
The Institute for Advanced Study

Annual Report 1986/87



The Institute for Advanced Study

Annual Report for the Fiscal Year
July 1, 1986-June 30, 1987

The Institute for Advanced Study
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It is fundamental to our purpose, and our express desire, that in the appointments to the staff and faculty, as well as in the admission of workers and students, no account shall be taken, directly or indirectly, of race, religion or sex. We feel strongly that the spirit characteristic of America at its noblest, above all, the pursuit of higher learning, cannot admit of any conditions as to personnel other than those designed to promote the objects for which this institution is established, and particularly with no regard whatever to accidents of race, creed or sex.

Extract from the letter addressed by the Founders to the Institute's Trustees, dated June 6, 1930, Newark, New Jersey.

Table of Contents

| | |
|---|-----|
| Trustees and Officers | 9 |
| Administration | 10 |
| The Institute for Advanced Study: Background and Purpose | 11 |
| Report of the Chairman | 13 |
| Report of the Director | 15 |
| Reports of the Schools | 19 |
| School of Historical Studies | 21 |
| School of Mathematics | 33 |
| School of Natural Sciences | 43 |
| School of Social Science | 57 |
| Record of Events, 1986-87 | 65 |
| Report of the Treasurer | 95 |
| Donors | 105 |

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The Institute for Advanced Study: Background and Purpose

The Institute takes the following premises on the nature of learning as fundamental: most important work is the product of the disciplined and creative individual mind; accordingly, the individual scholar must be responsible for how he uses the precious resources of his own time and energy; the community of peers in his area of intellectual work is the ultimate judge of the results. (From PROCEDURES FOR ACADEMIC GOVERNANCE OF THE INSTITUTE.)

The Institute for Advanced Study, an independent, private institution devoted to the encouragement, support and patronage of learning, was founded in 1930 as a community of scholars where intellectual inquiry could be carried out in the most favorable circumstances. Focused on mathematics and classical studies at the outset, the Institute today consists of the School of Historical Studies, the School of Mathematics, the School of Natural Sciences and the School of Social Science. Each School has a small permanent Faculty, and some 160 fellowships are awarded annually to Visiting Members from other research institutions and universities throughout the world.

The objectives of the Institute were described as follows in the Founders' original letter to the first Trustees: "The primary purpose is the pursuit of advanced learning and exploration in the fields of pure science and high scholarship to the utmost degree that the facilities of the institution and the ability of the faculty and students will permit." During the past half-century, these goals have been implemented by a Faculty of exceptional merit; by an annually renewed group of Visiting Members chosen from among the many who apply; and by the development of facili-

ties and a mode of operation designed specifically to support and assist the Institute's intellectual purposes in every way possible.

Although the Institute is small when measured in terms of the size of its immediate academic community or of its operating budget, its intellectual weight is great and its influence on science and scholarship extraordinary. From its earliest years, it has been internationally recognized as one of the world's leading centers of research. Indeed, its successful example has created numerous imitators both in the United States and abroad.

From the beginning, the Institute has been an international organization, although American in location and organizational form. It has operated throughout its existence on the premise that science and learning transcend national boundaries and that scholars and scientists are members of one commonwealth of the mind. Of the present Faculty, many have begun their scientific and scholarly careers outside the United States. One-third of the Visiting Members come from abroad, mostly from the great centers of learning of western Europe and Asia, and, to a lesser extent, from other regions of the world.

With its devotion to the continuing examination of new and centrally important questions as they arise at the frontiers of knowledge, the Institute partakes of the character of both a university and a research institute, but it also differs in significant ways from both. Unlike a university in its small size—its academic membership at any time numbers about 200—it has no commitment that all branches of learning be represented in its Faculty and Members. Unlike the usual research institute, it supports many different fields of study, maintains no laboratories, and above

12 Background and Purpose

all, welcomes temporary members whose intellectual development and growth are one of its principal purposes. But it shares with both universities and research institutes a devotion to learning, in the double sense of the continuing education of the individual and of the intellectual enterprise on which the member is embarked.

For more than five decades the Institute for Advanced Study has made a substantial contribution to the world of higher learning by providing support—intellectual and material—to Visiting Members. More than one third of these Visiting Members are young men and women 35 years of age or less whose work at the Institute involves the Faculty in a substantial amount of postdoctoral training. Though none of the Visiting Members is a student in the narrow sense of being a degree candidate, the communal atmosphere and many opportunities for discussion with Faculty members and peers, both within and outside seminar meetings, are propitious to scholarly growth.

The Institute devotes special attention to young people of accomplishment and promise, offering them membership at a stage in their careers when independent work is of the highest importance to their intellectual development. These younger Members then return to or join the faculties of universities all over the world and share what they have learned as a result of their stay at the Institute. This might be termed the invisible work of the Institute; its visible work is contained in the publications of the Faculty and Visiting Members. Both serve to reinforce in highly significant ways the quality of scholarship and research throughout the world.

The varied work of the Institute is, of course, specialized; no advanced study or deep scholarship can be otherwise. Formal attempts to organize scholarly work at the Institute are minimized, although lectures and seminars are a regular feature of its internal life. Schools may, for limited periods of time, select certain themes or programmatic arrays under which Members are encouraged to ap-

ply, but no concentration guarantees entry and no focus excludes those outside it. The choice and conduct of research are matters which are decided entirely by each individual member of the Institute.

The Institute is nonetheless an intellectual community and not a mere collection of scholars. Community is possible because Faculty and Members have some substantial knowledge outside their own fields of specialization. The fact that the Visiting Members live together in Institute housing, eat in the same dining hall, share the same common room and libraries, and carry out their work in an institutional setting where human scale has been carefully maintained is conducive to common interest, mutual understanding and friendship.

The Faculty and Members of the Institute are also a part of the larger community of Princeton, with its University and its many institutions of research and learning. Although the Institute has no administrative or organic connection with Princeton University, there has always been close collaboration between the two institutions on matters of common interest. Many Institute seminars are open to interested members of the University's faculty and graduate school, and University seminars and conferences are frequently attended by Institute Faculty and Members. Without the University, Princeton itself would be both physically and intellectually inadequate as the site of the Institute; and the Institute has brought a degree of international excellence to the general academic climate of Princeton, contributing to the development of what has become one of the world's great educational communities.

The Institute today occupies a square mile of land in Princeton, New Jersey. Most of this is farm and woodland. Its buildings house libraries, offices for Faculty and Members, seminar and lecture rooms, and common rooms. Subsidized, conveniently located housing is maintained for all Visiting Members, and transportation is regularly provided to the center of town.

Report of the Chairman

I am honored to present here my first report as the new Chairman of the Board of Trustees. I come to this position fully mindful of the fine record of leadership set by my immediate predecessors, Howard C. Petersen and J. Richardson Dilworth, and of the importance of the institution which we all serve.

It was with that importance in mind that we undertook a search for a successor to Dr. Harry Woolf who retired at the end of June, 1987, after eleven years as Director. The Trustee Search Committee was chaired by Thornton Bradshaw and included among its members Daniel Bell, Zeph Stewart, Donald Straus, and me, *ex officio*. Representing the Faculty to the Search Committee were Professors John Bahcall (from Natural Sciences), Giles Constable (from Historical Studies), Robert Langlands (from Mathematics) and Michael Walzer (from Social Science). After a search of eleven months and the evaluation and interviewing of a number of highly qualified candidates, the Trustees unanimously elected Dr. Marvin L. Goldberger as the new Director.

Dr. Goldberger will assume his new duties in September, 1987, as the sixth Director of the Institute in a distinguished line following Abraham Flexner, Frank Aydelotte, Robert Oppenheimer, Carl Kaysen and Harry Woolf. Born in Chicago, Illinois, in 1922, Dr. Goldberger received his undergraduate degree from the Carnegie Institute of Technology in 1943 and his PhD from the University of Chicago in 1948. He was a professor of physics at the University of Chicago until 1957, when he was appointed as Higgins Professor of Mathematical Physics at Princeton University. He served as Chairman of the Physics Department from 1970 to 1976. In 1978, he went to

the California Institute of Technology to serve as its President.

Dr. Goldberger has published widely in the field of elementary particle physics and has received numerous awards and academic honors. He has honorary degrees from Carnegie-Mellon University, the University of Notre Dame, and Hebrew Union College among others. He served as a member of the President's Science Advisory Committee from 1965 to 1969. He has been active in international security and arms control issues in connection with the National Academy of Sciences, of which he is a member. The Institute considers itself fortunate to have found such an outstanding scholar and so experienced an administrator to lead it forward in the years to come.

The Institute community honored Dr. Harry Woolf, the outgoing Director, in a number of ceremonies this spring. Under Dr. Woolf's direction, the Institute achieved significant growth and development in all dimensions. His contribution to the Institute is deeply appreciated.

Dr. Woolf will be a fellow at Churchill College, Cambridge, next year and will then return to the Institute as Professor-at-large.

A number of new Trustees have joined the Board during the year: Marvin L. Goldberger who, before he could take up his active role as a Trustee, was elected Director; Vartan Gregorian, Helene L. Kaplan, and Elizabeth J. McCormack.

Vartan Gregorian, President of the New York Public Library since 1981, was born in Iran and came to the U.S. in 1962. After receiving his PhD degree from Stanford University, he held positions at several colleges and universities, including San Francisco State

14 Report of the Chairman

College, University of Texas at Austin and the University of Pennsylvania where he was Provost from 1978-80. He is the author of *The Emergence of Modern Afghanistan, 1880-1946* and numerous articles. Dr. Gregorian has received a number of awards including the Phi Lambda Theta and Phi Delta Kappa awards of distinction.

Helene L. Kaplan is a member of the law firm of Webster & Sheffield in New York City. She was born in New York City and received her education at Barnard College and New York University Law School. Currently she is Chairman of the Board of Barnard College and of Carnegie Corporation of New York. Her professional affiliations include membership on the Council on Foreign Relations and the Rockefeller University Council.

Elizabeth J. McCormack was born in New York City. She has a BA degree from Manhattanville College, MA from Providence College, PhD from Fordham University, and LHD from Brandeis and Princeton Universities. Miss McCormack was President of Manhattanville College from 1966 to 1974 and has been an associate with Rockefeller Family and Associates in New York City since 1974.

Two of our Trustees, John Akers and Daniel Bell, have resigned. At the meeting of the Board on April 25, 1987, the following resolution was taken:

Daniel Bell was elected to the Board of Trustees in 1979 and has, since that time, provided a perspicacious, provocative and vigorous voice in our colloquies. He has shared with us his gifts of intelligence, wit, and broad experience to our great benefit. He has rendered abstruse sociological

doctrines clear. He has redesigned the shape of our meeting^{table} and in so doing, redesigned the quality of our communications. He has raised valid questions and has helped the Board seek acceptable answers. He chaired the Visiting Committee to the School of Social Science and in the subsequent report wrote so succinctly about the social sciences as to educate as well as enlighten the Board. We are grateful for the years of his Trusteeship and wish him good fortune in all the next adventures of his life.

At a later meeting, the Board honored John Akers with the following resolution:

John Akers became a Trustee in 1984, continuing a long tradition of fruitful association between the Institute for Advanced Study and IBM. He was helpful to the Board in its deliberations and, during his tenure as Trustee, in addition to his personal gifts, he arranged for a significant donation of IBM equipment to the School of Natural Sciences. We are deeply grateful for his time, attention, and generosity, and we will miss in the future both his counsel and good company.

As the Institute enters a new administration, I look forward to working with its several constituencies and the larger academic world which the Institute serves. The Board of Trustees is dedicated to maintaining the high quality of this unique center for mathematical, scientific and humanistic research and to strengthening the financial basis on which its existence depends.

James D. Wolfensohn
Chairman of the Board

Report of the Director

Since this represents my last report as Director, I will take the opportunity to review both the years of my tenure as a whole, as well as to report on some particular matters of concern to the Institute community which occurred in the past academic year.

In Memoriam

Let me begin on a note of loss and remembrance, for in so tightly knit a society as the Institute's, our losses are keenly felt and our memories contribute to our continuity. Arne Beurling, Professor Emeritus in the School of Mathematics, died on November 20, 1986, and Harold Cherniss, Professor Emeritus in the School of Historical Studies, died on June 18, 1987. Arne Beurling was a member of the Institute community for over thirty years, first as a visiting member from 1952 to 1954, and then as a professor from 1954 on. Born in Gothenburg, Sweden, Professor Beurling taught at Uppsala University and Harvard before coming to the Institute. His principal field was analysis, especially function theory, potential theory, and Dirichlet series. He was a member of the American Academy of Arts and Sciences and of a number of Scandinavian scientific societies, and he was awarded prizes by the Swedish Academy of Sciences and by the Royal Swedish Society of Sciences. He was honored by Yeshiva University in 1963 and the Mittag-Leffler Institute of Stockholm which held a Beurling Year in 1976-77. Also important was Arne Beurling's contribution in World War II to breaking the German secret code, for which work he was decorated by the Swedish government.

Harold Cherniss was born in Missouri in 1904, and he graduated from the University of

California at Berkeley in 1925, taking highest honors in Greek and Political Science. He did his graduate work at Berkeley as well as at the Universities of Chicago, Göttingen and Berlin, and received his PhD from Berkeley in Greek, Latin and Sanskrit in 1929. After teaching at Berkeley, Cornell, and Johns Hopkins, Professor Cherniss came to the Institute in 1948, where his research continued to reap academic honors from the University of Chicago, Hebrew Union College, Johns Hopkins, Brown, and the University of Rome. He was a member of the American Philosophical Society, the British Academy, the American Academy of Arts and Sciences, as well as academies in Argentina, Sweden and Belgium. His bibliography runs to over eighty items, among which are his major writings on ancient Greek and Roman philosophy and especially upon the relations of Aristotle's philosophy to Plato's. Both Professor Beurling and Professor Cherniss were eminent and honored scholars in their respective fields. Both were esteemed colleagues and will be missed.

Awards

During this past year, a number of prestigious awards were earned by our Faculty and Long-term Members. While the importance of our activities cannot be measured exclusively by these forms of recognition, it would be invidious to ignore them totally, for they are a mark of the larger public's awareness of the varied excellences of this institution. I mention the following as particularly noteworthy. In the School of Historical Studies, Professor John Elliott received the 1986 Wolfson Award for History and Biography for his book on *The*

Count-Duke of Olivares. In both the School of Historical Studies and the School of Natural Sciences, Otto Neugebauer, a Long-term Member here since 1960, won the Balzan Award which he has generously donated to the Institute as an endowment fund to support research and publication in the history of mathematics and mathematical astronomy. In the School of Mathematics, Professor Atle Selberg was awarded the 1986 Wolf Foundation Prize in Mathematics and was honored by a symposium on "Number Theory, Trace Formulas and Discrete Groups" held in Oslo in June. In the School of Social Science, Professor Emeritus Albert Hirschman was given the Kalman Silvert Prize of the Latin American Studies Association.

Emeriti

That several of the most active and highly acknowledged scholars at the Institute are emeriti is worth a point of emphasis. The tranquil environment, the sense of their continuing usefulness as colleagues, and above all, their unceasing commitment to scholarly pursuits have, in the vast majority of Faculty retirements, kept our emeriti in residence here, to the great benefit of the entire community. That sense of connection with their fields, established over years of active scholarship, provides an important element of cohesion and continuity, and we are all better for the presence among us of these fine men of learning.

Einstein House

During the summer of 1986, the house on Mercer Street in which Albert Einstein lived from 1934 until his death in 1955 was deeded to the Institute. One of the first Professors of the Institute, Einstein has remained the single most widely recognized figure in the Institute's history, although he had many brilliant colleagues whose names command equal reverence in their respective fields. By the express terms of Einstein's Will, the house may

not be used as a museum. The Institute hopes to use it, after the necessary repairs and refurbishing, as a residence for Long-term Visitors.

Director's Visitors

The Director's Visitor program was instituted in 1978-79 with my invitation to Abba Eban. A distinguished list of visitors followed: Isaiah Berlin in 1979-80, and again in 1980-81, along with the architect and urban planner Richard Llewelyn-Davies, in whose memory an endowed lectureship has been established which alternates between the Institute and the University of London. In 1981-82, Isaiah Berlin again returned, and Jacobo Timerman of Argentina was in residence. In 1982-83, William H. Luers came, between ambassadorial postings to Venezuela and Czechoslovakia. In 1983-84 Martin Meyerson was here, as well as Paul Berg and Maxine Singer who came as a team to work together on a molecular genetic project, returning again during this past year. Lawrence A. Cremin arrived in 1984-85 to complete his history of American education, and in 1985-86 Joseph Frank came to work on his multi-volume biography of Dostoevsky. My purpose has been to engage the community through the presence of these visitors in alternate modes of discourse and to perturb, in a benign and potentially creative way, familiar patterns of thought and endeavor in their fields as in ours.

Computing at the Institute

Among the most notable changes during the past eleven years has been the increasing importance and presence of computer technology in academic research at the Institute. In this period, powerful computer facilities were installed, including external network connections. Together with eleven other institutions, the Institute participated in establishing a major supercomputing center on Route 1 in Princeton. Named after a former Faculty member at the Institute, the John von Neumann Center (Consortium for Scientific Com-

puting) now offers, in combination with the recently installed computer complex at the Institute itself, first-rate computing facilities.

Tax status

After a long series of negotiations with the Township of Princeton, a settlement was arrived at which acknowledges the tax-exempt status of member housing as an integral part of the Institute's academic complex. The amicable arrangement subsequently agreed to reflects the ongoing good relationship with the community which the Institute has tried to maintain, evidenced in the open access to the Institute woods, the formation of the Friends of the Institute who have contributed both to the amenities of our common room and to the support of visiting members, and in the several *pro bono* activities which have been held in our facilities. Not least of our good neighbors has been the University; cordial and mutually profitable academic exchange has marked the relationship between the two institutions since the Institute's inception fifty-seven years ago.

Retrospective

It is tempting, after more than a decade in office, to rejoice in all that has happened of a beneficent nature. Certainly, the endowment has tripled from the \$51.7 million of 1975 to the \$181.9 million of 1987. Our faculty salaries and benefits are among the best in the country. Our properties have improved and increased, from the gift of Marquand House which has proved its worth as a graceful and attractive guest house to the acquisition through gift and purchase of a number of other houses which have then become available for Faculty residences or remain as part of the Institute's real property for present rental and future Faculty use. Corporate support in the form of stipends for Visiting Members to three of the four Schools has provided significant budget relief. Independent endowment

funds have been established for each School, including the Director's Office, to increase academic flexibility for the future, and of equal importance, the State of New Jersey, on a regular basis, now provides professorial and member support. In all of these endeavors our intellectual freedom has been totally preserved.

Our alumni/ae are now all gathered together in a single corporate entity, the Association of Members of the Institute for Advanced Study (AMIAS), affording us both an organized group of dedicated former members and a much appreciated source for a Visiting Members endowment. The hitherto separate libraries of the Schools of Historical Studies and Social Science, already proximate in many ways, have now been administratively and physically combined. An Institute archives has been established to gather together and preserve the essential documents of our history. At the same time, a pattern of visiting committees to the Schools has insured that the past will not lay too heavy a burden on present scholarship and that new opportunities and exploration will balance tradition in our evolution. Eleven new professors, out of a Faculty of twenty-two, have been appointed, with all Schools represented in a process as efficient as it was felicitous. But beyond all these substantial matters, a most welcome result of a decade of working together is that the Institute now truly works together. There is a genuine harmony, not without its necessary moments of interruption: intellectual effort and the true progress of learning cannot take place without contradictions and even confrontations. These are necessary tensions in the dialectic process, and we welcome them as integral to the cooperative enterprise which is now so firmly established. Peace has brought productivity and the opportunity to reexamine, as every generation should, the Institute's design and destiny.

In all this, the Institute community should take genuine pride. These are its achievements, deriving from conscientious and supportive Trustees, a skillful and loyal staff, and

18 Report of the Director

the felt concern of the Faculty, the visiting membership, and the alumni/ae. These will surely carry the Institute forward under my distinguished successor, Dr. Marvin L. Goldberger. For them there is always more to do, and the future will impose its own challenging agenda. As I reflect on the past decade, my greatest satisfaction has been in sharing a common cause with the remarkable individu-

als who make up the Institute's family, who together have made my tenure as Director such a rewarding period in my life, and in whose midst as a professor I look forward to continued growth. To each and every one of them, this brings my warm gratitude.

Harry Woolf
Director

Reports of the Schools

The School of Historical Studies

Faculty

Glen W. Bowersock
Giles Constable
John H. Elliott
Christian Habicht

Peter Paret
(Andrew W. Mellon
Professor)
Irving Lavin
Morton White

Professors Emeriti

Harold F. Cherniss*
Marshall Clagett
Felix Gilbert
James F. Gilliam

George F. Kennan
Benjamin D. Meritt
Kenneth M. Setton
Homer A. Thompson

Member with Long-term Appointment

Otto E. Neugebauer

*Deceased June 18, 1987

The School of Historical Studies

The School of Historical Studies is concerned principally with the history of western civilization. Within this wide area of study, a large range of topics has been explored at one time or another both by current and emeriti Faculty and by Visiting Members, but the emphasis has been particularly strong in the fields of Greek and Roman civilization, medieval and modern European history, and the history of art, science and ideas.

The particular emphases of the School are a product of its own history. Two years after the opening of the School of Mathematics in 1933, a School of Economics and Politics and a School of Humanistic Studies were established. In Humanistic Studies, the first professor was Benjamin Dean Meritt, a specialist in Greek history and epigraphy, who was closely associated with excavations in the Athenian Agora. The second appointment to the Faculty of the School of Humanistic Studies was that of the renowned German art historian, Erwin Panofsky. Panofsky ranged through the entire gamut of European art from the middle ages to motion pictures, but he was particularly associated with the development of the field of iconology.

Three additional appointments strengthened the field of classical studies: Elias Avery Lowe, a Latin paleographer who was embarked on the prodigious task of assembling, transcribing, documenting, photographing, and publishing all the extant Latin literary manuscripts copied before the ninth century; Ernst Herzfeld, a Near Eastern archaeologist and historian, whose scholarly work, by the time of his death, comprised nearly 200 titles; and Hetty Goldman, one of the pioneering American women involved in archaeology whose discoveries at Tarsus in Turkey were

published in six volumes. Modern history was represented at the Institute from the outset, with the appointment of the military historian Edward M. Earle. Earle was an original member of the School of Economics and Politics, which merged in 1949 with the School of Humanistic Studies to become the School of Historical Studies.

After World War II, classical studies were further augmented by the appointments of Homer A. Thompson in Greek archaeology, Harold F. Cherniss in Greek philosophy, and Andrew Alföldi in ancient history and numismatics. Although Alföldi published tirelessly on a wide range of subjects during his years at the Institute, he was mainly preoccupied with the history of Early Rome and that of Julius Caesar, on both of which subjects he wrote several books. Medieval history came to the Institute Faculty with Ernst Kantorowicz, whose interests stretched in time from the later phases of classical antiquity to the fifteenth and sixteenth centuries, and in space embraced both western Europe and the Byzantine and Islamic East. The art historical tradition was carried on by Millard Meiss, who was able to complete at the Institute his great work on late medieval manuscript painting in Burgundy.

Additions to the Faculty in modern history came with the appointments of Sir Ernest Llewelyn Woodward in British diplomatic history; George F. Kennan, former Ambassador to Russia, in Russian history and international relations; and Felix Gilbert, in Renaissance as well as modern history. Roman military history and papyrology were represented by James F. Gilliam; medieval history of the Latin East, Venice, and the relations between the Papacy and the Levant, by Kenneth

M. Setton; medieval science, especially the classical heritage, by Marshall Clagett.

While these traditions have remained strong in the School of Historical Studies, they have not excluded scholars working in other fields who have come here as Visiting Members. The total number of Visiting Members who have come to the School is now more than a thousand. The articles and books resulting from their research at the Institute are witness to the quality and productivity of their scholarly activity here.

Academic Activities, 1986-87

The School was host to thirty-eight long-term, term and annual Members in 1986-87 and five Visitors. During the summer of 1986, it also provided research facilities for eight summer Visitors. Twenty-five Members came from foreign countries, including Australia, Canada, Czechoslovakia, France, Hungary, Israel, Italy, The Netherlands, England and West Germany.

All Members and Visitors at the Institute are independent scholars and concentrate on their own subjects. The topics of their individual projects are listed in the next section. But contacts and exchanges with one another, whether organized or informal, are often fruitful and stimulating. Among the formal colloquia—lectures followed by discussions—were those in art history on a monthly basis in which Princeton University's department took part. Some of the Members also gave papers at meetings of the Institute's School of Social Science. All these are listed in the Record of Events.

Funding

During 1986-87, members in the School were funded by the Gerda Henkel Stiftung, the Samuel H. Kress Foundation, the Andrew W. Mellon Foundation, as well as by fellowships contributed by Elizabeth and J. Richardson Dilworth and Edwin C. and Elizabeth A. Whitehead.

Faculty

Professor Glen Bowersock taught a graduate seminar at Princeton University (fall term) on the epigraphy of the Roman Empire and participated in colloquia at Brown University, the University of Strasbourg, the Fondation Hardt (Geneva), and Delphi (Greece). He gave a commemorative lecture on "Gibbon's Historical Imagination" at Stanford University on the occasion of the two hundred fiftieth anniversary of the birth of Edward Gibbon. He published a dozen articles and reviews and began to prepare the Jerome Lectures which he will deliver in Ann Arbor (Michigan) and Rome in the spring of 1989. In addition, he continued his service on several editorial boards as well as the boards of the Center for Hellenic Studies, Dumbarton Oaks (Center for Byzantine Studies), the American Schools of Oriental Research, and the American Numismatic Society.

Professor Giles Constable lectured at the Centre d'Etudes Supérieures de Civilisation Médiévale, Université de Poitiers, on "The Ideal of the Imitation of Christ" and presented papers at La Mendola, near Trent, at the Forgery Congress in Munich, and at the Colloque International Penn-Paris at Morigny. He published articles on liturgical prayer and medieval monasticism, and he was elected a member of the American Philosophical Society and to the Nominating Committee of the American Historical Association.

