NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY

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Calendar of AMS Meetings and Conferences

This calendar lists all meetings which have been approved prior to the date this issue of *Notices* was sent to the 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 been assigned. *Programs* of the meetings will appear in the issues indicated below. *First* and *supplementary* announcements of the meetings will have appeared in earlier issues.

Abstracts of papers presented at a meeting of the Society are published in the journal *Abstracts of papers presented to the American Mathematical Society* in the issue corresponding to that of the *Notices* which contains the program of the meeting. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

Meetings

Meeting #		Date	Place	Abstract Deadline	Program Issue
845	*	October 28–30, 1988	Lawrence, Kansas	August 24	October
846	*	November 12-13, 1988	Claremont, California	August 24	October
847	*	January 11–14, 1989 (95th Annual Meeting)	Phoenix, Arizona†	October 12	December
		April 15–16, 1989	Worcester, Massachusetts	January 25	March
	*	May 19–20, 1989	Chicago, Illinois	March 1	April
		August 7–10, 1989 (92nd Summer Meeting)	Boulder, Colorado	May 16	July/August
		October 21–22, 1989	Hoboken, New Jersey	August 30	October
		October 27–28, 1989	Muncie, Indiana	August 30	October
		January 17–20, 1990 (96th Annual Meeting)	Louisville, Kentucky		
		January 16–19, 1991 (97th Annual Meeting)	San Francisco, California		

* Please refer to page 884 for listing of special sessions

† Preregistration/Housing deadline is November 10

Conferences

June 4–August 11, 1988: Joint Summer Research Conferences in the Mathematical Sciences, Bowdoin College, Brunswick, Maine

July 3–23, 1988: Summer Research Institute on Operator Theory/Operator Algebras and Applications, University of New Hampshire, Durham, New Hampshire

July 18–29, 1988: AMS-SIAM Summer Seminar on Computational Solution of Nonlinear Systems Equations, Colorado State University, Fort Collins, Colorado

August 6–7, 1988: AMS Short Course: Chaos and Fractals: The mathematics behind the computer graphics

September 6–10, 1988: International Neural Network Society, 1988 Annual Meeting, Boston, Massachusetts (see news item, page 269, February issue)

Deadlines

	September Issue	October Issue	November Issue	December Issue
Classified Ads*	Aug 1, 1988	Aug 31, 1988	Oct 3, 1988	Oct 31, 1988
News Items	Aug 5, 1988	Sept 6, 1988	Oct 7, 1988	Nov 4, 1988
Meeting Announcements**	Jul 28, 1988	Aug 24, 1988	Sept 26, 1988	Oct 24, 1988

* Please contact AMS Advertising Department for an Advertising Rate Card for display advertising deadlines.

** For material to appear in the Mathematical Sciences Meetings and Conferences section.

NOTICES
OF THE

AMERICAN MATHEMATICAL SOCIETY

ARTICLES

FEATURE COLUMNS

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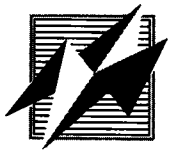
SUBSCRIPTION INFORMATION
Subscription prices for Volume 35 (1988) are $105 list; $84 institutional member; $63 individual member. (The subscription price for members is included in the annual dues.) A late charge of 10% of the subscription price will be imposed upon orders received from nonmembers after January 1 of the subscription year. Add for postage: Surface delivery outside the United States and India—$10; to India—$20; expedited delivery to destinations in North America—$15; elsewhere—$38. Subscriptions and orders for AMS publications should be addressed to the American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-9930. All orders must be prepaid.

ADVERTISING
Notices publishes situations wanted and classified advertising, and display advertising for publishers and academic or scientific organizations.

The paper used in this journal is acid-free and falls within the guidelines established to ensure permanence and durability. ♾

[*Notices of the American Mathematical Society* is published ten times a year (January, February, March, April, May/June, July/August, September, October, November, December) by the American Mathematical Society at 201 Charles Street, Providence, RI 02904. Second class postage paid at Providence, RI and additional mailing offices. POSTMASTER: Send address change notices to *Notices of the American Mathematical Society*, Membership and Sales Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940.] Publication here of the Society's street address, and the other information in brackets above, is a technical requirement of the U. S. Postal Service. All correspondence should be mailed to the Post Office Box, NOT the street address.



Centennial Celebration

This year's Summer Meeting has been termed the Centennial Celebration of the American Mathematical Society, but it is more than the occasion for the Society to celebrate its 100 years of service to the mathematical community. Yes, there will be a party atmosphere, with receptions, ceremonies, and happy hours for people to renew old friendships and start new ones. However, as with all Society meetings, the scientific program is the focal point and, in particular, this meeting will provide the opportunity for mathematicians to look ahead and to explore the future of mathematical research. The highlight of the scientific program is the "Symposium on Mathematics into the Twenty-First Century." This symposium will examine a spectrum of mathematical ideas, through a series of eighteen lectures by mathematicians selected for their outstanding contribution to mathematics and with the realization that they will continue their mathematical activities into the next century. The speakers include four Fields Medalists, three recipients of the Waterman Award, and several recipients of other major mathematical honors. Their lectures will be more expository in nature than usual and will appeal to the general mathematical audience.

The normal practice of having Special Sessions will not apply at this meeting, so as to provide the opportunity for the expanded set of invited addresses. Symposium lectures will be given each morning and afternoon, except for Monday morning which will be devoted to the Opening Ceremonies. Each lecture will be given in the Providence Performing Arts Center and they have been scheduled so as to avoid conflict with other major scientific activities. At least one contributed paper session will be held each day, and over 125 papers will be presented at these sessions. The AMS-MAA Invited Addresses, at this meeting, will be presented by Raoul Bott, Peter Lax, and Saunders Mac Lane and each will explore various aspects of mathematics during this century. The scientific program will be complemented by the AMS Short Course "Chaos and Fractals: The Mathematics Behind the Computer Graphics" and a series of MAA Minicourses. These activities will take place on Saturday and Sunday, prior to the Centennial Celebration.

All in all, the meeting will be rich in mathematics and enjoyable for its social activities.

