# Notices

## OF THE AMERICAN MATHEMATICAL SOCIETY

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**THE CALENDAR BELOW** lists all of the meetings which have been approved by the Council up to the date this issue of the *Notices* was sent to press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have yet been assigned.

**ABSTRACTS SHOULD BE SUBMITTED ON SPECIAL FORMS** which are available in most departments of mathematics; forms can also be obtained by writing to the headquarters of the Society. Abstracts to be presented at the meeting in person must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline for the meeting.

## CALENDAR OF AMS MEETINGS

| MEETING NUMBER | DATE | PLACE | DEADLINE for ABSTRACTS* and NEWS ITEMS |
|---|---|---|---|
| 763 | January 24–28, 1979 (85th Annual Meeting) | Biloxi, Mississippi | OCTOBER 25 |
| 764 | March 30–April 1, 1979 | Honolulu, Hawaii | JANUARY 30 |
| 765 | April 19–20, 1979 | New York, New York | FEBRUARY 27 |
| 766 | April 27–28, 1979 | Iowa City, Iowa | FEBRUARY 27 |
| 767 | June 15–16, 1979 | Vancouver, Canada | APRIL 24 |
| 768 | August 21–25, 1979 (83rd Summer Meeting) | Duluth, Minnesota | |
| | November 2–3, 1979 | Kent, Ohio | |
| | November 16–17, 1979 | Riverside, California | |
| | January 3–7, 1980 (86th Annual Meeting) | San Antonio, Texas | |
| | March 28–29, 1980 | Boulder, Colorado | |
| | April 25–26, 1980 | Davis, California | |
| | January 7–11, 1981 (87th Annual Meeting) | San Francisco, California | |

*Deadline for abstracts NOT presented at a meeting (by title)

| | |
|---|---|
| February 1979 issue: | JANUARY 23 |
| April 1979 issue: | FEBRUARY 20 |
| June 1979 issue: | APRIL 17 |

## OTHER EVENTS SPONSORED BY THE SOCIETY

| | |
|---|---|
| January 22–23, 1979 | Game Theory and its Applications (AMS Short Course), Biloxi, Mississippi |
| March 27–30, 1979 | Symposium on the Geometry of the Laplace Operator, University of Hawaii, Honolulu, Hawaii |
| June 19–30, 1979 | Seminar/Workshop on Algebraic and Geometric Methods in Linear Systems Theory, Harvard University, Cambridge, Massachusetts |
| June 25–July 20, 1979 | Summer Research Institute on Finite Group Theory, University of California, Santa Cruz, California |

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**OTHER CORRESPONDENCE** with the Society should be sent to the Society at P. O. Box 6248, Providence, R. I. 02940. Please affix one of the peel-off labels from copies of the *Notices* to any correspondence with the Society.

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Notices

# OF THE AMERICAN MATHEMATICAL SOCIETY



## CONTENTS

November, 1978

# 762ND MEETING

## *University of Chicago Chicago, Illinois November 12, 1978*

The seven hundred sixty-second meeting of the American Mathematical Society will be held on Sunday, November 12, 1978 at the University of Chicago, Chicago, Illinois. All sessions of the meeting will be held in the Center for Continuing Education, 1307 East 60th Street, which will also be the hotel headquarters for the meeting.

The time and place for the meeting were approved by the Executive Committee of the Council on October 1, 1977. The time of the meeting was selected in accordance with the following resolution approved by the Council at its meeting on August 23, 1976: "Since a considerable number of members of the Society have religious beliefs prohibiting attendance at meetings on Saturdays, the Society should schedule an appreciable fraction of its one-day meetings on other days of the week."

By invitation of the Committee to Select Hour Speakers for Western Sectional Meetings, there will be two invited one-hour addresses. PETER P. ORLIK of the University of Wisconsin, Madison, will speak at 11:00 a.m. on the topic "Singularities and group actions." RONALD R. COIFMAN of Washington University, St. Louis, will address the Society at 1:45 p.m. on "Applications of the Fourier transform in noncommutative harmonic analysis." Both lectures will be given in the Assembly located in the basement of the Center for Continuing Education.

By invitation of the same committee, there will be two special sessions of selected twenty-minute papers. ROBERT J. STANTON of Rice University has organized a special session on Harmonic analysis on real groups; the speakers will be Michael G. Cowling, Jiri Dadok, Daryl N. Geller, R. Ranga Rao, Peter A. Tomas, and Robert J. Zimmer. JOHN W. WOOD of the University of Illinois at Chicago Circle has organized a special session on Topology of varieties; the speakers will be James B. Carrell, Igor V. Dolgachev, Louis H. Kauffman, Anatoly S. Libgober, Walter D. Neumann, Richard C. Randell, and Philip D. Wagreich.

There will also be three sessions of contributed ten-minute papers.

### REGISTRATION

The registration desk will be located in the lobby of the Center for Continuing Education, and will be open from 8:00 a.m. to 3:00 p.m. The registration fee will be $5 for nonmembers, $3 for members, and $1 for students and unemployed mathematicians.

### ACCOMMODATIONS

Guest rooms will be available in the Center for Continuing Education on Saturday and Sunday nights. The rate will be $30 for single rooms and $35 for double rooms. Requests for reservations should be addressed to the Center for Continuing Education, The University of Chicago, 1307 East 60th Street, Chicago, Illinois 60637; telephone (312) 288-2500. The conference coordinator is Mr. Richard Muetze.

### FOOD SERVICE

Meals will be available in the Center. A cafeteria will be open for breakfast and lunch, and a dining room for dinner. Those attending the meeting are encouraged to use this facility, which is more than adequate.

### PARKING

The Center has ample parking space for overnight guests. There should be no shortage of daytime parking on surrounding streets.

### TRAVEL AND LOCAL INFORMATION

Those coming by air may use the C. W. South-Side Limousine Service from O'Hare Airport. Limousines leave O'Hare Airport at 30 minutes after the hour, from a point on the lower level in front of the Rotunda Building (between Terminals 2 and 3, the two terminals for domestic flights).

Those coming by car should leave the Dan Ryan Expressway at Garfield Boulevard and drive east through Washington Park to the university.

## Program of the Sessions

The time limit for each contributed paper in the general sessions is ten minutes. and in the special sessions is twenty minutes. To maintain the schedule, the time limits will be strictly enforced.

SUNDAY, 8:30 A. M.

Session on Analysis and Applied Mathematics, Room 2EF

8:30- 8:40 (1) An axiomatic foundation for finite-dimensional quantum theory. Dr. RAY E. ARTZ, Carnegie-Mellon University (758-81-3)

8:45- 8:55 (2) Harmonic analysis of homogeneous distributions on Heisenberg groups. Professor ALEXANDER DYNIN, State University of New York at Stony Brook (762-B3)

9:00- 9:10 (3) Limits of norms of powers of absolutely convergent Fourier series in several variables. Professor CHARLES H. HEIBERG, U. S. Naval Academy (762-B2)

9:15- 9:25 (4) An extremal property of the Bloch space. Professor LEE A RUBEL, University of Illinois, Urbana and RICHARD M. TIMONEY*, Indiana University, Bloomington (762-B1)

9:30- 9:40 (5) Asymptotic behaviour of solutions of a certain second order differential equation in the neighborhood of an irregular singular point of arbitrary rank. Professor T. K. PUTTASWAMY, Ball State University (762-B6)

9:45- 9:55 (6) The motions of an ordinary linear differential equation. Mr. JEFFREY POSLUSZNY* and Professor LEE A RUBEL, University of Illinois, Urbana-Champaign (762-B7)

10:00-10:10 (7) Flow of a viscous fluid. III. Dr. KAMESH GOVINDARAJU, University of Maryland, Eastern Shore (762-C1) (Introduced by Dr. E. W. Chapin)

10:15-10:25 (8) Models of bilipid vesicles. Professor JON C. LUKE, Indiana University-Purdue University at Indianapolis (762-C2)

SUNDAY, 8:30 A. M.

Session on Topology and Geometry, Room 2BC

8:30- 8:40 (9) Involutions on Dold manifolds. Preliminary report. Dr. C. F. PELTIER*, St. Mary's College, Indiana and Dr. R. P. BEEM, Indiana University, South Bend (762-G10)

8:45- 8:55 (10) Some equivariant eversions of the sphere. Preliminary report. Professor BERNARD MORIN, University of Strasbourg, Strasbourg, France and Professor GEORGE K. FRANCIS*, University of Illinois, Urbana (762-G14)

9:00- 9:10 (11) Simple periodic orbits of mappings of the interval. Preliminary report. Dr. LOUIS BLOCK, University of Florida (762-G3)

9:15- 9:25 (12) Surfaces of sphere-packed shells of equal edges. K. DEMYS, Santa Barbara, California (762-D1)

SUNDAY, 9:00 A. M.

Special Session on Topology of Varieties. I, The Assembly

9:00- 9:20 (13) Handlebody presentations of branched coverings. Preliminary report. Professor LOUIS H. KAUFFMAN, University of Illinois at Chicago Circle (762-G6)

9:30- 9:50 (14) Levine's formula in knot theory and quadratic reciprocity law. ANATOLY S. LIBGOBER, University of Illinois at Chicago Circle (762-G8)

10:00-10:20 (15) An invariant of plumbed manifolds. Preliminary report. Professor WALTER D. NEUMANN, University of Maryland, College Park (762-G7)

10:30-10:50 (16) The topology of Kaehler manifolds admitting a C* action. Professor JAMES B. CARRELL*, University of British Columbia and Professor ANDREW JOHN SOMMESE, University of Bonn, Federal Republic of Germany (762-B4)

SUNDAY, 9:30 A. M.

Special Session on Harmonic Analysis on Real Groups. I, Room 2BC

9:30- 9:50 (17) Complementary series for rank two groups. MICHAEL G. COWLING, Washington University, St. Louis (762-G9)

10:00-10:20 (18) Solvability of invariant differential operators of principal type on certain Lie groups and symmetric spaces. Mr. JIRI DADOK, Rice University (762-G11)

10:30-10:50 (19) Some explicit formulas in the theory of Weil representation. Professor R. RANGA RAO, University of Illinois, Urbana (762-G13)

*For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

SUNDAY, 11:00 A. M.

Invited Address, The Assembly

11:00-12:00 (20) Singularities and group actions. Professor PETER ORLIK, University of Wisconsin, Madison (762-G1)

SUNDAY, 1:45 P. M.

Invited Address, The Assembly

1:45- 2:45 (21) Applications of the Fourier transform in noncommutative harmonic analysis. Professor RONALD R. COIFMAN, Washington University (762-B5)

SUNDAY, 3:00 P. M.

Special Session on Harmonic Analysis on Real Groups. II, Room 2BC

3:00- 3:20 (22) Strichartz's conjecture on invariant multipliers. Preliminary report. PETER A. TOMAS*, University of Texas, Austin and CARLOS E. KENIG, Princeton University (762-B8)

3:30- 3:50 (23) Ergodic actions of real algebraic groups. Dr. ROBERT J. ZIMMER, University of Chicago (762-G5)

4:00- 4:20 (24) Necessary and sufficient conditions for local solvability on the Heisenberg group. Mr. DARYL N. GELLER, University of Chicago (762-G12)

SUNDAY, 3:00 P. M.

Special Session on Topology of Varieties. II, The Assembly

3:00- 3:20 (25) On projective weighted complete intersection varieties. Professor IGOR DOLGACHEV, University of Michigan, Ann Arbor (762-A3)

3:30- 3:50 (26) Complements of plane curves. Professor RICHARD C. RANDELL, University of Michigan, Ann Arbor (762-G4)

4:00- 4:20 (27) Discontinuous subgroups of complex linear groups. Professor PETER ORLIK, University of Wisconsin, Madison and Professor PHILIP D. WAGREICH*, University of Illinois at Chicago Circle (762-G2)

SUNDAY, 3:00 P. M.

Session on Logic and Algebra, Room 2EF

3:00- 3:10 (28) A second-order functional calculus C(ST). Preliminary report. Dr. IRVING H. ANELLIS, University of Florida (762-E1)

3:15- 3:25 (29) There are 9 different skew-equivalent Hadamard matrices of order 24. Professor JUDITH Q. LONGYEAR, Wayne State University (762-A2)

3:30- 3:40 (30) The square class invariant for quadratic forms over local fields. Professor ANITA E. SOLOW, Wayne State University (762-A4)

3:45- 3:55 (31) Locally power series algebras. Preliminary report. Mr. A. R. KUSTIN, University of Illinois, Urbana (762-A1)

4:00- 4:10 (32) Periods of some elliptic integrals. Preliminary report. Professor WILLIAM L. HOYT and Mr. MICHAEL J. KENT*, Rutgers University (762-A5)

4:15- 4:25 (33) Modularity in Lie algebras. Dr. RALPH AMAYO* and Mr. JOCHEN SCHWARZ, Southern Illinois University, Carbondale (762-A6)

Paul T. Bateman
Associate Secretary

Urbana, Illinois

PRESENTERS OF PAPERS

Following each name is the number corresponding to the speaker's position on the program

• Invited one-hour lecturers

* Special session speakers

Amayo, R. #33
Anellis, I. H. #28
Artz, R. E. #1
Block, L. #11
*Carrell, J. B. #16
•Coifman, R. R. #21
*Cowling, M. G. #17
*Dadok, J. #18
Demys, K. #12
*Dolgachev, I. #25
Dynin, A. #2
Francis, G. K. #10
*Geller, D. N. #24
Govindaraju, K. #7
Heiberg, C. H. #3
*Kauffman, L. H. #13
Kent, M. J. #32
Kustin, A. R. #31
*Libgober, A. S. #14
Longyear, J. Q. #29
Luke, J. C. #8
*Neumann, W. D. #15
•Orlik, P. #20
Peltier, C. F. #9
Posluszny, J. #6
Puttaswamy, T. K. #5
*Randell, R. C. #26
*Rao, R. R. #19
Solow, A. E. #30
Timoney, R. M. #4
*Tomas, P. A. #22
*Wagreich, P. D. #27
*Zimmer, R. J. #23

**1979 SYMPOSIUM** | *Houston, Texas* *January 4, 1979*

# SOME MATHEMATICAL QUESTIONS IN BIOLOGY

The thirteenth annual symposium on Some Mathematical Questions in Biology will be held January 4, 1979 in the Chaparral C Room of the Houston Marriott Hotel, Houston, Texas, in conjunction with the annual meeting of the American Association for the Advancement of Science. It will be cosponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and Section A of the American Association for the Advancement of Science. The support of the National Institutes of Health is anticipated.

The program is being arranged by the AMS-SIAM Committee on Mathematics in the Life Sciences, whose members are Hans J. Bremermann, Jack D. Cowan, Murray Gerstenhaber, Stuart Kauffman, Simon A. Levin (chairman), Robert M. May, George F. Oster, and Sol I. Rubinow.

The symposium will be divided into two half-day sessions, each including three one-hour speakers and will cover a range of biological topics to which substantive mathematical contributions are being made.

Information on housing and registration and a preliminary program appeared in the September 29, 1978 issue of Science.

PROGRAM

JANUARY 4, 1979, 9:00 A. M.

Chairman: George F. Oster, University of California, Berkeley, California

9:00 a.m. The persistence and stability of infectious diseases within populations of hosts. ROY M. ANDERSON, Imperial College of Science and Technology, University of London, England

10:00 a.m. Longitudinal studies of malaria. JOEL E. COHEN, The Rockefeller University, New York, New York

11:00 a.m. Some mathematical problems related to allergic reactions. CARLA WOFSY, University of New Mexico, Albuquerque, New Mexico

JANUARY 4, 1979, 3:00 P. M.

Chairman: Sol I. Rubinow, Cornell University, Medical Center, New York, New York

3:00 p.m. Flow mediated control mechanisms in the body. F. C. HOPPENSTEADT, University of Utah, Salt Lake City, Utah

4:00 p.m. An unusual free boundary problem from the theory of optimal harvesting. DONALD LUDWIG, University of British Columbia, Vancouver, British Columbia

5:00 p.m. Some fluid dynamical problems of cell biology. HARVEY P. GREENSPAN, Massachusetts Institute of Technology, Cambridge, Massachusetts

Simon A. Levin, Chairman, Organizing Committee
Thirteenth Annual AMS-SIAM Symposium on
Some Mathematical Questions in Biology

Ithaca, New York

# PRELIMINARY ANNOUNCEMENTS OF MEETINGS

**85TH ANNUAL MEETING**

*Convention Center*
*Biloxi, Mississippi*
*January 24–27, 1979*

N. B.: Members wishing to attend the Joint Mathematics Meetings in Biloxi should be aware of special circumstances that exist with regard to airline travel. For more information, see the section titled TRAVEL.

The eighty-fifth annual meeting of the American Mathematical Society will be held in Biloxi, Mississippi, from Wednesday, January 24, through Saturday, January 27, 1979. Sessions will be held primarily in the Convention Center, although some will be held in adjacent hotels.

The fifty-second Josiah Willard Gibbs Lecture will be presented at 8:30 p.m. on Wednesday, January 24, by MARTIN D. KRUSKAL of the Department of Astrophysical Sciences at Princeton University. The title of his lecture is "What are solitons and inverse scattering anyway, and why should I care?"

There will be one series of four Colloquium Lectures presented by PHILLIP A. GRIFFITHS of Harvard University. The title of his lecture series is "Complex analysis and algebraic geometry." The lectures will be given at 1:00 p.m. daily, Wednesday through Saturday, January 24-27.

The Bôcher Memorial Prize and the Leroy P. Steele Prizes will be awarded at a session at 3:20 p.m. on Thursday, January 25.

By invitation of the Program Committee, there will be eight invited one-hour addresses as follows: 9:00 a.m., Wednesday, MICHAEL ARTIN, Massachusetts Institute of Technology, "Some applications of algebraic geometry to ring theory"; 10:30 a.m., Wednesday, JULIUS L. SHANESON, Rutgers University, "Manifolds and submanifolds"; 3:30 p.m., Wednesday, JOHN E. FORNAESS, Princeton University, "Proper holomorphic maps"; 9:00 a.m., Thursday, HEINZ-OTTO KREISS, University of Uppsala, Sweden, "Problems with different time scales and their numerical solution"; 10:30 a.m., Thursday, JACOB FELDMAN, University of California, Berkeley, "Entropy, isomorphism, and reparametrization for finite measure-preserving actions of certain continuous groups"; 2:10 p.m., Thursday, ABRAHAM H. TAUB, University of California, Berkeley, "Space-times with distribution valued curvature tensors"; 2:15 p.m., Friday, CHARLES PESKIN, Courant Institute of Mathematical Sciences, New York University, "The heart valve problem of cardiac fluid dynamics and its numerical solution"; and 3:30 p.m., Friday, BHAMA SRINIVASAN, Clark University, "Representations of classical groups."

By invitation of the same committee, there will be thirteen special sessions of selected twenty-minute papers. The titles of these special sessions, the names of the mathematicians arranging them, and the tentative times of their meetings are as follows: Number theory and its applications, STEFAN BURR, Thursday morning and Thursday afternoon; Operator theory, DOUGLAS N. CLARK, Friday afternoon and Saturday afternoon; Differential geometry and general relativity, PAUL ERLICH, Thursday morning and Thursday afternoon; Ordinary differential equations: Oscillations and asymptotic behavior, JOHN R. GRAEF and A. G. KARTSATOS, Friday afternoon and Saturday afternoon; Mathematical psychology, WILLIAM C. HOFFMAN, Thursday morning and Thursday afternoon; Modular and automorphic functions in a single complex variable, MARVIN KNOPP, Friday afternoon and Saturday afternoon; Diffusion reaction systems in biology, SIMON A. LEVIN, Wednesday morning and Wednesday afternoon; Game theory, WILLIAM LUCAS, Wednesday morning and Wednesday afternoon; Global differential geometry, RICHARD MILLMAN, Wednesday morning and Wednesday afternoon; Constructive mathematics, RAY MINES and FRED RICHMAN, Wednesday morning and Wednesday afternoon; Integral equations with emphasis on Fredholm and Hammerstein equations, M. Z. NASHED, Wednesday morning and Wednesday afternoon; Summability and related topics, B. E. RHOADES, Thursday morning and Thursday afternoon; and Nonacademic mathematical research, ROBERT J. THOMPSON, Friday afternoon. Refer to the SUMMARY OF ACTIVITIES beginning on page 474 for the exact starting times of these sessions.

Most of the papers to be presented at these special sessions will be by invitation; however, anyone contributing an abstract for the meeting who felt that his or her paper would be particularly appropriate for one of these special sessions, should have so indicated this clearly on the abstract and submitted it by October 4, 1978, three weeks before the normal deadline for contributed papers.

There will be sessions for contributed ten-minute papers Wednesday morning, Wednesday afternoon, Thursday morning, Thursday evening, Friday afternoon, and Saturday afternoon. Abstracts should have been sent to the Society so as to arrive by the abstract deadline of October 25, 1978. There will be no provision for the presentation of late papers.

If there is sufficient interest in presentation by the poster method, poster sessions will be scheduled at times available for sessions of contributed papers. A standard abstract form marked "Poster Session" should have been submitted to the Society so that it arrived no later than October 25, 1978.

Rooms where special sessions and contributed-paper sessions will be held will be equipped with an overhead projector and screen. Black-

American Mathematical Society Short Course Series

# Game Theory and its Applications
# January 22–23, 1979

The American Mathematical Society will present a one and one-half day short course entitled "Game Theory and its Applications," on Monday and Tuesday, January 22 and 23, 1979, in the Holiday Inn in Biloxi, Mississippi.

This area of applied mathematics is unusual in the nature of its main areas of motivation and use (the behavioral sciences rather than the physical or engineering sciences), in the varied flavor of its technical methods (often lacking the usual dominance of calculus and its descendants), and in the broad intellectual appeal of the problems with which it deals. The topic provides both an attractive addition to the mathematics curriculum, and a vehicle for joint research with scholars studying decision processes from the viewpoint of other disciplines; the course is being planned with these attributes explicitly in mind.

Game theory is a collection of mathematical models designed to study situations involving conflict and/or cooperation. It allows for a multiplicity of decision makers who may have different preferences and objectives. Such models involve a variety of different solution concepts concerned with strategic optimization, stability, bargaining, compromise, equity and coalition formation. This short course will be primarily concerned with the n-person theory ($n \geqq 3$). It will emphasize the cooperative models, but the fundamental aspects of the noncooperative approach will also be covered. The applications will include auctions, bidding, and market equilibria in economics and measurements of power in political science, as well as some multiperson and equity considerations in operations research.

The program is under the direction of William F. Lucas of the Center for Applied Mathematics and School of Operations Research and Industrial Engineering at Cornell University. The short course was recommended by the Society's Committee on Employment and Educational Policy, whose members are Lida K. Barrett, Alan J. Goldman, Arthur P. Mattuck, Hugo Rossi, Martha K. Smith, and Robert J. Thompson. The short course series is under the direction of the CEEP Short Course Subcommittee, whose members are Alan J. Goldman, Ronald L. Graham, Cathleen S. Morawetz, and Harold M. Stark.

The program will consist of six seventy-five minute lectures. Three lectures (one by William F. Lucas, one by Lloyd S. Shapley of the Rand Corporation, and one by Robert J. Weber of the Cowles Foundation for Research in Economics and the School of Organization and Management, Yale University) will present the basic concepts and many of the fundamental theorems from multiperson game theory. The other three lectures will be devoted to important areas of application: to political science (Lloyd S. Shapley), to operations research (William F. Lucas), and to economic markets (Louis J. Billera of the School of Operations Research and Industrial Engineering, and the Department of Mathematics, Cornell University).

Abstracts for the talks and accompanying reading lists appear on pages A-671–A-673 of the October issue of the *Notices*. A basic knowledge of undergraduate mathematics will be presumed. A few specific theorems of a more specialized nature, e.g., Brouwer's fixed point theorem, will be employed, but prior knowledge of these is not essential. Those who wish to get the most benefit from the course should consult the excellent (but dated) elementary survey Games and Decisions by R. Duncan Luce and Howard Raiffa, Wiley and Sons, 1958, or a basic text such as Game Theory by Guillermo Owen, Saunders Company, 1968 (especially Chapters 1, 7 to 10, and the appendix). The reading lists also give a variety of sources for study prior to the course.

Note that a special session on game theory is also being planned for the January meeting, and some recent developments of a more advanced nature will be presented there.

The short course is open to all who wish to participate upon payment of the registration fee. There are reduced fees for students and unemployed individuals. Please refer to the section entitled MEETING PREREGISTRATION AND REGISTRATION for details.

boards will not be available.

At 4:45 p.m. on Friday, January 26, the AMS Committee on Science Policy will sponsor a panel discussion on "Mathematicians' views of government support of research." Richard D. Anderson will be the moderator. Among the speakers will be Joseph J. Kohn and Saunders Mac Lane.

The Society's Committee on Employment and Educational Policy (CEEP) will host a meeting of department chairmen on Wednesday, January 24, from 2:30 p.m. to 4:30 p.m.

CEEP will also present a panel discussion at 7:00 p.m. on Friday evening, January 26, entitled "The mathematician outside the university." This panel discussion, which is cosponsored by the Mathematical Association of America, will be devoted to career opportunities for mathematicians outside of academia, with emphasis on graduate programs designed to prepare mathematicians for such work. Attention will be given to academic preparation for work in industry at both the masters level and the doctorate level. The program is under the direction of William E. Boyce and Richard C. DiPrima of Rensselaer Polytechnic Institute; the panel members are Gary McDonald of General Motors Research Laboratories, Edward C. Posner of the Jet Propulsion Laboratory, California Institute of Technology, Albert C. Williams of Mobil Research and Development Corporation, and Norman D. Winarsky of RCA Laboratories.

Committee on the Agenda for Business Meetings

The Society has a Committee on the Agenda for Business Meetings. The purpose is to make Business Meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasi-political" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to

(a) doing nothing;
(b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting;
(c) recommending and planning a format for debate to suggest to a Business Meeting;
(d) recommending referral to a committee;
(e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a Business Meeting to refer it rather than to act on it without benefit of the advice of the committee.

The committee consists of Barbara L. Osofsky, David A. Sanchez, Michael Taylor, and Guido L. Weiss, with the secretary as chairman.

In order that a motion for the Business Meeting of January 25, 1979 receive the service to be offered by the committee in the most effective manner, it should be in the hands of the secretary by December 22, 1978

Everett Pitcher, Secretary

In addition to these activities, a special session on Nonacademic Mathematical Research has been arranged by Robert J. Thompson at the suggestion of CEEP. (See list of special sessions on p. 466.)

At 11:30 a.m. on Saturday, January 27, the Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics will cosponsor a progress report by Edmund G. Lee concerning the work of a Congressional Fellow.

## COUNCIL AND BUSINESS MEETING

The Council of the Society will meet in the Vogue Room of the Broadwater Beach Hotel at 2:00 p.m. on Tuesday, January 23. The Business Meeting of the Society will take place at 5:00 p.m. on Thursday, January 25, in the Coliseum at the Convention Center. The secretary notes the following resolution of the Council: "Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society." In further explanation, it is noted that "each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society." For additional information on the Business Meeting, refer to the box above.

## OTHER ORGANIZATIONS

The Mathematical Association of America (MAA) will hold its annual meeting on January 26-28, Friday–Sunday, in conjunction with this meeting of the Society. Some sessions of the Association on Sunday, January 28, will be held jointly with the National Council of Teachers of Mathematics (NCTM). For a more detailed listing of the activities of the Association, see the SUMMARY OF ACTIVITIES beginning on page 474.

The Association for Symbolic Logic (ASL) will hold its annual meeting onWednesday and Thursday, January 24-25. The SUMMARY OF ACTIVITIES provides more details on the ASL program.

The Association for Women in Mathematics will present a panel discussion on "ERA and Bakke" at 4:00 p.m. on Saturday, January 27. Judith Roitman will moderate.

The Conference Board of the Mathematical Sciences (CBMS) will sponsor a panel discussion at 2:15 p.m. on Friday, January 26, on "Mathematics today." Panel members include Felix E. Browder, Saunders Mac Lane (moderator), and J. Ian Richards. CBMS will also sponsor a symposium on "Computer science and the mathematical sciences: Interfaces and overlaps", at 7:30 p.m. on Thursday, January 25. The symposium is under the direction of E.P. Miles, Jr., of Florida State University

The Mathematicians Action Group will hold its Business Meeting at 8:00 p.m. on Thursday, January 25; an open meeting of its Steering Committee at 2:00 p.m. on Wednesday, January 24; and a panel discussion at 2:15 p.m. on Saturday, January 27.

National Science Foundation (NSF) staff members will be available in the exhibit area to provide counsel and information on NSF programs of interest to mathematicians from 9:00 a.m. to 5:00 p.m., Thursday through Saturday, January 25-27.

## MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

The Employment Register will be in session on Thursday, Friday, and Saturday, January 25–27, in the Foyer of the Convention Center. A short (optional) orientation session will be held by the AMS-MAA-SIAM Joint Committee on Employment Opportunities at 9:00 a.m. on Thursday, January 25. The purpose of this session is to familiarize participants with the operation of the Register and with registration procedures. Registration for the Register will begin at 9:30 a.m.

on Thursday, and interviews will begin at 9:30 a.m. on Friday and Saturday. Interview request cards must be turned in to the code clerk before 4:00 p.m. on the day prior to the interview.

Provision has been made for scheduling of interviews in half-day modules. This allows for four half-days of interviews; Friday A.M. and P.M., and Saturday A.M. and P.M. There will be no interviews scheduled for Thursday.

On Saturday afternoon, an "employers' choice" session has been scheduled. For this session, interviews will be scheduled with applicants requested by employers. Applicants may not submit interview request forms for this session. Requests for interviews must be submitted by the employer on Friday prior to the deadline of 4:00 p.m. in order to receive a schedule for Saturday afternoon.

Applicants and employers should be sure to indicate in the appropriate place on the forms exactly what times they will be available for interviews. Applicants and employers are asked not to duplicate their interview requests for both morning and afternoon schedules on the same day; applicants and employers should also be advised that the program will NOT automatically reschedule a morning appointment to an afternoon session, if it could not be scheduled when requested for the morning. Interview requests should not be submitted, of course, unless the individual requested has indicated availability during the time period desired. Morning schedules will be distributed on Friday and Saturday at 8:45 a.m.; the afternoon schedules will be distributed at 9:00 a.m. on the same days.

Applicants should be aware of the fact that interviews arranged by the Register are only an initial contact with employers, and hiring decisions are not always made immediately after the interview.

Those who plan to participate in the Register are urged to complete the special forms on pages A-733 and A-734 of this issue of the *Notices* and submit them with their meeting preregistration forms. Deadline for receipt of applicant and employer forms is the same as for meeting preregistration: December 22, 1978. These special forms also appear in the November issue of EMPLOYMENT INFORMATION IN THE MATHEMATICAL SCIENCES. Preregistration by both applicants and employers will not only facilitate procedures, but will again help to cut down waiting time when the Register opens in Biloxi.

The forms include a coded strip summarizing the information contained on the applicants' and employers' forms. Please be sure to provide the coded summary in addition to completing the regular form. These strips will be used to prepare printed lists of preregistered employers and applicants for the benefit of those who complete the special preregistration process described above. Other participants may obtain copies of the printed lists at the meeting for $1 each.

All participants in the Register are required to register for the Joint Mathematics Meetings. For applicants there is no additional fee for participation in the Register. For employers, additional fees are $10 if paid at time of preregistration, or $15 if paid at the meeting.

## EXHIBITS

The book and educational media exhibits will be located in the Exhibit Area of the Convention Center from Thursday through Saturday, January 25-27. The exhibits will be open from 9:00 a.m. to 5:00 p.m.

All participants are encouraged to visit the exhibits during the meeting.

## BOOK AND AUDIO TAPES SALES

Books published by the Society and the Association, and audio tapes of AMS invited addresses, will be sold for cash prices somewhat below the usual prices when these same books and tapes are sold by mail. The book sales will be located in the Exhibit Area of the Convention Center.

## MEETING PREREGISTRATION AND REGISTRATION

Participants who wish to preregister for the meetings should complete the preregistration form on page A-736 of these *Notices*. The deadline for receipt of preregistrations in Providence is December 22, 1978. Those who preregister will pay lower registration fees than those who register at the meeting, as indicated in the following schedule. Preregistrants will be able to pick up their badges and programs when they arrive at the meeting after 2:00 p.m. on Tuesday, January 23. Complete instructions on making hotel reservations are given in the section titled HOTEL ACCOMMODATIONS.

Meeting preregistration and registration fees partially cover expenses of holding the meetings. The preregistration fee does not represent an advance deposit for lodgings.

Please note that separate fees are required for the Short Course and the Joint Mathematics Meetings. These fees are as follows:

AMS Short Course
Game Theory and its Applications

| | Preregistration | At Meeting |
|---|---|---|
| Student/unemployed | $ 3 | $ 5 |
| All other participants | 18 | 20 |
| One-day fee for second day only | | 10 |

Joint Mathematics Meetings

| | Preregistration | At Meeting |
|---|---|---|
| Members of AMS, ASL, MAA, and NCTM | $23 | $25 |
| Nonmembers | 33 | 35 |
| Student/unemployed | 2 | 3 |

The fees for preregistration by members and nonmembers have been increased over those charged for the January 1978 meeting, but still leave a $2 differential to benefit those who preregister. The differential has been lowered since it is the preregistrant who receives the benefit of services of the Housing Bureau and the quicker process at the registration desk at the meeting. The costs of the meetings, in particular of the housing and preregistration services, have been increasing steadily over the past several years, and it is hoped that by charging those who receive the

benefit of these services a more realistic fee, some of the increased costs may be offset.

There will be no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

Students are considered to be only those currently working toward a degree who do not receive compensation totaling more than $7,000 from employment, fellowships, and scholarships.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned or retired from their latest position.

A fifty percent refund of the preregistration fee will be made for all cancellations received in Providence no later than January 21. There will be no refunds granted for cancellations received after that date, or to persons who do not attend the meetings.

Registration for the short course only will begin on Monday, January 22, at noon and will be located in the lobby of the Holiday Inn. Participants who are not attending the short course are advised that no general meeting information or registration material will be available prior to the time listed below for the Joint Mathematics Meetings registration. The Joint Mathematics Meetings registration desk will be located in the Exhibit Area of the Convention Center. The desks will be open during the hours listed below:

AMS Short Course on
GAME THEORY AND ITS APPLICATIONS
Holiday Inn Lobby

| | |
|---|---|
| Monday, January 22 | noon - 5:00 p.m. |
| Tuesday, January 23 | 8:00 a.m. - 2:00 p.m. |

JOINT MATHEMATICS MEETINGS
Exhibit Area, Convention Center

| | |
|---|---|
| Tuesday, January 23 | 2:00 p.m. - 8:00 p.m. |
| Wednesday, January 24 | 8:00 a.m. - 5:00 p.m. |
| Thursday, January 25 | 8:00 a.m. - 4:00 p.m. |
| Friday, January 26 | 8:00 a.m. - 4:00 p.m. |
| Saturday, January 27 | 8:00 a.m. - 4:00 p.m. |
| Sunday, January 28 | 8:30 a.m. - 2:30 p.m. |

HOTEL ACCOMMODATIONS

The form for requesting accommodations will be found on page A-736 of these *Notices*. The use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the meeting. Persons desiring accommodations should complete the appropriate form, or a reasonable facsimile, and send it to the Mathematics Meetings Housing Bureau, P.O. Box 6887, Providence, Rhode Island 02940, so that it will arrive no later than December 22, 1978. Reservations will be made in accordance with preferences indicated on the reservation form, insofar as this is possible, and all reservations will be confirmed by the Mississippi Gulf Coast Convention Bureau. Deposit requirements vary from hotel to hotel, and participants will be informed of any such requirement by the hotels directly, after confirmations are received. DO NOT INCLUDE PAYMENT FOR YOUR HOUSING WITH MEETING PREREGISTRATION FEE(S). All reservation requests must be received in writing and processed through the Housing Bureau in Providence. Telephone requests will not be accepted.

Participants who are able to do so are urged to share a room whenever possible. This procedure will be economically beneficial. The housing form should be fully completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide the name of each person with whom they plan to occupy a room. Each person should, however, complete a separate preregistration form. It would be helpful to receive the forms in Providence at the same time from all parties wishing to share the same room.

Participants wishing to share accommodations should be aware that the Broadwater Beach has some cottages which sleep four and some that sleep ten. These cottages have light kitchen facilities.

In all cases "single" refers to one person in one bed; "double" refers to two persons in one bed; and "twin" refers to two persons in two beds. A rollaway cot for an extra person can be added to double or twin rooms only.

Please make all reservation changes with the Housing Bureau in Providence prior to January 20. After that date, changes and cancellations must be made directly with Mrs. Nicey Lewis of the Mississippi Gulf Coast Convention Bureau (601-388-8000). The rates quoted below are subject to a seven percent sales tax; all hotels are in Biloxi, Mississippi 39531. The number in parenthesis after the name of the hotel refers to the number it carries on the map. Shuttle bus service will be provided to and from the Convention Center and all hotels listed except the Admiral Benbow, Biloxi Beach Motor Inn, Holiday Inn, and Howard Johnson's Motor Lodge. The Biloxi Beach Motor Inn will provide shuttle service for participants with its own vehicles.

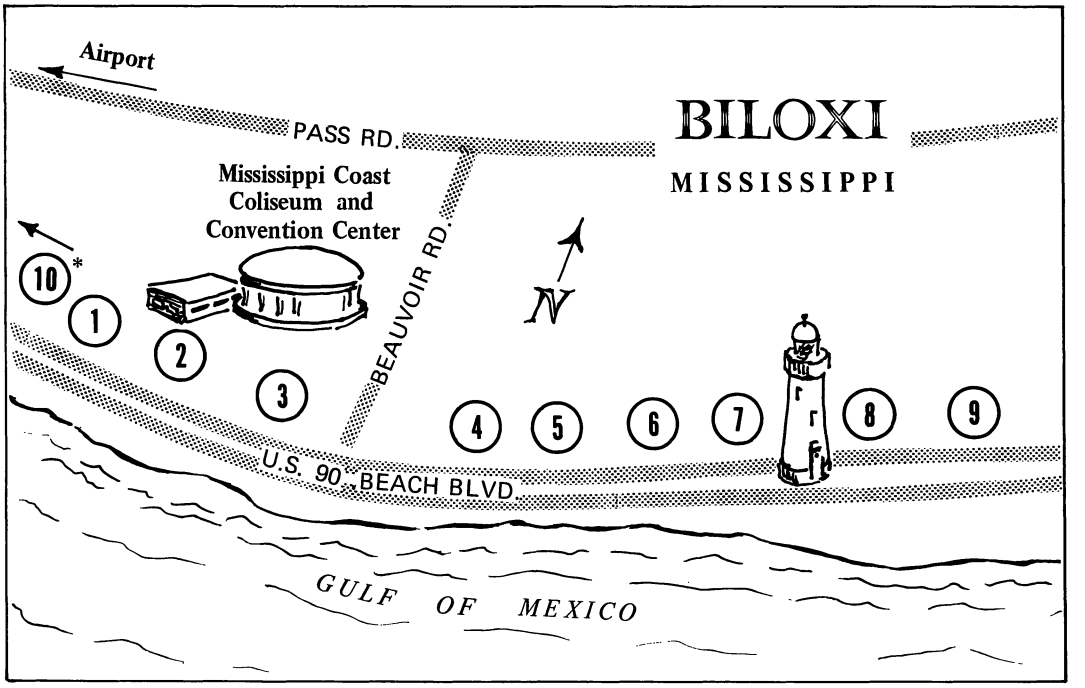
All hotels listed are on the beach and overlook the Gulf of Mexico.

THE BROADWATER BEACH (headquarters) ④
West Beach Boulevard
Telephone: Toll-free (800) 647-3964 or (601) 388-2211

| | | |
|---|---|---|
| Single | $32, $40 | |
| Double | $36, $44 | |
| Triple | $41, $49 | |
| Quadruple | $46, $54 | |
| Executive Cottage | $150 | (sleeps 10) |
| Single Cottage | $50 | (sleeps 4 ) |

ADMIRAL BENBOW INN ②
West Beach Boulevard
Telephone: (601) 388-1000

| | |
|---|---|
| Single | $17 |
| Double | $22 |
| Twin Double | $24, $26 |
| Triple | $28, $30, $32 |
| Quadruple | $32 |




1. Howard Johnson's
2. Admiral Benbow
3. Holiday Inn
4. Broadwater Beach
5. Biloxi Hilton
6. Sheraton-Biloxi
7. Rodeway Inn
8. Ramada Inn
9. La Linda Motor Inn

* 10. Biloxi Beach Motor Inn—*1½ miles west of* (1)

BILOXI BEACH MOTOR INN (10)
West Beach Boulevard
Telephone: (601) 388-3310

| | |
|---|---|
| Single | $21 |
| Double | $24 |
| Twin Double | $24 |
| Triple | $28 |
| Quadruple | $32 |
| Quintuple | $36 |
| Parlor Suite (one bedroom) | $75 |

BILOXI HILTON (5)
3580 West Beach Boulevard
Telephone: (601) 388-7000

| | |
|---|---|
| Single | $26, $29, $33, $38, $40, $42 |
| Double | $34, $37, $41, $46, $48, $50 |
| Twin Double | $34, $37, $41, $46, $48, $50 |
| Triple | $42, $45, $49, $54, $56, $58 |
| Quadruple | $50, $53, $57, $62, $64, $68 |
| Suites: 1 bedroom | $75, $110, $150 |
| 2 bedroom | $150, $186 |

HOLIDAY INN (3)
92 West Beach Boulevard
Telephone: (601) 388-3551

| | |
|---|---|
| Single | $24 |
| Twin Double | $30 |
| Triple | $34 |
| Quadruple | $38 |
| Quintuple | $42 |

HOWARD JOHNSON'S MOTOR LODGE (1)
3920 West Beach Boulevard
Telephone: (601) 388-6310

| | |
|---|---|
| Single | $22 |
| Twin Double | $28 |
| Triple | $32, $36 |
| Quadruple | $36 |

LA LINDA MOTOR INN (9)
3410 West Beach Boulevard
Telephone: (601) 388-4621

| | |
|---|---|
| Single | $20 |
| Double | $20 |
| Twin Double | $24 |
| Triple | $24, $28, $32 |
| Quadruple | $32 |
| Quintuple | $36 |

RAMADA INN (8)
3719 West Beach Boulevard
Telephone: (601) 388-5512

| | |
|---|---|
| Single | $21 |
| Twin Double | $23, $25 |
| Triple | $27, $29 |
| Quadruple | $31, $33 |
| Parlor Suite (one bedroom) | $60 |

RODEWAY INN (7)
West Beach Boulevard
Telephone: (601) 388-3131

| | |
|---|---|
| Single | $21 |
| Twin Double | $23, $28 |
| Triple | $27, $32, $36 |
| Quadruple | $31, $36 |
| Quintuple | $40 |

SHERATON-BILOXI MOTOR INN ⑥
3634 West Beach Boulevard
Telephone: (601) 388-4141

| | |
|---|---|
| Single | $36 |
| Twin Double | $42 |
| Triple | $46, $50 |
| Quadruple | $50 |
| Quintuple | $54 |
| Parlor Suite | |
| (one bedroom) | $120 |
| (two bedroom) | $160 |

## ENTERTAINMENT AND LOCAL INFORMATION

Biloxi, Mississippi, is located midway between New Orleans, Louisiana, and Mobile, Alabama, on a beautiful 26-mile long white sand beach. There is a wide range of outdoor recreational activities available including boating, tennis, swimming, fresh and salt water fishing, strolling along the beach or just plain lazin' in the sun. In addition, the area has such attractions as Beauvoir (Jefferson Davis' restored plantation estate), and theme parks like Marine Life, Deer Ranch and Eight Flags. Shopping, antiquing, scenic drives, and tours are available. Gourmet dining on delicious seafood and a choice of exciting "after dark" entertainment offer interesting night life. A tour of beautiful Bellingrath Gardens near Theodore, Alabama, may be of interest, or perhaps an excursion to old New Orleans for a delightful evening. Detailed information concerning these activities will be available at the Local Information Section of the Registration Desk.

The Local Arrangements Committee has planned a social for 9:00 p.m. on Friday, January 26, at the Convention Center. Food and drinks will be available. A jazz band and other entertainment will be provided. Additional details will be available in the January issue of the *Notices* and at registration.

## CHILD CARE

All the hotels being used for the meeting have lists of qualified babysitters who will come to the hotel. Prices range from $2 to $3 per hour. Several licensed day care centers are close to the hotels and Convention Center:

A B C Nurseries, 650 Forrest Avenue, Biloxi, 39531, twenty-four hours. $0.95/hr. one child, $1.60/hr. two children. Telephone (601) 435-4735.

Smith's Day Care & Kindergarten, 405 West Division Street, Biloxi, 39531, twenty-four hours. $1/hr. one child, $1.50/hr. two children. Telephone (601) 432-7304.

Kinderworld, Pass Road, Biloxi, 39531, twenty-four hours. $0.75/hr. one child, $0.90/hr. two children, $1.10/hr. three children. Telephone (601) 388-2748.

## MAIL AND MESSAGE CENTER

All mail and telegrams for persons attending the meetings should be addressed in care of Joint Mathematics Meetings, Mississippi Coast Coliseum and Convention Center, Biloxi, Mississippi 39531. Mail and telegrams so addressed may be picked up at the meeting registration area in the Convention Center.

A telephone message center will be located in the same area to receive incoming calls for all participants. The center will be open from January 23 through January 28, during the same hours as the Joint Meetings registration desk. Messages will be taken down and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. The telephone number of the center will be published in the January issue of the *Notices*.

N. B.: Those planning to attend the Joint Mathematics Meetings in Biloxi are strongly urged to read the following, since the regularly scheduled airline service into the Gulfport-Biloxi Regional Airport is not adequate to accommodate the large influx of participants just before and during the meetings, and many participants may otherwise find it extremely difficult or impossible to get to the meetings.

## TRAVEL

There are presently three ways to get into Gulfport/Biloxi, all on Southern Airways, the only major carrier serving the area.

(1) There are direct flights from Chicago, Memphis, and Milwaukee
(2) There are three flights daily from Atlanta.
(3) There are two flights daily from New Orleans.

The George Smith Travel Service of Gulfport has offered to assist participants in obtaining airline transportation at the lowest possible cost, including group and other special rates. To supplement the regular service, Mr. Smith is working with Southern Airways to arrange stops in Gulfport/Biloxi by flights without scheduled stops at present, and is also working with a small commercial airline out of New Orleans. He will, of course, be able to make these special arrangements only for participants who purchase their airline tickets through his agency.

The George Smith Travel Service will accept all major credit cards, and special billing can be arranged. (For further information and inquiry coupon, see advertisement on page A-732.)

Mr. Smith will also arrange ground transportation from New Orleans for those participants for whom he is unable to obtain airline seats on flights to Gulfport/Biloxi. There will be a transportation desk set up in the baggage claim area of New Orleans International Airport where participants should check in upon arrival. A lounge area will be available to enable participants to

wait in comfort for ground transportation to leave. The cost of this transportation is $15. There is also the Mississippi Coast Limousine Service (telephone 601-432-2649 or 864-7660), which operates by reservation only, and provides service from New Orleans six times daily. The trip takes about one hour and twenty minutes, and, again, the cost is $15. All major car rental agencies maintain desks at the New Orleans International Airport.

In winter, Biloxi is on Central Standard Time. The Gulfport/Biloxi Airport is approximately twelve miles from the Convention Center. Bus service to and from the hotels and airport has been arranged for participants at a cost of $4 one way. Room confirmations sent out to preregistered participants by the Convention Bureau will be accompanied by luggage tags color-coded for the hotel to which the participant has been assigned. These should be attached to the participant's luggage before it is loaded onto the aircraft at the point of origin. When the luggage arrives in Gulfport, it will automatically be sorted and delivered to the appropriate hotel in time for the participant's arrival, thus eliminating baggage handling by the participant at the airport. A transportation desk will be set up in the lobby of the airport, where participants may purchase, upon arrival, a ticket for the bus trip, and where those who did not preregister and request housing may receive color-coded luggage tags. The latter participants would then claim their luggage from the airport baggage claim area, affix the tags, and turn them over to the baggage handlers.

There will be shuttle bus service to and from the Convention Center and those hotels not immediately adjacent to it. The shuttle will also carry participants to and from restaurants in the area representing a wide range in both price and type of food during the evening mealtime hours. The cost of this service and the schedule will appear in the January issue of the *Notices*.