Professor John H. Elliott published *The Count-Duke of Olivares: The Statesman in an Age of Decline* (Yale University Press), for which he was awarded the Wolfson Literary Prize for History. He completed and published a number of articles and book reviews. He gave papers at two conferences in Spain, the first in Córdoba on "The Age of the Baroque," and the other in Salamanca on "The Cortes of Castile." He was appointed a Commander of the Order of Isabel la Católica by the King of Spain in the spring of 1987.

Professor Christian Habicht delivered the Louise Taft Semple Lectures at the University

of Cincinnati on "Cicero the Politician." He gave the same series of lectures at the Johann Wolfgang Goethe-Universität, Frankfurt am Main. At the University of Missouri, Columbia, he delivered the first Fordyce Mitchel Memorial Lecture. He read papers at other American Universities. He published several major articles and prepared the Semple Lectures for publication. He continued to serve as a member of the Publications Committee of the American Philosophical Society.

Professor Irving Lavin gave several lectures: at the College Art Association Annual Meeting in Boston, on "Art Without History"; at the Getty Center for Research in the History of Art and the Humanities at Santa Monica, California, on "The Art of Commemoration in the Renaissance"; at the Symposium on the Nasher Collection, Southern Methodist University, Dallas, Texas, on the historical roots of modern sculpture; and at the Institute of Fine Arts, New York University, on "Bernini's Image of the Sun King." He also delivered the Una's Lectures in the Humanities at the University of California, Berkeley, on "The Uses of the Past in Art." Professor Lavin was awarded the "Cultore di Roma" medal by the City of Rome and the Istituto di Studi Romani, and continued to serve as President of the Comité International d'Histoire de l'Art.

Professor Peter Paret lectured and gave seminars at a number of institutions, including Stanford and Princeton, published two articles, and several book reviews, contributed an essay to the *Festschrift* for Otto Büsch, and added several new sections to the German translation of his monograph *Clausewitz and the State*, which has already been translated into Spanish and Japanese. The English edition of his *Makers of Modern Strategy* was published by Clarendon Press.

Professors Emeriti

Professor Harold F. Cherniss pursued his studies of ancient Greek philosophy and especially of Aristotle's criticism of Plato and the Academy, until his death on June 18, 1987.

Professor Marshall Clagett has sent the first volume of his work on *Ancient Egyptian Science: A Source Book* to a publisher. The second and third volumes are in preparation. The American Philosophical Society has published Professor Clagett's *Computer-generated Hieroglyphs* as a separate brochure.

Professor Felix Gilbert presented a paper on "Leopold von Ranke as Teacher of Jacob Burckhardt" at the International Ranke Conference at Syracuse University in October 1986; the paper will be published together with the other papers presented at this conference by the Syracuse University Press. He spoke also at the first meeting of the Davis Seminar at Princeton University on "Jacob Burckhardt as Cultural Historian." Professor Gilbert continued to do research on the development of nineteenth-century historiography, and in this context published two articles: "Leopold von Ranke and the American Philosophical Society" in the *Proceedings of the American Philosophical Society* and "What Ranke Meant" in *The American Scholar*. He published reviews in *The American Historical Review*, *The New York Review of Books*, *Historische Zeitschrift*, *Times Literary Supplement*. He also received honorary degrees from Yale University (Doctor of Humane Letters) and from Harvard University (Doctor of Law).

Professor James F. Gilliam continued his research on Roman military history.

Professor George F. Kennan continued his research for the third volume on the Franco-Russian Alliance. He also spent extensive time editing a proposed edition of his private papers from the Seely G. Mudd Library at Princeton University. In addition to a number of book reviews, he published articles in *Foreign Affairs* and *Newsweek* and wrote the foreword for Norman Cousins' book, *The Pathology of Power*, published in February by W. W. Norton Company. He hosted the tenth anniversary celebration of the Kennan Institute for Advanced Russian Studies at The Wilson Center, Smithsonian Institute, Washington, D.C. and was the honored guest and speaker at the 40th anniversary celebration of the Pol-

icy Planning Staff, Department of State, Washington, D.C. in May, 1987. He headed the delegation to a "Conference on Soviet-American Relations since 1945," sponsored by IREX, the American Council of Learned Societies and the Moscow Institute of History, in June, 1987, in Moscow. He was the keynote speaker at a conference held by the German Marshall Fund in Berlin to commemorate the 40th anniversary of The Marshall Plan, in June, 1987. He was interviewed on CBS television by Walter Cronkite in December, 1986.

Professor Kenneth M. Setton published a lengthy study on *The Venetians in Greece, 1684-1866: Francesco Morosini and the Destruction of the Parthenon* (American Philosophical Society), and is now at work on a book on "Austria, Venice, and the Turks in the Seventeenth Century."

Professor Homer A. Thompson continued to supervise the study and publication of the results of the excavation of the Athenian Agora. He also completed a study of the Palace of the Giants, a great complex of the fifth century after Christ that overlay most of the area of the Agora in classical times.

Professor Morton White published his *Philosophy, The Federalist, and the Constitution*;

also *Pragmatism and the Politics of Epistemology*, his Neesima Lectures, delivered at Doshisha University in Kyoto. His article, "Normative Ethics, Normative Epistemology, and Quine's Holism," appeared in *The Philosophy of W. V. Quine*, a volume in the Library of Living Philosophers. In the summer of 1986, Professor White once again held an appointment as Visiting Scholar in Philosophy at Harvard University.

Long-term Member

Professor Otto E. Neugebauer submitted the manuscript of his monograph on "Abu Shaker's Chronography" to the *Sitzungsberichte* of the Vienna Academy for publication, and completed the third and final volume of "Chronography in Ethiopic Sources" which has also been submitted to the Vienna Academy. His paper on "Byzantine Chronography, a Critical Note" has been accepted for publication by the *Byzantinische Zeitschrift*. He was elected an honorary member of the Vienna Academy and awarded the Susan Colver Rosenberger Medal of Brown University, and the Benjamin Franklin Medal of the American Philosophical Society.

The School of Historical Studies

Members with Long-term Appointments, Members, Visitors, Research Associates and Research Assistants, 1986-87

In the section which follows, the information was obtained from material provided by the Members, Visitors, Associates and Assistants.

Member with Long-term Appointment

Otto E. Neugebauer, *History of exact sciences in antiquity and Middle Ages*.

Born 1899, Innsbruck, Austria. University of Göttingen, PhD 1926; University of St. Andrews, LLD 1938; honorary doctorate Brown University, Princeton University.

University of Göttingen, assistant professor 1927-33; founder and joint editor of *Quellen und Studien zur Geschichte der Mathematik, Astronomie, und Physik* 1930-38; University of Copenhagen, research professor 1933-39; University of Cambridge, W. Rouse Ball Lecturer 1939; Cornell University, Messenger Lecturer 1949; Brown University, professor of the history of mathematics and professor emeritus 1939-69; Institute for Advanced Study, School of Historical Studies, member 1950-55, 1959-60, member with long-term appointment 1960- , School of Natural Sciences, member 1950, 1952, 1954, 1956, 1958, member with long-term appointment, 1960- .

Members

Arnold Angenendt, *Das Frühmittelalter Kirchengeschichte von 400 bis 900*.

Born 1934, Goch, West Germany. Universität Münster, DR—Promotion 1970, Habilitation 1975.

Pontifical Institute of Medieval Studies, Toronto, visiting professor 1975-76; Ruhr-Universität Bochum, professor 1976-81; Universität Münster, professor 1981- .

David Roy Shackleton Bailey, *Cicero epistulae ad familiares* (ed.).

Born 1917, Lancaster, England. University of Cambridge, BA 1939, MA 1943, DLitt 1958.

Gonville and Caius College, Cambridge, fellow 1944-55, praelector 1954-55, deputy bursar 1964, senior bursar 1965-68, University lecturer 1948-68; Jesus College, Cambridge, fellow and director of studies in classics 1955-64; University of Michigan at Ann Arbor, professor 1968-75; Harvard University, visiting lecturer 1963, professor 1975- ; State University of New York at Buffalo, visiting professor 1973-74; Peterhouse, Cambridge, visiting fellow 1980-81.

Haim Beinart, *The expulsion of the Jews from Spain in 1492*.

Born 1917, Pskow, Russia. The Hebrew University, Jerusalem, MA 1947, PhD 1955.

The Hebrew University, teacher 1952-57, instructor 1958-62, lecturer 1963-64, senior lecturer 1964-65, associate professor 1966-70, professor 1971- ; Ben Gurion University, professor 1974-82.

Robert L. Bireley, *Antimachiavellianism, counterreformation, and the baroque*.

Born 1933, Evanston, Illinois. Loyola University of Chicago, AB 1956, MA 1963; Hochschule Sankt Georgen, Frankfurt/Main, STL 1965; Harvard University, PhD 1972.

Loyola University of Chicago, instructor 1971-72, assistant professor 1972-76, associate professor 1976-82, professor 1982- .

John F. Boler, *The concept of will in Augustine and Duns Scotus*.

Born 1929, Omaha, Nebraska. Creighton University, BA 1950; St. Louis University, MA 1951; Harvard University, PhD 1960.

University of Washington, assistant professor 1960-65, associate professor 1965-77, professor 1977- ; University of California at Berkeley, visiting assistant professor 1964-65; University of Michigan, visiting associate professor 1967; University of California at Irvine, visiting associate professor 1972; Rutgers University, visiting

26 School of Historical Studies

lecturer 1981; Washington University, visiting professor 1983.

Martha Brandt Bolton, *Locke and Leibniz on human understanding: competing theories in seventeenth-century European philosophy.*

Born 1943, Cincinnati, Ohio. Ohio Wesleyan University, BA 1965; University of Michigan, PhD 1973.

Rutgers University, assistant to associate professor 1971- .

Elizabeth Hill Boone, *The native tradition of Mesoamerican manuscript painting.*

Born 1948, Kingston, Rhode Island. College of William and Mary, BA 1970; University of Texas, MA 1974, PhD 1977.

University of California at Irvine, instructor 1979; University of Texas at San Antonio, research associate 1977-80; Dumbarton Oaks, associate curator 1980-83, director of studies 1983- .

Marcia Lillian Colish, *Peter Lombard and the theology of the first half of the twelfth century.*

Born 1937, Brooklyn, New York. Smith College, BA 1958; Yale University, MA 1959, PhD 1965.

Skidmore College, instructor 1962-63; Case Western Reserve University, lecturer 1966-67; Oberlin College, instructor 1963-65, assistant professor 1965-69, associate professor 1969-75, professor 1975- .

Daniela del Pesco, *Classical sources and architecture in baroque Rome.*

Born 1946, Trieste, Italy. University of Rome I, Laurea 1970; University of Naples, MA 1974.

University of Naples, graduate teaching assistant 1971-73, researcher 1974-83, professore incaricato 1976-82; University of Rome II, researcher 1981- .

Bruce Stansfield Eastwood, *The idea of circumsolar planetary motion in early medieval Europe.*

Born 1938, Worcester, Massachusetts. Emory University, AB 1959, MA 1960; University of Wisconsin, PhD 1964.

Russell Sage College, instructor 1963-64; Ithaca College, assistant professor 1964-67; Clarkson College of Technology, assistant professor 1967-70; Kansas State University, associate professor 1970-73; University of Kentucky, associate professor 1973-83, professor

1983- ; University of Virginia, visiting associate professor 1977-78; Institute for Advanced Study, member 1979-80.

Samuel Y. Edgerton, Jr., *Renaissance art and science.*

Born 1926, Cleveland, Ohio. University of Pennsylvania, BA 1951, MFA 1956, MA 1960, PhD 1965.

Wheaton College, assistant professor 1963-64; Boston University, assistant professor 1964-68, associate professor 1968, professor 1968-80; Institute for Advanced Study, member 1967-68; Williams College, professor 1980- .

Carlos M. N. Eire, *Attitudes toward death and the afterlife in Renaissance Spain.*

Born 1950, Havana, Cuba. Loyola University of Chicago, BA 1973; Yale University, MA 1974, MPhil 1976, PhD 1979.

St. John's University, assistant professor 1979-81; University of Virginia, assistant professor 1981- .

Paul Harris Freedman, *Origins of serfdom in medieval Catalonia.*

Born 1949, New York, New York. University of California at Santa Cruz, BA 1971; University of California at Berkeley, MLS 1977, PhD 1978.

Vanderbilt University, assistant professor 1979-84, associate professor 1984- .

Christopher R. Friedrichs, *Urban conflicts in seventeenth-century Germany.*

Born 1947, White Plains, New York. Columbia University, AB 1968; Princeton University, MA 1970, PhD 1973.

Princeton University, instructor 1972-73; University of British Columbia, assistant professor 1973-78, associate professor 1978- .

Gerd Grasshoff, *History of the Ptolemaic Star Catalogue.*

Born 1957, Moers, West Germany. University of Hamburg, MA 1983, DrRerNat 1985.

University of Hamburg, Wissenschaftlicher Mitarbeiter 1983-86.

Ulrich W. Haarmann, *Careers, fortunes and activities of Mamluk descendants.*

Born 1942, Stuttgart, Germany. Princeton University, BA 1965; Freiburg University, DrPhilHabil 1972.

German Archaeological Institute, Cairo, research assistant 1969-71; University of Freiburg, research associate 1971-76, professor 1976- ; University of California at Los Angeles, visiting professor 1974; McGill University, visiting professor 1976, 1986; German Research Institute, Beirut, director 1978-80.

Peter Hanák, *Vienna and Budapest at the turn of the century*.

Born 1921, Kaposvár, Hungary. Budapest University, MA 1948, PhD 1952.

Institute of History, Hungarian Academy of Sciences, fellow 1949-63, head of department for modern history 1963-85; Budapest University, associate professor 1953, 1957, professor 1980- ; Columbia University, visiting professor 1971, 1976.

Robert B. C. Huygens, *Berengar of Tours, Responsum contra Lanfrancum*.

Born 1931, The Hague, Netherlands. University of Leiden, Doctorat 1960.

University of Leiden, senior lecturer 1964-68, professor 1968- ; Institute for Advanced Study, Hebrew University, fellow 1983-84.

David Leslie Kennedy, *Roman Syria (43 BC—69 AD); eastern frontier of the Roman empire*.

Born 1948, Montrose, Scotland, United Kingdom. University of Manchester, BA 1974; Balliol College, University of Oxford, DPhil 1980.

University of Sheffield, lecturer 1976- ; University of Western Australia, visitor 1984.

Etan Kohlberg, *Suicide and martyrdom in Muslim thought*.

Born 1943, Tel Aviv, Israel. Hebrew University, BA 1966, MA 1968; University of Oxford, PhD 1971.

Hebrew University, lecturer 1972-76, senior lecturer 1976-82, associate professor 1983- ; Yale University, visiting lecturer 1978-79; Institute for Advanced Study, Hebrew University, fellow 1984-85.

Georges Charles Le Rider, *The gold coinage of Alexander the Great struck in Macedonia*.

Born 1928, Saint-Hernin, Finistère, France. University of Paris IV, Sorbonne, Doctorat d'Etat 1965.

Cabinet des Médailles, Bibliothèque Nationale, Paris, keeper 1961-75; Bibliothèque

Nationale, general director 1975-81; Ecole Pratique des Hautes Etudes, IV^e Section, Paris, directeur d'Etudes 1964- ; Institut Français d'Archéologie, Istanbul, director 1981-84; University of Paris IV, Sorbonne, professor 1984- .

Patrick Le Roux, *Histoire politique de l'Empire Romain*.

Born 1943, Morlaix (Finistère), France. Agrégation Histoire 1967; University of Bordeaux III, Docteur ès Lettres 1980.

University of Madrid, member of la casa de Velazquez 1970-73; University of Paris X, assistant 1973-77, maitre assistant 1977-83; University of Toulouse II, professor 1983- .

Robert Austin Markus, *Religion and society from Augustine to Gregory the Great*.

Born 1924, Budapest, Hungary. Manchester University, BSc 1944, MA 1946, PhD 1950.

University of Liverpool, lecturer to senior lecturer to reader 1955-70; University of Nottingham, professor 1974-82, professor emeritus 1982- .

Martin Jessop Price, *The coinage in the name of Alexander the Great and Philip Arrhidaeus*.

Born 1939, London, England. Queens' College, University of Cambridge, BA 1961; Downing College, University of Cambridge, MA 1964, PhD 1967.

The British Museum, Department of Coins and Medals, assistant keeper 1966-78, deputy keeper 1978- .

Simon R. F. Price, *Roman religion (Augustus to Constantine)*.

Born 1954, London, England. Queen's College, University of Oxford, BA 1976; University of Oxford, MA 1979, DPhil 1980.

Christ's College, University of Cambridge, junior research fellow 1978-81; Lady Margaret Hall, University of Oxford, fellow and tutor 1981- .

Roshdi Rashed, *History of Archimedian methods in Arabic mathematics and History of the burning mirrors*.

Born 1936, Cairo, Egypt. University of Cairo, licence ès lettres 1956; Université de Paris XI, licence ès sciences 1976; Université de Paris X, doctorat ès lettres 1984.

Centre National de la Recherche Scientifique,

28 School of Historical Studies

attaché de recherche 1965-71, chargé de recherche 1971-77, directeur de recherche 1977-

Frank Edward Romer, *The politics of tyranny at Athens, ca. 640-480 B.C.*

Born 1946, Brooklyn, New York. New York University, BA 1968; Stanford University, MA 1971, PhD 1974.

University of Vermont, visiting assistant professor 1974-75; Ohio State University, assistant professor 1977-78; The Johns Hopkins University, assistant professor 1979-86; City University of New York, visiting assistant professor summer 1984, summer 1986.

David Theunis Runia, *Aristotle in the ancient doxographical tradition.*

Born 1951, Noord-oost Polder, Netherlands. University of Melbourne, MA 1976; Free University, Amsterdam, DLitt 1983.

Free University, Amsterdam, assistant lecturer 1977-79, lecturer 1983-84; Netherlands Organization for the Advancement of Pure Research, research fellow 1980-82, 1985.

Trevor John Saunders, *Ancient Greek penology, with special reference to Plato.*

Born 1934, Corsham, United Kingdom. University College, BA 1956; University of Cambridge, PhD 1962.

Bedford College, assistant lecturer 1959-61; University of Hull, assistant lecturer to lecturer 1961-65; University of Newcastle upon Tyne, lecturer 1965-72, senior lecturer 1972-78, reader 1978, professor 1978-; Institute for Advanced Study, member 1971-72.

A. Mark Smith, *The evolution of the Ray-concept from Euclid to Fermat.*

Born 1942, West Point, New York. St. John's College, BA 1967; University of Wisconsin at Madison, MA 1972, PhD 1976.

Brandeis University, assistant professor 1976-79; Institute for Advanced Study, member 1979-80; University of California at Riverside, assistant professor 1982-86; University of Missouri at Columbia, associate professor 1986-

David Ross Smith, *Privacy and civilization in Dutch Art, 1650-1700.*

Born 1946, Little Rock, Arkansas. Washington University, AB 1968; Columbia University, MA 1971, PhD 1978.

University of Maryland, lecturer 1973-74; Bates College, instructor to assistant professor 1974-79; University of New Hampshire, assistant to associate professor 1979-

Christopher Tadgell, *Jacques-François Blondel and academic classical theory of architecture in France.*

Born 1939, Sydney, N.S.W., Australia. Sydney University, BA 1962; Courtauld Institute, University of London, MA 1970, PhD 1974.

Canterbury College of Art, School of Architecture, part-time lecturer 1970-75, senior lecturer 1975-; Polytechnic of the South Bank, London, lecturer 1973-80; University of Louisville, visiting professor fall 1985.

Bengt Erik Thomasson, *The development of the Roman legateship from the late republic through the principate.*

Born 1926, Falun, Sweden. University of Lund, FilMag 1948, FilLic 1954, FilDr 1960.

University of Lund, assistant professor 1960-61; Swedish Institute in Rome, director 1961-64; Lundby Gymnasium Göteborg, gymnasielektor 1964-72, 1978-; University of Göteborg, assistant professor 1972-78.

Nancy J. Troy, *The decorative arts in France, 1895-1925.*

Born 1952, New York, New York. Wesleyan University, BA 1974; Yale University, MA 1976, PhD 1979.

The Johns Hopkins University, assistant professor 1979-83; Northwestern University, assistant professor 1983-85, associate professor 1985-

Paul R. C. Weaver, *The administration of the early Roman empire.*

Born 1927, Roxburgh, New Zealand. University of New Zealand, MA 1949; King's College, University of Cambridge, BA 1955, PhD 1965.

University of Canterbury, New Zealand, assistant lecturer 1951-53; University of Western Australia, lecturer 1956-60, senior lecturer 1961-65, reader 1966; University of Tasmania, professor 1967-

Curtis A. Wilson, *D'Alembert versus Euler on the procession of the equinoxes and the mechanics of rigid bodies.*

Born 1921, Los Angeles, California.

University of California at Los Angeles, BA 1945; Columbia University, MA 1949, PhD 1952.

St. John's College, tutor 1948-66, 1973- , dean 1958-62, 1973-77; University of California at San Diego, visiting associate professor 1966-68, professor 1968-73; Institute for Advanced Study, member fall 1982, fall 1986.

John P. Wright, *Concepts of mind and body in seventeenth and eighteenth-century medicine.*

Born 1942, Toronto, Canada. University of Toronto, BA 1964, MA 1967; York University, PhD 1975.

University of Saskatchewan, assistant professor 1970-73; University of Toronto, visiting assistant professor 1975-76; University of Western Ontario, visiting assistant professor 1978-79, 1980-81; Simon Fraser University, visiting assistant professor 1981-83; University of Windsor, assistant professor 1983- .

Visitors

Lionel Gossman, *Culture and society in nineteenth-century Basle.*

Born 1929, Glasgow, United Kingdom. University of Glasgow, MA 1951; St. Antony's College, University of Oxford, DPhil 1958.

Glasgow University, assistant lecturer 1957-58; The Johns Hopkins University, assistant professor 1958-62, associate professor 1962-66, professor 1966-76; Princeton University, professor 1976- ; Institute for Advanced Study, visitor 1978-79, spring 1983.

Christopher P. Jones, *Abandoned and foster children in Greco-Roman antiquity.*

Born 1940, Chislehurst, Kent, England. University of Oxford, BA 1962, MA 1967; Harvard University, PhD 1965.

University of Toronto, lecturer to associate professor 1965-75, professor 1975- ; Institute for Advanced Study, member 1971-72, 1982-83.

Michael P. Mezzatesta, *The Capilla Mayor at the Escorial and Habsburg devotion to the Eucharist.*

Born 1948, New York, New York. Columbia University, BA 1970; Institute of Fine Arts, PhD 1980.

Kimbell Art Museum, curator European art; Duke University Museum of Art, director 1987.

Robert R. Palmer, *The revolutionary constitutions of eighteenth-century Europe.*

Born 1909, Chicago, Illinois. University of Chicago, BA 1931; Cornell University, PhD 1934. Princeton University, instructor to professor 1936-63, dean of the faculty of arts and sciences 1952-63, professor of history 1966-69; Washington University at St. Louis, professor 1963-66; Yale University, professor 1969-77, professor emeritus 1977- ; University of Michigan, visiting adjunct professor 1977-81; University of Chicago, visiting professor summer 1947, 1969, 1975; University of Colorado, visiting professor summer 1951; University of California at Berkeley, visiting professor summer 1962.

Gyöngyi Török, *Iconographic and stylistic problems of fifteenth-century central European altarpieces and book illuminations.*

Born 1945, Szentgotthárd, Hungary. University of Budapest, BA 1968; University of Vienna, DrPhil 1972.

Hungarian National Gallery, curator of medieval art 1967-81, principal scientific collaborator in the department of medieval art, 1981- .

Theodore Weiss, *English and creative writing.*

Born 1916, Reading, Pennsylvania. Muhlenberg College, BA 1938; Columbia University, MA 1940.

University of North Carolina, instructor 1942-44; Yale University, instructor 1944-46; Bard College, professor 1946-66; Massachusetts Institute of Technology, professor 1961-62; Princeton University, professor 1966- .

Research Associate

Robert C. Sleight, Jr., *Philosophy of Leibniz: his correspondence with Arnauld, Bayle and Malebranche.*

Born 1932, Marblehead, Massachusetts. Dartmouth College, BA 1954; Brown University, MA 1957, PhD 1963.

Wayne State University, instructor to associate professor 1958-68; Harvard University, visiting professor 1965; University of Massachusetts at Amherst, Professor 1969- ; University of Michigan, visiting professor 1973; Brown University, visiting professor 1981; Institute for Advanced Study, member 1982-83;

Universidad Nacional Autónoma de México, visiting professor 1983; University of Arizona, visiting professor 1984.

Research Assistants

Elizabeth Beatson

Born 1915, Worthing, Sussex, England.

Council of Europe Exhibition, Aachen, West Germany, assistant 1965; Zentralinstitut für Kunstgeschichte, Munich, member and part-time research assistant 1965-69; Institute for Advanced Study, assistant to Professor Millard Meiss 1969-76, assistant to Professor Giles Constable 1985-76, Princeton University, reader in the Index of Christian Art 1976-85.

James Clifton, *Depictions of contemporary events in seventeenth-century Naples.*

Born 1958, Lexington, Kentucky. University of Kentucky, BFA 1980; Princeton University, MFA 1984.

Institute for Advanced Study, assistant to Professor Irving Lavin 1986-87.

Henry Innes MacAdam, *Ancient Phoenicia: texts relevant to the flora and fauna.*

Born 1942, Long Island City, New York.

American University of Beirut, BA 1970, MA 1973; University of Manchester, PhD 1979.

American University of Beirut, assistant to associate professor 1979-87; University of Sheffield, visiting research fellow 1985-86; Institute for Advanced Study, assistant to Professor Glen W. Bowersock 1986-87.

Daniel Moran, *The Cotta Press, 1794-1832.*

Born 1951, New Orleans, Louisiana. Yale University, BA 1973; Stanford University, PhD 1982.

Institute for Advanced Study, assistant to Professor Peter Paret 1986-87.

Peter Sahlins, *Territory and nationality in the French-Spanish borderland.*

Born 1957, Ann Arbor, Michigan. Harvard College, BA 1980; Princeton University, PhD 1986.