Letters to the Editor

MS2000 Committee Representation

The April 1988 *Notices* listed the 16 individuals who have accepted appointments on the MS2000 Oversight Committee. (As many as three other appointments are under consideration.)

All members are either non-mathematicians or academicians. It seems a serious oversight that not one is currently practicing mathematics in government or industry.

Stanley J. Benkoski
Daniel H. Wagner, Associates
Sunnyvale, California
(Received April 25, 1988)

Queries Column

I am appalled that the *Notices* Editorial Committee has decided to discontinue the Queries Column, which has been ably and conscientiously edited by Hans Samelson. The Column, occupying only a single page, is the only regular feature of the *Notices* of permanent mathematical interest. It is ironic and galling that the announcement appears in an issue which has 30 of its 128 pages given over to paid advertisements.

What is more fundamental to mathematical inquiry than asking questions and getting answers to questions? Leading mathematicians, such as J.-P. Serre (in the current issue), have taken the pains to provide answers. How many research articles have been inspired by questions raised in the column? How much of our teaching has been enriched by it? Is there another major journal doing the same work?

I urge the Editorial Committee to reconsider its decision and restore the Column.

Seymour Kass
University of Massachusetts, Boston
(Received February 8, 1988)

A great pity that you decide to stop queries. It was a unique possibility to ask questions to the whole mathematical community, especially useful for us, mathematicians from countries with severe postage restrictions. I often used it, often obtained valuable answers. Many of my queries could not pass the USSR boundary, some where somewhy rejected by AMS–nevertheless, many were published. And now–alas. If the decreased number of queries is the unique reason–well, to tell the truth I could (and can) personally send as many senseful queries as you wish–I thought it nonpolite to send too many of them.

I'm really disappointed by the manner in which queries column was closed: a red-tape manner recalling the worst Soviet traditions, without any previous discussions (or even a suggestion for discussion). When I argued 10 years ago that reviewing is good for us, for mathematical community, for USSR, (in a special letter to my superior colleagues), queries possibility was one of the main points.

Maybe make it irregular, not close? To tell the truth I don't like the possibility to start correspondence with AMS like that I had with Soviet Airlines for their red-tape regulations, but the closure of queries is a bad precedent. Shall we open *Notices* with the same fear as we here some years ago opened Soviet newspapers: what else is made worst–without any consultation with us?

I'm not a lawyer but to my mind it is necessary that such decisions be made by AMS administrations as a whole, after public discussion–Editorial Committee must not act as a Stalin Politbureau.

Excuse my possibly non polite words.

Vladik Ya. Kreĭnovich
Leningrad, USSR
(Received March 4, 1988)

Policy on Letters to the Editor

Letters submitted for publication in *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 publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

Comments on a Commentary Letter

In "Commentary on Defense Funding" (October 1987), Mikhail Katz mentions John von Neumann as an example of a mathematician who was willing to work on military-related projects. Katz asserts "Thurston might well be challenged to produce a figure of von Neumann's stature on his side of the fence." The following passage from the late Richard Feynman's *Surely You're Joking, Mr. Feynman!*, however, casts doubt on the use of von Neumann's credentials in the context of the current debate:

> And von Neumann gave me an interesting idea: that you don't have to be responsible for the world that you're in. So I have developed a very powerful sense of social irresponsibility as a result of von Neumann's advice. (Richard Feynman, *Surely You're Joking, Mr. Feynman* [New York: Bantam Books, 1986], 115).

Stephen J. Fromm
Massachusetts Institute of Technology
(Received April 5, 1988)

ANNOUNCING...

MathSci™ on CD-ROM

Now you can access the American Mathematical Society's online database, MathSci, on CD-ROM (Compact Disc-Read Only Memory). The CD version, called MathSciDisc™, will combine the searching features of online MathSci with the browsing ease of printed *Mathematical Reviews (MR)*. For a fixed annual fee, MathSciDisc can be used at leisure without access charges or telephone connections.

Semi-Annual Issue

MathSciDisc will be produced by SilverPlatter ® and will be issued semi-annually. The first MathSciDisc, available in January 1989, will contain all the reviews and abstracts from *MR* 1985 through 1988 and over 50,000 entries from *Current Mathematical Publications (CMP)*. The July disc will have all the information on the January disc plus the January-June 1989 updates. Access to current information between the CD issues is available online from MathSci, which is updated monthly on DIALOG, BRS, and ESA.

Easy-to-Operate

MathSciDisc will be available for both the IBM PC and the Macintosh. SilverPlatter's user-friendly CD software with help screens and menus will make MathDisc easy to use. Words and phrases in the text of the reviews and abstracts will be searchable with an adjacency operator. Records can be downloaded from MathSciDisc to the hard disk for editing or for processing with TEX software into typeset form with mathematics.

The MathSciDisc 1989 annual lease fee will include the January and the July issues of MathSciDisc, the SilverPlatter search software for the IBM or the Macintosh, the SilverPlatter search manual with a MathSciDisc chapter, and a toll-free help line.

The 1989 MathSciDisc will be available at a low annual lease fee, equal to that of the printed *MR*:

Nonmembers: List price - $3,510*
additional leases - $2,106*

AMS members & *MR* subscribers:
AMS Members: $2,808*
MR subscribers: $2,106*
AMS members with an *MR* or MathSciDisc subscription: $1,685*

Individuals at institutions subscribing to MathSciDisc can order a copy for personal use at a 90% discount: $351*. (*Plus shipping & handling for addresses outside the U.S. and Canada.)

For Information

For more information on MathSciDisc or to receive a copy of the lease agreement, please contact Taissa Kusma, Head, Database Services, American Mathematical Society, P. O. Box 6248, Providence, RI 02940 or call (800) 556-7774 in the continental U.S. or (401) 272-9500. Internet: TTK@MATH.AMS.COM; Telex: 797192;

THE GROWTH OF THE AMERICAN MATHEMATICAL SOCIETY

Everett Pitcher

The American Mathematical Society has grown and expanded during its second fifty years while remaining true to its stated purpose. In 1938 the Society was an incorporated membership organization with 2139 members. Its purpose was stated in its article of incorporation as "the furtherance of the interests of mathematical scholarship and research." It published two journals, the *Bulletin* and the *Transactions*, and one book series, the *Colloquium Publications*. It held about ten meetings a year, an Annual Meeting in December, a Summer Meeting in September, and six to eight sectional meetings in three sections, Eastern, Western, and Far Western. Its headquarters was at Columbia University where it had a staff of four including an office manager. The annual dues were $8.00.

