

# THE INSTITUTE LETTER

INSTITUTE FOR ADVANCED STUDY

PRINCETON, NEW JERSEY · FALL 2004

## ARNOLD LEVINE APPOINTED FACULTY MEMBER IN THE SCHOOL OF NATURAL SCIENCES

The Institute for Advanced Study has announced the appointment of Arnold J. Levine as professor of molecular biology in the School of Natural Sciences. Professor Levine was formerly a visiting professor in the School of Natural Sciences where he established the Center for Systems Biology (see page 4). “We are delighted to welcome to the Faculty of the Institute a scientist who has made such notable contributions to both basic and applied biological research. Under Professor Levine’s leadership, the Center for Systems Biology will continue working in close collaboration with the Cancer Institute of New Jersey, Robert Wood Johnson Medical School, Lewis-Sigler Center for Integrative Genomics at Princeton University, and BioMaPS Institute at Rutgers, The State University of New Jersey, as well as such industrial partners as IBM, Siemens Corporate Research, Inc., Bristol-Myers Squibb, and Merck & Co.,” commented Peter Goddard, Director of the Institute.

Arnold J. Levine’s research has centered on the causes of cancer in humans and animals. In 1979, he and others discovered the p53 tumor suppressor protein, a molecule that inhibits tumor development, and whose disruption is associated with many human cancers, including cancer of the breast, lung, liver, skin, prostate, bladder, cervix, and colon. As chair of the National Institutes of Health Commission on AIDS Research and the National Academies Cancer Policy Board, Professor Levine has helped to determine national research priorities.

Before coming to the Institute, Professor Levine was President and Chief Executive Officer of The Rockefeller University in New York City from 1998 to 2002, as well as Heilbrunn Professor of Cancer Biology and laboratory head. Prior to his tenure at The Rockefeller University, Professor Levine was chair of the Department of Molecular Biology at Princeton University from 1984 until 1996, and also served as the Harry C. Wiess

Professor in the Life Sciences until 1998. He was on the faculty of the Biochemistry Department at Princeton University from 1968 to 1979, when he became chair and professor in the Department of Microbiology at the State University of New York at Stony Brook, School of Medicine.

The recipient of many honors, among his most recent are: the Medal for Outstanding Contributions to Biomedical Research from Memorial Sloan-Kettering Cancer Center (2000); the Keio Medical Science Prize of the Keio University Medical Science Fund, Japan (2000); the Albany Medical Center Prize in Medicine and Biomedical Research (2001); and the Award for Basic Research from the Surgical Society of Oncologists (2003). He is a member of the National Academy of Sciences and of the Academy’s Institute of Medicine; and is also the author or coauthor of over 300 scientific papers, as well as a book, *Viruses* (1993).

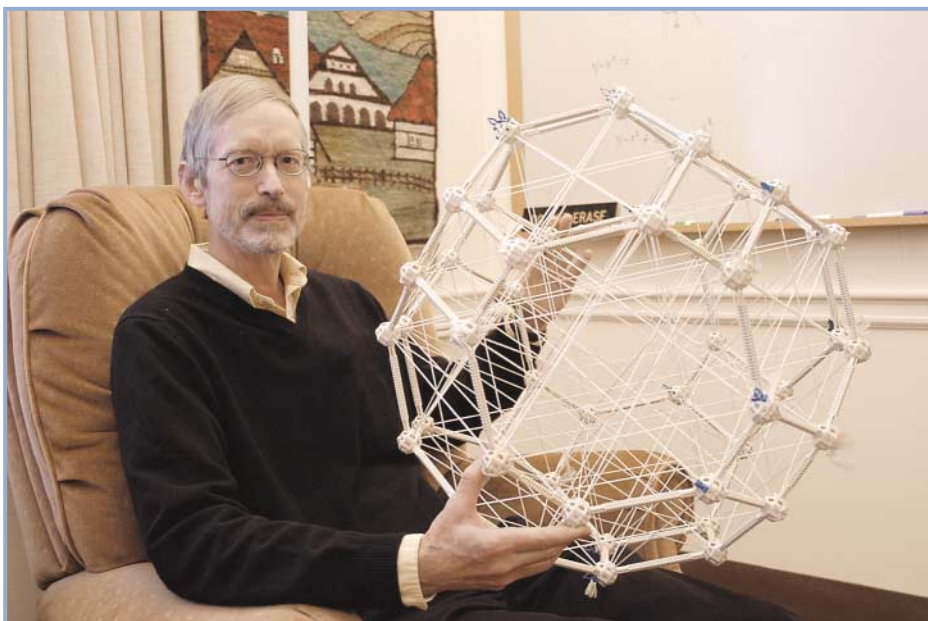
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Arnold J. Levine

CLIFF MOORE

## A CONFERENCE ON THE OCCASION OF THE SIXTIETH BIRTHDAY OF ROBERT MACPHERSON



Robert MacPherson

CLIFF MOORE

Robert MacPherson is a geometer whose work has introduced radically new approaches to the topology of singular spaces. At the Institute for Advanced Study, where he occupies the office of the late Professor Hassler Whitney (1907–1989)—one of the leading geometers of the twentieth century—Robert MacPherson works in several fields of geometry: algebraic geometry, algebraic topology, representation theory, combinatorics, automorphic forms, and K-theory. He is especially interested in aspects of geometry that interact with other areas of mathematics such as the geometry of spaces of lattices, which interacts with modular forms, and the geometry of toric varieties, which interacts with combinatorics.

“While the door to his office in Fuld Hall lacks Plato’s inscription: *let no man ignorant of geometry enter here*, Professor MacPherson clearly feels a kinship with the classical Greek mathematicians who struggled with the basic problems of geometry,” says Mark Goresky of his long-term collaborator. Today, Professor MacPherson contemplates high-dimensional mathematical objects and has brought his geometer’s intuition to many areas of mathematics. His lectures usually involve colored diagrams or carefully built models, designed to help the audience develop some intuition for such abstract objects of interest. His office is crowded with geometrical models of various sorts and sizes and a recent paper contained some sixty visual diagrams.

Since his earliest publication, “Fourier analysis of uniform random number generators,” written jointly with R. R. Coveyou in 1966, Professor MacPherson has made

(Continued on page 3)

## NEWS OF THE INSTITUTE COMMUNITY

This summer, GLEN W. BOWERSOCK, Professor of Ancient History in the School of Historical Studies, was named Chevalier of the Légion d'honneur by the French government. The order of merit, instituted by Emperor Napoleon I in 1802, is given for outstanding achievements in military or civil life. It is one of France's highest civilian honors. The award citation notes Professor Bowersock's "important contribution to French-American cultural cooperation." In addition, Professor Bowersock was named an Honorary Fellow of Balliol College, Oxford University, where he studied as a Rhodes Scholar from 1957–59.

CAROLINE WALKER BYNUM, Professor of Medieval European History in the School of Historical Studies, received an honorary Doctor of Letters from Emory University in May.