AMTRAK provides daily service from Chicago and Los Angeles into New Orleans. Trailways and Greyhound buses serve Biloxi on a regular basis. There is regular city bus service available from the Biloxi bus terminal to the hotels, as well as taxi service.

Participants driving to the meeting can reach Biloxi from the interstate highway system from the north on the Interstates I25, I35, I45, I55, I65, I85, and I95, which connect with the Interstates I90 or I10 from the east or west.

WEATHER

For the month of January in Biloxi the average daily maximum temperature is 16°C (60.7°F) and the average daily minimum is 6.3°C (43.4°F). The average January rainfall is 12 cm (4.76 inches). The highest temperature recorded in January is 24°C (75°F) and the lowest is -12°C (10°F); however, on the average, below freezing temperatures occur only 5 days in the month.

LOCAL ARRANGEMENTS COMMITTEE

Thomas A. Atchison (chairman), Frank T. Birtel (ex officio), Wendell Deer, Stephen A. Doblin, Roosevelt Gentry, James E. Keisler, William J. LeVeque (ex officio), Eldon L. Miller, Carol B. Ottinger, Charles S. Rees, David P. Roselle (ex officio), Robert A. Shive, Jr., and Billy R. Sneed.

New Orleans, Louisiana

Frank T. Birtel
Associate Secretary

## SUMMARY OF ACTIVITIES

The purpose of this summary is to provide assistance to registrants in the selection of arrival and departure dates. The program, as outlined below, is based on information available at press time.

| | AMERICAN MATHEMATICAL SOCIETY SHORT COURSE SERIES |
|---|---|
| MONDAY, January 22 | GAME THEORY AND ITS APPLICATIONS |
| noon - 5:00 p.m. | REGISTRATION (Short Course Only) |
| 2:00 p.m. - 3:15 p.m. | Game theory: An overview and the n-person cooperative model<br>William F. Lucas |
| 3:45 p.m. - 5:00 p.m. | Valuation of games<br>Lloyd S. Shapley |
| TUESDAY, January 23 | |
| 8:00 a.m. - 2:00 p.m. | REGISTRATION (Short Course Only) |
| 9:00 a.m. - 10:15 a.m. | Noncooperative games<br>Robert J. Weber |
| 10:45 a.m. - noon | Economic market games<br>Louis J. Billera |
| 1:30 p.m. - 2:45 p.m. | Measurement of power in political systems<br>Lloyd S. Shapley |
| 3:00 p.m. - 4:15 p.m. | Some uses of game theory in operations research<br>William F. Lucas |
| 4:30 p.m. - 5:00 p.m. | General discussion |

| | JOINT MATHEMATICS MEETINGS | |
|---|---|---|
| TUESDAY, January 23 | American Mathematical Society | Other Organizations |
| 2:00 p.m. - 8:00 p.m. | REGISTRATION | |
| 2:00 p.m. | Council Meeting | |
| WEDNESDAY, January 24 | AMS | Other Organizations |
| 8:00 a.m. - 5:00 p.m. | REGISTRATION | |
| 8:00 a.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 9:00 a.m. - 10:00 a.m. | INVITED ADDRESS<br>Some applications of algebraic geometry to ring theory<br>Michael Artin | |
| 9:00 a.m. - 10:30 a.m. | | Association for Symbolic Logic<br>Sessions for Contributed Papers |
| 10:30 a.m. - 11:30 a.m. | INVITED ADDRESS<br>Manifolds and submanifolds<br>Julius L. Shaneson | |
| 10:45 a.m. - 11:45 a.m. | | ASL - Retiring Presidential Address<br>A report on intuitionistic algebra<br>Dana Scott |
| 1:00 p.m. - 2:00 p.m. | COLLOQUIUM LECTURE I<br>Complex analysis and algebraic geometry<br>Phillip A. Griffiths | |
| 1:30 p.m. - 2:30 p.m. | | ASL - Invited Address<br>Determinateness and the continuum problem<br>John Steel |
| 2:00 p.m. - 5:00 p.m. | | Mathematicians Action Group<br>Steering Committee - Open Meeting |
| 2:15 p.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 2:30 p.m. - 4:30 p.m. | Committee on Employment and Educational Policy<br>Meeting of Department Heads | |
| 2:45 p.m. - 4:00 p.m. | | ASL - Special Session<br>A talk on proof theory<br>Daniel J. Leivant<br>Constructability and large cardinals<br>William Mitchell |

| WEDNESDAY, January 24 | American Mathematical Society | Other Organizations |
|---|---|---|
| 3:30 p.m. - 4:30 p.m. | INVITED ADDRESS<br>Proper holomorphic maps<br>John E. Fornaess | |
| 4:10 p.m. - 5:20 p.m. | | ASL - Sessions for Contributed Papers |
| 5:30 p.m. - 7:00 p.m. | | ASL - Cocktail party |
| 8:00 p.m. - 11:00 p.m. | | ASL - Council Meeting |
| 8:30 p.m. - 9:30 p.m. | JOSIAH WILLARD GIBBS LECTURE<br>"What are solitons and inverse scattering anyway, and why should I care?"<br>Martin D. Kruskal | |

| THURSDAY, January 25 | AMS | Other Organizations |
|---|---|---|
| 8:00 a.m. - 4:00 p.m. | REGISTRATION | |
| 8:00 a.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 8:40 a.m. - 9:50 a.m. | | ASL - Sessions for Contributed Papers |
| 9:00 a.m. - 10:00 a.m. | INVITED ADDRESS<br>Problems with different time scales and their numerical solution<br>Heinz-Otto Kreiss | |
| 9:00 a.m. - 5:00 p.m. | EXHIBITS | |
| 9:00 a.m. - 9:30 a.m. | EMPLOYMENT REGISTER ORIENTATION SESSION | |
| 9:00 a.m. - 4:00 p.m. | | Mathematical Association of America<br>Board of Governors Meeting |
| 9:30 a.m. - 4:00 p.m. | EMPLOYMENT REGISTER REGISTRATION | |
| 10:00 a.m. - 11:20 a.m. | | ASL - Special Session in Model Theory<br>First order theories of modules<br>Steven Garavaglia<br>Models of arithmetic<br>Julia Knight |
| 10:30 a.m. - 11:30 a.m. | INVITED ADDRESS<br>Entropy, isomorphism, and reparametrization for finite measure-preserving actions of certain continuous groups<br>Jacob Feldman | |
| 11:30 a.m. - 12:30 p.m. | | ASL - Retiring Presidential Address<br>New axioms for set theory<br>Joseph R. Shoenfield |
| 1:00 p.m. - 2:00 p.m. | COLLOQUIUM LECTURE II<br>Complex analysis and algebraic geometry<br>Phillip A. Griffiths | |
| 2:10 p.m. - 3:10 p.m. | INVITED ADDRESS<br>Space-times with distribution valued curvature tensors<br>Abraham H. Taub | |
| 3:20 p.m. - 4:50 p.m. | Bôcher and Steele Prize Session | |
| 5:00 p.m. - 6:00 p.m. | Business Meeting | |
| 7:00 p.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 7:00 p.m. | | MAA - Film Program |
| 7:30 p.m. - 10:00 p.m. | | Conference Board of the Mathematical Sciences - Symposium on Computer Science and the Mathematical Sciences: Interfaces and Overlaps<br>Keynote Address<br>Interplay between mathematics and computer science<br>Interactions in Specific Areas<br>Stylitism, synergism, syncretism - the interface of computer science and operations research<br>Computer science and recursion theory<br>Computer science core curriculum and mathematics |

| THURSDAY, January 25 | American Mathematical Society | Other Organizations |
|---|---|---|
| | | CBMS - Symposium (continued)<br>Computer science and numerical analysis<br>Computer science and graduate education in applied mathematics<br>Complexity of computations<br>Computer science and statistics<br>Computer related curricular changes in traditional mathematics<br>Conclusion<br>Summary and discussion |
| 8:00 p.m. - 10:00 p.m. | | ASL - Council Meeting |
| 8:00 p.m. - 10:00 p.m. | | MAG - Business Meeting |

| FRIDAY, January 26 | AMS | Other Organizations |
|---|---|---|
| 8:00 a.m. - 4:00 p.m. | REGISTRATION | |
| 9:00 a.m. - 5:00 p.m. | EXHIBITS | |
| 9:00 a.m. - 5:30 p.m. | EMPLOYMENT REGISTER INTERVIEWS | |
| 9:00 a.m. - 10:20 a.m. | | MAA - Panel Discussion<br>Innovations in the teaching of calculus<br>Louis Leithold<br>Jean Nunn<br>R. M. Pengelly<br>John Richmond |
| 10:30 a.m. - 11:20 a.m. | | MAA - Invited Address<br>Calculus with programmable calculators<br>Harry P. Allen |
| 10:30 a.m. - 11:50 a.m. | | MAA - Panel Discussion<br>Educational Testing Service and the graduate records exam<br>Richard D. Anderson<br>Israel N. Herstein<br>Gloria Hewitt<br>J. R. Jefferson Wadkins |
| 1:00 p.m. - 2:00 p.m. | COLLOQUIUM LECTURE III<br>Complex analysis and algebraic geometry<br>Phillip A. Griffiths | |
| 2:15 p.m. - 3:15 p.m. | INVITED ADDRESS<br>The heart valve problem of cardiac fluid dynamics and its numerical solution<br>Charles Peskin | |
| 2:15 p.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 2:15 p.m. - 4:15 p.m. | | CBMS - Panel Discussion<br>Mathematics today<br>Felix E. Browder<br>Saunders Mac Lane (moderator)<br>J. Ian Richards |
| 3:30 p.m. - 4:30 p.m. | INVITED ADDRESS<br>Representations of classical groups<br>Bhama Srinivasan | |
| 4:45 p.m. | Committee on Science Policy<br>Panel Discussion - Mathematicians' views of government support of research<br>Richard D. Anderson (moderator)<br>Joseph J. Kohn<br>Saunders Mac Lane | |
| 7:00 p.m. - 9:00 p.m. | AMS Committee on Employment and Educational Policy/MAA - Panel Discussion<br>The mathematician outside the university<br>Gary McDonald<br>Edward C. Posner<br>Albert C. Williams<br>Norman D. Winarsky | |
| 9:00 p.m. | COCKTAIL PARTY | |

| SATURDAY, January 27 | American Mathematical Society | Other Organizations |
|---|---|---|
| 8:00 a.m. - 4:00 p.m. | REGISTRATION | |
| 9:00 a.m. - 5:00 p.m. | EXHIBITS | |
| 9:00 a.m. - 5:30 p.m. | EMPLOYMENT REGISTER INTERVIEWS | |
| 9:00 a.m. - 9:50 a.m. | | MAA - Panel Discussion<br>National Science Foundation programs in mathematical education and research<br>Alphonse Buccino<br>Thomas A. Keenan<br>William H. Pell<br>Alvin Thaler |
| 10:00 a.m. - 10:50 a.m. | | MAA - Business Meeting |
| 11:00 a.m. - 11:50 a.m. | | MAA - Panel Discussion<br>Prospects in mathematics education in the 1980's: A report on a conference<br>Glora F. Gilmer<br>Donald L. Kreider<br>James W. Vick |
| 11:30 a.m. - 12:30 p.m. | AMS-MAA-SIAM<br>Progress report on the work of a Congressional Fellow<br>Edmund G. Lee | |
| noon - 1:00 p.m. | | MAA - Poster Session |
| 1:00 p.m. - 2:00 p.m. | COLLOQUIUM LECTURE IV<br>Complex analysis and algebraic geometry<br>Phillip A. Griffiths | |
| 2:15 p.m. | Special Sessions<br>Sessions for Contributed Papers | |
| 2:15 p.m. - 3:45 p.m. | | MAG - Panel Discussion |
| 4:00 p.m. - 5:00 p.m. | | Association for Women in Mathematics<br>Panel Discussion - ERA and Bakke<br>Judith Roitman (moderator) |
| 7:00 p.m. | | MAA - Film Program |
| **SUNDAY, January 28** | | **Mathematical Association of America** |
| 8:30 a.m. - 2:30 p.m. | REGISTRATION | |
| 9:00 a.m. - 9:50 a.m. | | Invited Address<br>Gödelian puzzles<br>Raymond M. Smullyan |
| 10:00 a.m. - 10:50 a.m. | | MAA/NCTM - Invited Address<br>The NSF status surveys in school mathematics<br>James T. Fey |
| 10:00 a.m. - 10:50 a.m. | | Invited Address<br>The Claremont program in applied mathematics<br>Jerome Spanier |
| 11:00 a.m. - 11:50 a.m. | | MAA/NCTM - Panel Discussion<br>Basic skills: Placement and pedagogy<br>Thomas A. Carnevale<br>Bernard L. Madison<br>Amber Steinmetz |
| 11:00 a.m. - 11:50 a.m. | | Invited Address<br>Intersection graphs, food webs, ecological phase space, and the boxicity conjecture<br>Fred S. Roberts |
| 1:30 p.m. - 2:20 p.m. | | Invited Address<br>Arithmetic complexity of computations - theory and applications<br>Shmuel Winograd |
| 2:30 p.m. - 3:20 p.m. | | Invited Address<br>Curvature and arc length<br>Andrew Gleason |
| 3:30 p.m. - 4:20 p.m. | | Invited Address<br>Sherlock Holmes in Babylon<br>R. Creighton Buck |

# 764 TH MEETING

## *University of Hawaii Honolulu, Hawaii March 27– April 1, 1979*

The seven hundred sixty-fourth meeting of the American Mathematical Society will be held at the University of Hawaii at Manoa in Honolulu, Hawaii, from Friday, March 30, through Sunday, April 1, 1979.

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be two invited one-hour addresses. These will be given by HENRY A. DYE of the University of California, Los Angeles, and by WILLIAM A. HARRIS, Jr., of the University of Southern California.

By invitation of the same committee, there will be at least five special sessions of invited twenty-minute papers. The titles of the special sessions and the names of the organizers are as follows: Geometric topology, CHRISTOPHER J. ALLDAY, HUGH M. HILDEN, and BOB LITTLE; Quadratic forms, RONALD P. BROWN and THOMAS C. CRAVEN; Countable models, WILLIAM P. HANF and DALE W. MYERS; Non-associative algebras and applications, NOBUO NOBUSAWA and ARTHUR A. SAGLE; Commutative harmonic analysis, L. THOMAS RAMSEY and BENJAMIN B. WELLS, Jr. All of the organizers are at the University of Hawaii at Manoa except for Arthur A. Sagle, who is at the University of Hawaii at Hilo.

The meeting coincides with a very busy tourist season in Hawaii, so participants should make their plans as soon as possible! Some flights are already booked; it is imperative that plans be made NOW. Reservations for air travel and hotel accommodations can be made through Hawaii Conference Planners, 2222 Kalakaua Avenue, P.O. Box 8519, Honolulu, Hawaii 96815. They will provide a choice of hotels, group air fare rates, and optional tours and activities. The deadline for receipt of hotel reservations is January 26, 1979. Participants communicating with HCP should mention that they are attending the mathematics meeting. For your convenience an information request form can be found on page A-690 of the October issue of the *Notices*. You may prefer to consult your own travel agent for assistance, or to determine whether any special air fares or travel packages would apply from your point of origin at that time.

Eugene, Oregon

### SYMPOSIUM ON THE GEOMETRY OF THE LAPLACE OPERATOR

With the anticipated support of the National Science Foundation, a symposium on the Geometry of the Laplace Operator is scheduled to take place Tuesday through Friday, March 27–30. This topic was selected by the Committee to Select Hour Speakers for Far Western Sectional Meetings, whose members are Paul C. Fife (chairman), David M. Goldschmidt, Robert Osserman, Rimhak Ree, and Kenneth A. Ross.

The purpose of the symposium is to bring together people working in several related areas of geometry and analysis. The common thread is the Laplace operator, whose eigenvalues and eigenfunctions have been found in recent years to contain an unsuspected wealth of information on the geometry and topology of the underlying domain. There are also links to physics through potential theory, the basic equations of wave motion and heat flow or diffusion, and quantum mechanics. These links have proven fruitful in both directions.

It is planned to have eight half-day sessions devoted to various subtopics, including the following: The spectrum of the Laplacian (distribution of eigenvalues, relations to periodic geodesics and global geometry); Riemann surfaces (Selberg trace formula, dependence of spectrum on genus, conformal type, etc.); bounds on eigenvalues (influences of curvature, topology, etc.); nonlinear problems (harmonic mappings, prescribed Gauss or scalar curvatures); group theory (the Laplacian on Lie groups and homogeneous spaces); and applications (physics, chemistry).

The Organizing Committee for the symposium includes David Bleecker, University of Hawaii, Honolulu, and Robert Osserman, Stanford University (co-chairmen); Victor Guillemin, Massachusetts Institute of Technology; Henry P. McKean, Jr., Courant Institute of Mathematical Sciences; Karen Uhlenbeck, University of Illinois at Chicago Circle; and Joel Weiner, University of Hawaii, Honolulu.

The speakers and the titles of their talks will be announced in the January issue of these *Notices*.

Kenneth A. Ross
Associate Secretary

# ORGANIZERS AND TOPICS OF SPECIAL SESSIONS

Names of the organizers of special sessions to be held at meetings of the Society are listed below, along with the topic of the session. Papers will be considered for inclusion in special sessions, if their abstracts are submitted to the Providence office by the deadlines given below. These deadlines are three weeks earlier than those for abstracts for regular sessions of ten-minute contributed papers. The most recent abstract form has a space for indicating that the abstract is for a special session. If you do not have a copy of this form, be sure your abstract is clearly marked "For consideration for special session (title of special session)." Papers not selected for special sessions will automatically be considered for regular sessions unless the author gives specific instructions to the contrary.

| 85th Annual Meeting | Biloxi, Mississippi, January 1979 | Deadline: Expired |
|---|---|---|
| Stefan Burr | Number theory and its applications | |
| Douglas N. Clark | Operator theory | |
| Paul Ehrlich | Differential geometry and general relativity | |
| Murray Gerstenhaber | Diffusion reaction systems in biology | |
| John R. Graef and A. G. Kartsatos | Ordinary differential equations: Oscillation and asymptotic behavior | |
| William C. Hoffman | Mathematical psychology | |
| Marvin Knopp | Modular and automorphic functions in a single complex variable | |
| William Lucas | Game theory | |
| Richard Millman | Global differential geometry | |
| Ray Mines and Fred Richman | Constructive mathematics | |
| M. Z. Nashed | Integral equations | |
| B. E. Rhoades | Summability and related topics | |
| Robert J. Thompson | Nonacademic mathematical research | |

| 764th Meeting | Honolulu, Hawaii, March 1979 | Deadline: January 9 |
|---|---|---|
| Christopher J. Allday, Hugh M. Hilden, and Bob Little | Geometric topology | |
| Ronald P. Brown and Thomas C. Craven | Quadratic forms | |
| William P. Hanf and Dale W. Myers | Countable models | |
| Nobuo Nobusawa and Arthur A. Sagle | Nonassociative algebras and applications | |
| L. Thomas Ramsey and Benjamin B. Wells, Jr. | Commutative harmonic analysis | |

| 766th Meeting | Iowa City, Iowa, April 1979 | Deadline: February 6 |
|---|---|---|
| Daniel D. Anderson | Commutative ring theory | |
| Kent R. Fuller | Noncommutative ring theory | |
| William H. Jaco | Three-dimensional manifold theory | |
| James P. Kuelbs and Walter V. Philipp | Probability on Banach spaces | |
| Richard P. McGehee | Dynamical systems | |
| Paul S. Muhly | Operator theory | |
| John C. Polking | Several complex variables | |

# INVITED SPEAKERS AT AMS MEETINGS

The individuals listed below have accepted invitations to address the Society at the times and places listed. For some meetings, the lists of speakers are incomplete.

Biloxi, Mississippi, January 1979

Michael Artin
Jacob Feldman
John E. Fornaess
Phillip A. Griffiths (Colloquium Lecturer)
Heinz-Otto Kreiss
Martin D. Kruskal (Gibbs Lecturer)
Charles Peskin
Julius L. Shaneson
Bhama Srinivasan
Abraham H. Taub

Honolulu, Hawaii, March 1979

Henry A. Dye
William A. Harris, Jr.

Iowa City, Iowa, April 1979

Charles G. Conley
Wolfgang R. G. Haken
Judith D. Sally
B. A. Taylor

Kent, Ohio, November 1979

Kyung W. Kwun
Daniel R. Lewis
Albert Marden
Paul H. Rabinowitz

# Annual MR Indexes

## 1973–1977

*Now Up-To-Date And Available At Reduced Prices*

The INDEX OF MATHEMATICAL PAPERS, or IMP, has been the annual index to MATHEMATICAL REVIEWS since 1973. Each volume is published in two parts, an author index with complete bibliographic data on each article or book reviewed, and a subject index listing author, title and MR number. These indexes have experienced delays in publication, but with the publication in 1978 of Volumes 7, 8 and 9, covering 1975–1977, we are happy to announce three significant developments:

Volume 10 and all future volumes will appear concurrently with the December issues of MR.

Subscribers to MR will receive them free as part of the subscription. Nonsubscribers who are members of the Society may purchase them separately at strongly discounted prices, as indicated by these prices for Volume 10:

| Volume 10 | | | |
|---|---|---|---|
| List price | $120 | Individual Member | $60 |
| Institutional Member | 90 | Reviewer | 30 |

Heretofore, IMP has been sold only at full list price, ranging from $80 to $120 for the past five volumes. Because of the cost and the delay in publication, a number of libraries and individual mathematicians failed to purchase the successive volumes. In order to obtain wider distribution of these invaluable research and reference works, Volumes 5–9 are now offered as a package at sharply reduced prices from what would earlier have been the total list price of $495:

| Volumes 5–9 | | | |
|---|---|---|---|
| List price | $360 | Individual Member | $180 |
| Institutional Member | 270 | Reviewer | 90 |

If you already own some of these volumes, then the others can be purchased separately at equally attractive discounts:

| Code | List Price | Institutional Member | Individual Member | Reviewer |
|---|---|---|---|---|
| IMP 5 (1973MR) | $80 | $60 | $40 | $20 |
| IMP 6 (1974MR) | 80 | 60 | 40 | 20 |
| IMP 7 (1975MR) | 95 | 71.25 | 47.50 | 23.75 |
| IMP 8 (1976MR) | 120 | 90 | 60 | 30 |
| IMP 9 (1977MR) | 120 | 90 | 60 | 30 |

For the first time since the last cumulative index appeared (covering the period 1965–1972), it is possible to have a current collection of MR indexes including at least one year per volume. Not only are these annual indexes faster to use than the semi-annual indexes that have been included with subscriptions up to now, because of the longer time span covered by each, but the subject indexes are considerably more convenient inasmuch as titles of articles are included in IMP, but not in the semi-annual indexes.

Those who want to save on shelf space can have an "abridged" set of MR, in the form of its annual indexes, and at considerable saving in cost.

Prepayment is required for all American Mathematical Society publications.
Send for the book(s) above to: AMS, P. O. Box 1571, Annex Station, Providence, RI 02901.

# N.S.F. CONSIDERS THE ESTABLISHMENT OF A MATHEMATICAL SCIENCES RESEARCH INSTITUTE

On March 16-17, 1978, the Director of the National Science Foundation, Dr. Richard C. Atkinson, forwarded material to the National Science Board (NSB) regarding the need for supplementing the Foundation's project research grant mechanism for the mathematical sciences by a research institute. A description of a possible model for such an institute was given, along with a discussion on alternative mechanisms.

At this meeting, the NSB approved the issuance by the Director of an announcement requesting proposals for the establishment of a research institute having the general features of the model described in this material.

The model of an institute described to the NSB, along with various alternative modes of research support, have generated much discussion in the U.S. mathematical sciences research community. Accordingly, as part of our effort to keep the mathematical sciences community as fully informed as possible concerning the National Science Foundation's plans with respect to the support of the mathematical sciences, the material which was sent to the NSB at the March 16-17, 1978 meeting is being published here in its entirety.

A few words of explanation may be helpful. One of the documents reprinted here bears the NSB number NSB-78-80 and appeared on the agenda of the March 16-17, 1978 meeting of the National Science Board. It consists of three parts:

(1) A memorandum to the National Science Board from Dr. Richard C. Atkinson;

(2) A draft of the Project Announcement referred to in (1); and

(3) A portion labelled "A Research Institute for the Mathematical Sciences," which contains material giving the rationale for an institute, historical remarks, delineation of a possible institute model, and description of alternate mechanisms for the support of mathematical research.

Notes: (a) Since the Project Announcement is merely a draft, the dates September 15, 1978 and January 1, 1979 have no meaning; (b) The pronoun "we" in (3) means the National Science Foundation.

In addition to NSB-78-80, this report contains the minutes on agenda item 8 of the meeting of March 16-17, 1978, a document entitled "Comments by Saunders Mac Lane on Open Session Minutes of March, 1978," and, finally, remarks by Dr. J. A. Krumhansl on the nature of a project announcement and on the budgeting issues raised in the minutes referred to above.

J. A. Krumhansl

## NSB-78-80

### MEMORANDUM TO NATIONAL SCIENCE BOARD

American research in mathematics is today in a golden age. But there is within the mathematical community a general consensus that, in order to maintain and even further to stimulate the unequalled pace of research of the past dozen years, another mathematical sciences research institute, similar but not identical to the famous Institute for Advanced Study, should be established. Over the past three years, this concept has been discussed during both formal and informal meetings of several of the mathematical sciences professional organizations. It has also been intensively reviewed by the NSF Advisory Panel for the Mathematical Sciences, which recommended that the Section entertain proposals for the establishment of an institute. A resolution recommending the establishment of such an institute was also passed recently by the Conference Board of the Mathematical Sciences.

Letters from and conversations with many American mathematicians show agreement with the need for continued stimulation of mathematical research and with the concept of a research institute as an efficient and effective method of providing such stimulation.

The anticipated funding level for an institute is such that Board approval of the grant will be required if the proposal review determines that this is the most advantageous method of achieving the stated goals.

I recommend that the Board approve the following resolution:

> RESOLVED that the National Science Board approves the establishment of a Mathematical Sciences Research Institute; further, the Board approves of a Project Announcement and the general plans for the establishment of the Institute.

Richard C. Atkinson, Director

### PROJECT ANNOUNCEMENT [Draft]

#### I. INTRODUCTION

In order to preserve and strengthen the intellectual vigor of the nation's current effort in the mathematical sciences, the Foundation plans to establish on a five-year trial basis an institute for research in the mathematical sciences. The primary purpose of this institute will be to stimulate research in diverse problem areas among both able mature mathematicians and promising young mathematicians from all parts of the country. The solution of research problems is frequently rendered easier by the coordinated efforts of groups of mathematical scientists, sometimes from the same and sometimes from different subfields of the mathematical sciences. At the same time the knowledge and research expertise of the participating scientists are enhanced and the boundary of mathematical knowledge in the field of research problems pushed forward in something approaching a maximally efficient way.

#### II. DESCRIPTION OF INSTITUTE

The institute under consideration will operate throughout the year and provide an environment in which mathematical scientists from different subdisciplines, locations, and age groups can interact. While providing an atmosphere conducive to the general exchange of mathematical ideas, its principal focus would be on concentrated activity in a few areas of great current mathematical interest. Such attention to some areas might extend through several years, while other areas might warrant attention for a shorter time.

Areas of applied mathematics as well as core mathematics would be expected to receive attention. Even in years in which the major activity of the institute is in an area of core mathematics, it is expected that application of that core subdiscipline would be encouraged. Areas of concentration would be announced well in advance.

It is expected that the institute will be located near a major resource or resources of mathematical research. This might mean that the institute would be located on a campus, although it is possible that an off-campus location might be preferable (see C.). The leadership of the institute would be provided by a director and perhaps an associate director, as well as a governing committee. The director would be a major figure in the mathematical sciences on long-term leave from his home institution, while the associate director could be on part-time leave from a nearby institution. There would be approximately forty (40) members of the institute at any one time, all temporary. Of these, perhaps 8 would be major research figures, about twice that number strong, well-established researchers, and the remainder, junior scientists who have given unequivocal evidence of strong research capability. It is expected that the cost of operating the institute will be approximately $1.75 million dollars per year.

II [sic]. DESCRIPTION OF FOUNDATION SUPPORT

Initial funding would be provided in FY 1980. Continued support for a period not to exceed five years would be subject to an annual review of satisfactory progress.

Funds provided by the Foundation would cover, in large part, the salaries as well as travel and living expenses of visitors, secretarial and related costs, computing and library expenses, costs of office space, and appropriate indirect costs.

IV. PROPOSAL SUBMISSION INFORMATION

A. Who May Submit. Proposals may be submitted by all categories of applicants described as eligible in "Grants for Scientific Research," NSF 76-38. However, participation in the preparation of proposals by a group of institutions in a consortium-like arrangement is strongly encouraged.

B. Timing of Submission. Proposals must be received at the Foundation by January 1, 1979. Proposers must notify the Foundation of their intent to submit a proposal by September 15, 1978.

Twenty copies of the formal proposal should be addressed to the Central Processing Section, National Science Foundation, Washington, D.C. 20550. It should be clearly indicated that the proposal is in response to this announcement on the Mathematical Sciences Research Institute.

C. Important Considerations. Research areas of specific problems in the mathematical sciences which appear to be ripe for exploitation or in need of concerted effort form suitable subjects for the attention of the institute. It is anticipated that the institute will deal with two or three areas (perhaps related) at a given time and that attention will shift gradually to other areas as time passes. In order to allow the choice of areas of emphasis to be mathematically rather than administratively driven, the selection procedure should be based upon written proposals from small groups of mathematicians who see a particular need and wish to participate in its development.

The question of the extent to which the research efforts of the institute should be administratively connected to the nearby universities or other resource institutions is left open. While it is felt that physical proximity to lecture rooms, library, etc., is important, it is not necessary that the institute be housed on a campus. If so located, it may be wise to have some physical separation from the institution's department of mathematics. All of these remarks gain added force if the institute is to be administered by a consortium.

Particular care must be given to the choice of the institute director since the director must have the unalloyed respect and confidence of the mathematical sciences community. He must be known as an able administrator with a wide acquaintance with mathematicians throughout the world.

Overall scientific guidance of the institute should be provided by a committee of scientists from several institutions, not all necessarily colleges or universities.

D. Proposal Content. The proposal should state what is hoped will be accomplished and provide a plan for its accomplishment. The proposed leaders of the project should be named and the extent of their commitment to it indicated. A description should be given of the proposed method of directing the project, choosing topics for study (see C.), getting the project started, maintaining continuity, choosing visiting participants, and providing an orderly phase-out of operations. The degree to which participation in the project would be open to scientists throughout the community should be explained. A method of disseminating research results throughout the mathematical community should be described. A plan for evaluating the extent to which the activity met its goal should be included.

The proposal should indicate arrangements for secretarial and related assistance, for office space, and for the use of existing library and computer facilities or the provision for new ones. No major capital expenditures are envisioned. The anticipated expenses of the project and the plan for dealing with them (including other sources of support) should be discussed in detail.

In format, the proposal should follow the general guidelines described in National Science Foundation Brochure 76-38, entitled "Grants for Scientific Research." Biographical and bibliographical information on the central figures who will participate in the project should be included.

E. Proposal Evaluation. Evaluation of competing proposals by members of the mathematical sciences community will be administered by the Foundation's Mathematical Sciences Section. An award will be made only if a proposal of sufficient merit is received.

Evaluation criteria will include:

1) the qualifications of the scientific personnel involved in the project, including those of the proposed director;

2) the character of the commitment of the proposed leadership;

3) the quality of the research to be produced;

4) ability of the proposers to attract high quality scientific membership with appropriate interests;

5) suitability of location with regard to contact with leading mathematical scientists and access to computing and library facilities, office space, and housing;

6) the suitability of the method of directing the project, choosing topics for study (see C.), getting the project started, maintaining continuity, choosing participants, and providing an orderly phase-out;

7) the suitablity of the plans for opening the project to scientists throughout the community and disseminating research results; and

8) the suitability of the plan for evaluating the extent to which the institute met its goal.

## A RESEARCH INSTITUTE FOR THE MATHEMATICAL SCIENCES

1. Introduction. For nearly a decade the major departments of the mathematical sciences in the United States have been subject to an increasingly important complex of demographic and economic influences whose long term effect will surely impair seriously their ability to maintain the current high level of significant research, as well as their capacity to train high quality mathematical scientists. Virtually all of our stronger departments of mathematics (as defined in [1], say) have become highly "tenured-in," stagnant in size, with little turnover in membership, and have decreasing graduate student enrollments. Departments in the smaller schools, having upgraded their faculties markedly over the past two decades often with extremely able young mathematicians, now also face the same phenomenon of stagnation, as well as their ever-besetting problem of isolation.

The long term effect of the situation sketched above will surely be a gradual loss in potential research achievement of our most creative mathematical scientists, and clearly a loss of the exploratory sparkle and vigor that the inflow and outflow of young and visiting faculty, as well as graduate students, brought to the field during the postwar decades. We must seek new forums in this era of static demographic constraints to prevent that loss.

In addressing the problem it may be well to consider one view of the dynamics of research in mathematics, in comparison with the experimental sciences. In the latter case it is apparent that carefully designed experiments eventually test the truth of theories. The best test of content in mathematics research is that of critical dialogue, which is both judgmental and stimulative to new ideas—hence of as great importance to this subject as facilities and equipment are to the physical sciences.

Thus, it is the belief of the Mathematical Sciences Section, its Advisory Panel, and a substantial segment of the community of U.S. mathematicians as evidenced through personal contacts, telephone conversations, and letters, as well as earlier incomplete efforts, that a salutary device for preventing the losses mentioned above, and for even enhancing the research vigor of the U.S. mathematical research enterprise, would be to use a small percentage of the support for mathematical research to establish a research institute, or eventually institutes, of the mathematical sciences.

The difficulties of this situation have been discussed by Press [2], Atkinson [3,4], and in a recent NSF study [5]. Earlier versions of this idea have been suggested in various forms, particularly in an essay by Saunders MacLane in 1974 [6]. Alternatively, an enlarged postdoctoral program has been suggested; we believe that this would simply not serve to alleviate the central problems which the institute mechanism has the potential to address successfully.

Whatever the previous models, whether fixed geographically or peripatetic, whether single or multiple, we now propose a single institute for a trial period of five years, with the program and the evaluation of its success, or not, to be determined by a broad cross-section of the mathematical sciences community.

At this point in time we want to provide for the outstanding young mathematician particularly, a situation where maturation through exposure to leaders in several subfields can take place to a degree not otherwise possible today.

2. A Tentative Model for a Research Institute for the Mathematical Sciences. By the term "research institute" we mean an organization where mathematical scientists, on leave from their institutions of permanent employment, can congregate in appropriate numbers for extended periods for the sole purpose of performing research. The pursuit of research on a fellowship or sabbatical at an academic institution may achieve this end for the individual, but the only U.S. institution in which the formal educational-degree-granting apparatus is absent, and which serves to enrich and/or mature exceptional talent in the mathematical sciences released from pedagogical commitments, is the Institute for Advanced Study (IAS) at Princeton, New Jersey.

There seems to be no strongly convincing argument for determining the optimal number of institutes. What does seem clear to many members of the academic community and to the Mathematical Sciences Section is that one institute would be salutary in its benefits. The prudent approach would then seem to be the establishment of a single institute. It is further suggested that funding be for a five-year period. In this way the concept can be tested and light shed on various questions relating to it.

2.1. Size of the Institute. What is the ideal size for the scientific staff of a research institute? This, like the optimal number of institutes, is not easy to determine, but we do have some vague guidelines. The IAS seems to function well at its present size, which is between 50 and 65. The Courant Institute of NYU, which functions somewhat like the institute we envisage (it has numerous postdoctorals in applied mathematics), is somewhat smaller, and is extremely effective. These examples indicate that 40 - 60 would be an ideal number for the scientific staff. An ill-defined minimum is related to the notion of "critical mass", i.e., the number of experts in a field required to produce an ambience in which productive interaction and communication are continual and intense; this is generally thought to be 3 or 4 for a subdiscipline. If we add to this an equal or somewhat larger number of talented young scientists, and assume the institute would at any given time devote its efforts to, say, four fields, then we arrive at a minimum of 30 - 35 scientific staff. Presuming a reasonable degree of success, this number might grow to 40 - 50 after a few years, particularly if foreign and short term visitors become a significant participatory element.

2.2. Makeup of the Institute Membership. The initial composition of the institute, we believe, should be approximately as follows:

a) Approximately 8 internationally renowned leaders in research. It would be largely up to these to give direction to the institute's efforts and provide inspiration for the younger and less experienced members. Each should not only be highly regarded for his research, but should have a solid record as a teacher, i.e., should have had several outstanding Ph.D. students.

b) Approximately 12 well-established researchers with perhaps 10 years production of consistently high quality research. These are in full flight, so to speak, and at, or approaching, the peak of their powers.

c) Approximately 20 young holders of the Ph.D. who have demonstrated high research promise. These would generally have had the doctorate from 1 to 5 or 6 years. It would perhaps be wise not to be rigid about the degree requirement. The goals of the institute might occasionally be best served by admitting to membership someone who does not have a doctorate and/or does not fit the age categories set down. We have in mind the transcendent young genius for whom the degree is an irrelevancy or the older man who suddenly "finds" himself in middle age.

It is envisaged that at any one time the institute would direct its attention to two or three different areas of mathematics that are somewhat related. This should not be difficult to accomplish with the leadership provided by the members of groups a) and b).

As the membership changed, the areas of research concentration would be changed slowly. This would, however, require very careful planning on the part of the institute leadership.

We repeat that the institute, as we have sketched it, would be a mechanism by which members can and would interact with each other across age and experience groups as well as across areas of disciplinary expertise. The bright, young scientists learn from and are inspired by the massive erudition of their elders, while the latter are tempted to deviate from well-trodden paths by the brilliant iconoclasm of the young.

All members of the institute would have temporary appointments, and to avoid obvious administrative problems, should have positions to which they could return after their sojourn at the institute. For categories a) and b) this would pose no problem, since they would be tenured faculty members of a university or college or, in some instances, a senior employee of an industrial concern, non-profit organization, or government laboratory or office. In the case of c), some care might have to be taken in making suitable arrangements.

Perhaps a more serious problem is that of the length of stay of the institute member. It is clear that for maximum effectiveness in producing research, visits should be at least several months in length. Since leaves of absence of a year's length are normally not difficult to arrange, this may be considered the typical length of stay. To provide continuity of leadership, the length of stay of the leadership cadre should perhaps be two or three years, but it is recognized that in some cases this may be difficult to arrange for either the academic or non-academic visitor. The term of membership of those in category c) would almost surely be somewhat shorter because of the nature of commitments to their home institution.

2.3. Physical Placement and Administration of the Institute. The site of the institute and its scientific administration are clearly critical to its successful functioning. However, it seems likely that the decision on these items, whatever it may be, will give rise to unhappiness somewhere within the mathematical community. The physical placement of the institute (if considered to be

permanent) on the campus of a university would almost surely be a matter of contention among institutions that consider themselves suitable locations for the facility. And yet there are cogent reasons for this arrangement. The location of the institute in the proximity of a university (but somewhat removed from the campus) would perhaps be less subject to contention, and seems almost mandated if the crucially needed office space, library, and computer facilities of the university are to be used. It would be desirable, and quite probable, that the university could furnish housing for the institute members and their families. The presence of the institute would certainly be of great benefit to the university, and as a quid pro quo it might be willing to offer use of these facilities at attractive rates.

The administration of the institute is also a difficult matter. We feel that while the existence of the institute and university (or universities) as neighbors is certain to benefit both markedly, it is important that the institute have an administration which is only loosely connected to that of the nearby universities, if at all. This is to insure that the institute remains committed to being a national resource rather than to being merely an arm of an existing education [sic] institution.

One possible mechanism for administration would be a consortium of universities, including, but not limited to, those proximate to the site of the institute. Such an arrangement would have especial relevance in case additional institutes were established, since the same administrative umbrella could serve all.

The executive leadership of the institute would be provided by a director. Observation of research devices somewhat similar to the projected institute indicate the critical nature of this appointment (D. Montgomery, IAS; Solomon Lefschetz, Research Institute for Advanced Study, Martin-Marietta; Richard Courant, Courant Institute, NYU; John Curtis, Institute for Numerical Analysis, National Bureau of Standards - UCLA, were all able, charismatic leaders). The director should have a strong mathematical background, be a capable administrator, have a wide acquaintance among mathematical scientists—in short, be a dynamic, widely known, strong figure. He should be chosen initially for two years, with reappointment for three years on review and mutual consent.

2.4. Selection of Participants. The selection of the categories b) and c) of participants in the institutes would be competitive nationwide, but because of their seniority and high standing in the community, the members of category a) would be chosen by invitation.

There are, of course, many feasible mechanisms for selecting the members of categories b) and c), but a tested and successful method would be that formerly used by NSF for the selection of post-doctoral fellows—with different criteria for each category. Selection of participants from the applications could be made through the Assembly of the Mathematical and Physical Sciences of the National Research Council, by a panel of consultants appointed by NSF, or by the Mathematical Sciences Section, NSF, with the aid of the Advisory Committee of the Division of Mathematical and Computer Sciences of NSF. The prime desideratum for the successful applicant would be past research accomplishment, although consideration should also be given to the question of mathematical and geographic isolation of applicants. In no sense, however, would an award be regarded simply as an employment device; as has been noted earlier, an applicant should have a place of employment to which he or she is to return after a visit to the institute. It is conceivable, of course, that the mathematical interests or abilities of applicants might be such as to indicate that the 20-12-8 arrangement be modified. Accommodation on this point should be possible.

The choice of members of category a) might reasonably be recommended by the director, although it might be preferable to have this very crucial selection made by a group such as makes the selection of categories b) and c). We repeat, however, that category a) should be chosen by invitation, while b) and c) would be by competition.

3. What Will the Institute Accomplish? The aim of the Institute is, of course, the promotion of research in the mathematical sciences. It is expected that this aim will be achieved by (1) accelerating and intensifying research in the mathematical sciences by bringing high-caliber mathematical scientists together over extended period [sic] of time, and (2) effecting a renewal of research vigor or the process of maturation through the research processes of (1).

But why is an institute needed? Granted that the objectives (1) and (2) are desirable, are they not now being achieved with the country's research apparatus? The answer to this is perhaps "yes", but is a shaky "yes", for there is a strong feeling in the mathematical community that all is not well in our research/educational edifice. Specifically, there is a widespread belief that there are now becoming visible phenomena which gravely endanger the unprecedented vitality of research and education in the mathematical sciences in this country.

The first of these dangers has to do with our major educational institutions of higher learning; the second with those that are smaller, younger, or more isolated, or a combination of these.

A research institute similar to the one envisaged here, is a singularly effective—perhaps the uniquely effective—device for focusing attention on and accelerating research in specific areas of the mathematical sciences. This belief is based on the accumulated evidence of two decades of operation of the Summer Institutes of the American Mathematical Society, the seminars, workshops, and "special" years sponsored by ONR and NSF, the fifteen-year history of the Institut des Hautes Etudes Scientifiques (Orsay, France) and, especially, the Institute for Advanced Study at Princeton.

An institute can adjust its program to focus on mathematical topics of great current interest, bringing together highly talented scientists in a given field for intensive study. Since it is planned that there be at any time concentrated attention devoted to two or three areas of the mathematical sciences, there will be excellent opportunities not only for cross-fertilization between areas of core mathematics but also for the exploitation of new core mathematical techniques in the solution of problems in applied mathematics. Such cross-fertilization has been perhaps the most important newer element in the great strides made by core mathematics in recent years, and its importance continues to loom large in research. The mathematization of the biological and social sciences is in its infancy, and it seems clear that further substantial progress will require the use of new mathematical techniques. Cross-talk between applied and core mathematicians in continued contact over substantial periods of time seems a most appropriate way to foster the development of such new methods. It goes without saying, of course, that the application of new mathematical techniques to other sciences, including the highly mathematized sciences of physics, engineering, etc., would also be expedited by the institute.

Finally, the Institute would produce a circulation of the best mathematical talent in the country: for the larger and better known departments, it would give not only the young but also the senior members an opportunity to meet many able people from other institutions representing a wide variety of subdisciplines, and enable them to sharpen old skills and to learn new ones; for members of smaller, isolated, and/or developing departments the effect will be much the same, but perhaps even more pronounced, in view of the comparatively greater access to other researchers and to a good library. This prolonged contact with highly talented mathematical scientists in a variety of fields will, for both young and old, from large school and small, be an excellent deterrent from the expected onset of stagnation.

4. Approximate Institute Paradigms. The institute model described in Section 2 has no existing duplicate. It is similar, however, to the Institute for Advanced Study (IAS) at Princeton in several important respects—a fact which is not accidental. The IAS has been a major force in mathematical research since its very inception,

and its effect on the development of U.S. mathematics has been decisive. One can hardly do better than to quote from a 1974 paper [6] of Saunders MacLane:

> "Its [the Institute's] first years coincided with the transition in American mathematics from provincial activities to world leadership. The IAS has brought to fruition many mathematical talents which might otherwise have been left undeveloped or limited to very special topics. One can list scores of individuals whose whole career has been decisively advanced by a sojourn of one or more years at the Institute. It has provided a remarkable cohesion; for example, during its first decade practically every active research mathematician in the United States has spent a period at IAS. In all these ways, the Institute has provided effective intellectual stimulus in mathematics."

To be specific on the matter of the Institute's role during the first decade referred to, 166 American mathematicians had spent three months or longer at the Institute by 1943. This at a time when the number of mathematicians in the U.S. doing significant research was almost surely not more than twice that number! The Institute has continued to play a most important role in U.S. (and, indeed, world) mathematics. For example, two of the reviewers of the most recent proposal to NSF from the IAS have stated that it was their feeling that the funding of that proposal should have absolute top priority for the Mathematical Sciences Section.

A second institution established comparatively recently (1958) which resembles our proposed institute in many respects, and has been showing promise in the past few years, is the Institut des Hautes Etudes Scientifiques (IHES), located just outside of Paris, adjacent to the University at Orsay. The IHES is similar in its objectives and organizations to the IAS, but limits itself to the disciplines of mathematics and theoretical physics. It has a permanent staff of 6, including its director, and has in residence at any one time from 20 to 40 visitors, with a total of 80 to 120 visiting there each year, whose only duties are to pursue research. Funding is by the French Ministry of Education, contributions from companies and organizations such as Commissariat à l'Energie Atomique, Esso-Standard, Banques de France, etc., and governments of other countries (but not the U.S.A.). Visitors come from many countries, especially the U.S., Britain, Switzerland, Italy, and Germany.

Resembling our model of the Institute in that they bring mathematical scientists in considerable numbers together for moderate periods of time, the research institutes, seminars, and workshops of the American Mathematical Society (AMS) and the Society for Industrial and Applied Mathematics mentioned earlier bear mentioning. Of these, the Research Institutes and Summer Seminars of the AMS are the most relevant, since they have a much longer history. These were started in the early 1950's, and bring together invited researchers on specific topics for a period of three weeks. There is no doubt that these gatherings have given strong positive impulses to research on the topics with which they have been concerned.

Our knowledge of successfully functioning research institutes in other fields which operate something like what we have in mind is small, but the Niels Bohr Institute and the Research Institute for Fundamental Physics at Kyoto seem to be in this category, as does the Center for Advanced Study for the Behavioral Sciences at Palo Alto. The Aspen Center for Physics seems to be quite successful, but operates only during the summer, and so does not serve as a model in important respects.

We feel that the above examples of research institutions which seem to work well argue convincingly for the success of a similar apparatus for the mathematical sciences.

5. The Context of Recent History. At present one would be hard put to document a perceptible decline in the extraordinarily brilliant output of recent U.S. research in mathematics. Yet a feeling of unease persists among many of our leaders, based on a number of quite definite trends which it is believed must inevitably mean a slackening of research momentum and a decline in the capacity of our graduate educational machine to produce high quality research scientists. What are these trends? First and foremost is the decline in enrollments in the colleges and universities. Second, for a nexus of reasons too complex to discuss here (and perhaps not well understood), interest in the mathematical sciences (except for computer science and statistics) has diminished somewhat, causing a sharp drop in course enrollments. These phenomena have jointly produced, if not a decline, certainly a state of no-growth in faculty population. Third, the college age population is going to be smaller until well toward the end of the century. Fourth, it seems likely that we have reached saturation insofar as the percentage of high school graduates which continues on to college is concerned—again, for a number of reasons, economic and sociological. Fifth, the ratio of tenured to total staff was over 0.7 by the end of 1975 in Ph.D.-granting departments in mathematics, and is believed now to approach 0.8 in our stronger departments. Finally, the faculties of our research-producing (i.e., Ph.D.-granting) institutions are young; in 1972 over 75% of the mathematics faculty population of the ACE Group 1 schools was less than 50 years of age. It is therefore clear that, barring the widespread adoption of an early retirement scheme, retirements will be very few in number before the 1990's.

