

THE INSTITUTE FOR ADVANCED STUDY

Founded by Mr. Louis Bamberger and Mrs. Felix Fuld

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THE INSTITUTE FOR ADVANCED STUDY
Princeton, New Jersey
October, 1941

*Extract from the letter addressed by
the Founders to their Trustees, dated
Newark, New Jersey, June 6, 1930*

“It is fundamental in 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.”

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WALTHER MAYER

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ERNST HERZFELD

E. A. LOWE

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ERWIN PANOFSKY

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Field Mediaevalist

KURT WEITZMANN

Research Assistant

HANNS SWARZENSKI

Assistants

FRANCES FOLLIN JONES

ISABELLE K. RAUBITSCHEK

W. KENDRICK PRITCHETT

THE GEST ORIENTAL LIBRARY

Curator

NANCY LEE SWANN

* Through the courtesy of Wellesley College, Professor Campbell is spending part of his time on work in connection with the Antioch excavation on behalf of the Institute.

CALENDAR

1941-1942

September 22	First term begins
December 20	First term ends
February 2	Second term begins
May 2	Second term ends

ADMISSION OF MEMBERS

Applications for admission should be addressed to the Institute for Advanced Study, Princeton, New Jersey. The Trustees have set aside a sum which may be used for stipends for persons of distinct ability and promise who require a limited amount of financial aid.

MEMBERS, 1940-1941

- FELIX ADLER, Ph.D., University of Zürich, 1938
WARREN AMBROSE, Ph.D., University of Illinois, 1939
PETER G. BERGMANN, Dr. rer. nat., German University of Prague, 1936
RICHARD BERNHEIMER, Ph.D., University of Munich, 1930
Assistant Professor, Bryn Mawr College
DAVID G. BOURGIN, Ph.D., Harvard University, 1926
Assistant Professor, University of Illinois
JAMES H. BREASTED, JR., M.A., University of Chicago, 1937
BERNARD BRODIE, Ph.D., University of Chicago, 1940
OSCAR BRONEER, Ph.D., University of California, 1931
Associate Professor, American School of Classical Studies at Athens
EDWARD CAPPS, JR., Ph.D., Princeton University, 1931
Assistant Professor, Oberlin College
KEI-WON CHUNG, Ph.D., Princeton University, 1938
PAUL A. CLEMENT, Ph.D., The Johns Hopkins University, 1930
CHARLES L. CRITCHFIELD, Ph.D., George Washington University, 1939
NEILSON CAREL DEBEVOISE, Ph.D., University of Illinois, 1930; Instructor, University of Chicago
ÉTIENNE ROLAND DENNERY, Agrégé, University of Paris, 1926; Professor, École libre des Sciences Politiques, Paris; Rockefeller Fellow
CHARLES DE TOLNAY, Ph.D., University of Vienna, 1925
DAVID DURAND, A.M., Columbia University, 1938

LEONARD EISENBUD, B.S., Union College, 1935
 GEORGE M. EWING, Ph.D., University of Missouri, 1935
 Assistant Professor, University of Missouri
 PAUL FRANKL, Ph.D., University of Munich, 1910
 ORRIN FRINK, JR., Ph.D., Columbia University, 1926
 Professor, Pennsylvania State College
 GUIDO FUBINI, Dr. Math., University of Pisa, 1900
 FELIX GILBERT, Ph.D., University of Berlin, 1931
 KURT GÖDEL, Ph.D., University of Vienna, 1930
 ALLAN S. HOEY, Ph.D., Yale University, 1940
 SHIZUO KAKUTANI, Rigakushi, Tohoku Imperial University,
 1934; Assistant Professor, Osaka Imperial University
 ALBERT T. LAUTERBACH, Dr. rer. pol., University of Vienna,
 1925
 ROBERT D. LEIGH, Ph.D., Columbia University, 1926
 President, Bennington College
 WILLIAM W. LOCKWOOD, M.A., Harvard University, 1939
 Secretary, American Committee for International Studies
 DOROTHY MAHARAM, B.S. Carnegie Institute of Technology,
 1937
 JONATHAN MITCHELL, A.B., Amherst College, 1921
 H. TOWNSEND MUHLY, Ph.D., The Johns Hopkins Uni-
 versity, 1940; National Research Council Fellow
 TOSHINOSUKE MUTO, Ph.D., Kyushu Imperial University,
 1934; Professor, Kyushu Imperial University
 GORDON PALL, Ph.D., University of Chicago, 1929
 Assistant Professor, McGill University; Guggenheim
 Fellow
 WOLFGANG PAULI, Ph.D., University of Munich, 1921
 Professor, Eidgenössische Technische Hochschule,
 Zürich

STEFAN T. POSSONY, Ph.D., University of Vienna, 1935
 ANTON RAUBITSCHKE, Ph.D., University of Vienna, 1935
 ERICH ROLL, Ph.D., University of Birmingham, 1930
 Professor, Hull University
 HERBERT ROSINSKI, Ph.D., University of Berlin, 1930
 CLAUDE E. SHANNON, Ph.D., Massachusetts Institute of
 Technology, 1940
 SEYMOUR SHERMAN, Ph.D., Cornell University, 1940; Na-
 tional Research Council Fellow
 CARL L. SIEGEL, Dr. Phil., University of Göttingen, 1920
 RICHARD F. S. STARR, Ph.D., Princeton University, 1938;
 Guggenheim Fellow
 RICHARD P. STEBBINS, Ph.D., Harvard University, 1940;
 Social Science Research Council Fellow
 RICHARD STILLWELL, M.F.A. in Architecture, Princeton Uni-
 versity, 1924; Associate Professor, Princeton University
 ABRAHAM H. TAUB, Ph.D., Princeton University, 1935
 Assistant Professor, University of Washington
 PAUL TEDESCO, Ph.D., University of Vienna, 1920
 ROBERT M. THRALL, Ph.D., University of Illinois, 1937
 Instructor, University of Michigan
 WALDEMAR TRJITZINSKY, Ph.D., University of Illinois, 1937
 Instructor, University of Illinois
 ALFRED VAGTS, Ph.D., University of Hamburg, 1927
 ALBERT K. WEINBERG, Ph.D., The Johns Hopkins University,
 1931; Instructor, The Johns Hopkins University
 MARIAN WELKER, Ph.D., University of Pennsylvania, 1938
 ENOS S. WITMER, Ph.D., University of Pennsylvania, 1923
 Assistant Professor, University of Pennsylvania