The Semicentennial Meeting was by far the largest meeting held until that time by the Society, with nearly seven hundred persons in attendance. Summer meetings were usually larger than winter meetings, but attendance figures around three hundred were common.

The world of the late 1930s was one of seventy-five Ph.D.'s in mathematics per year in the United States.

World War II had a substantial influence, both disruptive and developmental. The Zentralblatt für Mathematik und Ihre Grenzgebiete almost closed because of effects of antisemitism and war. The gap was filled by the founding of *Mathematical Reviews*, which began in January 1940 with literature from January 1939. It has been regarded as the most significant publication of the Society.

The need for space for publication increased after the war and was met by several steps. *The Bulletin* had consisted of two kinds of issues, gray issues of papers and green issues of all other material. The gray issues became the *Proceedings* in 1950, and the number of pages increased greatly. At the same time, the *Memoirs* was started as a book series (and later as a journal with back issues sold separately) by diverting longer papers from the *Transactions*. The latter increased greatly in size as well.

The programs of the Society, distributed as separata until 1953, became a journal, *Notices*, in 1954. Beginning in 1958, abstracts of contributed papers appeared in advance of meetings in the *Notices*. The abstracts were shifted to a new journal, the *Abstracts*, which appeared in 1980.

Mathematical Tables and Aids to Computation was a journal published by the National Research Council (NRC) since 1943. Beginning in 1962, it was published by the Society for the NRC, the title having been changed in 1960 to *Mathematics of Computation*. By 1966 it was a journal of the Society with representation on the Council.

The Society has engaged in translation of books and journals since 1948. The most abundant source language has been Russian. Translation from Chinese was carried on briefly and has begun again. The most recent entry is the journal *Sugaku Expositions*, which is the translation of expository papers from the Japanese journal *Sugaku*.

The Journal of the American Mathematical Society is the newest of its journals, with 1988 as its year of inception.

The Society has been associated with the *American Journal of Mathematics* since 1926, and supplies two of its editors, but has not otherwise subsidized the journal since 1975.

On the other hand, there are distinguished publications with which the Society has been associated but is now no longer. It supplied some editors for the Duke journal from its inception in 1935 to 1975. This action initially added support in prestige to the journal, which outgrew the need.

From 1940 to 1966 the Society supplied some editors for *The Annals of Mathematics*.

The Society has subsidized at least nine other journals in the interval 1946-1976. The principle was to help a new journal with a good concept when space available for publication was constricted.

Membership has grown with time. Here are a few figures.

Year	Number of Members
1940	2314
1950	4386
1960	6725
1970	14197
1980	19984

The current number is almost 21000.

The staff of the Society has grown as well. In 1938, there was a staff of four. The Society was housed in space rented from Columbia University. *Mathematical Reviews* was housed in Providence from the beginning. When the headquarters moved to Providence in 1951 the total was 19. An Executive Director had been in charge since the end of 1949. In 1962, the entire operation was still in Providence with about 82 employees. *Mathematical Reviews* moved to Ann Arbor in 1965. In 1968, there were about 87 employees in Providence and 26 in Ann Arbor. The number now stands at about 157 in Providence and 74 in Ann Arbor.

Since leaving Columbia, the Society has been housed in four different rented locations in Providence and *Mathematical Reviews* at three in Ann Arbor. The headquarters is now in a building built by the Society in 1973 and *Mathematical Reviews* is in a building bought and remodeled by the Society in 1984.

The style of publication has changed materially. It was in 1938 that it was first specified that articles submitted to *The Bulletin* must be typewritten. Mathematics was composed in cold type and printed by printing houses under contract. The Society has gone through a succession of technological changes; today the books and journals of the Society are composed on electronic computers in the language TEX in the Providence and Ann Arbor offices or by authors themselves. They are printed and bound in the Providence office, except for a few with the largest press runs.

People inquire gently sometimes about the cost of the operation. The dues in 1938 were $8.00. Inflation between 1938 and 1988, measured by the consumer price index, is a factor of 8.4. In those terms, the dues of 1938 translate to $67.00 today. In fact, the regular dues of 1988 are $88.00 for those with higher professional income and $66.00 for those with lower income. The change can be attributed to the increase in services and the changes in labor from volunteers to employees.

Here are some of the new services that have been instituted for the members, some self-supporting and others covered from general funds. In 1938 one did not apply for a position. One's thesis adviser had conversations with friends who were department heads and proposed one for a position. The Society now operates an employment register and publishes a journal on available candidates and positions.

The Annual Survey, covering a variety of questions on salaries and other aspects of employment, is in its thirty-second year.

The availability of fellowships and assistantships has been listed annually since 1959, and has appeared as a regular issue of *Notices* since 1965. Postdoctoral opportunities have been listed in the same issue. These matters are about to become a separate publication.

The annual, summer, and sectional meetings were all there was in 1938. Now the Society sponsors a summer institute in pure mathematics, a summer seminar in applied mathematics, up to ten summer research conferences, and several symposia each year.

From one book series and two journals the publication program has grown to twenty journals and eighteen book series.

The last one hundred years have witnessed an unprecedented growth in the volume, sophistication, and diversity of mathematical research. During that time, the American mathematical community has grown from a small group to a much larger one that now sets the world standard for many areas of mathematics. The range of services and publications the Society provides has grown in response to the increased needs of the mathematical community. The burgeoning of the discipline and the increasingly important role that mathematics plays in society will provide even greater challenges as the AMS enters its second century.

WILLIAM J. LEVEQUE RETIRES AS EXECUTIVE DIRECTOR

In September of this year, William J. LeVeque will retire from his position as Executive Director of the AMS. The Society wishes to express its appreciation for his many contributions during his eleven years of dedicated service.