Princeton University, assistant instructor 1984-85; Harvard College, lecturer 1985-86; Institute for Advanced Study, assistant to Professor John H. Elliott 1986-87.

The School of Mathematics

Faculty

Enrico Bombieri
(IBM von Neumann Professor)
Armand Borel
(Hermann Weyl Professor)
Luis A. Caffarelli
Pierre Deligne

Robert P. Langlands
John W. Milnor
(Oswald Veblen Professor)
Atle Selberg
Thomas Spencer

Professors Emeriti

Arne Beurling*
Deane Montgomery

André Weil
Hassler Whitney

* Deceased November 20, 1986

The School of Mathematics

Mathematics, though rooted in human experience, is concerned with relationships between objects and structures that are creations of the mind. What has rigorously been established can therefore not be invalidated by later experience, and so mathematics is cumulative in a way the natural sciences are not. Mathematical truths established in antiquity by Apollonius, Archimedes or Euclid are still alive and well and part of the body of mathematics today.

However, while the substance or content remains, the form in which it is presented is transitory and may change profoundly from one generation to the next. The landscape of mathematics is ever changing and the boundary lines between different areas are fluid. As mathematics develops there are tendencies of divergence, complexification, and fragmentation, as well as of unification and simplification.

Some areas may branch out in several different directions and divide into various specialties with little or no contact between them. It may also happen that new concepts and deeper insights bring together subjects that seemed far apart and unrelated, fitting them together in a new scheme of things, at once grander and simpler.

Mathematics, while it deals with objects of the mind, may be brought to bear on models of reality arising in other sciences. It has thus for a long time had a close relationship with physics and astronomy in particular. Historically, many mathematical concepts and theories have evolved because of stimuli provided by questions originating in these sciences. On the other hand, the mathematician's pursuit of a purely intellectual pastime has often led to concepts and theories which later turned out to have anticipated vital needs of these sciences in an almost uncanny way.

The areas of mathematics that most frequently draw their inspiration from problems in the natural sciences are commonly referred to as applied mathematics, as distinct from pure mathematics, but it is a distinction primarily of motivation or attitude rather than of essence.

Even in the branches of mathematics usually thought of as the purest, experimentation and empirical evidence have always played an important role in the discovery of new relationships. Today the development of the electronic computer has made such experimentation and the gathering and processing of empirical data possible on a scale far beyond anything seen or even imagined before. The consequences of this are already very noticeable in some areas, and this development is bound to affect mathematics much more profoundly in the future.

While it is true that great mathematics has sometimes been done in isolation under adverse circumstances, as a rule free communication and lively exchange of ideas between mathematicians are essential prerequisites for mathematical progress. Since antiquity, there have from time to time come into being centers that were the foci of the mathematical intercourse of their day.

In the nineteenth century, Paris, Berlin and Göttingen were such centers, with Göttingen gradually gaining the ascendancy and retaining this position of primacy until it came to an end with the Nazi regime. A contributing factor to the dominant position of Göttingen, beside its traditions and an excellent, though small, faculty, was probably the unusually large number of junior temporary positions available there.

The School of Mathematics of the Institute for Advanced Study started out as Göttingen

and the other German universities went into decline, and it benefited from the exodus of eminent scholars and scientists from Germany which started in 1933. Its earliest Faculty included three of the leading American mathematicians of the time: Oswald Veblen, James W. Alexander and Marston Morse. From Germany, Hermann Weyl from Göttingen and John von Neumann and Albert Einstein from Berlin joined the School. Later Kurt Gödel from Vienna and Carl Ludwig Siegel from Göttingen were added.

Under the guidance primarily of Veblen and Weyl, and drawing on experiences from Göttingen, the School developed a pattern of operation which put the emphasis on having a mix of temporary members with varied interests and at various stages in their mathematical career. The temporary members were thought of as the most important element, the real *raison d'être*, of the School, and the Faculty considered it a prime obligation to be freely available to the temporary members for consultation and advice. There was little in the way of formal organization, but as the interests of the temporary members and the Faculty might dictate, seminars and lecture series were arranged in which the members could participate or not according to their wishes, and otherwise do their own research. During these early years the School also to some extent, served as a clearing house for refugee mathematicians, receiving them for a time and helping to ease their absorption into the American university system. For many years after the end of World War II, the School was still the only international center devoted solely to postdoctoral studies and research in mathematics.

The School of Mathematics was, and still is, very much assisted by the presence at Princeton University of a very strong mathematics department, creating a local mathematical community much larger than the School by itself could provide. The informal cooperation with the University department has always been most beneficial; the only formal link be-

tween the two is that they jointly edit the *Annals of Mathematics*, the leading American mathematical journal.

The School has later largely continued the pattern of operation established in the early years, though as the membership has grown the number of seminars and lectures has increased.

In the sixties the School initiated a policy of having special programs during some academic years, by selecting some specific area that looked particularly promising at the time and bringing together a group of mathematicians with interests in or around this area, but without letting the special program take over completely. A sizable number of the membership was always selected that had no particular connection with the program. During the seventies this policy was discontinued for a while due to lack of funding, but was later resumed. The School now has special programs on the average every second year.

More recently an aperiodic series of survey lectures, called the Hermann Weyl Lectures, was instituted. These lectures consist of a broad survey of recent work in some area of mathematics of particular current interest, and are later published in the *Annals of Mathematics Studies*.

Both the special programs and the Hermann Weyl Lectures can serve as a way to stimulate research in areas beyond those represented by the School's Faculty. This function is important since the Faculty at no time has covered all vital areas of mathematics, though the coverage has shifted considerably over the years.

One characteristic feature of the School that has helped to keep it strong through the years and changes, is a highly developed "esprit de corps." Today, when several other centers devoted solely to mathematical research exist, it is still the ambition of the School Faculty that the School of Mathematics shall remain, as Hermann Weyl described it in 1954: "die schönste Forschungsstätte die es für die Mathematik in der Welt gibt."

Academic Activities, 1986-87

Professor Luis A. Caffarelli and Professor Thomas Spencer joined the School of Mathematics in September, 1986. These appointments significantly increased the faculty coverage of mathematics. Caffarelli, an analyst, is primarily interested in partial differential equations, especially free boundary problems. On the other hand, Spencer's work deals with the rigorous side of mathematical physics, particularly the construction and understanding of quantum field theories.

A large number of seminars met. The topology, dynamical systems and analytic number theory seminars continued to meet regularly this year. As a rule, these seminars were aimed at experts; the lectures were devoted to recent results and independent of one another. The members seminar follows a similar procedure and provides an opportunity for members to describe their own research, regardless of field.

Other seminars emphasize a main theme and aim at giving a coherent exposition of the present state of affairs in a given area. In such cases, an attempt is usually made to facilitate access to the main topics for people with peripheral interests by including some expository lectures. There were three seminars along those lines. One consisted of a series of lectures by Robert P. Langlands, requiring comparatively little background, giving a detailed proof of a theorem due to three physicists, Daniel Friedan, Zongan Qiu and Stephen Shenker, which describes the discrete series of representations of the Virasoro algebra. A second seminar organized by Frederic Bien, of Princeton University, was devoted to Kac-Moody algebras, loop groups and their representations. It was closely related to the first one. Both were of interest to mathematicians as well as to physicists working in string theory or conformal field theory. Thirdly, Armand Borel organized a seminar on compactifications of symmetric or locally symmetric varieties. It reviewed older and more recent work with various aims and motivations:

boundary values for eigenfunctions of invariant differential operators, enumerative geometry, deformations of isolated singularities, compactification of certain moduli schemes and automorphic forms.

This year there was a joint mathematical physics/analysis seminar with Princeton University. The lectures were given alternately in Fuld Hall and Fine Hall.

In October, 1986, the Tenth Marston Morse Memorial Lecture was delivered by Richard Hamilton entitled: "Deforming Metrics by their Ricci curvature."

As usual, these organized activities are to be viewed only as a part of the scientific life at the Institute: of equal, or even greater, importance are the individual work and the ongoing informal discussions between members and Faculty, for which the Institute provides a most favorable frame work.

Alte Selberg retired at the end of the academic year. Robert Langlands and Enrico Bombieri participated in a symposium held in his honor in Oslo, Norway, June 14-21.

As was noted in the Director's Report, Arne Beurling, Professor Emeritus in the School of Mathematics, died on November 20, 1986. At a memorial service held later, Lennart Carleson, Professor at the University of California at Los Angeles, introduced his description of Beurling's work with the following words:

Complex analysis can be considered to be the heart of mathematics. This is where essentially all branches of mathematics come together: physics, number theory, geometry and of course all aspects of analysis. It is also one of the most beautiful and mysterious areas where mathematical miracles happen. To be a true complex analyst you must be an artist and a wizard, you must only accept the beautiful and simple and you must by intuition see the hidden relationships, put there at the beginning of time to be discovered by very few chosen mathematicians. Arne Beurling was such a complex analyst.

The School of Mathematics

Members, Visitors and Assistants, 1986-87

In the section which follows, the information was obtained from material provided by the Members, Visitors and Research Associates, and Research Assistants.

Members

Alberto Albano, *Algebraic cycles on elliptic threefolds.*

Born 1956, Torino, Italy. Università di Pisa, Laurea 1978; University of Utah, PhD 1986. Università di Torino, ricercatore 1985- .

Erik Balslev, *Spectral and scattering theory of Schrödinger operators.*

Born 1935, Haurum, Denmark. Aarhus University, MS 1961; University of California at Berkeley, PhD 1963. State University of New York at Buffalo, visiting associate professor 1968-71; University of California at Los Angeles, visiting professor 1972-74; Aarhus University, professor 1974- .

Brian H. Bowditch, *Low-dimensional topology and geometry.*

Born 1961, Neath, West Glamorgan, Great Britain. University of Cambridge 1982, certificate of advanced study 1983; Warwick University, PhD 1987.

Vijayanthi Chari, *Representations of Kac-Moody Lie algebras.*

Born 1958, Madras, India. Bombay University, MSc 1980, PhD 1987. Tata Institute of Fundamental Research, fellow 1986- .

Ruth M. Charney, *Cohomology of groups and moduli spaces.*

Born 1950, New York, New York. Brandeis University, BA 1972; Princeton University, PhD 1977. University of California at Berkeley, lecturer 1977-79; Yale University, assistant professor 1979-

84; Ohio State University, associate professor 1984- .

Joseph P. Christy, *Low dimensional dynamical systems.*

Born 1953, Heidelberg, West Germany. Yale University, AB 1976; University of California at Berkeley, PhD 1984. Northwestern University, assistant professor 1984-86.

Marc Culler, *Low-dimensional topology and combinatorial group theory.*

Born 1953, Berkeley, California. University of California at Santa Barbara, BS 1973; University of California at Berkeley, MA 1975, PhD 1978. Rice University, instructor 1979-83; Rutgers University, assistant professor 1983-86; University of Illinois at Chicago, associate professor 1986- .

Bruce A. Dodson, *Abelian varieties; complex multiplication; Shimura varieties.*

Born 1950, Eugene, Oregon. University of Oregon, BSc 1972; State University of New York at Stony Brook, MA 1975, PhD 1976. State University of New York at Stony Brook, lecturer 1976-77; University of Florence, fellow 1977-78; Lehigh University, lecturer 1978-80, assistant professor 1980-86, associate professor 1986- .

Harold Donnelly, *Differential geometry.*

Born 1951, New York, New York. Massachusetts Institute of Technology, BS 1971; University of California at Berkeley, PhD 1974. Massachusetts Institute of Technology, instructor 1974-76; The Johns Hopkins University, assistant professor 1976-78; Purdue University, associate professor 1979-83, professor 1983- ; Institute for Advanced Study, member 1981-82.

Bruce K. Driver, *Constructive quantum field theory: a global Poincaré Lemma for connection forms.*

Born 1960, Minneapolis, Minnesota.

University of Massachusetts at Amherst, BS 1981; Cornell University, MS 1984, PhD 1986.

Albert Fathi, *Topology and dynamical systems*.

Born 1951, Cairo, Egypt. Université de Paris XI, thèse d'état 1980.

Centre National de la Recherche Scientifique, chargé de recherches 1974- .

Ian Hambleton, *Group actions on 4-manifolds*.

Born 1946, Toronto, Ontario, Canada. University of Toronto, BSc 1968, MSc 1969; Yale University, PhD 1973.

University of Chicago, instructor 1973-75; McMaster University, assistant professor 1975-79, associate professor 1979-84, professor 1984- ; Institute for Advanced Study, 1978-79.

Günter Harder, *Cohomology of arithmetic groups*.

Born 1938, Ratzeburg, Germany. Universität Hamburg, DrRerNat 1964, Habilitation 1966.

Universität Heidelberg, Wissenschaftlicher Rat 1967-69; Universität Bonn, professor 1969-74, 1980- ; Gesamthochschule Wuppertal, professor 1974-80; Institute for Advanced Study, assistant 1966-67, member 1972-73, fall 1983.

Jeffrey Hoffstein, *Metaplectic forms on $GL(n)$* .

Born 1953, New York, New York. Cornell University, BA 1974; Massachusetts Institute of Technology, PhD 1978.

Institute for Advanced Study, member 1978-79, fall 1985; Brown University, assistant professor 1979-82; University of Rochester, assistant to associate professor 1982- .

Johannes Hübschmann, *Characteristic classes for group extensions, homological perturbation theory*.

Born 1950, Heidelberg, West Germany. Eidgenössische Technische Hochschule, Zürich, Diplom 1974, PhD 1977; Universität Heidelberg, Habilitation 1984.

Universität Heidelberg, assistant 1976-85; Institute for Advanced Study, member 1985-86.

Henryk Iwaniec, *Analytic number theory*.

Born 1947, Elblag, Poland. University of Warsaw, PhD 1972; Mathematics Institute, Polish Academy of Sciences, Habilitation 1976, professor 1983.

Mathematics Institute, Polish Academy of Sciences, assistant 1972-78; associate professor

1978-83, professor 1983-85; Institute for Advanced Study, member 1983-86; Rutgers University, professor 1987- .

W. David Joyner, *Automorphic Forms*.

Born 1959, Philadelphia, Pennsylvania. Georgia Institute of Technology, BS 1981; University of Maryland, PhD 1983.

University of Maryland, instructor 1983-84; University of California at San Diego, assistant professor 1984-85; Princeton University, instructor 1985-86.

Yujiro Kawamata, *Classification of algebraic varieties*.

Born 1952, Tokyo, Japan. University of Tokyo, PhD 1980.

University of Tokyo, assistant 1977-84, lecturer 1984-86, associate professor 1986- .

Janos Kollar, *Structure of algebraic varieties*.

Born 1956, Budapest, Hungary. Eötvös University, DM 1980; Brandeis University, PhD 1984.

Harvard University, junior fellow 1984- .

Antoni A. Kosinski, *Differential topology*.

Born 1930, Warsaw, Poland. Warsaw University, PhD 1956.

University of California at Berkeley, assistant to associate professor 1959-66; Rutgers University, professor 1966- ; Institute for Advanced Study, member 1962-64, fall 1966, visitor 1969-70.

Antti Kupiainen, *Quantum field theory, disordered systems*.

Born 1954, Varkaus, Finland. Helsinki Institute for Technology, MS 1976; Princeton University, PhD 1979.

Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, visiting professor 1981-82, 1985-86; Helsinki University, senior researcher 1980- ; Harvard University, visiting professor 1984-85.

Peter S. Landweber, *Elliptic function theory in algebraic topology*.

Born 1940, Washington, D.C. University of Iowa, BA 1960; Harvard University, PhD 1965.

University of Virginia, assistant professor 1965-67; Institute for Advanced Study, member 1967-68; Yale University, assistant professor 1968-70; Rutgers University, associate professor 1970-74, professor 1974- .

Ronnie Lee, *Differential topology.*

Born 1942, Kwang Tung Province, China.
University of Michigan, PhD 1968.
Yale University, assistant professor 1970-73,
professor 1973- .

James D. Lewis, *Algebraic cycles on projective,
algebraic varieties.*

Born 1953, Vancouver, British Columbia,
Canada. University of British Columbia, BSc 1976,
PhD 1980.

University of Washington, acting assistant
professor 1981-82; Eastern Montana College,
assistant professor 1982-85; University of
Saskatchewan, assistant professor 1985- .

Anatoly S. Libgober, *Topology of algebraic varieties.*

Born 1949, Moscow, U.S.S.R. Moscow
University, MS 1970; Tel Aviv University, PhD
1977.

Institute for Advanced Study, member 1977-
78; University of Illinois, assistant professor 1978-
83, associate professor 1983- ; Harvard
University, visiting fellow 1982.

Ib Henning Madsen, *Algebraic topology and
geometric topology.*

Born 1942, Copenhagen, Denmark.
University of Copenhagen, CandScient 1965;
University of Chicago, PhD 1970.

University of Chicago, instructor 1970-71;
University of Aarhus, associate professor 1971-83,
professor 1983- .

Curtis T. McMullen, *Conformal dynamics and theory
of equations.*

Born 1958, Berkeley, California. Williams
College, BA 1980; Harvard University, PhD 1985.
University of Cambridge, fellow 1980-81;
Harvard University, fellow 1983-85;
Massachusetts Institute of Technology, instructor
1985- ; Mathematical Sciences Research Institute,
Berkeley, fellow 1986.

Lee Mosher, *Mapping classes of surfaces; fibrations
and flows on 3-manifolds.*

Born 1957, Charleston, West Virginia.
Michigan State University, BS 1979; Princeton
University, PhD 1983.
Harvard University, assistant professor 1983-
86.

Maruti Ram P. Murty, *Number theory.*

Born 1953, Guntur, India. Carleton
University, BSc 1976; Massachusetts Institute of
Technology, PhD 1980.

Institute for Advanced Study, member 1980-
81, fall 1983; Tata Institute of Fundamental
Research, fellow 1981-82; McGill University,
associate professor 1982- .

Ulrich Oertel, *Laminations in 3-manifolds.*

Born 1949, Bonn, West Germany. University
of Edinburgh, BSc 1970; University of California at
Los Angeles, MA 1978, PhD 1980.

Michigan State University, fellow 1980-82,
instructor 1982-83; University of Oklahoma,
assistant professor 1983-84, spring 1986;
Mathematical Sciences Research Institute,
Berkeley, fellow 1984-85.

Jean-Pierre Otal, *Low dimensional topology.*

Born 1958, Lourdes, France. Université de
Paris XI, Maîtrise 1980, Thèse III^e cycle 1983.

University of Geneva, assistant 1983-84; Max-
Planck-Institut, Bonn, researcher 1984-85; Centre
National de la Recherche Scientifique, attaché de
recherche 1985-86.

Judith Packer, *K-theory of C^* -algebras; operator
algebras corresponding to dynamical systems.*

Born 1956, Coronado, California. Wesleyan
University, BA 1978, MA 1978; Harvard
University, PhD 1982.

Mathematical Sciences Research Institute,
Berkeley, member 1982-83; National University of
Singapore, lecturer 1983- .

Etienne Pardoux, *Stochastic processes (stochastic
calculus, stochastic differential equations,
nonlinear filtering).*

Born 1947, Nancy, France. Ecole
Polytechnique, ingénieur 1969; Université de Paris
XI, Docteur ès Sciences 1975.

Centre National de la Recherche Scientifique,
research assistant 1970-79; Université de
Provence, Marseille, professor 1979- .

R. Parthasarathy, *Representation theory.*

Born 1945, Madras, India. Madras University,
BSc 1965; Indian Institute of Technology, MSc
1967; Bombay University, PhD 1971.

Massachusetts Institute of Technology,
instructor 1971-72; Institute for Advanced Study,
member 1972-73; University of California at San

40 School of Mathematics

Diego, visiting associate professor 1982-83; University of Utah, visiting associate professor 1982-83; Tata Institute of Fundamental Research, professor 1983- .

Dinakar Ramakrishnan, *L-functions*.

Born 1949, Madras, India. University of Madras, BS 1970; Polytechnic Institute of Brooklyn, MS 1973; Columbia University, MA 1976, PhD 1980.

University of Chicago, instructor 1980-82; Institute for Advanced Study, member 1982-83; The Johns Hopkins University, assistant professor 1983-85; Cornell University, associate professor 1985- ; Mathematical Sciences Research Institute, Berkeley, member spring 1987.

E. Arthur Robinson, Jr., *Ergodic theory and dynamical systems*.

Born 1955, Boston, Massachusetts. Tufts University, BS 1977; University of Maryland, MS 1979, PhD 1983.

Mathematical Sciences Research Institute, Berkeley, member 1983-84; University of Pennsylvania, lecturer 1984-86.

Mihail-Radu Rosu, *Integral geometry*.

Born 1949, Bucharest, Romania. University of Bucharest, MSc 1971, PhD 1984.

University of Bucarest, assistant to associate professor 1979-86.

Mitchell J. Rothstein, *Supergeometry*.

Born 1956, New York, New York. Massachusetts Institute of Technology, BS 1977; University of California at Los Angeles, PhD 1984.

University of Washington, acting assistant professor 1984- .

Susana A. Salamanca Riba, *Unitary representations of real reductive Lie groups*.

Born 1954, Mexico City, D.F., Mexico. Escuela Superior de Administración de Instituciones, Lic. Admon. de Instituciones 1976; Universidad Autónoma Metropolitana, LicMath 1980; Massachusetts Institute of Technology, PhD 1986.

Ji-Ping Sha, *Differential geometry*.

University of Science and Technology of China, BS 1982; State University of New York at Stony Brook, PhD 1986.

Richard B. Sher, *Complement theorems and embedding theorems in shape theory*.

Born 1939, Flint, Michigan. Michigan Technological University, BS 1960; University of Utah, MS 1964, PhD 1966.

University of Georgia, assistant professor 1966-69, associate professor 1969-74; Institute for Advanced Study, visitor 1969-70; University of North Carolina at Greensboro, professor 1974- .

Salahoddin Shokranian, *Automorphic forms, Trace formula*.

Born 1948, Tehran, Iran. Arya-Mehr University, Tehran, Iran, BSc 1971; Stanford University, MSc 1976; University of California, PhD 1982.

Arya-Mehr University, assistant professor 1971-74; University of California at Berkeley, teaching assistant 1977-82; University of Brasilia, assistant professor 1982-84, associate professor 1985- ; Tata Institute of Fundamental Research, visiting researcher 1984.

Tarlok Nath Shorey, *Theory of numbers*.

Born 1945, Patli, Punjab State, India. Punjab University, MA 1967; Bombay University, PhD 1975.

Tata Institute of Fundamental Research, professor 1968- ; Institute for Advanced Study, spring 1976.

Steven I. Sperber, *Arithmetic algebraic geometry*.

Born 1945, Brooklyn, New York. Brooklyn College, BA 1966; University of Pennsylvania, PhD 1975.

University of Illinois, visiting lecturer 1975-77; University of Minnesota, assistant professor 1977-79, associate professor 1979-83, professor 1983- ; Institute for Advanced Study, member 1978-79; Princeton University, visiting associate professor 1982-83.

Gabriella Tarantello, *Nonlinear P.D.E.*

Born 1958, Pratola Peligna (L'Aquila), Italy. University of L'Aquila, Laurea 1982; Courant Institute, New York University, MS 1984, PhD 1986.

Mina Teicher, *Algebraic geometry*.

Born 1950, Tel Aviv, Israel. Tel Aviv University, BSc 1974, MSc 1976, PhD 1981.

Institute for Advanced Study, member 1981-

82; Bar Ilan University, lecturer 1982-84, senior lecturer 1984-86.

Selim Tuncel, *Ergodic theory.*

Born 1957, Istanbul, Turkey. University of Sussex, BSc 1978; University of Warwick, MSc 1979, PhD 1982.

University of Washington, acting assistant professor 1982-83, assistant professor 1986- ; Mathematical Sciences Research Institute, Berkeley, research fellow 1983-84; University of Warwick, research fellow 1984-86.

Richard M. Weiss, *Finite groups; groups acting on graphs.*

Born 1946, Philadelphia, Pennsylvania. Princeton University, AB 1967; Harvard University, MA 1968; Technical University of Berlin, DrRerNat 1973.

Technical University of Berlin, assistant 1971-74; Free University of Berlin, assistant professor 1974-80; Tufts University, assistant to associate professor 1980-83, professor 1983- .

Mariusz Wodzicki, *Global analysis.*

Born 1956, Bytom, Poland. Moscow State University, MSc 1980; Steklov Mathematical Institute, USSR Academy of Science, Moscow, PhD 1984, habilitation 1985.

Mathematical Institute, University of Oxford, research assistant 1985-86; Mathematical Institute, Polish Academy of Sciences, assistant professor 1985- .

Gang Xiao, *Algebraic surfaces of general type.*

Born 1951, Wuxi, China. Université de Paris XI, Dr ès Science 1984.

East China Normal University, Shanghai, lecturer 1984-85, professor 1986- .

Yangbo Ye, *Modular forms and group representations.*

Born 1957, Beijing, China. Tsing Hua University, BS 1981; Columbia University, MA 1982, MPhil 1986, PhD 1986.

Tsing Hua University, teacher 1981- ; Columbia University, preceptor 1985-86.

David N. Yetter, *Applications of category theory in topology and geometry.*

Born 1957, Susquehanna, Pennsylvania. Dickinson College, BS 1979; University of Pennsylvania, PhD 1984.

Clark University, lecturer 1984-86.

Visitors

Vernor Arguedas, *The Noetherian property in Silva and Fredet algebras and related topics.*

Born 1946, San Jose, Costa Rica. University of Costa Rica, BS 1968, PhD 1973.

University of Costa Rica, instructor 1972-74, associate professor 1974-85, professor 1986- ; Universidad Autónoma de Madrid, visiting professor 1984.

Louis Crane, *String theory, supermanifolds, non-commutative geometry.*

Born 1949, Chicago, Illinois. University of Chicago, BA 1968, MS 1970, PhD 1984.

Institute for Advanced Study, member 1985-86.

Werner Lütkebohmert, *Arithmetic algebraic geometry.*

Born 1948, Reken, West Germany. University of Münster, Dr 1972, PhD 1982.

University of Münster, dozent 1979-81, professor 1982- .

