Paul R. Garabedian Awarded 1983 Birkhoff Prize

The George David Birkhoff Prize is awarded every five years to a recipient selected, by a joint committee of the American Mathematical Society and the Society for Industrial and Applied Mathematics, for outstanding contributions to "applied mathematics in the highest and broadest sense." The 1983 recipient is Paul R. Garabedian of the Courant Institute of Mathematical Sciences of New York University.

The Birkhoff Prize Fund was originally created by the Birkhoff family in 1967. The award is supplemented by an award from the Steele Prize Fund of the American Mathematical Society in the name of the Birkhoff Prize (the Steele Prize Fund was presented to the Society for prizes in honor of George David Birkhoff, William Fogg Osgood and William Caspar Graustein). In 1983 the award is $1500.

Previous recipients of Birkhoff prizes are Jürgen K. Moser (1968), Fritz John (1973), James B. Serrin (1973), Garrett Birkhoff (1978), Mark Kac (1978) and Clifford A. Truesdell III (1978).

The Birkhoff Prize for 1983 is awarded by the Council of the American Mathematical Society and the Executive Committee of the Council of the Society for Industrial and Applied Mathematics, on the recommendation of the joint AMS-SIAM Committee to Select the Winner of the Birkhoff Prize for 1983, whose members are Stuart S. Antman, David Gilbarg, chairman, and Werner C. Rheinboldt.

Paul R. Garabedian

The material which follows consists of the selection committee's citation, the remarks of Professor Garabedian at the Prize Session in Denver on the presentation of the award, a brief biography of Garabedian and an essay in which Peter Lax sketches Garabedian's contributions to applied mathematics.

Citation

The George David Birkhoff Prize for 1983 is presented to Paul R. Garabedian for his important contributions to partial differential equations, to the mathematical analysis of problems of transonic flow and airfoil design by the method of complexification, and to the development and application of scientific computing to problems of fluid dynamics and plasma physics.

Response

I am very grateful to have been awarded the Birkhoff Prize. It is an additional satisfaction that the award is supplemented from the Steele Fund honoring G. D. Birkhoff, W. F. Osgood and W. C. Graustein. This is especially true because my father was a Ph. D. student of G. D. Birkhoff and attributed his principal guidance in teaching to W. F. Osgood. It was moreover in Graustein's home that he first met my mother. They directed me to the Graduate School at Harvard, where it was under the influence of Garrett Birkhoff that I first studied hydrodynamics.

I wish to take this occasion to acknowledge the contributions to my research that have been made by the teachers, colleagues and students who have collaborated in my work. Many but not all have appeared as joint authors of my publications.

Biographical Sketch

Paul Roesel Garabedian was born on August 2, 1927, in Cincinnati, Ohio. He received an A.B. degree from Brown University in 1946, and both an A.M. (1947) and a Ph.D. (1948) from Harvard University. He was assistant professor at the University of California in 1949-1950. Between 1950 and 1959 he advanced from assistant professor to professor of mathematics at Stanford University. He has been professor of mathematics at the Courant Institute of Mathematical Sciences of New York University since 1959. Between 1972 and 1978 he was Director of the Courant Mathematics and Computing Laboratory of the U. S. Department of Energy at New York University and, since 1978 he has been Director of the Division of Computational Fluid Dynamics.

Professor Garabedian has been the recipient of fellowships from the National Research Council (1948-1949), the Alfred P. Sloan Foundation (1961–1963), and the Guggenheim Foundation (1966-1967 and 1981-1982). In 1975 he was Sherman Fairchild Distinguished Scholar at the California Institute of Technology. He served as Scientific Liaison Officer in the London Branch of the Office of Naval Research (1957-1958), and has received the NASA Public Service Group Achievement Award (1976) and the NASA Certificate of Recognition twice (1977 and 1980). In 1980 he received the Boris Pregal Award of the New York Academy of Sciences. He is a member of the editorial board of *Applicable Analysis*.

Professor Garabedian served as member-at-large of the Council of the American Mathematical Society from 1959 to 1961. He has been a member of the Program Committee for a Summer Seminar in Applied Mathematics (1957), the Committee on Applied Mathematics (1959–1964), and the AMS-MAA-SIAM Joint Projects Committee for Mathematics (1976, 1977). He gave an invited address in Los Angeles in November 1955. He has spoken at the Fifth Symposium on Applied Mathematics (Pittsburgh, June 1952), the Symposium on Special Topics in Applied Mathematics (Evanston, Illinois, November 1953), the Symposium on Applications of Nonlinear Partial Differential Equations (New York, April 1964), and at the Special Session on Operator Theory and Several Complex Variables (New York, March 1978).

Professor Garabedian is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Mathematical Society, the Society for Industrial and Applied Mathematics, the American Physical Society and the American Institute of Aeronautics and Astronautics. His major research interests are functions of a complex variable, computational fluid dynamics, and partial differential equations.

Paul Garabedian's Work in Applied Mathematics

Peter D. Lax

Garabedian has, of course, made outstanding contributions to pure mathematics in the theory of functions of one and several complex variables (Bieberbach's conjecture, the $\bar{\partial}$-Neumann problem), and the theory of partial differential equations. He has also made basic contributions to the theoretical aspects of applied mathematics, principally to the existence and construction of fluid flows with free surfaces. In this report, however, I would like to concentrate on his contributions to computational applied mathematics because of the extreme importance of this emerging new field, because of Garabedian's leadership in championing this new field, and because Garabedian has successfully brought sophisticated methods of theoretical mathematics to bear on problems of computational nature.

In the late fifties Garabedian solved the blunt body design problem of hypersonic flow by prescribing the shape of the bow shock and solving the Cauchy problem for the equations of compressible flow. Because the flow is subsonic across the point of symmetry of the shock, the equations are not hyperbolic; Garabedian circumvented this difficulty by introducing complex coordinates, in terms of which the problem becomes well posed. The methods developed were applied to the so-called reentry problem.

In the sixties Garabedian applied the method of complexification to the problem of transonic flows. He devised methods for designing airfoils which can accommodate shockless transonic flows, of great importance in reducing drag. He supervised wind tunnel tests of his designs, which bore out the theoretical predictions. Today Garabedian's airfoils and his method for designing airfoils are widely used in the aircraft industry and aerospace laboratories.

In the seventies Garabedian and his coworkers showed how to use and modify his methods for designing shockless airfoils to the design of efficient turbine and compressor blades. These have found wide applications in the aircraft engine industry.

In the last eight years Garabedian has turned to the problem of magnetohydrodynamic equilibria and their stability. These are essentially three dimensional configurations, whose calculation taxes the capacity of the most advanced current class VI supercomputers. The calculations can be performed only in special coordinates, and after preliminary analytical reductions. Garabedian's studies of so-called stellarator configurations are the state of the art in this branch of the magnetically confined fusion effort.

I would also like to mention Garabedian's early paper (1956) on the rate of convergence of the SOR method. This little gem relates the convergence rate to the lowest eigenvalue of the associated region. The method of analysis has proved fruitful in other contexts.