MEMBERS, 1941-1942

FELIX ADLER, Ph.D., University of Zürich, 1938
DAVID BLACKWELL, Ph.D., University of Illinois, 1941;
Rosenwald Fellow
RICHARD D. BRAUER, Ph.D., University of Berlin, 1925;
Assistant Professor, University of Toronto; Guggen-
heim Fellow
OSCAR BRONEER, Ph.D., University of California, 1931
SUBRAHMANYAN CHANDRASEKHAR, Ph.D., University of
Cambridge, 1933; Professor, Yerkes Observatory, Uni-
versity of Chicago
KEI-WON CHUNG, Ph.D., Princeton University, 1938
PAUL A. CLEMENT, Ph.D., The Johns Hopkins University,
1930
KENNETH S. COLE, Ph.D., Cornell University, 1926; Asso-
ciate Professor, Columbia University; Consultant Physi-
cist, Presbyterian Hospital; Guggenheim Fellow
SIDNEY M. DANCOFF, Ph.D., University of California, 1939;
National Research Council Fellow
REV. MARTIN CYRIL D'ARCY, S.J., Master of Campion Hall,
Oxford
NORMAN DAVIDS, Ph.D., New York University, 1940
CHARLES DE TOLNAY, Ph.D., University of Vienna, 1925
HARVEY A. DEWEERD, Ph.D., University of Michigan, 1937;
Associate Professor, Denison University
JOSEPH L. DOOB, Ph.D., Harvard University, 1932; Asso-
ciate Professor, University of Illinois
DAVID DURAND, Ph.D., Columbia University, 1941

PAUL FRANKL, Ph.D., University of Munich, 1910
GUIDO FUBINI, Dr. Math., University of Pisa, 1900
FELIX GILBERT, Ph.D., University of Berlin, 1931
KURT GÖDEL, Ph.D., University of Vienna, 1930
NELSON GLUECK, Ph.D., University of Jena, 1926; Pro-
fessor, Hebrew Union College
CYRUS H. GORDON, Ph.D., University of Pennsylvania, 1930
W. BRADDOCK HICKMAN, Ph.D., The Johns Hopkins Uni-
versity, 1937
GERHARD P. HOCHSCHILD; Ph.D., Princeton University, 1941
LEICESTER B. HOLLAND, Ph.D., University of Pennsylvania,
1919; Professor, University of Pennsylvania; Chief,
Division of Fine Arts, Library of Congress
SHIZUO KAKUTANI, Rigakushi, Tohoku Imperial University,
1934; Assistant Professor, Osaka Imperial University
ELLIS R. KOLCHIN, Ph.D., Columbia University, 1941; Na-
tional Research Council Fellow
MARION LAWRENCE, Ph.D., Radcliffe College, 1932; Assis-
tant Professor, Barnard College
ROBERT D. LEIGH, Ph.D., Columbia University, 1926;
Former President, Bennington College
DORO LEVI, Ph.D., University of Florence, 1920; Guggen-
heim Fellow
WILLIAM W. LOCKWOOD, M.A., Harvard University, 1939;
Secretary, American Committee for International Studies
CLARENCE D. LONG, JR., Ph.D., Princeton University, 1938;
Assistant Professor, Wesleyan University; Guggenheim
Fellow
GEORGE W. MACKEY, M.A., Harvard University, 1939;
Sheldon Fellow

DOROTHY MAHARAM, B.S., Carnegie Institute of Technology,
1937

ÉTIENNE MANTOUX, Docteur en droit, University of Lyon,
1941; Rockefeller Fellow

JONATHAN MITCHELL, A.B., Amherst College, 1921

DEANE MONTGOMERY, Ph.D., University of Iowa, 1933;
Associate Professor, Smith College; Guggenheim Fellow

WOLFGANG PAULI, Ph.D., University of Munich, 1921; Pro-
fessor, Eidgenössische Technische Hochschule, Zürich

DEWITT CLINTON POOLE, M.Dip., George Washington Uni-
versity, 1910

STEFAN T. POSSONY, Ph.D., University of Vienna, 1935

ANTON RAUBITSCHK, Ph.D., University of Vienna, 1935

HANS SAMELSON, Dr. Sc. Math., Eidgenössische Technische
Hochschule, Zürich, 1940

LEONARD J. SAVAGE, Ph.D., University of Michigan, 1941;
Rackham Fellow

MARIO SCHENBERG, Doutor Engenheiro, University of San
Pãulo, Brazil, 1935; Licenciado em Mathematica, 1936;
Associate Professor, University of San Pãulo; Guggen-
heim Fellow

CARL L. SIEGEL, Dr. Phil., University of Göttingen, 1920

RICHARD STILLWELL, M.F.A. in Architecture, Princeton Uni-
versity, 1924; Associate Professor, Princeton Univer-
sity

ARTHUR H. STONE, B.A., University of Cambridge, 1938

PAUL TEDESCO, Ph.D., University of Vienna, 1920

ROBERT M. THRALL, Ph.D., University of Illinois, 1937

MAXIM VON BREVERN, Ph.D., University of Washington,
1935; Assistant Professor, University of Washington

ALFRED VAGTS, Ph.D., University of Hamburg, 1927

JEAN WEILLER, Agrégé, Faculté de droit, University of
Paris, 1936; Professor, University of Toulouse; Rocke-
feller Fellow

SAUL S. WEINBERG, Ph.D., The Johns Hopkins University,
1936; Guggenheim Fellow

TUNG YIU, B.A., Oxford, 1938; Professor, National North-
western Union University, China

Officials of the Economic, Financial, and Transit Section of the League of Nations housed in Fuld Hall as guests of the Institute for Advanced Study.