PIERRE DELIGNE, Professor in the School of Mathematics, has been awarded the Balzan Prize for Mathematics (2004) by the International Balzan Foundation. Professor Deligne received the award for his "major contributions in several important domains of mathematics (algebraic geometry, algebraic and analytic number theory, group theory, topology, Grothendieck theory of motives), enriching them with new and powerful tools and with magnificent results such as his spectacular proof of the "Riemann hypothesis over finite fields" (Weil Conjectures)." Past winners include Professor Enrico Bombieri in 1980, Jean-Pierre Serre, frequent Member in the School of Mathematics from 1955 until 1984; Institute Trustee Martin Rees in 1989; and the late Professor Armand Borel in 1992.

PETER GOLDREICH, Professor in the School of Natural Sciences, was elected a Foreign Member of the Royal Society (London) in May.

PHILLIP A. GRIFFITHS, Professor in the School of Mathematics and former Director of the Institute, received the honorary degree of Doctor of Science in May from Duke University in recognition of his "exceptional contributions to world-class science."

JONATHAN ISRAEL, Professor of Modern European History in the School of Historical Studies, has been knighted by the Queen of the Netherlands for services to the writing of modern history including that of the Netherlands. The announcement was made in July, at a

ceremony at the Dutch ambassador's residence in London. Professor Israel was presented with letters patent making him a "ridder" in the Order of the Dutch Lion.

ROBERT P. LANGLANDS, Hermann Weyl Professor in the School of Mathematics, has been elected a Member of the American Philosophical Society.

ERIC S. MASKIN, Albert O. Hirschman Professor in the School of Social Science, delivered the Toulouse Lectures at the University of Toulouse in June. The three lectures, on the subject of "Bargaining, Coalitions, and Externalities," are to be published as a monograph by Princeton University Press. In July, Professor Maskin gave a plenary lecture at the Second World Congress of the Game Theory Society; and in May, he delivered a lecture, "Should Software be Patented?," in the Taesung Kim Lecture Series at Seoul National University.

JOAN WALLACH SCOTT, Harold F. Linder Professor in the School of Social Science, has received an honorary doctorate from the University of Bergen in Norway. Professor Scott's recently published papers include "Feminism's History" in the *Journal of Women's History*, Vol. 16 No. 2, 2004, and "French Universalism in the 1990s" in *differences*, Vol. 15, No. 2 Summer 2004.

*Arguing About War* by MICHAEL WALZER, UPS Foundation Professor in the School of Social Science, was published by Yale University Press in August.

EDWARD WITTEN, Charles Simonyi Professor in the School of Natural Sciences, was awarded an honorary Doctor of Science degree from the University of Southern California in June. In July, he led a summer school in physics in Heraklion, Crete.

ALBERT O. HIRSCHMAN, Professor Emeritus in the School of Social Science, received an honorary Doctor of Humane Letters from Amherst College in May, the twentieth such degree of Professor Hirschman's career.

PETER PARET, Professor Emeritus in the School of Historical Studies, served on the Academic Advisory Committee of the United States Holocaust Memorial Museum in Washington, D.C., for a forthcoming exhibition on propaganda, its techniques, and its political, social, and cultural effects in the era of the two World Wars.

The Royal Swedish Academy of Sciences has awarded the 2004 Nobel Prize in Physics to FRANK WILCZEK, J. Robert Oppenheimer Professor in the School of Natural Sciences (1988–00), and Member (1976–78). Professor Wilczek shares the award with DAVID J. GROSS, Member in the School of Natural Sciences (1973, 1977–78), and H. David Politzer. The three scientists were honored for their work on the theory of the "strong force," the force that holds subatomic particles together inside the nucleus. They described an aspect of the theory, called "asymptotic freedom," that quarks, the constituents of the protons and neutrons within the nucleus, behave almost as free particles at very close distances.

Professors Gross and Wilczek received the prize for work that was published in 1973 in the journal *Physical Review Letters*, when Frank Wilczek was a graduate student and Professor Gross was a professor at Princeton University (1969–97) and a Member in the School of Natural Sciences. Professor Gross is currently director of the Kavli Institute of Theoretical Physics at the University of California, Santa Barbara. He is the recipient of a MacArthur Foundation Fellowship (1987), the Dirac Medal (1988), and the Grande Médaille of the French Academy of Sciences (2004).

Professor Wilczek is now Herman Feshbach Professor of Physics at the Massachusetts Institute of Technology. He is also the recipient of a MacArthur Foundation Fellowship (1982) and the Dirac Medal (1994).

Institute Trustee VARTAN GREGORIAN received the 2004 Presidential Medal of Freedom, the nation's highest civil award, in June. Gregorian, who is President of Carnegie Corporation of New York, received the award in recognition of "his work in revitalizing the New York Public Library and for his years of service as a professor and leader at six universities in the United States as well as his philanthropic endeavors."

Two former Members in the School of Mathematics were this year's Abel Prize Laureates. MICHAEL ATIYAH, Member in the School of Mathematics (1955–57, 1959–60, 1967–68, 1975–76, 1987–88) and ISADORE SINGER, Member in the School of Mathematics (1955–56, 1975–76) received the Abel Prize 2004 from King Harald of Norway in a ceremony at the University of Oslo Aula. Drs. Atiyah and Singer were awarded the prize, regarded as the mathematician's Nobel, "for their discovery and proof of the index theorem, bringing together topology, geometry and analysis, and their outstanding role in the building of new bridges between mathematics and theoretical physics," according to the award citation.

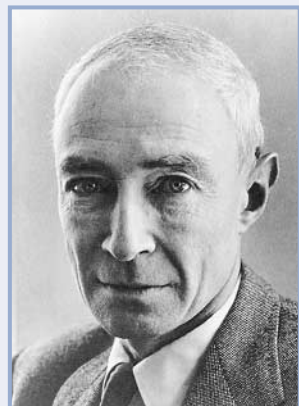
SHIING-SHEN CHERN, Member in the School of Mathematics (1943–46, 1954–55, 1964–65) is the recipient of the inaugural Shaw Prize in Mathematical Sciences. P. JAMES E. PEEBLES, Member in the School of Natural Sciences (1977–78, 1990–91, 1998–99), received the Shaw Prize in Astronomy. (See full story on page 5)

BENOIT B. MANDELBROT, Member in the School of Mathematics (1953–54), was elected to the American Philosophical Society in April. Dr. Mandelbrot is Sterling Professor of Mathematical Sciences at Yale University.

### OPPENHEIMER CENTENNIAL PROGRAM

J. Robert Oppenheimer (1904–1967) was Director of the Institute for Advanced Study from 1947 until 1966. He was Chairman of the General Advisory Committee of the Atomic Energy Commission (AEC) from 1947 through 1952, and oversaw the construction of the Los Alamos Laboratory, part of the Manhattan Project that successfully developed the atomic bomb. The Institute celebrated the centennial year of his birth on Wednesday, October 27, at 4:30 p.m., with remembrances by Jeremy Bernstein, author of *Oppenheimer: Portrait of an Enigma* (2004) and former Institute Member (1957–59), Freeman Dyson, Professor Emeritus in the School of Natural Sciences, and Morton White, Professor Emeritus in the School of Historical Studies and Institute Member (1953–54, 1962–63, 1968).