The picture we have then is [sic], is this: faculties are very highly tenured, they are unable to grow, and retirements will be quite limited for many years. In addition, with some exceptions, course enrollments on both the graduate and undergraduate levels have been declining. The upshot of all this is that faculties have become essentially static except for a small non-tenure track segment—a segment which has no hope of permament employment. There are fewer graduate students in courses and fewer courses. And although it is admittedly barely noticeable yet, many faculty members feel a diminution of the sparkle and vigor that the continual flow of many young faculty and large numbers of students brings, and a fear that this will grow as time goes on.

The danger which threatens the mathematics departments in the smaller or isolated colleges and universities is related, but somewhat different than that which the strong departments face. The inability of virtually all of the stronger departments to offer tenure-track in recent years or, indeed, any positions at all to young Ph.D.'s, has meant that a great many gifted young doctorates have perforce taken positions where they have been more plentiful, viz., in institutions with Ph.D.-scarce and/or rapidly growing faculties. Such have been found in four-year colleges and, to a lesser extent, in a number of universities (usually components of expanding state university systems). The colleges generally have departments which are small and whose library, computer, etc., resources are inadequate. The state university branches referred to have grown rapidly in recent years and are generally somewhat larger, but still too small to have much strength over any considerable spectrum of mathematical subdisciplines. The ills which beset larger departments may also, of course, be expected in time to affect these smaller and weaker departments in much the same way. It is believed, however, that departments of this sort that are isolated geographically face a second grave danger to their recently acquired research capabilities, modest though they may be. For the research mathematician at an institution which is isolated geographically, whether in a small department or in a relatively large one in which there are not other scientists with whom he or she can communicate, there will usually be a gradual diminution of research vigor, a dearth of new ideas, and a loss of enthusiasm for research.

With the success of the IAS and the AMS Summer Institutes in fostering research at hand, it is not surprising that in the late nineteen sixties several additional mechanisms were proposed for bringing mathematicians together in an unfettered atmosphere in order to better allow them to do research. The earliest move in this direction of which the writer is aware occurred in early 1968, when plans for a summer institute of six or eight week length at an unspecified location were discussed

with the writer by R. H. Bing (Wisconsin) and Burton Jones (Colorado). A tentative proposal had been written, but not submitted, by the Conference Board of the Mathematical Sciences (CBMS). This institute would have brought together 25 - 50 young Ph.D.'s, selected graduate students, and about 10 senior mathematicians to do research. Subsequent to this, a Committee on a Summer Research Institute was appointed by CBMS, and another and more carefully written proposal was drafted. This was discussed at the January 1970 meeting of the Council of the CBMS, but no action was taken to submit a proposal to the NSF or other agency, since the financial resources of none offered much encouragement at that time.

At about the same time that CBMS was discussing the institute concept, mathematicians at Rice, lead by Morton Curtis, were discussing at some length the possibility of establishing there a research institute modelled rather closely after the Institute for Advanced Study (IAS). The principal departure from the IAS model would be that the Rice version would have no permanent members. Membership would consist of about 25 young Ph.D.'s appointed for three years, along with a considerable array of distinguished visitors who would come for visits of one week to a year. It was hoped that this institute would be financed by a combination of private and government sources. In a communication to the writer in the spring of 1970, Curtis indicated that he expected to start work on the matter of funding in the autumn of 1970. Apparently nothing further came of this project.

These early initiatives suggest that as long as ten years ago there was a sizable number of mathematicians in the country who felt that some additional mode of aggregation of their numbers for accelerating the production of research would be desirable.

The earliest formal mention of the institute concept within NSF of which the writer is aware was by Herman Goldstine (IBM) and Irving Kaplansky (Chicago) at a meeting of the Advisory Committee of the Division of Mathematical and Physical Sciences, October 1969. Subsequently, in its annual report for calendar year 1969, this committee recommended the establishment of two Mathematical Institutes for Advanced Study, one in the midwest and one on the west coast. The paradigm was to be the IAS at Princeton, New Jersey.

Although there was no Foundation reaction to this recommendation, discussions among members of the Division Advisory Committee themselves, with the Section Advisory Panel, and members of the academic community continued during the early 1970's. It was during these years that the phenomena we have sketched in Secs. 1 and 2 began to develop, and by 1973 the Section felt that developing demographic trends warranted the inclusion of plans for a research institute or institutes in the long range plan for that year. Such plans have been included in each long range plan discussion since 1973.

6. Alternative Mechanisms. Several alternative devices for maintaining and strengthening the nation's present highly developed and effective research and educational system in the mathematical sciences have been discussed at some length in the Mathematical Sciences Section [7] and the mathematical sciences community [8]. Of these, it is the view of this Section that the research institute discussed in the preceding portion of this document would be the most effective. The alternative schemes all have merit, however, and some discussion of them is thus warranted.

(a) Institute with permanent faculty. This differs from the Institute we have described in preceding Sections only in that there is a faculty with tenure. Such an institute would be very much like the IAS and IHES. It may be assumed that the permanent staff would be essentially category a), i.e., world class research figures with strong teaching credentials. The notion of permanence would almost surely make the process of obtaining major research talent easier, so that this is a plus for the permanent staff institute. But such positions would imply a permanent institute, and while this might come to pass ultimately, we are not considering this possibility at present. It should be noted that if such an institute eventually came into being, the task of selecting the permanent staff would be a difficult one requiring extraordinary delicacy and sensitivity, since the direction of research would be fixed for some years. This would be regarded as undesirable by many, unless it would be feasible to set up enough institutes to give reasonable coverage of all of the mathematical sciences.

(b) The peripatetic institute. This type of mechanism is in certain respects closely related to that which we have proposed. It would have a continuing existence as an administrative entity, but would move periodically from one location (presumably having more or less the attributes of the location of a fixed institute) to another.

It is believed that such an arrangement would diminish what might well be widespread unhappiness caused by, in the eyes of many, unfair advantages accruing to the university (or other institution) adjacent to the fixed institute. But the peripatetic institute would no doubt also give rise to some jealousies, since even with this type only a small number of campuses (or other locations) would be favored with an institute unless a sizeable number was created.

One would expect the peripatetic institute to change location fairly frequently, if the advantages peculiar to this type were to be realized. It would therefore bring salutary benefits to a considerable array of host institutions. On the other hand, the logistical problems associated with this plan are formidable. With each move, the problems of finding offices, obtaining administrative services, and finding housing would have to be faced anew. One of the strengths of this plan could be that of utilizing to a limited extent the mathematical strengths of the nearby institution, but this would require a change in research emphasis with each move. This, too, could present administrative problems to the director in planning the membership.

(c) A postdoctoral fellowship program. A third method of attaining some of our desired objectives in a rather simple way would be to establish a reasonably large-scale postdoctoral program in the mathematical sciences. The recipient of a postdoctoral fellowship would hold it at the institution of his or her choice. There would be no concern about breadth of fields of coverage, since a fellow would be virtually certain of finding an institution with in-depth expertise in the area of the mathematical sciences in which he or she was interested. Mathematical scientists in need of invigoration or inspiration need not grow old waiting for their specialities to come up at an institute, and given ability and promise, or marked achievement, substantial chance of support might be entertained.

With a postdoctoral program, the logistical problems associated with institutes would be very much attentuated [sic], and, of course, the formidable administrative problems would also vanish. On the other hand, a fellowship program would not accomplish the larger ends as effectively as the institute. It would not bring major mature talents together, it would not give large numbers of able mathematicians the opportunity of as intense an interaction around quite as strong a common focus, and it might not–almost surely would not, in many instances–create the "critical mass" that many believe is central to the institute concept.

(d) The "Mini-institute." This mechanism was recommended in Reference 8 by the Committee on Science Policy of the American Mathematical Society. A "mini-institute" would concentrate on an area of expertise in which a host institution has especial strength, and would reside there over a period of time which would range from a single summer to the 27 month span covering two academic years and the adjoining summers. (Or, there might be a separate program for single summer institutes.) It would provide support for perhaps 6 - 10 persons who have received their degrees not more than, say, 6 years previously, at a rate comparable to an academic salary. The institute would provide partial support for 2 - 4 visiting faculty members with strong research credentials, with the remainder of their support coming, presumably, from the host institution. The institute would also provide some released time for those faculty members of the host institution who are involved in the institute.

Although the mini-institute would perhaps create the "critical mass," it seems clear that the intensity and

amount of interaction would fall short of that of either the fixed or peripatetic institute. Especially, since the number of scientists concerned is smaller, the interdisciplinary benefits would surely be considerably muted. Finally, unless the length of term of the mini-institute is small, or several are set up simultaneously, the prospective visitor would face essentially the same time delay as with other options before an institute in his or her specialty would become available.

7. Estimate of Costs of the Fixed Institute. As is always the case in planning for the future, it is possible to arrive only at rough estimates of anticipated costs. Nevertheless, such projections do have some value, and we carry them out for the fixed institute.

We compute the cost for possible largest size:

a) Professional salaries. We use a 10, 15, and 25 distribution of the categories of Sec. 2 of institute members: young, well-established, and senior-statesmen [sic]. If we assume 9 months salaries of $36, 27, and 18 thousand respectively, for these three categories, the total cost would be $1,485,000.

b) Administrative salaries. There would be need only for a director and secretarial assistance. The assumption of a director at a salary of $45,000 and five secretaries at $10,000 each yields $95,000.

c) Rental of space. The Foundation's Administrative Service office informs us that a sound overall figure for a professional occupant is 225 $ft^2$ per person. This takes into account secretarial space; however, a customary rule of thumb in office space calculations is that between 60 and 65% of total rental space is available for general office use, the remainder being required for general mechanical areas, elevators, sanitary facilities, etc. Thus, a total space rental of about 18,000 $ft^2$, which would yield about 12,000 $ft^2$ for people, seems a reasonable requirement. The present rough local figure for rental space is about $7/square foot, yielding a total rental figure somewhat less than $85,000.

d) Indirect costs. In view of the fact that the participants will not be permanently employed by the institute, one would anticipate that the cost of fringe benefits would not be high. One reasonable estimate for fringe benefits would thus be 15% of total salaries: about $225,000. As to the other costs, if arrangements were made with a consortium, these could be expected to be considerably smaller than the indirect costs proportion of most research grants. Discussion with NSF staff familiar with the administration of contracts with consortia and universities, indicate that the management fee is but a small percentage of the contract's total. For example, the management fee on the UCAR $17 million contract for operation of NCAR is $325,000. This includes the total cost of UCAR's administration: presidential and staff salaries, office rental space, etc. It would appear unlikely that the management fee for the mathematics research institute would exceed $50,000. To these costs there should perhaps be added a certain amount to establish at least minimal library facilities.

If one totals the above estimates of the costs of the various components, one arrives at a total estimated cost of the single fixed institute of $2,000,000 to $2,100,000 at full development. If it is built up gradually, beginning with a staff of 40, initial costs would be correspondingly lower, say $1.75M.

References

1. Kenneth D. Roose and Charles J. Andersen, A Rating of Graduate Programs, American Council of Education, Washington, D.C., 1969.

2. Frank Press, New Arrangements for Science in the Universities, Science, July 18, 1975.

3. Richard C. Atkinson in an address to the National Council of University Research Administrators, November 7, 1975.

4. Richard C. Atkinson in an address to the Association of Graduate Schools in the Association of American Universities, October 2, 1977.

5. Bruce L. R. Smith and Joseph J. Karlesky, The State of Academic Science, Change Magazine Press, June 1977.

6. An essay of June 4, 1974 entitled "Research Institutes for Mathematics."

7. Long Range Plan, Fiscal Years 1979-1983, memorandum submitted to Director, Division of Mathematical and Computer Sciences, August 23, 1976.

8. On Postdoctoral Research Support in Mathematics and the Mathematical Sciences, Committee on Science Policy, American Mathematical Society, March 1976.

## APPROVED MINUTES
## OPEN SESSION–196th MEETING
## NATIONAL SCIENCE BOARD

**NSB-78-136** March 16-17, 1978

Members Present: Norman Hackerman, Chairman, Russell D. O'Neal, Vice Chairman, Richard C. Atkinson, Raymond L. Bisplinghoff, W. Glenn Campbell, Jewell Plummer Cobb, Lloyd M. Cooke[1], Herbert D. Doan, Anna J. Harrison[2], John R. Hogness, W. N. Hubbard, Jr., William F. Hueg, Jr., Marian E. Koshland, Saunders Mac Lane, William H. Meckling, Grover E. Murray, William A. Nierenberg, Joseph M. Pettit, Joseph M. Reynolds, Alexander Rich, Charles P. Slichter, and James H. Zumberge.

Members Absent: T. Marshall Hahn, Jr., Donald B. Rice, Jr., and L. Donald Shields.

AGENDA ITEM 8
GRANTS, CONTRACTS, AND PROGRAMS

a. Action Item. Mathematical and Physical Sciences, and Engineering–Mathematical Sciences (NSB-78-80...)

Mathematical Sciences Research Institute–Approval was requested for the establishment of a Mathematical Sciences Research Institute to function along the same lines as the Institute for Advanced Study at Princeton. The concept for this Institute has been under active consideration by the mathematics community for several years. Its establishment has been strongly recommended by the professional mathematical societies, the Conference Board of the Mathematical Sciences, and members of the mathematics community.

The primary purpose of the Institute will be to stimulate research in diverse problem areas both among able mature mathematicians and promising young mathematicians from all parts of the country and to provide a central location within which this interchange can be fostered.

The Board discussion centered primarily on whether or not the establishment of the Institute reflects a consensus of the mathematics community and whether alternative plans for the support of basic research in mathematics have been fully considered. Considerable evidence was presented to indicate that the community is in favor of the establishment of the Institute despite the fact that funding for the Institute will have to be absorbed within the Division and not constitute an add-on to the mathematics budget.

Several Members of the Board expressed their concern that the establishment of yet another institute would again increase the percentage of committed funds in the Foundation's budget as against uncommitted funds for the support of new programs and young investigators. This recurring concern occurs frequently in Board discussions of the initiation of major new installations and centers.

It was suggested that independent advice be sought from groups other than the Foundation's advisory committees to advise the Board and the Foundation on the wisdom of initiating such major projects as this Institute. A motion to table the resolution to approve the Mathematical Sciences Research Institute to enable Foundation staff to

[1] Present Thursday only.
[2] Present Friday only.

consider an appropriate way to initiate such a mechanism for review of new projects did not receive a second.

The Programs Committee had recommended establishment of the Institute, and approval of the proposed Project Announcement and the general plans for the Institute by a vote of seven in favor and two abstentions. There were no negative votes.

Upon this recommendation and based on the Board and staff discussion, the Board took the following action:

NSB/Res-78-37.

The Board APPROVED the establishment of a Mathematical Sciences Research Institute; further, the Board APPROVED the issuance of a Project Announcement and the general plans for the establishment of the Institute.

The above resolution passed by a vote of ten in favor, five against, and three abstentions. Dr. Campbell, Dr. Koshland, Dean Meckling, Dr. Slichter, and Dr. Zumberge voted against the resolution on the grounds that an institute may not be the optimum way to support basic research, in this instance, in mathematics. Dr. Atkinson, Dr. Mac Lane, and Dr. Nierenberg abstained from voting.

## COMMENTS BY SAUNDERS MAC LANE TO OPEN-SESSION MINUTES OF MARCH 1978

[These comments were presented to the Board during its open meeting on Thursday, May 18, 1978. At that time, the Chairman of the Board agreed that these comments would be attached (as Appendix D) to the minutes of the Open Board Meeting for March 16, 1978.]

This will comment on an earlier set of minutes. The minutes of the Open Session Board meeting of March 16-17, 1978, (NSB-78-136) under Agenda Item 8 (Mathematical Sciences Research Institute–NSB-78-80.) When these minutes were approved, I failed to note that some statements in the minutes did not accurately reflect the actual discussion at the meeting. Since this may have contributed to some misunderstanding in the mathematical community, I have studied the transcript of the tape of that portion of the meeting and now offer the following observations:

The minutes state, as of the Mathematical Sciences Research Institute, that "Its establishment has been strongly recommended by the professional mathematical societies, the Conference Board of the Mathematical Sciences (CBMS), and members of the mathematical community." The clause "professional mathematical societies" should not have been included here. Its inclusion came from the following natural misunderstanding. At the meeting it was stated (correctly) that the CBMS had approved the project (at a meeting in January 1978) and that the CBMS is an umbrella organization whose component members include the American Mathematical Society (AMS), the Mathematical Association of America (MAA), the National Council of Teachers of Mathematics (NCTM), the Association for Symbolic Logic (ASL), the Association for Computing Machinery (ACM), the Society for Industrial and Applied Mathematics (SIAM), etc. This approval by CBMS (as was not clearly pointed out) does not constitute approval by these individual organizations (of which AMS, ASL, SIAM, in particular, are especially concerned with mathematical research). I do not know of, and doubt the existence of, any such action of approval by ASL or SIAM. There has been no such action by AMS. Indeed, at the Board meeting in question, Dr. Mac Lane stated that there had been a meeting (in January 1978) of the Policy Committee of the AMS and that there were varied opinions expressed there (that the policy committee took no action at that time). He quoted another sample of such varied opinions from the community and said that it was his view that the mathematical community is not wholly unanimous. He also stated that the Policy Committee of the AMS (about three years ago) studied plans for such a research institute and related alternative plans–and that this committee, in its report, preferred a different plan for "special year" programs. The report of this committee was explicitly cited in the materials provided to the Board.

In these minutes there are other items dealing with this institute which might be misleading because they may not exactly reflect the discussion at the Board meeting–but I do not know how to expeditiously correct or illuminate these items. They concern the observation that funds for the Mathematical Sciences Research Institute would not be add-on funds, but would be from funds from within the division; they concern more exactly the way in which the mathematical community may or may not understand this observation.

## REMARKS BY DR. J. A. KRUMHANSL

It is the Mathematical and Physical Sciences, and Engineering Directorate which has the responsibility and authority for planning and resource allocation in the mathematical and physical sciences, and engineering.

As Dr. Mac Lane has observed, minutes of meetings do not generally give a complete picture of the discussion. Statements taken out of context, particularly references to the budget and the budget process and their impact on the funding of mathematics, can be very misleading. It is important now to focus attention on the substantive issues involved in the decision to issue a project announcement. It is to be hoped that these comments will help remove much of the current confusion.

With respect to a project announcement, it should be stressed that its issuance is merely an early step in a careful and deliberate procedure involving preparation and submission of proposals, evaluation of the submitted proposals after extensive consultation with a group of experts broadly representative of the mathematical community, and, finally, the determination of which, if any, of the submitted proposals should be recommended for support. In this connection, let me call to your attention the statement prominently appearing in the first paragraph of the "Proposal Evaluation" section of the accompanying Project Announcement: "An award will be made only if a proposal of sufficient merit is received."

Much has been made of the financial implications of funding an Institute. Any decision involving the extent of support recommended for an Institute will be made not only in the context of budget allocations for the relevant fiscal years, but also relative to other modes of support. We do not expect any serious erosion in the funding of individual research grants, and we do not preclude the funding of other ideas.

As to the Foundation budget itself, I will not attempt to describe here the complicated and difficult process by which the Mathematical Sciences Section's budget allocation is ultimately determined, nor will I attempt to explain the meaning of such terms as "add-on." Rather, I will restate some comments already made to many members of the mathematical community, for it is these comments that have the greatest relevance.

"It is my intention to direct about 1% of the 1979 budget (about $2.5 million) across the MPE directorate to augment the support of the theoretical sciences. How this will be done depends to large degree on what special research opportunities present themselves. Moreover, my proposed FY 1980 budget continues to include a number like a $1 million increase in mathematics support which will continue as part of the base thereafter. Again, it should be stressed that the final allocation for mathematics will continue to depend significantly on the special research opportunities available."

In conclusion, let me assure you that views from your community will be carefully considered in our decisions.

J. A. Krumhansl
Assistant Director for
Mathematical and Physical
Sciences and Engineering

# LETTERS TO THE EDITOR

Editor, the *Notices*

In the current discussion of the possible research institute in the mathematical sciences, part of the issue concerns funding. I will try to summarize how the National Science Foundation (NSF) budget comes into being. First, however, I will summarize the organizational structure of the NSF.

The NSF consists of a National Science Board (NSB) and a Director. There are 24 persons plus the Director on the Board. Each Board member and the Director are Presidential appointees. The NSF is organized into seven Directorates–one for administration and six for the sciences and science education. Each Directorate is divided into Divisions, the Divisions into Sections, and the Sections into Programs. The Directorates are administered by Assistant Directors (four Assistant Directors are presidentially appointed). The Divisions are administered by Division Directors, the Sections by Section Heads, and the Programs by Program Managers.

There is a Directorate for Mathematical and Physical Sciences, and Engineering (MPE). Its Assistant Director, a Presidential appointee, is Dr. J. A. Krumhansl, a theoretical physicist, on leave from Cornell University. Dr. J. R. Pasta is Division Director for the Division of Mathematical and Computer Sciences, and Dr. W. H. Pell is Section Head for the Mathematical Sciences Section.

Now, let me try, as best I can, to summarize the budget process. The fiscal year 1979 budget will take effect with the year beginning October 1, 1978. Preparations for this budget started late in 1976. The Office of Management and Budget (OMB), acting for the President, gives each agency a "mark"; that is, a suggested total budget figure. The Section Heads, Division Directors and Assistant Directors then begin an active discussion of the structure of the NSF budget for FY 1979. If the NSF finds that its "mark" is too low, the Director, Dr. Richard Atkinson, can respond with a "reclamation" asking for a higher mark and giving explicit reasons for this request. The request may or may not be granted.

In addition to NSF staff, the National Science Board has a Budget Committee (consisting of three Board members, with staff support). This committee meets frequently with other NSF staff and eventually makes recommendations to the Board. In earlier years after preparing the basic budget there was a careful consideration of possible "new thrusts" in science; these often appeared in budget materials as "add-ons"–which take the form of persuasive description of additional national needs which could be met by specified additions to the budget. Board members, as well as staff, can suggest such add-ons. (For example, at one time I made such a suggestion for the 1978 budget. Like many such suggestions, this add-on did not survive to be added.)

The Carter administration introduced the "zero-based budgetary process" (ZBB). The title suggests that each year's budget is new and that its preparation does not follow the venerable and simple practice of making next year's budget like last year's with a few increases. Actually, the ZBB process is more complicated. This is what happens: The budget prepared by the Foundation staff starts with a very austere base budget and is thereafter broken up into a number of discrete packages. At the level of MPE each package totals roughly $500,000 to $1 million, is addressed to particular needs in a division or a section, and carries a description of the merits of these needs. (In some branches of science there are large individual budgetary items such as space telescopes, oceanographic vessels, drilling projects, and the like. The budgetary justification for such projects includes arguments for their importance. There have not been such large items in mathematics.)

The advantage of using such packages is that other Foundation officials and the Board can examine and rearrange them in a priority order. Packages are aggregated and combined at the Directorate and Foundation-wide levels. This rearrangement, as made, may include a sequence of seven or eight successively higher total budgetary levels beyond the austerity level.

This arrangement is discussed by various Foundation officials, the Director, the Budget Committee of the Board, and then by the Board (for instance, at a meeting in August 1977 for the FY 1979 budget). In each of these discussions, various adjustments can be made, packages can be transferred from one level to another, and NSF staff or Board members can raise particular questions. This entire process, as a part of the Administration's budget preparation, is privileged.

About September 1, 1977, the Director makes the final decisions and sends the budget to OMB. From mid-September through mid-December, OMB staff examines the budget, discusses it with senior NSF officials and makes recommendations to the President. In the case of NSF and other science agencies, the views of the President's Science Adviser (Dr. Frank Press) on major budgetary issues of interest to the President are sought by OMB, and are given great weight. There are rounds of negotiation about the overall size and shape of the budget, with the OMB Director and the President making final decisions about the budget to be sent to Congress.

The budget as prepared for the Congress carries for each program a considerable description and justification of the proposed budgetary expenses in that section. Thus, for example, the program directors in mathematics have the task of explaining, in generally understandable terms, what their program has accomplished and what it will accomplish if suitably funded. This is not an easy task and requires selection among the many possible projects in mathematics. Here, and elsewhere, in all branches of science, the development of the budget can have important support from thoughtful input from members of the scientific community concerning opportunities in these various fields. Such suggestions help the foundation staff to put the budget recommendation on a good scientific basis, and also serve to strengthen discussion with OMB and the Congress about funding allocations.

As with all Federal agencies, the NSF's budget is discussed in committees and subcommittees of both the House and Senate in preparation for the relevant bills: First, the authorization bill and then the subsequent appropriation bill. The Congressional committees hold hearings at which NSF staff and selected Board members appear to support the budget. The actions by Congress can alter the budget as proposed in various ways. Congress may impose ceilings on expenditures on one line item and floors on expenditures on another line item. It may strike items altogether or add new ones. It is certain to alter the total budget. Then, perhaps in September 1978, the Congress finally enacts a bill appropriating funds for the final budget. The bill is approved by the President, and the budget process is completed for that fiscal year.

There are available more detailed and more precise descriptions of the budget process. It is complex. Often the question is asked: Will a given new item come from existing funds or will it come from new funds? This is a question with no precise operational meaning because of the discontinuity from year to year and many other complicated issues. Put differently, the transformation from the FY 1979 budget to the FY 1980 budget is not an epimorphism nor a monomorphism, nor is it continuous. It may be stochastic.

With the Budget in hand, it is the responsibility of the National Science Foundation to oversee the making of grants within the total appropriated. This, too, is a complex matter, resting in part on peer reviews used on a basis for decision between proposals within programs and between programs and divisions. In other words, the officials at the National Science Foundation are obligated to see to it that the best possible research is supported from the limited funds appropriated by the Congress.

Saunders Mac Lane, Member
National Science Board

Editor, the *Notices*

The National Science Board and the National Science Foundation are currently considering the possible funding of a new research institute in mathematics. In this connection, I submit to the *Notices* the enclosed memorandum. It has already been sent to all the members of the Board, in advance of their meeting on September 21—22, 1978.

At present, I am the only mathematician who is a member of the National Science Board. This certainly does not mean that my opinion should be any more influential than that of others. However, I do wish to inform the members of the Board and the community as widely as possible of the present situation.

NSB-78-379 September 15, 1978

MEMORANDUM TO MEMBERS OF THE NATIONAL SCIENCE BOARD

Subject: Comments on the proposed research institute in Mathematics

At its meeting in March 1978 the Board voted to approve a "request for proposals" for an NSF-supported research institute in mathematics. Both before and since that time this institute has been vigorously discussed in the mathematics community. Some of the discussion has been lively and based in part on misinformation or partial information. This memo is to comment on the situation from my perspective as a long-time member of the mathematics community. I do so to make this perspective available to the Board and not to press any special case—I am keenly aware that Board members, as presidential appointees, must make impartial judgments as to the best use of limited funds to support the progress of all of science.

Background. Until 1933 American mathematics was strong in just a few outstanding departments, but also suffered from some provincial limitations. The influence of many talented refugees from Europe served as a great stimulus to previously neglected but central branches of mathematics. Much of this stimulus was focused at the Institute for Advanced Study in Princeton (established in 1932). Practically every active mathematician of my generation spent substantial time there. The institute provided a heady mix of mathematical excitement; for many visitors this led to a decisive broadening and deepening of research interests. In the next decade, at the end of the Second World War, many eager youngsters plunged into the study of mathematics. At the major institutions where they were concentrated, about half of the senior faculty were mathematicians who had come to this country from Europe. With research support from the ONR and other agencies and, subsequently, with extensive support from NSF, mathematics flourished. By about 1965 American mathematics was probably the best in the world.

This development depended on many stimuli in addition to the focus at the Institute for Advanced Study. The NSF supported "special years" where one institution assembled for a year most of the active workers in a particular specialty. Many of these were successful. The one best known to me is a special year in finite group theory organized in Chicago about 1962 by Adrian Albert. That year led to the decisive (and difficult) Feit-Thompson theorem and started the large and incredibly penetrating research activity which has brought within reach the solution of the basic problem of finding all finite simple groups. The NSF also supported summer seminars organized by the American Mathematical Society. These too have succeeded brilliantly, as I know personally from two such seminars in algebraic topology.

The NSF has also supported the research of many young mathematicians.

Difficulties. By 1970 substantial difficulties began to appear for mathematics. A number of branches of the science became so special, so active and so concentrated that there was very little communication with other mathematicians. For example, at one time the important but arcane and difficult subject of algebraic geometry could be learned in its modern form only in Cambridge, Princeton, or Paris. (Happily the subject is now less arcane, thanks to good texts and an NSF-supported summer session in California at Arcata.)

A report of the President's Science Advisory Committee, "Meeting Manpower Needs in Science and Technology" (the Gilliland Report), issued by The White House in December, 1962, called for a massive increase (4-fold to 8-fold) in the number of Ph.D.'s to be trained in mathematics. Enthusiasts in the profession pressed for such an increase and there was an increase of perhaps 3-fold. Soon, however, there were no longer enough positions for these new Ph.D.'s. For this and other reasons the job squeeze and the tenure crunch have been more severe in mathematics than in most other sciences (astronomy excepted).

For young mathematicians (and other scientists) the NSF postdoctoral fellowships were eliminated. Moreover, because of the "Mansfield Amendment," the military agencies (ONR, AFOSR and OOR) ceased their support for most branches of pure mathematics. As a result, mathematics turned to the NSF. But, as in other fields, only a fraction of the military "dropout" was covered by budgetary increases. The result was a very heavy pressure on the NSF budget for mathematics. Many senior mathematicians had once been able to obtain grants including support for a postdoctoral or a visitor—but in the funding squeeze these almost disappeared. This has led to the present situation in which summer support, including overhead, accounts for nearly three-quarters of the money granted by the NSF section of mathematics.

With postdoctoral appointments and postdoctoral fellowships both gone there was a serious gap in the process by which young mathematicians develop their powers. There has been a substitute. Many major departments appoint research instructors or research assistant professors for limited periods. This remedy, however, is imperfect: To be appointed a research instructor at University X one must be both bright and active in the selected specialties favored at that university. (To me this seems a far cry from an earlier time when I was appointed a Benjamin Peirce (Research) Instructor at Harvard because I was an algebraist and there were then no algebraists at the faculty at Harvard.) The statement above is not true of all universities X; some appoint the best young mathematicians, irrespective of field.

Comments on These Difficulties. These troubles have not gone unnoticed. For example, in 1973 Dr. Stever called a meeting of scientific society presidents. In that connection, on behalf of the American Mathematical Society, I wrote Dr. Stever (in part) as follows:

> During the past two decades under the stimulus of an intelligently conceived and administered policy of federal support to mathematics led by the NSF, American mathematics has led the international community in a burst of mathematical development which has made this one of the golden periods of the long history of mathematics.
>
> During the past eight years the total federal government support of mathematics has diminished. In 1966 the proportion of the federal research budget in mathematics was 3.2 per cent. In 1973 it was 2.3 per cent. No other listed field of science appears to have had a similar decrease. This is a disproportion between the achievement of mathematics and its support. What should be done?

(Rereading this now, I suspect that those percentages I quoted refer to the NSF budget only and not to the entire federal research budget.)

More recently, Richard V. Kadison at a National Science Board Forum in Philadelphia quoted data from David W. Breneman on the recent catastrophic drop in postdoctoral appointments in mathematics. Kadison ended with the statement:

> In pure mathematics the picture is alarming. Whether it intends to or not the situation in mathematics amounts to a crash program to strip the country of its research potential. Is the government aware of the situation? Is this what it intends?

Other mathematicians are now collecting data which may indicate the sense in which mathematics is substantially underfunded–for example, in comparison with other theoretical sciences. Some mathematicians believe that this situation comes because mathematics has never had "big projects"–after all, the practice of mathematical research is a lonely sort of individual affair and it is a rare paper in mathematics that has more than two authors.

All these difficulties seriously constrain the development of a new generation of American mathematicians and hence the future availability of mathematicians to meet national needs. This is a long-term problem because the connection of pure mathematics to the general welfare has a large time constant. (I recently learned of a new example. In 1917 an Austrian mathematician, J. Radon, made a study of the determination of a volume by taking integrals over slices. Now his results have turned out to be essential to the development of the computed tomographic scanner.)

The Research Institute Proposal. About 1973 various mathematicians, including some of the NSF staff, thought that the difficulties of the science could be met in part by establishing one or more new research institutes for mathematics. As President of the American Mathematical Society (1973–1974), I took part in these discussions. In 1974, just before I became a member of the National Science Board, I wrote up a paper describing the advantages of establishing new institutes for advanced study.

From my present perspective I would summarize the main argument thus: Mathematics depends vitally on continued input of new ideas from young mathematicians. Some of the most impressive new mathematicians appear "at once"–at the Ph.D. level; very many more develop more slowly in the four or five years following the Ph.D. This development seems to be possibly only in intensive contact with major centers of mathematics–and often involves a considerable shift in research interests to a new and deeper or more active field. This intensive contact and such research shifts have in the past often resulted from a stay at a major department of mathematics or at the Institute for Advanced Study. Today, one such institute is by no means big enough–mathematics has become larger and more specialized and no one center can cover all of mathematics. Hence the support of one or more new institutes would be a decisive contribution to the development of the talents of younger mathematicians–and hence to the total strength of the science in this country. On this basis such an institute should be supported.

As another mathematician, R. Fossum, recently wrote:

> Young Ph.D. recipients (in mathematics) have lost their direction... I attribute this absence of mathematical maturity to the fact that these young people have not been exposed to quality mathematics or quality mathematicians on a day-to-day basis.

Various other proposals to help young mathematicians have been explored. In 1975–1976 the Committee on Science Policy of the AMS considered the following various plans:

One or more new institutes for advanced study.
More modestly, one or more peripatetic institutes.
A reasonably large-scale continuing postdoctoral fellowship plan.

This committee then recommended Postgraduate Research Institutes (PRI) with the following plan: A PRI grant could be made to an institute of higher learning to support a group of faculty members with common research interests to support at that institution 6 to 10 junior people and 2 to 4 visiting faculty–for a period ranging from a summer to 27 months. This committee did find the postdoctoral fellowship program most appealing, but did not choose it because it seemed politically unrealistic at that time.

Before the 1980 budget, none of these proposals received much support at NSF. For the FY 1978 budget I had proposed that $400,000 be devoted to "postdoctoral research support, mathematical sciences." The proposal did not find favor with the Budget Committee of the Board. For the FY 1979 budget it was informally proposed (January, 1977) to establish a research institute in mathematics. This again did not find favor.

These disappointments may have reinforced the general opinion of the mathematics community that the very real problems of the science were not heeded.

Discussion and Dissension. After the Board (March 1978) had approved the issue of a "request for proposals" for a mathematics research institute, the news reached the mathematics community only slowly and inaccurately. In particular, the minutes of that meeting stated (196:14): "Considerable evidence was presented indicating that the community is in favor of the establishment of the institute despite the fact that funding for the institute will have to be absorbed within the division and not constitute an add-on to the mathematics budget."

As I have already noted at the May Board meeting, this statement is inaccurate. The inaccuracy was most unfortunate. It left the impression that the whole cost of the institute might be met by cutting down grants to present principal investigators–though it is my understanding that this is not the intention.

This statement in the minutes was doubly unfortunate because it came to a community which generally felt (with considerable reason) that mathematics was already underfunded in comparison with other sciences. Nearly any active mathematician could think of other good and promising projects now languishing without support. Many of these mathematicians promptly mentioned such projects. The result was confusing and disorganized and gave the appearance of a discordant collection of special interests.

I hope that this period of confusion is now passing. It is my judgment that the development of mathematics needs substantive funding assistance from the NSF and that this assistance should not be a simple expansion of the present status quo. Various options are open: The support of research instructorships, or peripatetic institutes, or of postdoctoral fellowships, or of a research institute. It is my own opinion that a sizable part of the present problem is the need to expose young mathematicians to ideas beyond their own immediate special interests. For this reason, research instructorships and peripatetic institutes do not seem to me especially effective. Other mathematicians have conflicting views. Nevertheless, I hope that the mathematics community, recovering from its present confusion, will now turn to a constructive examination of what steps are best for the science and for the development of young mathematicians. I also hope that the Board and the Foundation will recognize this problem and will take appropriate measures.

## ADDENDUM

My memorandum above has been shown to a number of my mathematical colleagues. Their suggestions have suggested a few supplementary points:

Postdoctoral Fellowships. An article by David W. Breneman "Effects of Recent Trends in Graduate Education on University Research Capability in Physics, Chemistry, and Mathematics" is on page 131ff of the State of Academic Science by Bruce L. R. Smith and Joseph J. Karlevsky (Volume II, Background papers). Table 8 on page 151 gives the number and distribution of postdoctoral fellows in 146 Physics, 168 Chemistry, and 120 Mathematics Departments, as follows:

| | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|---|
| Physics | 1107 | 1125 | 1159 | 1147 | 1250 | 1337 | 1242 | 1227 |
| Chemistry | 1954 | 2147 | 2205 | 2148 | 2265 | 2356 | 2322 | 2264 |
| Mathematics | 186 | 182 | 188 | 169 | 164 | 128 | 78 | 55 |

This is the total cited by R. V. Kadison, as noted in my memorandum.

Self-Discovery. A colleague reminds me of another aspect of research institutes. At such institutes young Ph.D.'s in mathematics can suddenly discover that that Ph.D. thesis which they just finished was nowhere nearly as wonderful or as original as they thought. Seeing more exciting and deeper work of mature mathematicians brings them to the sudden realization that they had better work in a new direction. The community knows striking examples of mathematicians who have made this discovery; many of us (I am one) remember how it happened to us and what a great difference it made.

This sort of development requires eager youngsters in contact with more experienced mathematicians who have the time to advise and to talk. This can and does happen at major centers of mathematics; however, these centers are now hectic and many of the senior mathematicians have little time. The unique virtue of a research institute is that it brings together, in a protected environment, the young and the experienced.

During an open meeting of the National Science Board (NSB) on September 21, 1978, Dr. James A. Krumhansl presented an information item about the NSF proposal for a research institute in the mathematical sciences. I have prepared a memorandum dated September 26, 1978, describing this part of the open meeting and including the information item. I have distributed this memorandum widely; interested mathematicians not having access to a copy may obtain one by writing me (Department of Mathematics, University of Chicago, 5734 University Avenue, Chicago, Illinois 60637).

Saunders Mac Lane, Member
National Science Board

Editor, the *Notices*

The proposed NSF Institute, which is described in NSB-78-80 (see p. 481 of this issue of the *Notices*), is a project which represents an entirely new way of supporting mathematical research in the U.S. The annual cost of this project would be approximately 10% of the total NSF mathematics budget. The establishment of such an institute would have far-reaching consequences which merit serious consideration in the mathematical community.

Up to the present time discussion of this matter has been limited to a very small portion of the community. A serious study of this question was undertaken by the Committee on Science Policy of the AMS which issued a report entitled: "On postdoctoral research support in mathematics and the mathematical sciences," in 1976. This Committee found that alternative ways of support of mathematical research are preferable to the proposed institute. (As an appendix to these comments I am attaching an excerpt from the report which describes one of the recommended alternatives. Another alternative favored by many Committee members was a postdoctoral fellowship program, which in 1976 seemed politically impossible.) The report of the Science Policy Committee was approved by the Council of the AMS in April 1976. This matter was brought up to the Science Policy Committee again at the 1978 Atlanta Meeting and the Committee did not change its mind.

Unfortunately, much of the subsequent discussion of the NSF Institute has been conducted under the following misconceptions: (1) The proposed NSF Institute is the only way to get additional funding. (2) There is no possibility for a postdoctoral fellowship program. For example, several writers of the letters of support, which were presented to the NSB in March, changed their minds when these misconceptions were corrected.

When the government deliberates on a policy that affects a professional group (be it scientists, doctors, lawyers, etc.) it cannot be bound by the opinion of that group; rather it must strive to determine what is best for the country. At the same time, however, it is important that the affected group should have an opportunity to assess the implications of the proposed policy, in open and meaningful discussions. The decision whether or not to adopt the policy should be taken only after the outcome of such discussions has been carefully considered. Regretably the present conditions make it extremely difficult to carry on a meaningful discussion. The NSF, as of 21 September 1978, plans to call for proposals for such an Institute as well as for proposals for other options for the possible additional support of mathematical research. These other options (such as postdoctoral research support, AMS Policy Committee recommendations, etc.) will be compared with the proposals for the Institute. It is very hard to take a position against the establishment of the NSF Institute and at the same time apply for it. A most disturbing aspect of this situation is that the NSF call for proposals comes after the Council of the AMS, on 15 September 1978, passed the following resolution (by mail ballot with a vote of $26\frac{2}{15}$ in favor, $3\frac{7}{10}$ opposed and $2\frac{1}{6}$ for postponing the question):

> "The Council of the American Mathematical Society respectfully requests the National Science Board to hold in abeyance any action on the Mathematical Sciences Research Institute until the mathematical community has had an opportunity to consider this matter at its 1979 Winter Meeting."

Despite all of these difficulties I hope that the mathematics community will undertake extensive discussions. Such discussions would have a very high educational value since, quite apart from the issue at hand, they would involve mathematicians in the questions of funding priorities and of policy making. I am confident that the outcome of these discussions will constitute an important input in the deliberations of the National Science Board.

Financial Considerations. Before examining the costs of the proposed institute we must take a brief look at the general situation of funding of mathematical research. The picture is bleak. During the last twelve years there has been a steady erosion of support. One worrisome aspect of the situation is that the level of support of mathematics is substantially below that of the other theoretical sciences. This situation has been eloquently described in a widely distributed letter, dated 1 August 1978, from Professor Kenneth Hoffman to Dr. J. A. Krumhansl. The following is an excerpt from this letter:

"... In any discussion of funding priorities in mathematics, it is extremely important to be aware of (and keep in mind) the fact mathematics is almost entirely dependent on NSF. So, even if we get our fair share of NSF funds, that does not at all imply that mathematics gets its fair share of government science support. What does one mean by "fair share"? In my opinion, the situation is lopsided enough that we don't need a precise definition. I assert that if one looks at contract and grant support which theoretical physicists and mathematicians have at major universities, one will find a picture like this:

| | Mathematicians | Physicists |
|---|---|---|
| Summer salary | yes | yes |
| Travel | a little | much more |
| Publication costs | a little | much more |
| Grad. students | almost none | a fair number |
| Postdoctorates | virtually none | a lot |
| Acad. year salary of faculty | virtually none | a lot |

I believe that the total difference in government support is very sizable and that this can be easily documented. To one who doesn't live in a position to see these differences, it does not seem plausible at first that such discrepancies could exist, but they do. I have begun gathering data which will document this. I believe others who attended the July 7 meeting are doing likewise.

"Why do I attach such importance to the general level of government funding, when we are discussing priorities for the use of NSF funds? It is because, when one is aware of the extent of the general tightness in mathematics, certain choices in the use of funds which might be made (or might appear to have been made in the past) don't really look like choices at all.

"Let me take one from the past. The question came up in the July 7 meeting as to why the mathematicians (or the MSS) had "chosen" not to support graduate students or postdocs as other fields had done. The reason we are where we are is not that the mathematicians were more greedy about their summer salaries, than, say, the chemists or physicists, it is because the situation is and has been so tight in mathematics that it was virtually inevitable that we would drift toward the situation where grants consist of summer salaries and virtually nothing else. The same thing would have happened to the physicists, except that they have had more money per person all the way along."

It is my impression (shared by many knowledgeable colleagues) that similar inequities exist between the funding of mathematics and that of theoretical chemistry, biology, and astronomy.

To make matters worse over the past six years the gap between the support of mathematics and other sciences by the NSF Division of Mathematical and Physical Sciences, and Engineering has been widening. The percentage of total MPE expenditures are as follows:

| years | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|
| % of MPE for Math. Sci. | 9.6 | 9.7 | 9.6 | 9.1 | 9.3 | 8.9 |

Since the total 1977 MPE budget was approximately $225 million, the mathematical sciences budget was approximately 20 million and thus it was about 1.6 million less than what it would have been had the percentage for mathematics stayed at 9.6. To partially rectify this situation the NSF plans to augment the 1980 mathematics budget by approximately 1 million dollars. Of course this does not eliminate the inequity nor does it even begin to address the much larger inequity described in Hoffman's letter.

It is important to realize that, at least during its first year, the proposed NSF Institute will not bring any additional funds for mathematics. Thus current plans are that the 1980 budget for mathematics will consist of approximately 8.9% of the 1980 MPE budget plus one million dollars, regardless of whether or not the Institute is established.

Now I call your attention to section 7 of NSB-78-80 (see p. 487). There the cost of the proposed Institute (for 11 months) is estimated as follows:

| | | |
|---|---|---|
| Salaries: | Director | 45,000 |
| | 10 senior-statesmen (at 44,000 each) | 440,000 |
| | 15 well-established (at 33,000 each) | 495,000 |
| | 25 young (at 22,000 each) | 550,000 |
| | 5 secretaries (at 10,000 each) | 50,000 |
| Fringe benefits | | 225,000 |
| Rent | | 85,000 |
| Library and management fees | | 110,000 |
| | Total | $2,200,000 |

The argument has been made that a project of this magnitude will tend to attract more money to support research in mathematics. This seems very unlikely for two reasons. First, during the initial year of the Institute, its establishment will cause cuts in the traditional means of support of mathematics. Second, the NSF Institute would not have a separate budget line, it would be a small part of the budget for Mathematical Sciences. Projects which have a separate budget line very often acquire a life of their own and their funding may well depend on their perceived merit. Efforts were made to give the proposed Institute a separate line, however this was not possible and the full cost of the Institute is to be charged to the normal mathematics budget. Under these circumstances it seems highly improbable that in the future the Mathematics Budget would increase because some 10% is used to fund the Institute. On the contrary, if the support of Mathematics should be decreased the program directors would have a great deal of discretion as to where to make the cuts and they may well choose to make them in the traditional modes of support rather than in the budget of their Institute.

The Postdoctoral Fellowship Program. At present a very substantial NSF-wide program of postdoctoral fellowships is under active consideration. There has been an NSB proposal calling for the support of some 1,500 fellows per year at a cost of approximately $24 million. Smaller versions of this proposal are currently also under study.

There are now approximately 3,000 postdoctoral appointments supported by the NSF. The proposed program calls for keeping the total number of postdoctoral appointments constant and shifting half of them to fellowships.

For mathematics this program presents tremendous opportunities as well as some serious problems. Under this program it may well be possible to support some 180 fellows in mathematics. (This is the approximate number recommended by the Advisory Board to the Office of Mathematical Sciences NRC). At present there are less than 50 postdoctoral appointments in mathematics supported by the NSF. Thus it may be possible to support an additional 130 mathematicians in postdoctoral positions under this program. The big problem is how this would affect the mathematics budget.

As far as I know the financing of this program has not been worked out yet. However, the fellowship program might have a separate budget line and thus would have a chance of attracting new funds. In any case, once it is in full operation, its funding would not depend on the mathematics budget. Nevertheless, it is quite likely that initially participation in this program would cut substantially into the mathematics budget.

In my view it is very likely that participation in the postdoctoral fellowship program would be financially advantageous for mathematics. The reasons for this opinion are the following. First, giving mathematics preferential treatment in the fellowship program would be an administratively easy way to redress some of the inequities described in the preceding section. Second, it is widely recognized that young mathematicians do very well in competing for fellowship awards with other young scientists.

The postdoctoral fellowship program has a very wide support in the mathematical community. In fact the community feels so strongly about postdoctoral fellowships that the AMS has a fellowship program which is partly funded from voluntary contributions.

Some Philosophical Questions. The proposed Institute is a radical departure from previous methods of funding mathematical research. It seems to me that a government institute for funding academic research is justified only if such research cannot be effectively carried out in existing academic institutions. Examples which may necessitate government institutes are oceanography, radio astronomy, etc., which need a large technical staff and sophisticated specialized equipment.