Biographical sketch

Dr. LeVeque was born on August 9, 1923 in Boulder, Colorado. He earned his B.A. degree with highest honors from the University of Colorado in 1944, and received both a master's degree in 1945 and a Ph.D. in 1947 from Cornell University. From 1947 to 1949 he was a Benjamin Peirce Instructor in Mathematics at Harvard University. Becoming an Instructor at the University of Michigan in 1949, he advanced to the rank of Professor by 1960, and from 1967 to 1970 he served as Chairman of the mathematics department. In 1970, he accepted a position as Professor at the Claremont Graduate School in Claremont, California, where he served as Chairman of the mathematics department in 1973 and 1974. He remained at Claremont until he became Executive Director of the Society in 1977. During 1951-1952, Dr. LeVeque was a Fulbright Research Scholar in Manchester, England. He was also a Sloan Research Fellow from 1957 to 1960 in London, England and Göttingen, Germany.

Dr. LeVeque was very active within the Society even before he became Executive Director. He served on the *Proceedings* Editorial Committee from 1961-1963 and was Executive Editor of *Mathematical Reviews* in 1965 and 1966. He also served on the *MR* Editorial Committee and the *MR* Crisis Committee. In addition, he has been a member of many other Society committees, including the Invitations and Organizing Committee for the November 1963 Symposium in Number Theory; the Committee to Monitor Problems in Communication (Chairman, 1967-1969); the Selection Committee for the Cole Prize in Number Theory (1971); the Committee on a Comprehensive Subject Index (1971-1972); and the Committee on Science Policy (1975-1977).

Dr. LeVeque has also been involved in a number of scientific sessions at AMS meetings. He spoke at the Symposium on Theory of Numbers in Pasadena in November 1963, and at a Special Session on Probabilistic Number Theory at Urbana in November 1970. He also organized Special Sessions on Number Theory (Houston, Jaunuary 1967), and on Distribution Modulo 1, and Random Number Generation (San Francisco, January 1974).

William J. LeVeque

Active in national science policy matters, Dr. LeVeque served as Chairman of the Commission on a National Information System in Mathematics in 1968 and 1969, and as a member of the Advisory Panel of the Mathematical Sciences Section of the National Science Foundation from 1969-1972 (Chairman, 1971-1972). He also was a member of the U. S. National Committee for the International Mathematical Union of the National

Academy of Sciences (1969-1975), a United States delegate to the 1970 and 1974 General Assemblies of the International Mathematical Union, and Chairman of the Conference Board of the Mathematical Sciences from 1973 to 1975.

Dr. LeVeque's research interest is in number theory, and he has published several books on the subject, including *Topics in Number Theory* in 1956, *Elementary Theory of Numbers* in 1962, and *Number Theory* in 1978. In 1978, Dr. LeVeque received an award from the Special Libraries Association for editing the six-volume work, *Reviews in Number Theory*, and for his association with *MR*. The award cited his contributions to the documentation of the literature of mathematics.

Comments

George Daniel Mostow, President of the Society was asked to provide his personal reflections on Dr. LeVeque's contributions to the AMS. He responded:

I first met Bill LeVeque, then a young number theorist from Michigan, on an AMS committee. I soon learned to listen very closely to his comments, which invariably made good sense and were illuminating. That impression of Bill has persisted throughout all the years and has been repeatedly confirmed during my term as president of the AMS.

Very often, in scientific societies, there is a divergence of viewpoints among the staff and the scholars. Fortunately for the AMS, Bill has never drifted far from the moorings of his distinguished academic career as a mathematician. His great vigor has consistently been directed at the right target: the advancement of mathematics.

During his stewardship, our Society has significantly increased its services to mathematicians, and Bill has played an important role in developing the revenue to pay for the increased mathematical activities.

During the past two years, as the need to develop a higher visibility for mathematics in the public forum became recognized, Bill played a unique role in leading the Joint Policy Board for Mathematics through a tense period of mounting budgets. Thanks to Bill's persuasive and steady role, JPBM finally can look forward to an Office of Government and Public Affairs which can both accomplish our purpose and be affordable.

Bill's stature and achievements have imparted considerable prestige to the AMS Executive Director position. I came to appreciate this keenly during my service on the search committee for his successor.

I join the many admirers of Bill LeVeque in hailing the lasting contributions he has made to the American Mathematical Society.

Irving Kaplansky, President of the Society during 1985-1986, was asked to provide his personal reflections on Dr. LeVeque's contributions to the AMS. He responded:

Some time soon it will be appropriate to look back at the decade of the 1980s and ask: how is mathematics doing? Is the enterprise in good health? A list of accomplishments might include: the classification of finite simple groups, the Mordell conjecture, the Bieberbach conjecture, the van der Waerden conjecture on permanents, the four-dimensional Poincaré conjecture, the structure of smooth four-manifolds, and the new knot polynomials. Let me add that the decade also saw the reconciliation of mathematics and physics moving ahead nicely. So the verdict is that mathematics is thriving. Moreover, American mathematics is clearly at the forefront, the American Mathematical Society is the nerve center of American mathematics, and all this is happening with Bill LeVeque at the helm of the Society.

On the mathematical political scene, the remarkable David report was followed by a degree of visibility for mathematics and its Washington presence that would have been unthinkable just a short while ago. The AMS deserves much of the credit, in the crudest quantitative sense: the lion's share of the funding of the Washington presence is being provided by the Society, under Bill's leadership.

We owe other things to Bill. Not the least of these are his fine two volume treatise on number theory, his collection of Reviews in Number Theory, and his years as Executive Editor of Mathematical Reviews.

The years 1985 and 1986 were good years to be the President of the Society. There was a gratifying turn around of the proverbial dime, from alarming deficits to reassuring surpluses. Bus Jaco will inherit a Society that is fiscally sound, ready to march in good order to the end of the century.

What was it like to work with Bill? In a word: great. I remember with pleasure his courtesy, his wit, and his untiring efforts to get everybody to do their jobs right. When needed, there was also a hint of steel inside the velvet glove. Many times, when a tricky discussion was bogging down, he would wait till the right moment and then firmly point to the nub of the matter.