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MRS. P. W. VAN ITTERSUM	Netherlands
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MR. PERCY G. WATTERSON	Great Britain

I

HISTORY AND ORGANIZATION

FOR more than half a century preceding the outbreak of the World War in 1914 American scholars and scientists who had received the Ph.D. degree and who desired further opportunities for research under the direction of a great master usually went to a foreign university.

Meanwhile, progress in advanced study beyond the graduate school had been taking place in America. The leading American universities in addition to offering abundant opportunities for those desiring to obtain the Ph.D. degree have during the last generation steadily increased their facilities for advanced work on the part of competent and well trained individuals. The Rockefeller Foundation, the Carnegie Corporation of New York, the Guggenheim Foundation, and the Commonwealth Fund had been making grants which enabled young men who had already attained the Ph.D. degree to work under first-rate scholars and scientists in American universities quite independently of the ordinary routine of the graduate school.

In 1930 an additional step forward was taken when Mr. Louis Bamberger and his sister, Mrs. Felix Fuld, decided to establish an institute for advanced study—an institute entirely free from all degree-giving obligations and designed to offer informal opportunities, without routine, to a carefully chosen fac-

ulty who would surround themselves with a group of selected younger men who had given promise of scholarly and scientific development. The Institute discarded both undergraduate and graduate departments on the ground that these already existed in abundance; the real need was felt to lie in the field beyond the graduate school. The Trustees and Faculty of Princeton University welcomed the Institute to Princeton and have most generously made available to the staff and members all its resources in faculty, libraries, and other facilities for advanced work. Nothing could exceed in cordiality and mutual helpfulness the relationships established between the University and the Institute during the last eight years.

Gifts have been made for specific purposes as follows: the Rockefeller Foundation has contributed half the cost of the great Gest Oriental Library; and the Carnegie Institution of Washington has continued its coöperation in the field of Latin palaeography. In addition, various members of the Institute have been supported by fellowships or stipends from the Rockefeller Foundation, the Carnegie Corporation, the National Research Council, the Guggenheim Foundation, the Emergency Committee in Aid of Displaced Foreign Scholars, the Commonwealth Fund, the Julius Rosenwald Fund, the C.R.B. Educational Foundation, and other agencies.

The Founders have increased the capital funds of the Institute so that in addition to the School of Mathematics, which was opened in 1933, the School

of Humanistic Studies and the School of Economics and Politics were started in 1935. In the autumn of 1939 the three schools as well as the office of the director were moved to Fuld Hall, the gift of the Founders, who have also provided funds for a working library in these schools. This new building is located on the Olden Farm, the site of the Battle of Princeton outside the Borough beyond the Graduate College. The first director, Dr. Abraham Flexner, retired in October, 1939, and Dr. Frank Aydelotte, then President of Swarthmore College, was selected as his successor.

In order that the ideals of the Founders might be realized, the organization and administration of the Institute have been kept simple and unostentatious, and the several schools are, in their internal conduct, as nearly autonomous as possible. The Board of Trustees is composed of laymen, scholars, and scientists. In order to avoid difficulties and evils that have developed in institutions where both full-time and part-time arrangements are employed, the Institute is pledged to its Founders to adhere strictly to the full-time basis.

The Institute is composed not of a group of students and teachers but rather of a group of scholars working together. Professors from other institutions who come to the Institute as members work in close coöperation with the regular staff of the Institute and with professors of Princeton University to the mutual advantage of all three groups. While advanced scholars may profit by seminars or lecture

courses which bring them in touch with the latest advances in the various branches of their science, they value even more the opportunity for informal and frequent contact with other investigators with whom they exchange ideas regarding the problems or fields in which they are interested. For this they make their own individual arrangements; no two persons have ever pursued the same course of action. The group contains members several of whom conduct seminars or meet in conference on various subjects. There is in addition a steady stream of young men who have already given evidence of unusual talent.

It is the purpose of the Institute to provide stimulating conditions for independent study and research. The interaction between the various groups at Princeton creates an intellectual atmosphere that is highly stimulating both to the members of the permanent staff and to those who come to Princeton for a more or less limited period. Thus, while the Institute and Princeton University are organically and administratively entirely distinct, the faculties and students of the two institutions cooperate in any direction that promises more favorable results than either institution could obtain alone, the students availing themselves of the courses, seminars, and opportunities for conference and direction of work in both institutions.

II

SCHOOL OF MATHEMATICS

IN the School of Mathematics work is carried on by individual contact with students, by seminars, by courses of lectures, and by other means, each professor being free to follow the methods he prefers and to vary them from year to year. It will be noticed that the staff consists only of professors, assistants, and one associate, differing in this respect from the faculty of a university which has varied teaching responsibilities. However, as is shown below, the work of the permanent staff is amplified by the activities of the temporary members.

Most of the lectures and seminars by members of the School of Mathematics are held in Fine Hall on the campus of Princeton University. These lectures and seminars are open to advanced students in the University; and University courses are open to members of the Institute.

In 1940-1941 Professor Alexander lectured on topology and lattice theory. In 1941-1942 he plans to lecture on combinatory analysis situs.

In 1940-1941 Professor Einstein pursued his investigations in general relativity, and he intends to continue in this direction during 1941-1942.

In 1940-1941 Professor Morse conducted a seminar on the foundations of the variational theory of multiple integrals. In 1941-1942 he will continue this seminar, extending the theory in the large and

devoting as much time as possible to the topological aspects of the theory.

In 1940-1941 Professor Veblen studied the theory of binary spinors in collaboration with Professor Taub and Dr. Schwartz. In 1941-1942 he intends to continue along this line, and if the work develops favorably, to join with Professor von Neumann in a seminar on algebraic devices in projective geometry.