The development of mathematics in the U.S. faces a number of very serious problems. Some aspects of the current situation are listed below.

1. There are at present many talented young mathematicians who are out of touch with the centers of mathematical research.

2. It is now almost essential for a new Ph.D. to spend one or two years at an active mathematical center while beginning his own research career.

3. The resources of the mathematical centers themselves to maintain postdoctoral appointments are strictly limited and have been decreasing over the last decade, while the number of qualified candidates has increased enormously.

4. During the past decade in most mathematics departments both the average faculty age and the tenure to non-tenure ratio have been steadily increasing. The new retirement laws will accelerate these increases.

We are confronted with a dilemma that has a dual character. On the one hand the problem concerns the plight of individual mathematicians. On the other hand, the existing centers of mathematical research suffer because their traditional role of inspiring and being in turn inspired by young mathematicians is eroding. It is my contention that the proposed Institute would not do the individual mathematician as much good as the type of alternative proposed by the AMS Science Policy Committee (see appendix, p. 494).

In section 4 of NSB-78-80 (p. 484) it is claimed that the proposed Institute is similar to the Institute for Advanced Study (IAS) and to the Institut des Hautes Etudes Scientifiques (IHES). In section 2.1 of NSB-78-80 (p. 483) it is claimed that the Courant Institute of NYU functions somewhat like the proposed Institute. My contention is that the essential features of these institutes are fundamentally different from those of the proposed Institute and

that the NSF Institute would not be capable of functioning as these institutes do.

The core of the Mathematics School of the IAS is the permanent faculty of truly outstanding mathematicians with complete freedom to pursue their research interests. A large portion of this faculty is dedicated to the IAS and takes a very active part in the selection and guidance of the visiting members. It is inconceivable that the "approximately 8 internationally renowned leaders," described in section 2.2 of NSB-78-80 (p. 483), whose length of stay at the NSF Institute would be two to three years, would be in any way analogous to the permanent faculty of the IAS. It is impossible for a temporary visitor to develop the kind of dedication which is so essential. An important ingredient of the success of the IAS is the atmosphere created by its permanent faculty. Such an atmosphere could not be duplicated or approximated by the NSF Institute.

The IHES is primarily dedicated to foreign visitors, it provides excellent housing and facilities which are not available elsewhere in France. The IHES also has a distinguished permanent faculty to provide direction and continuity. It cannot possibly serve as a model for the NSF Institute.

It is ironic that the postdoctoral program at the Courant Institute is given as an example which the NSF Institute should emulate, for this truly outstanding program has now dwindled, because of a lack of funds, to six supported visitors. Wouldn't it make more sense for the NSF to fund programs of proven value rather than to let them languish in order to create an untried instrument?

Perhaps the most troubling aspect of the proposed Institute is its potential for doing real damage to the universities. During the 1960s the NSF gave ample support to mathematics in the universities. This included support for research during the academic year, support of research assistants (graduate students), and postdoctoral fellowships. Substantial contributions were made to acquiring new buildings and enlarging older buildings to provide space for this increased tempo of activity. At present the mathematics departments in the universities are confronted with the situation described above and in addition the universities themselves are faced with serious economic problems. The net result is that the facilities, both intellectual and physical, of the university mathematics departments are underused. Virtually the only postdoctoral fellows at the universities are those supported by foreign governments and by private foundations. The proposed Institute would only aggravate this situation since it would divert both talent and financial support from the universities.

The need of the proposed NSF Institute for eight senior mathematicians, who would be on leave of absence for two to three years from their universities, poses another problem. It is clear that, for most established people, moving to another location for such an extended period would cause a great disruption. It would, however, be attractive for senior mathematicians to have the opportunity to visit the NSF Institute for a year or less. How much influence would they have in this time? Could such transient visits create the kind of tradition and atmosphere that has characterized all previously known outstanding research centers?

Conclusions. In 1980 the budget for mathematics will be augmented by approximately one million dollars. Suppose that at that time the proposed NSF Institute is established. Then the support of mathematics by traditional modes will decrease by approximately one million dollars. Which segment of the mathematical community would most benefit by such a shift of resources? From the estimated budget for the NSF Institute given above, we see that over one million dollars is to be used to support the "well established" and "senior statemen" categories. Does this use of our resources really answer our needs? Wouldn't it be better to use these resources for postdoctoral fellowships, special year programs, reduction of teaching load, etc.? All of these modes would be more specifically directed at younger mathematicians and at the same time strengthen existing institutions.

## APPENDIX

Excerpt from 1976 AMS Policy Committee Report

The Recommended Plan. In greater detail, then, the committee supports the inception of a program to support what we shall call Postgraduate Research Institutes (PRI). A PRI grant would have the following characteristics:

(a) It would be awarded to an institution of higher learning on the basis of a proposal initiated by a group of faculty members of that institution with common research interests; since the awards would be competitive, it can be assumed that these faculty members would have considerable stature, individually and collectively.

(b) It would be for a specified period of time, which might range from a single summer to the 27-month span covering two academic years and the adjoining summers. (Perhaps there should be a separate program for single-summer Institutes.)

(c) It would provide support, during this period, for perhaps 6-10 "junior" persons (who have received their Ph.D.'s within the preceding six years, say), at a rate comparable to an academic salary. It would provide partial support for 2-4 visiting faculty members, these to be people with established research credentials who might also hold part-time appointments with the host institution during the period of the Institute. It would also provide some released time for one or two of the local faculty members, so that they could participate fully and effectively in the program.

(d) After a PRI grant had been made to an institution, this fact would be announced and proposals would be accepted from junior Ph.D.'s (in the sense of (c)—no chronological age requirement is intended) for awards to participate in the Institute. Along with the applicant's professional accomplishments and promise, due consideration should be given to the impact an award could be expected to have on the applicant and on his or her home department.

(e) The host institution would provide office space, library and computing facilities, and other amenities. Appropriate clerical service could be funded in the grant.

Thus there are two decisions to be made by the granting agency or agencies: which groups of faculty are to have Research Institutes, and which junior people are to participate in them. As regards the first of these, consideration should be given, among proposals of equal merit, to such matters as which specialties have recently been covered, and at which institutions. Care should be taken to cover the various active branches of applied mathematics, including statistics and computing science, as well as pure mathematics.

J. J. Kohn
Princeton University

Letters submitted for publication in the *Notices* are reviewed by the editorial committee whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and the publication of the earliest issue of the *Notices* in which it could appear. The committee adopted a policy that the *Notices* does not ordinarily publish complaints about reviews of books or articles, although, following an instruction from the Council, rebuttals and correspondence concerning reviews in the Bulletin will be considered for publication. Letters submitted for consideration by the editorial committee should be mailed to the Editor of the *Notices*, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

EDITORS' NOTE: The following letter communicates to readers of the *Notices* one version of an article which has been circulated widely for several months, both in the U.S. and at the International Congress of Mathematicians in Finland last August. The editors of the *Notices* have sent preprints of this letter (including this note) to a number of the Soviet mathematicians mentioned, and will be pleased to consider any replies that are submitted.

Editor, the *Notices*

The following report on some aspects of mathematical life in the Soviet Union has been compiled by a group of scientists having first-hand information about the subject.

THE SITUATION IN SOVIET MATHEMATICS

1. A little history. Before World War II the situation in Soviet mathematics was better than in other fields.

Ideological pressure in mathematics was less severe than in the humanities, biology, and even physics, where relativity theory was denounced as idealistic (this occured at Moscow University). The general policy of discrimination against the old intelligentsia was felt in mathematics too—there were restrictions on access to education for children from non-proletarian families and for children of the so-called enemies of the people. But the consequences of this policy were softened by the influence of prominent scholars, who often managed to persuade the authorities to make exceptions for the most talented young people.

Even the purges of the thirties, which drained many areas of Russian culture, left mathematics almost intact (N.N. Luzin was hounded in the press, but he was not arrested and remained an Academician).

A new development in Soviet life at the end of World War II was official anti-Semitism. It first affected mathematicians in 1944-1945 when the Ministry of Higher Education begin restricting the entry into graduate schools of Jewish applicants. Soon party organizations at universities started objecting to the admission of students with Jewish last names. The discrimination was carried out under various pretexts: insufficient participation in political activities, low grades in political disciplines and the like. But it was considered slanderous to mention anti-Semitism, and students who did so were harassed to the point of expulsion.

Although the existence of anti-Semitism could not be discussed, it was possible to fight for individual cases. In the first years after the war mathematicians did their best to defend Jewish students and often succeeded. Particular mention should be made of the great roles played in this regard by V.V. Stepanov, then director of the Mathematical Institute at Moscow University, and by I.G. Petrovsky, first dean and later rector of Moscow University. In Leningrad V.I. Smirnov fought passionately against injustice. Nevertheless discrimination gradually spread from university admission to job placement after graduation, and so on. For example in the late 1940s almost all Jews were forced out of the Kiev Mathematical Institute, including B. Korenblum, M. Krasnoselsky, M. Krein, S. Krein.

In the last years of Stalin's life anti-Semitism in the Soviet Union became hysterical. In Khrushchev's era the situation improved but anti-Jewish discrimination did not stop completely, and the publicly condemned list of Stalin's excesses did not include anti-Semitism. Then in the beginning of the sixties the moral atmosphere in mathematics worsened. Positions of influence were attained by mathematicians, even highly qualified ones, who carried through anti-Semitic policies with zeal and enthusiasm, including restrictions on the publication of books and articles and on the awarding of degrees.

2. The role of the Academy of Sciences. The Academy of Sciences occupies a special position in the USSR as the monitor of all scientific activities, including the publication of results, contacts with foreign scientists, the work assignment of top level scientists, and so on. Until the late fifties only mathematicians of great scientific stature were elected members and corresponding members of the Academy. Then the situation changed radically. When the Siberian division of the Academy was opened, numerous middle-level scientists were elected to the Academy because of their invitation to work in Siberia. At approximately the same time the government announced a number of vacancies for applied mathematicians involved in classified research. These vacancies were filled by people relatively unknown in the mathematical world. As a result the scientific level of the mathematical division of the Academy fell significantly. A stable majority formed which was interested in preserving the new status and has rejected many deserving candidates. Unlike the situation in the first years after World War II, the key positions in mathematics nowadays are occupied by people who are not only unwilling to protect the interests of science and scientists in the face of the authorities, but who go even beyond official guidelines in their policies of political and racial discrimination. Under the thirty-year leadership of Academician Vinogradov, the prestigious Steklov Mathematical Institute has become "free of Jews" (with one exception). Not only Jews but also other mathematicians disliked by the ruling group are given a hard time.

The National Committee of Soviet Mathematicians (corresponding formally to the U.S. National Committee for Mathematics) controls the international contacts of Soviet mathematicians. This Committee determines the membership of delegations to international conferences and has to approve all the addresses by Soviet mathematicians. No Soviet mathematician may join any international society or the editorial board of a foreign journal without the blessing of the Committee. This doubtless explains why scientists who happen to be Jewish rarely take trips abroad, even when the trip is recommended by the employing institution and by the local party organization. Before the creation of the National Committee in the late sixties no organized attempt had been made to influence invitations of Soviet mathematicians to International Congresses. The authorities did not grant exit visas to individuals who were not in their favor, but it was possible to send manuscripts of addresses by mail. The National Committee has changed this situation. When an attempt to exclude some Jews from the list of mathematicians invited to speak at the Nice Congress of 1970 failed, the Committee dropped the addresses which it had not approved from the Russian

edition of the Proceedings. Before the next Congress (Vancouver 1974) new tactics were employed. A letter with the following contents, signed by Vinogradov, was sent to a number of institutes. "The National Committee has discussed the invitation of the member of your staff ____ to the International Congress of mathematicians and decided not to include him in the Soviet delegation. We do not recommend sending ____'s manuscript to the Congress." The people targeted by these letters included Arnold, Dobrushin, Dynkin, Kazhdan, Henkin and others. Only in two cases did the heads of the institutes refuse to obey Vinogradov and sent the addresses (but of course not the speakers!).

3. The publication of scientific works. The discrimination in this area dates from the last decade. A striking example is the history of Matematicheski Sbornik. After the death of I. G. Petrovsky, a new editorial board was appointed in 1975 with L. S. Pontryagin as the editor. The table at the bottom of the page traces the development of a new editorial policy.

In the Doklady all articles are presented by Academicians. Following radical changes in the membership of the Academy, many important results, especially by young authors, do not reach the Doklady. A great many of them are published in the section of short communications of the Uspehi Matematicheskich Nauk labeled as the Communications of the Moscow Mathematical Society. Unfortunately the English translation of Uspehi published by the London Mathematical Society under the title Russian Mathematical Surveys does not include this section, and this material is almost inaccessible to anyone outside of the USSR. This is a regrettable fact because their level is now comparable to that of the mathematical section of the Doklady. The London and American Mathematical Societies ought to discuss the possibility of publishing an English translation.

The Section of Physics and Mathematics of the publishing house "Nauka" is the main publisher of mathematical monographs in the USSR. Before the end of the sixties, the fate of manuscripts depended mainly on their scientific level. After that the editorial board was reorganized. There has since been a radical change in the editorial policy. Manuscripts by Jews and other unwanted people are often rejected, even when they are prepared on the initiative of the publisher.

The same policy is enforced in the preparation of the Mathematical Encyclopedia (first volume, Moscow, 1977). Almost all proposals to invite contributions from Jewish authors are rejected by editors under different pretexts. The already-published Volume One contains 346 articles and only ten were written by authors with "dubious" last names. Referring to emigrants is commonly prohibited. For example, I. Dolgachev was forbidden to mention the name of Pyatetsky-Shapiro in his paper on homogeneous domains or even to include Pyatetsky-Shapiro's book in the list of references. (Because of this, Dolgachev refused to write the article.)

The power of a small ruling group in mathematics was vividly illustrated when a collection of survey articles "Mathematics in the USSR, 1958–1967" was being prepared. Before the preparation of this collection, surveys covering the period 1917–1957 had been published under the auspices of the Moscow Mathematical Society. This new volume was prepared and edited by G. E. Shilov and S. V. Fomin. A few dozen of the most competent specialists prepared articles surveying all fields of mathematics. Many more mathematicians were involved in collecting material and writing separate sections of the articles. The surveys were approved by the Council of the Moscow Mathematical Society and by the publishing house. However, only the second volume (the bibliographies) appeared. The material composed for the first volume (the survey articles) was destroyed. It never was published in spite of a letter from Petrovsky, the rector of Moscow University, and in spite of a resolution passed at a meeting of the Moscow Mathematical Society. The work of dozens of mathematicians was wasted.

4. Admission to institutions of higher learning. The discrimination against Jewish young people began in the Ukraine. For example in 1948 one-third to one-half of the student body of the Odessa Institute of Telecommunication was Jewish. In 1952, Jews made up only four percent of the new admissions. Hardly any Jews were admitted either to the Department of Physics of Moscow University or to the Moscow Institute of Engineering Physics. However, before the middle of the sixties discrimination in admission to the Faculty of Mathematics and Mechanics of Moscow University happened only occasionally. In view of the exceptional role of Moscow University in the preparation of mathematical scientists, the policy used in the admission to the Faculty is not a local issue but is of national importance. Among the students admitted in 1964 there were 84 out of 410 who were identified as Jews in their passports.* The discrimination increased dramatically in 1968 and reached its present form in 1970: Since then only from two to four Jews among 400 to 500 students are admitted each year. (They are mostly relatives or friends of influential people. Among the rejected are many winners of mathematical olympiads, i.e., individuals who manifest great mathematical capability.) Some discrimination is also directed against non-Jews of the "intelligentsia," in particular, graduates of some special mathematical high schools with the reputation of "breeding-grounds of liberalism".

Effective methods for implementing the discrimination have been devised. More or less independent professors are excluded from giving entrance examinations. The written test consists of two rather simple problems and two or three problems requiring cumbersome calculations and examining many particular cases. The time is strictly limited and only solutions without any minor slips are given credit. As a result, mediocre students who solve only two simple problems get the same grades as the best students who practically solve the rest of the problems as well, but are penalized for minimal inaccuracies.

*The domestic passports of Soviet citizens mention their ethnic nationality. In the case of different nationalities of father and mother, the nationality of the child may be chosen by the parents.

| Year | 1970 | | | 1971 | | | 1972 | | | 1973 | | | 1974 | | | 1975 | | | 1976 | | | 1977 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Volume | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 |
| Total number of articles | 34 | 38 | 36 | 34 | 37 | 33 | 36 | 37 | 36 | 36 | 32 | 38 | 37 | 43 | 31 | 33 | 29 | 34 | 34 | 37 | 30 | 34 | 32 | 29 |
| Number of articles by Jewish authors | 11 | 20 | 12 | 17 | 15 | 16 | 14 | 10 | 9 | 11 | 11 | 12 | 11 | 12 | 10 | 7 | 2 | 3 | 3 | 2 | 3 | 4 | 1 | 0 |

In this way the bright students are deprived of their advantage on the only examination which might be evaluated by objective criteria.

On orals in mathematics and physics, specially selected examiners give Jews very difficult problems requiring knowledge beyond the high-school program and allow a very short time for answers. For those who survive this treatment, there remains the written test in Russian composition and a gifted young mathematician can be given a failing grade for "insufficiently developed theme".

For some years gifted young mathematicians turned down by Moscow University entered the division of applied mathematics of two Moscow schools: the Institute of Electronics and the Institute of Transportation. Both Institutes accepted extremely strong classes. However, a few years ago, the Institute of Electronics stopped accepting Jews almost completely, and in 1977 the Institute of Transportation did the same.

5. Dissertations and degrees. There exist in the Soviet Union two advanced academic degrees. The "Candidate of Sciences" degree corresponds approximately to an American Ph.D.; "Doctor of Sciences" is a much higher degree and less than one of ten Candidates reaches it.

Up until the late sixties, good Doctor of Sciences dissertations were accepted for defense without any discrimination. The defense was usually successful and the degrees were quickly confirmed by the expert committees of VAK (the Central Attestation Commission).

At the end of the sixties, difficulties began with VAK's confirmation of doctoral dissertations. (At that time G.E. Shilov resigned in protest from VAK.) Doctoral dissertations of Jews, especially in algebra, theory of functions, functional analysis, and cybernetics, were sent out for additional review to specially selected readers. This caused the review process to last six years or more, and in most cases resulted in a refusal. More recently, this arbitrariness has also been applied to non-Jewish candidates who either have Jewish advisors or are simply out of favor with the members of VAK.

Among doctoral dissertations turned down by VAK are those of Balk, Belitsky, Brudny, Vinberg, Markus, Tsalenko, and Shmulyan. However, the majority of "undesirable" mathematicians simply cannot find a place to submit their dissertations or, knowing the reality, do not even try. Therefore many world renowned mathematicians have no doctoral degree.

Until about 1970-1972 no great difficulties arose with the Candidate of Sciences dissertations. Now the situation has changed. As in the case of doctoral degrees, there are three stages: acceptance of a dissertation by an institution, the defense, and the confirmation by VAK. The main discrimination which is almost invisible to the public is applied at the first stage. In the last five years the academic institutions of Moscow and Leningrad almost stopped accepting dissertations from Jews. But for some time it was possible to find a place in other cities to defend dissertations. A few years ago, however, VAK was reorganized, and the right of awarding degrees in each field of mathematics was left to only a small number of institutions. Many outstanding scientists were excluded from degree-awarding councils and their place was taken by individuals known more for their political than their scientific activity.

As a result, even if a dissertation of a Jewish student is admitted for a defense, it is often turned down despite the fact that all participants in the discussion testify to the high quality of the work. Such incidents have become more and more common at Moscow University over the last few years. A striking example was the defense of Gutkin on October 15, 1976. Even a successful defense is not always confirmed by VAK, as illustrated by several recent cases.

6. What western mathematicians can do. It is possible to hold varying political views. One may believe that the structure of Soviet society is the concern of the Soviet people. But whatever one's political views, it should be possible to distinguish between honesty and dishonesty and to uphold a universal standard of professional ethics. It is crucial that the world mathematical community be aware of the behavior of certain groups of influential mathematicans in the Soviet Union, and that these mathematicians feel the moral disapproval of their colleagues. Within the Soviet Union, there is no way for public opinion to express itself. It is therefore all the more important that each arbitrary action receive an adequate response outside the Soviet Union.

Much too often in the Soviet Union, foreign travel is simply a reward for political services. (The only one to benefit from such a trip is the traveller himself, and his benefits are primarily material.) It is necessary to insist that real scholars be included in scientific exchange programs. If the world mathematical community is willing to persevere, this goal can be achieved. Otherwise, scientific exchange makes no sense.

One should not be afraid that publicity may hurt Soviet mathematicians. Experience shows that publicity is in fact their best protection against arbitrariness.

An invitation sent to a Soviet scholar is important even when it cannot be accepted. Given the present conditions in Soviet mathematics, recognition abroad is the only way to distinguish truly scientific achievements from a reputation gained through political machinations.

In view of the publication difficulties in the Soviet Union it would be helpful to send more invitations to Soviet scholars asking them to submit their articles and those of their students to western journals. Publication in the west of these articles and even of books, is sometimes possible in spite of bureaucratic red tape.

Although the authors of the above report are now outside the Soviet Union, revealing their names could do harm to persons in the USSR connected with them. We believe the authors have made every effort to present a true picture of the situation.

| | | | |
|---|---|---|---|
| M. Artin, MIT | M. Kac, Rockefeller | H. W. Kuhn, Princeton | I. Segal, MIT |
| J.L. Doob, Illinois | J. Kiefer, Cornell | L. Nirenberg, Courant | I.M. Singer, Berkeley |
| I.N. Herstein, Chicago | J.J. Kohn, Princeton | R. Phillips, Stanford | D.C. Spencer, Princeton |
| N. Jacobsen, Yale | B. Kostant, MIT | A. Rosenberg, Cornell | A. Zygmund, Chicago |

Editor, the *Notices*

The review of my book, Mathematical Cosmology and Extragalactic Astronomy (Academic Press, 1976) in the Bulletin of the American Mathematical Society, has more to say about the field of the reviewer than the contents of the book; and, unfortunately, when it does turn to the book, strong statements which are not entirely correct are made.

1. On page 708 (line 6 from bottom): 'No equations ...are presented or discussed in this book'. Quite the contrary; the book is in significant part founded on Maxwell's equations and especially their scalar form, the wave equation. These hardly need a new exposition and are not given one, but play a key and explicit role in the derivation and interpretation of the crucial redshift-distance relation; see especially pp. 80-82.

2. On page 709 (line 4 from bottom): 'The chronometric theory as described in this book is not a theory concerning the nature of the universe nor the behaviour of objects in it'. In fact, it indubitably does concern the large-scale structure of space-time, and hence what is commonly described as the 'universe'; and it does treat, at length, the behavior of some of the objects in it, notably photons, but also the size and distance of other objects. Its methods for so doing are applicable to arbitrary mass zero relativistic particles; provide mathematical constraints on models for massive particles; and have implications for the structure and dynamics of galaxies, quasars, etc.

3. On page 709, continuing: 'Rather it ignores the effect of gravitational forces on these objects, postulates that astronomical bodies in it are at rest without explaining how this happens and ascribes the redshift to a particular description of methods of measurement which is at variance with that used in theories such as general relativity.' (a) 'At rest'; there is in fact no objection in the theory to a substantial peculiar motion for each galaxy, such as the observed motion of Andromeda towards us at about 200 km/sec. (b) 'Without explaining'; the published data on thousands of galaxies and hundreds of quasars provide no model-independent indication whatever that they are moving with the appreciable fraction of the velocity of light–more than 9/10, in the cases of a number of quasars–which the review implies is a natural state. (c) 'At variance'; there is no special 'method of measurement' used in 'theories such as general relativity' (which appears to define a class of one); astronomy, no less than other physical sciences, depends on local instrumental measurements; these would not differ in the chronometric theory from those in special relativity, to any physically observable extent, if at all. Rather, the redshift is ascribed to the difference between the generators of the causal automorphism group of space-time which represent the chronometric energy (postulated as the true physical driving energy) and the special relativistic energy (measured by conventional observational techniques).

4. On page 710 (line 18 from the bottom): Reference is made to 98 galaxy measurements 'by Sandage'; but many of these were made by others, i.e. are somewhat heterogeneous; and there may well be no such thing as a model-independent bright cluster galaxy magnitude determination. In any event, it would seem more than appropriate to refer also to much larger samples of galaxies, including a comparatively objective one of more than 700, which are at variance with the Hubble law, but well fitted by the chronometric law.

Irving Ezra Segal
Massachusetts Institute of Technology

## AMS MEMBER'S CHANGE OF ADDRESS OR STATUS NOTIFICATION

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# PERSONAL ITEMS

AHARON ATZMON of the Israel Institute of Technology has been appointed to a visiting associate professorship at the University of Hawaii for the 1978–1979 academic year.

REINHOLD BAER of the Eidgenössische Technische Hochschule, Zürich, was granted a Doctor of Science degree honoris causa by the University of Birmingham, England, in July 1978.

H. D. BLOCK of Cornell University will be on sabbatical leave, mainly at Tokyo University, for the 1978–1979 academic year. He was also elected visiting scholar at Corpus Christi College, Cambridge University, England, for the 1979 Easter term.

JOHN P. D'ANGELO of the Massachusetts Institute of Technology has been appointed to an assistant professorship at the University of Illinois at Urbana-Champaign.

GARY D. FAULKNER has been appointed to an assistant professorship at North Carolina State University at Raleigh.

RALPH S. FREESE of the University of Hawaii is on sabbatical leave at Vanderbilt University for the 1978–1979 academic year.

EMDEN R. GANSNER of the Massachusetts Institute of Technology has been appointed a visiting lecturer at the University of Illinois at Urbana-Champaign.

DAVID H. GLUCK of the University of Chicago has been appointed a visiting lecturer at the University of Illinois at Urbana-Champaign.

VICTOR GOODMAN of Indiana University has been appointed to a visiting associate professorship at the University of Wisconsin, Madison, for the 1978–1978 academic year.

WILLIAM S. HALL of the University of Pittsburgh has been appointed a National Academy of Science Scholar at the Mathematics Institute of the Czechoslovak Academy, Prague.

GERALD N. HILE of the University of Hawaii will be on leave at the Technische Hochschule at Darmstadt and at the Free University of Berlin, for the spring 1979 semester.

MARK HOLMES of the University of California, Los Angeles, has been appointed to an assistant professorship at the Rensselaer Polytechnic Institute.

THOMAS B. HOOVER of the University of Hawaii will spend the 1979 spring semester on sabbatical leave at the University of New Hampshire.

IOAN MACKENZIE JAMES of the University of Oxford has been awarded the third biennial Whitehead Prize by the London Mathematical Society.

DAVID S. JOHNSON of Rice University has been appointed to an assistant professorship at the University of Hawaii.

C. TIMOTHY KELLEY of the University of Wisconsin has been appointed to an assistant professorship at North Carolina State University at Raleigh.

JUSSI KETONEN of the University of Hawaii, is on leave at Stanford University for the 1978–1979 academic year.

MARIA M. KLAWE of Oakland University is on leave at the University of Toronto.

HAI-PING KO of Ohio State University has been appointed to an assistant professorship at Oakland University.

LALA B. KRISHNA of Kent State University has been appointed to a visiting assistant professorship at Oakland University.

YUK J. LEUNG of the University of Michigan has been appointed to a visiting assistant professorship at the University of Hawaii for the 1978–1979 academic year.

LEONARD J. LIPKIN of the University of North Florida has been appointed to a visiting associate professorship at the University of Maryland.

ADOLF MADER of the University of Hawaii is on sabbatical leave at the New Mexico State University for the fall 1978 semester.

THOMAS J. MAHAR of the Courant Institute of Mathematical Sciences, New York University, has been appointed to an assistant professorship at Northwestern University.

DAVID P. MAHER of Worcester Polytechnic Institute has been named to the Harold J. Gay Assistant Professorship in Mathematics.

LOIS MANSFIELD of the University of Kansas has been appointed to an associate professorship at North Carolina State University at Raleigh.

ROBERT J. McELIECE of the Jet Propulsion Laboratory, Pasadena, has been appointed to a professorship at the University of Illinois at Urbana-Champaign.

BRUCE C. McQUARRIE of Worcester Polytechnic Institute has been named to the John E. Sinclair Associate Professorship in Mathematics.

HARALD G. NIEDERREITER of the University of Illinois at Urbana-Champaign has been appointed to the Chair in Pure Mathematics at the University of the West Indies, Kingston, Jamaica.

MARVIN E. ORTEL of Carleton University has been appointed to an assistant professorship at the University of Hawaii.

SURENDRA-NATH PATNIAK of the Indian Institute of Technology, Delhi, has visited the Institute des Hautes Études Scientifiques, Bures-sur-Yvette, France, the Collège de France, Paris and the Université de Paris-VI. He was also a fellow at the Institute of Mathematics at the University of Florence and a guest scientist at the International Centre for Theoretical Physics. Trieste, Italy. He will now spend six months as a fellow at the Mathematics Institute of Aarhus University, Aarhus, Denmark.

CARL POMERANCE of the University of Georgia has been appointed to a visiting associate professorship at the University of Illinois at Urbana-Champaign.

JEAN E. ROBERTS of Oakland University is on leave at the University of Virginia.

HASKELL ROSENTHAL of the University of Illinois at Urbana-Champaign has been appointed to a visiting professorship at the University of Texas at Austin for the first semester of 1978–1979.

For the second semester he will be visiting the University of Paris-VI, France.

PAUL SCHAEFER of the State University of New York, College at Geneseo, and RAYMOND KILLGROVE of the California State University at Los Angeles are participating as exchange professors for the 1978–1979 academic year.

MARK E. SHEINGORN of Baruch College, CUNY, has been appointed a visiting lecturer at the University of Illinois at Urbana-Champaign.

JACK W. SILVERSTEIN of Brown University has been appointed to an assistant professorship at North Carolina State University at Raleigh.

J.M.S. SIMÕES-PEREIRA has been appointed to an associate professorship at Hunter College (CUNY).

GARY A. SOD of the Courant Institute of Mathematical Sciences, New York University, has been appointed to an assistant professorship at North Carolina State University at Raleigh.

J. BARRY TURETT of Texas Tech University has been appointed to an assistant professorship at Oakland University.

STUART S. WANG of Texas Tech University has been appointed to a visiting assistant professorship at Oakland University.

CHRISTINA M. ZAMFIRESCU has been appointed to an assistant professorship at Hunter College (CUNY).

## PROMOTIONS

To Assistant to the President. Southern Illinois University: RICHARD S. MILLMAN.

To Dean, College of Arts and Sciences. Western Michigan University: A. BRUCE CLARKE.

To Chairman, Department of Mathematics. University of California, Berkeley: SHOSHICHI KOBAYASHI.

To Professor and Chairman, Department of Mathematics. Southern Methodist University: RICHARD K. WILLIAMS.

To Professor. North Carolina State University at Raleigh: JOE A. MARLIN, CARL D. MEYER; Polytechnic Institute of New York: EMERIC DEUTSCH; University of Illinois at Urbana-Champaign: STEPHEN V. ULLOM.

To Associate Professor and Chairman, Department of Mathematics. Trinity College: D. A. ROBBINS.

To Associate Professor. University of Alabama in Huntsville: MOU-HSIUNG CHANG; University of Illinois at Urbana-Champaign: LYNN McLINDEN.

To Assistant Professor. Southern Methodist University: CAROLYN SHULL; State University of New York, College at Geneseo: JUNG TSAI; University of Alabama in Huntsville: HELEN H. JAMES.

## DEATHS

Mr. STEPHEN W. BORDEN of the University of British Columbia died on January 29, 1978, at the age of 43. He was a member of the Society for 7 years.

Professor Emeritus HUBERT E. BRAY, former Trustee Distinguished Professor of Mathematics at Rice University, died on August 30, 1978, at the age of 89. He was a member of the Society for 58 years.

Mr. EDWARD T. FRANKEL of Schenectady, New York, died on January 21, 1978, at the age of 86. He was a member of the Society for 50 years.

Professor OTTO A. FROSTMAN of the University of Stockholm died on December 29, 1977, at the age of 70. He was a member of the Society for 24 years.

Professor H.H. HANSEN of the Danmarks Ingeniørakademi died on November 29, 1977, at the age of 70. He was a member of the Society for 29 years.

Mr. MOHAMMAD ISMAIL of McMaster University died on December 25, 1977, at the age of 29. He was a member of the Society for 1 year.

Professor JESSE B. JACKSON of Morganton, North Carolina, died on March 20, 1978, at the age of 88. He was a member of the Society for 55 years.

Professor Emeritus GUSTAV KUERTI of Case Western Reserve University died on July 10, 1978, at the age of 74. He was a member of the Society for 19 years.

Mr. ROBERT M. MEISEL of Great Neck, New York, died on March 5, 1978, at the age of 54. He was a member of the Society for 23 years.

Professor Emeritus HENRY W. RAUDENBUSH of Queens College died on April 14, 1978, at the age of 75. He was a member of the Society for 50 years.

Professor ROBERT C. SEBER of Western Michigan University died on September 6, 1978, at the age of 51. He was a member of the Society for 28 years.

Dr. DEREK A. WALLER of the University College of Swansea, Wales, died on June 23, 1978, at the age of 37. He was a member of the Society for 8 years.

Professor HSIEN-CHUNG WANG of Cornell University died on June 25, 1978, at the age of 59. He was a member of the Society for 28 years.

# NEWS ITEMS AND ANNOUNCEMENTS

## 1979–1980 AMS-MAA-SIAM CONGRESSIONAL SCIENCE FELLOWSHIP

Applications are invited from candidates in the mathematical sciences for a Congressional Science Fellowship to be supported jointly by the American Mathematical Society, the Mathematical Association of America and the Society for Industrial and Applied Mathematics for the twelve-month period beginning September 1, 1979. The AMS-MAA-SIAM Fellow will serve, along with several Fellows selected by the American Association for the Advancement of Science and around a dozen Fellows sponsored by other scientific societies, under an annual program coordinated by AAAS. The stipend for the 1979–1980 AMS-MAA-SIAM Fellowship is $18,500, which may be supplemented by a small amount toward relocation and travel expenses. It may also be supplemented by sabbatical salary or other employer contribution in the case of a person on sabbatical leave for the 1979–1980 year.

The first AMS-MAA-SIAM Congressional Science Fellowships were awarded for 1978–1979. The September 1, 1978, issue of Science gives a brief description of the overall program and the Fellows for 1978–1979, one of whom is a member of the Society: Edmund Gregory Lee of Fordham University. Professor Lee will give a progress report on the work of a Congressional Fellow at the joint mathematical meeting in Biloxi in January.

The AMS-MAA-SIAM Congressional Science Fellowship is to be awarded competitively to a mathematically trained person at the postdoctoral level without regard to sex, race, or ethnic group. Selection will be made by a panel of the AMS-MAA-SIAM Joint Projects Committee for Mathematics, a nine-member committee consisting of three representatives from each of these organizations, with the cooperation and advice of the overall AAAS Program. Applications should be sent to the Conference Board of the Mathematical Sciences, 1500 Massachusetts Avenue, N.W., Suite 457-458, Washington, D.C. 20005. The deadline for receipt of applications is February 15, 1979, and it is anticipated that the award will be made by around April 1, 1979.

In addition to demonstrating exceptional competence in some areas of the mathematical sciences, an applicant for the AMS-MAA-SIAM Congressional Science Fellowship should have a rather broad scientific and technical background and a strong interest in the uses of the mathematical and other sciences in the solution of societal problems. He or she should also be articulate, literate, flexible and able to work effectively with a wide variety of people. An application should state why the applicant wants to be a Congressional Science Fellow, should summarize his or her qualifications, and should be accompanied by a resume. Also, CBMS should receive by February 15, 1979 three letters from knowledgeable persons about the applicant's competence and suitability for the award.

## AMS RESEARCH FELLOWSHIPS
### Invitation for Applications

In order to announce the 1979–1980 AMS Research Fellowship Awards in February 1979, the application deadline has been set at December 31, 1978, one month earlier than in previous years. In addition the stipend has been increased to $11,000 (part of which is tax-exempt) plus an expense allowance of $500.

These postdoctoral fellowships will support research in mathematics during the academic year 1979–1980, and are open to individuals who have recently received the Ph.D. degree, regardless of age, and who are citizens or permanent residents of a country in North America. Recipients of the fellowships may not hold another grant or salaried position concurrently with the Research Fellowship.

For further information and application forms, write to Dr. William J. LeVeque, Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

## AMS RESEARCH FELLOWSHIP FUND
### Request for Contributions

The AMS Research Fellowship Fund was established in 1973 because of the scarcity of funds for postdoctoral fellowships. From this fund AMS Research Fellowships are awarded annually to individuals who have received the Ph.D. degree, who show unusual promise in mathematical research, and who are citizens or permanent residents of a country in North America. Currently each fellowship carries a partially tax-exempt stipend of $11,000.

Fourteen Research Fellowships have been awarded including five granted for 1978–1979 (see the announcement in the June 1978 *Notices*, p. 254). The number of fellowships awarded depends, of course, on the contributions the Society receives. The Society itself contributes a minimum of $9,000 to the Fund each year, matching one-half the funds in excess of $18,000 raised from other sources, up to a total contribution by the Society of $20,000. It is hoped that every member of the Society will contribute to the Fund.

Contributions to the AMS Research Fellowship Fund are tax deductible. Checks should be made payable to the American Mathematical Society, clearly marked "AMS Research Fellowship Fund", and sent to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, Rhode Island 02901.

## NATIONAL SCIENCE FOUNDATION MINORITY GRADUATE FELLOWSHIPS

The National Science Foundation (NSF) plans to award approximately 50 new three-year Minority Graduate Fellowships for the academic year 1979–1980. These will be in addition to continuing support of approximately 43 awards made in 1978. These fellowships are awarded to minority individuals who have demonstrated ability and special aptitude for advanced training in the sciences. The following description of the program is a press release from the National Research Council:

The National Research Council will advise the NSF in the selection of candidates for the Foundation's program of Minority Graduate Fellowships. Panels of eminent scientists and engineers appointed by the National Research Council will evaluate qualifications of applicants. Final selection of Fellows will be made by the Foundation, with awards to be announced in March 1979.

The NSF Minority Graduate Fellowship Program is open only to persons who are citizens or nationals of the United States as of the time of application, and who are members of an ethnic minority group underrepresented in the advanced levels of the Nation's science talent pool–i.e., American Indian, Alaskan Native (Eskimo or Aleut), Black, Mexican American/Chicano, or Puerto Rican.

Initial NSF Minority Graduate Fellowship awards are intended for students at or near the beginning of their graduate study. Eligibility is limited to those individuals who, as of the time of application, have not completed postbaccalaureate study in excess of 30 semester-hours or 45 quarter-hours, or equivalent, in any field of science, engineering, social science, or mathematics. Subject to the availability of funds, new fellowships awarded in the spring of 1979 will be for periods of three years, the second and third years contingent on certification to the Foundation by the fellowship institution of the student's satisfactory progress toward an advanced degree in science.

These fellowships will be awarded for study or work leading to master's or doctoral degrees in the mathematical, physical, medical, biological, engineering, and social sciences, and in the history and philosophy of science. Awards will not be made in clinical, education, or business fields, in history or social work, for work leading to medical, dental, law, or public health degrees, or for study in joint science-professional degree programs. Applicants will be judged on the basis of ability. The annual stipend for Minority Graduate Fellows will be $3,900 for a twelve-month tenure with no dependency allowances.

Applicants will be required to take the Graduate Record Examinations designed to test aptitude and scientific achievement. The examinations, administered by the Educational Testing Service, will be given on December 9, 1978 at designated centers throughout the United States and in certain foreign countries.

The deadline date for the submission of applications for NSF Minority Graduate Fellowships is December 8, 1978. Further information and application materials may be obtained from the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington, DC 20418.

## VOLUNTEERS SOUGHT FOR EMPLOYMENT REGISTER JOB COUNSELING

The AMS-MAA-SIAM Joint Committee on Employment Opportunities has long recognized the desire of applicants using the Employment Register at annual meetings for counseling and encouragement regarding many phases of job seeking, not only in the area of research mathematics, but in special areas of employment such as government and industrial work, actuarial mathematics, positions in foreign countries, etc. The Joint Committee and the Society's Committee on Employment and Educational Policy seek volunteers from the mathematical community to serve as counselors in conjunction with the Register scheduled January 25–27, 1979 in Biloxi, Mississippi. Persons planning on attending the Biloxi meeting who are interested in participating in this program for one or two hours should write to Dr. William J. LeVeque, Executive Director, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

## SUMMER INSTITUTE OF 1980

Suggestions of topics for a summer institute for 1980 are being received by the Committee on Summer Institutes, prior to January 15 for consideration at the Biloxi meeting. The institute is intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics (there being other provisions for presentations in applied mathematics). Optimally, the suggestions should include the proposed members of the organizing committee (or at least its chairpersons) and a two- or three-page detailed outline of what are the subjects to be covered including suggested principal speakers.

Recent topics have been Automorphic Forms, Representations and L-functions (1977), and Harmonic Analysis and Euclidean Spaces (1978); the topic for 1979 is Finite Group Theory. There have in fact been very few suggestions in recent years. Suggestions may be sent to any member of the committee which consists of Daniel Gorenstein (Rutgers University), Robion C. Kirby (University of California, Berkeley), Peter E. Ney (University of Wisconsin, Madison), Ralph E. Showalter (University of Texas at Austin), Harold M. Stark, Chairman (Massachusetts Institute of Technology), and Joseph L. Taylor (University of Utah).

# SPECIAL MEETINGS INFORMATION CENTER

**THIS CENTER** maintains a file on prospective symposia, colloquia, institutes, seminars, special years, and meetings of other associations, helping the organizers become aware of possible conflicts in subject matter, dates, or geographical area. The printed lists contain announcements of meetings of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings or symposia devoted to specialized topics. The lists also contain announcements of regularly scheduled meetings of national or international mathematical organizations.

**AN ANNOUNCEMENT** will be published in these *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year and page of the issue in which the complete information appeared.

**IN GENERAL**, SMIC announcements of meetings held in the United States and Canada carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadline dates for abstracts or contributed papers, and name of person to write for further information. Meetings held outside the North American area may carry more detailed information. Information on the pre-preliminary planning will be stored in the files, and will be available to anyone desiring information on prospective conferences. All communications on special meetings should be sent to the Special Meetings Information Center of the American Mathematical Society in Providence.

**DEADLINES** are the same as the deadlines for abstracts. They are listed on the inside front cover of each issue.

1978-1979. **Academic Year devoted to Algebraic Geometry and the Geometry of Banach Spaces,** The Mittag-Leffler Institute, Djursholm, Sweden. (January 1978, p. 62)

January 1-December 16, 1978. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany (January 1978, p. 62)

1978-1979. **Special Year in Harmonic Analysis,** University of Maryland. (April 1978, p. 192; see also February 1978, p. A-339)

### NOVEMBER 1978

1-3. **Fourth Department of Energy Statistical Symposium,** Sandia Laboratories, Albuquerque, New Mexico. (June 1978, p. 251)

2-3. **SIAM Symposium on Sparse Matrix Computations and their Applications,** Knoxville Hyatt Regency Hotel, Knoxville, Tennessee. (June 1978, p. 252)

4. **Seventh Midwest Conference on Differential Equations,** University of Missouri-Rolla, Rolla, Missouri. (October 1978, p. 439)

6-8. **Second Conference on PhysicoChemical Hydrodynamics,** National Academy of Sciences, Washington, D.C. (October 1978, p. 439)

10-12. **Midwest Global Dynamical Systems Seminar,** Northwestern University, Evanston, Illinois. (October 1978, p. 439)

15-16. **Composite Structural Materials and Processes Seminar,** Ramada Inn, Southfield, Michigan. (October 1978, p. 439)

17-18. **Mini-Conference on Programmable Calculators and Calculus,** The Ohio State University, Columbus, Ohio. (October 1978, p. 441)

20-26. **Journées sur les Modèles Mathématiques en Biologie,** Montpellier, France. (October 1978, p. 439)

### DECEMBER 1978

3-15. **Seminar on Mathematical Logic,** Universidad Católica de Chile, Santiago, Chile. (October 1978, p. 439)

4-6. **Association for Computing Machinery Annual Conference,** Sheraton Park Hotel, Washington, D.C. (February 1978, p. 133; October 1978, p. 440)

5-8. **Asian-South Pacific Regional Meeting in Astronomy,** Wellington, New Zealand. (June 1978, p. 220)

13. **Computer Networking Symposium,** Gaithersburg, Maryland. (October 1978, p. 440)

15-17. **Canadian Mathematical Society Annual Winter Meeting,** Université Laval, Québec City, Canada.
*Information*: Norbert Lacroix, Département de Mathématiques, Université Laval, Cité Universitaire, Québec, Canada G1K 7P4.

17-18. **Reunion sur les Equations aux Derivees Partielles et l'Analyse Fonctionelle,** Han-sur-Lesse, France. (October 1978, p. 440)

17-19. **Fourth Conference on Gambling,** Reno, Nevada.
*Program*: The conference is open to anyone interested in computers and computer simulation. Contributed papers are invited; two copies should be sent to the address below as soon as possible.
*Information*: William Eadington, Program Coordinator, Bureau of Business and Economic Research, University of Nevada, Reno, Nevada 89557.

17-22. **IV Latin American Symposium on Mathematical Logic,** Universidad Católica de Chile. (October 1978, p. 440)

18-20. **Ordinary Differential Equations and their Applications,** University of Birmingham, England. (August 1978, p. 329)

18-20. **Workshop on Software Testing and Test Documentation,** Bahia Mar Hotel, Fort Lauderdale, Florida. (October 1978, p. 440)

### JANUARY 1979

January 1-December 22, 1979. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany.
*Information*: Martin Barner, Institute Director, University of Freiburg, 7800 Freiburg i. Br., Werthmannplatz, Federal Republic of Germany.

January

1-6. Arbeitsgemeinschaft Salzmann
*Chairman*: H. Salzmann, Tübingen.

7-13. Formale Methoden und mathematische Hilfsmittel für die Softwarekonstruktion
*Chairmen*: H. Langmaack, Kiel; E. Neuhold, Stuttgart; M. Paul, Munchen.

14-20. Charakteristikfreie Darstellungstheorie symmetrischer Gruppen
*Chairmen*: A. Kerber, Aachen; G. Rota, Cambridge.

21-27. Mathematische Wirtschaftstheorie
*Chairmen*: H. Föllmer, Zürich; W. Hildenbrand, Bonn; D. Sondermann, Hamburg.

28-February 3. Stochastic Programming
*Chairman*: P. Kall, Zürich.

28-February 3. Boolesche Algebren
*Chairmen*: S. Koppelberg, Berlin; D. Monk, Boulder.

February

4-10. Mehrdimensionale konstruktive Funktionentheorie
*Chairmen*: W. Schempp, Siegen; K. Zeller, Tübingen.

11-17. Funktionentheorie
*Chairmen*: G. Frank, Hagen; K. Strebel, Zürich; H. Wittich, Karlsruhe.

18-24. Medizinische Statistik
*Chairmen*: K. Dietz, Tübingen; H. J. Jesdinsky, Düsseldorf.

25-March 3. Partielle Differentialgleichungen
*Chairmen*: E. Heinz, Göttingen; G. Hellwig, Aachen.

March

4-10. Mathematische Stochastik
*Chairman*: H. Föllmer, Zürich.

18-24. Numerische Methoden der Approximationstheorie
*Chairmen*: L. Collatz, Hamburg; G. Meinardus, Siegen; H. Werner, Münster.

25-31. Algebraische Zahlentheorie: Arithmetik der Kreiskörper und der Klassenkörper der komplexen Multiplikation
*Chairmen*: W. Jehne, Köln; H. W. Leopoldt, Karlsruhe; P. Roquette, Heidelberg.

April

1-7. Gewöhnliche Differentialgleichungen
*Chairmen*: H. W. Knobloch, Würzburg; R. Reissig, Bochum.

8-14. Algebraische Gruppen
*Chairmen*: T. A. Springer, Utrecht; J. Tits, Paris.

15-21. Arbeitsgemeinschaft Geyer-Harder
*Chairman*: To be announced.

22-28. Mathematische Logik
*Chairmen*: W. Felscher, Tübingen; E. Specker, Zürich.

29-May 5. Gruppentheorie
*Chairmen*: W. Gaschütz, Kiel; K. W. Gruenberg, London.

May

6-12. Mathematische Optimierung
*Chairmen*: H. König, Saarbrücken; B. Korte, Bonn; K. Ritter, Stuttgart.