I am currently having a good taste of administration. Let me tell something to the readers of this piece. When we go to a meeting and find everything running smoothly with every need foreseen, we probably do not give it a thought. (Of course, when the opposite is true we scream bloody murder.) The next time this happens to you at an AMS meeting, think about it. Somebody has worked hard to make it happen. That somebody is Bill LeVeque, ably aided by the superb staff he has assembled.

Bill, I wish to give you my personal heartfelt thanks in this public way, and wish you lots of fun in the next stage of your career.

THE AMS — THEN, NOW, AND SOON

William J. LeVeque

A talk presented at the 842nd meeting of the Society in Las Cruces, 8 April 1988.

How I Got Here

As I started thinking about this talk and how the Society used to be, I got to thinking about how *I* used to be—and how I came to be talking about the AMS instead of mathematics tonight. It occurred to me that there were one or two anecdotes that would shed some light on the Society's development, and at the same time provide some clues to those of you who would prefer to stay clear of the kind of thing I have been engaged in these past eleven years, or, equally, to those of you who might be interested in getting into this kind of work.

My first serious brush with the AMS came almost 30 years ago. During a two-year stay in Europe a few years earlier, while on a Sloan Fellowship, Harold Davenport and I had begun to talk about a rather grandiose plan to prepare a sequel to Dickson's *History of the Theory of Numbers*. This was a monumental book which covered the subject from antiquity to about 1910; it was known and used by every number theorist in the world, I suppose. When I returned to Michigan, Don Lewis and I developed the plan further. It was to be a splendid book, with chapters by about a dozen number theorists of the caliber of Erdős, Turán, Linnik, and Mahler, tracing the development of their specialties, and with lists of open problems as well as complete bibliographic listings for the period involved. But it turned out to be too expensive and the NSF didn't fund the proposal. At that point Gordon Walker, then executive director of the AMS, invited me to work for *Mathematical Reviews* instead, and I went to Providence for three months in the summer of 1961.

MR was then near death. The executive editor's attention had been diverted to the problem of translating Chinese mathematics, another editor was bogged down in the problem of producing a 1959 subject index, already two years overdue, and a third was temporarily on leave. Walter Hayman, then of Imperial College, London, had finished a speaking tour in this country a few months early, and he came to Providence too. We were put to work assigning journal articles to the various reviewers, from what seemed to be an enormous backlog. As we finished assigning the articles in each issue we put the latter on a pile in the corner of the room—until the top of that pile rose to eight feet and we had to start a new one. Of course we soon lost track of what we had assigned and to whom, and probably some reviewers got hundreds of articles eventually. I don't know just when 'eventually' was, as not a single issue was removed from the stack and processed further during our stay there! There was a new executive editor a few months later (Jack Lohwater) who was capable of working 18–20 hours a day, and within about three years he had the journal back on schedule.

The summer of '61 didn't seem especially significant in my life at the time, as I was otherwise busy teaching and doing research in number theory at Michigan. But in fact it strongly influenced much of what happened to me after that. By 1964 the Board of Trustees had decided that the *MR* editorial office had to be moved to a large university with an abundant supply of consulting specialists. When the decision was made to move it to Ann Arbor, I agreed to take over from Lohwater, who was by then ready to retire from the job, and to set up the new office. I had never hired or fired anyone, nor kept regular hours, nor made or attempted to abide by a budget, and I didn't really know much about how *MR* worked, so it was a plunge into unknown waters. I hired a secretary, a Slavic expert, a proofreader, and a librarian, and we all went to Providence for six weeks to learn our jobs. Only two staff members moved back with us in June of 1965, but somehow all our issues went off to the printer at most two weeks late, and we had hired a nearly complete staff of about 20 by the end of the summer.

A little over a year later Sterling Berberian took over as editor and I went off to the Moscow Congress, and again it seemed that I was finished with AMS jobs. But by 1968 I found myself chairman of the newly formed

Committee to Monitor Problems in Communication, or Comm.-Comm., as it came to be known. This must have been one of the most active committees in the annals of the Society; we met quarterly for a day or two for the better part of my three-year term, at least. This level of activity was probably due primarily to Gordon Walker, who helped enormously through his awareness of new developments in scientific communication and technology; this was his first opportunity to make practising mathematicians realize what was going on in these areas in the other sciences.

Not everything we tried was successful, of course, but some things lasted:

• We organized a conference at which an entirely new classification scheme was developed for modern mathematics; a slight variant of it is still used by *MR* and *Zentralblatt für Mathematik.* (By the way, if you are unhappy with either the Dewey Decimal or the Library of Congress classification system, don't think they have gone unnoticed; Society representatives have tried many times to get them improved, without success.)

• The Mathematical Offprint Service, or MOS, was a precursor of the online bibliographic databases common today, and I think it was the first full-blown service of its kind in any scholarly discipline. Each subscriber provided a profile of his or her interests, using the classification system just mentioned, and each article from hundreds of journals was similarly classified as to its contents. Then the computer matched articles with subscribers, and appropriate offprints, which had been obtained from the publishers, were sent out. There were about 1100 subscribers, but the price had been set too low, and the service was finally killed for lack of sufficient income.

• Comm.-Comm. also did smaller things, such as instituting abstracts and key words in AMS journals, getting the zero-backlog policy adopted for all Society journals, and starting a new periodical, *Contents of Contemporary Mathematical Journals.* The latter was an inexpensive journal consisting simply of copies of tables of contents of about 300 major journals. Later, its format was changed and it was renamed as *Contents of Mathematical Publications.* It is still thriving.

• We also tried something much more ambitious, to create a so-called National Information System for the Mathematical Sciences. We worked at this for over a year with representatives from about ten other mathematical organizations, but it never got off the ground.

I left Ann Arbor in 1970 after three stormy years during the Viet Nam War as chairman of the department at Michigan. During the seven years I taught in California, I finally accomplished part of one of my earlier goals by publishing a six-volume collection of *Reviews in the Theory of Numbers.* But it covered only the period after 1940; the subject had simply grown too large for me to have the courage or resources to push back past the date at which *MR* had started.