In 1940-1941 Professor von Neumann gave the following lectures: in the first term, a course on the theory of invariant measures in groups, and also a series of lectures on the theory of games; in the second term he lectured in collaboration with Dr. Ambrose and Dr. Halmos on the ergodic theorem and connected topics. He expects to lecture in 1941-1942 on topics in the theory of linear spaces and in the theory of measure.

During 1940-1941 Professor Weyl, with Professor Chevalley of Princeton University, conducted a seminar on current literature. He also gave a one-term course on geometry of numbers. His plans for 1941-1942 are as follows: a course on analytic functions during the first term, a course on hydro- and aero-dynamics during the second term, and an informal seminar on some special algebraic subject.

During 1941-1942 Professor Mayer will continue his lectures of 1940-1941 on topology and foundations of the variation calculus.

During the first term of 1940-1941 Dr. Ambrose and Dr. Halmos gave a series of lectures on the theory of probability, particularly on the asymptotic

properties of sequences of independent chance variables and Markoff chains. In the second term Dr. Halmos gave a course on finite matrices presented from the general point of view of the modern theory of operators.

Professor Chandrasekhar will give a series of lectures during the first term of 1941-1942 on principles of stellar dynamics.

By special request Professor Fubini gave a course of lectures in 1941 on the elements of exterior ballistics.

In 1941 Dr. Gödel lectured on some results concerning intuitionistic logic, and in 1941-1942 he will continue his researches on this subject and its connection with the continuum problem.

Professor Pauli lectured throughout 1940-1941 on the theory of elementary particles. These lectures included a review of recent field theories and their applications. In 1941-1942 he expects to lecture on the theory of the cosmic rays.

During the first term of 1940-1941 Professor Siegel lectured on some problems of celestial mechanics, and in the second term on the theory of reduction. In 1941-1942 he intends to give a course of lectures on modular functions.

In the second term of 1940-1941 Dr. Thrall organized and conducted a seminar in the theory of representations, with particular emphasis on the full linear and symmetric groups.

Members of the mathematical groups, both of Princeton University and of the Institute for Ad-

vanced Study, including the temporary members of the Institute as well as occasional visitors from outside, coöperate in several seminars and in the Mathematics Club. Among the papers presented during the past year the following may be noted as indicating the scope and variety of subjects:

- A. ADRIAN ALBERT: Extensions of p-adic fields
Non-associative algebras
- THEODORE W. ANDERSON, JR.: A method of paired comparisons
Analysis of variance for binomial and Poisson data
- BRADFORD H. ARNOLD: Cyclic transitivity
Upper semi-continuous decompositions
- ISAAC L. BATTIN: Application of certain symmetric functions to sampling
A homogeneity test in multivariate analysis
- EDWARD G. BEGLE: Continuous curves
Representations of compact groups
Vietoris cycles
Interior transformations
- GARRETT BIRKHOFF: A generalization of transfinite arithmetic
- H. FREDERIC BOHNENBLUST: Axiomatic characterization of L_p spaces
Introduction to Banach spaces
Projections in L_p spaces
Banach limits
- DAVID G. BOURGIN: Asymptotic behavior of eigenvalues of differential operators
Some problems connected with the damped wave equation

- CLAUDE CHEVALLEY: A theorem of H. Weyl about compact groups
H. Hopf, Topology of generalized groups
- DAN E. CHRISTIE: Free transformations
Fibre spaces
- ALONZO CHURCH: Formulation of the simple theory of types
- CHARLES L. CRITCHFIELD: Meson-pair theory of nuclear forces
- DOUGLAS R. CROSBY: The Gauss-Bonnet formula
- R. P. DILWORTH: Birkhoff lattices
- CHARLES L. DOLPH: Conjugate spaces
- LEONARD EISENBUD: Static meson fields
- PAUL ERDÖS: Polynomials
- ORRIN FRINK, JR.: Series expansions in Banach spaces
- JOHN T. GILCHRIST: Differential trigonometry
- MARIO O. GONZÁLEZ: On integrating factors
- PAUL R. HALMOS: Square roots of measure-preserving transformations
Direct sums of measure spaces
Linear topological spaces
- GERHARD P. HOCHSCHILD: The Riesz theory of operators
- ROBERT HOOKE: Valuations
- NATHAN JACOBSON: Non-commutative principal-ideal rings
- MARK KAC: Statistical methods in number theory
- SHIZUO KAKUTANI: Characterization of the space of continuous functions
Haar measure and Markoff processes on compact groups
Weak topology of Banach spaces
The type problem of Riemann surfaces

- T. KOOPMANS: Linear regression when all the terms are subject to error
- PACO A. LAGERSTRÖM: Independence of the axioms of the theory of types
Boolean algebras and partially ordered linear spaces
- SOLOMON LEFSCHETZ: Vietoris and related homology theories
- WILLIAM T. MARTIN: Removable singularities
- DONALD C. MAY, JR.: Kronecker integrals
Gauss-Bonnet formula for hypersurfaces in Euclidean n -space
- PHILIP J. MCCARTHY: Parabolic tests for linkage
Tests of hypotheses concerning location and scale parameter
On the Behrens-Fisher problem
- BROCKWAY McMILLAN: Chaos
- EDWARD J. MCSHANE: Generalized curves
- FREDERICK C. MOSTELLER: Relations between two sets of variates
The L_1 statistical test
Sampling theory of canonical representations
- HARRY T. MUHLY: The theory of ideals in algebraic geometry
Uniformization of algebraic varieties
- GORDON PALL: Semi-simple algebras
Unique factorization in generalized quaternions
- WOLFGANG PAULI: Stueckelberg and Patry's work on the meson theory of nuclear forces
- GEORGE PÓLYA: The decomposition of definite forms into sums of squares
- HANS A. RADEMACHER: On Ramanujan's and Zuckerman's identities