Earl J. Taft, *Structure of Hopf algebras.*

Born 1931, New York, New York. Amherst College, BA 1952; Yale University, MA 1953, PhD 1956.

Columbia University, instructor 1956-59; Rutgers University, assistant professor 1959-62, associate professor 1962-66, professor 1966- ; Institute for Advanced Study, member 1969, 1973, 1978, 1982.

Research Associate

K. G. Ramanathan, *Algebraic numbers, modular forms and Ramanujan's work.*

Born 1920, Hyderabad (A.P.), India. Madras University, MA 1942, MSc 1945; Princeton University, PhD 1951.

Institute for Advanced Study, member 1948-51, 1961-62, 1981-82; Tata Institute of Fundamental Research, senior professor 1970-85.

Research Assistant

Paolo Francia, *Algebraic geometry.*

Born 1951, Turin, Italy. Università di Genova, PhD 1975.

Università di Genova, professore incaricato 1978-82, professore associato 1983- ; Institute for Advanced Study, assistant to Professor Enrico Bombieri 1986-87.

The School of Natural Sciences

Faculty

Stephen L. Adler

(New Jersey Albert Einstein Professor)

John N. Bahcall

Roger Dashen

Freeman J. Dyson

Piet Hut

Permanent Member

Julian H. Bigelow

Members with Long-term Appointments

Jeremy Goodman

Otto E. Neugebauer

Tsvi Piran

Donald Schneider

Nathan Seiberg

David Spergel

Andrew E. Strominger

Tim de Zeeuw

The School of Natural Sciences

Over time, the School of Natural Sciences has come to concentrate on two fundamental areas: the physics of the very small (meaning elementary particle physics, high energy physics and field theory) and the physics of the very large (astrophysics and general relativity).

Within the category embraced by the physics of the very small is a family of fascinating problems and processes. The problem of resolving the increasingly finer problems of the structure of matter has called for smaller and smaller probing fingers or wavelengths. In turn, this has demanded larger and larger probing energies so that high energy physics, the physics of the big machines, has become synonymous with the physics of elementary particles. From a theoretical point of view this requires the simultaneous reconciliation of quantum mechanics with Einstein's special relativity, that is, of defining a reality in which the transformation of matter into energy holds, according to the famous formula $E = mc^2$, even though according to quantum mechanics there is an uncertainty in determining the energy of a system because an arbitrarily large number of particles is involved, which leads to systems with infinite degrees of freedom. Quantum electrodynamics, which is the system describing the interaction between electrons and photons (or in field language, the interaction of the electron with the electromagnetic field), was one response to this situation. Unfortunately, it did not prove adequate to the task of dealing with the four basic types of particle interactions: the electromagnetic, the strong forces which hold the nucleus together, the weak forces responsible for β -decay in radioactivity, and gravitation. Quantum electrodynamics has now been sub-

sumed into a more general framework, the electroweak theory, which unifies two of these forces. A separate generalization of electrodynamics, called quantum chromodynamics, is by now believed to be the correct theory of the strong force. The latter involves what is perhaps the most complex (but subtle) set of equations ever contemplated by scientists. Considerable work at the Institute is directed toward extracting the consequences of this theory. It is hoped that someday quantum chromodynamics can be combined with the electroweak theory to produce a so-called grand unified theory and that someday gravity can also be incorporated. A number of Institute members work in this area. The history and discussion of modern particle theory at the Institute are thus attempts to find ways of developing a satisfactory theoretical understanding of particles and their interactions.

In dealing with the physics of the very large, which is the second major area of interest within the School of Natural Sciences, the astronomer faces problems whose conditions are separate and distinct from the general practice of science. Unlike the physicist who deals with the very small, the astronomer has no access to controlled laboratory experiments. His knowledge is derived from distant objects, which up to the Second World War were exclusively optical in character. The new technologies which were spawned during the war bloomed rapidly in the years that followed, broadening the spectrum of observable phenomena to include the radio spectrum, the infrared, the ultraviolet, X-ray and gamma-ray astronomy, and even the possibility of neutrino and gravitational radiation.

Changing observational methods have also led to the discovery or prediction of new as-

tronomical objects such as neutron stars, black holes, pulsars (later identified as neutron stars), quasi-stellar objects such as quasars as well as the continuing study of old familiars such as novae, supernovae and white dwarfs. Of equal interest has been the study of the interstellar medium, important because of its influence on the transmission of radiation signals, and the cosmic black body radiation which once filled the universe in an earlier, hotter stage of its expansion. For astrophysicists, general relativity theory thus assumes great importance as they come to grips with the gravitational effects of very large masses. Small well-known deviations from Newtonian predictions within the solar system have been delineated by general relativity theory, but its greatest importance lies in the physics of neutron stars, black holes and theories of cosmic evolution. These revolutionary developments in astronomy have rekindled the interest in general relativity, so that Einstein's work remains at the edge of contemporary science as a vigorous research frontier.

Under these rather sweeping rubrics, the work of the School of Natural Sciences concentrates on particular areas: neutrino astronomy, galactic evolution, star counts, stellar dynamics, supernovae, compact X-ray sources, neutron stars and black holes. Additionally, quasars as the most distant objects, and the recently discovered rings of Uranus as some of the nearest, have occupied the research attention of the astrophysics group. The group also specializes in predicting what the Space Telescope will see at the very faint levels of light and in the new parts of the spectrum that will be accessible from this first permanent international observatory in space.

Academic Activities, 1986-87

A. Particle Physics

Much high energy physics activity continued to focus on the new superstring theories,

which are candidates for the sought-after "Theory of Everything," and would unify the strong, electo-weak and gravitational forces. Strominger and collaborators showed that the action for string field theory can be written as simply the cube of the string field, using a suitably defined product on the space of string fields. The action is unusual in that it contains no kinetic term, but it does describe string propagation when quantized around a suitable classical background solution, and can be used to rederive the usual string Feynman rules. Strominger also discovered that the string field product leads to associativity anomalies, which play a crucial role in including closed strings within the string field framework. Thorn worked on the problem of extracting Feynman rules from Witten's string field theory; he gave a pretty solution to the problem of gauge fixing and showed that one could then derive the Feynman rules. He also investigated various aspects of string scattering amplitudes. Pernici and Labastida applied string field methods to obtain the BRST quantization of massless higher spin field equations. Moore studied various aspects of the problem of proving the conjecture that the cosmological constant vanishes to all finite orders in string perturbation theory; beyond one loop order, subtle and difficult mathematics comes into play.

Work in non-string physics centered primarily on quantum cosmology and Monte Carlo physics. In the former, Hu completed a survey of recent developments in cosmological theories, describing the interaction in a cosmological context of classical general relativity, quantum gravity, and unified theories of particle physics. Hu also wrote a paper laying the foundations for the field-theoretical study of kinetic theory in curved spacetime. In Monte Carlo physics, Sexton studied the scaling of the deconfinement temperature for pure QCD on asymmetric lattices. He generated a large catalog of Monte Carlo sweeps which are currently the basis for an ambitious series of measurements, tackling such ques-

tions as B meson physics and the nucleon electromagnetic form factors. Also in Monte Carlo physics, Adler reinvestigated the stochastic overrelaxation algorithm he introduced several years ago. He showed that critical slowing down is improved by a factor of order the linear size of the lattice, and that one can construct an exactly gauge invariant overrelaxed algorithm for Wilson SU(n) lattice gauge theory.

B. Astrophysics

As in previous years, members and visitors collaborated in a variety of different fields with astrophysics, including stellar dynamics, cosmology, interstellar matter, active galactic nuclei, planetary physics, general relativity, gravitational lenses, and dark matter. Visitors this year included James Binney (University of Oxford), John Black (Steward Observatory), Alan Dressler (Mt. Wilson and Los Campanos Observatory), George Efstathiou (University of Cambridge), Mike Fall (Space Science Telescope Institute), Carlos Frenk (University of Durham, UK), Shogo Inagaki (University of Kyoto), Stephen Kent (Center for Astrophysics), David Merritt (Canadian Institute for Theoretical Astrophysics), William Press (Center for Astrophysics), Doug Richstone (University of Michigan), Daiichiro Sugimoto (University of Tokyo), Scott Tremaine (Canadian Institute for Theoretical Astrophysics), and Simon White (Steward Observatory).

Supernova 1987a was the brightest supernova since Kepler's supernova in 1604. Fortunately, the large Japanese water Cherenkov detector, Kamiokande II, was converted to a solar neutrino detector just in time to observe the neutrinos emitted from Supernova 1987a. Bahcall worked with several of the post doctoral members and visitors [Dar, Goodman, Loeb, Piran, Press, and Spergel, and Glashow of Harvard] in analyzing what the supernova neutrinos revealed about supernova and about the characteristics of neutrinos. Bahcall

and his collaborators concluded that the experimental results are consistent with the general ideas of how supernova explode and neutron stars are formed. In particular, the total energy and the temperature of the neutrinos are in good agreement with preconceptions based upon detailed computer models of supernova explosions. The observations also placed a valuable upper limit on the mass of the electron's neutrino, 16 eV.

Bahcall and Ulrich completed their systematic reinvestigation of the solar neutrino problem. They determined the expected event rate with the associated uncertainties for all of the projected solar neutrino experiments and showed what these experiments can teach us about nuclear reactions in the sun and about neutrino physics. Bahcall and Ulrich also made a comprehensive study of the pressure mode oscillations of the sun and demonstrated that observations of the well known "5 minute oscillations" are complimentary to solar neutrino experiments in what they can tell us about the sun.

Hut concentrated his research on the interface between computer science and astrophysics. He continued a long-term collaboration with Sussman, from the Artificial Intelligence Laboratory at M.I.T., aimed towards developing a "computational observatory." Specifically, Hut developed a new gravitational many-body code which provided a "work-bench" for testing a wide range of old and new methods in an integrated environment; Hut and Sussman investigated general individual timestep predictor-corrector algorithms for integrating the equations of motion of long-range forces; Barnes and Hut performed a detailed error analysis for a novel tree-type algorithm for performing N -body calculations, developed by them in the previous year; Hut and Makino performed a detailed study of the cost-effectiveness of existing N -body codes, developed a general theoretical foundation for such an analysis and suggested optimal values for tuning parameter which before had been de-

terminated only empirically; Aarseth, Hut and McMillan investigated modifications for existing Aarseth-codes necessary for treating higher numbers of particles than treated before.

Hut continued his collaboration with Heggie, working towards a comprehensive analytical understanding of three-body scattering cross sections and reaction rates. Hut and Teuben started a systematic study of the interaction and merging of small stellar systems. Together with McMillan, and Casertano, Hut studied the relaxation rates in small star systems; they confirmed the theoretical scaling with particle number, but found a larger time scale than expected. Hut and Inagaki continued their investigation of stochastic heating of globular cluster cores by binary reactions.

Another field of interdisciplinary research in which Hut was active was a collaboration between four paleontologists (including Erle Kauffman and Gerta Keller), two geologists (including Walter Alvarez) and two astronomers. They finished an ongoing collaboration, resulting in a comprehensive paper which addressed the possibility of comet showers causing mass extinctions, in a critical comparison of material from all three disciplines.

Barnes in collaboration with Efstathiou completed a study of the generation of angular momentum by tidal torques in cosmological N -body simulations, comparing detailed results for different fluctuation spectra. He continued his numerical study of the response of dark halos, which are thought to surround many if not all disk galaxies, to the formation of the luminous disks we see inside them. In collaboration with Hillis, Barnes published a description of some new N -body algorithms for fine-grain parallel computers. He has also since developed new algorithms which demonstrate that parallel computers can make good use of multiple-time-step methods.

Binney in collaboration with Tremaine finished work on their book *Galactic Dynamics*, which will be published in the fall of 1987. In

collaboration with Lacey, Binney obtained an approximate analytic solution of the Fokker-Planck equation for three-dimensional Spitzer-Schwarzschild diffusion, and a Monte-Carlo code was written to test the validity of this solution. In collaboration with Ostriker, Binney worked on models of the globular cluster population of M87.

Dar focused his attention on neutrino physics and neutrino astrophysics. Research included investigations into the solar neutrino problem, supernovae explosions, the neutrino magnetic moment and the fundamental properties of neutrinos in collaboration with Bahcall, Goodman, Piran and Nussinov.

Dejonghe worked on the following topics: (1) He introduced and investigated "augmented mass density" for models that non-trivially depend on three integrals of the motion in a Stäckel potential. The general form now includes mathematical operators. It is possible, however, to establish the multiplicity of the solutions for the distribution function, when a mass density in a Stäckel potential is given. (2) Construction of axisymmetric stellar systems, with a distribution function that depends on the two classical integrals of the motion. Work is in progress to construct a family of analytical models for which the distribution function is explicit (with J. Bishop). (3) Introduction of the Jaynes entropy into stellar dynamics. This entropy has a purely statistical basis, and as such differs from other entropies that were motivated by the Tolman H-function theorem for collisionless systems. The Jaynes entropy reduces to the Boltzmann entropy in a special case.

Dressler who has been working on the evolution of galaxies in rich clusters spent his visit preparing final data for 7 clusters and analyzing the results which showed that galaxy populations in clusters have evolved in cosmic time: 30% of the galaxies in clusters at $z = 0.5$ show signs of recent star formation as compared with less than 10% for galaxies in present-epoch clusters. He also worked with Schneider on some software data reduction matters.

Elson continued her research on the structure and stellar content of the rich young star clusters in the LMC, with the aim of understanding their formation and early evolution. This work was done in collaboration with Fall and Freeman. With Waltherbos, she studied the star clusters in the nearby spiral galaxy M31. This research addressed the global properties of the cluster system and compared it to that of our own galaxy.

Goodman, with Blandford, Romani and Narayan, examined the possibility that slow pulsar scintillation is dominated by caustics. In further ongoing research with Narayan, he studied the scatter-broadening of pulsar "images" at radio wavelengths, and the relations between this scattering and certain periodicities seen in dynamic scintillation spectra. In collaboration with Spergel and Piran, Goodman studied the classical dynamics of superconduction cosmic strings and suggested new mechanisms by which such strings might acquire large currents.

Hernquist investigated the formation of shells around spherical galaxies using the restricted 3-body method. He then extended his analysis to non-spherical potentials. In addition to his work he investigated the use of the hierarchical N -body method (Barnes and Hut) for cosmological applications. Simulations for simple initial conditions using the tree algorithm reproduced the behavior of the two-point correlation function expected on the basis of earlier work. Hernquist continued application of the hierarchical method to the problem of disk galaxies interacting with low-mass satellites. Initial results are in agreement with the non self-consistent simulations of Quinn and Goodman and demonstrate the fragile nature of the disks.

Inagaki visited to discuss with Goodman, Hut, Ostriker, and Sugimoto the Japan-US collaborative research program, sponsored by the NSF and the Japan Society for the Promotion of Science, on "The Dynamics of Globular Clusters and the Gravitational Many-Body Problem." Inagaki continued his collaboration with Hut on the long-term evolution of

globular cluster cores. He constructed a simple model and through a series of computer calculations found the oscillations of the core densities. Inagaki discussed with Aarseth, Hut, McMillan, and Sugimoto new ways of constructing N -body simulations.

Kent investigated the rotation curves of early-type bulge-dominated galaxies. He derived an algorithm for computing rotation curves in oblate spheroids with variable flattening and showed how to derive the density and flattening profiles from two-dimensional images of such galaxies.

Merritt investigated the stability of stellar dynamical models with Dejonghe. A generalization of Antonov's sufficient criterion for stability of isotropic systems to radial perturbations was derived and applied to a family of anisotropic models. Non-radial stability was tested using an N -body code.

Piran continued to work on Numerical Relativity: with Marck, he developed construction of a spectral methods code for three dimensional flow around a Kerr black hole and a new counter example, the Cosmic Censorship hypothesis, with Ori. In collaboration with Goldwirth, Piran produced a calculation of the gravitational collapse of a massless scalar field.

Press showed with Spergel that rational function extrapolation does no better a job at extrapolating the force on a particle in an N -body code than does simple polynomial extrapolation. After the supernova occurred he collaborated with Bahcall, Piran, and Spergel in demonstrating that a simple single-temperature model, at about 4MeV, is a good statistical fit to all measured neutrino energies and angles in both detectors.

Richstone worked on dynamical implications of the large M/L 's and short relaxation times for galactic nuclei. These results indicated that the central relaxation times in the nuclei of M31 and M32 are probably less than the age of the galaxies. He investigated with Spergel the possible shape and dynamics of the galactic dark matter halo. A third area of activity, in collaboration with Goodman, in-

volved the role of mergers in dense stellar systems.

Rood described the major extragalactic research contributions of Holmberg and how they permeate the present astronomical situation. He catalogued morphological and redshift data for all 2712 Abell clusters which were examined primarily to understand more fully the random and systematic errors inherent in the data. Distance-dependent systematic errors were identified, which contribute to observed dependencies of morphological type on distance. In collaboration with Struble, he described structural diversity among clusters of galaxies.

Sugimoto visited to discuss with Goodman, Hut, Inagaki and Ostriker, the Japan-US collaborative research program, sponsored by the NSF and the Japan Society for the Promotion of Science on "The Dynamics of Globular Clusters and the Gravitational Many-body Problem." Sugimoto concentrated on the evolution of self-gravitating systems in terms of thermodynamical concepts, which deviate in important respects from the usual thermodynamic framework in that negative heat capacity occurs in centrally condensed self-gravitating systems. In particular, he discussed idealized simulations which can highlight thermodynamic properties and instabilities. In addition, he studied the processes of tidal formation, hardening and merging of binaries, in order to suggest calculations to be performed with Eriguchi's three-dimensional code for obtaining stellar equilibrium configurations.

Schneider undertook a large scale survey for faint, high-redshift quasars with Schmidt and Gunn. While observing in Palomar he was able to confirm within two hours of initial detection that a proposed supernova candidate was indeed a star explosion. He completed two detailed studies on unusual examples of SN 1987a, both of which occurred in distant galaxies. Schneider participated in a large observational program to identify new gravitational lens systems. The most interest-

ing discovery was that two extended objects located $\approx 5''$ from a known gravitational lens (2016 + 112) are emission line "clouds" associated with the lensed $z = 3.273$ quasar; without the magnification of the lens (approximately a factor of ten), the images of the clouds would be too faint and too close to the quasar to have been detected.

Spergel explored the physics and astrophysics of superconducting cosmic strings. He developed, with Piran and Goodman, a formalism of these strings and used it to calculate radiation from these strings and study their interactions with the environment. He proposed, with Babul and Paczynski, that these strings could be visible as gamma-ray bursters and obtained an exact analytic exterior metric for these strings. He studied with Piran, Bahcall and Press the implications of the detection of neutrinos from supernova 1987a for astrophysics and particle physics. Spergel also explored new methods of detecting nonphotonic astrophysical matter. He developed a method for studying resonant orbits and explored whether the formation of a thick disk is an inevitable part of galaxy formation.

Teuben worked on the dynamics of interacting galaxies. He was involved with building up a set of data analysis programs for the new set of SUN graphics workstations. Head-on collisions between two spherical star systems was simulated using a recently written efficient algorithm to perform N -body calculations. The calculations were performed on the SUN workstations, and some more elaborate cases on the Cyber 205 at the John von Neumann Supercomputer Center.

Tremaine, with Duncan and Quinn, investigated the origin and evolution of the solar system comet cloud. Their calculations strongly suggested that there is an extensive comet cloud interior to the conventional Oort cloud with a population five times that of the Oort cloud. With Richstone, he investigated maximum entropy techniques for constructing models of stellar systems. They wrote a

code constructing the maximum entropy phase space distribution consistent with given photometric and kinematic observations of a spherical galaxy. With Araki and Wisdom, he investigated the Kinetic theory of granular flows seen in planetary rings. They introduced the use of Enskog theory in modeling shear flows of inelastic particles.

Tonry pursued two projects during his visit. First, he reduced spectroscopic observations of the faint galaxies crowding around giant cD galaxies found at the center of rich clusters. These velocity data will help distinguish the effects of dark matter from the effects of orbital anisotropy and cluster substructure. Second, he studied with Lauer binary elliptical galaxies. This phase of the project involved detailed modeling of the components of a binary system to look for the plumes and distortions signaling tidal interactions.

Van Dishoeck studied with Black the infrared spectrum of the H_2 molecule due to fluorescent excitation. The model calculations were found to agree well with H_2 infrared line observations in a variety of objects, ranging from reflection nebulae to starburst galaxies, and could be used to place constraints on the physical conditions in these regions. With Kurucz and Tarafdar, she pointed out that continuous absorption in the OH and CH molecules may be an important source of ultraviolet opacity in solar and stellar atmospheres.

Walterbos applied the model that describes the stellar content of the Milky Way galaxy, developed by Bahcall and Soneira, to other galaxies in preparation for observations with the Hubble Space Telescope scheduled for launch in late 1988 or 1989. The model was applied to the largest nearby spiral, the Andromeda galaxy, which is one of the prime targets for observations with the Space Telescope. In collaboration with Kennicutt, Walterbos completed an extensive study of the optical light distribution of the Andromeda galaxy. A detailed analysis of the extinction of

light in the dust lanes in the galaxy showed that the properties of the dust grains are very similar to those in the Milky Way.

White studied the nonlinear gravitational instability of the well-known similarity solution for an expanding spherical shell in an Einstein-de Sitter cosmology. The shell is found to break up into fragments with a well-defined mass, roughly one percent of the shell mass. However, the growth rate of the instability is rather slow. White and Frenk continued their long-term collaborative study of the formation of structure in a universe dominated by cold dark matter. They found that the clumps of material which form in such a universe have masses, internal structure, and abundance in good agreement with those inferred for the dark halos of galaxies and clusters of galaxies.

De Zeeuw continued work on the detailed internal structure of triaxial equilibrium models with Stäckel potentials. He derived the explicit distribution function for the oblate models with maximum streaming. Together with Schwarzschild and Park, the analogous prolate solutions were constructed. He and Dejonghe showed that the potential of our own galaxy can be accurately fitted with a Stäckel potential, thus providing a framework for an efficient and comprehensive discussion of the kinematical properties of the galaxy. Furthermore, de Zeeuw and Dejonghe extended and generalized their previously found method for the construction of anisotropic axisymmetric equilibrium modes, and also solved the stellar hydrodynamical equations directly. Finally, he edited the Proceedings of IAU Symposium No. 127, *Structure and Dynamics of Elliptical Galaxies*, held at the IAS, May 28-31, 1986.

C. Miscellaneous

Dyson was partly occupied with writing books, partly with pure mathematics. He finished and prepared for publication a book, *Infinite in All Directions*, based on his 1985 Gif-

ford Lectures in Aberdeen, Scotland. This is scheduled to appear in March 1988. It is a mixture of popular science, history and philosophy. His mathematical work was concerned with problems in number-theory and classical

analysis arising out of the work of the Indian mathematician Ramanujan. Dyson was one of the main speakers at the centennial conference celebrating Ramanujan's hundredth birthday in June 1987.

The School of Natural Sciences

Permanent Member, Members with Long-term Appointments, Members and Visitors, 1986-87.

In the section which follows, the information was obtained from material provided by the Members and Visitors.

Permanent Member

Julian H. Bigelow, *Applied mathematics; electronic computers; experimental physics.*

Born 1913, Nutley, New Jersey.

Massachusetts Institute of Technology, BS 1934, MS 1935.

Sperry Rand Corporation, research engineer 1936-39; IBM Corporation, research engineer 1939-41; Massachusetts Institute of Technology, research associate 1941-42, instructor 1942-43, neurosciences research program, visiting scientist 1969-70; Columbia University, OSRD, statistical research group, associate director 1943-46; Institute for Advanced Study, Electronic Computer Project, head of experimental group of 1946-51, School of Mathematics, permanent member 1951-70, School of Natural Sciences, permanent member 1970- ; University of California at Los Angeles, visiting professor 1966-67.

Members with Long-term Appointments

Jeremy Goodman, *Theoretical astrophysics.*

Born 1956, Washington, D.C. Harvard University, BA 1979, MA 1979; Princeton University, PhD 1983.

California Institute of Technology, Bantrell fellow 1983-85; Institute for Advanced Study, long-term member 1985- .

Otto Neugebauer, see page 25 for biographical entry.

Tsvi Piran, *General relativity, relativistic astrophysics and numerical physics.*

Born 1949, Tel Aviv, Israel. Tel Aviv

University, BS 1970, MS 1972; Hebrew University, PhD 1976.

Hebrew University, teaching assistant 1975-76, senior lecturer 1981-82, associate professor 1983- ; University of Oxford, research associate 1976-77; University of Texas, research associate 1977-79, assistant professor 1979; Institute for Advanced Study, member 1980-81, long-term member 1981- .

Donald P. Schneider, *Observational cosmology.*

Born 1955, Hastings, Nebraska. University of Nebraska, BS 1976; California Institute of Technology, PhD 1982.

California Institute of Technology, research fellow 1982-85; Institute for Advanced Study, long-term member 1985- .

Nathan Seiberg, *Field theory and particle physics.*

Born 1956, Tel Aviv, Israel. Tel Aviv University, BS 1977; Weizmann Institute of Science, PhD 1982.

Institute for Advanced Study, member 1982- ; Weizmann Institute of Science, professor 1984- .

David Spergel, *Stellar dynamics and cosmology.*

Born 1961, Rochester, New York. Princeton University, BA 1982; Harvard University, MA 1984, PhD 1985.

Harvard University, teaching assistant 1985-86, postdoctoral fellow spring 1986; Institute for Advanced Study, long-term member 1986- .

Andrew E. Strominger, *High energy physics and string theory.*

Born 1955, Cambridge, England. Harvard University, BA 1977; University of California at Berkeley, MA 1979; Massachusetts Institute of Technology, PhD 1981.

Massachusetts Institute of Technology, research assistant 1979-81; Institute for Advanced

Study, member 1981-84, long-term member 1984- ; University of California at Santa Barbara, assistant professor 1986- .

Tim de Zeeuw, *Astrophysics: dynamics of galaxies*.

Born 1956, Sleen, The Netherlands. Leiden University, BSc Mathematics 1976, BSc Astronomy 1977, MSc 1980, PhD 1984.