The presentations—"Oppenheimer: A Student's View," "Oppenheimer as Scientist, Administrator and Poet," and "Remembering Robert Oppenheimer," by Bernstein, Dyson and White, respectively—took place in Wolfensohn Hall, following tea in the Fuld Hall common room at 3:45 p.m. The documentary film, "The Day After Trinity," featuring archival footage and commentary from scientists and soldiers directly involved with the creation of the atomic bomb and including interviews with Oppenheimer's brother Frank Oppenheimer and Freeman Dyson, was screened at 2:15 p.m. in Wolfensohn Hall.



J. Robert Oppenheimer

ULI STELZER

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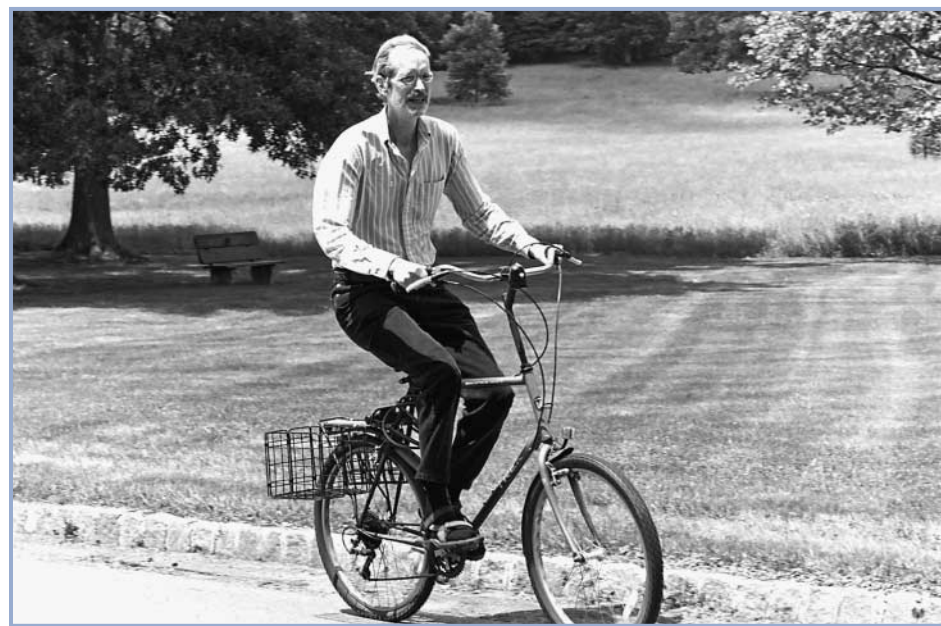
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## MACPHERSON AND HOMOLOGY THEORY *(Continued from page 1)*

important contributions in a number of different areas of mathematics. This first paper introduced the “spectral test,” still considered the premiere test for randomness of a computer-generated sequence of numbers.

The work for which Professor MacPherson is best known is the discovery of “intersection homology theory,” a joint project with Mark Goresky (Member in the School of Mathematics (1985–86, 1994–04)). This work began in 1974 and was recognized in 2002 when MacPherson and Goresky jointly were awarded the American Mathematical Society’s Leroy P. Steele Prize for a Seminal Contribution to Research. MacPherson and Goresky were honored for two papers: “Intersection Homology Theory,” published in *Topology* 19, no. 2 (1980), and “Intersection Homology II,” published in *Invent. Math.* 72, no. 1 (1983). The papers show how to extend Poincaré Duality to many singular spaces. The prize citation stated that these two papers “made possible investigations across a great spectrum of mathematics which further extended key classical manifold phenomena and methods to singular varieties and used these to solve well-known problems.”

In the American Mathematical Society’s *History of Mathematics*, vol. 2, Steven L. Kleiman, Professor of Mathematics at the Massachusetts Institute of Technology, describes intersection homology theory as “a brilliant new tool that yielded profound results.” Of MacPherson and Goresky’s discovery and the contributions to subsequent research that their work has engendered, Dr. Kleiman writes: “All told, within a decade, the development of intersection homology theory had involved an unprecedented number of very bright and very creative people. Their work is surely one of the grand mathematical endeavors of the century.”



Robert MacPherson enjoys riding his bicycle around Princeton. He is a familiar sight at the Institute and on the tow path of the Delaware & Raritan canal nearby.

Since the 1970s, intersection homology theory has been further developed and extended through the efforts of many talented, dedicated mathematicians. It is now such a rich, burgeoning field that the American Mathematical Society has designated a classification number (55N33) for papers dealing with intersection homology. It has been especially important in representation theory, where many of the naturally occurring objects have singularities.

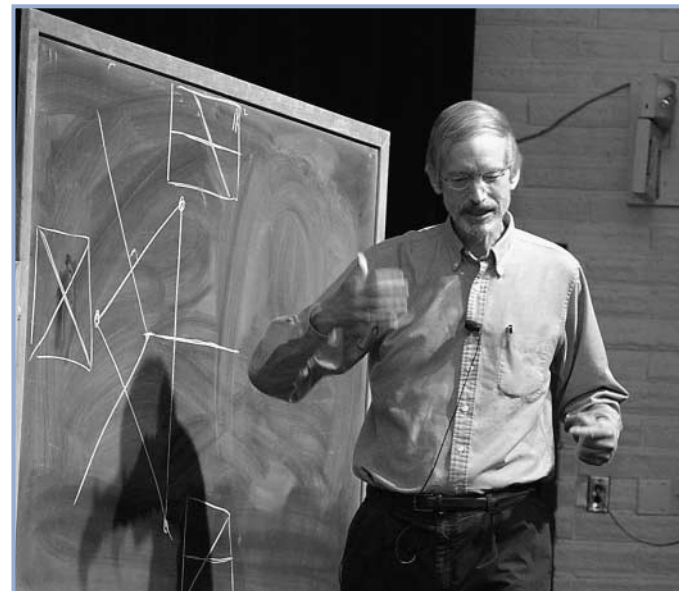
Intersection homology theory and its various extensions act as a vehicle by which mathematicians have extended to singular objects many of the theorems and techniques that previously were known only for smooth manifolds. “A large class of mathematical objects are referred to as smooth manifolds,” explains Mark Goresky. “Meaning approximately that the object has no edges or corners or sharp spikes. For example, in general relativity, space-time is thought of as a 4-dimensional smooth manifold.”

The special geometrical properties of smooth manifolds have fascinated mathematicians since the time of Bernhard Riemann (1854) and Henri Poincaré (1892). Smooth manifolds continue to play a major role in current mathematical research, but there is a much larger class of objects with “singularities” for which much of the theory that was developed for smooth manifolds does not apply. Most of Robert MacPherson’s work concerns the geometry of these singular “stratified” objects.

Another project of MacPherson’s (also joint with Goresky) was the development of “stratified Morse theory,” a generalization to singular stratified objects of a technique for analyzing the geometry of smooth manifolds. The technique was originated by the late Marston Morse (1892–1977), Professor in the School of Mathematics from 1935 to 1962.