- RUSSELL REMAGE, JR.: Isoperimetric inequality for surfaces of negative curvature
- ABRAHAM SCHWARTZ: A consequence of the Ricci equations
Relations between the first and second fundamental forms
- IRVING E. SEGAL: Closure of translations of functions
- CLAUDE E. SHANNON: Use of Boolean algebra in relay and switching circuits
- SEYMOUR SHERMAN: A fixed point theorem
- MAX SHIFFMAN: The Morse relations in the Plateau problem
- ERNST SNAPPER: Group rings
Structure of linear sets
- NORMAN E. STEENROD: Topological aspects of defining tensors over manifolds
- ARTHUR H. STONE: Dimension theory
- ALFRED TARSKI: The decision problem in Boolean algebra
- ABRAHAM H. TAUB: Lorentz groups
- ROBERT M. THRALL: Representation spaces
Orthogonal representations of the symmetric group
The symmetric and full linear groups
Group rings
- CHARLES B. TOMPKINS: Isometric imbedding of Riemannian spaces in Euclidean space
Continuity of the area of harmonic surfaces
- WALDEMAR J. TRJITZINSKY: Report on Menchoff's "Factors of conversions for orthogonal series"
Linear partial differential equations
- JOHN W. TUKEY: Reflexive Banach spaces
Ideal chains

ERNEST J. VILLAVASO: A class of distributions which approach the normal distribution

Detection of linkage

JOHN VON NEUMANN: Construction of Haar measure

DAVID F. VOTAW, JR.: Transformations of statistics to simplify their distributions

Quasi-factorial designs

Confidence limits for continuous distributions

ALEXANDER D. WALLACE: Mappings

More transformations

ANDRÉ WEIL: New views on the Riesz theory of integration

Cauchy's theorem for functions of several complex variables

VICTOR F. WEISSKOPF: Possible properties of the mesotron

HERMANN WEYL: Potential theory and its relation to Hilbert space and topology

Lattices and reduction

Representations of the orthogonal group

HASSLER WHITNEY: Geometric methods of combinatorial topology

YUNG CHOW WONG: A generalized equiangular spiral

A quarterly journal called *Annals of Mathematics*, a collection of advanced mathematical texts known as the *Princeton Mathematical Series*, and the less formal photoprinted *Annals of Mathematics Studies*, are published by the Princeton University Press under the joint sponsorship of the Department of Mathematics of Princeton University and the School of Mathematics of the Institute for Advanced Study. The *Annals of Mathematics Studies* continue in improved form the *Princeton Mathematical Notes*,

multigraphed notes of lecture courses given in Princeton for which there had been an ever increasing demand in this country and abroad. The editors of the *Princeton Mathematical Series* are Professors Marston Morse, H. P. Robertson, and A. W. Tucker. The editorial board of the *Annals of Mathematics* consists of Professors S. Lefschetz, H. F. Bohnenblust, J. von Neumann, and associate editors from various institutions.

III

SCHOOL OF ECONOMICS AND POLITICS

IN the School of Economics and Politics Professors Riefler, Stewart, and Warren are mainly interested in research in financial aspects of contemporary economic problems, and Professor Earle in military problems in their relation to foreign policy. Professor Mitrany, who is on leave of absence for special work in the British Foreign Office, is concentrating on political problems of the Balkans.

The work of the School in financial research has been for a number of years closely correlated with the program of the National Bureau of Economic Research. Professor Riefler is Chairman of the Bureau's Committee on Research in Finance and has devoted a considerable proportion of his time during the past year to the studies of recent trends in the financial structure on which they are currently engaged. The studies in Consumer Finance, also developed at the Bureau, are now substantially completed. Eight of the eleven volumes projected have already appeared and it is expected that the others will be published in the near future. Professor Riefler is also acting as Chairman of the Bureau's Committee in Charge of the Corporate Bond Investigation, which, with the aid of a large staff, has been engaged in assembling a wide body of data relating to the loss experience and market behavior of corporate bonds. These data are now tabulated and ready for analysis.

These studies present the facts of current economic activity with quantitative exactness and fullness of detail which would be impossible for any individual investigator and only obtainable by carefully organized coöperative research.

Professor Stewart has continued his work on the financial aspects of contemporary economic organization. During 1940-1941 he acted in an advisory capacity to the Treasury Department in Washington and will continue in this work during the coming year.

Professor Warren, as a member of the newly organized American Economic History Committee, has spent some part of the past year in the preliminary organization and planning of the Committee's program. One research project undertaken by this Committee will explore the financial and monetary history of the American colonies. In this project Professor Warren will be assisted by Mr. Robert McClurkin of the University of Pennsylvania.

Dr. David Durand, formerly associated with the National Bureau of Economic Research, spent last term at the Institute completing his work, *Risk Elements in Consumer Instalment Financing*, published by the Bureau. He will work next term on the construction of a series of basic interest rates based on data derived from the Bond Standards Project referred to above.

Dr. W. Braddock Hickman, who has been on leave from Princeton University during the past year to work with the National Bureau's Bond Standards

Project, will spend the current year at the Institute. He will study certain aspects of the effectiveness of legal regulation of investments on the basis of the material made available by the Project.

President Robert D. Leigh, formerly of Bennington College, spent the year 1940-1941 working on a survey of social science studies in selected secondary schools. He plans to complete his work, including extensive field trips, as a member of the Institute, by the end of the calendar year 1941.

Professor Erich Roll of Hull University, England, who had previously spent one term at the Institute, was here for the second term of 1940-1941 working on his study of the British balance of payments. Professor Roll came to this country on a Rockefeller fellowship. In the spring of 1941 he left the Institute to accept a post with the British Food Mission in this country.

Mr. Jonathan Mitchell, a member of the Institute last term, will be in residence during 1941-1942, continuing the study which he began last year on the diplomatic and financial history of the 1920's.

Professor Clarence D. Long, Jr., of Wesleyan, who has been awarded a Guggenheim fellowship for 1941-1942, will work at the Institute for that period on a history of unemployment.