13-19. Kommutative Algebra und algebraische Geometrie
*Chairmen*: H.-J. Nastold, Münster; E. Kunz, Regensburg; L. Szpiro, Paris.

20-26. Mathematical Problems in the Theory of Gases
*Chairmen*: H. Neunzert, Kaiserslautern; D. C. Pack, Glasgow.

27-June 2. Diophantische Approximationen
*Chairman*: Th. Schneider, Freiburg.

June

3-9. Differentialgeometrie im Grossen
*Chairmen*: S. S. Chern, Berkeley; W. Klingenberg, Bonn.

10-16. Arbeitsgemeinschaft Algebra
*Chairmen*: H. P. Kraft, Bonn; C. M. Ringel, Bonn.

17-23. Funktionalgleichungen
*Chairmen*: J. Aczel, Waterloo; W. Benz, Hamburg; A. Ostrowski, Basel.

24-30. Riesz Spaces and Order Bounded Operators
*Chairmen*: W. A. J. Luxemburg, Pasadena; H. Schaefer, Tübingen.

July

1-7. Masstheorie
*Chairman*: D. Kölzow, Erlangen-Nürnberg.

8-14. Kategorien
*Chairman*: H. Schubert, Düsseldorf.

15-21. Universelle Algebra
*Chairmen*: W. Felscher, Tübingen; G. Grätzer, Winnipeg; R. Wille, Darmstadt.

22-28. Harmonische Analyse und Darstellungstheorie topologischer Gruppen
*Chairmen*: H. Leptin, Bielefeld; E. Thoma, München.

August

5-11. Graphentheorie
*Chairman*: G. Ringel, Santa Cruz

12-18. Algebraische Zahlentheorie
*Chairman*: P. Roquette, Heidelberg

19-25. Jordan-Algebren
*Chairmen*: K. McCrimmon, Charlottesville; K. Meyberg, München; H. P. Petersson, Münster.

26-September 1. Topologie
*Chairmen*: T. tom Dieck, Göttingen; K. Lamotke, Köln; C. B. Thomas, London

September

2-8. Topologie (Spezialtagung)
*Chairmen*: Th. Bröcker, Regensburg; D. Eisenbud, Waltham, Mass.; E. Looijenga, Amsterdam.

9-15. Komplexe Analysis
*Chairmen*: H. Grauert, Göttingen; R. Remmert, Münster; K. Stein, München.

16-22. IUTAM-Symposium: Laminar-Turbulent Transition
*Chairman*: R. Eppler, Stuttgart.

23-29. Geometrie
*Chairmen*: K. Leichtweiss, Stuttgart; K. Voss, Zürich.

30-October 6. Funktionalanalysis: Operatorfunktionen und Spektraltheorie
*Chairmen*: I. Gohberg, Tel Aviv: B. Gramsch, Mainz; H. Schaefer, Tübingen.

October

7-13. Dynamische Systeme (Stabilität, Stochastik, Nichtlinearität, Modellbildung)
*Chairmen*: W. Schiehlen, Stuttgart; W. Wedig, Karlsruhe; F. Weidenhammer, Karlsruhe.

14-20. Arbeitsgemeinschaft Geyer-Harder
*Chairman*: To be announced.

21-27. Komplexitätstheorie
*Chairmen*: C. P. Schnorr, Frankfurt; A. Schönhage, Tübingen; V. Strassen, Zürich.

28-November 3. Didaktik: Anwendungsbezüge im Mathematikunterricht (der Sekundarstufen I und II)
*Chairman*: A. Kirsch, Kassel.

November

4-10. Angewandte mathematische Statistik
*Chairmen*: K. Behnen, Bremen; G. Neuhaus, Hamburg.

18-24. Numerische Behandlung von Integralgleichungen
*Chairmen*: J. Albrecht, Clausthal-Zellerfeld; L. Collatz, Hamburg.

25-December 1. Fortbildungslehrgang für Studienräte
*Chairman*: To be announced.

December

2-8. Nichtlineare Funktionalanalysis und ihre Anwendung auf partielle Differentialgleichungen
*Chairmen*: H. Amann, Bochum; P. Hess, Zürich.

9-15. Informationstheorie
*Chairman*: R. Ahlswede, Bielefeld.

16-22. Arbeitstagung Stochastik
*Chairman*: H. Rost, Heidelberg.

3-8. **AAAS Annual Meeting,** Houston, Texas.
*Program*: The theme of the meeting will be "Science and Technology: Resources for Our Future". There will be 140 symposia, ten public lectures on popular aspects of science, and the AAAS Science Film Festival. A preliminary program for the meeting appears in the September 29 issue of *Science*.

*Information*: AAAS Meetings Office, 1776 Massachusetts Avenue, N.W., Washington, D. C. 20036.

4-5. **Assessment in Mathematics,** University of Birmingham, Birmingham, England. (October 1978, p. 440)

15-27. **Computer Science School (Escola de Computação),** São Paulo, Brazil.

*Program*: Five basic courses, two advanced courses, invited talks, communication sessions.

*Sponsors*: Universidade de São Paulo, Universidade Estadual de Campinas, Pontifícia Universidade Católica do Rio de Janeiro.

*Information*: Tomasz Kowaltowski, IMECC - UNICAMP, Caixa Postal 1170, 13100 - Campinas, S.P., Brazil.

15-February 9. **Australian Mathematical Society Nineteenth Summer Research Institute,** Macquarie University, New South Wales, Australia. (October 1978, p. 440)

*Program*: The emphasis will be on the relationship between various branches of mathematics and the application of mathematics to other fields. There will be a series of expository lectures on a number of topics, and a wide-ranging variety of activities in specialized sections.

*Speakers*: G. Andrews; C. Ash; I. Babuska; P. Prenter; R. Richardson; D. Taylor; T. Kato; J. L. Lions; C. S. Morawetz; E. Montroll; P. Huber; and L. Moses.

*Information*: Alan McIntosh, School of Mathematics and Physics, Macquarie University, North Ryde, New South Wales 2113, Australia.

29-31. **Sixth ACM SIGACT-SIGPLAN Symposium on Principles of Programming Languages,** San Antonio, Texas. (August 1978, p. 329)

## FEBRUARY 1979

4-8. **1979 Applied Mathematics Conference,** Leura Motel, New South Wales. (October 1978, p. 440)

13-16. **Fifth Interamerican Conference on Mathematical Instruction,** Campinas, São Paulo, Brazil. (August 1978, p. 330)

## MARCH 1979

15-17. **Algebra and Ring Theory Conference,** University of Oklahoma, Norman, Oklahoma.

*Principal Speakers*: David Eisenbud, T. Y. Lam, O. T. O'Meara and Richard Swan.

*Program*: The conference is conceived to be educational in nature. Its goal is to inform mathematicians and algebraists about current trends in ring theory. Partial support will be available for other speakers and abstracts are invited. Expository talks and surveys will be given preference.

*Information*: B. R. McDonald, Conference Director, Department of Mathematics, 601 Elm Avenue, Room 423, University of Oklahoma, Norman, Oklahoma 73019.

18-23. **Conference on Geometry (Foundations) and Differential Geometry,** University of Haifa, Haifa, Israel. (October 1978, p. 440)

28-30. **1979 Conference on Information Sciences and Systems,** Baltimore, Maryland. (October 1978, p. 440)

## APRIL 1979

3-5. **1979 ACM SIGNUM Meeting on Numerical Ordinary Differential Equations,** Department of Computer Science, University of Illinois at Urbana-Champaign, Urbana, Illinois. (October 1978, p. 440)

3-5. **IEEE Specifications of Reliable Software Conference,** Cambridge, Massachusetts. (October 1978, p. 441)

30-May 2. **Eleventh Annual ACM Symposium on Theory of Computing,** Atlanta, Georgia.

*Sponsors*: ACM Special Interest Group for Automata and Computability Theory; the Georgia Institute of Technology.

*Contributed Papers*: Detailed abstracts should be sent by December 1, 1978.

*Information*: Walter A. Burkhard, Computer Science Division C-014, University of California, San Diego, California 92093.

## MAY 1979

19-26. **International Conference on Functional-Differential Systems and Related Topics,** Błażejewko, Poland.

*Program Committee*: A. Bielecki (Lublin), Z. Mikołajska-Mlak (Kraków). J. Mikusiński (Katowice), A. Olbrot (Warszawa), D. Przeworska-Rolewicz (Warszawa).

*Program*: The main interest of this meeting will be recent advances in the following topics: differential and integral equations with transformed argument; time-lag systems; control and observation problems, stability and stabilization, optimization; algebraic methods; applications in engineering, economics, etc. Conference languages are English and Russian.

*Contributed Papers*: Abstracts (1 - 2 pages) should be sent to the Program Committee no later than January 15, 1979. Information on acceptance will be given before March 1, 1979.

*Information*: D. Przeworska-Rolewicz, Mathematical Institute, Polish Academy of Sciences, Śniadeckich 8, 00-950 Warszawa, Poland or A. Olbrot, Institute of Automatics, Politechnika Warszawska, ul. Nowowiejska 15/19, 00-665 Warszawa, Poland.

23-25. **Optimization Days 1979,** McGill University, Montreal, Canada.

*Sponsors*: SIAM, the IEEE Control Systems Society.

*Organizers*: Concordia University, Université Laval, McGill University, École Polytechnique, Université du Québec, Université de Montreal.

*Program*: Topics will include mathematical programming, optimal control, numerical methods of optimization, systems theory, stability theory, identification methods, and applications. Sessions will consist of invited and contributed talks. Conference languages will be English and French.

*Call for Papers*: Two copies of a 200-700 word summary should be forwarded to the address below by January 31, 1979.

*Information*: Bruce Francis, Optimization Days, Department of Electrical Engineering, 3480 University Street, Montreal, P.Q., Canada H3A 2A7.

31-June 6. **Seventh Conference of Analytic Functions,** Wisła (Carpathian Mountains, Province Sielsko-Biała), Poland. (October 1978, p. 441)

## JUNE 1979

20-22. **1979 International Symposium on Fault-Tolerant Computing,** Madison, Wisconsin. (October 1978, p. 441)

20-22. **Third IMACS International Symposium on Computer Methods for Partial Differential Equations,** Lehigh University, Bethlehem, Pennsylvania. (October 1978, p. 441)

25-29. **1979 International Symposium on Information Theory,** Grignano, Italy. (October 1978, p. 441)

## SEPTEMBER 1979

4-9. **Ninth IFIP Conference on Optimization Techniques,** Warsaw, Poland.

*Purpose*: To present recent advances in the theory of optimization and its applications to various theoretical and practical problems; particular emphasis will be placed on optimization problems in economics.

*Program Committee*: A. V. Balakrishnan, R. Kluge, R. Kulikowski, J. L. Lions, G. I. Marchuk, C. Olech, L. S. Pontryagin, A. Ruberti, J. Stoer, J. Westcott.

*Call for Papers*: Abstracts of about two pages in length should be submitted by February 15, 1979, to the address below.

*Information*: K. Iracki, Secretary of the Ninth IFIP Conference, Systems Research Institute, Polish Academy of Sciences, ul. Newelska 6, 01-447 Warszawa, Poland.

19-21. **Sixteenth Midwestern Mechanics Conference,** Kansas State University, Manhattan, Kansas.
*Call for Papers*: Papers on all areas of theoretical and applied mechanics are invited. Authors should request information from S. C. Sinha, Chairman, Program Committee, at the address below.
*Deadline for submission*: February 15, 1979.
*Information*: P. G. Kirmser or C. L. D. Huang, Conference Co-Chairmen, College of Engineering, Kansas State University, Manhattan, Kansas 66506.

# QUERIES

*Edited by Hans Samelson*

QUESTIONS WELCOMED from AMS members regarding mathematical matters such as details of, or references to, vaguely remembered theorems, sources of exposition of folk theorems, or the state of current knowledge concerning published or unpublished conjectures.

REPLIES from readers will be edited, when appropriate, into a composite answer and published in a subsequent column. All answers received will ultimately be forwarded to the questioner.

QUERIES AND RESPONSES should be typewritten if at all possible and sent to Professor Hans Samelson, American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

## QUERIES

**162. Stuart Hastings** (Department of Mathematics, State University of New York at Buffalo, Buffalo, New York 14214). Can anyone give me a definitive reference to the origin of the term "Robin boundary conditions" as applied to certain "mixed" boundary conditions for partial differential equations? Resolution of this problem, which I believe was first posed by Professor Rutherford Aris of the University of Minnesota, presumably would determine the correct pronunciation of "Robin" in this context. Armed with this information, I could withstand the barbs aimed at me alternately by Francophiles and Anglophiles as I oscillate rapidly and almost periodically between the most obvious choices.

**163. Alexander Abian** (Department of Mathematics, Iowa State University, Ames, Iowa 50011). Consider the 1 by $n$ matrices $u$ and $v$ and $n$ by $n$ matrices $A, B, P, Q$ with entries, say, over the reals. What relations must exist among $A, B, P, Q$ such that for every $u$ and $v$ we have:

$$(uAv')(vBu') \leqslant (uPu')(vQv')$$

where $u'$ and $v'$ are the transposes of $u$ and $v$ respectively? Same question for $(uAv')(vBu') \geqslant (uPu')(vQv')$, or, for any meaningful interchanging of $u$ and $v$ in the above inequality (clearly, for $A = B = P = Q = I$ we have the Cauchy-Schwarz inequality).

**164. Scott Smith** (27 Colonial Lake Drive, Lawrenceville, New Jersey 08648). Define a $X$-sum set, where $X$ is an $n$th power character $X \bmod p (\equiv 1 (\bmod n))$, as a set $A = \{1 = a_1 < a_2 < \cdots < a_m \leqslant p - 1\}$ so that

(a) $X(a_i) = +1 \qquad 1 \leqslant i \leqslant m$

(b) $X(a_i + a_j) = +1 \qquad 1 \leqslant i \leqslant j \leqslant m.$

A similar definition can be given for $X$-difference sets. Have $X$-sum or difference sets ever been studied before?

## RESPONSES

The reply below has been received to a query published in a recent issue of these *Notices*. The editor would like to thank all who reply.

**150 (vol. 25, p. 252, June 1978, Donovan).** To prove Sylow's theorem by Galois theory would require this: given a (finite) Galois extension $E/F$, for any prime $p$ find a subfield $E'$, $F \subseteq E' \subseteq E$ such that $[E:E']$ is a $p$-power and $[E':F]$ prime to $p$. But the most natural way of answering this problem is to use Galois theory to transfer it into group theory. This situation may be slightly better for Hall's theorem; here one has to show: If $E/F$ is soluble of degree divisible by $p$, then there is a subfield $E_0$ such that $[E_0:F]$ is a $p$-power and $[E:E_0]$ prime to $p$. Here one may be tempted to begin by showing that $E/F$ has a subextension of degree $p$, but that need not be true in general (it will hold if $\mathrm{Gal}(E/F)$ is nilpotent). (Contributed by P. M. Cohn)

# Deadlines for Fellowships and Assistantships

The following schedule gives application deadlines for assistantships and fellowships described in the special December issue of the *Notices*. These dates have been compiled from the 1977 special issue and updated with information received in preparation for the 1978 issue, and from news items published during the past year. For information about the various programs the reader is referred to the issue of the *Notices* in which the news item appeared or to the appropriate section of the December 1977 issue as follows: [GS] = Graduate Support Section; [PS] = Postdoctoral Support Section; [TSA] = Travel and Study Abroad Section. An asterisk (*) indicates information from the 1977 issue, not yet confirmed for this year.

1978

November 1

American-Scandinavian Foundation [TSA]
E. D. Bergmann Memorial Research Grants [TSA]
Indo-American Fellowship Program [TSA]

November 3

National Academy of Sciences [TSA]
National Science Foundation (National Needs) [PS]
North Atlantic Treaty Organization. Postdoctoral Fellowships [TSA]

November 15

Weizmann Institute of Science. Feinberg Graduate School Postdoctoral Fellowships [TSA]

November 30

Lady Davis Visiting Professorships (Hebrew University) [TSA]
National Science Foundation Graduate Fellowships [GS]
National Science Foundation LOCI Program [GS]

December 1

Fannie and John Hertz Foundation Fellowships [GS]
National Science Foundation (SEED Program) [PS]
Royal Norwegian Council for Scientific and Industrial Research [TSA]
Sigma Delta Epsilon. Eloise Gerry Fellowship [GS]

December 4

National Science Foundation. Science Faculty Professional Development Program [PS]

December 8

National Science Foundation. Minority Graduate Fellowships [GS] [November 1978, p. 502]

December 9

American Philosophical Society [PS]*
Danforth Graduate Fellowships [GS]

December 15

American Association of University Women. American Fellowships [PS] [October 1978, p. 436]

December 30

C. L. E. Moore Instructorships in Mathematics [PS]

December 31

American Mathematical Society Research Fellowships [PS]
Brookhaven National Laboratories [PS]
Lady Davis Visiting Professorships (Technion) [TSA]

1979

January 1

Courant Institute. Instructorships in Mathematics and Computer Science [PS]
Courant Institute. Postdoctoral Visiting Memberships [PS]
Jacob David Tamarkin Instructorships [PS]
Lady Davis Fellowship Trust [TSA]
Václav Hlavatý Research Assistant Professorships [PS]
Zonta International [GS]

January 2

T. H. Hildebrandt Research Assistant Professorships [PS]

January 5

Mid-East and Africa Field Research Fellowships [TSA]

January 9

Benjamin Peirce Lectureships [PS]

January 12

L. E. Dickson Instructorships in Mathematics [PS]

January 15

Courant Institute [GS]
E. R. Hedrick Assistant Professorships in Mathematics [PS]
G. C. Evans Instructorships [PS]
IBM Thomas J. Watson Research Center [PS]
Institute for Advanced Study Memberships [PS]
Kosciuszko Foundation [GS] [PS] [TSA]
National Center for Atmospheric Research [PS]
National Research Council [PS]
National Research Council of Canada. Postdoctorate Fellowships [TSA]
North Atlantic Treaty Organization [TSA]
Sigma Delta Epsilon, Grant-in-Aid Fellowships [GS]
Smithsonian Institution [GS]
Smithsonian Institution. Postdoctoral Fellowships [PS]

January 20

State University of New York at Buffalo [PS]*

January 30

Solomon Lefschetz Research Instructorships [TSA]

"Before February"

J. Willard Gibbs Instructorships [PS]

February 1

American Society for Engineering Education [PS]
Hughes Aircraft Company Fellowships [GS]

February 5

California State Graduate Fellowships [GS]

February 9

American Philosophical Society [PS]*

February 15

AMS-MAA-SIAM Congressional Science Fellowship [PS]
John Wesley Young Research Instructorships [PS]
Kappa Kappa Gamma Fraternity [GS]

February 26

AAAS Mass Media Intern Program [February 1978, p. 119] [GS]*

March 1

Hubert Humphrey Doctoral Fellowships [June 1978, p. 258] [GS]
Rotary Foundation Graduate Fellowships and Undergraduate Scholarships [TSA]

March 15

U.S.-India Exchange [TSA]

April 1

Air Force Office of Scientific Research [PS]

April 6

American Philosophical Society [PS]*

April 30

North Atlantic Treaty Organization [TSA]

May 15

Weizmann Institute of Science [TSA]

June 1

Fulbright-Hays [American Republics; Australia and New Zealand] [TSA]

July 1

Fulbright-Hays [Africa, Asia, Europe] [TSA]

July 30

OTA Congressional Fellowship [PS]

August 10

American Philosophical Society [PS]*

September 15

North Atlantic Treaty Organization [TSA]
U.S.-India Exchange [TSA]

October 1

John Simon Guggenheim Memorial Foundation Fellowships [PS]

October 12

American Philosophical Society [PS]*

October 15

National Science Foundation. Research and Travel Grants [PS]

October 18

Kennedy Scholarship [Foreign Nationals]

# NEW AMS PUBLICATIONS

## PROCEEDINGS OF SYMPOSIA IN PURE MATHEMATICS

(ISSN 0082-0717)

*ALGEBRAIC AND GEOMETRIC TOPOLOGY*
edited by R. James Milgram

The American Mathematical Society held its 24th Summer Research Institute at Stanford University on August 2-21, 1976. The topic of the meeting was Algebraic and Geometric Topology. Particular emphasis was placed on Algebraic $K$- and $L$-Theory, Surgery and Surgery Classifying Spaces, Group Actions on Manifolds, and 3 and 4 Manifold Theory.

The topics in Part 1 are: Algebraic $K$- and $L$-Theory; Surgery and its Applications; Group Actions.

Included in Part 2 are: Structure of Topological Manifolds; Low Dimensional Manifolds; Geometry of Differential Manifolds and Algebraic Varieties; $H$-Spaces, Loop Spaces, and $CW$ Complexes; Problems.

Among the contributors are S. Cappell, P. Conner, A. Hatcher, W. C. Hsiang, R. Kirby, R. Lashof, J. P. Lin, I. Madsen, J. P. May, R. J. Milgram, R. Oliver, T. Petri, J. Stallings, J. Wagoner, F. Waldhausen and C. T. C. Wall.

These are for the most part reports of research in the area of algebraic topology and the overall effect is an overview of the subject at this time.

Volume XXXII, Parts 1, 2
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## AMS TRANSLATIONS—SERIES 2

(ISSN 0065-9290)

*NINE PAPERS ON HILBERT'S 16TH PROBLEM*
D. A. Gudkov and G. A. Utkin

The study of the topology of real algebraic curves in the plane and surfaces in space is a classical problem in algebraic geometry. In his 16th problem, Hilbert singled out the case of nonsingular algebraic curves and surfaces. It is known that in studying the location of ovals of nonsingular curves difficulties are first encountered with sixth order curves. Similarly, in the study of the number, shape and location of pieces of nonsingular surfaces the difficulties begin with fourth order surfaces. Both cases were cited by Hilbert; but their investigation by Hilbert's pupils, Grete Kahn and Klara Löbenstein, and by Karl Rohn did not yield substantial results. I .G. Petrovskiĭ showed that a sixth order curve cannot consist of eleven ovals located outside one another. Furthermore, I. G. Petrovskiĭ and O. A. Oleĭnik proved that a fourth order surface which consists entirely of ovals can contain at most ten ovals.

The idea of applying the concepts of roughness and degree of nonroughness to the study of algebraic curves was conceived by A. A. Andronov in 1948. In previous work, as well as in the present volume, the authors have attempted to carry out this idea. In particular, reexamination of the investigations of Kahn, Löbenstein and Rohn from this viewpoint has proved fruitful.

The present volume contains the solution of the classical problem concerning the location of ovals of a nonsingular sextic curve. Moreover, substantial results about the topology of a nonsingular fourth order surface are also presented. It also proved convenient to establish certain theorems about nonsingular algebraic curves and surfaces of arbitrary order.

The method employed in the investigation of the location of ovals of sixth order curves can also be applied to study the mutual disposition of the following: a curve of order five and a line; nonsingular curves of orders two and four; and a pair of cubic curves.

It would be interesting to determine whether a fourth order surface can consist of 11 pieces and/or have rank 13. There are examples, due to Rohn and Hilbert respectively, of a fourth order surface consisting of ten ovals and of a surface of rank 12.

Volume 112
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## MATHEMATICAL SURVEYS

(ISSN 0076-5376)

*SYMPLECTIC GROUPS*
O. T. O'Meara

This volume, the sequel to the author's *Lectures on Linear Groups*, is the definitive work on the isomorphism theory of symplectic groups over integral domains. Recently discovered geometric methods which are both conceptually simple and powerful in their generality are applied to the symplectic groups for the first time. There is a complete description of the isomorphisms of the symplectic groups and their congruence subgroups over integral domains. Illustrative is the theorem $PSp_n(\mathfrak{o}) \cong PSp_{n_1}(\mathfrak{o}_1) \Longleftrightarrow n = n_1$ and $\mathfrak{o} \cong \mathfrak{o}_1$ for dimensions $\geq 4$. The new geometric approach used in the book is instrumental in extending the theory from subgroups of $PSp_n (n \geq 6)$ where it was known to subgroups of $P\Gamma Sp_n (n \geq 4)$ where it is new. There are extensive investigations and several new results on the exceptional behavior of $P\Gamma Sp_4$ in characteristic 2.

The author starts essentially from scratch (even the classical simplicity theorems for $PSp_n(F)$ are proved) and the reader need be familiar with no more than a first course in algebra.

Volume ~~14~~ 16
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# VISITING MATHEMATICIANS — *Supplementary List*

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists. These are a supplement to the listing in the October 1978 issue of the *Notices*.

## U.S. and Canadian Mathematicians Visiting Abroad

| Name and Home Country | Host Institution | Field of Special Interest | Period of Visit |
|---|---|---|---|
| Block, H. D. (U.S.A.) | Tokyo University, Japan; Corpus Christi College, Cambridge University, England | Applied Mathematics | 9/79 - 3/79<br>4/79 - 5/79 |
| Ganong, Richard (U.S.A.) | Bhaskaracharya Pratishtana Institute for Mathematics, India | Topics in the Biregular Geometry of Affine Spaces | 8/78 - 6/79 |
| Goldberg, Samuel (U.S.A.) | Cambridge University, England; Technion, Israel Institute of Technology | Differential Geometry | Spring 1979 |
| Hile, Gerald N. (U.S.A.) | Technische Hochschule Darmstadt; Free University of Berlin | Partial Differential Equations | Spring 1979 |
| Ogus, Arthur (U.S.A.) | Université de Paris-Sud, France | Algebraic Geometry | 9/78 - 6/79 |
| Petrich, Mario (U.S.A.) | University of Belgrade, Yugoslavia | Mathematics Semigroup Theory | 9/78 - 6/79 |
| Rieffel, Marc (U.S.A.) | University of Copenhagen, Denmark | Ring Theory | 9/78 - 6/79 |
| Takeuti, Gaisi (U.S.A.) | Nagoya University | Logic | Spring 1979 |
| Zelinsky, Daniel (U.S.A.) | Tata Institute, India | Brauer Groups and Cohomology | 12/78 - 2/79 |

## Visiting Foreign Mathematicians

| | | | |
|---|---|---|---|
| Bazzoni, Silvana (Italy) | Tulane University | | 9/78 - 6/79 |
| Chen, Jing-run (China) | Institute for Advanced Study | Number Theory | 1/79 - 4/79 |
| Dales, H. Garth (England) | University of California, Berkeley | Analysis | 9/78 - 6/79 |
| Grippenberg, Jarl. I. (Finland) | University of Wisconsin, Madison | | 9/78 - 5/79 |
| Haag, Rudolf (Germany) | University of California, Berkeley | Mathematical Physics | 4/79 - 6/79 |
| Ivanšić, Ivan (Yugoslavia) | University of North Carolina at Greensboro | Topology | 9/78 - 6/79 |
| Parvizi, Djamchid (Iran) | New York University, Courant | Lie Algebras | 9/78 - 6/79 |
| Penrose, Roger (England) | University of California, Berkeley | Relativity | 9/78 - 1/79 |
| Poguntke, W. (Federal Republic of Germany) | McMaster University | Algebra | 9/78 - 12/78 |
| Rawnsley, John (Ireland) | University of California, Berkeley | Quantum Theory | 1/79 - 6/79 |
| Verma, Daya-Nand (India) | Clark University | Algebraic Groups and Invariant Theory | 9/78 - 12/78 |
| Walters, Peter (England) | University of California, Berkeley | Ergodic Theory, Dynamical Systems | 9/78 - 4/79 |
| Wu, Wen-tsun (China) | Institute for Advanced Study | Topology | 1/79 - 4/79 |

# RECENT APPOINTMENTS

President R. H. Bing has appointed Murray S. Klamkin and Ivan Niven to the Committee on Prizes. Continuing members of this committee are Louis Auslander, James C. Cantrell, Walter Feit, John W. Milnor, and Mary Ellen Rudin.

President R. H. Bing has extended the term of George D. Mostow on the Program Committee for National Meetings and has appointed Hugh L. Montgomery to replace Harold M. Stark whose term expires at the end of 1978. Continuing members of the committee are C. Edmund Burgess, James G. Glimm, Donald S. Ornstein, Barbara L. Osofsky, and Everett Pitcher (ex officio). James G. Glimm has been appointed chairman.

Edwin Duda has been appointed by President R. H. Bing to the Committee on Academic Freedom, Tenure, and Employment Security. Continuing members of the committee are A. T. Bharucha-Reid, Philip Curtis, John R. Durbin, Mary W. Gray (chairman), and Calvin C. Moore.

President R. H. Bing has appointed Donald C. Rung and William P. Ziemer to the Committee on Employment and Educational Policy. Continuing members of the committee are Lida K. Barrett (chairman), Alan J. Goldman, Arthur P. Mattuck, and Robert J. Thompson.

Henry O. Pollak and Gian-Carlo Rota have been appointed to the Steele Prize Committee by President R. H. Bing. Continuing members are Edward B. Curtis, Irving Kaplansky, H. Blaine Lawson, Jr., Hans Samelson, Stephen S. Shatz, Joseph L. Taylor, Raymond O. Wells, Jr., and Hans F. Weinberger (chairman).

Ervin Y. Rodin has been appointed by SIAM President Werner C. Rheinboldt to the AMS-MAA-SIAM Joint Committee on Employment Opportunities. Continuing members of the committee are Richard D. Anderson, Wilfred E. Barnes (MAA), and Roger A. Horn (AMS).

President R. H. Bing, in consultation with President Werner C. Rheinboldt of SIAM, has appointed Roger Brockett to the AMS-SIAM Joint Committee on Applied Mathematics. Other members of the committee are D. J. Benney, Frank C. Hoppensteadt (chairman), Edward L. Reiss, Martin Schultz, and David Siegmund. A principal duty of this committee is to select the subject and the organizing committee for the Summer Seminar in Applied Mathematics.

James B. Ax and Michael Artin have been appointed by President R. H. Bing to the Committee to Select Hour Speakers for Eastern Sectional Meetings. Continuing members of the committee are Associate Secretary Raymond Ayoub (ex officio), James M. Greenberg, and Jack C. Kiefer. Professor Artin has been appointed chairman.

Robert D. Edwards and Daniel W. Stroock have been appointed by President R. H. Bing to the Committee to Select Hour Speakers for Far Western Sectional Meetings. The continuing members of the committee are Robert Osserman, Rimhak Ree, and Associate Secretary Kenneth A. Ross (ex officio). Professor Osserman will be the new chairman.

Jonathan P. Brezin and Robert J. Daverman have been appointed by President R. H. Bing to the Committee to Select Hour Speakers for Southeastern Sectional Meetings. The continuing members of the committee are William K. Allard, Associate Secretary Frank T. Birtel (ex officio), and Thomas A. Chapman. The new chairman will be Professor Allard.

William H. Jaco and Mary Ellen Rudin have been appointed by President R. H. Bing to the Committee to Select Hour Speakers for Western Sectional Meetings. Continuing members are Associate Secretary Paul T. Bateman (ex officio), Melvin Hochster, and Karen Uhlenbeck. Professor Hochster will be the new chairman.

Shiing-shen Chern, Eugene B. Dynkin, and Nicholas D. Kazarinoff have been appointed by President R. H. Bing to the AMS-IMS Committee on Translations from Russian and Other Foreign Languages. They will be members of the AMS subcommittee of this committee, whose continuing members are Felix Albrecht, Ivo Babuška, Israel Berstein, Ralph P. Boas, Ronald G. Douglas (chairman), David Ebin, James King, and Melvyn Nathanson.

Richard D. Anderson has been appointed by President R. H. Bing to the Committee on Science Policy. Continuing members of the committee include Jerald J. Kovacic, Peter D. Lax, Brockway McMillan, I. M. Singer, and J. Ernest Wilkins, Jr.

President R. H. Bing has appointed Nathan Jacobson, Daniel G. Quillen, and Richard G. Swan to be the Committee to Select the Winner of the Cole Prize for 1980. The prize is awarded alternately in algebra and number theory, 1980 being a year for algebra.

President R. H. Bing has appointed Robert C. Hartshorne and Bernard Maskit to the Committee on Postdoctoral Fellowships for a term of three years. Continuing members are Leonard Gillman, Myles Tierney (chairman), William P. Thurston, and Karen Uhlenbeck.

Vera S. Pless has been appointed by President R. H. Bing to the Committee on the Human Rights of Mathematicians for a term of three years. Continuing members of the committee are Lipman Bers (chairman), Chandler Davis, Murray Gerstenhaber, Mary W. Gray, John A. Nohel, and Eduardo Daniel Sontag.

Felix E. Browder has been appointed by President R. H. Bing to the AMS-MAA-SIAM Joint Projects Committee for Mathematics. Continuing members of the committee are Frederick J. Almgren, Jr., Richard D. Anderson, George F. Carrier, Hirsh G. Cohen (chairman), Richard DiPrima, Robion C. Kirby, William H. Kruskal, and George D. Mostow.

COMMITTEES DISCHARGED

The Executive Committee and Board of Trustees have discharged with thanks the Committee on Page Charges and the Committee on the Feasibility of a Proposal on Engineering and Scientific Mathematics. The recommendations of the latter Committee will be carried out by administrative action or by referral to the Committee on Applied Mathematics. (See the Report on Engineering and Scientific Mathematics on pages 422-424 of the October 1978 *Notices*.)

# REPORTS OF MEETINGS

## THE SUMMER MEETING IN PROVIDENCE

The eighty-second summer meeting of the American Mathematical Society was held at Brown University in Providence, Rhode Island. All sessions took place on the campus of the university.

Owing to the meeting of the International Congress of Mathematicians, there were no Colloquium Lectures. By invitation of the Society's Program Committee however, there were eight one-hour invited addresses. These were as follows: Raoul H. Bott of Harvard University spoke on "Yang-Mills Theory"; he was introduced by Arthur Jaffe. Donald J. Brown of the Cowles Foundation for Research in Economics, Yale University spoke on "Myopic economic agents" and was introduced by Jerome Keisler. Anil Nerode of Cornell University spoke on "The limits of effectiveness in classical mathematics" and was introduced by Richard Shore. John W. Morgan of Columbia University spoke on "Hodge theory for the algebraic topology of nonsingular varieties" and was introduced by Herbert Clemens. James G. Arthur of Duke University spoke on "Automorphic forms and the trace formula" and was introduced by R. Askey. Boris Moishezon of Columbia University spoke on "Global problems in singularities theory" and was introduced by George Whitehead. Spencer Bloch of the University of Chicago spoke on "On the geometry of algebraic cycles" and was introduced by Daniel Grayson. James V. Ralston of the University of California, Los Angeles, spoke on "The scattering of sound waves" and was introduced by Linda Rothschild.

There were two special lectures dealing with mathematical discovery. These were: Hassler Whitney of the Institute for Advanced Study who spoke on "Fostering and hindering creativity in mathematics"; H. Zassenhaus of Ohio State University who spoke on "The genesis of the four subgroup theorem". Both were introduced by Raymond Ayoub.

Also by invitation of the Program Committee there were twenty special sessions. The titles, organizers and speakers were as follows: Algebraic cycles, SPENCER BLOCH, speakers were Robert Lazarsfeld, William Fulton, Daniel R. Grayson and Spencer J. Bloch; Yang-Mills Theory, RAOUL H. BOTT, speakers were Arthur M. Jaffe and Michael E. Peskin; Mathematical Economics, DONALD J. BROWN, speakers were H. Jerome Keisler, Robert M. Anderson, and Glenn C. Loury; Algebraic topology of smooth algebraic varieties, CHARLES HERBERT CLEMENS, speakers were James E. Carlson, Ron Donagi, and E. Cattani; Problems in logic arising from mathematics, ANIL NERODE, speakers were David B. Posner, Manuel Lerman, C. Smorynski, Richard A. Shore, Michael J. Stob, William H. Wheeler, John Baldwin, Bruce I. Rose, Rick Smith, William J. Mitchell, E. Kleinberg, Gersion Sageev, and Mitchell Spector; Some aspects of of the biology and mathematics of neural modeling, JAMES ANDERSON and ERKKI OJA, speakers were James A. Anderson, Erkki Oja and Stuart Geman; Functional differential equations, H. THOMAS BANKS, speakers were J. A. Burns, George W. Reddien, William W. Hager, E. F. Infante, Richard F. Datko, Marc Q. Jacobs, A. Manitius, and R. D. Driver; Partial differential equations, RICHARD W. BEALS, speakers were Mel S. Berger, R.E.L. Turner, Linda P. Rothschild, Eugene Fabes, Nicholas Hanges, M. S. Baouendi, David S. Tartakoff, Michael G. Crandall, Paul R. Wenston, Richard Kramer, and Barry MacKichan; Combinatorial aspects of mathematical programming, LOUIS J. BILLERA, speakers were Vaclav Chvatal, Ellis L. Johnson, Richard P. Stanley, William H. Cunningham, Robert G. Bland, Arnaldo Mandel, Michael J. Todd, and J. Scott Provan; Geometric methods in control theory, C. BYRNES, speakers were Roger W. Brockett, Eduardo D. Sontag, Arthur

J. Krener, Robert Hermann, Christopher I. Byrnes, and Peter L. Falb; Operator theory and functional analysis, IVAN N. ERDELYI, speakers were Carl M. Pearcy, C. R. Putnam, J. J. Buoni, Robert Sine, Ivan Erdelyi, Joseph G. Stampfli, George Bachman, Ridgley Lange, and Harm Bart; Several complex variables, JOHN ERIK FORNAESS, speakers were B. A. Taylor, Eric Bedford, J. J. Kohn, Frank Beatrous, Thomas Bloom, Michael Freeman, and S. M. Webster; Galois theory, MURRAY GERSTENHABER, speakers were H. F. Kreimer, Nickolas Heerema, James K. Deveney, Raymond T. Hoobler, and Ralph M. May; Number theory, LARRY J. GOLDSTEIN, speakers were Benedict H. Gross, D. Kubert, Lawrence C. Washington, Bruce A. Dodson, H. Kisilevsky, and Michael Razar; The identity problem, M. GUTTIEREZ, speakers were John G. Ratcliffe, Donald L. Wolitzer, Bradley W. Jackson, Nobuyuki A. Sato, Howard L. Hiller, Mauricio A. Guttierez, and Ralph L. Cohen; History of mathematics, M. MAHONEY, speakers were Uta C. Merzbach, Wilbur Knorr, Michael S. Mahoney and Jed J. Buchwald; Approximation theory, PAUL G. NEVAI, speakers were Richard Askey, Mourad E.M. Ismail, A. S. Cavaretta, Jr., P. W. Smith, I. Borosh, C. K. Chui, Geza Freud, and A. Sharma; Interacting particle systems, LAURIE J. SNELL, speakers were Maury Bramson, Lawrence Gray, T. E. Harris, Thomas M. Liggett, David Griffeath, and Stanley Sawyer; Combinatorics, ALAN P. SPRAGUE, speakers were David A. Drake, Stanley E. Payne, Kenneth P. Bogart, Richard P. Stanley, Allen J. Schwenk, and Ira Gessel; Conceptual analysis in rational thermomechanics, CLIFFORD TRUESDELL, speakers were Stuart S. Antman, Bernard D. Coleman, Jerald L. Ericksen, Morton E. Gurtin, Walter Noll, James Serrin, David R. Owen, and C. Truesdell.

There were eleven sessions for contributed papers. Presiding at these sessions were: J. Baildon, W. A. Beyer, R. Brzerk, R. Chen, C. Comstock, C. Fulton, L. A. Hortinsky, Bradley Jackson, W. R. Madych, J. D. Nelson, and D. Owen.

The meeting of the Society was held in conjunction with the Mathematical Association of America, Pi Mu Epsilon and the Association of Women Mathematicians. The Hedrick lectures of the MAA were given by Richard Guy. The J. Sutherland Frame Lecture of Pi Mu Epsilon was given by Herbert Robbins. The Association of Women Mathematicians had a panel discussion on "Women Mathematicians before 1950".

Because of the International Congress, there was no council meeting. There was a brief business meeting, a report of which appears below.

There were a clambake for interested participants and a chamber music concert.

University Park, Pennsylvania — Raymond G. Ayoub, Associate Secretary

## Business Meeting

The Business Meeting of August 11, 1978 was held at 4:00 P.M. in Meehan Auditorium on the campus of Brown University in Providence, Rhode Island. Vice President George W. Whitehead presided.

The Secretary observed that the Council, in recognition of the obligations of a number of its members to the immediately forthcoming International Congress in Helsinki, had not held a meeting in conjunction with the current scientific meetings, so that he had little to report.

The names of nominees for contested positions in the election of 1978 were announced (see page 514).

The names of the candidates for the Nominating Committee for the 1979 election were read. They are:

Richard D. Anderson
Lida K. Barrett
Judy Green
Paul R. Halmos
Victor L. Klee, Jr.
H. O. Pollak
Charles E. Rickart
James B. Serrin

Of these four are to be elected. Professor Green was nominated by petition.

The Secretary repeated the announcement made at the Business Meeting of January 1978 that ballots would be mailed before Labor Day to allow a long time, about 70 days, for their delivery and return.

There were no questions and no new business. The meeting was adjourned at 4:10 P.M.

Bethlehem, Pennsylvania — Everett Pitcher, Secretary

Vice President (one to be elected):
George D. Mostow
Jacob T. Schwartz

Members-at-large (five to be elected)
Gerald R. Chachere*
Chandler Davis
Robert D. Edwards
Robert P. Gilbert*
Johan H. B. Kemperman
Mark Mahowald*
Bruce I. Rose*
Wilfried Schmid
William P. Thurston
Karen Uhlenbeck
Daniel H. Wagner

*Nominated by petition.

Secretary: Everett Pitcher
Associate Secretaries (two positions)
Raymond G. Ayoub
Frank T. Birtel
Treasurer: Franklin P. Peterson
Associate Treasurer: Steve Armentrout
Trustee: Alex Rosenberg

Committee to Monitor Problems in Communication (2 positions)
Robert G. Bartle
Carl M. Pearcy

Publication Committees

Bulletin
Isadore M. Singer
Colloquium
John W. Milnor
Mathematical Reviews
Elwyn R. Berlekamp
Mathematical Surveys
Donald W. Anderson
Mathematics of Computation
Daniel Shanks
Proceedings
Lawrence A. Zalcman
Transactions and Memoirs (three positions)
Michael Artin
Steven Orey
R. O. Wells, Jr.

# AMS RECIPROCITY AGREEMENTS

## *Supplementary List*

A current listing of the mathematical organizations around the world with which the American Mathematical Society has concluded "reciprocity agreements" was published in the August issue of the *Notices* (pages 315-319). The Society has since received updated listings for the societies in Argentina and Poland. Their present entries appear below.

In addition, the AMS has copies of application forms for several societies, and AMS Reciprocity Membership application forms for 1979 have been sent to each Society with which the AMS has a reciprocity agreement. Application forms are available from the Providence office for the following organizations:

Australian Mathematical Society
Sociedade Brasileira de Matemática
Gesellschaft für Angewandte Mathematik und Mechanik
Allahabad Mathematical Society
Calcutta Mathematical Society
Vijnana Parishad
Unione Matematica Italiana
Mathematical Society of Japan
Polskie Towarzystwo Matematyczne

### Argentina

**Unión Matemática Argentina**

Apply for membership to: Secretary of the Unión Matemática Argentina, Casilla de Correo 3588, Buenos Aires, Argentina.
Dues: $6
Pay dues to: Unión Matemática Argentina
Privileges of membership: Revista de la Unión Matemática Argentina (two issues/year).
Officers: Orlando E. Villamayor (President), Carlos Germán D. Gregorio (Secretary).

### Poland

**Polskie Towarzystwo Matematyczne**

Apply for membership to: Polski Towarzystwo Matematyczne, Sniadeckich 8, 00-950 Warszawa, Poland.
Dues: $6
Pay dues to: Polskie Towarzystwo Matematyczne.
Privileges of membership: Any two of the five series of Annales Societatis Mathematicae Polonae: Commentationes Mathematicae (in congress languages), Wiadomości Matematyczne (Mathematical News, in Polish), Matematyka Stosowana (Applied Mathematics, in Polish), Fundamenta Informaticae (in congress languages), Popularny Miesięcznik Matematyczno-Fizyczny "Delta" (Popular Mathematical-Physical Monthly "Delta", in Polish). Participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions.
Officers: Władysław Orlicz (President), Wiesław Zelazko (Vice-President), Tadeusz Iwiński (Secretary), Eugeniusz Fidelis (Treasurer).

American Mathematical Society

# BOOKS ON NUMBER THEORY

**Books marked with a star may be obtained free. Select one of them as a gift with each $15 purchase. A $30 purchase means two free books.**

## REVIEWS IN NUMBER THEORY

*Edited by William J. LeVeque*

The editor has collected essentially all reviews of number theoretic interest that appeared in Volumes 1–44 (1940–1972) of *MATHEMATICAL REVIEWS*; a total of 14,426 reviews in all. The collection contains all reviews that appeared in Math Reviews, Section 10 (Number Theory) and Section 12 (Algebraic Number Theory, Field Theory and Polynomials). In addition, reviews of papers of an arithmetical nature regardless of Math Reviews classification are also included; e.g. arithmetic results in algebraic geometry and arithmetical implications of nonstandard analysis.

The reviews are classified in this collection by a modification of the 1970 M.O.S. classification scheme; a modification being necessary to keep sections to a reasonable size. There are 20 chapters. Each chapter is divided into sections; there are some 336 sections in all.

Each section, except for those in the chapter on Forms, contains about 50 reviews. Hence closely related papers appear together under a descriptive heading, (e.g. Distribution of primes: local questions (e.g. $p_{n+1} - p_n$), Distribution of primes: global questions (e.g. $\pi_n(x)$), Goldbach type problems, Equations in many variables, $p$-adic linear groups, Abelian varities over global fields, Rational points on surfaces, Cyclotomy). Within each section the reviews appear chronologically. Thus one can quickly and easily survey the development of a problem or idea over the 32 year span.

To each review is appended a backwards–forwards list of reviews–those referred to in the review and those referring to the article reviewed. This permits one to see the evolution of an idea and to trace its present refinements and the consequences that flowed from the idea. As a consequence, someone first approaching a problem or concept can in a short time grasp what has occurred and what papers deserve in-depth scrutiny.

Finally there is a list of authors with a list of their publications whose reviews are included in this collection.

These 3 features (small groupings, backwards–forwards referencing, and author index) are of great assistance in locating a result when one only remembers certain approximate data concerning the result, but not enough to directly locate it.

We should caution the reader that this is a collection of reviews and so it necessarily inherits any weakness present in the reviewers. As is well known reviews are not always ideal–some are at times uninformative, a few even misinform; others really tell nothing and some lack references (as a consequence, at times the editor had trouble classifying and the backwards–forwards referencing may be incomplete). But in spite of these minor drawbacks, this is an excellent source of information on the development of number theory since 1940, and we can only speak of it with high accolade. One regret, the interval 1920–1940 (from the completion of Dickson's History to the start of Math Reviews) has not been treated–if it had, number theory would have an essentially complete bibliographic file; as it is, it now has the best file of any branch of mathematics.

*From a review by D. J. Lewis*

The chapter headings for each volume are: Volume 1: A. Congruences; arithmetic functions; primes, factorization; continued fractions and other expansions; B. Sequences and sets; C. Polynomials and matrices. Volume 2: D. Diophantine equations; E. Forms and linear algebraic groups; F. Discontinuous groups and automorphic forms; G. Diophantine geometry. Volume 3: H. Geometry of numbers; J. Diophantine approximation; K. Distribution modulo 1; metric theory of algorithms. Volume 4: L. Exponential and character sums; M. Zeta functions and $L$-functions; analysis related to multiplicative and additive number theory; N. Multiplicative number theory; P. Additive number theory; lattice point problems; Q. Miscellaneous arithmetic-analytic questions. Volume 5: R. Algebraic number theory: global fields; S. Algebraic number theory: local and $p$-adic fields; T. Finite fields and finite commutative rings; U. Connections with logic. Volume 6: Z. General; to the reader; subject index and author index.

| | List | Institutional Members | Individual Members | Student | Code |
|---|---|---|---|---|---|
| Volume 1 | $50 | $35 | $20 | $10 | REVNUM/1 |
| Volume 2 | 50 | 35 | 20 | 10 | REVNUM/2 |
| Volume 3 | 40 | 28 | 16 | 8 | REVNUM/3 |
| Volume 4 | 50 | 35 | 20 | 10 | REVNUM/4 |
| Volume 5 | 40 | 28 | 16 | 8 | REVNUM/5 |
| Volume 6 | 40 | 28 | 16 | 8 | REVNUM/6 |
| Complete set of Volumes 1–6 | | | | | |
| | 190 | 133 | 76 | 38 | REVNUM |

## MATHEMATICAL REVIEWS SECTIONS

Members of the AMS may subscribe to one or more sets of Mathematical Reviews Sections.