Since 1974, Professor MacPherson has supervised 24 Ph.D. theses and often gives graduate courses in the Department of Mathematics at Princeton University. Between 1976 and 1994, MacPherson made a series of trips to Russia, bringing mathematical news from the West to the Russians, and news of Russian discoveries to America. When the Soviet empire collapsed and many Russian mathematicians left for greener pastures, MacPherson was instrumental in convincing the American Mathematical Society and the Soros Foundation to offer financial support to many talented Russian mathematicians who wished to remain in their homeland. This support provided a buffer of a few years,

while these scientists looked for ways to earn a living under the new regime. MacPherson was also a founding member of the Independent University in Moscow, and in 1992 he was named an honorary life member of the Moscow Mathematical Society. This year he was a lecturer in the Graduate Summer School at the Park City Mathematics Institute.



Robert MacPherson was a lecturer in the Graduate Summer School at the IAS/Park City Mathematics Institute this summer.

Robert MacPherson grew up in Oak Ridge, Tennessee, where his father

served as Deputy Director of the Oak Ridge National Laboratory. He majored in Mathematics, Physics, and Music at Swarthmore College and completed his Ph.D. at Harvard University under the direction of Raoul Bott. Since 1994, he has been a faculty member of the Institute for Advanced Study, where his love and knowledge of music have found expression in his support of the Artist-in-Residence program. He was a Member in the School of Mathematics from 1985 to 1986. He was a professor at the Massachusetts Institute of Technology and at Brown University before joining the permanent faculty of the Institute. Visiting appointments have taken him to Paris, Chicago, Bonn, Rome, Moscow, Utrecht, and Lille. He has received honorary doctorates from Brown University and the University of Lille, and was awarded the National Academy of Sciences Award in Mathematics in 1992. He is a member of the American Academy of Arts and Sciences, the National Academy of Sciences, and the American Philosophical Society.

A conference on the occasion of the 60th birthday of Robert MacPherson took place at the Institute, October 7–9, 2004. The conference reflected Professor MacPherson’s lifelong passion for geometry, his broad range of mathematical interests, and his commitment to students and young mathematicians. Speakers included Daniel Bliss (University of Chicago), Anders Björner (KTH, Stockholm), Tom Braden (University of Massachusetts, Amherst), Bill Casselman (University of British Columbia), William Fulton (University of Michigan), Alexander Goncharov (Brown University), Lisa Jeffrey (University of Toronto), Robert Kottwitz (University of Chicago), Eduard Looijenga (University of Utrecht), George Lusztig (Massachusetts Institute of Technology), Zoltán Szabó (Princeton University), and Kari Vilonen (Northwestern University). The conference was supported by a grant from the National Science Foundation. ■

## PROGRAM FOR WOMEN IN MATHEMATICS



From left to right: Program Administrator Anne Baxter Humes; Cynthia Rudin of Princeton University; Andrea Nahmod of the University of Massachusetts (Member in the School of Mathematics 1997–98, 2003–04); Gigliola Staffilani of Massachusetts Institute of Technology (Member in the School of Mathematics 1995–96, 2003–04); Sun-Yung Alice Chang of Princeton University (Member in the School of Mathematics 1976–77, 1992–93, 2003–04); John B. Conway of the National Science Foundation and guest speaker in the Program for Women in Mathematics, and Peter Goddard, Director of the Institute for Advanced Study. Sun-Yung Alice Chang was the organizer of the 2004 Program for Women in Mathematics; Cynthia Rudin organized the Women in Science seminars and Gigliola Staffilani taught in the Advanced Lecture course.

## PETRA: THE LOST CITY OF THE NABATEANS

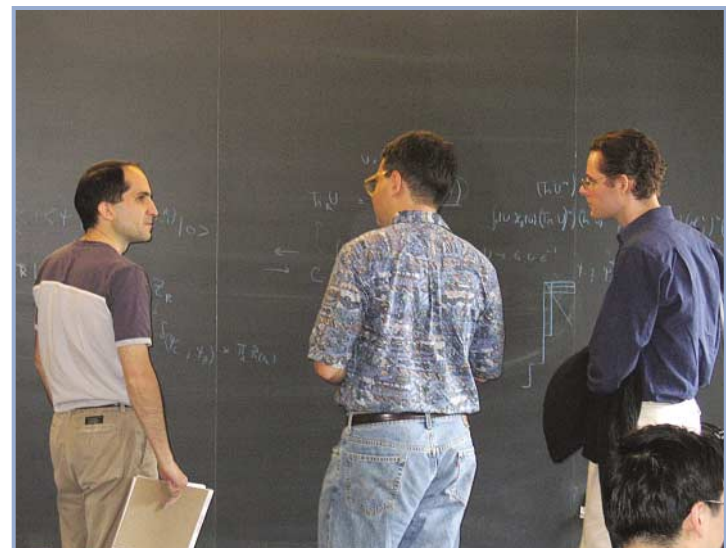


RACHEL GRAY

Judith McKenzie, Member in the School of Historical Studies (2003–04) and Glen Bowersock, Professor in the School of Historical Studies, in front of carvings from “PETRA: Lost City of Stone,” a traveling exhibition of some two hundred works of art organized by the Cincinnati Art Museum and the American Museum of Natural History in New York. Professor Bowersock and Dr. McKenzie were instrumental in organizing the exhibition and both contributed scholarly essays to *Petra Rediscovered: The Lost City of the Nabateans* (Abrahms, 2004), titled “The Nabateans in Historical Context,” and “Carvings in the Desert: The Sculpture of Petra and Khirbet et-Tannur,” respectively. The exhibition was on view in New York from October 18, 2003 until July 6, 2004. In June, members of the Chairman’s and Director’s Circles of the Friends of the Institute for Advanced Study were given a private tour of the exhibition, led by Professor Bowersock and Dr. McKenzie.

## PROGRAM IN THEORETICAL PHYSICS

Juan Maldacena, Professor in the School of Natural Sciences at the Institute for Advanced Study, was among the physicists participating as lecturers in this year’s Prospects in Theoretical Physics summer program geared toward advanced graduate students actively involved in research in string theory. Participating lecturers who talked about their current work and discussed



MARY DANIELS

Theoretical physicist Juan Maldacena, Professor in the School of Natural Sciences at the Institute for Advanced Study, in Bloomberg Hall with participants in the Prospects in Theoretical Physics Program held at the Institute during the summer of 2004.

open problems and possible new directions in string theory included Nathan Seiberg and Edward Witten of the School of Natural Sciences; Curtis Callan, Steven Gubser, Nissan Itzhaki, Igor Klebanov, Chiara Nappi, Alexander Polyakov, Leonardo Rastelli, and Paul Steinhardt of Princeton University; Louise Dolan of the University of North Carolina at Chapel Hill; Burt Ovrut of the University of Pennsylvania and Member in the School of Natural Sciences (1980–82, 1996–00); Stephen Shenker of Stanford University; Kenneth Intriligator of the University of California at San Diego and Member in the School of Natural Sciences (1995–97, 1998–99); and Charles Thorn of the University of Florida in Gainesville. Prospects in Theoretical Physics builds on the strong relationship of the research groups at the Institute and Princeton University, and many faculty members from the physics and astrophysics departments at Princeton University are actively involved in the program together with scientists from neighboring institutions.