Mrs. Valentine T. Bill, an assistant in the School of Economics and Politics, devoted her time during 1940-1941 to a study of the Caribbean area—its economic aspect in relation to the United States. In connection with her work she spent the summer

of 1941 in Puerto Rico, supplemented by visits to some of the adjacent islands. During the present year she will continue her work in this field, extending it to a study of Latin America.

During the past academic year meetings have been held at Princeton of the officers of the American Statistical Association, of which Professor Riefler is President, and of the Economic History Committee.

Professor Earle has continued his seminar in the foreign and military policies of the United States. Attention has been focussed upon the traditional concepts of American security and the extent to which they have been challenged by changing world conditions and advancing military technology. In association with professors of Princeton University, notably Dr. Harold Sprout and Dr. Charles P. Stacey, Professor Earle has helped to bring into existence in the community of Princeton a *centre d'études militaires* which coördinates studies of military problems with history, political science, and foreign policy.

The studies now being conducted at the Institute are not, however, technical studies in military strategy, tactics, or technology. They are studies in political science, conducted by historians, economists, and political scientists on the assumption that defense is a basic function of government, that it profoundly affects the economic and social structure, that it is inextricably connected with world politics and, in particular, with American foreign policy. This is in no sense an emergency program; on the contrary, it is believed to have its principal value in the emphasis

which it places on long-range investigation and fundamental research.

In a paper, "National Defense and Political Science," in the *Political Science Quarterly* for December, 1940, Professor Earle indicated the objectives of this work and the manner in which military policy is related to foreign and domestic affairs. Dr. Vagts has written two similar articles: one for the *Journal of the American Military Institute* and another for *The Virginia Quarterly Review*. Dr. Brodie discussed the rôle of the technical school in an article in *The Technology Review* for January, 1941. The members of the seminar have taken part in recent meetings of the American Historical Association, the American Political Science Association, the Academy of Political Science, and the American Association for the Advancement of Science in analyzing the rôle of military and foreign policy in relation to the social sciences as a whole.

With the assistance of the Carnegie Corporation of New York, it has been possible for the Institute to initiate a research program in American foreign policy, particularly as it is affected by power politics. In this connection, Professor Earle's seminar is engaged in the preparation of a coöperative volume on the Changing Conditions of American Security, as well as on a book of readings dealing with the phenomena of war and preparation for war in modern society, a critical and descriptive bibliography of military works as they are related to the social science curricula, and a number of specialized works. Dr. Vagts

has completed his study on the balance of power and is now concerning himself with the relation between military discipline and authority, on the one hand, and political freedom on the other. Under a grant from the American Philosophical Society, made for a study of the historical evolution of American nationalism, Dr. Weinberg is continuing his studies in the foundations of American foreign policy, relating them to the problem of security. Dr. Rosinski has devoted his major effort to the preparation of a volume on *Command of the Sea*, which formed his Lowell Lectures for 1941 and will be published in the autumn. Dr. Brodie's study on naval technology as it affects world politics was published during the spring by the Princeton University Press under the title *Sea Power in the Machine Age*. Dr. Dennery and Dr. Stebbins have been concerned with the rôle of the army in a democratic society, basing their researches, respectively, upon the experiences of the Third French Republic and upon the evolution of military policy in the United States. Dr. Lauterbach has published several papers on the general subject of the social implications of a military economy and is now completing a book on *Wehrwirtschaft* or the economics of the military state. Dr. Gilbert has virtually completed his volume on *European Influences on American Foreign Policy* and has prepared articles on Machiavelli and on the idea of a democratic diplomacy. Dr. Possony is preparing a volume on certain non-military aspects of power politics, particularly the critical problem of morale.

During the spring term Professor Earle made an extended trip to the American naval and military bases in the Caribbean region, especially those recently acquired by agreement with Great Britain. The results of this travel and investigation, financed by a grant from the Carnegie Corporation of New York, will be utilized in the work of his seminar and in the larger studies of American foreign policy on which he is engaged. Some of his observations have been placed before the appropriate government services in Washington and elsewhere. During the year Professor Earle gave the first of the Stafford Little Lectures at Princeton University as well as lectures at the United States Military Academy and Columbia University.

As secretary of the American Committee for International Studies (of which Professor Earle is chairman and director of research) Mr. William W. Lockwood has devoted himself to furthering research outside Princeton. The Institute for Advanced Study provides quarters for the work of the Committee and is a convenient center for research and for discussion of problems which are of concern to scholars elsewhere. As far as the international situation has permitted, liaison has been maintained with foreign scholars; indeed the Committee is recognized both in the United States and abroad as a body through which such contacts may effectively be made.

In September, 1941, a five-day conference of scholars and government officials from the United States, Great Britain, and Canada, was held under

the auspices of the Committee to discuss the problems of the Atlantic Area in wartime and in the period of post-war adjustment. The discussions of the conference were fruitful of suggestions for the consideration of government policies and the formulation of research programs to give such policies the maximum of intellectual guidance and support.

During the coming year Professor Earle and his associates will continue the researches in which they are now engaged and hope to bring to completion some of the studies now in progress. Professor Earle has recently been appointed a member of the staff to direct research in the office of the Coordinator of Information in Washington.

Professor Mitrany was granted leave of absence for the year 1940-1941 to work with the Chatham House group attached to the British Foreign Office. The work is carried on at Balliol College, Oxford. Professor Mitrany will continue in the same position during the year 1941-1942.

A group of officials of the Economic, Financial and Transit Department of the League of Nations, with their secretaries and assistants, who transferred from Geneva to Princeton in the summer of 1940, spent the last academic year in Fuld Hall as guests of the Institute, carrying on, under the direction of Mr. Loveday, their regular work as officials of the League. They will continue in residence during 1941-1942. There has been informal collaboration of the greatest interest and value between the League group and the School of Economics of the Institute. On

April 19 and 20, 1941, a reunion was held in Princeton on the invitation of Princeton University, the Rockefeller Institute and the Institute for Advanced Study, of Americans who had during the last twenty years participated in the technical and non-political activities of the League of Nations. Nearly half of the two hundred individuals invited to the conference were present. The program covered careful discussion by relevant experts of the whole range of the technical and non-political activities of the League of Nations.

