ABEL
PRISEN

The Norwegian Academy of Science and Letters has decided to award the Abel Prize for 2005 to

Peter D. Lax
Courant Institute of Mathematical Sciences, New York University

for his groundbreaking contributions to the theory and application of partial differential equations and to the computation of their solutions.

Ever since Newton, differential equations have been the basis for the scientific understanding of nature. Linear differential equations, in which cause and effect are directly proportional, are reasonably well understood. The equations that arise in such fields as aerodynamics, meteorology and elasticity are nonlinear and much more complex: their solutions can develop singularities. Think of the shock waves that appear when an airplane breaks the sound barrier.

In the 1950s and 1960s, Lax laid the foundations for the modern theory of nonlinear equations of this type (hyperbolic systems). He constructed explicit solutions, identified classes of especially well-behaved systems, introduced an important notion of entropy, and, with Glimm, made a penetrating study of how solutions behave over a long period of time. In addition, he introduced the widely used Lax-Friedrichs and Lax-Wendroff numerical schemes for computing solutions. His work in this area was important for the further theoretical developments. It has also been extraordinarily fruitful for practical applications, from weather prediction to airplane design.

Another important cornerstone of modern numerical analysis is the “Lax Equivalence Theorem”. Inspired by Richtmyer, Lax established with this theorem the conditions under which a numerical implementation gives a valid approximation to the solution of a differential equation. This result brought enormous clarity to the subject.

A system of differential equations is called “integrable” if its solutions are completely characterized by some crucial quantities that do not change in time. A classical example is the spinning top or gyroscope, where these conserved quantities are energy and angular momentum.

Integrable systems have been studied since the 19th century and are important in pure as well as applied mathematics. In the late 1960s a revolution occurred when Kruskal and co-workers discovered a new family of examples, which have “soliton” solutions: single-crested waves that maintain their shape as they travel. Lax became fascinated by these mysterious solutions and found a unifying concept for understanding them, rewriting the equations in terms of what are now called “Lax pairs”. This developed into an essential tool for the whole field, leading to new constructions of integrable systems and facilitating their study.

Scattering theory is concerned with the change in a wave as it goes around an obstacle. This phenomenon occurs not only for fluids, but also, for instance, in atomic physics (Schrödinger equation). Together with Phillips, Lax developed a broad theory of scattering and described the long-term behaviour of solutions (specifically, the decay of energy). Their work also turned out to be important in fields of mathematics apparently very distant from differential equations, such as number theory. This is an unusual and very beautiful example of a framework built for applied mathematics leading to new insights within pure mathematics.

Peter D. Lax has been described as the most versatile mathematician of his generation. The impressive list above by no means states all of his achievements. His use of geometric optics to study the propagation of singularities inaugurated the theory of Fourier Integral Operators. With Nirenberg, he derived the definitive Gårding-type estimates for systems of equations. Other celebrated results include the Lax-Milgram lemma and Lax’s version of the Phragmén-Lindelöf principle for elliptic equations.

Peter D. Lax stands out in joining together pure and applied mathematics, combining a deep understanding of analysis with an extraordinary capacity to find unifying concepts. He has had a profound influence, not only by his research, but also by his writing, his lifelong commitment to education and his generosity to younger mathematicians.

Peter D. Lax

Peter D. Lax was born May 1, 1926 in Budapest, Hungary. He was on his way to New York with his parents on December 7, 1941 when the US joined the war.

Peter D. Lax received his PhD in 1949 from New York University with Richard Courant as his thesis advisor. Courant had founded the Courant Institute of Mathematical Sciences at NYU where Lax served as Director from 1972-1980. In 1950 Peter D. Lax went to Los Alamos for a year and later worked there several summers as a consultant, but already in 1951 he returned to New York University to begin his life work at the Courant Institute. Lax became professor in 1958. At NYU he has also served as Director of the AEC (Atomic Energy Commission) Computing and Applied Math Center.

In nominating Lax as a member of the US National Academy of Sciences in 1962, Courant described him as “embodying as few others do, the unity of abstract mathematical analysis with the most concrete power in solving individual problems”.