The program is supported by The Concordia Foundation, J. Seward Johnson, Sr. Charitable Trusts, and the National Science Foundation. ■

## LEVINE (Continued from page 1)

Arnold J. Levine is a graduate of Harpur College, State University of New York, and earned his Ph.D. in microbiology from the University of Pennsylvania School of Medicine. Subsequently, he was postdoctoral fellow of the Public Health Service at the California Institute of Technology. He holds honorary degrees from, among other institutions, Rider University, the University of Medicine and Dentistry of New Jersey, the Weizmann Institute of Science, and the University Pierre and Marie Curie in Paris.

Among the numerous scientific organizations and educational institutions for which Professor Levine has served as board member or adviser, are the N.J. Biotechnology Institute, the American Cyanamid Corporation, the SUNY Health Sciences Center in Brooklyn, Albert Einstein College of Medicine, the Weizmann Institute, the Huntsman Cancer Center of the University of Utah, and the Institute for Cancer Research in Lausanne, Switzerland.

“Arnold Levine’s appointment as the first biologist on the permanent Faculty is a milestone in the Institute’s history. Professor Levine has had a profound impact on the biomedical sciences, both through the achievements of his research and through his leadership. Now, his vision, integrating the physical and biological sciences, is guiding the development of theoretical biology at the Institute,” said Peter Goddard. ■

## IAS Center for Systems Biology

The IAS Center for Systems Biology conducts research at the interface of molecular biology and the physical sciences. Under the direction of Professor Arnold J. Levine, the Center comprises a group of Members and Visitors whose current research interests include genetics and genomics, polymorphisms and molecular aspects of evolution, signal transduction pathways and networks, stress responses, and pharmacogenomics in cancer biology.

The Institute’s biology initiative began in 1998 with the appointment of Dr. Martin Nowak. From 1998 to 2003, Dr. Nowak led a group of postdoctoral scholars and visiting senior scientists in the Institute’s Program in Theoretical Biology. Research interests of the group included the dynamics of infectious diseases, evolutionary genomics, genetic instability and tumor progression, evolution of language and evolutionary theory in general. In 2002, Arnold J. Levine was named Visiting Professor in the School of Natural Sciences, and in July 2003, he assumed leadership of the biology initiative. With the appointment of Professor Levine to the Faculty of the School of Natural Sciences in July 2004, the Center for Systems Biology was formally made a program of the School.

On September 14, 2004, the IAS Center for Systems Biology held its first annual Central New Jersey Systems Biology Symposium at the Institute for Advanced Study. Designed to promote collaboration among scientists at academic institutions and in industry in New Jersey, the inaugural symposium included presentations by participating scientists: Mona Singh, Saeed Tavazoie, Olga Troyanskaya and Ned Wingreen of Princeton University; Gareth Bond of the University of Medicine and Dentistry of New Jersey; Harlan

Robins of the Institute for Advanced Study; and Rebecka Jornsten of Rutgers, The State University of New Jersey.

The IAS Center for Systems Biology collaborates with a number of New Jersey academic/medical institutions and industrial partners: the Cancer Institute of New Jersey, Robert Wood Johnson Medical School, Lewis-Sigler Center for Integrative Genomics at Princeton University, and BioMaPS Institute at Rutgers, The State University of New Jersey, IBM, Siemens Corporate Research, Inc., Bristol-Myers Squibb, and Merck & Co. The Center provides opportunities for scientists (physicists, computer scientists, statisticians, mathematicians, biologists and chemists) practicing in systems biology to meet, hold seminars and symposia, collaborate in research and interact on a regular basis.

On June 15, 2004, the Center held a joint symposium with Siemens Corporate Research. Titled “Systems Biology: Towards Personalized Medicine,” symposium participants were welcomed by Professor Levine and Lance Ladic of Siemens Corporate Research. Participating scientists included: Xiang Zhou and Claus Neubauer of Siemens Corporate Research; Bruce A. Shapiro of the National Cancer Institute; Harlan Robins of the Institute for Advanced Study; David Botstein of the Lewis-Sigler Institute, Princeton University; Daniel A. Nottelman of the University of Medicine and Dentistry of New Jersey; and Anirvan Sengupta of BioMaPS Institute at Rutgers, The State University of New Jersey.

The Center for Systems Biology receives support from the Leon Levy and Shelby White Initiatives Fund, and other grants. For further information on academic seminars and public lectures see <http://www.csb.ias.edu>. ■

## SHIING-SHEN CHERN WINS THE FIRST SHAW PRIZE IN MATHEMATICAL SCIENCES

Shiing-Shen Chern is the first recipient of a new prize from the Shaw Foundation, established by Sir Run Run Shaw, a Hong Kong film and television producer, to promote education, and scientific and technological research. The prize, which has been dubbed the “Nobel of the East,” consists of three annual awards of \$1 million each, in astronomy, life science and medicine, and mathematical sciences. Professor Chern received the prize for his initiation of the field of global differential geometry and his contribution to the development of mathematics in the last 60 years.

Internationally recognized as the foremost differential geometer of our time, Professor Chern was a Member in the School of Mathematics on three occasions: from 1943 to 1946, from 1954 to 1955, and from 1964 to 1965. Since then, he has maintained close ties with the Institute for Advanced Study, and with the Institute’s former Director and fellow mathematician Phillip A. Griffiths, who attended the award ceremony in Hong Kong, on September 7 2004, at which Professor Chern received the first Shaw Prize in Mathematical Sciences.

“More than any other mathematician, Shiing-Shen Chern has defined the subject of global differential geometry, a central area in contemporary mathematics. In work that has spanned almost seven decades, he has helped to shape large areas of modern mathematics. His influence can be read from the proliferation of basic concepts of modern mathematics to which his name is attached: Chern classes, the Chern-Weil map, the Chern connection, the Bott-Chern forms, Chern-Moser invariants, and the Chern-Simons invariants,” comments Professor Griffiths.

Professor Chern’s influence on the mathematical community stems from work that he began at the Institute for Advanced Study. He has said that his most important work, *A Simple Intrinsic Proof for the Gauss-Bonnet Formula of Closed Riemannian Manifolds*, was completed while he was a Member in the School of Mathematics in the mid-1940s. It was then that Professor Chern began the work that brought to the fore the relationship between differential geometry and topology and opened up fertile new ground for other mathematicians to develop.

“Many of Chern’s contributions to geometry and



Professor Phillip A. Griffiths of the School of Mathematics with Shiing-shen Chern in Hong Kong on the occasion of the Shaw Prize presentation.

topology, including Chern classes and Chern-Simons forms, play an extensive role in contemporary theoretical physics. Areas of application range from string theory to condensed matter physics,” says mathematical physicist Edward Witten, Charles Simonyi Professor in the School of Natural Sciences.

Professor Chern’s proof of the Gauss-Bonnet Formula, led to the development of many fundamental concepts in topology. The Chern-Simons invariants, named for Professor Chern and Institute Trustee Dr. James Simons, inform both theoretical physics and three-dimensional topology. Professor Chern has guided the

field of differential geometry and led it into interaction with topology, algebraic geometry, integral geometry, complex geometry, exterior differential systems, global analysis, and partial differential equations.

After completing his undergraduate work at Nankai University and his M.Sc. degree work at Tsinghua University, Professor Chern studied with Wilhelm Blaschke in Hamburg and Elie Cartan in Paris during the 1930s. He first came to the Institute for Advanced Study at the invitation of Oswald Veblen and Hermann Weyl. Following World War II, Professor Chern moved to the University of Chicago where, together with André Weil and others, he helped to establish one of the leading mathematics departments in the world. At the end of the 1950s, Professor Chern took up a position as professor of mathematics at the University of California at Berkeley.