IV

SCHOOL OF HUMANISTIC STUDIES

DURING 1941-1942 Professor Goldman, assisted by Miss Frances Follin Jones, will continue the preparation for publication of material from Tarsus and complete the work on Halae which was published in part in 1940. Dr. Leicester B. Holland of the Library of Congress will spend one semester at the Institute, and he and Professor Goldman will work together on problems of domestic and temple architecture at Colophon in Asia Minor, a site excavated some years ago under the joint auspices of the Archaeological Institute of America and the Fogg Museum of Harvard University.

Dr. Marion Welker has been engaged in research the object of which is to trace back to their origins, with the aid of the Tarsus material, many problematical elements in the cultures of Syria and Anatolia of the second and third millennia B.C. at the time when large-scale racial movements were taking place in these regions. The emphasis is chiefly on the pottery, as providing the widest range of material evidence, which extends back into the fourth millennium.

Dr. Saul Weinberg, holder of a Guggenheim fellowship and a former fellow of the American School of Classical Studies at Athens, will prepare for publication studies begun in Greece and continued at the

Oriental Institute of Chicago University, on the early cultures of Greece and the Aegean Islands.

Professor Herzfeld's Lowell Lectures, delivered at Harvard University in 1936, have recently appeared under the title of *Iran in the Ancient East* (Oxford University Press, New York), the publication made possible by an appropriation from the Carnegie Corporation of New York. Professor Herzfeld has during the past year completed work on Volume VI of the *Excavations of Samarra*, dealing with a survey and history of that town.

Dr. Tedesco has continued his investigations in Slavic linguistic history, especially South-Slavic, and completed an article on the name of the town of Shiraz as well as a larger treatise on the Slavic present-type *mire*-. Dr. Tedesco is spending the year 1941-1942 at Yale University, where he will give a course in old Iranian dialects.

Dr. Starr spent the year 1940-1941 at the Institute under a Guggenheim fellowship, at work on a handbook of the art of the Ancient Near East from its inception down approximately to the time of Alexander the Great. In addition, he saw the following studies through the press: *Indus Valley Painted Pottery* (Princeton University Press, April, 1941, "Princeton Oriental Texts"), and "A Rare Example of Akkadian Sculpture," in the *American Journal of Archaeology*.

Professor Lowe gave the second part of his Introductory Course in Latin Palaeography during the winter and spring months of 1941. Under his super-

vision, material is being collected for a study of the origin and development of the earliest types of Latin script prior to Uncial. Work on the fourth volume of *Codices Latini Antiquiores* has been seriously hampered by world conditions, but it may be advisable to bring the publication to completion as well as possible under the circumstances. Professor Lowe proposes to give a general course and a seminar in the winter of 1941.

The palaeographical work of Dr. Hoey with Professor Lowe has dealt with the various types of Latin script of the first three centuries of the Roman Empire. A survey of the whole field was begun, which will result in an up-to-date detailed list of extant material to make possible a fruitful study of the development of writing in the period. In Roman history Dr. Hoey proceeded with the collection of material for a comprehensive study of the religious cults of the Roman Army. The Roman military calendar from Dura, *Feriale Duranum*, was published at the end of 1940.

The work of the epigraphical seminary is being continued according to plan. The investigations made by Professor Meritt in connection with newly discovered inscriptions from Athens have led to the publication of several short reports and to one volume, *The Chronology of Hellenistic Athens*, which Dr. W. Kendrick Pritchett and he published together. Professor Meritt has also published a general treatise on the methods of epigraphical study under the title *Epigraphica Attica*. The students associated with the

work of epigraphical study in connection with the inscriptions from the Athenian Agora continue their coöperation with the seminary at the Institute very much as they did last year. Dr. Eugene Schweigert, who returned from Greece and was a member of the Institute during the spring of 1940, has accepted a position at the University of Pennsylvania, where he is able to keep in constant touch with the archives deposited in Princeton.

Dr. Raubitschek has completed his manuscript on the early Attic dedications and is now turning his attention to the public funeral monuments, for which he is planning a much needed new edition.

Dr. Clement continues to act as Managing Editor of Publications for the School at Athens, and occasional reports by members of the Institute have appeared in its journal, *Hesperia*.

Professor Broneer has continued his study of the topography and cults of early Athens, having presented in abbreviated form one chapter of this work at the December, 1940, meeting of the Archaeological Institute at Baltimore. He has finished a monograph on the "Lion Monument at Amphipolis," which was published in the spring of 1941. This is a detailed account of an imposing marble structure, possibly a cenotaph erected at the end of the fourth century B.C. for one of the commanders of Alexander's expeditions to the East. The monument was excavated and restored in 1936-1937 by the French and American Schools in Athens. Professor Broneer is engaged in a study of a terracotta deposit from

Corinth which promises to throw some interesting light on a little-known phase of the religious history of the city.

Professor Earle R. Caley of Princeton University has been engaged with Professor Meritt in a joint enterprise which will assure the preservation of fragile epigraphical records by the application of synthetic resin. The necessary treatment has already been given to a considerable part of the extensive collection belonging to the Institute.

Professor Meritt again offers to consult during 1941-1942 with advanced students of the Institute and of the University on problems related to Athenian inscriptions.

Professor Panofsky has pursued his research on early Dutch and Flemish book illumination but has devoted most of his time to the preparation of his book on Dürer, which will be ready for publication before the end of 1941. His edition of the "Leonardo" manuscript in the Pierpont Morgan Library and several articles have been published during the past year. The publication of Professor Panofsky's work in collaboration with Dr. F. Saxl on Dürer's engraving *Melancholia I* is delayed on account of war conditions.