The point in recounting these activities is to show you how I was naturally and gradually led away from my career in teaching, and research in number theory, to a stronger interest in the dissemination of information in mathematics. When I was invited to succeed Gordon Walker as director I really couldn't resist, and I went to Providence again in 1977.

How The Society Was Then

The Society was then doing many of the things it does now, of course. In the thirty years since the headquarters had been moved from New York City it had outgrown four successive sites, including a portion of a mental hospital, and the Society had finally built its own building two years before I came. The hundred or so employees were busy producing our various books and journals, running meetings, maintaining membership records, fulfilling orders, and keeping the books, just as today. The Society's computer, a Univac Spectra, was used for all of these functions. Its use in publishing, along with some other exotic equipment, was quite unusual for that time, as most publishers still sent paper copy to commercial typesetting houses where hot type was cast on a Linotype machine. Again, Gordon Walker must be credited with envisaging the effect that modern technology could have on publishing.

Let me tell you about some of this avant garde work. The least exotic, perhaps, but to me the most impressive technique involved the use of typewriters. A number of the journals were then prepared on typewriters, in the interests of economy, and of course it's not easy to type decent-looking mathematics. The solution to that problem still astounds me. The machines were IBM Selectrics, which used type balls instead of keys. In front of each of the typists were thirteen balls, with italic, Cyrillic, Greek, and Roman alphabets in various sizes, as well as balls with special mathematical symbols. The typists appeared to use all thirteen balls with equal fluency, interchanging them rapidly and sometimes frequently, and typing with no discernable diminution in speed, and usually without special keyboard templates. Like Chinese acrobatics, it had to be seen to be believed.

An experiment using more technology was still under way when I came. By that time the Society already owned its second, improved, model of the Photon, a pioneering optical typesetter. On this machine, when the typist struck a key it caused an opaque disk to rotate so as to position an aperture having the shape of the desired character in front of a beam of light. Lenses focused the beam on light-sensitive film so that the image of the character was recorded in the right place on the film, and then the operation was repeated.

Code names in ordinary ASCII letters could be used to call up nonstandard characters, so the potential number of characters was very large. But the Photon had far too many moving parts and mechanical components, of course, and it was soon displaced by a typesetting program run on a computer; the code was input in Providence and shipped on tape to a firm on Long Island, where it was processed and the material was set on a phototypesetter.

Equipment was also in the office for scanning material into the computer from manuscripts prepared with special typewriters having bar codes beneath the various letters. It was thought that the bar codes could be more reliably read than the special fonts then in use with scanning equipment. But the equipment could never be made sufficiently robust, and the experiment was abandoned soon after I came. Another unsuccessful experiment was with the Flexowriter, a machine that turned keystrokes into punched tape, which in turn was fed into a computer. Its use had been pretty well discontinued by the time I came, but I still heard stories of mountains of tangled and torn paper tape, and of millions of little round dots of paper that had been punched out and were floating around the building.

What Has Happened Since

So that's how it was in 1977. Since then, change has permeated every facet of the AMS operation, and I might mention some of the major events and movements.

The Univac wasn't in great health when I came, and we soon installed a DEC 20-20 and began rewriting almost all the hundreds of production programs then in use. We thought the new computer would suffice for several years, but this was the first time-sharing machine in the office, accessible to persons who were not computer experts. The operators couldn't install terminals fast enough to get everyone on who wanted to use it, so in fact the machine lasted only about six months, when we had to replace it with the bigger model 20-60. Then *MR* was tied in from Ann Arbor, and usage continued to grow, so we bought a second 20-60, thinking we would soon replace one of the two with the still larger 20-80. But then DEC announced it was discontinuing the entire line. Even though the machines might have lasted indefinitely, there would be no new software for them and programmers would not be interested in working on them, so after a thorough study of the options we purchased a VAX 8600 two or three years ago and again started rewriting the programs. Now we also have a VAX 8700, and with the 20s still in place for another year or so, we temporarily have plenty of computing power.

Along with hardware came software advances. *MR* had already started to computerize its operations on the University of Michigan computer system, and moving the system to the Providence machine entailed constructing a rather large and intricate database. Now we are in the midst of converting both Providence's and Ann Arbor's major programs to large databases on the VAX. This will be about a five-year project in Providence, and rather less in Ann Arbor because much of the structure of the database has already been worked out.

Perhaps I will give you some data on the size of the various groups involved so that you can see the magnitude of the work the two offices engage in. Twenty-four people are now employed in the Computer Services division in Providence, including programmers, analysts, and computer operators, and there are eight more in Ann Arbor.

Two other technological developments are worth mentioning. In 1978 Don Knuth gave the Gibbs Lecture on mathematical typography and announced his new composition system for mathematical text, which he called TEX. Even before that the Society had become involved with TEX, and we have contributed strongly to its development ever since. We hired Michael Spivak to write an add-on package, which we call $\mathcal{A}_{\mathcal{M}}\mathcal{S}$-TEX, to simplify the use of TEX for mathematicians. We now use these systems for the composition of all our books and journals, and we publish papers from TEX input tape prepared by authors. We also provide the personnel to edit the TEX Users Group newsletter, TUGboat, and we make available to the public several collections of characters for TEX output, including Fraktur, Cyrillic, and our definitive collection of mathematical symbols.

About 30 people in Providence and five more in Ann Arbor are principally engaged in the keyboarding and composition of text for our books and journals.

Also on the publishing side, we decided a number of years ago to make *MR* available as an electronic database, which we call MathSci. You can dial in to one of the commercial vendors (Dialog or BRS) and search all of MR back to 1959. Recently, we have added other societies' databases on statistics and computer science, augmenting the coverage of these subjects in *MR*, and you can access all of this material through MathSci. In your search you can use any boolean combination of words from the author's name, the title of the article or book, the classification code, the journal name, and the review itself. This enormously strengthens the access modes available in comparison with the traditional author and subject indexes. The mathematical symbols in the reviews are in TEX input code, which is fairly readable as it stands, or you can run each record through TEX and get a page that looks like the original *MR* review.

Speaking of *MR* indexes, it finally became possible, with the help of computers and TEX, to produce that missing subject index from 1959 that I mentioned earlier, and all its brethren, so that there is finally a complete

set of author and subject indexes from 1940 on. This grand project, which was guided by John Selfridge while he was *MR* editor, involved some hundreds of thousands of dollars in production costs.