It was there, in the summer of 1961 as a visiting graduate student, that Phillip Griffiths first met Professor Chern. Their friendship resulted in a professional collaboration that continues today. According to Professor Griffiths, “Chern likes nothing better than to gather people of all ages and perspectives to talk about mathematics. He has taken special pleasure in advancing the professional lives of those who have had the opportunity to work with him. He has always been among the first to understand the importance of the work of his colleagues and to bring it to the attention of the wider mathematical community.”

In advancing the cause of mathematics, Professor Chern became founding director of the Mathematical Sciences Research Institute (MSRI) in 1980. On his return to China, in 2000, he established the Mathematics Research Institute at Nankai University.

Born in China in 1912, Professor Chern remains active in mathematics, most recently initiating a revitalization of the subject of Finsler geometry. In August 2004, Nankai University hosted an International Symposium and delivered an address on the subject. His former students populate the mathematics departments of major universities across the globe from the United States to China. A passionate advocate for mathematics, Professor Chern likens the appreciation of mathematics to the appreciation of art. “Few of us are great artists, but everyone can admire great paintings,” he has said. ■

## INSTITUTE FOR ADVANCED STUDY RECEIVES NATIONAL SCIENCE FOUNDATION GRANT FOR PCMI MATHEMATICS EDUCATION

The National Science Foundation (NSF) has awarded \$5.5 million to the Institute for Advanced Study for the IAS/Park City Mathematics Institute (PCMI), an integrated mathematics program sponsored by the Institute for Advanced Study. Participants in the program include research mathematicians, graduate students, undergraduate students, mathematics education researchers, undergraduate faculty, and high school teachers. The PCMI summer program brings mathematics researchers, educators, and post-secondary students together for professional development and study.

“We are delighted that the Division of Mathematical Sciences at the National Science Foundation has shown its continued confidence in the quality and direction of the PCMI and our efforts to reach out to the broader mathematics community,” commented C. Herbert Clemens, Director of PCMI and Professor in the Department of Mathematics, Ohio State University. “We also very much appreciate the Institute for Advanced Study and the Trustees’ and Faculty’s support of the program since 1993. We view this grant as a vote of confidence in the Institute’s initiative in this direction.”

The grant provides for an expanded Summer Session High School Teacher Program and for the design and implementation of a comprehensive in-year program of teacher



Participants in the High School Summer Teacher Program that is part of the IAS/Park City Mathematics Institute.

professional development in three K-12 school districts in the United States: Cincinnati (Ohio), McAllen (Texas), and Seattle (Washington). Participating institutions of higher education partners are the University of Cincinnati, Texas State University-San Marcos, University of Texas-Pan American, and University of Washington. The grant is one of the NSF’s Math Science Partnership awards and is effective over a three-year period. It is part of \$216.3 million the NSF is directing toward the improvement of math and science education in the United States and Puerto Rico.

The director of IAS/PCMI is C. Herbert Clemens, Ohio State University. The Project Director is Gail Burrill, Michigan State University, and the program administrator is Catherine Giesbrecht of the Institute for Advanced Study.

PCMI 2004 was made possible by the generosity of the following: The National Science Foundation, The Starr Foundation, The State of New Jersey, The National Security Agency, The George S. and Delores Doré Eccles Foundation, The Wolfensohn Family Foundation, The Spencer Foundation, Rosanna and Charles Jaffin, The Clay Mathematics Institute, and Chautauqua Workshop Programs.

For more information, visit the Institute’s website at [www.ias.edu](http://www.ias.edu). ■

## FIVE TRUSTEES ELECTED TO THE BOARD OF THE INSTITUTE FOR ADVANCED STUDY

The Institute for Advanced Study has announced the appointment of five new members to its Board of Trustees. They are Jeffrey P. Bezos, Roger W. Ferguson, Jr., Peter L. Galison, Martin Rees, and Peter Svennilson.



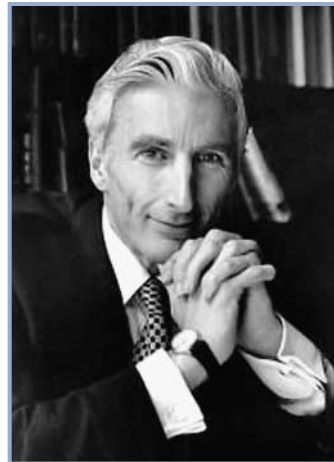
**JEFFREY P. BEZOS** is Chairman of the Board, President, and Chief Executive Officer of Amazon.com, Inc., which he founded in 1995. A *summa cum laude*, Phi Beta Kappa graduate of Princeton University in electrical engineering and computer science, Mr. Bezos led the development of computer systems that helped to manage assets for Bankers Trust Company and to build one of the most technically sophisticated quantitative hedge funds on Wall Street for D. E. Shaw & Co. Located in Seattle, Washington, Amazon.com is an Internet retailer of books, music, and other information-based products. Mr. Bezos was named *Time* magazine's Man of the Year in 1999.

**ROGER W. FERGUSON, Jr.** is serving his second term as Vice Chairman of the Board of Governors of the Federal Reserve System, of which board he has been a member since 1997. As Vice Chairman, he represents the Federal Reserve in international policy groups. Dr. Ferguson received a B.A. in economics (*magna cum laude*) in 1973, a J.D. in law (*cum laude*) in 1979, and a Ph.D. in economics in 1981, all from Harvard University. In 1973 and 1974, Dr. Ferguson was Frank Knox Fellow at Pembroke College, Cambridge University. Before joining the Federal Reserve, he was Director of Research and Information Systems for McKinsey and Company. Dr. Ferguson is a member of the Board of Overseers of Harvard University.



**PETER L. GALISON**, a Member in the School of Social Science at the Institute for Advanced Study in 1994–95, was elected to be the Academic Trustee for the School for Social Science. Professor Galison is Mallinckrodt Professor of the History of Science and of Physics at Harvard University. In 1997, he was a John D. and Catherine T. MacArthur Foundation Fellow. He was a winner of the 1999 Max

Planck Prize of the Max Planck Gesellschaft and Humboldt Stiftung. Professor Galison's main work explores the complex interaction between the three principal subcultures of twentieth century physics—experimentation, instrumentation, and theory. In addition, he pursues the powerful cross-currents between physics and other fields. He is the author of *How Experiments End* (1987), *Image and Logic: A Material Culture of Microphysics* (1997), and *Einstein's Clocks, Poincaré's Maps* (2003).



nomical Society and the Einstein Award of the World Cultural Council.