Dr. Swarzenski has completed his studies on the Scriptorium of Weingarten and on the origin and evolution of Romanesque painting and goldsmith works in Lorraine as well as on the artistic relations between Rome in the fourth century and the Northern Carolingian Renaissance. Of special importance

in this connection is his article pertaining to a previously unidentified purple leaf in a Carolingian manuscript in Brussels, published in the *Art Bulletin*, 1940. During the past year Dr. Swarzenski collaborated with Professor Stohlman of Princeton University in his seminar on Mediaeval Minor Arts and gave five lectures on Mosan and German enamels.

In the first term of 1940 Dr. Weitzmann gave, in the Department of Art and Archaeology of Princeton University, a series of lectures for graduate students on problems in manuscript illustration and in the second term held a seminary on the same subject in connection with Professor A. M. Friend, Jr. An article on "An Odyssey Illustration" and two chapters entitled "The Iconography of the Reliefs from the Martyrion" and "Illustrations of Euripides and Homer in the Mosaics of Antioch" for Volume III of *Antioch-on-the-Orontes* went into print. The first of the *Studies in Manuscript Illumination*, entitled "Illustrated Greek Mythographers," has been completed, and the work on other studies for the same series has progressed, as well as the work on the corpus of the *Illustrations in the Manuscripts of the Septuagint*.

Dr. de Tolnay made a critical survey of the Flemish paintings of the fifteenth to the seventeenth century in the National Gallery of Art, Washington, which appeared on the occasion of the dedication of the new building. He has continued his work on the Michelangelo Corpus, the first volume of which is

now nearly finished. During the past year Dr. de Tolnay has published the following articles:

"Michelangelo Studies" (*The Art Bulletin*, 1940)

"Marcello Venusti as Copyist of Michelangelo" (*Art in America*, 1940)

"Le Jugement Dernier de Michelange, Essai d'interpretation" (*The Art Quarterly*, 1940)

"Le Menu de Michelange" (*The Art Quarterly*, 1940)

Dr. de Tolnay is at work on the following: Michelangelo Corpus, Volume II (Sistine Ceiling); "Music of the Universe" in fine arts from the Middle Ages to the Baroque (iconographical researches on the representation of the harmony of the spheres).

Dr. Frankl gave a series of advanced lectures during 1940-1941 on Gothic architecture, under the joint auspices of Princeton University and the Institute for Advanced Study. He is now at work on a book which will be entitled *History of Gothic Architecture*.

Dr. Bernheimer has laid the foundation for a book on the representative function of art and its relation to religion, endeavoring to determine the logical status, function and structure of signs in the humanistic field. Emphasis is laid on those signs which in humanistic terminology are known as symbols. He is trying to analyze and classify symbols, understand the rules of their syntax, and finally to describe the kind of experience which they are supposed to con-

vey, the difference between "expressing" and "symbolizing" receiving particular attention.

Professor Stillwell, beside his editorial work on the proofs of *Antioch-on-the-Orontes*, Volume III, which was published in the spring of 1941, has continued the studies relative to the final publication of the architectural monuments of the site, in particular, the problem of the domestic architecture and the baths. This involves a study of all the available comparative material in an effort to determine the relationship of Antiochene architecture with that in other parts of the Roman Empire. It is hoped thereby to ascertain to what degree Antioch, as a long-established center of Hellenistic culture, contributed to contemporary and later building elsewhere and also how it may have served as a center of distribution of Oriental influences.

Professor Campell was occupied partly with the field statistic for Volume III of *Antioch-on-the-Orontes* (Princeton University Press, 1941) to which he was a considerable contributor, and partly with research on an important Early Christian Martyrion which he unearthed in Seleucia, the port of Antioch, a building whose architectural features, sculpture, and mosaic decoration bid fair to make it one of the most important of Early Christian churches.

Professor Edward Capps, Jr. was engaged in preparing for publication a corpus of Late Antique and Early Mediaeval Ivory Carvings, which will consist

of an introduction and a descriptive catalogue of all the Early Christian ivories from about 200 A.D. to about 700 A.D., as well as a number of carvings in ivory with pagan subjects which are closely related in style and in date with the Christian group.

V

GEST ORIENTAL LIBRARY

IN the Gest Oriental Library at 20 Nassau Street, accessioned volumes now on the shelves according to the categories of the Chinese standard library four-fold classification system exceed 100,000 volumes, in addition to unaccessioned material, such as documents, pamphlets, maps, rubbings, etc., as well as 528 stitched volumes acquired this year to complete the list of at least one provincial gazeteer for each Chinese province. Definite progress continues in the work on bibliography and the development of the catalogue under the direction of Dr. Nancy Lee Swann, Curator. A Chinese educator, Mr. Yiu Tung (B.A. Oxon), has given daily services along with his use of the facilities of the library in his own field of study, and Dr. Chung Kei-won, in pursuance of his interests in Far Eastern languages, has continued his studies in the Gest Oriental Library since his return from the University of California, where, as guest-scholar he studied Manchu, Mongol, Tibetan, and Russian linguistics during the three autumn months of 1940.

The acquisition of the Gest Oriental Library by the Institute extended to Far Eastern Studies the existing cooperation with both the Department of Oriental Studies and the Department of Art and Archaeology of Princeton University. Far Eastern acquisitions of Princeton University other than those

in the field of Oriental Art continue to be shelved in the Gest Library, in particular those purchased out of the gift to the University by the General Education Board. There are more than 4000 volumes, most of which have been selected by Dr. David Nelson Rowe, Lecturer in Far Eastern Affairs of the University, who has during the past academic year offered instruction in elementary Chinese in the Department of Oriental Languages and Literatures of the University.

During the autumn of 1940 the Institute acquired title to the Gest Collection of Far Eastern Curios and Objects of Art, which has been an integral part of the holdings of the Gest Library since its inception and has been housed with the Library since its acquisition by the Institute in July, 1936. This collection, as well as the unusual one of Chinese Shadow Play figures secured last year, greatly enhance the historic and cultural value of the literary holdings of the Library. A number of items from this collection and from the Gest Oriental Library were loaned to the New Jersey State Museum in Trenton last December for use in their exhibition, *The Biography of the Book*.