Leiden University, teaching assistant 1977-80, research assistant 1980-84; Harvard College Observatory, research associate, 1984- ; Institute for Advanced Study, long-term member 1984- .

Members

Joshua Barnes, *Dynamics and evolution of starclusters, galaxies, and galaxy clusters*.

Born 1956, London, England. Harvard University, BA 1979; University of California at Berkeley, PhD 1984.

Institute for Advanced Study, member 1984- .

Clifford Burgess, *Superstrings à la Polyakov*.

Born 1957, Portage la Prairie, Canada. University of Waterloo, Ontario, BSc 1980; University of Texas at Austin, PhD 1985.

University of Texas, research assistant 1984-85; McGill University, assistant professor 1987- ; Institute for Advanced Study, member 1985-86.

Gerald Cecil, *Astrophysics*.

Born 1954, Oxford, United Kingdom. McGill University, BS 1977, MA 1979; University of Hawaii, PhD 1986.

Herwig Dejonghe, *Stellar dynamics*.

Born 1957, Ronse, Belgium. University of Gent, BS 1977, MSc 1979, PhD 1984.

University of Gent, teaching assistant 1979-80, research assistant 1980-85; Institute for Advanced Study, member 1985- .

Dongsheng Du, *CP-violation of heavy flavors in standard model*.

Born 1939, Hebei Province, China. Peking University, BS 1964; Institute of Atomic Energy, Academia Sinica, PhD 1968.

Institute of High Energy Physics, Academia Sinica, research assistant 1968-77, research associate 1977-79, associate professor 1979-86, professor 1986- ; Centre Européen de la

Recherche Nucléaire, visiting scholar 1978-79; Institute for Advanced Study, member 1985-86.

Rebecca A. W. Elson, *Structure and evolution of star clusters*.

Born 1960, Montreal, Canada. Smith College, AB 1980, University of British Columbia, MSc 1982; University of Cambridge, PhD 1986.

Daniel Z. Freedman, *String and superstring theory*.

Born 1939, Hartford, Connecticut. Wesleyan University, BA 1960; University of Wisconsin, MA 1962, PhD 1964.

Institute for Advanced Study, member 1967-68, 1973-74; State University of New York at Stony Brook, professor 1968-80; Massachusetts Institute of Technology, professor 1980- .

Carlos A. P. Galvão, *Particle physics*.

Born 1941, Natal, RN, Brazil. Federal University, Natal, Brazil, BS 1966; Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brazil, MS 1974, PhD 1976.

Federal University, professor 1969-71; Centro Brasileiro de Pesquisas Físicas, assistant researcher 1976-82, associate researcher 1982- ; Institute for Advanced Study, member 1985-86.

Bei-Lok Hu, *General relativity, field theory and cosmology*.

Born 1947, Chungking, China. University of California at Berkeley, BA 1967; Princeton University, MA 1969, PhD 1972.

Institute for Advanced Study, member 1972-73; Stanford University, research associate 1973-74; University of California at Berkeley, research mathematician 1975-76; University of California at Santa Barbara, research physicist 1977-79; Harvard University, honorary research fellow 1979-80; University of Maryland, assistant professor 1980-84, associate professor 1984- .

José M. F. Labastida, *High energy physics*.

Born 1958, Madrid, Spain. Universidad Autónoma de Madrid, Licenciatura 1980; State University of New York at Stony Brook, MA 1984, PhD 1985.

Institute for Advanced Study, member 1985- .

Harry C. S. Lam, *Particle physics*.

Born 1936, Hong Kong. McGill University,

BSc 1958; Massachusetts Institute of Technology, PhD 1963.

McGill University, assistant professor 1965-68, associate professor 1968-75, professor 1975-

Gregory Moore, *Applications of the theory of modular forms and algebraic geometry to the path integral formulation of string theory.*

Born 1961, Washington, D.C. Princeton University, BA 1982; Harvard University, PhD 1985.

Timothy R. Morris, *Superstring field theory.*

Born 1960, Birmingham, England. University of Cambridge, BA 1982, MA 1986; University of Southampton, PhD 1985.

Institute for Advanced Study, member 1985-86.

Mark Mueller, *Particle physics, string theory.*

Born 1956, Milwaukee, Wisconsin. Massachusetts Institute of Technology, BS 1978; Stanford University, PhD 1984.

Institute for Advanced Study, member 1984-86.

Mario Pernici, *String field theory; Kaluza Klein supergravity.*

Born 1958, Trieste, Italy. Università degli Studi, Milan, Laurea 1981; State University of New York at Stony Brook, PhD 1986.

Zongan Qiu, *Field theory, particle physics and statistical mechanics.*

Born 1960, Zhengzhou, Henan, China. University of Zhengzhou, BS 1981; University of Chicago, PhD 1985.

University of Chicago, teaching assistant 1981-82; research assistant 1982-85; Institute for Advanced Study, member 1985-

A. Norman Redlich, *Field theory and particle physics.*

Born 1956, Colorado Springs, Colorado. McGill University, BS 1980; Massachusetts Institute of Technology, PhD 1984.

Massachusetts Institute of Technology, research associate 1984-85; Brandeis University, research associate 1985-86.

Gert Roepstorff, *General dynamical systems, chaotic behavior and relaxation.*

Born 1937, Hamburg, Germany. University of Hamburg, Dr 1965.

University of Hamburg professor 1970-74; Institut für Rheinisch-Westfälischen Technischen Hochschule, Aachen, professor 1974- ; Institute for Advanced Study, member 1980-81.

James C. Sexton, *Scaling studies of lattice QCD.*

Born 1956, Dublin, Ireland. Trinity College, Dublin, BA 1978; Columbia University, MPhil 1981, PhD 1985.

Fermi National Accelerator Laboratory, research associate 1984-86.

Joel A. Shapiro, *Particle theory (strings).*

Born 1942, New York, New York. Brown University, BSc; Cornell University, PhD 1967.

University of California at Berkeley, research associate 1967-69; University of Maryland, research associate 1969-71; Rutgers University, assistant professor 1971-76, associate professor 1976- ; Massachusetts Institute of Technology, visiting scientist 1977-78.

Rafael Sorkin, *Quantum Gravity.*

Born 1945, Orlando, Florida. Harvard University, BS 1966; California Institute of Technology, PhD 1974.

University College, Cardiff, Research Assistant 1974-77, SRC fellow 1977-78; University of Chicago, research assistant 1978-80; Institute for Advanced Study, member 1981; University of Maryland, CTP fellow 1982-83; Syracuse University, professor 1983-

Mordechai Spiegelglas, *Field theory, string theory and particle physics.*

Born 1955, Tel Aviv, Israel. Tel Aviv University, BSc 1974, MSc 1979, PhD 1985.

Tel Aviv University, instructor 1977-85; Institute for Advanced Study, member 1985-86.

Kellogg Stelle, *Quantum gravity.*

Born 1948, Washington, D.C. Harvard University, BA 1970; Brandeis University, PhD 1977.

Brandeis University, teaching assistant 1972-77; King's College, London, temporary lecturer 1977-78; Imperial College, London, research associate 1978-80, research fellow 1982-83, lecturer 1983- ; Centre Européen de la Recherche Nucléaire, Geneva, scientific associate 1980-81.

54 School of Natural Sciences

Peter Teuben, *Astrophysics*.

Born 1958, Veendam, The Netherlands. University of Groningen, BSc 1979, MSc 1982, PhD 1986.

University of Groningen, teaching assistant 1979-81, research assistant 1982-86.

Charles Thorn, *Aspects of string theory*.

Born 1946, Washington, Indiana. Massachusetts Institute of Technology, BS 1968; University of California at Berkeley, MA 1969, PhD 1971.

Massachusetts Institute of Technology, assistant professor 1973-78, associate professor 1978-80; University of Florida, professor 1980-

René Walterbos, *Structure and evolution of nearby galaxies*.

Born 1957, Groenlo, The Netherlands. University of Leiden, BA 1979, MS 1982, PhD 1986.

University of Leiden, research assistant 1982-86.

Visitors

James Binney, *Stellar dynamics*.

Born 1950, London, England. University of Cambridge, MA 1974; University of Oxford, DPhil 1976.

Princeton University, assistant professor 1979-81; University of Oxford, lecturer 1981- ; Institute for Advanced Study, visitor 1984-

John H. Black, *Chemistry of interstellar and intergalactic clouds*.

Born 1949, Indianapolis, Indiana. Harvard College, BA 1971; Harvard University, MA 1973, PhD 1975.

University of Minnesota, assistant professor 1975-78; Harvard University, research associate and lecturer 1978-83; University of Arizona, associate professor 1983-

Stefano Casertano, *Galactic structure and dynamics*.

Born 1958, Naples, Italy. University of Pisa, Laurea 1979; Scuola Normale Superiore, Pisa, Perfezionamento 1983.

Institute for Advanced Study, member 1983-86; Groningen University, postdoctoral fellow 1986-

Arnon Dar, *Neutrino physics, astrophysics and cosmology*.

Born 1939, Karkur, Israel. Hebrew University, MSc 1961, PhD 1963.

Massachusetts Institute of Technology, research associate 1966-68, associate professor 1971-72; Technion-Israel Institute of Technology, associate professor 1968-71, professor 1972- ; University of Paris XI, visiting professor 1975-76; University of Pennsylvania, visiting professor 1982-83.

Ewine F. van Dishoeck, *Molecular astrophysics*.

Born 1955, Leiden, The Netherlands. University of Leiden, BSc (chemistry) 1976, BSc (mathematics) 1977, MS 1980, PhD 1984.

Harvard University, research assistant 1980, junior fellow 1984-87; Leiden University, research assistant 1980-84; Institute for Advanced Study, visitor 1984-87.

Alan Dressler, *Evolution of galaxies in rich clusters*.

Born 1948, Cincinnati, Ohio. University of California at Berkeley, BA 1970; University of California at Santa Cruz, PhD 1976.

Hale Observatories, Carnegie fellow 1976-80; Mt. Wilson and Las Campanas Observatories, staff member 1980-

Shogo Inagaki, *Dynamical evolution of globular clusters*.

Born 1948, Wakayama, Japan. Osaka University, BEng 1970; Kyoto University, MSc 1972, DSc 1977.

Kyoto University, instructor 1978-

Stephen Kent, *Galaxy dynamics and dark matter*.

Born 1952, West Orange, New Jersey. Massachusetts Institute of Technology, BS 1974; California Institute of Technology, PhD 1980.

Center for Astrophysics, Cambridge, Massachusetts, research associate 1980-81; Massachusetts Institute of Technology, research associate 1981-83; Harvard University, assistant professor 1983-

David Merritt, *Stability of elliptical galaxies*.

Born 1955, Los Angeles, California. Princeton University, PhD 1982.

University of California at Berkeley, postdoctoral research associate 1983-85; Canadian

Institute for Theoretical Astrophysics, research associate 1985- .

Samuel Nussinov, *QCD inequalities; particle physics and neutrinos.*

Born 1939, Jerusalem, Israel. Hebrew University, MSc 1961; University of Washington, PhD 1966.

Tel Aviv University, assistant professor 1963-71, associate professor 1971-77, professor 1977- ; Institute for Advanced Study, member 1975-77.

Bohdan Paczynski, *X-ray and gamma-ray bursts, gravitational lensing.*

Born 1940, Wilno Poland. Warsaw University, Poland, MS 1962, PhD 1964, Dozent 1967.

Warsaw University, research assistant 1961-62; Polish Academy of Science, research assistant to professor 1962-85; Institute for Advanced Study, visitor 1974- ; Princeton University, professor 1981- .

William H. Press, *Significance of apparent correlation between sunspots and solar neutrinos.*

Born 1948, New York, New York. Harvard College, BA 1969; California Institute of Technology, MS 1971, PhD 1972.

California Institute of Technology, assistant professor 1973-74; Princeton University, assistant professor 1974-76; Harvard University, professor 1976- .

Herbert J. Rood, *Structure of systems of galaxies.*

Born 1937, New Brunswick, New Jersey. Massachusetts Institute of Technology, BS 1959; University of Michigan, MS 1961, PhD 1965.

Wesleyan University, assistant professor 1965-72; Institute for Advanced Study, member 1972-73, visitor 1980- ; Michigan State University, associate professor 1973-76, associate adjunct professor 1980-82.

Scott Tremaine, *Galactic structure. stellar dynamics, solar system dynamics.*

Born 1950, Toronto, Canada. McMaster University, BSc 1971; Princeton University, MA 1973, PhD 1975.

California Institute of Technology, research fellow 1975-77; Institute of Astronomy, Cambridge, research associate 1977-78; Institute for Advanced Study, long-term member 1978-81; Massachusetts Institute of Technology, associate professor 1981-85; University of Toronto, professor 1985- .

Simon White, *Dynamics of galaxies, cosmology.*

Born 1951, Ashford, England. University of Cambridge, BA 1972, PhD 1976.

Churchill College, University of Cambridge, research fellow 1977-80; University of California at Berkeley, senior fellow 1980-84; Institute for Advanced Study, member 1981-82; University of Arizona, associate professor 1984-87, professor 1987- .

The School of Social Science

Faculty

Clifford Geertz

(Harold F. Linder Professor of Social Science)

Joan Wallach Scott

Michael Walzer

(UPS Foundation Professor)

Professor Emeritus

Albert O. Hirschman

The School of Social Science

In terms of its formal existence, the School of Social Science is the youngest of the Institute's four divisions. Although its roots go back to 1935 to what was then the School of Economics and Politics at the Institute, its creation as an enduring program came with a permanent academic appointment in 1970-71 and its formulation as a School in 1973. This process of moving from program to School, from experimental venture to institutionalization, is an essential characteristic of growth at the Institute.

The School of Social Science pursues an operational pattern parallel to that of other Institute Schools, combining a rather small number of permanent Faculty with a larger group of visiting annual members drawn from an ever wider pool of candidates.

The School of Social Science does not normally attempt to take on large-scale statistical or quantitative studies. Such work has been done at the Institute, but it is not central to its purpose. Furthermore, the School does not select certain social problems and, seeking their solutions, come up with prescriptions for this or that social malaise. This does not mean that such uses may not be made of work accomplished at the Institute. Indeed, an interest in policy questions has characterized the work of some members of the School and will surely do so in the future. However, the main focus of the School is interpretive in nature, investigating the meanings of social behavior and delineating the determinants of social change. As such it is resolutely multidisciplinary, cross-cultural and internationally comparative, drawing its data from historical as well as contemporary problems, exploiting ethnographic as well as quantitative sources.

In a sense, the empirical findings of the social sciences are employed to criticize and to refine both methodology and theory in the contemporary human sciences. Thus the School, while giving credit to the long dominant quantitative approach in American social science, nevertheless shares in the growing numbers of reservations expressed about it, that is, that its methods are narrow and overspecialized, that its procedures lead to a warping present-mindedness and that both combine to create an unjustified scientism, incapable of producing a legitimate, durable set of solutions to the pressing social and economic problems of our time.

This intellectual posture demonstrates one of the roles of the Institute for Advanced Study as part of the seamless fabric of higher education and research—to use, when warranted, its private security and intellectual freedom for an independent position in, and critical assessment of, the academic accomplishment embraced by its areas of expertise.

Academic Activities, 1986-87

During 1986-87 the School of Social Science had fifteen Visiting Members and two Visitors.

The Thursday Luncheon Seminars were well attended, not only by the members of the School but by colleagues from Historical Studies and members of the Princeton academic community. The list of topics can be seen in the Record of Events. Four of the seminars were given by Visiting Members of the School of Historical Studies and one by a guest from Princeton University; the other eighteen were given by Visiting Members and Visitors from

the School of Social Science. The range of issues discussed was wide, as usual.

The core group among the Visiting Members consisted of six scholars who studied interpretation of hermeneutic and epistemological problems in the social sciences. This year's project was the third part of a three-year program on "interpretive social science." The first year focused on life histories as a tool of sociological research and the second year, on inequality and hierarchy.

A yearlong seminar was held in which scholars from varying disciplines participated—political science (William Connolly, Carole Pateman, James Scott, Michael Walzer), economics (Albert Hirschman, Stephen Jones), history and philosophy of science (Ian Hacking, Andrew Pickering), sociology (Wolfgang Fach, Giovanna Procacci), literary criticism and literary history (Joseph Frank, Barbara Herrnstein Smith, Theodore Weiss), anthropology (Valentine Daniel, Clifford Geertz, Emiko Ohnuki-Tierney, Barbara Tedlock, Dennis Tedlock), history (Joan Scott), and law (Stanford Levinson).

A series of some twenty discussions focusing on "interpretive," "hermeneutic," or "semiotic" approaches were held. Among the substantive subjects covered were: recent decisions in the courts concerning women's rights, developments in the understanding of unemployment in economics, the role of biography in literary interpretation, the relation between literary theory and cultural theory, the implications of the work of Michel Foucault for modern political theory, translation issues in anthropology and linguistics, modes of political expression among subordinate groups in society, the role of experiment in concept formation in the natural sciences, the nature of social criticism, and literary styles in anthropological writing. Though the subjects were diverse, the continuing theme throughout the entire seminar was the implications of recent developments in interpretive theory in history, philosophy, literary criticism and law for the social sciences.

Planning Activities

The permanent members of the Faculty (Professors Geertz, Scott and Walzer with the assistance of Professor Hirschman) met in December and January to make membership application decisions for the 1987-88 year.

In a separate competition for a German fellow of junior university rank, sponsored by the Volkswagen Foundation, Dr. Wolf Lepenies, Rector of the Wissenschaftskolleg zu Berlin, served as an advisory consultant. This was the third year of that competition.

In all, over three hundred applications were read. Outside referees were asked to evaluate and rank the most promising applicants.

In 1987-88 the School will begin another three-year program dealing with Group Identities. For the first year, 1987-88, the focus will be gender and the different meanings and uses of ideas of male and female. Several scholars in the fields of social history, sociology, anthropology, economics and history of science will address this issue. In the following year the focus will be the revival of ethnic and religious commitment and the political forms that revival takes. In the third year, the focus will be the emerging national identity of post-colonial Third World states.

Funding

During the 1986-87 academic year, two members of the core program in interpretive social science were supported by a grant from The Henry Luce Foundation. Another five members were supported, wholly or in part, by the National Endowment for the Humanities. The Exxon Research and Engineering Company, and Stiftung Volkswagenwerk supported one fellow each. General support was provided by grants from the UPS Foundation and the Charles E. Culpeper Foundation.

Faculty

Professor Clifford Geertz spent the summer in the Humanities Research Centre, Australian

National University in Canberra, Australia, where he participated in two conferences on the relations between Asia and the West, the proceedings of which are now in the process of being published. He completed his book, *Works and Lives: The Anthropologist as Author*, which will appear from Stanford University Press shortly. He received the Distinguished Scholar Award from the Association for Asian Studies, and honorary degrees from the New School for Social Research and Yale University.

Professor Joan Scott finished a book, *Gender and the Politics of History*, which will be published by Columbia University Press in the fall of 1988. A new edition of her book, *Women, Work and Family* (coauthored with Louise Tilly) was published by Methuen in 1987. Professor Scott was an editor and contributor to the Fall 1987 issue of *Daedalus*; "Learning About Women: Gender, Politics, and Power." Her essay, "Gender: A Useful Category of Historical Analysis," was published in the *American Historical Review* in December, 1986. She lectured at the Wesleyan Humanities Center, Notre Dame, Berkeley, Harvard and the University of Iowa, where she was Ida Beam Distinguished Lecturer. In addition, she gave papers at conferences at the Stanford Humanities Center and at l'Université de Paris VII. She served as a member of the Ford Foundation Committee on the Undergraduate Initiative and gave a seminar at the New School for Social Research.

Professor Michael Walzer was on sabbatical leave during the spring semester of 1986-87, visiting the Institute for Advanced Studies at Hebrew University in Jerusalem. During the fall semester, he lectured at Trinity University (San Antonio), The New School for Social Research, Goucher College, University of Maryland/Baltimore, West Point, and Columbia University. He served for a third and last year on the Fulbright selection committee for Israel. In Israel in the spring, he lectured at Hebrew University and at Haifa University, and spoke to the President's Seminar in Tel Aviv. In May he visited the University of Bologna to

give a paper at a conference on the bicentenary of the U.S. Constitution. His book *Interpretation and Social Criticism* was published by Harvard University Press in March, and French and Italian translations of his *Exodus and Revolution* appeared in the course of the year. He continued to work on a second book on social criticism, tentatively titled *The Company of Critics*.

Professor Emeritus Albert O. Hirschman published *Rival View of Market Society and Other Recent Essays* (Elisabeth Sifton Books/Viking Press, 1986) as well as an article, "Out of Phase Again," (*New York Review of Books*, December 18, 1986). The latter was an excerpt from a paper entitled "The Political Economy of Latin American Development: Seven Exercises in Retrospection," which he presented at the meetings of the Latin American Studies Association in October 1986 in Boston. On that occasion he was awarded the Association's Kalman Silvert Prize. His *Essays in Trespassing* (1981) and *Shifting Involvements* (1982) were both published in Spanish translations. A Hungarian translation of *Exit, Voice and Loyalty* (1971) was issued in 1984 by the Hungarian Academy of Sciences. He attended a seminar in Paris at the Development Center of the Organization for Economic Cooperation and Development (OECD) on Alternative Development Strategies and continued as an active member of the Executive Panel of the Ford Foundation Project on Social Welfare Policy and of the Committee on States and the Social Structures of the Social Science Research Council. He lectured at the New School and at the University of California, San Diego. He is presently working on some common structures of conservative-reactionary thought in the nineteenth and twentieth centuries. A volume entitled *Development, Democracy, and the Art of Trespassing: Essays in Honor of Albert O. Hirschman*, edited by A. Foxley, M. McPherson and G. O'Donnell, was published in 1986 by the University of Notre Dame Press. In April 1987, Professor Hirschman was elected to membership of the National Academy of Sciences.

The School of Social Science

Members, Visitors and Assistants, 1986-87

In the section which follows, the information was obtained from material provided by the members, visitors and assistants.

Members

William E. Connolly, *Political theory and modernity: a study of definitions of "the modern" and "pre-modern" in representative theorists.*

Born 1938, Flint, Michigan. University of Michigan at Flint, BA 1960; University of Michigan at Ann Arbor, PhD 1965.

Ohio University, assistant professor 1965-68; University of Massachusetts, assistant professor, associate professor, professor 1968-85; The Johns Hopkins University, professor 1986- .

E. Valentine Daniel, *The anthropology of collective violence: the case of Sri Lanka.*

Born 1946, Lindula, Sri Lanka. Amherst College, BA 1971; University of Chicago, MA 1973, PhD 1979.

University of Washington, assistant professor 1978-83, associate professor 1983- .

Wolfgang Fach, *The pursuit of happiness: on the revival of pre-welfare ideology.*

Born 1944, Neuenbürg, Germany. Free University of Berlin, Diplom 1970; University of Konstanz, Dr 1971, Habil 1975.

University of Konstanz, dozent 1975-81, professor 1981- .

Joseph Frank, *Dostoevsky and his times.*

Born 1918, New York, New York. University of Chicago, PhD 1960.

Princeton University, lecturer 1955-56, professor 1966-85; Stanford University, professor 1985- ; University of Minnesota, assistant professor 1958-61; Rutgers University, associate professor to professor 1961-66; Harvard University, visiting professor spring 1965; Institute for Advanced Study, director's visitor 1985-86.

Paul E. Gootenberg, *Trade policies and the state in nineteenth-century Latin America.*

Born 1954, Washington, D.C. University of Chicago, BA 1978, PHD 1985; St. Antony's College, University of Oxford, MPhil 1981.

University of Illinois at Chicago, visiting assistant professor 1985-86; Brandeis University, assistant professor 1987- .

Ian Hacking, *The creation of categories in the natural and social sciences.*

Born 1936, Vancouver, Canada. University of British Columbia, BA 1956; University of Cambridge, BA 1958, MA/PhD 1962.

University of British Columbia, assistant to associate professor 1965-69; University of Cambridge, lecturer 1969-74; Stanford University, professor 1975-81; University of Toronto, professor 1983- .

Stephen R. G. Jones, *The nature of unemployment.*

Born 1957, Wallasey, England. University of Cambridge, BA 1979; University of California at Berkeley, PhD 1983.

University of California at Berkeley, visiting professor 1984-85; University of British Columbia, assistant professor 1983- .

Sanford V. Levinson, *Constitutional faith: the role of the Constitution in American civil religion.*

Born 1941, Hendersonville, North Carolina. Duke University, BA 1962; Harvard University, PhD 1969; Stanford University Law School, JD 1973.

Ohio State University, assistant professor 1968-70; Princeton University, assistant professor 1975-79; University of Texas Law School, professor 1980- ; Hebrew University, visiting professor 1984.

Emiko Ohnuki-Tierny, *Symbolic transformations in Japanese culture.*

Born 1934, Kobe, Japan. Tsuda College, Tokyo, Japan, BA 1957; University of Wisconsin at Madison, MS 1964, PhD 1968.

Beloit College, assistant professor 1974-76; University of Wisconsin at Madison, assistant professor 1977-80; associate professor 1981-83, professor 1983-

Carole Pateman, *The sexual contract*.

Born 1940, Sussex, England. University of Oxford, BA 1967, MA 1971, DPhil 1971.

Somerville College, University of Oxford, research fellow 1970-72; University of Sydney, lecturer to senior lecturer 1972-79, reader 1980-; Stanford University, visiting professor 1980; Princeton University, visiting professor 1985-86.

Andrew R. Pickering, *Pragmatism and the social construction of scientific knowledge*.

Born 1948, Coventry, England. University of Oxford, BA 1970; University of London, PhD 1973; University of Edinburgh, PhD 1984.

Niels Bohr Institute, Copenhagen University, research fellow 1973-74; Science Research Council, Daresbury Laboratory, research associate 1974-75; Edinburgh University, research fellow 1976-84; Massachusetts Institute of Technology, fellow 1984-85; University of Illinois at Urbana-Champaign, associate professor 1985-

Giovanna Procacci, *Governing poverty: the social question in France between the two revolutions, 1789-1848*.

Born 1947, Rome, Italy. University of Naples, Laurea 1969; University of Paris VIII, DEA 1977, PhD 1983.