**MARTIN REES** is Master of Trinity College in the University of Cambridge and Professor of Cosmology and Astrophysics. He served as Academic Trustee for the School of Natural Sciences from 1998–2003. A Fellow of the Royal Society, he holds the honorary title of Astronomer Royal. After studying at the University of Cambridge, he held post-doctoral positions in the United Kingdom and the United States before becoming a professor at Sussex University. In 1973, he became a fellow of King's College and Plumian Professor of Astronomy and Experimental Philosophy at Cambridge and served for ten years as director of Cambridge's Institute of Astronomy. From 1992 to 2003 he was a Royal Society Research Professor. His awards include the Gold Medal of the Royal Astro-

**PETER SVENNILSON** is founder and Chief Executive Officer of Three Crowns Capital, a biotechnology finance firm. He has helped start, develop, or finance several U.S. biotechnology companies, such



as Sunesis Pharmaceuticals, PTC Therapeutics, Somalogic, and ChemoCentryx. He has also served as managing director of Irongate and Stoneporch Ltd., and Assistant Managing Director of Nomura Securities, London. A member of the Swedish Economics Society, he holds an M.B.A. from Stockholm School of Economics, and undertook postgraduate study at INSEAD in Fontainebleau, France. ■

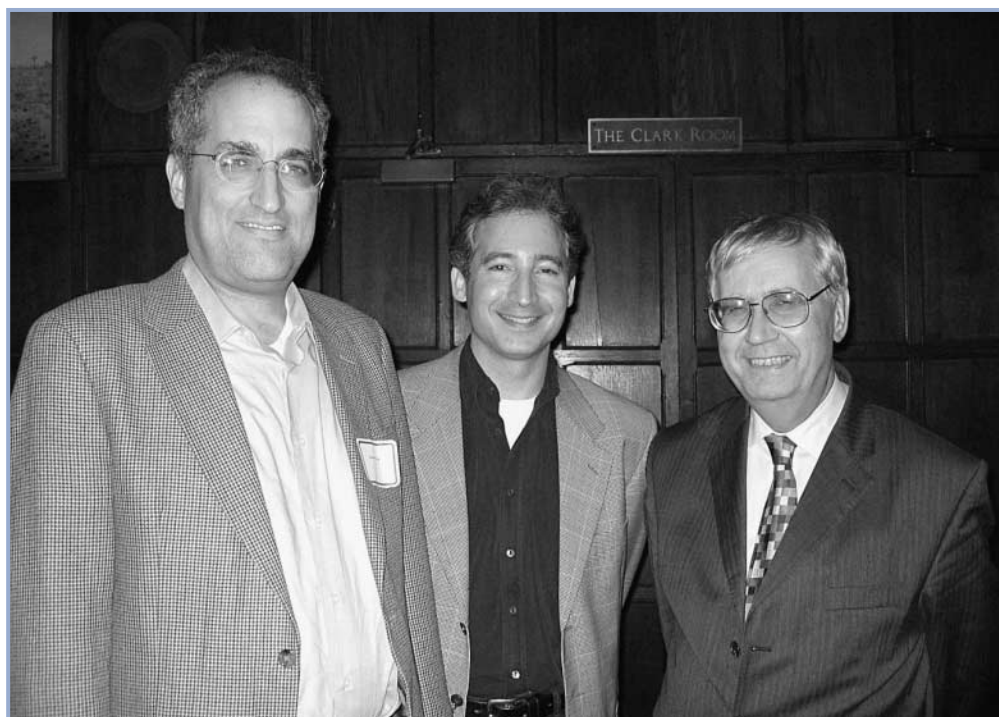


**MICHEL L. VAILLAUD**, who has served as Trustee of the Institute since 1984, has been named Trustee Emeritus.

## ASSOCIATION OF MEMBERS OF THE INSTITUTE FOR ADVANCED STUDY (AMIAS)

**Brian Greene**, Professor of Physics and Mathematics at Columbia University and former joint Member in the Schools of Natural Sciences and Mathematics (1992–93) and a Member in the School of Natural Sciences (1993–94), was the guest speaker at a reception for AMIAS (Association of Members of the Institute for Advanced Study) members held at The Explorers Club in New York City in September. Dr. Greene (author of the recent book *The Fabric of the Cosmos: Space, Time, and the Texture of Reality*, 2004) spoke on "The Fabric of the Cosmos." He is also the author of *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory* (1999), and is the host of the NOVA program, "The Elegant Universe."

A leader in the field of superstring theory, Dr. Greene received his undergraduate degree from Harvard University and his doctorate in 1987 from



From left: Edward Witten, Brian Greene, and Peter Goddard.

Oxford University, where he was a Rhodes Scholar. He lectures extensively to both general and technical audiences on superstring theory which he believes may give us the "first sensible theory of quantum gravity as well as a unified theory of all forces and all matter" and which "has the potential of realizing Einstein's long sought for dream of a single, all encompassing, theory of the universe."

The event was attended by Professor Edward Witten, Charles Simonyi Professor in the School of Natural Sciences, and Institute Director Peter Goddard, among others.

Dr. Greene's talk and the reception that followed were sponsored by AMIAS, the organization of scholars and researchers who are current or former Members or Visitors of the Institute for Advanced Study. Founded in 1974, AMIAS has some 5,500 members in more than fifty countries. ■

CHRISTINE BERBARA

## INSTITUTE FOR ADVANCED STUDY CONCERTS AND LECTURES



Philip Glass

Glass's repertoire includes music for opera, dance, theater, chamber ensemble, orchestra, and film scores *A Brief History of Time*, *The Truman Show*, and *Kundun*, among others. He studied with Vincent Persichetti, Darius Milhaud, William Bergsma, and Nadia Boulanger.

Works by Philip Glass and minimalist composers John Adams, John Cage, and Alvin Curran, together with texts by authors including T.S. Eliot, Wallace Stevens, and Virginia Woolf, comprised the opening concert of this year's Institute for Advanced Study 2004–05 concert season. The concert, *Pianomorphosis*, which took place on Friday and Saturday, October 15 and 16, was designed, "to take the concept of the piano recital into a different realm, by combining minimalist piano music with literary, visual, and theatrical resources," said the Institute's Artist-in-Residence Jon Magnussen. In a pre-concert conversation on Friday, October 15, Philip Glass joined Magnussen and pianist Bruce Brubaker for a discussion of the minimalist aesthetic and its impact on the musical world.

Prior to the October 16 concert performance, Magnussen and Brubaker discussed *Pianomorphosis* and the history of the piano recital.

Dedicated to extending the repertory and the way music is presented, while keeping alive the deeply expressive potential of the piano, Bruce Brubaker's articles on music have appeared in *The Wall Street Journal*, *The Piano Quarterly*, *Keyboard Classics*, and *Chamber Music*. A graduate of the Juilliard School, he has performed Philip Glass's piano music in concerts and broadcasts throughout the world and is currently on the piano faculty of the New England Conservatory.

The conversation and concert talk were part of the Institute for Advanced Study concert series, "Recent Pasts 20/21," an exploration of a variety of aesthetic perspectives in Western art music of the 20th and early 21st centuries, which continues throughout the year. This is the second season of the projected four-year series, which is sponsored by the Institute's Artist-in-Residence Program.

Future concerts and lectures in the Institute series include "A Princeton Connection" in December, highlighting music by Princeton composers. *CONTINUUM*®, an ensemble directed by Cheryl Seltzer and Joel Sachs, which features music by composers of the South Caucasus is scheduled for February.