The nearly complete computerization of Society operations, while in a way the largest effort of the past ten years, is certainly not as visible to outsiders as some of the other developments. The *Notices*, for example, has changed considerably. The *Abstracts* was split off as a separate journal some time ago. Several new kinds of articles were incorporated, such as short reports on recent important mathematical developments, Dick Palais' column on technical word processing, and the annual reports of the Secretary and myself. And there has been a gradual but steady improvement in the overall appearance of the *Notices*, culminating in a complete redesign this year.

One new book series, *Contemporary Mathematics*, was started and now contains about 70 volumes. Another, *Surveys and Monographs*, was successfully rejuvenated and usually several new books now appear in it each year. And 1988 saw Volume 1 Number 1 of the new *Journal of the AMS*. It will be followed this summer by *Sûgaku Expositions*, a journal of translations of Japanese expository articles.

The editorial function, of readying authors' manuscripts for keyboarding, engages the attention of about 35 employees in each of the Providence and Ann Arbor offices.

The steady-state meetings program is very similar to what it was eleven years ago, except that we now also run the ten Summer Research Conferences each year. Of course, the ICM in 1986 and the Centennial meeting coming up this summer are major perturbations in what was already a very demanding program for the staff involved. You can have no idea of the amount of detailed planning that goes into a national meeting! There is a check list of over 1,000 items to take care of, from the simple matter of learning the telephone number of the local FBI office to the preparation of the complete meeting schedule. The collection of instructions for everyone working at a meeting runs to more than 200 pages. I doubt very much that any other society takes such pains as does the AMS to see to it that meetings are as pleasant and smooth as possible for the participants.

These meetings, the SRCs, and another 15 meetings and conferences are organized and run each year by a staff of ten.

Five or six years ago we decided we could do our own printing and warehousing more cheaply than we could pay someone else to handle these functions, so we put a rather large addition onto the Providence building to house them. About 20 employees are required to staff these operations. And three or four years ago we bought the building occupied by *MR* in Ann Arbor, so the Society now owns about five million dollars worth of real estate.

By now I've accounted for about 110 Providence employees. The other big groups that I haven't mentioned include the department that handles membership records and order fulfillment, the fiscal department, and the management groups in the two offices. Altogether, there are now about 150 employees in Providence and about 70 in Ann Arbor.

And of course we also have had a small contingent in Washington for the past few years, in the person of Ken Hoffman and his staff, who are engaged in public awareness efforts. But that is really a joint activity with the MAA and SIAM.

Soon...

Now let me turn to the future activities of the Society. I can't fail to mention first that this centennial year is also the year of the changing of the guard. I will be replaced in September by William Jaco (or Bus, as he is commonly known), who is coming from Oklahoma State University. And Everett Pitcher, the very able Secretary of the Society for the past 21 years, retires at the end of 1988. He will be followed by Robert Fossum of the University of Illinois. These are much younger men and they will surely bring many new ideas with them. There are also a number of young and very active members of the Council who can be expected to influence Society policy. So I think you can look forward to a good number of changes that I can't possibly predict.

I can predict some new developments, however, simply because they are already in the works. One is that the Society will be concerning itself rather more than in the past with mathematics education. The first visible movement in this direction came just this spring, when we sent off to the NSF a joint proposal, with the MAA, for funding a newsletter concerned exclusively with collegiate mathematics education. This will be a bimonthly at the outset, in newspaper format, and it will be sent free during 1989 to all members of the AMS, MAA, and AMATYC, as well as to all teachers of advanced placement mathematics in the country's high schools. Also, the Executive Committee of the Council is now developing a committee structure that will enable the Society to work effectively with the MAA, the MS2000 project, and the Mathematical Sciences Education Board on problems of common concern. The AMS has a parochial interest in these matters, of course, because of the predictable shortage of PhDs in mathematics to staff the nation's colleges and universities during the next decade or two. But there is also growing awareness among many research mathematicians that our participation is needed if the spectrum of problems in mathematics

education from the elementary schools through graduate school is to be properly addressed.

In the publications area, I recently mentioned in my annual report in the *Notices* that several new books series have been authorized. These include books on the history of mathematics, reprints of important older books that have been allowed to go out of print by other publishers, and translations of books originally published in Chinese or Japanese.

Speaking of translations, we have a contract to publish a new Soviet journal, scheduled to commence in 1989. And it appears that *glasnost'* may enable the Society to establish more direct relationships with Soviet mathematicians who are writing books, so that we can copublish books in English more or less simultaneously with the Russian editions.

The big news about *MR* is that it will soon be published in an entirely new form, as a compact disc. The contents of about five years' worth of issues of *MR* can be digitally recorded on one CD-ROM, as this kind of disc is called. Using appropriate indexes and search software, also recorded on the disc, you will be able to search the disc just as you can MathSci, described earlier, and see the reviews on the monitor. With a printer attached to your microcomputer, you can search and read the reviews retrieved at your leisure. The price of a subscription, in which the discs will be updated semiannually or maybe even quarterly, will be only a few hundred dollars for individuals at institutions having subscriptions to the discs. This may sound expensive at first reading, but it is extremely low by the standards of the CD-ROM industry, and it will give you much more powerful access to the mathematical literature than does *MR* on paper.

Somewhat less exciting, perhaps, is that *Mathematical Reviews*, in collaboration with *Zentralblatt für Mathematik*, is preparing a revised version of the classification scheme, to be used in both journals starting in 1990.

I would guess that the Society will establish an electronic bulletin board in the near future. Anyone with a microcomputer and a modem can then dial in and keep in touch with any of various special interest groups, such as the people interested in a certain mathematical specialty, a committee, an editorial board, or a collection of calculus teachers. This service may be free at first, if Federal funding can be obtained, and in any case it should be quite inexpensive.

Efforts are now being made to find ways to get mathematical publications to Third World libraries at costs they can afford. These may include gifts of, or large discounts on, AMS publications, as well as arrangements for donations of unwanted books and journals by American mathematicians.