University of Naples, researcher 1972-78; University of Paris IV, chargée de cours 1976-79; Collège de France, researcher 1978-80; University of Milan, researcher 1978-81, tenured researcher 1981-; Center for Studies of Social Change, New York, affiliated researcher spring 1986; New School for Social Research, visiting lecturer spring 1986.

James C. Scott, *The cultural origins of resistance to domination*.

Born 1936, Mt. Holly, New Jersey. Williams College, BA 1958; Yale University, MA 1964, PhD 1967.

Wesleyan University, instructor 1967; University of Wisconsin at Madison, assistant professor to professor 1967-76; Yale University, professor 1976-

Barbara Herrnstein Smith, *Contingencies of value: post-axiological perspectives in critical theory*.

Born 1932, New York, New York. Brandeis University, BA 1954, MA 1955, PhD 1965.

Bennington College, faculty 1961-73; University of Pennsylvania, professor 1973-, university professor 1981-

Dennis Tedlock, *Interpretive anthropology*.

Born 1939, St. Joseph, Missouri. University of New Mexico, BA 1961; Tulane University, PhD 1968.

University of California at Berkeley, assistant professor 1967-69; Brooklyn College, City University of New York, assistant professor 1970-71; Wesleyan University, visiting assistant professor 1971-72; Yale University, assistant professor 1972-73; Boston University, associate professor 1973-82, professor 1982-

Visitors

Bernard Lewis, *Islamic history*.

Born 1916, London, England. University of London, BA 1936; University of Paris, Diplôme des Etudes Sémitiques 1937; University of London, PhD 1939; honorary doctorate Hebrew University 1974, Tel Aviv University 1979.

University of London, School of Oriental and African Studies, assistant lecturer in Islamic history 1938, lecturer 1940, senior lecturer 1946, reader 1947, professor of the history of the Near and Middle East 1949-74; University of California at Los Angeles, visiting professor 1955-56; Columbia University, visiting professor 1960; Indiana University, visiting professor 1963; Princeton University, visiting professor 1964, Cleveland E. Dodge Professor of Near Eastern Studies 1974-; Institute for Advanced Study, member 1969, member with long-term appointment 1974-86.

Barbara Tedlock, *Interpretive anthropology*.

Born 1941, Battle Creek, Mississippi. University of California at Berkeley, BA 1967; Wesleyan University, MA 1973; State University of New York at Albany, PhD 1978.

Tufts University, lecturer 1977-78, assistant professor 1978-82, associate professor 1982-

Assistant

Denise Riley, *The category of "woman" in eighteenth and nineteenth century European history.*

Born 1948, Carlisle, England. University of Cambridge, BA 1970, MA 1974; University of Sussex, MA 1975, DPhil 1980.

Griffith University, Brisbane, Australia, visiting lecturer 1981; Northeast London Polytechnic, research fellow 1982-87; Brown University, research fellow 1984-85; Institute for Advanced Study, assistant to Professor Joan W. Scott 1986-87.

Record of Events, 1986-87

The following events of interest to the Institute community took place between July 1, 1986 and June 30, 1987. Not all meetings, such as some of the more informal seminars are recorded, but what follows indicates the variety and quality of Institute activities.

September 16

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: F. Avignone, University of South Carolina;
A. Drukier, Center for Astrophysics, Harvard University;
C. Mammon, New York University; S. McMillan, Drexel
Institute

September 22

School of Natural Sciences

Monday Lunchtime Seminar: "Supergravity equations from the
dynamics of particles and strings in superspace"

Joel A. Shapiro, Rutgers University; Visiting Member, School of
Natural Sciences, IAS

September 23

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: Bohdan Paczynski, Princeton University, IAS
Visitor; David Spergel, Harvard University, IAS Long-term
Member; Jerry Ostriker, Princeton University; Joel Primack,
University of California at Santa Cruz

September 25

School of Mathematics

Topology Seminar: "Magnus' kernel is not finitely presented"
Marc Culler, University of Illinois, Chicago; Visiting Member,
School of Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie
algebras"

Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "Structure of affine Kac-Moody
algebras"

Guest Lecturer: Frederic Bien, Princeton University

September 26

School of Natural Sciences

Theoretical Physics Seminar: "Time dependent perturbation
theory for quaternionic quantum mechanics and application to
CP-nonconservation in K decays"

Stephen L. Adler, Professor, School of Natural Sciences, IAS

66 Record of Events

September 29

School of Mathematics

Dynamical Systems Seminar: "Introduction to the Hénon map"
John W. Milnor, Professor, School of Mathematics, IAS

September 30

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Introductory survey"
Armand Borel, Professor, School of Mathematics, IAS

School of Mathematics

Joint Mathematical Physics and Princeton University-IAS
Mathematical Analysis Seminar: "Gaussian upper bounds for
heat kernels"
Guest Lecturer: E. B. Davies, King's College

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: Piet Hut, IAS Faculty; L. Spitzer, Princeton
University; J. Felton, NASA, Goddard Space Flight Center;
E. Jenkins, Princeton University; R. Wilson, AT&T;
T. Williams, Rutgers University

October 2

School of Historical Studies

Art History Colloquia: "Incarnations of the Aztec supernatural:
Huitzilopochtli as seen through Mexican and European eyes"
Elizabeth Hill Boone, Dumbarton Oaks Research Library;
Visiting Member, School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Finite group actions on CP^2 "
Ronnie Lee, Yale University; Visiting Member, School of
Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Seminar: "Regular and irregular orbits"
David Spergel, Harvard University; Long-term Member, School
of Natural Sciences, IAS

School of Mathematics

Affine Kac-Moody Groups: "Highest weight representations of
affine algebras"
Guest Lecturer: Frederic Bien, Princeton University

October 6

Concert

The Endellion String Quartet

School of Mathematics

Dynamical Systems Seminar: "Holomorphic motions in
conformal dynamics"
Curtis T. McMullen, Mathematical Sciences Research Institute,
Berkeley, California; Visiting Member, School of Mathematics,
IAS

- School of Natural Sciences
Monday Lunchtime Seminar: "Duality and string field theory"
Guest Lecturer: Mark Rubin, Rockefeller University
- October 7*
School of Mathematics
Seminar on Compactifications of (Locally) Symmetric Varieties:
"Torus embeddings, I"
Guest Lecturer: Ching-Li Chai, Princeton University
- School of Natural Sciences
Astronomy Seminar Luncheon
Participants: J. Barnes, IAS Visiting Member; G. Efstathiou,
University of Cambridge, IAS Visitor; B. Paczynski, Princeton
University, IAS Visitor; P. Teuben, IAS Visiting Member;
D. Stinebring, Princeton University; R. Schommer, Rutgers
University
- School of Mathematics
Joint Mathematical Physics and Princeton University-IAS
Mathematical Analysis Seminar: "Harmonic maps with
defects"
Lecturer: Elliott H. Lieb, Princeton University
- October 9*
School of Mathematics
Topology Seminar: "Application of index theory on Lipschitz
manifolds"
Guest Lecturer: Jonathan M. Rosenberg, University of Maryland
- Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS
- Affine Kac-Moody Groups: "The character formula for affine
algebras"
Guest Lecturer: Frederic Bien, Princeton University
- School of Natural Sciences
Astrophysics Seminar: "Regular and irregular orbits"
Jeremy Goodman, Long-term Member, School of Natural
Sciences, IAS
- October 10*
School of Natural Sciences
Theoretical Physics Seminar: "Ray representation of conformal
transformations and particle production"
Guest Lecturer: Roman Jackiw, Massachusetts Institute of
Technology
- October 14*
School of Mathematics
Seminar on Compactifications of (Locally) Symmetric Varieties:
"Torus embeddings, II"
Guest Lecturer: Ching-Li Chai, Princeton University
- Joint Mathematical Physics and Princeton University-IAS
Mathematical Analysis Seminar: "Subharmonics with
prescribed minimal period for Hamiltonian systems"
Gabriella Tarantello, Courant Institute, New York University;
Visiting Member, School of Mathematics, IAS

68 Record of Events

October 16

School of Mathematics

Topology Seminar: "Sums of incompressible surfaces"
Ulrich Oertel, University of Oklahoma; Visiting Member, School
of Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "Characters of the unitary
representation of the Virasoro algebra"
Guest Lecturer: Alvany Rocha-Caridi, City University of New
York

School of Social Science

Social Science Luncheon Seminar: "Morocco, Indonesia and me:
or, how I spent my sabbatical"
Clifford Geertz, Professor, School of Social Science, IAS

October 19

Concert

Princeton Chamber Orchestra

October 20

School of Mathematics

Joint Princeton University-IAS Dynamical Systems Seminar:
"Continuity properties of entropy"
Guest Lecturer: Sheldon E. Newhouse, University of North
Carolina, Chapel Hill

Marston Morse Memorial Lecture: "Deforming metrics by their
Ricci curvature"
Guest Lecturer: Richard Hamilton, University of California, San
Diego

School of Natural Sciences

Monday Lunchtime Seminar: "Finiteness of one-loop amplitudes
in the type I string"
Clifford Burgess, McGill University; Visiting Member, School of
Natural Sciences, IAS

School of Social Science

Interpretation Seminar: Organization meeting
Clifford Geertz, Professor, School of Social Science, IAS

October 21

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Complete symmetric varieties, I"
Guest Lecturer: Frederic Bien, Princeton University

Joint Mathematical Physics and Princeton University-IAS
Mathematical Analysis Seminar: "A maximum principle
approach to a-priori estimates"
Luis A. Caffarelli, Professor, School of Mathematics, IAS

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: Jeremy Goodman, IAS Long-term Member;
S. Nussinov, Tel Aviv University, IAS Visitor; R. Walterbos,
Sterrewacht Leiden, IAS Visiting Member; J. Gausted,
Swarthmore College; J. Hayes, Rutgers University; N. Netzer,
Princeton University; M. G. Park, Princeton University;
C. Thompson, Princeton University

October 23

School of Mathematics

Topology Seminar: "Geometrical finiteness and fundamental domains"

Brian Bowdith, University of Warwick, Visiting Member, School
of Mathematics, IAS

K-Theory Seminar: "Exotic log det"

Mariusz Wodzicki, Mathematical Institute, University of Oxford;
Visiting Member, School of Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie algebras" (continued)

Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "Decomposition of the category O "

Vyjayanthi Chari, Tata Institute, Bombay; Visiting Member,
School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "The political economy of Latin American development: seven exercises in retrospection"

Albert O. Hirschman, Professor Emeritus, School of Social
Science, IAS

October 24

School of Natural Sciences

Theoretical Physics Seminar: "Dynamical breaking of symmetries in Hamiltonian QCD"

Guest Lecturer: Luis Oliver, Laboratory of Theoretical Physics,
Orsay

October 27

School of Mathematics

Dynamical Systems Seminar: "The structure of attractors on 3-manifolds"

Joseph P. Christy, Northwestern University; Visiting Member,
School of Mathematics, IAS

Members Seminar: "t-structures in the derived category of representations of quivers"

R. Parthasarathy, Tata Institute, Bombay; Visiting Member,
School of Mathematics, IAS

70 Record of Events

October 28

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Complete symmetric varieties, II"
Guest Lecturer: Frederic Bien, Princeton University

Joint Mathematical Physics and Princeton University-IAS
Mathematical Analysis Seminar: "The heat kernel on complete
Riemannian manifolds with applications to index theory"
Harold Donnelly, Purdue University; Visiting Member, School of
Mathematics, IAS

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: H. Dejonghe, Sterrenkundig Observatorium, Gent,
IAS Visiting Member; R. Elson, Space Telescope Science
Institute, The Johns Hopkins University, IAS Visiting Member;
J. Goodman, IAS Long-term Member; Donald Schneider, IAS
Long-term Member; S. Tremaine, University of Toronto, IAS
Visitor

October 29

School of Natural Sciences

Computational Topics in Physics and Mathematics: "Scaling
studies of lattice QCD"
James Sexton, Fermi National Accelerator Laboratory; Visiting
Member, School of Natural Sciences, IAS

October 30

School of Mathematics

K-Theory Seminar: "K-theory and Galois action on
 $\pi_1(\mathbb{P}^1 - \{0, 1, \infty\})$ (conjectures)"
Pierre Deligne, Professor, School of Mathematics, IAS

Topology Seminar: "Equivariant Lipschitz structures"
Guest Lecturer: Mel Rothenberg, University of Chicago

Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "A survey of unitary representations
of affine algebras"
Vyjayanthi Chari, Tata Institute, Bombay; Visiting Member,
School of Mathematics, IAS

School of Natural Sciences

Non-linear Dynamics Seminar: "Dynamical friction in spherical
systems"
Scott Tremaine, University of Toronto; Visitor, School of Natural
Sciences, IAS

School of Social Science

Social Science Luncheon Seminar: "The making of child abuse"
Ian Hacking, University of Toronto; Visiting Member, School of
Social Science, IAS

November 3

School of Mathematics

Dynamical Systems Seminar: "A closing orbit proof of Brouwer's plane translation lemma"
 Albert Fathi, Centre National de la Recherche Scientifique;
 Visiting Member, School of Mathematics, IAS

Members Seminar: "Lyapounov exponents for linear stochastic differential systems"
 Etienne Pardoux, Université de Provence; Visiting Member,
 School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "Perturbative string field theory"
 Charles Thorn, University of Florida; Visiting Member, School of
 Natural Sciences, IAS

November 4

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
 "Compactifications of real symmetric spaces, I"
 Armand Borel, Professor, School of Mathematics, IAS

Joint Mathematical Physics and Princeton University-IAS
 Mathematical Analysis Seminar: "Estimates for solutions
 of $\bar{\partial}$ "

Lecturer: John E. Forness, Princeton University

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: W. Press, Harvard University, IAS Visitor; H. Rood,
 IAS Visitor; S. Bajtlik, Princeton University; G. Groth,
 Princeton University; S. Kent, Harvard University; J. Peterson,
 Princeton University

School of Social Science

Interpretation Seminar: "Dostoevsky: notes from underground"
 Joseph Frank, Stanford University; Visiting Member, School of
 Social Science, IAS

November 5

School of Natural Sciences

Computational Topics in Physics and Mathematics: "N-body
 simulation of collisional stellar systems"
 Sverre Aarseth, University of Cambridge; Visitor, School of
 Natural Sciences, IAS

November 6

School of Mathematics

K-Theory Seminar: "K-theory and Galois action on
 $\pi_1(\mathbb{P}^1 - \{0,1,\infty\})$ (conjectures), II"
 Pierre Deligne, Professor, School of Mathematics, IAS

Topology Seminar: "Unknotting a graph in S^3 "
 Jean-Pierre Otal, Centre National de la Recherche Scientifique;
 Visiting Member, School of Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie
 algebras" (continued)
 Robert P. Langlands, Professor, School of Mathematics

72 Record of Events

Affine Kac-Moody Groups: "Characters, theta functions and vertex operators"

Guest Lecturer: James I. Lepowsky, Rutgers University

School of Social Science

Social Science Luncheon Seminar: "Loyalty oaths, wedding vows, and apostles' creeds: constituting communities through words that bind"

Sanford Levinson, University of Texas Law School at Austin; Visiting Member, School of Social Science, IAS

November 7

School of Natural Sciences

Theoretical Physics Seminar: "Non-Abelian orbifolds"

Guest Lecturer: Cumrun Vafa, Harvard University

November 10

School of Mathematics

Dynamical Systems Seminar: "Entropy estimates for billiards and hard sphere gases"

Guest Lecturer: Maciej P. Wojtkowski, University of Maryland

School of Natural Sciences

Seminar: "Dissociative shocks in dense molecular clouds"

Guest Lecturer: D. Neufeld, Harvard University

November 11

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:

"Complete symmetric varieties and enumerative geometry"

Guest Lecturer: C. de Concini, Brandeis University

Joint Mathematical Physics and Princeton University-IAS

Mathematical Analysis Seminar: "Coarea, liquid crystals and minimal surfaces"

Lecturer: Frederick J. Almgren, Jr., Princeton University

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: R. Duncan, Princeton University; C. Josephs, Princeton University; G. Knapp, Princeton University; R. Kulsrud, Plasma Physics Laboratories; D. Monet, Naval Research Laboratories

November 12

School of Natural Sciences

Theoretical Physics Seminar: "The induced non-Abelian gauge fields in Adiabatic processes"

Guest Lecturer: Hua-Zhong Li, Zhong-shan University

Computational Topics in Physics and Mathematics:

"Introduction to scheme: a modern dialect of Lisp"

Joshua Barnes, Visiting Member, School of Natural Sciences, IAS

School of Historical Studies

Colloquium: "Babatha's Archive: unpublished papyri from the Judean desert"

Guest Lecturer: Naphtali Lewis, City University of New York

November 13

School of Historical Studies

Art History Colloquium: "Leone Leoni's *Charles V and Fury Restrained*: emblem of imperial propaganda and artistic ambition"

Guest Lecturer: Michael Mezzatesta, Kimball Art Museum, Fort Worth

School of Mathematics

K-Theory Seminar: "K-theory and Galois action on $\pi_1(\mathbb{P}^1 - \{0, 1, \infty\})$ (conjectures), III"

Pierre Deligne, Professor, School of Mathematics, IAS

Lecture Course: "Representations of infinite-dimensional Lie algebras" (continued)

Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "Characters, theta functions and vertex operators, II"

Guest Lecturer: James I. Lepowsky, Rutgers University

School of Social Science

Social Science Luncheon Seminar: "Reflections on self-criticism"

Michael Walzer, Professor, School of Social Science, IAS

November 17

School of Mathematics

Dynamical Systems Seminar: "Meromorphic continuation of Ruelle zeta functions"

Guest Lecturer: Folkert Tangerman, Courant Institute

Members Seminar: "Introduction to algebraic threefolds"

Janos Kollar, Harvard University; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "Baryon resonances without Quarks: A Skyrme model perspective"

Guest Lecturer: M. Kaliner, Stanford Linear Accelerator Center

School of Social Science

Interpretation Seminar: "Equal Employment Opportunities Commission (EEOC) v. Sears, Roebuck & Co."

Sanford Levinson, University of Texas Law School, Austin, Visiting Member, School of Social Science, IAS; and

Joan Scott, Professor, School of Social Science, IAS

November 18

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "Compactifications of real symmetric spaces, II"

Armand Borel, Professor, School of Mathematics, IAS

Joint Mathematical Physics and Princeton University-IAS

Mathematical Analysis Seminar: "Restriction theorems and partial differential equations"

Guest Lecturer: C. Sogge, University of Chicago

74 Record of Events

- School of Natural Sciences
Astronomy Seminar Luncheon
Participants: E. van Dishoeck, Center for Astrophysics, Harvard University, IAS Visitor; E. Groth, Princeton University; M. Fall, Space Telescope Science Institute, The Johns Hopkins University; T. Lauer, Princeton University; B. Ryden, Princeton University
- November 19*
School of Mathematics
Special Seminar: "Modular forms and multi-loop string physics"
Gregory Moore, Harvard University; Visiting Member, School of Natural Sciences, IAS
- School of Natural Sciences
Computational Topics in Physics and Mathematics: "Knowledge-based systems for process control"
Guest Lecturer: Janet Efstathiou, Queen Mary College, London
- November 20*
School of Mathematics
K-Theory Seminar: "Regulators, I"
Dinakar Ramakrishnan, Cornell University; Visiting Member, School of Mathematics, IAS
- Topology Seminar: "Computing Whitehead groups for hyperbolic manifolds (after Farrell-Jones)"
Guest Lecturer: Wu-chung Hsiang, Princeton University
- Lecture Course: "Representations of infinite-dimensional Lie algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS
- Affine Kac-Moody Groups: "Affine Lie algebras on Riemann surfaces"
Guest Lecturer: Edward Witten, Princeton University
- School of Social Science
Social Science Luncheon Seminar: "The concept of self in Japanese culture: a historical perspective"
Emiko Ohnuki-Tierney, University of Wisconsin, Madison; Visiting Member, School of Social Science, IAS
- November 21*
School of Natural Sciences
Theoretical Physics Seminar: "Self-propulsion at low Reynolds number"
Guest Lecturer: Frank Wilczek, National Science Foundation Institute, Santa Barbara
- Astrophysics Seminar: "Chaotic rotation of Hyperion"
Guest Lecturer: Jack Wisdom, Massachusetts Institute of Technology
- November 24*
School of Mathematics
Dynamical Systems Seminar: "Remarks on Moser's new proof of the twist theorem"
Guest Lecturer: De La Llave, Princeton University

- Members Seminar: "Eisenstein classes and non-compact modular symbols"
Günter Harder, Mathematisches Institut der Universität Bonn;
Visiting Member, School of Mathematics, IAS
- School of Natural Sciences
- Astrophysics Seminar: "Dynamics and kinematics of barred spirals"
Stephen Kent, Harvard University; Visitor, School of Natural Sciences, IAS
- November 25*
- School of Mathematics
- Seminar on Compactifications of (Locally) Symmetric Varieties: "Non-arithmetic lattices in hyperbolic spaces of arbitrary dimension"
Guest Lecturer: I. Piatetski-Shapiro, Yale University and Tel Aviv
- Joint Analysis IAS-Princeton University Seminar: "On the Arnold conjecture"
Guest Lecturer: Andreas Floer, Courant Institute
- School of Natural Sciences
- Theoretical Physics Seminar: "Dynamical origin of Cabibbo angle and Kaon $\Delta I = \frac{1}{2}$ rule"
Guest Lecturer: M. Scadron, University of Arizona
- Astronomy Seminar Luncheon
Participants: L. Aguilar, Center for Astrophysics, Harvard University; R. Bond, University of Toronto; S. Kent, Harvard University; P. J. Peebles, Princeton University
- November 26*
- School of Natural Sciences
- Theoretical Physics Seminar: "Strings in background fields: A BRS Hamiltonian approach"
Guest Lecturer: J. Maharana, Centre Européen de la Recherche Nucléaire (Geneva)
- December 1*
- School of Mathematics
- Dynamical Systems Seminar: "Decay of correlations in exact dynamical systems"
Gert Roepstorff, Institut für Theoretische Physik, Aachen, West Germany; Visiting Member, School of Natural Sciences, IAS
- Members Seminar: " $\lambda_1 \geq \frac{3}{16}$ "
Henryk Iwaniec, Visiting Member, School of Mathematics, IAS
- School of Natural Sciences
- Monday Lunchtime Seminar: "BRST operator and negative norm states: an application of the Bosonic string"
Mordechai Spiegelglas, Tel Aviv University; Visiting Member, School of Natural Sciences, IAS
- School of Social Science
- Interpretation Seminar: "Hermeneutics of and in the spoken word"
Dennis Tedlock, Boston University; Visiting Member, School of Social Science, IAS

76 Record of Events

December 2

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Stable cohomology of Satake compactifications of arithmetic
quotients, I"
Ruth Charney, Ohio State University; Visiting Member, School
of Mathematics, IAS

Joint Analysis IAS-Princeton University Seminar: "Microlocal
hypo-analyticity of linear P.D.O.'s of principal type"
Lecturer: A. Himonas, Princeton University

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: J. Bahcall, IAS Faculty; W. Alvarez, University of
California at Berkeley; Lars Hernquist, University of California
at Berkeley

December 3

School of Mathematics

Special Seminar: "String loop amplitudes"
Guest Lecturer: D. Phong, Columbia University

School of Natural Sciences

Theoretical Physics Seminar: "Geometric derivation of string
field theory from first principles"
Guest Lecturer: M. Kaku, City College of New York

December 4

School of Historical Studies

Art History Colloquium: "Jacopo Lauro's *Antiquae Urbis Splendor*
as a source for Roman baroque architecture"
Daniela del Pesco, University of Rome; Visiting Member, School
of Historical Studies, IAS

School of Mathematics

K-Theory Seminar: " K_3 of the complex numbers"
Guest Lecturer: Charles A. Weibel, Rutgers University

Topology Seminar: "A topologist looks at the eta-invariant"
Guest Lecturer: S. Weinberger, University of Chicago

Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "Semi-infinite cohomology and
realizations of Kac-Moody algebras"
Guest Lecturer: Igor Frenkel, Yale University

School of Natural Sciences

Theoretical Physics Seminar: "Berry's phase in physics and its
experimental verification"
Guest Lecturer: Yong-Shi Wu, University of Utah

School of Social Science

Social Science Luncheon Seminar: "The boundaries of Roman
imperial religion"
Simon R. F. Price, Oxford University; Visiting Member, School of
Historical Studies, IAS

December 8

Concert
Elena Bashkirova, Pianist

School of Mathematics
Members Seminar: "Canonical singularities and minimal models of algebraic varieties"
Yujiro Kawamata, University of Tokyo; Visiting Member, School of Mathematics, IAS

December 9

School of Mathematics
Seminar on Compactifications of (Locally) Symmetric Varieties: "Stable cohomology of Satake compactifications of arithmetic quotients, II"
Ruth Charney, Ohio State University; Visiting Member, School of Mathematics, IAS

Joint Analysis-Dynamical Systems-Princeton University-IAS
Seminar: "Pseudo-orbits of contact forms"
Guest Lecturer: A. Bahri, Courant Institute

December 10

School of Natural Sciences
Theoretical Physics Seminar: "Wess-Zumino consistency condition in string field theory"
Guest Lecturer: M. Bochicchio, Princeton University

December 11

School of Mathematics
K-Theory Seminar: "Regulators, II"
Dinakar Ramakrishnan, Cornell University; Visiting Member, School of Mathematics, IAS

Topology Seminar: "The crossing rule, vector fields on spheres and the Radon-Hurwitz numbers"
Guest Lecturer: Shmuel Friedland, University of Illinois, Chicago

Lecture Course: "Representations of infinite-dimensional Lie algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

Affine Kac-Moody Groups: "The Kirillov formula for characters of affine Kac-Moody algebras"
Guest Lecturer: Roe Goodman, Rutgers University

Special Seminar: "An invariant attached to Abelian varieties over finite fields"
Guest Lecturer: Robert Kottwitz, University of Washington

School of Social Science
Social Science Luncheon Seminar: "'Signs of Blood, Signs of Redemption': A chapter from my forthcoming book on the anthropology of collective violence"
E. Valentine Daniel, University of Washington; Visiting Member, School of Social Science, IAS