Peter D. Lax is one of the greatest pure and applied mathematicians of our times and has made significant contributions, ranging from partial differential equations to applications in engineering. His name is connected with many major mathematical results and numerical methods, such as the Lax-Milgram Lemma, the Lax Equivalence Theorem, the Lax-Friedrichs Scheme, the Lax-Wendroff Scheme, the Lax Entropy Condition and the Lax-Levermore Theory.

Peter D. Lax is also one of the founders of modern computational mathematics. Among his most important contributions to High Performance Computing and Communications community was his work on the National Science Board from 1980 to 1986. He also chaired the committee convened by the National Science Board to study large scale computing in science and mathematics – a pioneering effort that resulted in the Lax Report.

Professor Lax’s work has been recognized by many honours and awards. He was awarded the National Medal of Science in 1986, presented by President Ronald Reagan at a White House ceremony. Lax received the Wolf Prize in 1987 and the Chauvenet Prize in 1974 and shared the American Mathematical Society’s Steele Prize in 1992. He was also awarded the Norbert Wiener Prize in 1975 from the American Mathematical Society and the Society for Industrial and Applied Mathematics. In 1996 he was elected a member of the American Philosophical Society.

Peter D. Lax has been both president (1977-80) and vice president (1969-71) of the American Mathematical Society.

Professor Peter D. Lax is a distinguished educator who has mentored a large number of students. He has also been a tireless reformer of mathematics education and his work with differential equations has for decades been a standard part of the mathematics curriculum worldwide.

Peter D. Lax has received many Honorary Doctorates from universities all over the world. When he was honoured by the University of Technology in Aachen, Germany in 1988, both his deep contribution to mathematics and the importance his work has had in the field of engineering were emphasized. He was also honoured for his positive attitude toward the use of computers in mathematics, research and teaching.

CURRICULUM VITAE
Peter D. Lax

BORN:	May 1, 1926 Budapest, Hungary	
EDUCATION:	New York University, AB	1947
	New York University, Ph.D.	1949
POSITIONS:	Los Alamos Scientific Laboratory Manhattan Project	1945-46
	Los Alamos Scientific Laboratory, Staff Member	1950
	Assistant Professor New York University	1951
	Fulbright Lecturer in Germany	1958
	Professor, New York University	1958-Present
	Director, Courant Institute of Mathematical Sciences, New York University	1972-80
HONORS AND AWARDS:		
	Lester R. Ford	1966, 1973
	von Neumann Lecturer, S.I.A.M.	1969
	Hermann Weyl Lecturer	1972
	Hedrick Lecturer	1973
	Chauvenet Prize, Mathematical Association of America	1974
	Norbert Wiener Prize, American Mathematical Society and Society of Industrial and Applied Mathematics	1975
	Member, National Academy of Sciences of the U.S.A.	1982
	Member, American Academy of Arts and Sciences	1982
	Honorary Life Member, New York Academy of Sciences	1982
	Foreign Associate, French Academy of Sciences	1982
	National Academy of Sciences, Award in Applied Mathematics and Numerical Sciences	1983
	National Medal of Science	1986
	Wolf Prize	1987
	Member, Soviet Academy of Sciences	1989
	Steele Prize	1992
	Member, Hungarian Academy of Sciences	1993
	Member, Academia Sinica, Beijing	1993
	Distinguished Teaching Award, New York University	1995
	Member, Moscow Mathematical Society	1995
HONORARY DOCTORAL DEGREES:		
	Kent State University	1975
	University of Paris	1979
	Technical University of Aachen	1988
	Heriot Watt University	1990
	Tel Aviv University	1992
	University of Maryland, Baltimore	1993
	Brown University	1993
	Beijing University	1993
	Texas A&M University	2000
PROFESSIONAL SOCIETIES:		
	Board of Governors	
	Mathematical Association of America	1966-67
	New York Academy of Sciences	1986-87
	Member, Society of Industrial and Applied Mathematics	
	Vice President, American Mathematical Society	1969-71
	President, American Mathematical Society	1977-80
GOVERNMENT SERVICE:		
	President's Committee on the National Medal of Science	1977
	National Science Board	1980-86
	DOE Related:	
	Theory Division, Advisory Committee, LANL	
	Senior Fellow, Los Alamos Scientific Laboratory Review	
	Committee, Oak Ridge National Laboratory	