me to submit the book to Academic Press, and I am grateful to Sammy Eilenberg, not only for accepting it in his prestigious series of monographs, but also for giving it its title, *Riemann's zeta function*, which I think is just right.

As I explain briefly at the end of the book, in order to pursue further the study of the Riemann hypothesis, it seemed to me necessary to go beyond the classical zeta function and to study the generalized zeta functions that occur in algebraic geometry and algebraic number theory. Through a great piece of good fortune, I learned at just this time, in 1973, that the Vaughn Foundation was interested in supporting work on Fermat's last theorem. Their encouragement and financial support made possible the second book for which the prize is now being awarded. It is an exposition, using the genetic method, of some basic aspects of algebraic number theory, including Kummer's proof of Fermat's last theorem for regular prime exponents.

I go into all this detail about how the two books came to be written, because it is only against this background that I can explain, even partially, the great joy and satisfaction that this prize gives me. It is not by research alone that mathematics grows and flourishes. Work in mathematical exposition and the history of mathematics—as well as such other areas as the philosophy of mathematics and reviewing—are essential to its well-being. Richard Courant realized this, and, at the Institute which he built, men like Magnus, Morris Kline, and Peter Lax keep this tradition alive. However, in the mathematical community as a whole—and particularly in the American Mathematical Society—it has always seemed to me that research was all, and that other activities were, at best, tolerated.

There have been a few indications in recent years that the attitude of the Society was changing and that it did want to recognize and encourage work other than research in the narrowest sense. For example, I think an explication of Riemann's memoir like the one I envisaged ten years ago might well be suitable now for the new *Bulletin* of the AMS. But this award of the Steele prize for expository writing seems to me to be the strongest and most unequivocal evidence of a broader attitude on the part of the Society about the kind of work it wants to promote.

Thus, my happiness in receiving this award—already great because of the award itself and because it was so unexpected—is all the greater because I see it as an indication of this change. I feel certain that more talented mathematicians will now be encouraged to devote more of their efforts to good exposition and that in this way the Society will be promoting both the accessibility and the richness of our mathematical culture.

In conclusion, I would like simply to express my gratitude for this honor. As I read the list of the names and works of the other recipients of the Steele prize I am humbled. The fact that so few mathematicians have been writing expositions must have worked in my favor. The competition is likely to get stiffer, but I am determined to keep up with it.

Biographical Sketch

Harold M. Edwards was born August 6, 1936, in Champaign, Illinois. He received a B.A. from the University of Wisconsin in 1956, an M.A. from Columbia University in 1957, and a Ph.D. from Harvard University in 1961. He was an instructor at Harvard (1961-1962) and research associate and assistant professor at Columbia (1962–1966). Since 1966, he has been at New York University, where he is now professor of mathematics at the Courant Institute of Mathematical Sciences. In 1971 he was a visiting senior lecturer at the Australian National University.

Professor Edwards has spoken at the special session on the history of mathematics at the Annual Meeting in San Antonio (January 1976) and at the special session on number theory in Washington, D.C. (October 1979). He organized the special session on the history of mathematics at the Annual Meeting in St. Louis (January 1977) and presided at the special sessions commemorating the Gauss bicentennial at the Spring Meeting in New York (April 1977).

In addition to the books cited in the award of the Steele prize, Professsor Edwards is the author of a book on advanced calculus (soon to be republished by the Krieger Publishing Company) and of a number of articles and book reviews. He and Professor Bruce Chandler were the founding editors of the *Mathematical Intelligencer.*

Professor Edwards is married to Betty Rollin, an author and correspondent for NBC television news. He and his wife live in New York City.

CITATION FOR THE STEELE PRIZE FOR WORK OF FUNDAMENTAL OR LASTING IMPORTANCE:

The Steele Prize for fundamental work is awarded to Gerhard P. Hochschild of the University of California, Berkeley, for his significant work in homological algebra and its applications as exemplified by five papers:

On the cohomology groups of an associative algebra, Annals of Mathematics (2) **46**(1945), 58–61

On the cohomology theory for associative algebras, Annals of Mathematics (2) **47**(1946), 568–579

The cohomology of group extensions (with Serre), Transactions of the American Mathematical Society **74**(1953), 110–134

The cohomology of Lie algebras (with Serre), Annals of Mathematics (2) **57**(1953), 591–603

Cohomology in class field theory (with Nakayama), Annals of Mathematics (2) **55**(1952),348–366

Hochschild is one of the originators of homological algebra. The first two papers cited are the beginning of the cohomology of associative algebras where the so-called Hochschild cohomology, now ubiquitous in the theory of algebras, was introduced. The third and fourth papers mentioned are fundamental contributions to other areas of homological algebra, namely the cohomology of groups and Lie algebras. They construct what are now known throughout the literature as the Hochschild-Serre spectral sequences. The fifth paper is the first place where class field theory is given a homological treatment. This point of view now dominates that subject and has led to generalizations impossible with the older points of view. The Cole Prize winning work of John Tate is based in part on the contributions found in the last cited paper.

Taken all in all, these papers form a consistent and deep application of homological methods to wide and interesting areas of algebra and number theory. They are in no small part responsible for the lasting influence of homology and cohomology on algebraic questions.

EDITOR'S NOTE. While deeply honored by the Society's consideration of his work for a prize, Professor Hochschild reported that for personal reasons he is unable to accept the Steele award. Nevertheless the selection committee has reaffirmed its view that Hochschild's work cited above fully merits the Steele Prize.