78 Record of Events

December 12

School of Mathematics

Special Seminar: "Eta invariant and adiabatic approximation"
Guest Lecturer: Jeff Cheeger, State University of New York at
Stony Brook

School of Natural Sciences

Theoretical Physics Seminar: "Soliton stars"
Guest Lecturer: T. D. Lee, Columbia University

December 15

School of Mathematics

Dynamical Systems Seminar: "More on period doubling"
Guest Lecturer: John Guckenheimer, Cornell University

Members Seminar: "On unitary representations with non-
vanishing cohomology"
Susana Salamanca-Riba, Massachusetts Institute of Technology;
Visiting Member, School of Mathematics, IAS

School of Social Science

Interpretation Seminar: "Moral and political philosophy in the
interpretive mode"
Michael Walzer, Professor, School of Social Science, IAS

December 16

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Compactifications of real symmetric spaces, III"
Armand Borel, Professor, School of Mathematics, IAS

December 17

School of Mathematics

Special Seminar: "Super Riemann surfaces and super
Teichmüller theory"
Louis Crane, University of Chicago; Visiting Member, School of
Mathematics, IAS

December 18

School of Mathematics

Affine Kac-Moody Groups: "Gaussian measures and
representations of gauge groups"
Guest Lecturer: Nolan Wallach, Rutgers University

Lecture Course: "Representations of infinite-dimensional Lie
algebras" (continued)
Robert P. Langlands, Professor, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "At the mercy of the play:
Shakespeare and the discontents of language"
Theodore Weiss, Princeton University; Visitor, School of
Historical Studies, IAS

December 22

School of Mathematics

Members Seminar: "Mumford-Tate groups of Abelian varieties"
Bruce A. Dodson, Lehigh University; Visiting Member, School of
Mathematics, IAS

- January 5
School of Natural Sciences
- Monday Lunchtime Seminar: "The finite temperature transition in lattice QCD"
Guest Lecturer: Andreas Gocksch, University of California, San Diego
- January 6
School of Natural Sciences
- Astronomy Seminar Luncheon
Participants: Piet Hut, IAS Faculty; Todd Lauer, Princeton University; Bob Schommer, Rutgers University
- January 8
School of Historical Studies
- Art History Colloquium (at Princeton University): "Thoughts on the convergence of genre and portraiture in seventeenth-century Dutch painting"
David R. Smith, University of New Hampshire; Visiting Member, School of Historical Studies, IAS
- School of Mathematics
- Topology Seminar: "Knot polynomials-algebra, combinatorics (and geometry)"
David Yetter, Clark University; Visiting Member, School of Mathematics, IAS
- School of Social Science
- Social Science Luncheon Seminar: "Positivism/holism/constructivism"
Andrew Pickering, University of Illinois; Visiting Member, School of Social Science, IAS
- January 12
School of Social Science
- Interpretation Seminar: "'Where the word breaks off'—a chapter from a book on *Politics and Ambiguity*"
William Connolly, The Johns Hopkins University; Visiting Member, School of Social Science, IAS
- January 13
School of Natural Sciences
- Astronomy Seminar Luncheon
Participants: Rene Walterbos, Sterrewacht Leiden, IAS Visiting Member; Marc Postman, Princeton University
- January 15
School of Mathematics
- Topology Seminar: "Cobordism, complete intersections, and modular forms"
Peter S. Landweber, Rutgers University; Visiting Member, School of Mathematics, IAS
- Affine Kac-Moody Groups: "Introduction to loop groups"
Guest Lecturer: Andrew Pressley, King's College, London
- School of Social Science
- Social Science Luncheon Seminar: "Telling stories of political origins: the case of the missing contract"
Carole Pateman, University of Sydney; Visiting Member, School of Social Science, IAS

80 Record of Events

January 20

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Real points of de Concini-Procesi compactifications, I"
Armand Borel, Professor, School of Mathematics, IAS

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: Bohdan Paczynski, Princeton University, IAS
Visitor; Jeremiah Ostriker, Princeton University; Lyman
Spitzer, Princeton University; Edward Turner, Princeton
University

January 22

School of Mathematics

Topology Seminar: "Characteristic classes for group extensions"
Johannes Huebschmann, Mathematisches Institut, Heidelberg,
West Germany; Visiting Member, School of Mathematics, IAS

Affine Kac-Moody Groups: "The basic representation of LU_n "
Guest Lecturer: Andrew Pressley, King's College, London

School of Social Science

Social Science Luncheon Seminar: "Resistance: the peasant art of
escaping notice"
James Scott, Yale University; Visiting Member, School of Social
Science, IAS

January 23

School of Natural Sciences

Theoretical Physics Seminar: "Four-dimensional Chiral models
from type II strings"
Guest Lecturer: Lance Dixon, Stanford Linear Accelerator Center

Astrophysics Seminar: "Tidal interactions between spherical
galaxies"
Guest Lecturer: Luis Aguilar, Center for Astrophysics,
Cambridge, Massachusetts

January 26

School of Natural Sciences

Monday Lunchtime Seminar: "Mathematical formulation of
E. Witten's string and superstring"
Guest Lecturer: Stuart Samuel, City College of New York

School of Social Science

Interpretation Seminar: "Remarks on meaning, communication
and interpretation"
Barbara Herrnstein Smith, University of Pennsylvania; Visiting
Member, School of Social Science, IAS

January 27

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Real points of de Concini-Procesi compactifications, II"
Armand Borel, Professor, School of Mathematics, IAS

- School of Natural Sciences
Astronomy Seminar Luncheon
Participants: Tsvi Piran, IAS Long-term Member; David Spergel, Harvard University, IAS Long-term Member; Luis Aguilar, Center for Astrophysics, Harvard University; William Press, Center for Astrophysics, Harvard University
- January 29*
School of Mathematics
Topology Seminar: "Invariants of plane algebraic curves via representations of braid groups"
Anatoly S. Libgober, University of Illinois; Visiting Member, School of Mathematics, IAS
- Affine Kac-Moody Groups: "Construction of loop groups as Banach Lie groups"
Guest Lecturer: Nolan Wallach, Rutgers University
- School of Social Science
Social Science Luncheon Seminar: "Civic celebrations and religious conflict in the late Roman world"
Robert Markus, University of Nottingham; Visiting Member, School of Historical Studies, IAS
- February 3*
School of Mathematics
Seminar on Compactifications of (Locally) Symmetric Varieties: "Differential equations with regular singularities on symmetric spaces"
Guest Lecturer: Frederic Bien, Princeton University
- School of Mathematics
Analytic Number Theory: "Survey of metaplectic forms on $GL(n)$ "
Jeffrey Hoffstein, University of Rochester; Visiting Member, School of Mathematics, IAS
- Analysis Seminar: "Riemann surfaces and determinants"
Guest Lecturer: Daniel Freed, Massachusetts Institute of Technology
- School of Natural Sciences
Astronomy Seminar Luncheon
Participants: Freeman Dyson, IAS Faculty; Donald Schneider, IAS Long-term Member; Piotr Amsterdanski, University of Texas; Stefano Casertano, University of Groningen
- February 5*
School of Historical Studies
Art History Colloquium: "Medieval medicine, renaissance art and modern scientific anatomy"
Samuel Y. Edgerton, Jr., Williams College; Visiting Member, School of Historical Studies, IAS
- School of Mathematics
Affine Kac-Moody Groups: "Chern classes of based loop groups"
Guest Lecturer: Daniel Freed, Massachusetts Institute of Technology

82 Record of Events

- School of Social Science Luncheon Seminar: "Value without truth-value"
Barbara Herrnstein Smith, University of Pennsylvania; Visiting Member, School of Social Science, IAS
- February 6*
School of Natural Sciences Theoretical Physics Seminar: "Critical dimensions for linear and non-linear σ -models from path integrals"
Guest Lecturer: Peter van Nieuwenhuizen, City University of New York at Stony Brook
- February 9*
School of Mathematics Members Seminar: "Variations on Radon transform"
Mihail-Radu Rosu, University of Bucharest; Visiting Member, School of Mathematics, IAS
- School of Natural Sciences Monday Lunchtime Seminar: "Fine structure of strings"
Guest Lecturer: Domenech Espriu, Harvard University
- School of Social Science Interpretation Seminar: "How economists propose models, use evidence, and make interpretations"
Stephen Jones, University of British Columbia; Visiting Member, School of Social Science, IAS
- February 10*
School of Mathematics Seminar on Compactifications of (Locally) Symmetric Varieties: "Differential equations with regular singularities on symmetric spaces" (continued)
Guest Lecturer: Frederic Bien, Princeton University
- Analytic Number Theory: "Primes in arithmetic progressions: Introduction"
Guest Lecturer: Henryk Iwaniec, Rutgers University
- School of Natural Sciences Astronomy Seminar Luncheon
Participants: Roman Juskevicz, University of California at Berkeley; Hank Spruit, Max-Planck-Institut, Munich; Amiel Sternberg, Tel Aviv University; Ed Turner, Princeton University; Steven Vogt, Lick Observatory
- February 12*
School of Mathematics Topology Seminar: "Non-linear similarity"
Guest Lecturer: Mark Steinberger, Rutgers University, Newark
- Affine Kac-Moody Groups: "Toward arithmetic string theory"
Guest Lecturer: Daniel Friedan, University of Chicago
- School of Social Science Social Science Luncheon Seminar: "Democracy and normalization"
William Connolly, The Johns Hopkins University; Visiting Member, School of Social Science, IAS

February 16

School of Mathematics

Members Seminar: "Homotopy groups of the complements to singular hypersurfaces"
 Anatoly S. Libgober, University of Illinois; Visiting Member, School of Mathematics, IAS

February 17

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "Differential equations with regular singularities on symmetric spaces" (continued)
 Guest Lecturer: Frederic Bien, Princeton University

Joint Analysis Princeton University-IAS Seminar: "The heat equation and the index theorem"

Harold Donnelly, Purdue University; Visiting Member, School of Mathematics, IAS

Analytic Number Theory: "Primes in arithmetic progressions" (continued)

Guest Lecturer: John Friedlander, University of Toronto

February 19

School of Mathematics

Affine Kac-Moody Groups: "Complex affine Lie groups, Hamiltonian systems and theta functions"

Guest Lecturer: Nolan Wallach, Rutgers University

Analytic Number Theory: "Kloosterman sums and the trace formula"

David Joyner, Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Anthropology as dialogue"

Dennis Tedlock, Boston University; Visiting Member, School of Social Science, IAS

Concert

Charles Rosen, Pianist

February 20

School of Natural Sciences

Theoretical Physics Seminar: "A renormalization group approach to string theory"

Guest Lecturer: Emil Martinec, University of Chicago

February 23

School of Natural Sciences

Monday Lunchtime Seminar: "String theory as integrable analytic geometry"

Dan Friedan, University of Chicago; Visiting Member, School of Natural Sciences, IAS

February 24

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "Partial compactifications"

Guest Lecturer: E.J.N. Looijenga, Catholic University Nijmegen and Columbia University

Analytic Number Theory: "Primes in arithmetic progressions, III"
 Enrico Bombieri, Professor, School of Mathematics, IAS

Joint Analysis Princeton University-IAS Seminar: "Weak convergence and the crystallographic theory of Martensite"
 Guest Lecturer: John Ball, Herriott-Watt University, Edinburgh

February 25
 School of Natural Sciences

Astronomy Seminar Luncheon
 Participants: Bohdan Paczynski, Princeton University, IAS Visitor; Jim Gunn, Princeton University

February 26
 School of Mathematics

Topology Seminar: "Algebraic automorphisms of affine surfaces"
 Guest Lecturer: Ted Petrie, Rutgers University

Affine Kac-Moody Groups: "Generalization of the Borel-Weil-Bott theorem for infinite dimensional flag spaces"
 Guest Lecturer: Olivier Mathieu, Yale University

Analytic Number Theory: "A review of hyper-Kloosterman sums"
 Steven I. Sperber, University of Minnesota; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "'L'ouvrière! Mot impie, sordide . . .': women workers in the discourse of French political economy, 1840-1860"
 Joan Scott, Professor, School of Social Science, IAS

March 2
 School of Mathematics

Joint Princeton University-IAS Dynamical Systems Seminar: "Arnold conjecture II"
 Guest Lecturer: Andreas Floer, Courant Institute

School of Natural Sciences

Astronomy Seminar Luncheon
 Participants: John Bahcall, IAS Faculty; Rebecca Elson, Space Telescope Science Institute, The Johns Hopkins University, IAS Visiting Member; Bohdan Paczynski, Princeton University, IAS Visitor; Alan Boss, Carnegie Institute of Washington; Todd Lauer, Princeton University

March 3
 School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "Partial compactifications" (continued)
 Guest Lecturer: E.J.N. Looijenga, Catholic University Nijmegen and Columbia University

Analytic Number Theory: "Primes in arithmetic progressions, IV"
 Enrico Bombieri, Professor, School of Mathematics, IAS

March 4

School of Natural Sciences

Theoretical Physics Seminar: "Neutrino mass and solar neutrinos"
Guest Lecturer: Lincoln Wolfenstein, Carnegie-Mellon

March 5

School of Historical Studies

Art History Colloquium (at Princeton University): "French seventeenth-century plans to complete the Louvre"
Christopher Tadgell, Canterbury College of Art; Visiting Member, School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Topological structure of the space of algebraic varieties"
Guest Lecturer: H. Blaine Lawson, Jr., State University of New York at Stony Brook

Affine Kac-Moody Groups: "Vertex operators calculus and the Monster I"
Guest Lecturer: James I. Lepowsky, Rutgers University

Analytic Number Theory: "Zagier's method, I"
W. David Joyner, Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Back to imperialism: empiricists, theorists and Free Trade for Peru, 1820-60"
Paul Gootenberg, University of Illinois; Visiting Member, School of Social Science, IAS

March 6

School of Natural Sciences

Theoretical Physics Seminar: "Construction of vertex operators for NSR superstrings"
Guest Lecturer: Antal Jevicki, Brown University

March 9

School of Natural Sciences

Monday Lunchtime Seminar: "Open and closed string field theory"
Andy Strominger, Visiting Member, School of Natural Sciences, IAS

Astronomy Seminar Luncheon
Participants: Piet Hut, IAS Faculty; Mike Hawkins, Schmidt Telescope, United Kingdom; C. P. Masson, California Institute of Technology; John Wheeler, University of Texas

School of Social Science

Interpretation Seminar: "Discussion of two chapters from *Works and Lives*"
Clifford Geertz, Professor, School of Social Science, IAS

March 10

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "A cell decomposition of the Siegel upper half plane"
Guest Lecturer: Robert MacPherson, Brown University

Analytic Number Theory: "Primes in arithmetic progressions, V"
Enrico Bombieri, Professor, School of Mathematics, IAS

Joint Analysis Princeton University-IAS Seminar: "Estimates for the Bergman kernel in some weakly-pseudo convex domains"
Guest Lecturer: Alexander J. Nagel, University of Wisconsin

March 12

School of Mathematics

Topology Seminar: "S-cobordisms of three-dimensional manifolds"

Guest Lecturer: Sylvain Cappell, Courant Institute

Affine Kac-Moody Groups: "Vertex operators calculus and the Monster, II"

Guest Lecturer: James I. Lepowsky, Rutgers University

Analytic Number Theory: "Zagier's method, II"

W. David Joyner, Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Experiments in ethnographic writing"

Barbara Tedlock, Tufts University; Visitor, School of Social Science, IAS

March 13

School of Natural Sciences

Astrophysics Seminar: "Missing mass in the solar neighborhood"

Guest Lecturer: Mike Hawkins, U. K. Schmidt Telescope, Australia

March 16

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: Piet Hut, IAS Faculty; Rebecca Elson, Space Telescope Science Institute, The Johns Hopkins University, IAS Visiting Member; Tsvi Piran, IAS Long-term Member; Marc Postman, Princeton University

March 17

School of Mathematics

Analysis Seminar: "Shape of a two dimensional surface"

Guest Lecturer: Peter Sarnak, Stanford University

Seminar on Compactifications of (Locally) Symmetric Varieties: "Finding generators and relations for the cohomology of moduli spaces"

Guest Lecturer: Frances C. Kirwan, Oxford University

Analytic Number Theory: "Primes in arithmetic progressions, VI"

Enrico Bombieri, Professor, School of Mathematics, IAS

Joint Analysis Princeton University-IAS Seminar: "Existence theorems for weak solutions of fully non-linear elliptic equations"

Guest Lecturer: Craig Evans, University of Maryland

March 18

School of Mathematics

Dynamical Systems Special Seminar: "Cone fields and ergodicity for smooth dynamical systems"
 Guest Lecturer: Anatole Katok, California Institute of Technology

March 19

School of Mathematics

Topology Seminar: "'Continued fraction' expansions of measured foliations"
 Lee Mosher, Harvard University; Visiting Member, School of Mathematics, IAS

Affine Kac-Moody Groups: "The Monster in 196884 dimensions"
 Guest Lecturer: John Conway, Princeton University

School of Social Science

Social Science Luncheon Seminar: "Interpreting unemployment"
 Stephen Jones, University of British Columbia; Visiting Member, School of Social Science, IAS

March 20

School of Natural Sciences

Theoretical Physics Seminar: "Conformal field theory and string loop calculations"
 Guest Lecturer: Ashoke Sen, Stanford Linear Accelerator Center

Astronomy Seminar: "Planetary observations in the early Middle Ages"
 Bruce Eastwood, University of Kentucky; Visiting Member, School of Historical Studies, IAS

March 23

School of Mathematics

Joint Dynamical Systems Princeton University-IAS Seminar: "Surgery on complex polynomials"
 Guest Lecturer: Adrien Douady, Ecole Normale Supérieure, Paris

School of Natural Sciences

Monday Lunchtime Seminar: "Generalized GSO projections for modular-invariant aperiodic strings"
 Harry Lam, McGill University; Visiting Member, School of Natural Sciences, IAS

Astronomy Seminar Luncheon
 Participants: Scott Tremaine, University of Toronto, IAS Visitor; James Binney, University of Oxford; Stuart Bowyer, University of California at Berkeley; Simon White, University of Arizona

School of Social Science

Interpretation Seminar: "Making sense of science: pragmatism, realism and interactionism"
 Andrew Pickering, Massachusetts Institute of Technology; Visiting Member, School of Social Science, IAS

88 Record of Events

March 24

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Partial compactifications" (continued)
Guest Lecturer: E.J.N. Looijenga, Catholic University Nijmegen
and Columbia University

Analytic Number Theory: "Primes in arithmetic progressions,
VII"

Enrico Bombieri, Professor, School of Mathematics, IAS

Joint Analysis Princeton University-IAS Seminar: "Lower bounds
for the green function of a parabolic equation"

Guest Lecturer: Eugene B. Fabes, University of Minnesota

March 26

School of Mathematics

Topology Seminar: "Combinatorics and Dahn surgery"

Guest Lecturer: John Luecke, Courant Institute

Affine Kac-Moody Groups: "Modular invariance and conformal
field theory"

Guest Lecturer: Doron Gepner, Princeton University

School of Social Science

Social Science Luncheon Seminar: "Alienation of death in
nineteenth-century Vienna and Budapest"

Peter Hanák, Budapest Eötvös Lorand University; Visiting
Member, School of Historical Studies, IAS

March 30

School of Mathematics

Joint Dynamical Systems Princeton University-IAS Seminar: "A
shadowing-like property in twist maps"

Guest Lecturer: G. R. Hall, Boston University

March 31

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
"Compactifications over \mathbb{Z} of moduli spaces"

Guest Lecturer: G. Faltings, Princeton University

Analytic Number Theory: "Primes in arithmetic progressions,
VIII"

Enrico Bombieri, Professor, School of Mathematics, IAS

Analysis Seminar: "Elliptic genera and S^1 actions-analytic
proof"

Guest Lecturer: Clifford Taubes, Harvard University

School of Natural Sciences

Astronomy Seminar Luncheon

Participants: Jeremy Goodman, IAS Long-term Member; Donald
Schneider, IAS Long-term Member; Ed Jenkins, Princeton
University; Jim Peebles, Princeton University; Bill Press,
Harvard University; Peter Quinn, Los Alamos; David
Weinberg, Princeton University

April 2

School of Historical Studies

Art History Colloquium: "Cubism and decoration"
 Nancy J. Troy, Northwestern University; Visiting Member,
 School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Lamniscates and trees"
 Guest Lecturer: F. Catanese, University of Pisa and Columbia
 University

Affine Kac-Moody Groups: "Orbifolds and twisted strings"
 Guest Lecturer: Jeffrey Harvey, Princeton University

School of Social Science

Social Science Luncheon Seminar: "The thin man: on life and
 love in liberalism"
 Wolfgang Fach, University of Konstanz; Visiting Member, School
 of Social Science, IAS; and
 Giovanna Procacci, University of Milan; Visiting Member, School
 of Social Science, IAS

April 3

School of Natural Sciences

Theoretical Physics Seminar: "Cohomology and heterotic
 worldsheet anomalies"
 Guest Lecturer: Burt Ovrut, University of Pennsylvania

April 6

School of Natural Sciences

Monday Lunchtime Seminar: "Diseases of physical gauges in
 QCD"
 Guest Lecturer: J. C. Taylor, University of Cambridge

School of Social Science

Interpretation Seminar: "Frivolous cases: do lawyers really know
 anything at all?"
 Sanford Levinson, University of Texas Law School, Austin;
 Visiting Member, School of Social Science, IAS

April 7

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties:
 "Compactifications over \mathbb{Z} of moduli spaces" (continued)
 Guest Lecturer: G. Faltings, Princeton University

Joint Analysis Princeton University-IAS Seminar: "Higher order
 microlocalization and applications to non-linear propagation or
 singularities"

Guest Lecturer: N. Lerner, Purdue University

School of Natural Sciences

Astronomy Seminar Luncheon
 Participants: E. van Dishoeck, Center for Astrophysics, Harvard
 University, IAS Visitor; D. Hoggie, University of Edinburgh;
 L. Hernquist, University of California at Berkeley; D. Koo,
 Space Telescope Science Institute, The Johns Hopkins University;
 J. Ostriker, Princeton University; E. Turner, Princeton
 University

90 Record of Events

April 8

School of Mathematics

Special Seminar: "Index theorem and Lefschetz fixed point formula on symmetric spaces of Q-rank 1"
Guest Lecturer: Werner Müller, Akademie Der Wissenschaften der DDR

April 9

School of Mathematics

Topology Seminar: "Homogeneous spaces with symmetry group $SU(3) \times SU(2) \times U(1)$ "

Guest Lecturer: Mathias Kreck, Universität Mainz

Affine Kac-Moody Groups: "Vertex operators construction of some non-basic standard modules"

Guest Lecturer: Robert Wilson, Rutgers University

School of Social Science

Social Science Luncheon Seminar: "The use and abuse of the nation: Catalonia between France and Spain"

Peter Sahlins, Columbia University; Research Assistant, School of Historical Studies, IAS

April 10

School of Natural Sciences

Astrophysics Seminar: "Neutrinos II"

John Bahcall, Professor, School of Natural Sciences, IAS

April 13

School of Historical Studies

Lecture: "The chorus as protagonist: myth and imagery in Aeschylus' *Supplikes*"

Guest Lecturer: Desmond J. Conacher, Trinity College, University of Toronto

School of Mathematics

Joint Dynamical Systems Princeton University-IAS Seminar: "The proof of the Weinstein conjecture in \mathbb{R}^n "

Guest Lecturer: C. Viterbo, Courant Institute

April 14

School of Mathematics

Seminar on Compactifications of (Locally) Symmetric Varieties: "Compactifications over \mathbb{Z} of moduli spaces" (continued)

Guest Lecturer: G. Faltings, Princeton University

April 16

School of Mathematics

Affine Kac-Moody Groups: "Endoscopy and affine Kac-Moody groups"

Guest Lecturer: Frederic Bien, Princeton University

School of Natural Sciences

Theoretical Physics Seminar: "Asymmetric vertex operators"
Guest Lecturer: Paul Ginsparg, Harvard University

April 21

Symposium

The Historical Society of Princeton: "Intellectual emigrés in Princeton, 1930-1950"

Moderator: Freeman Dyson, Professor, School of Natural Sciences, IAS

- School of Mathematics Joint Analysis Princeton University-IAS Seminar: "Hartree-Fock equations"
Guest Lecturer: P. L. Lions, Université de Paris-Dauphine
- School of Social Science Interpretation Seminar: "Hidden transcript"
James Scott, Yale University; Visiting Member, School of Social Science, IAS
- April 24*
School of Natural Sciences Lecture: "Supernova 1987A"
John Bahcall, Professor, School of Natural Sciences, IAS
- April 27*
School of Mathematics Joint Princeton University-IAS Dynamical Systems Seminar: "Ratnor's rigidity theorem for geometrically finite groups"
Guest Lecturer: Livio Flaminio, University of Maryland
- May 1*
School of Natural Sciences Theoretical Physics Seminar: "Anomalies, ambiguities and the index of the Dirac-Ramond operator"
Guest Lecturer: Nicholas Warner, Massachusetts Institute of Technology
- May 4*
School of Natural Sciences Monday Lunchtime Seminar: "Calculating the properties of closed strings in open string field theory"
Charles Thorn, University of Florida; Visiting Member, School of Natural Sciences, IAS
- School of Social Science Interpretation Seminar: "An interpretive solution to the problem of humoral medicine in Latin America"
Barbara Tedlock, Tufts University; Visitor, School of Social Science, IAS
- May 5*
School of Natural Sciences Astronomy Seminar Luncheon
Participants: Bohdan Paczynski, Princeton University, IAS Visitor; E. Jenkins, Princeton University; A. Loeb, Soreq Nuclear Research Center, Israel; D. Sugimoto, University of Tokyo

Astrophysics Seminar: "Autoresonant laser acceleration of particles to high energies"
Guest Lecturer: Avi Loeb, Soreq Nuclear Research Center, Yavne, Israel
- May 6*
School of Natural Sciences Lunchtime Seminar: "Monte Carlo investigation of effective Hamiltonians"
Guest Lecturer: Klaus Pinn, University of Hamburg

92 Record of Events

May 11

School of Social Science

Interpretation Seminar: "Sociology and its poor"
Giovanna Procacci, University of Milan; Visiting Member, School of Social Science, IAS

May 12

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: P. Hickson, University of Vancouver; D. Richstone, University of Michigan; A. Toomre, Massachusetts Institute of Technology; R. B. Tully, University of Hawaii

Concert

L'Ensemble

May 18

School of Natural Sciences

Monday Lunchtime Seminar: "Remarks on the one-loop string cosmological constant"
Gregory Moore, Harvard University; Visiting Member, School of Natural Sciences, IAS

May 21

School of Natural Sciences

Theoretical Particle Physics Seminar: "Spacetime supersymmetry in compactified string theory and superconformal models"
Guest Lecturer: Doron Gepner, Princeton University

School of Social Science

Interpretation Seminar: "The historicization of space"
E. Valentine Daniel, University of Washington; Visiting Member, School of Social Science, IAS

May 27

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: J. Bahcall, IAS Faculty; Bohdan Paczynski, Princeton University, IAS Visitor; D. Schneider, IAS Long-term Member; A. Dressler, Mt. Stromlo Observatory; P. Shapiro, University of Texas

May 29

School of Natural Sciences

Theoretical Particle Physics Seminar: "Radiation from cosmic strings"
Guest Lecturer: A. Vilenkin, Tufts University

June 1

School of Natural Sciences

Monday Lunchtime Seminar: "Supersymmetric non-linear Maxwell theories"
Guest Lecturer: Ulf Lindstrom, City University of New York at Stony Brook

June 2

School of Natural Sciences

Astronomy Seminar Luncheon
Participants: A. Bosma, University of Michigan; R. Duncan, Princeton University; J. van Gorkom, Virginia Laboratory for Astrophysics; J. Villumsen, California Institute of Technology

- June 9*
School of Natural Sciences
- Astronomy Seminar Luncheon
Participants: J. Bahcall, IAS Faculty; J. Barnes, IAS Visiting Member; Bohdan Paczynski, Princeton University, IAS Visitor; D. Schneider, IAS Long-term Member; M. Abromowicz, University of Trieste; L. Spitzer, Princeton University
- June 23*
School of Natural Sciences
- Astronomy Seminar Luncheon
Participants: Gerald Cecil, IAS Visiting Member; Marc Postman, Princeton University; Chris Thompson, Princeton University; Ed Turner, Princeton University
- Lunchtime Seminar: "Particle creation in the formation of cosmic strings"
Guest Lecturer: Leonard Parker, University of Wisconsin-Milwaukee
- In addition, the following lectures at the Institute were arranged by the Princeton Society of the Archaeological Institute of America.
- October 22*
- Lecture: "Problems relating to the temple of Apollo Epikourios at Bassae (Phigalia)"
Guest Lecturer: Professor Nicholas Yalouris, Athens
- November 19*
- Lecture: "Underwater archaeology: yesterday and today"
Guest Lecturer: Dr. Anna Marguerite McCann, Cosa Port Excavations
- December 10*
- Lecture: "Recent work at Aphrodisias"
Guest Lecturer: Professor Kenan Erim, New York University
- February 11*
- Lecture: "Recent work at the sanctuary of Apollo Maleatas in Epidauros"
Guest Lecturer: Professor V. Lambrinoudakis, Athens
- March 11*
- Lecture: "A vital clue for archaeologists: stamped amphora handles"
Guest Lecturer: Professor Carolyn Koehler, University of Maryland
- April 8*
- Lecture: "Outposts in the desert: Roman/Byzantine fortresses in the East"
Guest Lecturer: Professor John Betlyon, Smith College
- April 22*
- Lecture: "Paphos on Cyprus: A leading mosaic center of late antiquity"
Guest Lecturer: Professor Victor Daszewski, Norton Memorial Lecturer, University of Warsaw

Report of the Treasurer

Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld
Foundation

The market value of the Institute's endowment totaled \$185,738,688 on June 30, 1987.