### SECTION 10: NUMBER THEORY

Elementary number theory; diophantine equations; forms; automorphic theory; geometry of numbers; diophantine approximation; exponential sums, character sums, multiplicative theory; additive theory, probabilistic theory (measure, dimension, etc.); sequences of integers; rational arithmetic of algebraic objects; connections with logic.

Section 10: $20.00 plus $4.00 subscription fee. Code:79 MRS/10

### SECTION 12: ALGEBRAIC NUMBER THEORY, FIELD THEORY AND POLYNOMIALS

Algebraic number theory; global fields, local and $p$-adic fields; finite fields and finite commutative rings; real and complex fields; general field theory; field extensions; homological methods, differential and difference algebra; topological fields; near-fields and other generalizations; connections with logic.

Section 12: $16.00 plus $4.00 subscription fee. Code: 79 MRS/12
Both Sections–10 and 12: $40.00. Code: 79 MRS/10, 12

# PROCEEDINGS OF SYMPOSIA IN PURE MATHEMATICS

## NUMBER THEORY

*Edited by W. J. LeVeque*

| | | |
|---|---|---|
| *A. O. L. Atkin* | *S. Kochen* | *A. M. Macbeath* |
| *D. G. Cantor* | *D. J. Lewis* | *H. M. Stark* |
| *H. Davenport* | *W. J. LeVeque* | *E. G. Straus* |

A portion of the seventy-third annual meeting of the American Mathematical Society, held in Houston, Texas on 24–28 January, 1967, was devoted to a Special Session on recent advances in the theory of numbers.

This book comprises all but one of the papers presented at the Special Session. The work discussed by S. H. Schanuel, entitled "Extension of Terjanian's counter-example", has not been presented for publication. All the talks were 20 minutes in duration except that of Professor H. M. Stark who gave an hour address. In several cases, what was only sketched in the talk, for lack of time, is presented here in detail.

1969; 98 pages; list $12.80; member $9.60. Code: PSPUM/12

## 1969 NUMBER THEORY INSTITUTE

*Edited by D. J. Lewis*

| | | |
|---|---|---|
| *J. Ax* | *J. S. Milne* | *J. A. Shalika* |
| *A. Baker* | *O. T. O'Meara* | *D. Shanks* |
| *B. J. Birch* | *A. Pfister* | *H. M. Stark* |
| *E. Bombieri* | *H.-E. Richert* | *T. Storer* |
| *K. Iwasawa* | *J. Robinson* | *H. P. F. Swinnerton-Dyer* |
| *N. M. Katz* | *A. Schinzel* | *P. Turan* |
| *Y. Kawada* | *W. M. Schmidt* | *W. C. Waterhouse* |
| *T. Kubota* | *A. Selberg* | *E. Wirsing* |
| *K. Mahler* | | |

This book is an outgrowth of the American Mathematical Society's Sixteenth Summer Research Institute, which had as its topics algebraic number theory, diophantine problems, and analytic number theory.

One of the purposes of the institute was to acquaint the participants from the various areas of number theory with the important results and methods developed recently, especially in areas other than their own. It is impossible to cover all areas of number theory in a single institute; many of the areas not emphasized at this institute were the subject of other institutes and conferences held here and abroad this past year. In order to survey the achievements of the decade, the Organizing Committee invited sixteen speakers to each give a series of lectures. This volume consists of the sixteen invited lecture series, plus nine seminar talks which were felt to have been particularly effective surveys. The papers are addressed to a general number theory audience rather than to a group of specialists and are meant to enable a number theorist to become acquainted with important innovations in areas outside his own specialty. It is hoped that this collection of papers will facilitate access to various parts of number theory and foster further development.

1971; 451 pages; list $24.80; member $18.60. Code: PSPUM/20

## ANALYTIC NUMBER THEORY

*Edited by Harold G. Diamond*

| | | |
|---|---|---|
| *A. Baker* | *D. Henseley* | *H.-E. Richert* |
| *B. C. Berndt* | *C. Hooley* | *K. F. Roth* |
| *E. Bombieri* | *M. Huxley* | *C. Ryavec* |
| *J. Coates* | *W. B. Jurkat* | *D. Shanks* |
| *H. G. Diamond* | *D. J. Lewis* | *H. M. Stark* |
| *P. D. T. A. Elliott* | *K. Mahler* | *J. S. Sunley* |
| *P. Erdös* | *H. L. Montgomery* | *E. Szemeredi* |
| *M. Forti* | *H. G. Niederreiter* | *P. Turán* |
| *P. X. Gallagher* | *K. K. Norton* | *R. C. Vaughan* |
| *L. J. Goldstein* | *A. P. Ogg* | *C. Viola* |
| *E. Grosswald* | *W. Philipp* | *P. J. Weinberger* |
| *H. Halberstam* | *I. Richards* | |

A symposium on Analytic Number Theory and Related Parts of Analysis was held on March 27–30, 1972.

Twenty-nine number theorists were invited to lecture on their recent research, which covers a broad spectrum of contemporary work in number theory.

This volume contains accounts of all the lectures presented at the symposium.

It is hoped that the lively ideas presented at the symposium will be further disseminated by this volume and will spawn new number theoretic research in the years to come.

1973; 340 pages; list $27.20; member $20.40. Code: PSPUM/24

# PROCEEDINGS OF SYMPOSIA IN APPLIED MATHEMATICS

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## EXPERIMENTAL ARITHMETIC, HIGH SPEED COMPUTING, AND MATHEMATICS

*Edited by N. C. Metropolis, A. H. Taub, J. Todd, C. B. Tompkins*

| | | |
|---|---|---|
| *B. J. Alder* | *F. H. Harlow* | *R. E. Quandt* |
| *F. L. Bauer* | *P. Henrici* | *J. B. Rosser* |
| *H. D. Block* | *J. O. Hirschfelder* | *H. Rutishauser* |
| *J. G. Charney* | *E. T. Irons* | *E. Stiefel* |
| *H. Cohn* | *H. W. Kuhn* | *C. B. Tompkins* |
| *E. C. Dade* | *P. D. Lax* | *R. J. Walker* |
| *G. G. Dahlquist* | *D. H. Lehmer* | *H. Wang* |
| *M. Davis* | *G. J. F. MacDonald* | *J. H. Wilkinson* |
| *P. Elias* | *A. Nordsieck* | *C.-P. Yang* |
| *R. E. Gomory* | *E. T. Parker* | *H. Zassenhaus* |
| *R. W. Hamming* | | |

This volume contains all but two of the papers which were presented at two symposia sponsored by the American Mathematical Society and other co-sponsors in the spring of 1962.

EXPERIMENTAL ARITHMETIC

The objective of this symposium was to examine ways in which the arithmetical potential of modern high-speed computers can furnish experience which sheds light on outstanding problems in mathematics and other sciences.

INTERACTIONS BETWEEN MATHEMATICAL RESEARCH AND HIGH-SPEED COMPUTING

The objective of this symposium was to enable mathematicians to become familiar with the potentialities of computers of types currently available and with the problems involved in the proper and effective exploitation of these computers.

The close relationship between the subject matters of the two symposia prompted the organizing committees to merge the proceedings into this single volume.

1963; 396 pages; list $15.20; member $11.40. Code: PSAPM/15

# CBMS REGIONAL CONFERENCE SERIES IN MATHEMATICS

## SMALL FRACTIONAL PARTS OF POLYNOMIALS

*Wolfgang M. Schmidt*

1. Heilbronn's Theorem
2. The Heilbronn Alternative Lemma
3. Vinogradov's Lemma
4. About sums $\Sigma \|\xi_i\|^{-1}$
5. About sums $\Sigma c(\alpha n^2)$
6. Proof of the Heilbronn Alternative Lemma
7. Fractional parts of polynomials
8. A general Alternative Lemma
9. Sums $\Sigma \|\xi_i\|^{-1}$ again
10. Estimation of Weyl sums

11. What happens if the Weyl sums are large
12. Proof of the general Alternative Theorem
13. Simultaneous approximation
14. A reduction
15. A Vinogradov Lemma
16. Proof of the Alternative Lemma on simultaneous approximation
17. On $\max\|\alpha_i n^2\|$
18. A determinant argument
19. Proof of the three Alternatives Lemma
20. Quadratic polynomials in several variables
21. Proofs for quadratic polynomials

1977; 41 pages; list $7.20; member $5.40. Code: CBMS/32

# MATHEMATICAL SURVEYS

## AN INTRODUCTION TO THE ANALYTIC THEORY OF NUMBERS

*R. Ayoub*

There exist relatively few books, especially in English, devoted to the analytic theory of numbers and virtually none suitable for use in an introductory course or suitable for a first reading. This is not to imply that there are no excellent books devoted to some of the ideas and theorems of number theory. Mention must certainly be made of the pioneering and monumental work of Landau and in more recent years of the excellent books of Estermann, Ingham, Prachar, Vinogradoff and others. For the most part, however, these works are aimed at the specialist rather than at the general reader. No further apology therefore will be made for adding to the vast and growing list of mathematical treatises.

The subject of analytic number theory is not very clearly defined and while the choice of topics included here is to some extent arbitrary, the topics themselves represent some important problems of number theory to which generations of outstanding mathematicians have contributed.

The book is divided into five chapters.

I. Dirichlet's theorem on primes in an arithmetic progression.
II. Distribution of primes.
III. The theory of partitions.
IV. Waring's problem.
V. Dirichlet $L$-functions and the class number of quadratic fields.

1963, 379 pages; list $18.40; member $13.80. Code: SURV/10

# SIAM-AMS PROCEEDINGS

## COMPUTERS IN ALGEBRA AND NUMBER THEORY

*Edited by G. Birkhoff and M. Hall, Jr.*

This volume contains the written versions of talks delivered at the Symposium on Computers in Algebra and Number Theory on March 25 and 26, 1970.

Applications of algebraic ideas to computing are first considered by Garrett Birkhoff and Shmuel Winograd. Their papers devote especial attention to problems of optimizing computer algorithms.

The next five articles are devoted to number theory and combinatorial theory. Those by H.P.F. Swinnerton-Dyer and Bryan Birch are pure number theory, that by Leonard Baumert purely combinatorial. Hans Zassenhaus considers the problem of finding the Galois group of a field extension. J.H. van Lint studies perfect error-correcting codes and applies the effective methods of Alan Baker to related Diophantine problems.

The final section deals with the application of computers to finite groups. Problems on the construction and uniqueness of the new sporadic simple groups have involved heavy use of computers, and in several instances the existence of the groups has not been proved in any other way. The article by Marshall Hall is concerned with problems of existence and construction. The paper by M. D. Hestenes and D. G. Higman is concerned with relations between graphs and permutation groups. The articles by John Conway, John McKay, John Cannon, and Charles Sims deal with problems on the structure and subgroups of groups already known. Joachim Neubüser is concerned with algorithms for detailed analysis of a known group.

1971, 200 pages; list $16.80; member $12.60. Code: SIAMS/4

# MEMOIRS OF THE AMERICAN MATHEMATICAL SOCIETY

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## THE MODIFIED ALGORITHM OF JACOBI-PERRON

*Leon Bernstein*

SUMMARY OF RESULTS. Pursuing an idea of Jacobi and Perron the author defines a certain algorithm which derives from every given $(n-1)$-tuple of numbers an infinite sequence of $(n-1)$-tuples. One of the applications of this algorithm is a new method for the solution of algebraic equations, giving in some cases a root of the equation as the ratio of two simple infinite series. Previous results of the author are generalized.

1966; 44 pages; list $4.40; member $3.30. Code: MEMO/67

★

## NUMBERS WITH SMALL PRIME FACTORS, AND THE LEAST $k$th POWER NON-RESIDUE

*Karl K. Norton*

Asymptotic formulas are given for the distribution of numbers which have only relatively small prime factors and which lie in an arithmetic progression or are relatively prime to a given number. These lead to $O$-estimates for the least $k$th power non-residue to any modulus, and specific upper bounds are also given for this non-residue when the modulus is prime. A specific upper bound is given for the number of distinct prime factors of any positive integer.

1971; 106 pages; list $4.40; member $3.30. Code: MEMO/106

★

## MIXING SEQUENCES OF RANDOM VARIABLES AND PROBABILISTIC NUMBER THEORY

*Walter Philipp*

There are many applications of probability to number theory involving a large variety of methods, spread over the literature of the last sixty years. The essential tools in the metric theory of continued fractions are limit theorems for mixing sequences of random variables. Roughly speaking, these are sequences of random variables which are asymptotically independent, i.e., the dependence between the beginning of the sequence and its end is weak. In the study of the distribution of values of additive functions complex variable methods as well as probability methods are in use. The latter ones mainly consist of several truncations of the random variables involved; these truncated random variables in turn are approximated by independent random variables to which the standard limit theorems of probability apply.

The purpose of this paper is to present the results of an attempt to unify much of probabilistic number theory by means of mixing sequences of random variables.

1971; 102 pages; list $4.00; member $3.00. Code: MEMO/114

## ON THE GENERAL ROGERS-RAMANUJAN THEOREM

*George E. Andrews*

This paper is devoted to proving a general partition theorem that asserts the identity of two partition functions $A_{\lambda,k,a}(n)$ and $B_{\lambda,k,a}(n)$ provided $k \geqslant \lambda$, $k \geqslant a > \lambda/2$. The Rogers-Ramanujan identities are the case $\lambda = 0$, $k = 2$, $a = 1, 2$. Gordon's generalization of the Rogers-Ramanujan identities is the case $\lambda = 0$. The Göllnitz-Gordon identities are the case $\lambda = 1$, $k = 2$, $a = 1, 2$, and Schur's theorem is the case $\lambda = k = a - 2$. Previously the result had been proved only for $k \geqslant 2\lambda - 1$.

1974; 86 pages; list $5.20; member $3.90. Code MEMO/152

## ★ FOUNDATIONS OF A STRUCTURAL THEORY OF SET ADDITION

*G. A. Freĭman*

This book is addressed to students of graduate courses and to doctoral candidates studying number theory as well as to the specialists working in this field. Only a basic knowledge of number theory is presupposed. Many of the problems treated in the first chapter may be used as topics for independent mathematical research.

The book consists of three chapters. The first chapter contains an exposition of the basic concepts, general ideas and elementary results. In the second chapter a difficult specific inverse problem is solved. The third chapter is devoted to applications.

1973; 108 pages; list $20.00; member $15.00. Code: MMONO/37

# TRANSLATIONS OF MATHEMATICAL MONOGRAPHS

## ★ ADDITIVE THEORY OF PRIME NUMBERS

*L. K. Hua*

This book is a summing up of the methods of study of the additive theory of prime numbers by Academician Vinogradov of Soviet Russia and the author, with discussions centering on Vinogradov's mean-value theorem and its improvement by the author.

The author combines the methods of study of the Goldbach problem and the Waring problem, the latter being extended by letting the summands be polynomials with integral coefficients in which the variables are restricted to prime values. He also limits the variables in Tarry's problem to assuming only prime values, and at the same time carries out broader discussions on indeterminate equations in unknown primes.

In its original form this book was first published in the Russian language in the Soviet Union in 1947. In 1953 the Chinese edition was published by the Chinese Academy of Sciences. In its present form the book is completely revised and supplemented with great changes made in the contents.

1965; 190 pages; list $16.40; member $12.30. Code: MMONO/13

## ★ MAHLER'S PROBLEM IN METRIC NUMBER THEORY

*V. G. Sprindžuk*

This book deals with the solution of a group of questions related both to the general theory of transcendental numbers and to the metrical theory of diophantine (and also algebraic) approximations. The fundamental problem in this field has been known in the literature since 1932 as Mahler's conjecture, since it arose in connection with the classification of numbers which he introduced.

After Mahler's basic papers, a number of mathematicians (Koksma, LeVeque, Kubilius, Kasch, Volkmann and others) achieved significant advances in their efforts to prove Mahler's conjecture.

The main result in this book is a proof of Mahler's conjecture and some analogous theorems (on $p$-adic numbers and on power series over finite fields).

1969; 192 pages; list $13.60; member $10.20. Code: MMONO/25

# PROCEEDINGS OF THE STEKLOV INSTITUTE

## ALGEBRAIC NUMBER THEORY AND REPRESENTATIONS

*Edited by D. K. Faddeev*

In this volume we consider a series of questions related to algebra and the theory of numbers. A significant number of the papers in the present volume are devoted to integral representations.

In the longer of D. K. Faddeev's two papers, general results on the arithmetic of modules of integral representations for rings are presented; in particular, in §5 of the paper the author develops a far-reaching generalization of multiplicative theory of ideals to modules of integral representations for rings of which the linear closures are projective modules. In the papers of D. K. Faddeev, and Z. I. Borevič and D. K. Faddeev, integral modules for rings of special form are studied. In these are applied ideas which are developed in Faddeev's paper.

A series of papers is devoted to study of the structure of the multiplicative group of units in normal extensions of a local field as representation modules for the Galois group.

In the papers of B. B. Venkov applications of the machinery of homological algebra and the theory of sheaves to the theory of algebras and the theory of group representations are given. The book contains fourteen related papers.

1968; 215 pages; list $27.60; member $20.70. Code: STEKLO/80

## ★ ERGODIC PROBLEMS IN THE THEORY OF CONGRUENCES AND OF DIOPHANTINE APPROXIMATIONS

*A. G. Postnikov*

The basis for the present book is the analogy between mechanics and analytical number theory. We are referring to those fields of mechanics which are concerned with the kinematic description of flow phenomena and which have become more and more perfected in the course of time. In mathematical terms the problem is to describe the trajectories of a system of differential equations. In a more abstract approach one considers dynamic systems in which "time" has a general meaning: it may, for example, be a parameter which runs through the sequence of positive integers.

In dealing with a difficult problem one attempts to isolate aspects of it which can be handled by means of "model" techniques. Among such model techniques of the theory of dynamic systems some questions have been studied which are by their nature related to the theory of diophantine approximations.

1967; 128 pages; list $18.00; member $13.50. Code: STEKLO/82

## PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUMBER THEORY

*Edited by I. M. Vinogradov*

This volume contains the cover-to-cover translation of the proceedings of the International Conference on Number Theory held in Moscow, September 14–18, 1971.

The following papers are included: "Address of the president of the Academy of Sciences of the USSR" by Academician M. V. Keldyš, "Exponential sums in the development of number theory" by Chandrasekharan, "Recent works of I. M. Vinogradov" by Ju. V. Linnik, "Some exponential sums" by L. J. Mordell, "Artin's conjectures and the law of reciprocity" by A. I. Vinogradov, "The arithmetic of K3 surfaces" by I. I. Pjateckiĭ-Šapiro and I. R. Šafarevič, "The Hilbert modular group and some algebraic surfaces" by F. Hirzebruch, "Recent advances in transcendence theory" by A. Baker, "The principle of the theory of nonstandard functional equations for Dirichlet functions, consequences and applications of it" by A. F. Lavrik, "Largest prime factor of the product of k consecutive integers" by K. Ramachandra, "On the uniform boundness of the torsion of elliptic curves over algebraic number fields" by V. A. Dem'janenko, "On the partition function of positive definite matrices" by T. Mitsui, "Über das Normenrestsymbol einer lokalen unverzweigten Erweiterung von 2-Potenzgrad" by H. Koch, "Distribution problems of arithmetic functions" by Ĭ. P. Kubilius, "On sums of squares" by J. W. S. Cassels, "On $(\infty \times p)$-adic coverings of curves (the simplest example)" by Y. Ihara, "Siegel forms and zeta-functions" by A. N. Andrianov, "Applications of the method of trigonometric sums to the metric theory of diophantine approximation of dependent quantities" by V. G. Sprindžuk, "Reducibility of quadrinomials" by A. Schinzel, "Lattice points in moredimensional ellipsoids" by B. Novák, "The geometry of linear algebraic groups" by V. E. Voskresenskiĭ, "The arithmetic theory of linear algebraic groups and number theory" by V. P. Platonov, "On arithmetic properties of values of analytic functions" by A. B. Šidlovskiĭ, "Dirichlet characters and polynomials" by D. A. Burgess, "On the extended Hecke theta-formula" by T. Tatuzawa, "Modular correspondences, heights and isogenies of abelian varieties" by A. N. Paršin, "Constructive method in the theory of equations over finite fields" by S. A. Stepanov, "On sums of real characters" by M. Jutila, "On large sieve inequalities and their applications" by E. Bombieri, and "On some problems of prime number theory connected with I. M. Vinogradov's method" by A. A. Karacuba.

1973, 298 pages; list $34.40; member $25.80. Code: STEKLO/132

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## *Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)*


*78T-A209 RUSSELL MERRIS, California State University, Hayward, Hayward, California 94542 and WILLIAM WATKINS, California State University, Northridge, Northridge, California 91330.

Elementary divisors of transformations on tensor spaces.

Let V be an n-dimensional complex vector space. Let T be a linear operator on V. Assume T has a single elementary divisor. Let K(T) denote the associated transformation induced on a symmetry class of tensors either corresponding to a permutation group and irreducible character or of the Young type. The elementary divisors of K(T) are found together with those of a certain induced "derivation" operator D(T). The method of proof is to use the representation theory of the full linear group and Weyl's principle of the irrelevance of algebraic inequalities to reduce the problem to one recently solved by J. D. McFall. (Received July 28, 1978.)

*78T-A210 Francis E. Masat, Glassboro State College, Glassboro, N.J. 08028. Idempotents and Inverses in Conventional Semigroups.

A conventional semigroup S is a regular semigroup in which E, the set of idempotents, is self-conjugate; that is, $cEc' \subseteq E$ for each $c \in S$ and for each inverse $c'$ of c. This property was derived from orthodox semigroups wherein the set of idempotents, being a subsemigroup, is inherently self-conjugate. Viewed as classes, the following relationships hold with all the inclusions being proper: inverse semigroups $\subset$ orthodox semigroups $\subset$ conventional semigroups $\subset$ regular semigroups. This paper investigates inverses and the set of idempotents in a conventional semigroup. In particular, in a conventional semigroup the set E can be decomposed into its orthodox elements and non-orthodox elements. For S conventional, the inverses of E are described in terms of E and those $\mathcal{H}$-classes of S which are not subgroups of S. Lastly, the inverses of A are described, where A is the kernel of a congruence on S. (Received August 7, 1978.)

*78T-A211 LARRY I. BASENSHPILER, 5569 Gasmer 747, Houston, Texas 77035. On the reconstruction of Trees.

Let C(G) be the collection of all non-isomorphic types of elementary contracted graphs of G. Theorem 1 If G is disconnected or separable or G is a tree then G is reconstructible from C(G) up to an isomorphism. Th. 2 The outerplanar graph G is reconstructible up to a 2 - isomorphism. (Received August 7, 1978.) (Author introduced by S. Fajtlowicz).

78T-A212 DAVID ZEITLIN, 1650 Vincent Ave. North, Minneapolis, Minnesota, 55411. On complete sequences $\{S_{n+b} - Cn - D\}$, where $\{S_n\}$ is a complete sequence.

Definition. A sequence of positive integers is complete with respect to the set of positive integers if every positive integer is the sum of a finite number, without repetition, of the terms of the sequence. The Fibonacci sequence is given by $F_0 = 0, F_1 = 1$, $F_{n+2} = F_{n+1} + F_n$, $n = 0,1,\ldots$; the Lucas sequence is given by $L_0 = 2, L_1 = 1$, $L_{n+2} = L_{n+1} + L_n$, $n = 0,1,\ldots$.

THEOREM 1. $\{F_{n+3} - n - 1\}$, $n = 1,2,\ldots$, is a complete sequence.

THEOREM 2. Let $U_1 = 1$, $U_2 = 2$, and $U_n = L_n - n + 2$, $n \geq 3$. Then $\{U_n\}$ is a complete sequence.

THEOREM 3.

$$\text{Let } U_n = \begin{bmatrix} 2^{n-1}, & n = 1,2,\ldots,P; & (P \geq 1) \\ F_{n+3} - (P+1)n + P^2 + P - 1, & n \geq P+1 & \end{bmatrix}. \text{ Then } \{U_n\} \text{ is a complete sequence.}$$

THEOREM 4.

$$\text{Let } U_n = \begin{bmatrix} 2^{n-1}, & n = 1,2,\ldots,P; & (P \geq 1) \\ L_{n+1} - (P+1)n + P^2 + P, & n \geq P+1 & \end{bmatrix}. \text{ Then } \{U_n\} \text{ is a complete sequence.}$$

Remarks. Proof of theorems above is via Theorem 1 in paper by J.L. Brown, Amer. Math. Monthly, 68 (1961), 557. See my abstract, these NOTICES, October, 1978, for additional theorems on complete sequences. (Received August 23, 1978.)

78T-A213 WITHDRAWN

*78T-A214 K. H. KIM AND F. W. ROUSH, Mathematics Research Group, Box 69, Alabama State University, Montgomery, Al. 36101. On the $J$-class of a product.

DEFINITION. We say that one $J$-class is above another in the $J$-ordering if the two-sided ideal generated by the first $J$-class contains the other.

This gives the well-known partial order on the set of $J$-classes. By considering the case of free semigroups, it appears that no theorem can be obtained unless some *regularity condition* is assumed.

THEOREM. *In any semigroup $S$, if a product $ab$ is regular, then the $J$-class containing $ab$ is the maximal $J$-class $J$ such that $bS \cap Sa \cap J$ contains an idempotent.* (Received August 31, 1978.)

78T-A215 V. SITA RAMAIAH, Andhra University, Waltair 530003, India. On the order of the error function of a class of arithmetical functions.

Let $k \geqq 2$ be a fixed integer and $x$ a real variable $\geqq 3$. Let $g_k$ be any multiplicative function such that (i) $g_k(p^j) = 1$ if $1 \leqq j \leqq k-1$ and $g_k(p^k) = 0$, for all primes $p$ and (ii) $g_k(m) = O(m^{\epsilon})$ for each $\epsilon > 0$. In this paper we prove that $\sum_{m \leqq x} g_k(m) = ax + O(x^{1/k}\delta(x))$, where $a$ is a certain constant (depending on $g_k$) and $\delta(x) = \exp\{-H\log^{3/5}x(\log\log x)^{-1/5}\}$, $H$ being a positive constant. On the assumption of the Riemann hypothesis we also improve the above error term to $O(x^{2/(1+2k)}W(x))$, where $W(x) = \exp\{H\log x(\log\log x)^{-1}\}$. In particular we deduce results due to D. Suryanarayana and R. Sita Rama Chandra Rao (Proc. Amer. Math. Soc. 37(1973), 340-346; J. Austral. Math. Soc. 20(1975), 129-141) and improve a result due to E. Cohen (Acta Sci. Math. 22(1961), 223-233). (Received May 5, 1978.) (Author introduced by D. Suryanarayana).

78T-A216 GREGORY BUTLER, Dept. of Pure Mathematics, University of Sydney, N.S.W., 2006, Australia. Maximal subgroups of the sporadic simple group of Held. Preliminary report

Theorem: The sporadic simple group He of order $2^{10}3^3 5^2 7^3 17$ discovered by D.Held has 11 conjugacy classes of maximal subgroups.The isomorphism types of their representatives are

| | | |
|---|---|---|
| $(E_{16}\backslash E_8)\backslash L_2(7)$ | $(E_4\backslash L_3(4))\backslash S_3$ | $S_4 \times L_2(7)$ |
| $E_{64}\backslash(Z_3\backslash S_6)$ (2 classes) | $Z_3\backslash S_7$ | $E_{25}\backslash Q$ |
| $F_7^3 \times L_2(7)$ | $(Z_7\backslash E_{49})\backslash(S_3 \times Z_3)$ | $E_{49}\backslash SL_2(7)$ |
| $SP_4(4)\backslash Z_2$ | | |

where $A\backslash B$ denotes a group with a normal subgroup isomorphic to $A$ such that $(A\backslash B)/A$ is isomorphic to $B$, $Z_n$ is the cyclic group of order n, $S_n$ is the symmetric group of degree n, $E_n$ is an elementary abelian group of order n and $F_n^m$ is a Frobenius group with kernel $Z_n$ and complement $Z_m$. Q is the central product of $SL_2(3)$ with $Z_4$. (Received September 11, 1978.) (Author introduced by J. N. Ward).

78T-A217 W. H. REYNOLDS, SUNY College at Cortland, Cortland, New York 13045. Subgroups of abelian groups that are maximal with respect to avoiding elements. Preliminary report.

It is known that for $x \neq 0$ in an abelian group $A$ and for $H$ a subgroup that is maximal with respect to avoiding $x$, the quotient $A/H$ is p-cocyclic (isomorphic to $Z(p^n)$ for some prime $p$ and $n \in \{1, 2, \cdots, \infty\}$). Using this fact, a characterization of such subgroups $H$ is easily obtained when $A$ is a direct sum of copies of the additive rationals. This result is used to give the precise structure of such a subgroup $H$ when $A$ is torsion free of rank 2. A simple characterization is given of abelian groups $A$ such that for each prime $p$ and each $x \neq 0$ in $A$, there is at most one subgroup $H$ of $A$ that is maximal with respect to avoiding $x$ and for which $A/H$ is p-cocyclic. Other results are obtained concerning such subgroups $H$ in more general abelian groups. (Received August 28, 1978.)

*78T-A218 JOSEPH ROTMAN, University of Illinois, Urbana, Illinois 61801. Integral duality and duality groups. Preliminary report.

An elementary proof (avoiding cup products and complete resolutions) of the duality isomorphism for finite groups $G$, viz, $(H^k(G,B))^* \cong H_k(G,B^*)$, is given which is valid for a class of infinite groups that includes the duality groups of Bieri and Eckmann. A typical consequence: If $G$ is a Poincaré duality group of dimension $n$, then for all $k \geq 0$ and all $m > 0$,

$$H_{n-k}(G,Z/mZ) \cong H_k(G,Z/mZ).$$ (Received September 5, 1978.)

78T-A219 PHILIP OLIN, York University, Downsview, Canada M3J 1P3. Logical properties of V-free products of bands. Preliminary report.

It was shown earlier (*Notices* A.M.S., October 1978, abstract 78T-A204) that if $V$ is any subvariety of the variety $N$ of all normal bands then for any $A, A', B, B'$ in $V$ if $A \equiv A'$ ($A$ elementarily equivalent to $A'$) and $B \equiv B'$ then $A(*_V)B \equiv A'(*_V)B'$, where $(*_V)$ is the varietal free product operation for the variety $V$. We now show the converse: if $V$ is any variety of bands with $V \not\subseteq N$, then there are $A, B$ in $V$ with $A \equiv B$ but $A(*_V)A \not\equiv B(*_V)B$ and $A(*_V)A \not\equiv A(*_V)B$. This is done by obtaining, for any such $V$, a unique normal form theorem for the elements in $A(*_V)B$ in the case that $A$ and $B$ are linearly ordered sets thought of as meet semilattices. If $V$ is either the left regular, the right regular, the left quasinormal or the right quasinormal variety we obtain a normal form theorem for the elements in $A(*_V)B$ for any $A, B$ in $V$ and show that if $A, B, C \in V$, $A$ finite and $B \equiv C$ then $A(*_V)B \equiv A(*_V)C$. (Received September 5, 1978.)

*78T-A220 ALBERT A. MULLIN, USA BMD Advanced Technology Center, Data Processing, P.O. Box 1500, Huntsville, AL 35807. On combinatorial prime number theory.

Let $S_n$ be the finite set of primes in the mosaic [ Proc. Nat. Acad. Sci. USA 50 (1963), 604-606 ] of natural number $n > 1$. E.g., if $k=11!$, then $S_k = \{2,3,5,7,11\}$.

Lemma. For each natural number $n$ and prime number $p$ there exists a natural number $k$ such that $\bigcap_{(k+1) \leq j \leq (k+n)} S_j = \{p\}$. I.e., given a positive integer $n$ and a prime $p$ there exist $n$ consecutive sets of primes of $S_{(\cdot)}$ whose intersection is the singleton $\{p\}$. E.g., suppose $n=9$ and $p=2$. Then choose $k=2521$ in the Lemma.

Scholium. The conjecture "$S_n = S_{n+1}$ iff $n=8$" is related to an important unsettled conjecture of number theory posed by E.C. Catalan in the year 1842. (Received September 5, 1978.)

78T-A221 Jeff Dinitz, The Ohio State University, Columbus, Ohio, 43210. Orthogonal 1-factorizations of $K_n$. Preliminary report.

Two 1-factorizations $\mathfrak{F}_1$, $\mathfrak{F}_2$ of the complete graph $K_n$ are orthogonal if for any 1-factors $F_1$ of $\mathfrak{F}_1$ and $F_2$ of $\mathfrak{F}_2$, $F_1$ and $F_2$ have at most one edge in common. Let $q = 2^k t + 1$ be a prime power with $t > 1$ odd. Mullin and Nemeth have shown that there exists a set of three pairwise orthogonal 1-factorizations of $K_n$ where $n = q + 1$. If $k = 1$ (i.e. $q \equiv 3 \bmod 4$), Wallis gives a construction for $t = \frac{1}{2}(q - 1)$ pairwise orthogonal 1-factorizations of $K_n$. We generalize both these previous results to obtain a set of $t = (q - 1)/2^k$ pairwise orthogonal 1-factorizations of $K_{q+1}$ for any $k \geq 1$. (Received September 5, 1978.)
(Author introduced by Richard M. Wilson).

*78T-A222 Jay Shapiro, Wayne State University, Detroit, Michigan 48202. Quotient rings of a ring and a subring which have a common right ideal.

Let R be a unital subring of S. If $\mathcal{J}$ is an idempotent filter of right ideals of S, then $\mathcal{J} \cap R = \{B_R \subseteq R | B \supseteq H \cap R, H \in \mathcal{J}\}$ and $\mathcal{J}^* = \{B_R \subseteq R | BS \in \mathcal{J}\}$. If $\mathcal{L}$ is an idempotent filter of right ideals of R, then $\mathcal{L}S = \{B_R \subseteq R | BS \in \mathcal{J}\}$. We use similar notation for the left side. Let $A \subseteq R$ be a right ideal of S. Let $\mathcal{L}$ ($\mathcal{N}$) be an idempotent filter of right (left) ideals of R. Theorem. If each element of S/A is annihilated by some element of $\mathcal{L}$ (if $RA \in \mathcal{N}$), then $\mathcal{L}S$ ($S\mathcal{N}$) is an idempotent filter of S. In the other direction let $\mathcal{J}$ ($\mathcal{G}$) be an idempotent filter of right (left) ideals of S. Theorem. If $A \in \mathcal{J}$, ($SA \in \mathcal{G}$) then $\mathcal{J} \cap R$ ($\mathcal{G}^*$) is an idempotent filter of R. The quotient ring of S at $\mathcal{J}$($\mathcal{G}$) is also the quotient ring of R at $\mathcal{J} \cap R$ ($\mathcal{G}^*$) Corollary. If A (SA) is dense as a right (left) ideal of S, then S and R have the same right (left) maximal quotient ring. (Received September 8, 1978.)

*78T-A223 R. STANTON HALES, Pomona College, Claremont, California 91711. Binding Number of Two Strong Cartesian Graph Products.

In recent, as yet unpublished work, V. G. Kane and S. P. Mohanty calculate the binding number of several strong cartesian products of graphs. They pose the problems of determining bind $(L_m * K_2)$, $m \geq 3$, and bind $(C_m * K_2)$, $m \geq 4$, where $L_m$ is the path on m vertices, $C_m$ the cycle on m vertices, and $K_2$ the 2-clique. Theorem 1. For $m \geq 3$, bind $(L_m * K_2) = (2m-1)/(2m-3)$. Theorem 2. For $m \geq 4$, bind $(C_m * K_2) = (2m-1)/(2m-5)$. (Received September 12, 1978.)

*78T-A224 Alexander ABIAN, Department of Mathematics, Iowa State University, Ames, Iowa 50011. Zero-Product-Associative rings without nonzero nilpotent elements.

A not necessarily associative or commutative ring A is called Zero-Product-Associative if and only if a product of elements of A which is equal to zero remains equal to zero no matter how its factors are associated.

Let A be a not necessarily associative or commutative ring. Then (1), (2), (3) are pairwise equivalent statements:

(1) A is Zero-Product-Associative and has no nonzero nilpotent elements.

(2) A is isomorphic to a subdirect product of rings with no divisors of zero.

(3) A is Zero-Product-Associative and an infinitely distributive (i.e., $r \sup_{i \in K} x_i = \sup_{i \in K} rx_i$ for every nonempty index set K) partially ordered set with respect to $\leq$ where $\leq$ is defined via $x \leq y$ if and only if $xy = x^2$ for every element x and y of A.

We show that if A is a Zero-Product-Associative ring without nonzero nilpotent elements and if A is infinite and has sufficiently many zero divisors then A has at least as many (completely) prime ideals as A has elements. (Received September 12, 1978.)

78T-A225 Carl Faith, Rutgers, The State University, New Brunswick, New Jersey 08540. Injective Modules over Levitzki Rings.

An injective right R-module is said to be $\Sigma(\Delta)$-injective if the set of right ideals which are the annih- of subsets of E satisfies the acc(dcc). A theorem of Teply-Miller and Natasescu states that every $\Delta$-injective module E is $\Sigma$-injective; and then a theorem of Hansen implies that Q = Biend $E_R$, the bicom mutator or biendomorphism ring, is semiprimary. A between ring S for E is a subring of Q containing the canonical copy of $R/\mathrm{ann}_R E$ in Q. THEOREM. An R-module E is $\Delta$-injective iff E is $\Sigma$-injective and some between ring for Q is semiprimary. COROLLARY. Then E is a finite direct sum of homogeneous injectives (= one which is a direct sum of copies of an indecomposable module.) This is independently due to J. Golan. Also an example of Schelter and Small shows that Q need not be right Artinian, although this is obviously sufficient for $\Delta$-injectivity of E. The commutative ring case

of the next is due to Natasescu. COROLLARY. If some between ring S for E is right Kasch, e.g. primary-decomposable, then S = Q is right Artinian. COR: Every inj. rt. module is $\Delta$-inj. iff R is rt. Artinian. Any Artinian (Noetherian) module over comm. R is $\Sigma(\Delta)$-injective. (Received September 12, 1978.)

78T-A226 NIOVI KEHAYOPULU, University of Athens, Dpt. of Math. Panepistimiopolis, Athens-621, Greece. On <m,n>-ideal elements in poe-semigroups. Preliminary report.

A poe-semigroup is a semigroup S which is at the same time a po-set with a greatest element e such that: $a\leq b$ implies $ac\leq bc$ and $ca\leq cb$ for all $a,b,c\in S$. By a Ve-semigroup we mean a semillatice S under V with an associative multiplication such that: $a(b\vee c)=ab\vee ac$ and $(a\vee b)c=ac\vee bc$ for all $a,b,c\in S$. If S is a poe-semigroup and m,n non-negative integers, then an element a of S is called <m,n>-ideal element if $a^m e a^n\leq a$, <m,n>-regular if $a\leq a^m e a^n$ (for $a,b\in S, a^0 b:=ba^0:=b$), normal if ae=ea and subidempotent if $a^2\leq a$. S is called subidempotent if every element of S is so. Theorem 1. Let S be a poe-semigroup satisfying the descending chain condition for its subidempotent elements. If S has a normal, subidempotent <m,n>-ideal element, where m>1 and n>1, then S has either a normal, subidempotent, <1,k>-ideal element which is also <1,k>-regular, or a normal, subidempotent, <k,1>-regular, <k,1>- ideal element, too (k>1). Now, an element a of a poe-semigroup S is called r (resp. l)-closed with respect to b ($b\in S$) if $a\leq b$ and $ab\leq a$ (resp. $a\leq b$ and $ba\leq a$). Let $F_r^{(b)}$ (resp. $F_l^{(b)}$) be the set of r (resp. l)-closed elements with respect to b. Theorem 2. Let S be a poe-semigroup. Moreover, we consider the following statements: 1) $\exists\, a_i\in F_r^{(a_{i-1})}$, $i=1,\dots,m$, $b_1\in F_l^{(a_m)}$, $b_j\in F_l^{(b_{j-1})}$, $j=2,\dots,n$, $a_0:=e$. 2) There exists an <m,n>-ideal element, say a of S. Then, 1)$\Longrightarrow$2). In particular, if S is a Ve-semigroup and a is besides subidempotent, then 2)$\Longrightarrow$1). We note that $a=b_n$ in both cases. Thus, in subidempotent Ve-semigroups 1)$\Longleftrightarrow$2). (Received September 12, 1978.)

# *Analysis (26, 28, 30–35, 39–47, 49)*

78T-B196 S.Zaidman, Université de Montréal, Montréal, Québec, Canada. Notes on abstract-Bochner-almost periodicity.

Let $x(t)$, $-\infty<t<\infty \to X$ -a Banach space- be an almost-periodic solution of the differential equation: $x'(t)=A\,x(t)$. Then: $\inf_{t\in R}\|x(t)\|>0$ or else $x(t)\equiv\theta$.
This result, which is well-known in finite dimensional spaces, is extended twice in the present work. First, A can be the infinitesimal generator of a semi-group $T_t$ of class $C_0$. Next, if X is separable, $A=A(t)$ will be an operator-valued function, $t\in R\to L(X,X)$, such that $A(t)x$ is almost-periodic in Bochner's sense for any $x\in X$. (Received June 5, 1978.)

78T-B197 D. V. CHUDNOVSKY and G. V. CHUDNOVSKY, Columbia University, New York, New York 10027. Higher Burgers-Hopf equations and two-dimensional nonlinear partial differential equations.

For function $u=(\log\varphi)_x$ the equation $\varphi_t=\varphi_{\underbrace{x\dots x}_{n}}$ is equivalent to the nth Burgers-Hopf equation $u_t=BH_n[u]$ for polynomial $BH_n[u]$ in $u, u_x, \dots$. Let $dL_m/dt-dL_n/dy=[L_n, L_m]$, $L_n=\sum_{i=0}^n u_i(d^i/dx^i)$, $L_m=\sum_{j=0}^m v_j(d^j/dx^j)$, $u_n=v_m=1$, $u_{n-1}=v_{m-1}=0$. Theorem. For any $u(x)$ there exists such a solution $u_i$, $v_j$ that $u_{n-2}(x,0,0)=u(x)$, $u_{n-2}=nw_x$, $v_{m-2}=mw_x$, where $w_t=BH_n[w]$, $w_y=BH_m[w]$ and $u_k=\sum_{s=k+1}^{n-2}C_s^{k+1}w^{(s-k-1)}u_s+C_n^{k+1}w^{(n-k-1)}$ : $k=n+2,\dots,0$. (Received May 30, 1978.)

78T-B198 Ju.A.ABRAMOVIČ, 197227 Leningrad, Serebristyi bul'var 24, korpus 4, kv.197, USSR. On the semi M-spaces of de Jonge. Preliminary report.

De Jonge (Compos.Math. 34, f.2, 1977) has discovered for normed lattice X some condition, necassary and sufficient, for $(X_c^*)^d$ to be isometrically AL-space in the sence of Kakutani. Hehe $X_c^*$ (resp. $X_n^*$) is the band of sequentially order continuous (resp. order continuous) functionals and $(X_c^*)^d$ is the disjoint complement of $X_c^*$ in $X^*$. Bellou we give the isomorphic version of de Jonge's condition. We say that normed lattice X has condition (wsM) if there exists $C>0$ such that for any $x_1,\dots$

$x_k \in X$ with $\|x_i\| \leq 1$ $(i=1,2,\ldots,k;\ k=1,2,\ldots)$ from $x_1 \vee \ldots \vee x_k \geq v_n \downarrow_n 0$ follows that $\lim_n \|v_n\| \leq C$. If we restrict oneself with only pairweise-disjoint $x_i$ then the corresponding condition is denoted by $(wsM_d)$. Theorem. For normed lattice X the following assertions are equivalent a) $(X_c^*)^d$ is order isomorphic to AL-space, b) X has (wsM), c) X has $(wsM_d)$. For band $(X_n^*)^d$ the analogous result is also valid if only we change the sequences $\{v_n\}$ on generalized sequences $\{v_\beta\}$. (Received July 3, 1978.)

78T-B199 PAVEL G. TODOROV, The University of Plovdiv, Plovdiv 4000, Bulgaria. New explicit formulas for the nth derivative of composite functions.

Theorem. Let $w = g(t) = w_0 + g_1(t - t_0) + \ldots$ and $z = f(t) = z_0 + f_1(t - t_0) + \ldots$, with $f_1 \neq 0$. Then the composite function $w = \phi(z) \equiv g \circ f^{(-1)}(z)$ has the expansion $\phi(z) = w_0 + \sum_1^\infty (\phi_n / f_1^{(2n-1)})(z - z_0)^n$ where $f^{(-1)}$ denotes the inverse of $f$ and $\phi_n = \det(e_{jk})$, where $e_{jk} = [(j - k + 1)n/j - 1] f_{j-k+1}$, for $1 \leq k \leq \min(j, n-1)$, $1 \leq j \leq n$, $n \geq 2$, where $e_{j,k} = 0$ for $j + 1 \leq k \leq n - 1$, $1 \leq j \leq n - 2$, $n \geq 3$, and where $e_{jn} = g_j$, $1 \leq j \leq n$, $n \geq 1$. The term $f_1^{2n-1}$ is a "sharp" one. A particular application of the preceding result yields an expansion for the inverse of a function $z = f(t) = t + \ldots$ that is univalent in the unit disc. (Received July 27, 1978.)

*78T-B200 PEI YUAN WU, National Chiao Tung University, Hsinchu, Taiwan, Republic of China. Double commutants of $C_{1\cdot}$ contractions. Preliminary report.

In this note we prove the following theorem.

Theorem. Let T be a completely non-unitary $C_{1\cdot}$ contraction with defect indices $d_T = n \leq d_{T^*} = m < \infty$. Then the following are equivalent:

(1) $n \neq m$;

(2) T is not of class $C_{11}$;

(3) $\{T\}'' = \{u(T) : u \in H^\infty\}$,

where $\{T\}''$ denotes the double commutant of T.

This generalizes the main result in Sz.-Nagy and Foiaş' paper "Vecteurs cycliques et commutativité des commutants. II" (Acta Sci. Math., 39 (1977), 169 - 174), at least in the case of finite defect indices. (Received July 27, 1978.)

78T-B201 Andrew F. Acker, Mathematisches Institut I, Universität Karlsruhe 75 Karlsruhe 1, Fed. Rep. of Germany. An area-preserving domain perturbation which increases torsional rigidity. Preliminary Report.

The torsional rigidity $I$ of a simply-connected region $\Omega \subset R^2$ (bounded by a simple closed curve $\Gamma$) is defined by $I = \iint_\Omega U(p)\,dx\,dy$, where $U(p)$ solves the boundary value problem: $\nabla^2 U = -1$ in $\Omega$, $U = 0$ on $\Gamma$. We also define $\|\Omega\| := \iint_\Omega a^2(p)\,dx\,dy$, $\ell(\Gamma) := \int_\Gamma a(p) \cdot |dp|$, and $\|\Omega\|_0 := \iint_\Omega dx\,dy$ for any $\Omega$, where $a(p) > 0$ is a continuous function in $R^2$. Now assume $\Gamma$ has bounded curvature. For any sufficiently small $\delta > 0$, let the region $\Omega_\delta$ be obtained from $\Omega$ by shifting $\Gamma$ a distance $\delta n(p) = (\delta / a(p)) - (\varepsilon / |\nabla U(p)|)$ in the exterior normal direction at each $p \in \Gamma$. Here $|\nabla U(p)| := \lim_{q \to p} |\nabla U(q)|$ for each $p \in \Gamma$ (where $q \in \Omega$), and $\varepsilon = \varepsilon(\delta) > 0$ is chosen such that $\|\Omega_\delta\| = \|\Omega\|$. Then:

$$I_\delta = I + (\Phi + [\|\Omega\|_0 / \ell(\Gamma)] \cdot \Psi) \cdot \delta + \delta \cdot \mu(\delta), \tag{1}$$

where $\Phi = \inf_{\lambda \geq 0} \int_\Gamma [(|\nabla U(p)| - \lambda \cdot a(p))^2 / a(p)] \cdot |dp| \geq 0$, $\Psi = \inf_{\lambda \geq 0} \int_\Gamma [(|\nabla U(p)| - \lambda \cdot a(p))^2 / |\nabla U(p)|] \cdot |dp| \geq 0$, and $\mu(\delta) \to 0$ as $\delta \to 0$. (1) is (after being extended to less regular $\Omega$) useful for analyzing free boundary optimization problems involving torsional rigidity (i.e. maximizing $I$ subject to the constraint: $\|\Omega\| \leq A$), and provides a scheme for the successive approximation of solutions of such problems. (Received August 10, 1978.)