Concert tickets are free but must be reserved. No tickets are necessary for the talks. For ticket information, or further information about the Institute for Advanced Study's Artist-in-Residence Program, call (609) 734-8228 or visit [www.ias.edu/air](http://www.ias.edu/air). ■

## HERMAN H. GOLDSTINE

(1913–2004)

Herman H. Goldstine, mathematician and pioneer of the development of the modern computer, died on June 16 in Bryn Mawr, Pennsylvania. Dr. Goldstine was a Permanent Member in the Schools of Natural Sciences and Historical Studies at the Institute for Advanced Study. He played a key role in the development of the electronic digital computer at the Institute, from 1946 to 1957, when he was Associate Project Director for the Electronic Computer Project.

Dr. Goldstine came to the Institute at the invitation of John von Neumann to work on the design of the IAS machine, a stored-program computer the design of which was particularly influential in subsequent computer developments. He worked on the ENIAC (Electronic Numerical Integrator and Computer) project at the University of Pennsylvania and collaborated with von Neumann on its successor.

Herman Heine Goldstine was born in Chicago in 1913. He studied mathematics at the University of Chicago, receiving a bachelor's degree Phi Beta Kappa in 1933, a master's degree in 1934, and a Ph.D. in 1936. For the next five years, he worked as a research assistant in the university's department of mathematics.

During World War II, Dr. Goldstine was Reserve Officer of the Ordnance Department and was assigned to the BRL (Ballistic Research Laboratory), located at the Aberdeen Proving Ground in Maryland. Under the jurisdiction of the Ordnance Department, the BRL produced ballistic tables, vital to the war effort. Dr. Goldstine was army liaison to the Moore School of Electrical Engineering at the University of Pennsylvania in Philadelphia, where he was responsible for the computing and training programs. With his skill in mathematics, he played an important role in the development of the ENIAC, a joint effort between the university and the Army that began in June 1943, with initial funding from the Ordnance Department.

Dr. Goldstine's book, *The Computer from Pascal to von Neumann*, published by Princeton University Press in 1972, is an account of the history of mathematics and the



Herman H. Goldstine

development of computer science. In it, Dr. Goldstine examined the development of computing machinery, from the seventeenth century through the early 1950s, and recorded his recollections of the development of the ENIAC and the IAS machine. His other published works include *Numerical Analysis from the 16th to the 19th Century* (1977), and *New and Full Moons 1001 B.C. to A.D. 1651* (1973).

In 1958, Dr. Goldstine joined IBM Corporation, where he established the Mathematical Sciences Department and served as its first director. He worked at IBM until 1984, serving also as director of scientific development for the data processing division and consultant to the research director. In recognition of his contributions to IBM and to science, Dr. Goldstine was appointed an IBM Fellow in 1967, a position he retained until his retirement in 1973. In the 1990s, IBM named an IBM postdoctoral fellowship in his honor. The IBM Herman Goldstine Fellowship in Mathematical Sciences is one of several honors bestowed upon Dr. Goldstine for his many achievements in mathematics and computing. In 1985, he received a National Medal of Science from President Ronald Reagan for "fundamental contribu-

tions to development of the digital computer, computer programming and numerical analysis." He was also a recipient of the United States Army Distinguished Service Medal, the University of Chicago's Alumni Achievement Award, the IEEE (Institute of Electrical and Electronics Engineers) Computer Pioneer Award, and the Harry M. Goode Memorial Award from the IEEE Computer Society. He was a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society, for which he served as Executive Director from 1984 to 1997.

Dr. Goldstine is survived by his wife, Ellen Watson Goldstine of Bryn Mawr; two children from his first marriage to Adele Katz Goldstine, Jonathan Goldstine and Madlen Goldstine Simon; and four grandchildren. ■

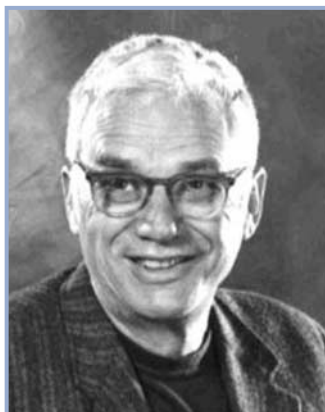
## JOSEPH L. DOOB

(1910–2004)

Joseph Leo Doob, an expert in probability theory whose work pioneered the study of its mathematical foundations and interplay with other areas of mathematics, died on June 7 in Urbana, Illinois. Dr. Doob was Trustee Emeritus of the Institute for Advanced Study. He was a Trustee from 1974 to 1982 and a Member in the School of Mathematics on three occasions: from 1941 to 1942, 1964 to 1965, and 1971 to 1972.

During the 1940s and 1950s, Dr. Doob developed basic martingale theory and many of its applications. In 1984, he received the American Mathematical Society's Steele Prize for "his fundamental work in establishing probability as a branch of mathematics and for his continuing profound influence on its development."

Born in Cincinnati, Ohio, on February 27, 1910, Dr. Doob was awarded a Ph.D. from Harvard University in 1932. He was a professor at the University of Illinois from 1935 until his retirement in 1978. There, he supervised the



Joseph L. Doob

work of the outstanding doctoral students Warren Ambrose (Member in the School of Mathematics 1939–41, 1946–47, 1959–60), David Blackwell (Member in the School of Mathematics 1941–42), and Paul Halmos (Member in the School of Mathematics 1939–42, 1947–48, 1957–58). His book *Measure Theory* was published in 1994 when he was 84 years old.

Dr. Doob was a member of the National Academy of Sciences and a Foreign Associate of the Academy of Sciences, France. He was President of both the Institute of Mathematical Statistics (1950) and the American Mathematical Society (1963–1964). He received the National Medal of Science in 1979, and was awarded an honorary D.Sc. from the University of Illinois in 1981.

In 1931, Joseph Leo Doob married Elsie Haviland Field, who predeceased him in 1991. He is survived by their three children, Stephen, Peter and Deborah, and four grandchildren. ■

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AP PHOTO/TOBY TALBOT

The above image shows voters at the polls in Vermont in 2000. It was used in “The Fairest Vote of All” an article by economists Eric S. Maskin and Partha Dasgupta in *Scientific American*, March 2004. The article discusses the fundamental question of which kinds of voting systems yield the truest representation of the wishes of the electorate.

Following an examination of alternative systems and using examples drawn from the 2000 presidential election in the United States and the 2002 presidential election in France, Professors Maskin and Dasgupta conclude that simple or true majority rule, incorporating information about the ranking of candidates by the electorate, yields the most accurate representation of voters’ views. Conceding that “there is no such thing as a perfect voting system,” Maskin and Dasgupta argue that true majority rule of the type they describe conforms to four principles required of any good electoral method, under more circumstances than any of the alternatives.

Eric S. Maskin is the Albert O. Hirschman Professor in the School of Social Science at the Institute for Advanced Study. Partha Dasgupta is Frank Ramsey Professor of Economics at the University of Cambridge. Frequent research collaborators, their paper “On the Robustness of Majority Rule and Unanimity Rule,” can be found as part of a series of Economic Working Papers at [www.sss.ias.edu/home/papers.html](http://www.sss.ias.edu/home/papers.html). The website also includes occasional papers by Members and Faculty in the School of Social Science, including many that were given as talks at the School of Social Science’s weekly Thursday Seminar at which Members present work-in-progress.

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