During fiscal year 1987, total expenses were \$12,106,900. After applying \$2,586,745 in operating fund gifts and grants against these expenditures, the Institute was required to provide \$9,520,155 for current operating purposes principally from endowment resources. The total resources required from endowment for current operations, capital acquisitions and debt reduction for fiscal year 1987 was in excess of \$10 million. This represents approximately 6.2% of the three-year average market value of the endowment at June 30, as compared to 7.7 percent of the comparable endowment totals for fiscal year 1986.

The performance of the Institute's portfolio is measured annually by Hamilton, Johnston and Co., Inc. Over the ten-year period ending June 30, 1987, dividend and interest income and net realized and unrealized gains combined for a total average annual compound rate of return on Institute investments of 18.6 percent. Over the past five years, the average annual compound rate of return was 22.3 percent. For fiscal 1987, the annual rate of return was 17.2 percent.

The financial statements of the Institute for Advanced Study are audited by Deloitte Haskins & Sells. The auditors' opinion letter and the financial statements for the fiscal year ended June 30, 1987, follow this report.

Ralph E. Hansmann
Treasurer

Report of Independent Accountants

To the Board of Trustees of the Institute for Advanced Study-Louis Bamberger and Mrs. Felix Fuld Foundation:

We have examined the balance sheet of the Institute for Advanced Study-Louis Bamberger and Mrs. Felix Fuld Foundation as of June 30, 1987, and the related statements of support and revenue, expenses, capital additions and changes in fund balances and of changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the aforementioned financial statements present fairly the financial position of the Institute at June 30, 1987, and the results of its operations and the changes in its financial position for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Deloitte Haskins & Sells
Princeton, New Jersey

September 25, 1987

Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation

Exhibit A

Balance Sheet at June 30, 1987
 (With Comparative Totals for 1986)

| ASSETS | 1987 | 1986 |
|--|----------------------|----------------------|
| Operating Funds: | | |
| Cash | \$ 24,143 | \$ 25,802 |
| Temporary investments | 710,503 | 855,120 |
| Accounts and notes receivable | 69,619 | 71,758 |
| Government contracts receivable | 162,396 | 183,943 |
| Private gifts and grants receivable | 116,139 | 40,879 |
| Accrued income on investments | 1,372,307 | 1,217,476 |
| Deferred charges | 168,745 | 156,129 |
| Total operating funds | <u>\$ 2,623,852</u> | <u>\$ 2,551,107</u> |
| Plant Funds: | | |
| Temporary investments | \$ 20,000 | \$ 18,000 |
| Debt service fund deposits | 440,693 | 434,232 |
| Unamortized debt expense | 74,571 | 77,679 |
| Land, buildings and improvements, equipment and rare book collection at cost, less accumulated depreciation of \$12,332,024 at June 30, 1987 (Note C) | 15,504,671 | 15,898,601 |
| Total Plant Funds | <u>\$ 16,039,935</u> | <u>\$ 16,428,512</u> |
| Endowment and Similar Funds: (Note B) | | |
| Cash | \$ 10,991 | |
| Due from brokers, net | | \$ 522,775 |
| Marketable securities, at cost (Note D) | 161,552,825 | 136,537,598 |
| Mortgages and notes receivable from faculty and staff | 2,164,198 | 2,224,585 |
| Total Endowment and Similar Funds | <u>\$163,728,014</u> | <u>\$139,284,958</u> |
| LIABILITIES AND FUND BALANCES | | |
| | 1987 | 1986 |
| Operating Funds: | | |
| Accounts payable and accrued expenses | \$ 507,769 | \$ 548,724 |
| Deferred restricted revenue (Note G) | 967,637 | 603,567 |
| Fund balance (Exhibit B)—unrestricted | 1,148,446 | 1,398,816 |
| Total operating funds | <u>\$ 2,623,852</u> | <u>\$ 2,551,107</u> |
| Plant Funds: | | |
| Interest payable (Note D) | \$ 310,693 | \$ 314,233 |
| Long-term debt (Note D) | 8,039,322 | 8,616,544 |
| Deposit | 20,000 | |
| Plant funds balance (Exhibit B) | 7,669,920 | 7,497,735 |
| Total plant funds | <u>\$ 16,039,935</u> | <u>\$ 16,428,512</u> |
| Endowment and Similar Funds: | | |
| Due to brokers, net | \$ 4,446,018 | |
| Fund balances (Exhibit B): | | |
| True endowment | 39,364,190 | \$ 33,835,693 |
| Quasi-endowment funds: | | |
| Restricted | 5,330,230 | 4,908,988 |
| Unrestricted: | | |
| Designated | 8,228,243 | 6,839,419 |
| Undesignated | 106,359,333 | 93,700,858 |
| Total endowment and similar funds | <u>\$163,728,014</u> | <u>\$139,284,958</u> |

See notes to financial statements.

**Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation**

Exhibit B

**Statement of Support and Revenue, Expenses, Capital Additions, and Changes in Fund Balances
for the Year Ended June 30, 1987 (With Comparative Totals for 1986)**

| | Operating Funds | | Total | Plant Funds | Endowment and Similar Funds | TOTAL 1987 | TOTAL 1986 |
|---|-----------------|-------------|--------------|----------------|--------------------------------|--------------|--------------|
| | Unrestricted | Restricted | | | | ALL FUNDS | ALL FUNDS |
| Support and Revenue: | | | | | | | |
| Endowment income (net of management fees) | \$5,376,993 | \$2,401,804 | \$ 7,778,797 | | | \$ 7,778,797 | \$ 8,111,423 |
| Private gifts and grants | 3,800 | 2,069,726 | 2,073,526 | | | 2,073,526 | 2,031,638 |
| Government contracts | | 513,219 | 513,219 | | | 513,219 | 576,067 |
| Total support and revenue | 5,380,793 | 4,984,749 | 10,365,542 | | | 10,365,542 | 10,719,128 |
| Expenses: | | | | | | | |
| School of Mathematics | 932,704 | 1,461,392 | 2,394,096 | \$ 139,525 | | 2,533,621 | 2,426,050 |
| School of Natural Sciences | 1,143,496 | 1,171,270 | 2,314,766 | 364,522 | | 2,679,288 | 2,763,397 |
| School of Historical Studies | 1,569,956 | 423,206 | 1,993,162 | 233,579 | | 2,226,741 | 2,202,491 |
| School of Social Science | | 1,095,362 | 1,095,362 | 77,947 | | 1,173,309 | 1,079,339 |
| Libraries | 985,312 | 163,599 | 1,148,911 | 84,161 | | 1,233,072 | 1,162,169 |
| Director's Special Purpose Fund | 37,350 | 48,596 | 85,946 | 517 | | 86,463 | 97,767 |
| Administration and General | 1,735,667 | 14,781 | 1,750,448 | 157,147 | | 1,907,595 | 1,984,291 |
| Auxiliary Activity—tenants' housing expenses net of \$143,071 of revenue in 1987 | | | | | | | |
| Total expenses | 122,998 | 80,124 | 203,122 | 63,689 | | 266,811 | 324,688 |
| | 6,527,483 | 4,458,330 | 10,985,813 | 1,121,087 | | 12,106,900 | 12,040,192 |
| Excess (deficiency) of support and revenue over expenses before capital additions | (1,146,690) | 526,419 | (620,271) | (1,121,087) | | (1,741,358) | (1,321,064) |

| | | | | | | | | |
|--|-------------|-----------|--------------|-------------|---------------|--|-------------|---------------|
| Capital Additions: | | | | | | | | |
| Gifts and grants | | 729,327 | \$ 348,661 | | 1,077,988 | | | 1,044,919 |
| Realized gain on retirement of long-term debt | | 99,097 | | | 99,097 | | | |
| Realized net gains on investments | | 69,770 | 20,411,587 | | 20,481,357 | | | 17,757,466 |
| Investment income | | 1,769 | | | 1,769 | | | 3,818 |
| Total capital additions | | 899,963 | 20,760,248 | | 21,660,211 | | | 18,806,203 |
| Excess (deficiency) of support and revenue over expenses after capital additions | (1,146,690) | 526,419 | (620,271) | (221,124) | 19,918,853 | | | 17,485,139 |
| Fund Balances at Beginning of Year | 1,398,816 | -0- | 1,398,816 | 7,497,735 | 139,284,958 | | | 130,696,370 |
| Transfers: | | | | | | | | |
| Proceeds from disposal of plant facilities | 519,125 | | 519,125 | (519,125) | | | | |
| Plant acquisitions and principal debt service payments | (912,434) | | (912,434) | 912,434 | | | | |
| Quasi-endowment funds utilized | 1,289,629 | | 1,289,629 | | | | (1,289,629) | |
| Transfers to endowment and similar funds | | (526,419) | (526,419) | | 526,419 | | | |
| Fund Balances at End of Year | \$1,148,446 | \$ -0- | \$ 1,148,446 | \$7,669,920 | \$168,100,362 | | | \$148,181,509 |

See notes to financial statements.

**Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation**

Statement of Changes in Financial Position
for the Year Ended June 30, 1987 (With Comparative Totals for 1986)

Exhibit C

| | Operating Funds | Plant Funds | Endowment and Similar Funds | TOTAL 1987 ALL FUNDS | TOTAL 1986 ALL FUNDS |
|---|--------------------|----------------|--------------------------------|-------------------------|-------------------------|
| Resources Provided: | | | | | |
| Excess (deficiency) of support and revenue over expenses before capital additions | \$ (620,271) | \$(1,121,087) | | \$ (1,741,358) | \$ (1,321,064) |
| Capital additions: | | | | | |
| Gifts and grants | | 729,327 | \$ 348,661 | 1,077,988 | 1,044,919 |
| Realized gain on retirement of long-term debt | | 99,097 | | 99,097 | |
| Realized net gain on investments | | 69,770 | 20,411,587 | 20,481,357 | 17,757,466 |
| Investment income | | 1,769 | | 1,769 | 3,818 |
| Excess (deficiency) of support and revenue over expenses after capital additions | (620,271) | (221,124) | 20,760,248 | 19,918,853 | 17,485,139 |
| Items not using (providing) resources: | | | | | |
| Depreciation | | 1,121,087 | | 1,121,087 | 1,089,493 |
| Amortization of debt expense | | 3,108 | | 3,108 | 3,107 |
| Gain on disposition of investments-net | | (69,770) | (20,411,587) | (20,481,357) | (17,757,466) |
| Proceeds from sale of investments | | | 177,735,677 | 177,735,677 | 231,615,852 |
| Proceeds from disposal of plant facilities | | 519,125 | | 519,125 | 350,118 |
| Decrease in receivables | | | 522,775 | 522,775 | 533,905 |
| Decrease in accrued income | | | 4,446,018 | 4,446,018 | 14,202 |
| Increase in payables | | 20,000 | | 20,000 | 236,102 |
| Increase in deposit | 364,070 | | | 364,070 | 62,940 |
| Increase in deferred restricted revenue | | | | | |
| Total resources provided | (256,201) | 1,372,426 | 183,053,131 | 184,169,356 | 233,633,392 |

| | | | | |
|---|------------------|--------------------|--------------------|--------------------|
| Resources Used: | | | | |
| Purchases of investments | | 182,278,930 | 182,278,930 | 227,721,821 |
| Purchases of plant facilities and equipment | 1,176,512 | | | 1,899,344 |
| Increase in receivables | 51,574 | | 51,574 | 522,775 |
| Increase in deferred charges | 12,616 | | 12,616 | 29,174 |
| Increase in debt service fund deposits | 6,461 | | 6,461 | 1,621 |
| Increase in accrued income | 154,831 | | 154,831 | 31,897 |
| Decrease in payables | 40,955 | | 44,495 | 2,884,499 |
| Reduction of long-term debt | 577,222 | | 577,222 | 146,222 |
| Total resources used | <u>1,763,735</u> | <u>182,278,930</u> | <u>184,302,641</u> | <u>233,237,353</u> |

| | | | | |
|--|----------------|------------------|----------------|------------|
| Transfers: | | | | |
| Proceeds from disposal of plant facilities | 519,125 | | | |
| Plant acquisitions and principal debt service payments | (912,434) | | | |
| Quasi-endowment funds utilized | 1,289,629 | | (1,289,629) | |
| Transfers to endowment and similar funds | (526,419) | | 526,419 | |
| Total transfers | <u>369,901</u> | <u>(763,210)</u> | <u>393,309</u> | |
| Increase (decrease) in cash and temporary investments | \$ (146,276) | \$ 10,991 | \$ (133,285) | \$ 396,039 |

See notes to financial statements.

Notes to Financial Statements

June 30, 1987

A. Summary of Significant Accounting Policies

The Institute has stated its purpose as follows: "The Institute for Advanced Study, an independent, private institution devoted to the encouragement, support, and patronage of learning, was founded in 1930 as a community of scholars where intellectual inquiry could be carried out in the most favorable circumstances.

Focused on mathematics and classical studies at the outset, the Institute today consists of the School of Historical Studies, the School of Mathematics, the School of Natural Sciences, and the School of Social Science. Each School has a small permanent Faculty, and some 160 fellowships are awarded annually to Visiting Members from other research institutions and universities throughout the world.

The objectives of the Institute were described as follows in the Founders' original letter to the first Trustees: "The primary purpose is the pursuit of advanced learning and exploration in fields of pure science and high scholarship to the utmost degree that the facilities of the institution and the ability of the faculty and students will permit."

Basis of Presentation

The accompanying financial statements are prepared on the accrual basis and are presented in accordance with recommendations contained in *Audits of Certain Nonprofit Organizations* by the American Institute of Certified Public Accountants.

Plant Assets and Depreciation

Uses of operating funds for plant acquisitions and principal debt service payments are accounted for as transfers to plant funds. Proceeds from the sale of plant assets, if unrestricted, are transferred to operating funds, or, if restricted, to deferred amounts restricted for plant acquisitions. Depreciation is provided over the estimated useful lives of the respective assets on a straight-line basis (buildings and capital improvements 20-40 years, equipment 3-6 years).

Fund Accounting

The accounts of the Institute are maintained in accordance with the principles of "fund accounting." This is the procedure by which resources for various purposes are classified for accounting and reporting purposes into funds that are in accordance with activities or objectives specified. Separate accounts are maintained for each fund; however, in the accompanying financial statements, funds that have similar characteristics have been combined into fund groups.

Fund balances restricted by outside sources are so indicated and are distinguished from unrestricted funds al-

located or designated to specific purposes by action of the governing board. Externally restricted funds may only be utilized in accordance with the purpose established by the source of such funds and are in contrast with unrestricted funds over which the governing board retains full control to use in achieving any of its institutional purposes.

True endowment funds are subject to the restrictions of gift instruments requiring in perpetuity that the principal be invested and the income only be utilized. Quasi-endowment funds have been established by the governing board to function as endowment funds and any portion of these funds may be expended. Unrestricted funds functioning as endowments have no external restrictions. However, certain of these funds have been internally designated to support specific needs of the Institute.

All gains and losses arising from the sale, collection, or other disposition of investments and other non-cash assets are accounted for in the fund which owned such assets. Ordinary income derived from investments, receivables, and the like, is accounted for in the fund owning such assets, except for income derived from investments of endowment and similar funds, which income, if unrestricted, is accounted for as revenue in unrestricted operating funds, or if restricted, as deferred restricted revenue until used in accordance with the terms of the restriction or transferred to endowment and similar funds.

B. Investments

Investments purchased by the Institute are recorded at cost; investments received by gift are carried at fair market value at the date of donation. Realized gains and losses are computed based on the average cost of the investment.

Assets of endowment and similar funds are pooled with each individual fund subscribing to or disposing of units on the basis of the market value per unit, determined on a quarterly basis.

The following tabulation summarizes changes in relationships between carrying and market values of the pooled investments:

| | Pooled Assets | | Net Increase | Market Value Per Unit |
|--|-----------------|-------------------|---------------------|-----------------------------|
| | Market Value | Carrying Value | | |
| July 1, 1986 | \$165,242,290 | \$139,284,958 | \$25,957,332 | \$6.460 |
| June 30, 1987 | 185,738,688 | 159,281,996 | <u>26,456,692</u> | 7.276 |
| Unrealized appreciation for the year ended June 30, 1987 | | | 499,360 | |
| Realized net gain for the year ended June 30, 1987 | | | <u>20,411,587</u> | |
| Net change for the year ended June 30, 1987 | | | <u>\$20,910,947</u> | |

Earnings per unit, for the year ended June 30, 1987, exclusive of realized gains and losses, amounted to \$304, after deducting management fees.

The pooled investments at June 30, 1987 are comprised of the following:

| | Carrying Value | Market Value |
|--------------------------------|----------------------|----------------------|
| Cash | \$ 10,991 | \$ 10,991 |
| Cash equivalents | 10,274,682 | 10,274,682 |
| Equity securities | 74,263,139 | 100,259,844 |
| Debt securities | 77,015,004 | 77,474,991 |
| Mortgages and notes receivable | 2,164,198 | 2,164,198 |
| Investment accounts receivable | 2,595,477 | 2,595,477 |
| Investment accounts payable | (7,041,495) | (7,041,495) |
| | <u>\$159,281,996</u> | <u>\$185,738,688</u> |

C. Physical Plant

Physical plant and equipment are stated at cost at date of acquisition, less accumulated depreciation. Library books, other than rare books purchased subsequent to June 30, 1947, have not been capitalized because it is not practicable to determine the value of such books.

A summary of plant assets follows:

| | |
|-------------------------------|----------------------|
| Land | \$ 2,350,032 |
| Buildings and improvements | 20,138,621 |
| Equipment | 5,148,534 |
| Rare book collection | 199,508 |
| Total | <u>27,836,695</u> |
| Less accumulated depreciation | <u>(12,332,024)</u> |
| Net book value | <u>\$ 15,504,671</u> |

D. Long-Term Debt

A summary of long-term debt follows:

| | |
|--------------------------------|--------------------|
| 7.804%, 1980—NJEFA | \$8,130,000 |
| Less unamortized bond discount | (90,678) |
| Total long-term debt | <u>\$8,039,322</u> |

On July 24, 1980, the Institute for Advanced Study received proceeds of the New Jersey Educational Facilities Authority (NJEFA) offer of \$8,775,000 Revenue Bonds, 1980 Series A, the Institute for Advanced Study Issue. Of the net proceeds, \$4,100,000 was used to reimburse the Institute for the construction of its West Building, Dining Hall, and Social Science Library, and \$1,976,559 was used to reimburse certain capital improvements. The balance was used for major repairs and remodeling to the apartment housing facility for Visiting Members and other construction and major remodeling projects of Institute facilities.

The bonds are dated July 1, 1980, bear interest, payable semi-annually, at the net average annual rate of 7.804%, are subject to redemption at various prices, and require principal payments and sinking fund installments through July 1, 2011. Bond principal in the amount of \$130,000 matured on July 1, 1987 and bond principal in the amount of \$135,000 (1988), \$145,000 (1989), \$155,000 (1990) and \$165,000 (1991) will mature on July 1 of the designated years. The obligation to pay the Authority on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation of the Institute and is collateralized by United States Treas-

ury Notes, 13.00% due November 15, 1990, with an aggregate face amount of \$8,700,000.

During fiscal year 1987, the Institute for Advanced Study retired the Institute for Advanced Study Apartment Bonds of 1956. This retirement resulted in a realized gain of \$99,097.

Interest expense on long-term debt for the year ended June 30, 1987 was \$653,000.

E. Retirement Plans

Separate voluntary defined contribution retirement plans are in effect for faculty members and eligible staff personnel, both of which provide for annuities which are funded with the Teachers Insurance and Annuity Association and/or the College Retirement Equities Fund. Payments for the year ended June 30, 1987 amounted to \$531,000.

In addition to the formal plans, the Board of Trustees or the Director has at various times authorized the payment of pensions to certain members, employees, and the widow of a deceased member. Total pension payments which aggregated \$84,000 for the year ended June 30, 1987 have been charged to expense and no reserves have been provided for pensions payable in subsequent years.

In addition to providing pension benefits, the Institute provides certain health care and life insurance benefits for retired employees and faculty. Substantially all of the Institute's employees may become eligible for those benefits if they reach normal retirement age while working for the Institute. The cost of retiree health care and life insurance benefits is recognized as expense as premiums are paid. For fiscal year 1987, those costs totaled \$52,000.

F. Funds Held in Trust by Others

The Institute is the residuary beneficiary of a trust under the Will of George Placzek, Deceased, and upon the death of the life tenant will be entitled to receive the corpus thereof. The approximate market value of the assets under the Will, as reported by the administrator of the Estate, aggregated \$1,758,000 as of June 30, 1987 and is not included in the accompanying financial statements.

G. Changes in Deferred Restricted Revenue

Restricted receipts, which are recorded initially as deferred restricted revenue, are reported as revenues when expended in accordance with the terms of the restriction. Changes in deferred restricted revenue amounts are as follows:

| TOTAL DEFERRED RESTRICTED REVENUE | |
|---|-------------------|
| Balance at July 1, 1986 | \$ 603,567 |
| Additions: | |
| Contributions, grants, etc. | 2,947,015 |
| Net restricted endowment income | <u>2,401,804</u> |
| Total additions | <u>5,348,819</u> |
| Deductions: | |
| Funds expended from contributions, grants, etc. | 2,582,945 |
| Funds expended from restricted endowment | 1,875,385 |
| Transfer to endowment and similar funds | <u>526,419</u> |
| Total deductions | <u>4,984,749</u> |
| Balance at June 30, 1987 | <u>\$ 967,637</u> |

H. Functional Allocation of Expenses

The costs of providing the various programs and other activities have been summarized on a functional basis in the statement of support and revenue, expenses, capital additions, and changes in fund balances. Accordingly, certain costs have been allocated among the programs and supporting services benefited. The costs incurred by the Institute in operating both the Dining Hall (\$280,000 net of \$301,000 in revenues) and Members' Housing (\$247,000 net of \$751,000 in revenues) have been allocated among the programs and supporting services benefited.

I. Securities Lending

The Institute for Advanced Study maintains an agreement with a bank which permits the lending of securities to brokerage firms. The securities are returnable on demand and are collateralized primarily by cash, letters of credit, or U.S. Government or agency securities. At June 30, 1987, there were no security loans outstanding under this agreement.

The Institute continues to receive the interest and dividends on the loaned securities. Income from the investment of the collateral amounted to \$39,000 for fiscal year 1987, net of fees and related expenses.

Donors

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