*78T-B202 MARIA FRAGOULOPOULOU, University of Athens, Math. Institute, 57 Solonos St., Athens 143, Greece. Semi-simplicity of l.m.c. *-algebras. Preliminary report.

If E is a l.m.c. (resp. *-) algebra, $\mathcal{M}(E)$ denotes its spectrum and R(E) its continuous topologically irreducible representations. Then, E is called *semi-simple* (resp. *-*semi-simple*) if $\bigcap\{\ker(f): f\in\mathcal{M}(E)\}=\{0\}$ (resp. $\bigcap\{\ker(\varphi):\varphi\in R(E)\}=\{0\}$, equivalently the canonical map of E into its enveloping algebra $\mathcal{E}(E)$ is 1-1, when E has also a b.a.i.) [ for notation see M. Fragoulopoulou, *Notices* 25 (1978), August and October ]. Theorem 1. *Let E, F be complete, l.c. semi-simple algebras, with l.e. spectra, and $\tau$ a compatible topology on $E\otimes F$. Then, (i) $\tau$ is faithful $\Longleftrightarrow$ (ii) $E\hat{\otimes}_{\tau}F$ is semi-simple $\Longleftrightarrow$ (iii) $\overline{E'\otimes F'}=(E\hat{\otimes}_{\tau}F)'_s$.* In case E, F are complete, barrelled, l.m.c. Q-*-algebras with the C*-property and identities, the projective tensorial topology $\pi$ is always faithful. Theorem 2. *If E, F are complete, barrelled, l.m.c. *-semi-simple Q-algebras with identities, and $\pi$ is a faithful topology on $E\hat{\otimes}_{\pi}F$, then $E\hat{\otimes}_{\pi}F$ is also *-semi-simple.* A sort of a strengthened converse to Th. 2 is the following: Theorem 3. *If E, F are l.m.c. *-algebras with b.a.i's and $E\hat{\otimes}_{\pi}F$ is *-semi-simple, then E, F are also *-semi-simple.* Semi-simplicity and *-semi-simplicity coincide on every commutative, complete l.m.c. *-algebra with the C*-property and continuous Gel'fand map. (Received August 21, 1978.) (Author introduced by Professor A. Mallios).

*78T-B203 J. Weyer, Mathematics Institute, University of Cologne, West Germany. Maximal Monotonicity of Operators of the Form $L^*\Phi\circ L$. Preliminary Report.

In a Hilbert space H, we consider operators of type $A = L^*\Phi\circ L$, where L is a closed, linear operator and $\Phi$ is a maximal cyclically monotone, coercive operator. Our principle result is a nonlinear extension of an earlier theorem of v.Neumann for $A = L^*L$.

Theorem: Suppose that either $(L^*)^{-1}$ is bounded or that both $L^{-1}$ is bounded and $D(\Phi)\supset N(L^*)$. Then $L^*\Phi\circ L$ is maximal cyclically monotone.

Maximality of sums $\sum_{i=0}^{n}(L^*)^i\Phi_i\circ L^i$ is also considered, and the theory is applied to concrete differential operators of the form $\sum_{i=0}^{n}(-1)^i f_i(u^{[i]})^{[i]}$, with monotone functions $f_i$ and various boundary conditions. (Received August 23, 1978.) (Author introduced by N. W. Bazley).

*78T-B204 THEAGENIS ABATZOGLOU, Iowa State University, Ames, Iowa 50011. Unique best approximation from a $C^2$-manifold in Hilbert space.

Consider a $C^2$-manifold M in a Hilbert space H. Let $1/\rho(m,v)$ be the maximum principal curvature of M at m in the direction v. We define the curvature of M at m by $1/\rho(m) = \sup_v 1/\rho(m,v)$ where v is orthogonal to M at m and $\|v\| = 1$. We also define the folding of M at m by $\phi(m) = \sup\{r \mid B(m,s)\cap M$ is connected for every $s\le r\}$

THEOREM. Let M be a $C^3$, complete, connected, n-dimensional manifold embedded in a Hilbert space H. Suppose x is in H, m in M and $x-m\perp M$ at m. Assume $1/R \ge \sup_{\mu\in M}\{1/\rho(\mu) \mid \|\mu - m\|\le 2R\}$. Then if $\|x - m\| < \min\{R,\phi(m)/2\}$, m is the unique best approximation from M to x. (Received August 25, 1978.)

*78T-B205 BUCK WARE, California State University, Chico, California 95929. A new small divisor condition. Preliminary report.

Consider the autonomous ordinary differential equation $\dot{x} = f(x)$ defined in a neighborhood of the stationary point 0 in the Hilbert space $\ell_2$ of square-summable sequences. Suppose that f is analytic and that its linear part is diagonal, $(Df)_0$: $(x_i)_{i\ge1}\to(\lambda_i x_i)_{i\ge1}$. For any sequence $p = (p_i)_{i\ge1}$ of natural numbers with finite support, define $|p| = \sum_{i=1}^{\infty}p_i$ and $p\cdot\lambda = \sum_{i=1}^{\infty}p_i\lambda_i$. Suppose that there are no relations among the eigenvalues, $\lambda_j \ne p\cdot\lambda$ for any $j\ge1$, $|p|\ge2$. For $k\ge2$, let

$$b_k = \sup\left\{|p\cdot\lambda - \lambda_j|^{-1}:\ j\ge1,\ |p|\le k\right\}.$$

If the small divisor condition

$$\sum_{k=2}^{\infty} \frac{1}{k} \log \frac{b_{k+1}}{b_k} < \infty$$

is satisfied, then there is an analytic change of variables which transforms $\dot{x} = f(x)$ into the linear equation $\dot{y} = (Df)_0 \cdot y$. (Received September 5, 1978.)

*78T-B206 GUSTAVO PERLA MENZALA, Universidade Federal do Rio de Janeiro, IMUFRJ, Caixa Postal 1835, ZC-00 20000 Rio de Janeiro, R.J. Brasil. On global classical solutions of a nonlinear wave equation.

We study the existence and uniqueness of a classical solution of the nonlinear evolution equation

$$u_{tt} + \Delta^2 u - M(\|\text{grad } u(\cdot,t)\|^2_{L^2})\Delta u = f(x,t)$$

for $x \in \mathbb{R}^n$ and $0 \le t < +\infty$. Under suitable conditions on $M$, $f$ and the initial data we obtain the desired result by using classical techniques such as the Fourier transform and the energy method. The above equation, in the particular case $n=1$ and $M(s) = 1+s$ has been studied - mainly on bounded domains - by several authors as a model describing the free lateral "finite" vibrations of uniform beams with the ends restrained so they remain a fixed distance apart. (Received September 7, 1978.)

*78T-B207 L. THOMAS RAMSEY, University of Hawaii, Honolulu, Hawaii 96822. A theorem of C. Ryll-Nardzewski and metrizable l.c.a. groups.

$\Gamma$ denotes a metrizable locally compact abelian group and $\overline{\Gamma}$ its Bohr compactification. Let $\gamma \in \Gamma$ be a cluster point of some subset $E$ of $\Gamma$ in the topology of $\overline{\Gamma}$. Then there are two disjoint subsets of $E$ which also cluster at $\gamma$ in the Bohr group topology. The proof is elementary and provides a new proof of the theorem of C. Ryll-Nardzewski on cluster points of I-sets in $R$. Given the continuum hypothesis, either theorem characterizes metrizability in locally compact abelian groups. In fact, this characterization is equivalent to the continuum hypothesis. (Received September 8, 1978.)

78T-B208 Eric Todd Quinto, Tufts University, Medford, Massachusetts, 02155. The dependence of the generalized Radon transform on defining measures.

Guillemin proved that the generalized Radon transform, $R$, and its dual, $R^t$, are Fourier integral operators and that $R^tR$ is an elliptic pseudodifferential operator. In this paper we investigate the dependence of the Radon transform on the defining measures. In the general case we calculate the symbol of $R^tR$ as a pseudodifferential operator in terms of the measures and give a necessary condition on the defining measures for $R^tR$ to be invertible by a differential operator. Then we examine the Radon transform on points and hyperplanes in $R^n$ with general measures. First we calculate the symbol of $R^tR$ in terms of the defining measures for this case; this calculation clearly illustrates the condition on the measures for $R^tR$ to be invertible by a differential operator. Finally if $R^tR$ is a translation invariant operator on $R^n$ then we prove that $R^tR$ is invertible and that our condition on the measures is equivalent to $(R^tR)^{-1}$ being a differential operator. (Received September 8, 1978.)

78T-B209 JOSEPH DIESTEL, Kent State University, Kent, Ohio 44242. Some remarks on J. Lindenstrauss's paper "Weakly compact sets--their topological properties and the Banach spaces they generate" and its recent Review.

In a recent issue of the Mathematical Reviews (volume 55, 1977) the author of the present announcement mentioned that he was aware of no substantial progress on problem 9 of the Lindenstrauss paper (are smooth spaces embeddable in WCG spaces); though it is true that

I was not aware of such, I should have been! In fact, W. B. Johnson and J. Lindenstrauss (Israel J. Math., 17 (1974), 219-230) have given an example of a non-WCG Banach space with Frechet differentiable norm whose dual is WCG; their example contains a noncomplemented copy of $c_0$ and as such cannot be WCG. Also worth noting is the Compte Rendus note of M. Talagrand (volume 284 (1977), 745-748) wherein the "open" problem cited in the discussion after Problem 2 (if a space with a Lindelof weak topology imbeds in a WCG) is shown to have a negative answer. (Received September 11, 1978.)

*78T-B210 JAU-D. CHEN, National Taiwan Normal University, Taipei, Taiwan, R.O.C. The representation of functions of several variables defined on the torus. Preliminary report.

It is proved that any function f(x), measurable and finite almost everywhere on the n-torus $T^n$, can be represented by an n-fold trigonometric series, summed by rectangles. More precisely, we show that there exists an F continuous on $T^n$ such that the rectangular sums of the multiple trigonometric series $\sum_m (i)^{m_1+m_2+\cdots+m_n} m_1 m_2 \cdots m_n \hat{F}_m e^{i m \cdot x}$ converge to f(x) almost everywhere, where $m = (m_1, m_2, \ldots, m_n)$ is an integer lattice point of $R^n$ and $\hat{F}_m$ the mth Fourier coefficient of F. This result generalizes a representation problem, which is posed by Lusin and solved by Men'shov, for finite almost everywhere measurable functions on $T^1$ to functions on $T^n$. Also it extends our previous work (see *Notices*, October 1978, p. A-584; Abstract #78T-B152) which says that any finite almost everywhere measurable function on $T^n$ can be representable by a multiple trigonometric series, summed by squares. (Received September 11, 1978.)

78T-B211 Prof. M. Rajagopalan, Univ. of Arkansas, Fayetteville (Ark) and Universidad de Los Andes Mérida (Venezuela) Uniform Algebras and Scattered spaces. (Preliminary report)

A compact Hausdorff space is said to support a uniform algebra (proper) if there is a uniformly closed point separating algebras of continuous complex valued functions on it containing the constants and different from the set of all continuous functions. It is conjectured that a compact Hausdorff space supports a proper uniform algebra iff it is not scattered (i.e. contains a perfect subset). In this paper we give a very elementary proof of the sufficiency part of this conjecture which does not use the high powered result of Mergelyan on approximation by polynomials, or the Bishop's theorem in uniform algebras. We also prove the necessary part of this conjecture for all compact ordered spaces. As a corollary we get that the usual Cantor Ternary set and the closed Unit interval support proper uniform algebras. This in turn implies that the conjecture is true for all compact metric spaces. (Received August 8. 1978.)

78T-B212 WITHDRAWN

*78T-B213. Gerasimos Ladas, University of Rhode Island, Kingston, Rhode Island 02881. Sharp conditions for eventually positive or negative solutions of delay differential inequalities.

In "Sharp Conditions for Oscillations Caused by Delays" (to appear in Applicable Analysis) G. Ladas showed that under the conditions: $p(t) > 0$ and continuous, $\tau > 0$ and constant, $\underline{\lim}_{t\to\infty}\int_{t-\tau}^{t} p(s)ds > \frac{1}{e}$, and $\underline{\lim}_{t\to\infty}\int_{t-\tau/2}^{t} p(s)ds > 0$ every solution of the delay differential equation (DDE) $y'(t)+p(t)y(t-\tau) = 0$ is oscillatory. Under the above conditions (and with a similar argument) we proved that every solution of the delay differential inequality $y'(t)+p(t)y(t-\tau) < 0$ is eventually negative. Similarly every solution

of $y'(t)+p(t)y(t-\tau) > 0$ is eventually positive. The above results are caused by the retarded argument and do not hold when $\tau = 0$. For example $y'(t)+y(t) < 0$ has the positive solution $y(t) = e^{-2t}$ (and $y'(t)+y(t) > 0$ has the negative solution $y(t) = -e^{-2t}$). When $p(t)$ is equal to a constant $p$, the above conditions reduce to $p\tau e > 1$ which is a sharp condition. Finally we applied the above results to obtain sharp conditions for the existence of oscillatory solutions of the unstable second-order DDE $y''(t)-[p^2+q(t)]y(t-2\tau) = 0$. For example, if $q(t) \geq 0$ and continuous, $\tau > 0$ and constant, and $p\tau e > 1$ every bounded solution of the DDE is oscillatory. (Received September 12, 1978.)

# *Applied Mathematics (65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)*

78T-C52 V. JA. KREINOVIC and O. M. KOSHELEVA, USSR 192123, Leningrad D-123, poste restante. Probabilistic way to avoid Arrow's paradox. Preliminary report.

Well-known Arrow's theorem states the undecidability of the voting problem. As a solution of that puzzle, one can (as usual in game theory) suggest to change the choice between pure outputs (i.e. alternative $A_i$ from $\{A_1,\ldots,A_n\}$) to mixed one (output is a lottery): each voter $j$ $(=1,\ldots,m)$ writes down the vector $\bar{u}_j$, whose ith coordinate = his utility in case $A_i$ is accepted (0-1-normed; voters for whom everything is equivalent are not considered). Then Nash's m-dimensional solution is applied, i.e. the lottery $\bar{p}$, $0 \leqq \bar{p}$, $\sum p^i = 1$ is chosen such that $\Pi(\bar{p}\bar{u}_j) = \max$. This solution is symmetric with respect to renaming of voters and/or alternatives. In case sufficiently many voters think differently it is also unique. Theorem. The solution is unique if either (1) n voters exist for which $\bar{u}_i$ are linearly independent or (2) $(n = 2,3)$ for any i, or voter j exists who obtains 1 iff $A_i$ is accepted (in case of no such j, $A_i$ would not be placed onto the voting list). (Received May 30, 1978.)

78T-C53 V. JA. KREINOVIC, USSR 192123, Leningrad D-123, poste restante. To what extent are nondetermined sets close to determined ones? Preliminary report.

Recall that a set $D \subset \{0,1\}^N$ is called determined (d) iff in the correspondent Banach-Mazur game one of the players has a winning strategy. Denote by $|A|$ the cardinality of A, by $A \Delta B$ their symmetric difference. Theorem 1. For any cardinality $n \leqq 2^{\aleph_0}$ there exists a non-d A such that (a) if $|A \Delta B| < n$ then B is non-d; (b) there exists a d B such that $|A \Delta B| = n$. Theorem 2. (1) For any non-d A there exists a d B such that Hausdorff dimension $\dim(A \Delta B) \leqq 1/2$. (2) For any $\alpha < 1/2$ there exists a non-d $A_\alpha$ such that (a) if $\dim(A_\alpha \Delta B) < \alpha$ then B is non-d; (b) there exists a d B for which $\dim(A_\alpha \Delta B) = \alpha$. Theorem 3. For any non-d A there exists a d B such that $A \Delta B$ is of measure 0 and of I Baire category. Corollary. (a) $\exists$ d A that is not Lebesgue measurable; (b) $\exists$ nonanalytic d A; (c) any set is a union of two d sets. (Received May 30, 1978.)

78T-C54 O. M. KOSHELEVA, USSR 192123, Leningrad D-123, poste restante. Extensions of nondetermined games. Preliminary report.

It is well known that nondetermined (nd) games (that have no solutions in pure strategies) have solutions in appropriately generalized ones. We show that for some (but not all) such games usual mixed strategies (i.e. denumerable linear combinations of pure ones) are sufficient: Theorem. (1) There exists a nd game that has an equilibrium point in mixed strategies; (2) There exists a nd game in which the maximal income of the I player differs from the minus minimal loss of the II and both do not depend on whether we consider pure or mixed strategies. (Received May 30, 1978.)

78T-C55 ETHELBERT N. CHUKWU, University of Jos, Jos, Nigeria. Euclidean controllability of nonlinear, functional differential systems of neutral type. I

A necessary and sufficient condition is developed for the Euclidean controllability of the linear functional differential system of neutral type,

$$\frac{d}{dt} D(x(.), t) = L(t,x,u,), \quad (I)$$

where,

$$L(t,x,u) = \int_{t_o-h}^{t} d_s\, A(t,s)\, x(s) + \int_{t_o-h}^{t_o} dB(t,s)\, u(t+s).$$

As a consequence of this we prove that if (I) is Euclidean controllable, then the perturbed system,

$$\frac{d}{dt}\, D(x(.),\ t) = L(t,x,u) + f\,(t,\ x\,(.),\ u(.)),\ \text{(II)}$$

is Euclidean controllable provided the function f satisfies appropriate growth conditions. These growth conditions are satisfied when f is bounded. (Received May 31, 1978.)

*78T-C56 Charles E. Blair, University of Illinois, Urbana, Illinois 61801. Disjunctive Constraints and Sequences of Cutting-Planes.

Let $P\subset R^n$ be a polytope, $d_i\in R^n$, $e_i\in R$ be such that $P\cap d_i x\geq e_i$ is a face of P for all $i\in I$. $I=D_1\cup D_2\cup\ldots D_t$ is finite. $T_j=\bigcup_{j\in D_j}\{x\,|\,x\in P\,\&\,d_i x\geq e_i\}$. $S=\mathrm{conv}(\bigcap_1^t T_j)$. Let $W=\{(y,j,Q)\,|\,S\subset Q\subset P;\ y$ is an extreme point of Q and $y\notin T_j$. Theorem: There are functions $L:W\to R^n$ $R:W\to R$ such that (i) $L(y,j,Q)\cdot y<R(y,j,Q)$ (ii) $\{x\,|\,L(y,j,Q)\cdot x\geq R(y,j,Q)\}\supset \mathrm{conv}(Q\cap T_j)$ (iii) There is no infinite sequence $(y_i,j_i,Q_i)\in W$ $i=1,2,\ldots$ such that $Q_1=P$ and $Q_{i+1}=\mathrm{conv}(Q_i\cap L(y_i,j_i,Q_i)\cdot x\geq R(y_i,j_i,Q_i)$.

Intuitive interpretation: We start with the polytope P and add one cut at a time. At each step the extreme point to be cut away (y) and the disjunction used to create the cut (j) are specified. S is obtained in finitely many steps. This answers a question in "A Cutting-Plane Game and Its Application" by R. Jeroslow. (Received August 28, 1978.)

*78T-C57 ALI KYRALA, Arizona State University, Tempe, Arizona 85281. Transformation between relatively accelerated frames. Preliminary report.

The objective is to find a transformation between reference frames with instantaneous relative velocity v and constant relative acceleration a which reduces to the Lorentz transformation for a=0. The principle of equivalence applied to a point at a great distance R from a point mass M permits the quantity q in the Schwarzschild metric to be written in terms of a $q=1-2aR^2/c^2(R+x)$ which for small x is approximately $q=1-2aR/c^2+2ax/c^2$ and where GM has been replaced by $aR^2$. With the radial form of the Schwarzschild $ds^2=qc^2dt^2-dx^2/q = c^2d\underline{t}^2-d\underline{x}^2$ equated to the Minkowski metric (dr=dx) by the invariance of interval, one has to seek coefficients A,B,C,D for which $c\,d\underline{t}=Ac\,dt+B\,dx$, $d\underline{x}=Cc\,dt+D\,dx$. The conditions are given by $A^2-C^2 = q$, $AB-CD=0$, $q(D^2-B^2)=1$ so that defining w by $w^2(1-(v/c)^2)=1$ one has $A=wq^{\frac12}$, $D=w/q^{\frac12}$, $C=-vA/c$, $B=-vD/c$ and the required transformation becomes $d\underline{x}=w(dx/q^{\frac12}-v\,dt\,q^{\frac12})$, $c\,d\underline{t}=w(c\,dt\,q^{\frac12}-v\,dx/cq^{\frac12})$. With $u_1=dx/dt$, $u_2=d\underline{x}/d\underline{t}$ one has $v=(u_1-qu_2)/(q-u_1u_2/c^2)$ replacing the special relativistic law of composition of velocities. The length contraction factor becomes $\sqrt{q}\,/w$ and the time dilation factor becomes $w\sqrt{q}$. Under this transformation the square magnitude of the 4-vector momentum is not conserved since $(E/c)^2 - p^2$ becomes $q(E/c)^2 - p^2/q$. Also one notes that for $u_1=c+\varepsilon$ and $u_2=c-\varepsilon$ the limit of v as $\varepsilon\to 0$ is -c unlike the special relativity case. (Received August 30, 1978.)

78T-C58 Ronald F. Pannatoni, M.I.T., Cambridge, MA 02139. WKB connection formulae for the O.D.E. $u'' + (x^2 + s/x)u = 0$ and an application to density wave theory. Preliminary report.

1. Define $\varepsilon_\pm(x) = x^{-\frac12}\exp\{\pm i(\frac12 x^2 - 3\pi/8)\}$. Let u(x) be a solution of $u'' + (x^2 + s/x)u = 0$ ; s is a small constant. If $u(x)\sim\varepsilon_-(x)$ as $x\to+\infty$ then $u(xe^{-i\pi})\sim(i-1+s2I)\varepsilon_+(x) + i\varepsilon_-(x)$ as $x\to+\infty$. The constant $I = \pi^2/4\Gamma^2(3/4)\simeq 1.643$. These formulae ignore $O(s^2)\varepsilon_\pm$ and $O(s/x)\varepsilon_\pm$ terms.

2. The density wave theory for differentially rotating fluid disks [1] including the corotation resonance is studied in an asymptotic analysis using the foregoing result. The dispersion relation for discrete spiral mode pattern frequencies $\omega_p = \omega_r + i\omega_i$ given in [2] is modified as follows:

$$\int_{r_{ce}}^{r_{co}} k(r)dr = (n + \tfrac12)\pi + i\tfrac12\ln 2 + \tfrac12(1-i)sI.\ \text{The parameter } s = 2\left|\frac{\kappa}{a_o}\,\frac{m\omega'}{\kappa}\right|^{-\frac12}\frac{\omega}{r\omega'}\,\frac{d}{dr}\,\ln(\kappa^2/\omega\sigma_o)\,\Big|_{r=r_{co}}$$

(see [1] for the physical meanings of the symbols on the right) measures the exchange of angular momentum between the wave system and the fluid at corotation. If s is positive (negative) the growth rate $|\omega_i|$ is reduced (increased). Even $s \simeq 0.2$ has a significant effect on the growth rate. Accurate numerical studies of a particular fluid model substantiate these trends; these studies will be reported elsewhere.

3. References.

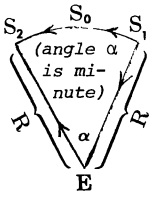

[1] C.C. Lin and Y.Y. Lau (1975), SIAM J. Appl. Math., 29, pp.352-370.

[2] C.C. Lin and Y.Y. Lau (1976), Adv. in Math., 22, pp.120-128.

(Received August 30, 1978.)

78T-C59 K. DEMYS, 844 San Ysidro Lane, Santa Barbara, Calif. 93108. A GRAVITATIONAL *EXPERIMENTUM CRUCIS*.

Quantum theory today seeks a physical explanation of gravitation. The number of competing gravitational theories is notorious. Their *embarras de richesses* is because the great majority of their basic concepts are purely theoretical, with no way of clear verification. An exception in this regard is the more phenomenological explanation announced in 1964 at the School of Theoretical Physics, Univ. of Naples [*Ric.sci.*, 35(I), 193-204], which calls for the active role of a Dirac-like vacuum and a bona-fide fourth dimension of physical space. A crucial consequence is that a ray of light sent from a high-orbit satellite at $S_1$ to a designated station (E) on earth would reach its destination in less time than the light sent from E to the satellite (now at $S_2$) over the same distance R. In suitable approximation, S moves through $S_1S_0S_2$ (= $\alpha R$) at mean linear speed v as the light travels over $S_1ES_2$ at mean speed c. The time t of travel equals the time of movement: $t = 2R/c = \alpha R/v \Longrightarrow v/c = \frac{1}{2}\alpha$. The time $t_1$ over path $S_1E$ and the time $t_2$ over $ES_2$ are independently recorded by presynchronized time recorders, one at E and one on Satellite; positions $S_1$, $S_2$ are preprogrammed. The referenced theory (and no other) predicts $t_2 > t_1$, this difference exceeding the smaller time difference (predicted by all theories, including Newton-Maxwell) due to the light's mass ($h\nu/c^2$)-- where $h$ is Planck's Constant and $\nu$ is the frequency of the monochromatic beam, laser light being preferred in this experiment. Hence also the velocity of the light from $S_1$ to E exceeds that from E to $S_2$, much as in Fizeau's experiment.




(Received September 12, 1978.)

78T-C60 S. K. DEY, Eastern Illinois University, Charleston, Illinois 61920. Numerical instabilities of nonlinear partial differential equations.

In this work a mathematical study has been undertaken to analyze nonlinear instabilities of finite difference equations which are consistent approximations of nonlinear partial differential equations. Assuming that the nonlinear model is mathematically wellposed, conditions have been derived which are both necessary and sufficient for convergence of numerical solution to the analytical solution. It has been found that for the linear case, Lax's Equivalence theorem is a particular case of this analysis. The theory developed in this work has been applied successfully to nonlinear Burgers equation to predict nonlinear numerical instabilities. (Received September 12, 1978.)

*78T-C61 DANIEL SOLOW, Case Western Reserve University, Cleveland, Ohio 44106. Homeomorphisms of triangulations with applications to computing fixed points.

In the past decade various complementary pivoting algorithms have been developed to search for fixed points of certain functions and point to set maps. All these methods generate a sequence of simplexes which are "shrinking" to a point. This paper proposes a new method for shrinking the simplexes. It is shown that under certain conditions, the function whose fixed point is sought may be used to control this shrinking process. A computational method for implementing these ideas is also suggested and several examples are solved using this approach. (Received September 12, 1978.)

# Geometry (50, 52, 53)

*78T-D25 Douglas E. Elerath, Stanford University, Stanford, California 94305. Nonnegatively curved 3-manifolds with a point of positive curvature.

Recall that a point $p$ in a Riemannian manifold is called a pole if the exponential map $\exp_p : M_p \to M$ is a submersion or has maximal rank all over the tangent space $M_p$.

Let $M$ be a complete open nonnegatively curved Riemannian 3-manifold with a point at which all sectional curvatures are positive, and suppose that $M$ contains a pole. Then $M$ is not flat on the compliment of any compact set.

Note that this is clearly false for 2-manifolds. Furthermore, the need for a pole in $M$ most likely represents a defect in the proof, which I hope soon to remedy. (Received July 10, 1978.) (Author introduced by Professor David Hoffman).

# Logic and Foundations (02, 04)

78T-E86 JEFFREY B. REMMEL, University of California at San Diego, La Jolla, California 92093. Recursive isomorphism types of recursively presented Boolean algebras. Preliminary Report.

Let $\mathcal{B} = (B,\wedge,\vee,\neg)$ be a countable Boolean algebra. We say $\mathcal{B}$ is *recursively presented* (r.p.) if $B$ is a recursive set and the operations $\wedge,\vee$, and $\neg$ are partial recursive. We say $\mathcal{B}$ is *decidable* if $TH(\mathcal{B},b)_{b\in B}$ is decidable. Let $\mathcal{A}(\mathcal{B})$ denote the atoms of $\mathcal{B}$ and $\mathcal{J}(\mathcal{A}(\mathcal{B}))$ denote the ideal generated by $\mathcal{A}(\mathcal{B})$. If $\mathcal{B}_1$ and $\mathcal{B}_2$ are r.p.B.A.'s, we write $\mathcal{B}_1 \simeq \mathcal{B}_2$ for $\mathcal{B}_1$ is isomorphic to $\mathcal{B}_2$ and $\mathcal{B}_1 \simeq_r \mathcal{B}_2$ for $\mathcal{B}_1$ is recursively isomorphic to $\mathcal{B}_2$ (i.e., $\mathcal{B}_1 \simeq_r \mathcal{B}_2$ if there is a partial recursive isomorphism $f: \mathcal{B}_1 \to \mathcal{B}_2$). We have several results on the recursive isomorphism types of recursively presented and decidable B.A. We give some examples.

Theorem 1. Let $\mathcal{B}$ be a r.p. B.A. such that $\mathcal{A}(\mathcal{B})$ is infinite. (a) There exist r.p. $\mathcal{B}_1$ and $\mathcal{B}_2$ such that $\mathcal{B} \simeq \mathcal{B}_1 \simeq \mathcal{B}_2$ but $\mathcal{A}(\mathcal{B}_1)$ is immune and $\mathcal{A}(\mathcal{B}_2)$ is not immune. (b) If $\mathcal{A}(\mathcal{B})$ is also recursive, then for any r.e. degree $\delta$, there exists r.p. $\mathcal{B}_3$ such that $\mathcal{B}_3 \simeq \mathcal{B}$ and $\mathcal{A}(\mathcal{B}_3)$ has degree $\delta$. Theorem 2. Let $\mathcal{B}$ be an infinite r.p.B.A., then there are decidable $\mathcal{D}_1$ and $\mathcal{D}_2$ such $\mathcal{D}_1 \simeq \mathcal{D}_2$, $\mathcal{D}_1 \bmod \mathcal{J}(\mathcal{A}(\mathcal{D}_1)) \simeq \mathcal{B}$, but $\mathcal{D}_1 \not\simeq_r \mathcal{D}_2$. We note that part (a) of Theorem 1 is a strengthening of a result of P. LaRoche (these Notices, 24 (Oct. 1977), pg. A-552). (Received August 25, 1978.)

*78T-E87 BOHUSLAV BALCAR, ČKD-Polovodice, 140 03 Prague, Czechoslovakia and PETER VOJTAS, Math. Inst. of Slovak Acad. of Sci., Komenského 14, 041 54 Košice, Czechoslovakia. Almost disjoint refinement for ultrafilters on N.

The following is proved only in ZFC, without any additional set theoretical assumptions.

Theorem. For every uniform ultrafilter $U$ on the set of natural numbers $N$, there is an almost disjoint refinement for $U$, i.e. a family $\{v_x : x \in U\}$ of pairwise almost disjoint infinite sets such that $v_x \subseteq x$ for each $x \in U$.

From topological point of view it means that every point of $\beta N-N$ is a $2^{\omega}$-point. This gives the affirmative answer a problem raised by Comfort and Hindman. The proof develops a method used in a paper of B. Balcar and R. Frankiewicz, Ultrafilters and $\omega_1$-points in $\beta N-N$, Bull. Acad. Polon. Sci., to appear. (Received September 11, 1978.) (Author introduced by Professor Thomas Jech).

78T-E88 CHARLES W. LEININGER, State University of New York, Cortland, New York 13045. Properties of relations of odd order on finite domains.

For nomenclature see Notices (1977), A-552, and Representation of relations of odd order on finite domains, Notices, October 1978, by the same author. If the 12 axioms stated by A. Tarski (On the calculus of relations, J. Symb. Logic 6 (1941), 73-89) are rewritten for relations of odd order, then the analogues of the 32 theorems given by Tarski, except Theorem XII and those dependent upon it,

follow from the axioms. Where $\odot'$ denotes relative product, $\bar{R}$ the complement of R and $1_j$ the type j universal relation, the analogue of Theorem XII states that $R \odot 1_j = 1_j . \vee . 1_j \odot \bar{R} = 1_j$. A counter-example, where $n = k = 2$, $j = 1$, is given by R such that $[uv].R(a_1,a_1,u,v). \sim R(a_2,a_2,u,v)$. Let M denote the collection of relations of order $2n - 1$ and type j with arguments from a domain D. Theorem: $(M, \odot)$ is a submonoid of the monoid $(S, \odot)$ of relations of order 2n on D. Theorem: If $H \subset M$, $R \in H$, for each p there is exactly one q, and for each q exactly one p, such that $B_R^{(j)}(p,q) = 1$, then $(H, \odot)$ is a subgroup of the maximal subgroup of $(S, \odot)$. (Received September 11, 1978.)

78T-E89 VITĚZSLAV ŠVEJDAR, Mathematical Institute, ČSAV, 115 67 Prague, Czechoslovakia. Degrees of interpretability.

We study the notion of relative interpretability in the sense of Tarski, Mostowski and Robinson, Undecidable theories, Amsterdam, 1953. Let T be axiomatizable first-order theory that contains Peano arithmetic PA, i.e. PA is relatively interpretable in T. For sentences $\varphi$, $\psi$ in the language of T put $\varphi \leqq_T \psi$ iff the theory $T + \varphi$ is relatively interpretable in the theory $T + \psi$. $V_T$ is the corresponding structure of degrees. $V_T$ is a lower semilattice with 0 and 1. The ordering $\leqq_T$ is dense and the countable atomless Boolean algebra is embeddable into $V_T$, by a construction due to R. G. Jeroslow, Fund. Math. 72(1971), 17-40. For every degree d there is a degree incomparable with d. If T is essentially reflexive then $V_T$ is a distributive lattice but no element except 0, 1 has a complement. In every degree there are arithmetical $\Pi_2$ and $\Sigma_2$ sentences. This is not true if 2 is replaced by 1, but $\Pi_1$ sentences are cofinal in $V_T$ whereas $\Sigma_1$ sentences are not. (Received September 11, 1978.) (Author introduced by Professor Jan Mycielski).

## *Statistics and Probability (60, 62)*

*78T-F12 STUART GEMAN, Division of Applied Mathematics, Brown University, Providence, Rhode Island, 02912. A limit theorem for the norm of random matrices.

This paper establishes an almost sure limit for the operator norm of rectangular random matrices: Suppose $\{v_{ij}\}$ $i = 1,2,\ldots$, $j = 1,2,\ldots$ are zero mean i.i.d. random variables satisfying the moment condition $E|v_{11}|^n \leq n^{\alpha n}$ for all $n \geq 2$ and some $\alpha$. Let $\sigma^2 = Ev_{11}^2$ and let $V_{pn}$ be the $p \times n$ matrix $\{v_{ij}\}_{1 \leq i \leq p; 1 \leq j \leq n}$. If $p_n$ is a sequence of integers such that $p_n/n \to y$ as $n \to \infty$, for some $0 < y < \infty$, then $\frac{1}{n}|V_{p_n n} V_{p_n n}^T| \to (1+\sqrt{y})^2 \sigma^2$ almost surely, where $|A|$ denotes the operator ("induced") norm of A. Since $\frac{1}{n}|V_{p_n n} V_{p_n n}^T|$ is the maximum eigenvalue of $\frac{1}{n} V_{p_n n} V_{p_n n}^T$, the result relates to studies on the spectrum of symmetric random matrices. (Received August 23, 1978.)

78T-F13 ADNAN M. AWAD, Yale University, New Haven Ct. 06520. Martingale conditional central limit theorems. Preliminary report.

Let $\{Z_n\}$ be a sequence of random variables defined on $(\Omega, F, P)$, and let $\{F_n\}$ be a sequence of sub-$\sigma$-fields of F. How can $Z_n | F_n \xrightarrow{d} Z$ be defined? Does an analogue of the Levy continuity theorem exist in the conditional case? We give an answer to these questions and we prove the following conditional central limit Theorem. Assume that (i) $\{X_{nj}, F_{nj}, n \geq 1, j \geq 0\}$ is a martingale difference array, (ii) $E(\sup_{j \geq 1} X_{nj}^2) \leq K$, (iii) $\sup_{j \geq 1} |X_{nj}| \xrightarrow{p} 0$, and (iv) $\Sigma_{j=1}^{\infty} X_{nj}^2 \xrightarrow{p} 1$. Then $\Sigma_{j=1}^{\infty} X_{nj} | F_{n0} \xrightarrow{d} N(0,1)$.

This theorem is used to derive conditional central limit theorems for the tail and for the partial sum of a martingale difference array. It is also applied to the asymptotic normality of (i) posterior distribution, (ii) maximum likelihood estimate, and (iii) log-likelihood-ratio process. (Received August 29, 1978.)

*78T-F14 DAVID E. COOK and ROBERT L. TRUAX, The University of Mississippi, University, MS 38677. Multiple choice tests and normal distribution. Preliminary report.

In order to calculate z-scores, scale scores, percentiles, and other items for reporting results of multiple choice tests, it is common practice to assume that the raw scores have a normal distribution. The authors have found that this assumption is in error for achievement tests (tests in which a penalty is imposed for incorrect answers) in which many students answer, perhaps randomly, every question. This was observed in the scores of Mississippi high school students participating in the "Annual High School Mathematics Examination" for the past several years. An analysis of the 1978 data showed that these 3500 scores do not have a normal distribution and that if for $0 \leq n \leq 30$, $f(n)$ denotes the number of students answering exactly n questions, then $f(30) > 2 \cdot f(n)$ for each $n < 30$. The authors show that this bias will be present in any set of scores on an achievement test in which many students answer all questions and suggest that reports of these z-scores, scale scores, etc., will be in error. (Received September 11, 1978.)

## *Topology (22, 54, 55, 57, 58)*

78T-G126 A. I. BASHKIROV, Ivanovo Textile Institute, Ivanovo, USSR. On continuous maps and maximal compactifications of Isbell spaces.

An Isbell space $I(R)$ is a topological space of the form $R \cup N$ where $R$ is an infinite maximal almost-disjoint family of infinite subsets of $N$ (Gillman and Jerison, Rings of continuous functions, pp. 79, 269). Let AH denote the statement: every maximal almost-disjoint family has cardinality $c$. We consider some properties of maps of Isbell spaces. Theorem 1. Every Isbell space can be quotient mapped onto a strongly 0-dimensional Isbell space, but [AH] it can be (quotient) mapped onto a nonstrongly 0-dimensional one iff it is a preimage of the segment. Definition. A subfamily $P$ of a maximal almost-disjoint family $R$ is called complete if $\mathrm{cl} \cup P^*$ is open in $N^*$, and $R$ is called minimal complete if every complete subfamily is either finite or cofinite. Theorem 2. For every $X = I(R)$ the followings are equivalent: (a) $|\beta X \setminus X| = 1$, (b) if $Z$ is a zero-set then either $X \setminus Z$ is countable or $Z \setminus N$ is finite, (c) $R$ is minimal complete and $X$ is a preimage of the segment. Theorem 3. [AH] every Isbell space can be quotient mapped onto an Isbell space $Z$ such that $|\beta Z \setminus Z| = 1$. Theorem 4. For every metrizable compact $K$ there exist $\exp c$ pairwise nonhomeomorphic Isbell spaces that have Stone-Čech remainders homeomorphic to $K$. (Received July 20, 1978.)

78T-G127 CHARLES D. BASS, Pembroke State University, Pembroke, North Carolina 28372. Shrinking Cell-like decompositions of factored continua in Euclidean n-space. Preliminary report.

Let $X$ be a cellular compactum in $E^n$, $n \geq 5$; $\pi$ a proper CE map of $E^n$ onto a space $Q$ such that (1) $\pi | E^n - X$ is one-to-one and (2) $Q$ is of finite dimension. Can $\pi$ be approximated by homeomorphisms? R. J. Daverman has given an affirmative answer to this question in case $\dim \pi(X) \leq 1$; a negative answer in case $\dim \pi(X) \geq 2$. Following Daverman we call such a compactum elastic if every proper CE map satisfying (1) and (2) above can be approximated by homeomorphisms. Using R. D. Edwards' fundamental characterization of shrinkable decompositions of $E^n$ (these notices, abstract #751-G5, p. A-649, 1977) we obtain the following results. Theorem 1. If $X$ is a space such that $X \times E^1$ is homeomorphic to $E^n$, $n \geq 5$, and $Y$ is a cell-like set in $X$ with $\dim Y \leq n-3$, then $Y \times [0,1]$ is elastic in $E^n$. Theorem 2. Let $X$ be a space such that $X \times E^1$ is homeomorphic to $E^n$, $n \geq 5$. If $Y$ is an $(n-2)$-cell in $X$, then $Y \times [0,1]$ is elastic in $E^n$. (Received August 22, 1978.)

*78T-G128 TOM FARRELL, Pennsylvania State University, University Park, Pennsylvania 16802 and LOWELL JONES, State University of New York at Stony Brook, Stony Brook, New York 11790.
New attractors in hyperbolic dynamics.

Theorem 1. There exists a simply connected, compact, closed, two-dimensional branched manifold which supports an expanding self immersion. Theorem 2. There exists a two-dimensional expanding attractor whose first integral-Cech homology group vanishes. (Received August 22, 1978.)

*78T-G129 JONATHAN A. HILLMAN, Pure Mathematics, S.G.S., Australian National University, Canberra.
Homology boundary links. Preliminary report.

1. Any ribbon link is a sublink of a ribbon link for which surgery on the longitudes gives a connected sum of copies of $S^1 \times S^2$. Hence there are many links for which the analogue of the knot theoretic Property R fails, and sublinks of homology boundary links need not be homology boundary links. Higher dimensional examples of this latter phenomenon also exist.
2. A $\mu$-component link $L : \mu S^1 \to S^3$ extends to an embedding of $\mu$ disjoint surfaces (not necessarily orientable) if and only if the link group maps onto ${}^{\mu}_{*}(Z/2Z)$ via a map carrying meridians to the standard generators. A 2-component link L is such a Z/2Z boundary link if and only if $\Delta_1(L)(-1,-1) = 0$. A concordance between 2-component Z/2Z boundary links extends to an embedded cobordism between the spanning surfaces. There are analogous results for higher dimensions and for Z/2Z-homology boundary links. (Received August 31, 1978.)

*78T-G130 ROBERT MYERS, The University of Texas, Austin, Texas 78712. Companionship of Knots and the Smith Conjecture.

Suppose J is a counterexample to the Smith Conjecture, i.e. a knot in $S^3$ which is the fixed point set of a PL-homeomorphism of period p. Let C(J) be an invariant knot space. Theorem 1: Every essential torus in C(J) is isotopic to a torus which is either invariant or disjoint from its translates under h. This enables us to study the conjecture in terms of Schubert's theory of companionship of knots. In particular: Theorem 2: Every prime factor of J is a counterexample. Theorem 3: J is not a cable knot. Theorem 4: J is not a doubled knot. Theorem 5: J is not a cable braid. Theorem 6: J is not a non-simple knot with bridge number less than five. Also: Theorem 7: If the Smith Conjecture is true for all simple fibered knots, then it is true for all fibered knots. Theorem 8: The Smith Conjecture is true for all non-fibered knots having a unique isotopy type of incompressible spanning surface. (Received June 9, 1978.)

78T-G131 GEORGE M. RASSIAS, Research Center for National Defense, K.E.E$\Theta$.A., Galatsi, Athens, GREECE.
On the Morse - Smale characteristic of a differentiable manifold.

Definition : Let M be a closed $C^{\infty}$ differentiable manifold, dimM=n. The Morse-Smale characteristic of M, denoted by $\mu(M)$, is $\mu(M) = \min_{f\in\Omega} \sum_{i=o}^{n} c_i\,(M,f)$, where $\Omega$ is the space of Morse functions on M, and $c_i(M,f)$ is the number of critical points of index i of $f\in\Omega$.
Theorem. (1) Let M be a closed $C^{\infty}$ differentiable manifold, dimM= $n > 4$. Then, the Morse-Smale characteristic $\mu(M^n)=\min_{f\in\Omega} \sum_{i=o}^{n} c_i(M^n,f) = \sum_{i=o}^{n} \min_{f\in\Omega} c_i(M^n,f) \iff$ the Whitehead torsion $\tau(W;\, M^n)=o$, where $(W;M^n,M^n)$ is any h-cobordism, i.e. $\partial W=M^n+(-M^n)$ and $M^n \to W$ is a homotopy equivalence.
(2) Let M be a closed $C^{\infty}$ differentiable manifold, dimM=n $< 4$. Then, $\mu(M^n)=\min_{f\in\Omega} \sum_{i=o}^{n} c_i\,(M^n,f)=\sum_{i=o}^{n} \min_{f\in\Omega} c_i\,(M^n,f)$.
Conjecture. Let M be a closed differentiable manifold, dimM=4. Them, $\min_{f\in\Omega} \sum_{i=o}^{4} c_i(M,f) = \sum_{i=o}^{4} \min_{f\in\Omega} c_i(M,f)$.
Remark. The importance of the Morse-Smale characteristic to the Poincaré conjecture and in general to the fundamental problem of the classification of differentiable manifolds is shown. (Received September 5, 1978.)

78T-G132 THEMISTOCLES M. RASSIAS, Research Center For National Defense, K.E.E$\Theta$.A., Galatsi, Athens, Greece.
On Morse Theory and Plateau's Problem.

An attempt to solve Plateau's problem for Riemannian manifolds led the author to a generalization of the Morse - Palais - Smale theory for Hilbert manifolds to be applied to multi-dimensional

variational problems, thus developing a special theory for the problem of unstable minimal surfaces bounded by a given closed curve in a Euclidean space.

The problem of finding the number of minimal surfaces spanning a given Jordan curve $\Gamma$ in $R^3$ has resisted solution since the 18th century, the time of Lagrange and Euler. Towards the solution of the above fundamental problem the author has proved the following :

Theorem. For any natural number n, there exists a Jordan curve $\Gamma$ in $R^3$ that has exactly (2n+1) minimal surfaces spanning $\Gamma$.

Conjecture. For any $C^1$ - Jordan curve $\Gamma$ in $R^3$ there exists an odd number of minimal surfaces spanning $\Gamma$.

An affirmative answer to the above cojecture will imply, as a special case, a general solution of Plateau's problem for $C^1$ - Jordan curves $\Gamma$. (Received September 5, 1978.)

*78T-G133 JÓZEF H. PRZYTYCKI, Institute of Mathematics, Warsaw University, PKiN 00901 Warsaw. $Z_n$-actions on some 2 and 3-manifolds.

We classify $Z_n$-actions on handlebodies and F-bundles over $S^1$, where $F=S^1, S^2, P^2, D^1$ or $D^2$. We assume they are free on the complement of a finite set of points (possibly $=\emptyset$). We classify also free actions of $Z_n$ on $\#(S^1 \times S^2)$ (up to free actions of $Z_n$ on $S^3$) and on surfaces. We classify all orientation-preserving actions on surfaces using the modified method of P.A.Smith ("Abelian action on 2-manifolds", Mich.Math.Jour. 14 (1967)). In particular we prove the following Theorem: $Z_n$ can act reversing the orientation on the handlebody of genus s with exactly m points with nontrivial isotropy group iff n is an even number , m is a multiple of n/2 and either $s-m-1 \geqslant 0$, then s-m-1 is a multiple of n or s-m-1=-2 and n=2. Furthermore ,if $s-m-1 \geqslant 0$, or s-m-1=-2 ,then there exists at most one such action (up to conjugation) and if s=m+1, then there exist $E(\varphi(n)/2)$ such actions (up to conjugation) and one action up to weak equivalence (see P.Orlik, Seifert Manifolds,p.144). $\varphi(n)$ denotes the cardinality of the set of all numbers prime to n less than n. (Received September 8, 1978.)
(Author introduced by Professor Joan S. Birman).

*78T-G134 BARRY W. HILL-TOUT and CLINT G. McCRORY, Brown University, Providence, Rhode Island 02912. Cellular Homology by Degree.

A homology theory for CW complexes is developed without using any other homology theory. The boundary map in the chain complex is defined using the Brouwer degree as presented by J. Milnor in Topology from the Differentiable Viewpoint, and it is proved geometrically that the definition does give a chain complex (i.e. that $\partial \circ \partial = 0$ ) . The induced mapping on homology is also defined using degree, and the Eilenberg-Steenrod axioms are verified for the theory. (Received September 12, 1978.)

# LATE PAPERS | *Presented at past meetings*

761-B36 JAMES A. PENNLINE, Virginia Commonwealth University, Richmond, Virginia 23284, A simple procedure for generating solutions to certain non-homogeneous Riemann-Hilbert problems. Preliminary Report.

The well-known Riemann-Hilbert problem on an arc is to determine a function f(z) which is analytic in the finite complex z plane cut along a line segment L and satisfies the following conditions: 1) f(z) is continuous onto each side of the interior of L and has finite degree at, $\infty$ 2) at each endpoint of L , f(z) has growth rate less than that of a simple pole, 3) at interior points of L , the boundary values $f_+(x)$ , $f_-(x)$ satisfy the relation $f_+(x) - A(f)f_-(x) = r(x)$ where A and r are given functions. We investigate a special method for finding solutions to certain non-homogeneous cases (particularly ones which arise from singular integral equations with Cauchy-type kernels). The method generates solutions to specific non-homogeneous problems from known homogeneous solutions. Then for certain given non-homogeneous problems, solutions are formed by taking an appropriate linear combination of the generated solutions. Although the method is much more limited than the standard Carleman method, it may be applicable to vector problems. (Received September 11, 1978.)

**762ND MEETING**

*University of Chicago*
*Chicago, Illinois*
*November 12, 1978*

# *Algebra and Theory of Numbers (05, 06, 08, 10, 12–18, 20)*

762-A1 A. R. KUSTIN, University of Illinois, Urbana, Illinois, 61801. Locally Power Series Algebras. Preliminary report.

Let R be a commutative noetherian domain. The R-algebra A is a locally power series R-algebra if $A_{\underline{m}}$ is isomorphic to $R[[T]]_{\underline{m}}$ for all maximal ideals $\underline{m}$ of R. The symbol T denotes a finite collection of variables. Bass, Connell, and Wright [Inventiones Math. (1977)] have classified locally polynomial R-algebras.

Theorem 1. If R is normal then every locally power series R-algebra is actually a formal power series algebra over R.

Let R be finitely generated as an algebra over a field. Let T represent just one variable. Let $\mathcal{U}$ be the cover of X = spec R consisting of a finite collection of open affine sets $X_f$. Let $\mathcal{A}$ be the collection of isomorphism classes of R-algebras A such that $A_f \simeq R[[T]]_f$ for all f with $X_f \in \mathcal{U}$. Let F be the sheaf on X with the property that $F(X_f)$ is equal to the units of $R_f \cap R'$, where R' is the integral closure of R.

Theorem 2. There is a one-to-one correspondence between the elements of $\mathcal{A}$ and the elements of the Cech cohomology group $H^1(\mathcal{U},F)$. (Received September 11, 1978.)

*762-A2 JUDITH Q. LONGYEAR, Wayne State University, Detroit, MI 48202. There are 9 different skew-equivalent Hadamard matrices of order 24.

Hadamard matrices H and K are equivalent if H may be obtained from K by permuting and negating lines. They are different if H is not equivalent to K or its transpose $K^T$. A Hadamard matrix is skew equivalent if it is equivalent to some K for which $K^T = -K \pm 2I$.

The 9 different skew-Hadamard matrices of order 24 are the quadratic residue matrix, with both characters 1 ; the Kronecker product of the matrices of order 12 and order 2, with characters (12,1) ; and seven new ones, of characters (6,2) , $(4,3_1)$ , $(3_1,2)$ , $(3_1,3_1)$ , $(3_1,3_2)$ , (4,2) , the latter having two different matrices. (Received September 14, 1978.)

*762-A3 IGOR DOLGACHEV, University of Michigan, Ann Arbor, Michigan 48109. On projective weighted complete intersection varieties.

Topological, algebraic and classification problems of projective varieties given by a system of weighted homogeneous polynomials will be discusses in this talk. (Received September 18, 1978.)

*762-A4 Anita E. Solow, Wayne State University, Detroit, Michigan 48202. The square class invariant for quadratic forms over local fields.

Let F be a local field of characteristic not 2 with residue class field $\bar{F}$. Let q be a quadratic form over F. The square class invariant for q is a map $m_q : \dot{F}/\dot{F}^2 \to Z$ defined by: for each square class a, $m_q(a)$ is the largest integer such that $q \simeq m_q(a)\langle a\rangle \perp q'$.

**Theorem.** Assume that the characteristic of $\bar{F}$ is not two. If the square class invariant classifies quadratic forms over $\bar{F}$, then it classifies quadratic forms over F.

This theorem applies, for instance, if $\bar{F}$ is a quadratically closed field, real closed field, finite field, pythagorean SAP field, or superpythagorean field.

If $\bar{F}$ is a finite field of characteristic two (i.e., F is a dyadic $\mathfrak{p}$-adic field), then the square class invariant does not classify quadratic forms over F.

Theorem. Quadratic forms over dyadic $\mathfrak{p}$-adic fields are classified by the square class invariant and the discriminant. (Received September 18, 1978.)

*762-A5 WILLIAM L. HOYT, Rutgers University, New Brunswick, NJ 08903 and
MICHAEL J. KENT, Rutgers University, New Brunswick, NJ 08903.
Periods of some elliptic integrals. Preliminary report.

Periods for Manin's integral $\int_{\infty}^{P} dx/y$ corresponding to $\mathbb{Q}(t)$-rational solutions P of $y^2 = x(x-1)(x-t^2-c)$, $c \neq 0, 1$, are determined up to sign and up to addition of coboundaries of the form $\frac{1}{2}(N_1, N_2)(I - M(\delta))$. It is shown that these differ from suitable pairs of periods of related 2-forms $N_3(c^2 - c)^{\frac{1}{2}}(8\pi t^2)^{-1}y^{-1}dt \wedge dx$ by coboundaries of the form $(1/N_4)(N_5, N_6)(I - M(\delta))$. Here $\delta \to M(\delta)$ is the monodromy representation and all $N_i \in \mathbb{Z}$. We are seeking a bound for $N_4$. (Received September 18, 1978.

*762-A6 Ralph Amayo and Jochen Schwarz, Southern Illinois University, Carbondale, IL 62901.
Modularity in Lie Algebras.

For subsets A, B of a Lie algebra L, $\langle A,B\rangle$ denotes the subalgebra of L generated by A and B. A subalgebra M of L is said to be modular if the following two lattice-type conditions hold:

(i) $\langle U,M\rangle \mathbin{\|} V = \langle U, M \mathbin{\|} V\rangle$ if $U \leq V \leq L$.

(ii) $\langle U,M\rangle \mathbin{\|} V = \langle U \mathbin{\|} V, M\rangle$ if $M \leq V \leq L$.

These conditions hold in case M is a quasi-ideal of L, namely, $\langle U,M\rangle = U + M$ (vector space sum) for any subalgebra U of M.

Theorem 1: A modular subalgebra M of a Lie algebra L is a quasi-ideal of M + A for any solvable subalgebra A of L with $\langle M,A\rangle = M + A$.

Theorem 2: If M is a modular subalgebra of a finite-dimensional Lie algebra L over a field of characteristic zero then one of the following holds

(i) M is a quasi-ideal of L

(ii) M is a maximal subalgebra of L, $M/M_L$ is one-dimensional and $L/M_L$ is a three dimensional non-split simple Lie algebra. (Received September 19, 1978.)

## *Analysis (26, 28, 30–35, 39–47, 49)*

*762-B1 Lee A. Rubel, University of Illinois, Urbana, Illinois 61801 and Richard M. Timoney, Indiana University, Bloomington, Indiana 47401, An extremal property of the Bloch space.

The Bloch space $\mathcal{B}$ is the space of functions f analytic in the unit disc D such that $|f'(z)|(1-|z|^2)$ is bounded. It is shown that $\mathcal{B}$ is the largest Mobius - invaraiant linear space of analytic functions on D that can be equipped with a Mobius - invariant seminorm in such a way that there is at least one "decent" continuous linear functional on the space. A linear functional L is called "decent" if $L \neq 0$ and $|L(f)| \leq \operatorname{Sup}\{|f(z)| \mid z \in K\}$ for some compact $K \subseteq D$.

A simple corollary is that H(D), the holomorphic functions on D with the topology of uniform convergence on compacta, has no non-trivial Mobius - invariant closed subspaces.

(Received July 5, 1978.)

*762-B2 Charles H. Heiberg, U.S. Naval Academy, Annapolis, Md. 21402. Limits of norms of powers of absolutely convergent Fourier series in several variables

If $f$ is a function which is defined on $T^r$, has an absolutely convergent Fourier series, is in absolute value less than one at all points of $T^r$ other than $(1,1,\ldots,1)$ and can be written in the form

$$f(\langle e^{it_j}\rangle) = \exp(\vec{a}\cdot\vec{t}\,i - (\lambda + \gamma)(\vec{t}))$$

for all $\vec{t}$ in some neighborhood of $\vec{0}$, where $\vec{a} \in R^r$, $\lambda$ is a polynomial in r variables such that for some r-tuple $\vec{q}$ of positive integers

$$\lambda(\langle s^{1/q_j} t_j\rangle) = s\,\lambda(\vec{t})$$

for all $s > 0$, $\mathrm{Re}\,\lambda(\vec{t}) > 0$ for all $\vec{t} \neq \vec{0}$, $\gamma \in C^m(R^r)$, $m = \max(2r, q_1, q_2, \ldots, q_r)$ and

$$\gamma(\vec{t}) = o\left(\sum_{j=1}^{r} |t_j|^{q_j+1}\right), \quad \vec{t} \to \vec{0},$$

then

$$\|f^n\| \to (2\pi)^{-r}\,\|\hat{F}\|_1, \quad n \to \infty,$$

where $F(\vec{t}) = \exp(-\lambda(\vec{t}))$ for all $\vec{t}$ in $R^r$ and $\|f^n\|$ denotes the sum of absolute values of the Fourier coefficients of $f^n$. (Received August 30, 1978.)

*762-B3 ALEXANDER DYNIN, State University of New York at Stony Brook, Stony Brook, New York, N.Y. 11794. Harmonic Analysis of homogeneous distributions on Heisenberg groups.

An odd dimensional Euclidean space is furnished with the Heisenberg Lie group structure. So for Schwartz distributions on the space we have both commutative and non-commutative Fourier transforms. They are related through Weyl quantization. Consider distributions on the Heisenberg group which are homogeneous with respect to Stein dilations. Using the relation above we give a complete description of their Heisenberg Fourier transforms in terms of special pseusodifferential operators. (Received September 15, 1978.)

*762-B4 JAMES B. CARRELL, University of British Columbia, Vancouver, B.C., Canada V6T 1W5, and ANDREW JOHN SOMMESE, University of Bonn, Math. Inst., (53) Bonn, Fed. Rep. Germany. The topology of Kaehler manifolds admitting a $C^*$ action.

We prove the following strong version of Frankel's Theorem (T.T. Frankel, Fixed points and Torsion on Kaehler manifolds, Ann. of Math. 70 (1959), 1-8). Let $X$ be a compact Kaehler manifold and let $C^*$ act holomorphically on $X$ with non-trivial fixed point set having components $F_1,\ldots,F_k$. Decompose $T(X)|F_j = T(F_j)\oplus N(F_j)^+\oplus N(F_j)^-$ in the usual way, and let $\lambda_j$ denote the rank of $N(F_j)^+$. Then there exist injective morphisms $\mu_{j,k}: H_{k-\lambda_j}(F_j,Z) \to H_k(X,Z)$ for every $k$ so that $\mu_k = \bar{Z}_j\mu_{j,k}$ is an isomorphism. Two consequences are: (a) an explicit description of the Picard variety of $X$ in terms of the $F_j$ with $\lambda_j = 1$, and (b) an expression for the Hodge numbers of $X$ in terms of those of the $F_j$. This result does not extend to compact algebraic varieties. (Received September 18, 1978.)

762-B5 RONALD R. COIFMAN, Department of Mathematics, Washington University, St. Louis, Missouri 63130. Applications of the Fourier transform in noncommutative harmonic analysis.

• We describe recent results where the $L^2$ (or $L^p$) boundedness of an operator (not commuting with translations) can be proved by use of the Euclidean-Fourier transform in combination with real variable techniques. These results concern commutators of pseudodifferential operators, multilinear pseudodifferential operators, certain maximal functions and their relation to Fourier integral operators. Our object is to show that the usual techniques of the theory of Fourier multipliers are effective even in the noncommutative case. (Received September 19, 1978.)

762-B6 T. K. PUTTASWAMY, Ball State University, Muncie, Indiana 47306. Asymptotic behaviour of solutions of a certain second order differential equation in the neighborhood of an irregular singular point of arbitrary rank.

The investigations of this paper is devoted to the solution in the large of the differential equation

$$z^2 \frac{d^2y}{dz^2} + z(b_o + b_1 z^{\alpha} + b_2 z^{2\alpha}) \frac{dy}{dz} + (c_o + c_1 z^{\alpha} + c_2 z^{2\alpha}) y = 0 \qquad (1)$$

Here, $\alpha$ is any positive integer, the variable $z$ is complex and the coefficients $b_i$, $c_i$ $(i=0,1,2)$ are real or complex with $b_2 \neq 0$. Then (1) will have a regular singular point at $z=0$ and an irregular singular point at $z = \infty$. The indicial equation about $z = 0$ is found to be

$$h(h-1) + b_o h + c_o = 0 \qquad (2)$$

We shall also assume that the roots $h_1$ and $h_2$ of (2) are such that their difference is incongruent to zero modulo $\alpha$. (Received September 19, 1978.)

*762-B7 JEFFREY POSLUSZNY and LEE A. RUBEL, University of Illinois, Urbana-Champaign, Urbana, Illinois 61801. The motions of an ordinary linear differential equation.

The motions of a homogeneous linear ordinary differential equation are those functions $\varphi$ such that if $y$ solves the equation then $y \circ \varphi$ also solves it. The motions form a semigroup and we characterize (up to conjugation) exactly which semigroups can occur. There are certain subgroups of the ordinary affine group and certain "half-groups" of these. There are, in all, exactly seventeen semigroups that can occur. (Received September 19, 1978.)

762-B8 PETER A. TOMAS, University of Texas, Austin, Texas, 78712 and CARLOS E. KENIG, Princeton University, Princeton, New Jersey, 08540. Strichartz's conjecture on invariant multipliers. Preliminary report.

Let G be a connected noncompact semisimple Lie group with finite center and Lie algebra . Strichartz's conjecture is that there exist no non-trivial Fourier multipliers on which are invariant under the action og AdG. The authors present a positive solution to this conjecture, when the multiplier has some mild growth restrictions. Applications are given to PDE's. An analogous problem, the summability of Fourier series by discrete series characters, is discussed. (Received September 19, 1978.)

## *Applied Mathematics (65, 68, 70, 73, 76, 78, 80–83, 85, 86, 90, 92–94)*

762-C1 RAMESH GOVINDARAJU, University of Maryland-Eastern Shore, Princess Anne, Md. 21853. Flow of a viscous fluid III.

The kinetic energy $k$ is assumed to be functionally dependent on the vorticity $\omega$ in the steady two-dimensional flow of an incompressible viscous fluid. It is proved that if the streamlines and isobars do not coincide, the vorticity is a function of $\tau$, where $\tau$ is linear in $p$ and $\psi$. In this case the curves of constant vorticity are either parallel lines or concentric circles and the flow is a special case of Jeffery flow. If the streamlines and isobars do coincide, the pressure will remain constant and the streamfunction is given by $\psi(x,y) = A(x-x_o)+B(y-y_o) - \exp\left[C(x-x_o) + D(y-y_o)\right]$, where $A,B,C,D,x_o$ and $y_o$ are constants. (Received September 15, 1978.)

(Author introduced by Dr. E. W. Chapin).

762-C2 JON C. LUKE, Indiana University--Purdue University at Indianapolis, Indianapolis, Indiana 46205. Models of bilipid vesicles.

Certain membrane models that have been used in the study of red blood cell shape are mentioned. Then a related problem is considered, where there is a mechanism that causes the area of an idealized bilipid vesicle to increase with time. Examples are given of the shape changes that result. (Received September 18, 1978.)

# Geometry (50, 52, 53)

762-D1 K. DEMYS, 844 San Ysidro Lane, Santa Barbara, Calif. 93108. Surfaces of sphere-packed shells of equal edges.

Accounts and observations of such surfaces first appeared in 1957 (*J. Boehme Soc. Q.*, vol.4,no.3,p.8) and then again in 1965 (*Progress in Biocybernetics II*, J. Schadé and N. Wiener, Elsevier, Amsterdam, pp.227-238). In the 1960's Buckminster Fuller and his trainees worked out some rather complicated formulas for the number of spheres in such shells of different shape. However, Fuller and his group apparently overlooked the forest for the trees, because a very simple formula for the surface measure - unnoticed by them - exists in terms of the number of equal spheres composing the surface. Proved, by the condition of equal edges and by topological considerations, the expression is (when $A_n$ is the number of spheres in the surface and $n$ the number of spheres per edge):
$A_n = k(n-1)^2+2$. Here $k = \frac{1}{2}t + s + 3h$, where $t$ is the number of equilateral triangular faces in the surface; $s$, the number of squares; and $h$, of regular hexagons. Thus, an icosahedral sphere-packed shell has a surface of $10(n-1)^2+2$ spheres; for a square pyramidal shell, $A_n = 3(n-1)^2+2$; for a faceted or snub cube shell, $A_n = 22(n-1)^2+2$; for a triangular prism, $A_n = 4(n-1)^2+2$; for a pentagonal dipyramid, $A_n = 5(n-1)^2+2$, *et al.* If two differently shaped shells have the same $A_n$ (e.g. triangular prism and octahedron; icosahedron and cuboctahedron; rhombicuboctahedron and faceted [or snub] cube) one member of such a pair would contain the same number of spheres as the other member for its surface when both figures have the same edge. (Received September 18, 1978.)

# Logic and Foundations (02, 04)

*762-E1 IRVING H. ANELLIS, University of Florida, Dept. of Philosophy, Gainesville, Florida 32611. A second-order functional calculus C(ST). Preliminary report.

We construct a second-order calculus C(ST) and provide a set-theoretic interpretation. Let \$ be a set of first-order undefined constants for $\$ = \{s_{00}, s_{01}, \ldots s_{\omega\omega}\}$ and let S and # be sets of first-order functions where $S = \{\mathcal{S}_{x_{s0}}, \mathcal{S}_{x_{s1}}, \ldots \mathcal{S}_{x_{s\omega}}\}$ and $\# = \{\#_{s0}, \ldots \#_{s\omega}\}$. Let $\$^s$ and $T_\$$ be sets of second-order functions where $\$^s = \{\$^{s0}, \ldots \$^{s\omega}\}$ and $T_\$ = \{T_{\$0}, \ldots T_{\$\omega}\}$. For some $\$^{sk}(Z_k\langle x_1, x_n\rangle)$ we have Df.1. $\$^{sk}(Z_k\langle x_1, x_n\rangle) =_{df} \$^{sk}(\langle \$_{x_{sk-1}}(s_{0k-1}), \$_{x_{sk}})\rangle)$, where $Z_k$ is a second-order propositional function in whose range are a well-ordered pair of first-order functions, each of which capture a well-ordered non-identical pair of first-order undefined constants of the set \$. Df.2. $\#_{sk} =_{df} \$^{sk}(Z_k\langle x_1, x_n\rangle)$. Thm.1. $\#_{sk}$ defines a lattice for $\$^{sk}(Z_k\langle x_1, x_n\rangle)$ and $\#_{sk} = \$^{sk}\{\langle s_{01}, s_{11}\rangle, \langle s_{21}, s_{31}\rangle : (s_{01} \in \$ \cdot \ldots s_{31} \in \$)\}$. Df.3. $T_{\$k}(\#_{sk-1}, \#_{sk}) =_{df} \#\#$ and Thm.2. $\#\# = T_{\$k}\{\langle \#_{sk-1}, \#_{sk}\rangle\}$ and $T_{\$k}$ defines a lattice for $\#\#$. The inference rules for C(ST) are the same as those for the PM calculus.

Set-theoretically, the second-order functions of the sets $\$^s$ and $T_\$$ are interpreted as operators; the functions of $\$^s$ bring together in a well-ordered pair a set whose elements are first-order functions taking elements of \$; those of $T_\$$ create a set of well-ordered n-tuples taking well-ordered pairs created by functions of $\$^s$ as their elements. (Received September 14, 1978.)

# Topology (22, 54, 55, 57, 58)

762-G1 PETER ORLIK, Department of Mathematics, University of Wisconsin, Madison, Wisconsin 53706. Singularities and group actions.

• There has been a vigorous interaction between the theory of singularities and the theory of transformation groups ever since the foundation of the latter by F. Klein and S. Lie. The last decade has seen a great resurgence in this activity due to the discovery by Pham and Brieskorn that exotic spheres occur as links of singularities and to Milnor's fibration theorem. We shall review some recent highlights of this interaction including constructions of exotic actions on spheres, constructions of smooth codimension one foliations on odd spheres, singularities with $\mathbb{C}^*$-action, equivariant resolutions of surface singularities with $\mathbb{C}^*$-action, automorphic forms and quotient singularities, and equivariant deformation theory. (Received July 27, 1978.)

*762-G2 PETER ORLIK, University of Wisconsin, Madison, Wisconsin 53706 and PHILIP WAGREICH, University of Illinois at Chicago Circle, Box 4348, Chicago, Illinois 60680. Discontinuous subgroups of complex linear groups. Preliminary report.

Suppose $G \subset GL(n, \mathbb{C})$ is a discrete subgroup. Let $U = \{x \in \mathbb{C}^n \mid G \text{ acts discontinuously at } x\}$. We say $G$ is discontinuous if $U \neq \emptyset$. Let $W$ be a connected component of $U$. Then $W/G$ is a complex space of dimension $n$. We are interested in the classification of $G$ and $W/G$. Explicit results are given the case that $n = 2$ and the image of $G$ in $PGL(2, \mathbb{C})$ is a Fuchsian group. In this case $W/G$ is an algebraic surface with $\mathbb{C}^*$-action. The topology of $W/G$ is explicitly determined from certain numerical invariants of $G$. (Received August 4, 1978.)

762-G3 LOUIS BLOCK. University of Florida, Gainesville, Florida 32611. Simple periodic orbits of mappings of the interval. Preliminary report.

Let $f$ be a continuous map of a closed bounded interval into itself. Let $P$ be a periodic orbit of $f$ with period $m$ a power of 2. We say $P$ is simple if for any subset $\{q_1, \ldots q_n\}$ of $P$ (where $n$ divides $m$ and $n \geq 2$) and any positive integer $r$ which divides $m$ such that $\{q_1, \ldots q_n\}$ is a periodic orbit of $f^r$ with $q_1 < q_2 < \ldots < q_n$, we have $f^r(\{q_1, \ldots, q_{\frac{n}{2}}\}) = \{q_{\frac{n}{2}+1}, \ldots, q_n\}$. It is shown that $f$ has a periodic point whose period is not a power of 2 if and only if $f$ has a periodic orbit of period a power of 2 which is not simple. (Received September 5, 1978.)

*762-G4 Richard Randell, University of Michigan, Ann Arbor, Michigan 48109. Complements of Plane Curves.

Suppose $C$ is a complex algebraic curve in the projective plane $P^2$ We will discuss recent results on the structure of $\pi_1(P^2-C)$. For example, O. Zariski has conjectured that this group is abelian if $C$ has no singularities other than ordinary double points. Theorem. If $C$ is irreducible and has only ordinary double points, $\pi_1(P^2-C)$ is an extension of a perfect group by a finite cyclic group. (Received September 11, 1978.)

762-G5 ROBERT J. ZIMMER, University of Chicago, Chicago, Illinois 60637. Ergodic actions of real algebraic groups.

If $G$ is a real algebraic group, many natural $G$-spaces have a regular orbit structure in the sense that every orbit is locally closed. We examine this phenomenon for some particular actions and discuss the implications for the study of some broad classes of ergodic actions of $G$. (Received September 11, 1978.)

762-G6 LOUIS H. KAUFFMAN, University of Illinois at Chicago Circle, Chicago, Illinois 60680. Handlebody presentations of branched coverings. Preliminary report.

Let $K \subset S^3$ be a knot (or link) with connected spanning surface $F \subset S^3$. Let $F' \subset D^4$ be the result of pushing $F$ into the interior of $D^4$ (rel boundary), and let $F_a$ denote the a-fold cyclic branched cover of $D^4$ along $F'$ $(a = 2, 3, \ldots)$. Theorem. $F_a$ is a handlebody obtained from the four-ball by attaching 2-handles. This handle presentation is related naturally to the branched covering structure. Generalizations and applications of the theorem to the study of singularities will be discussed. (Received September 13, 1978.)

762-G7 WALTER D. NEUMANN, University of Maryland, College Park, Maryland 20742. An invariant of plumbed manifolds. Preliminary report.

Let $M^3$ be a plumbed 3-manifold ("graph-manifold" in Waldhausen's sense) which is a $(\mathbb{Z}/2)$-homology sphere. We define an invariant $\bar{\mu}(M) \in \mathbb{Z}$, whose modulo 16 reduction is the usual $\mu$-invariant. The properties of $\bar{\mu}$ generalize slightly part of "4-manifolds constructed via plumbing" by S. Weintraub and the author (to appear in Math. Ann.). Much more far reaching applications are hinted at by the fact that for all known homology bordisms of plumbed $(\mathbb{Z}/2)$-spheres, $\bar{\mu}$ is an invariant. But it is not known if $\bar{\mu}$ is a homology bordism invariant in general, and premature to conjecture it. (Received September 15, 1978.)

762-G8 Anatoly S. Libgober, University of Illinois at Chicago Circle, Chicago, Illinois 60680 Levine's formula in knot theory and quadratic reciprocity law.

Levine's formula in knot theory provides a relation between Arf invariant of Zeifert surface and Alexander polynomial of knot. Algebraic ingredient of the proof is the result that Arf invariant of reduction mod 2 of quadratic form over Z, such that determinant d of associated bilinear form is odd, is equal to value $(\frac{2}{d})$ of Jacobi symbol. We shall discuss the connection of this statement with Weil - Milgram reciprocity law for Gauss sums. This approach led to a generalization which for quadratic forms defined over algebraic number field and with odd determinant d of associated bilinear form gives the relation between Arf invariants of reductions in dyadic prime ideals and the determinant d. (Received September 15, 1978.)

762-G9 MICHAEL COWLING, Washington University, St. Louis, Missouri 63130. Complementary series for rank two groups.

Some partial results on the complementary series for semisimple Lie groups of real rank two, including a description of Kostant's "critical strip" for the class-one principal series of the groups $SO(n,2)$ and $SU(n,2)$, are to be presented. (Received September 15, 1978.)

762-G10 C.F. PELTIER, St. Marys College, Notre Dame, IN. 46556 and R.P. BEEM, Indiana University, South Bend, IN. 46615. Involutions on Dold Manifolds. Preliminary Report.

Given a smooth involution T on the Dold manifold $X = S^m \times_{Z/2} CP(n)$ such that X is totally non-homologous to zero in $X_{Z/2}$, then (1) the fixed set of T has at most three components; (2) if F is such a component, then $H^*(F;Z/2) = H^*(RP(k);Z/2)$ or $H^*(CP(k);Z/2)$ or is generated by elements x and y such that $\dim(x) = \dim(y) = 1$ or $\dim(y) = 2\dim(x) = 2$ with $Sq^1 y = xy$. In case where $\dim(x) = \dim(y) = 1$ we show algebraic conditions which guarantee that $H^*(F;Z/2)$ is the cohomology of the projectivization of a real vector bundle over some RP(k). (Received September 18, 1978.)

*762-G11 JIRI DADOK, Rice University, Houston, Texas 77001. Solvability of invariant differential operators of principal type on certain Lie groups and symmetric spaces.

Let D be a real biinvariant differential operator on a Lie group H (resp. a real invariant diff. op. on Riemannian symmetric space of noncompact type $G/K$). If a bicharacteristic of D does not reduce to a point then it is a translate of 1-parameter subgroup of H (resp. it is a geodesic in $G/K$). For D of principal type this implies solvability in $\mathcal{D}'(H)$ when H is exponential solvable (resp. in $\mathcal{D}'(G/K)$).

Also, to give a new proof of solvability for an invariant D in $C^\infty(G/K)$ via Holmgren's uniqueness theorem sufficiently many noncharacteristic hypersurfaces are easy to construct. (Received September 18, 1978.)

*762-G12 DARYL GELLER, University of Chicago, Chicago, Illinois 60637. Necessary and sufficient conditions for local solvability on the Heisenberg group.

On the Heisenberg group $\mathbb{H}^n$, let $Z_1,\ldots,Z_n$, $\overline{Z}_1,\ldots,\overline{Z}_n$, T denote the standard basis for complex left-invariant vector fields, the only non-trivial commutation relations being $[Z_j,\overline{Z}_j] = -2iT$. Let L be a left-invariant differential operator on $\mathbb{H}^n$; express it as $L = p(Z,\overline{Z})$ for some polynomial p. Here $Z = (Z_1,\ldots,Z_n)$. Its degree is determined by setting $\deg Z_j = \deg \overline{Z}_j = 1$. Suppose L is homogeneous (in the natural sense) and $p(\partial/\partial z, \partial/\partial\overline{z})$ is elliptic on $\mathbb{C}^n$ (where $\partial/\partial z = (\partial/\partial z_1,\ldots,\partial/\partial z_n)$). Then there exists a regular homogeneous distribution K and a principal value distribution P with $LK = \delta - P$; here $f \to f*P$ is the projection in $L^2(\mathbb{H}^n)$ onto $[L\mathcal{S}(\mathbb{H}^n)]^{\perp}$. P is real analytic away from 0 and if f is a distribution of compact support, $Lu = f$ near $q \in \mathbb{H}^n$ for some distribution u iff $f*P$ is real analytic near q. This generalizes the criterion of Greiner, Kohn and Stein for the Lewy operator $Z_1$ on $\mathbb{H}^1$. The proof uses the group Fourier transform. (Log terms may be present in K if $\deg L \geq 2n+2$.) (Received September 18, 1978.)

762-G13 R. RANGA RAO, University of Illinois, Urbana, IL 61801. Some explicit formulas in the theory of Weil representation.

An explicit formula is given for the operators of the Weil projective representation of the symplectic group. It is shown that there is a unique way of defining these operators in order that the representation possess certain properties. An explicit formula for the multiplier is also obtained. Also an explicit factor set of the projective representation is given generalizing the work of Kubota for $SL_2$. (Received September 18, 1978.)

*762-G14 BERNARD MORIN, University of Strasbourg, 67-Strasbourg, France and GEORGE K. FRANCIS, University of Illinois, Urbana, Illinois 61801. Some equivariant eversions of the sphere. Preliminary report.

The following parametrization, obtained by the first author, describes a sequence $f_n$ of eversions of the sphere in space that maintain rotational symmetry of order $n \geq 2$ throughout the regular homotopy. For n odd, the middle stage $t = 1/2$ factors through an immersion of the projective plane, generalizing Boy's surface (n=3). For n even the middle surface has 2n-fold symmetry, generalizing Morin's surface (n=2). For each t, consider $S^2 \to S^1 \times R \to C \times R \to R^3$, where the first map is the central projection of the sphere (minus poles) to the cylinder, the last inverts stereographic projection from the (south) pole and the middle is best described in mixed coordinates: polar on cylinder to complex plane

$$(n-1)ie^{-i\theta}\cos\pi t + (e^{i(n-1)\theta} + (\tfrac{n-1}{n+1})e^{-i(n+1)\theta})\sin\pi t + \zeta(\tfrac{n-1}{n})(\sin\pi t + 1/5)e^{-i\theta},$$

cartesian on sphere to height above plane

$$(z + 3\mathrm{Re}(x+iy)^n)\cos\pi t - \mathrm{Im}(x+iy)^n(z+\mathrm{Re}(x+iy)^n)\sin\pi t.$$

The composition extends smoothly (class $C^{n-1}$) to the poles. (Received September 18, 1978.)

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# ERRATA—Volume 25

FRED GALVIN, On a problem of Čech. Abstract 78T-E81, October 1978, Page A-604.

The instances of the announced result where $\kappa = \omega$ or $\kappa$ is a measurable cardinal were obtained earlier by Roderick A. Price, using a different method.

AUGUSTIN BANYAGA, On the groups of diffeomorphisms preserving a symplectic form or a volume form up to a constant number. Abstract 960-G12, October 1978, Page A-649.

In line 4 after "where $f \in \mathbb{R}$, resp. $h^*\alpha = \alpha$" insert "equipped with the $\mathcal{C}^\infty$-topology of Cerf."

MAXWELL O. READE and PETRU T. MOCANU, On a conjecture due to Robinson. Preliminary report. Abstract 761-B16, October 1978, Page A-658.

In lines 2, 3, for "$F(z) \equiv (1/z)\int_0^z f(\zeta)d\zeta$ and $H(z) \equiv (1/z)\int_0^z h(\zeta)d\zeta$" read "$F(z) = (1/z)\int_0^z f(\zeta)d\zeta$ $H(z) \equiv (1/z)\int_0^z h(\zeta)d\zeta$.

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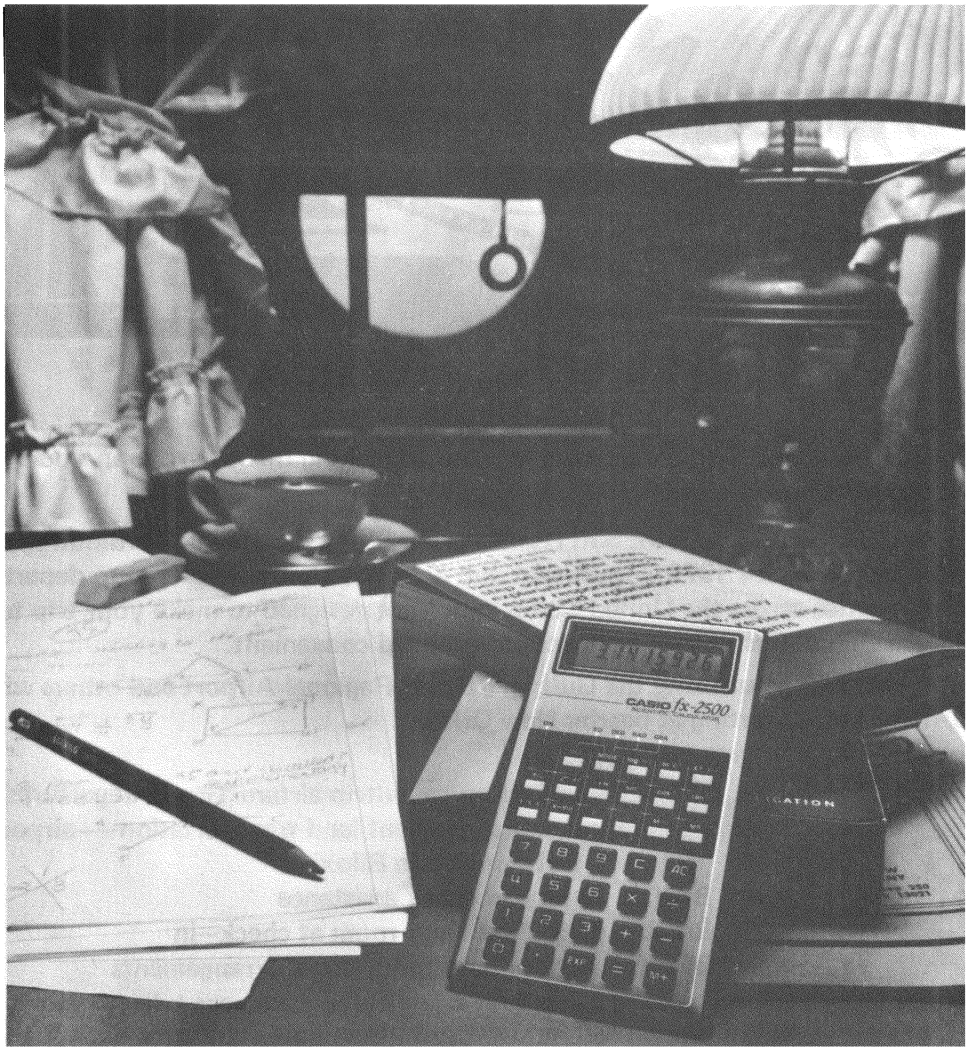


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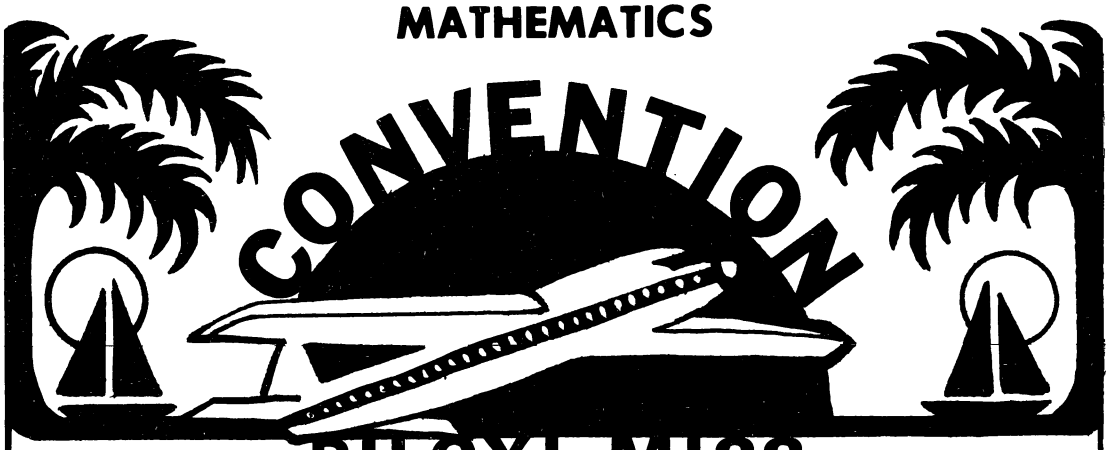


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## APPLICANT FORM

(See pp. 468–469.)

Name _____

Mailing address _____

Ⓐ Specialties _____

Ⓑ Career objectives - ACADEMIC ☐ Research, ☐ Teaching; NON-ACADEMIC ☐ Research and Development, ☐ Consulting, ☐ Supervision

Near-term career goals _____

Significant achievements: Significant projects, including role _____

Honors and offices _____

Others _____

Selected Titles of Papers, Reports, Books, Patents _____

Ⓒ Degree _____ Year _____ Inst. _____

Ⓓ Number of Abstracts and Internal Reports _____

Ⓔ Number of Papers Accepted _____

Ⓕ Number of Books and Patents _____

| Employment: | Position | Employer | Duties | Years |
|---|---|---|---|---|
| Present | | Ⓖ | Ⓗ | to |
| Previous | | | | |

Desired Position _____ Ⓘ Duties _____ Ⓙ Available mo. ____/yr. ____ Location _____ Salary _____

Ⓚ References _____

Ⓛ Citizenship _____

Ⓜ Available for Interviews [ ] Fri. A. M. 9:30–11:45 [ ] Fri. P. M. 1:15–5:00 [ ] Sat. A. M. 9:30–11:45 [ ] Sat. P. M.* 1:15–5:00

SUMMARY STRIP Name (family name first) (7) — Ⓐ Specialties — Ⓑ Career Objectives — Ⓒ Highest degree — Year (28)

Ⓒ Institution (39) — Ⓓ (42) — Ⓔ (45) — Ⓕ (48) — Ⓖ Most recent employer — Ⓗ Present duties — Ⓘ Desired duties (59) — Ⓙ Available Mo. / Yr. (64) — Ⓛ (69)

NOTES: A Algebra=AL, Analysis=AN, Biomathematics=BI, Biostatistics=BS, Combinatorics=CB, Communication=CM, Control=CN, Computer Science=CS, Circuits=CT, Differential Equations=DE, Economics=EC, Mathematical Education=ED, Functional Analysis=FA, Financial Mathematics=FI, Fluid Mechanics=FL, Geometry=GE, History of Mathematics=HM, Logic=LO, Mathematical Biology=MB, Mechanics=ME, Modeling=MO, Mathematical Physics=MP, Management Science=MS, Numerical Analysis=NA, Number Theory=NT, Operations Research=OR, Probability=PR, Systems Analysis=SA, Statistics=ST, Topology=TO, B Academic Research=AR, Academic Teaching=AT, Nonacademic Research and Development=NR, Nonacademic Consulting=NC, Nonacademic Supervision=NS, H I Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Data Processing=DP, J Date Available, 01/78, e.g. location: East=E, South=S, Central=C, Mountain=M, West=W, Outside U.S.=O, Indifferent=I, K References: Give three names with affiliations. L U.S. Citizenship Status: U.S. Citizen=C, Permanent resident=P, Temporarily in U.S.=T, Non-U.S.=N *Interviews are scheduled in this session on the basis of employer's requests only.

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EMPLOYER FORM
(See pp. 468–469.)

Institution _____ Dept. _____
Interviewer _____ Title _____
City, State, Zip _____

Ⓐ Title of Position _____ Number of Positions _____ Ⓑ Number of People Supervised _____

Ⓒ Starting Date _____/_____ (mo. / yr.) Salary _____ Ⓓ Term of Appointment _____ yrs. Ⓔ Renewal [ ] Possible [ ] Impossible

Teaching hrs./week _____ Ⓕ Specialties Sought _____

Ⓖ Degree Preferred _____ Ⓗ Degree Accepted _____ Ⓘ Duties _____ Ⓙ Experience _____ Ⓚ Citizenship Restriction _____

Ⓛ Available for interviews
1 [ ] Fri. A.M. 9:30-11:45
2 [ ] Fri. P.M. 1:15-5:00
3 [ ] Sat. A.M. 9:30-11:45
4 [ ] Sat. P.M.* 1:15-5:00

**SUMMARY STRIP**

Institution (7) | City, State | Ⓐ Title of Position (28) | Ⓑ No. (33) | Ⓒ Start Mo. / Yr. (36)

Ⓓ (41) | Ⓔ (43) | Ⓕ Specialties Sought (45, 58) | Ⓖ (60) | Ⓗ (62) | Ⓘ Duties | Ⓙ Experience (67) | Cit. Ⓚ (72) | Ⓛ Interviews (75)

NOTES: Ⓐ Inst, Lect, Asst Prof, Asso Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESC (Research Scientist); Ⓒ Date 01/79, e.g.; Ⓔ Possible=P, Impossible=I; Ⓕ Algebra=AL, Analysis=AN, Biomathematics=BI, Biostatistics=BS, Combinatorics=CB, Communication=CM, Control=CN, Computer Science=CS, Circuits=CT, Differential Equations=DE, Economics=EC, Mathematical Education=ED, Functional Analysis=FA, Financial Mathematics=FI, Fluid Mechanics=FL, Geometry=GE, History of Mathematics=HM, Logic=LO, Mathematical Biology=MB, Mechanics=ME, Modeling=MO, Mathematical Physics=MP, Management Science=MS, Numerical Analysis=NA, Number Theory=NT, Operations Research=OR, Probability=PR, Systems Analysis=SA, Statistics=ST, Topology=TO; Ⓖ Ⓗ Bachelor=B, Master=M, Doctor=D, Ⓘ Ⓙ Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Data Processing=DP, No experience required=N; Ⓚ U.S. Citizen=C, U.S.Citizen or permanent resident=CP, No restriction=NR; Ⓛ Periods available for interviews: List 1,2,3, and/or 4, see the FORM above.

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# PREREGISTRATION AND HOUSING FORM, BILOXI, MISSISSIPPI

Short Course on Game Theory, January 22-23, 1979 — Joint Mathematics Meetings, January 24-28, 1979

MUST BE RECEIVED NO LATER THAN DECEMBER 22, 1978

Please complete this form and return with your payment for registration fee(s) to:
Mathematics Meetings Housing Bureau, P. O. Box 6887, Providence, R. I. 02940

Those participants who desire to PREREGISTER ONLY should complete only the preregistration section of the form below. Please note that separate preregistration fees are required for the Short Course, for the Joint Meetings, and for employers preregistering for the Employment Register.

| | FEE SCHEDULE Preregistration prior to 12/22 | At Meeting |
|---|---|---|
| JOINT MATHEMATICS MEETINGS | | |
| Members of AMS, ASL, MAA, NCTM | $23 | $25 |
| * Student or unemployed | $ 2 | $ 3 |
| Nonmember | $33 | $35 |
| SHORT COURSE ON GAME THEORY | | |
| Member/Nonmember | $18 | $20 |
| * Student or unemployed | $ 3 | $ 5 |
| One day fee for second day | --- | $10 |

*The Unemployed status refers to any participants currently unemployed and actively seeking employment. It is not intended to include participants who have voluntarily resigned or retired from their latest position. Students are considered to be only those currently working toward a degree who do not receive an annual compensation totaling more than $7,000 from employment, fellowships, and scholarships.

---

## PREREGISTRATION : Please check the function(s) for which you are preregistering:

Joint Mathematics Meetings [ ]
Short Course on Game Theory [ ]
* Employment Register { Applicant (no charge) [ ] / Employer (fee $10) [ ]

*Please be sure to complete and return herewith the appropriate Employment Register form (see pp. A-733, A-734).

1) _____
NAME (Please print) surname first middle

2) _____
ADDRESS number and street city state zip code

3) Employing institution _____ Unemployed [ ]

4) I am a student at _____ (5) Name of spouse _____
(List only if accompanying to meeting)

6) Accompanying children (number) _____ (7) Member of: AMS [ ], ASL [ ], MAA [ ], NCTM [ ], (Member discount applies only to members of these organizations) or NONMEMBER [ ]
Member of other organizations: AWM [ ], MAG [ ], NAM [ ]

8) Preregistration fee(s) $ _____

9) Employer fee $ _____ (10) TOTAL AMOUNT ENCLOSED $ _____
(check or money order only)

(Please make check payable to AMERICAN MATHEMATICAL SOCIETY.)

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## HOUSING : Please indicate at least three choices in order of preference by writing numbers 1, 2, and 3 in spaces at left and by circling the requested type of room and rate. If less than three choices are given, or if first three choices are no longer available, the Housing Bureau will make your room assignment at the next available hotel with lowest rates.

1) I will arrive (date) _____ (hour) _____ a. m. /p. m., and depart (date) _____ (hour) _____ a. m. /p. m.
2) Please secure accommodations for me as ranked below: (Confirmation will be sent only to individual submitting form.)

| Order of choice | Name of Hotel | Single | Double | Twin Dbl. | Triple | Quad | Quint | Suite(s) |
|---|---|---|---|---|---|---|---|---|
| | The Broadwater Beach | $ 32/40 | $ 36 | $ 36/44 | $ 41/49 | $ 46/54 | $N/A | N/A |
| | | Exec. cottage (sleeps 10) $150 [ ]; Single cottage (sleeps 4) $50 [ ] | | | | | | |
| | Admiral Benbow Inn | 17 | 22 | 24/26 | 28/30/32 | 32 | N/A | N/A |
| | Biloxi Beach Motor Inn | 21 | 24 | 24 | 28 | 32 | 36 | $ 75 |
| | Biloxi Hilton | 26/29/33 | 34/37/41 | 34/37/41 | 42/45/49 | 50/53/57 | N/A | 75,110 |
| | | 38/40/42 | 46/48/50 | 46/48/50 | 54/56/58 | 62/64/68 | N/A | 150,186 |
| | Holiday Inn | 24 | N/A | 30 | 34 | 38 | 42 | N/A |
| | Howard Johnson's Motor Lodge | 22 | N/A | 28 | 32/36 | 36 | N/A | N/A |
| | La Linda Motor Inn | 20 | 20 | 24 | 24/28/32 | 32 | 36 | N/A |
| | Ramada Inn | 21 | N/A | 23/25 | 27/29 | 31/33 | N/A | 60 |
| | Rodeway Inn | 21 | N/A | 23/28 | 27/32/36 | 31/36 | 40 | N/A |
| | Sheraton-Biloxi Motor Inn | 36 | N/A | 42 | 46/50 | 50 | 54 | 120,160 |

3) Other room occupants, if sharing:

| FULL NAME | ADDRESS | Arrival date and hour | Departure date and hour |
|---|---|---|---|
| | | | |
| | | | |

[ ] I will not require a room.

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