As regards meetings, I think that it can be predicted that there will have to be serious reconsideration of Summer meetings. The AMS is one of the relatively few organizations that holds two national meetings a year, and the one in the summer regularly costs tens of thousands of dollars more than the income generated from registration fees. It may be that with the ten annual summer research conferences, and all the other conferences, symposia, and meetings that everyone can find to attend, the Summer meeting is an anachronism. I have no inside knowledge on the subject, but I do foresee a reexamination of the Society's meetings program.

So these are the principal things I can see coming. Both the new secretary and the next executive director are articulate and thoughtful mathematicians, and I am sure you will be hearing from both of them next year, with really interesting ideas for the future. I suggest you stay tuned.

RESEARCH MATHEMATICIANS IN MATHEMATICS EDUCATION

Part I: Background & Issues

Research mathematicians have traditionally had little to do with school mathematics, but this situation appears to be changing. This article, the first of a two-part series, will examine the background and issues pertaining to the involvement of research mathematicians in education. The second part will describe some educational activities now being led by members of the research community.

At a recent meeting of an advisory panel for a government agency, one university mathematician, prominent in the national science policy scene and a well-respected researcher, asked for an explanation of the acronym NCTM (National Council of Teachers of Mathematics). His ignorance of this enormously influential organization of more than 70,000 school mathematics teachers across the country exemplifies the endemic lack of communication between research mathematicians and mathematics educators.

However, this situation appears to be improving. Spurred by the declining numbers of college degrees awarded in mathematics, outdated mathematics curricula that neither take advantage of new technologies nor impart a sense of the beauty and utility of the subject, and the general climate of educational reform, more mathematics researchers are responding to calls to "build bridges" between the research and education communities.

The Roles of Research Mathematicians

As the group with the deepest and most sophisticated understanding of the subject, research mathematicians clearly have important contributions to make to mathematics education. The most fundamental role is ascertaining that what is taught is accurate; and that the general direction of mathematics education is appropriate to the discipline and the way it is changing. Gail Young, Program Director for Materials Development at the National Science Foundation (NSF), says that, in school mathematics, "we want to teach what is fundamental," and mathematicians are the ones who know which mathematical concepts are truly fundamental. For example, some argue that the study of geometry should be replaced by a course on tilings in the plane. Whether or not this is an appropriate direction for school mathematics to take "is a question for mathematicians," says Young. "We have to be involved in arguments like that."

Other contributions that mathematicians can make to education include providing a solid mathematical training for future teachers and improving the understanding of current teachers. In addition, mathematicians are the only ones who can ensure that the profundities of mathematics are part of the teaching of the subject. Their enthusiasm and love for mathematics can also be a powerful motivator for both students and teachers. And finally, research mathematicians can lend legitimacy to the entire mathematics teaching enterprise.

Yet very few research mathematicians show active commitments to education: queries about such individuals repeatedly turn up the same half dozen or so names. The main reason for this lack of involvement is that good mathematical research and a substantial commitment to education are time-consuming activities, and very few have the capacity to do both at the same time. Lenore Blum, professor of mathematics and former department head at Mills College in Oakland, California, has been involved in both education and research. She says that, to do a good job in education, "you can't do it in your spare time. It takes as much time and commitment as research. It's not just what happens in the classroom, but how you build a community of teachers that respect themselves and their profession."

In addition, says Blum, "educational activities are not afforded the prestige that research activities are." Work in a local high school might count as community service, but is seen as completely separate from scholarly activity. Blum says that too often mathematicians are labeled either as researchers or educators, and the mathematical community is not flexible enough to allow people to move between the two roles. "The mathematical community has to take responsibility for giving innovative

educational activities on the part of mathematicians the recognition they deserve."

These problems are perpetuated by the academic system, in which one's research publications, not one's commitment to education and teaching, are the basis for tenure decisions. Becoming seriously involved in educational matters, especially at the precollege level, can imperil one's academic career. Herbert Clemens, professor of mathematics at the University of Utah, says he believes that mathematicians have recently begun to show greater interest in education, but they lack institutional support to become more involved. If, for example, universities would release mathematics faculty from some of their teaching duties to allow them to spend time with elementary school teachers, their research need not suffer. But, says Clemens, "the universities don't show a willingness to do that."

Comparison with Other Sciences

Of course, the "publish or perish" phenomenon is not unique to mathematics—it exists in all academic disciplines. So how does the involvement of mathematicians in education compare to that of researchers in other areas of science? Few have a sufficiently broad perspective on both science and mathematics education to give a definitive answer. However, most seem to agree that researchers in such areas as physics, chemistry, and biology have been more active in education than have mathematicians. For example, the main professional society for chemists, the American Chemical Society, has an educational division that focuses on chemistry education at the college and precollege levels. One of the current projects is to introduce societal issues into the high school chemistry curriculum in order to make it more relevant to the students' lives.

T. Christine Stevens, on leave from her position as professor of mathematics at Arkansas State University to serve as a a Program Director for Teacher Preparation and Enhancement at the NSF, speculated on a number of reasons why mathematicians are less involved in education than other scientists. For one thing, she said, chemistry, physics, and biology are generally electives in high school, and researchers in those disciplines know that unless they interest students in science before college, the students' exposure to these subjects will be minimal. Because mathematics courses are usually required, exposure to the subject is automatic.

Stevens also pointed out that a good school project for teacher enhancement or materials development can be "a big administrative deal" involving mathematicians, mathematics educators, the school system, and so on. "It can involve research mathematicians in many things they may not know anything about," such as school boards, parent groups, and teacher unions. Stevens says that scientists in other disciplines may be more accustomed to dealing with complex administrative structures because many of them do research within the administrative structure of a laboratory. "Mathematicians tend to be much more solitary in their work."

In addition, Stevens says that attempts to improve mathematics education can have greater ramifications than in science. "At the pre-high school level, there is so little science instruction and there is no fixed curriculum that needs to be covered," she said, so there is more freedom to experiment. In some cases, improvement in science education means introducing science classes where there were none, but mathematics is generally a compulsory course of study. "Intervening in the mathematics curriculum is more difficult because people think they know what should be learned in mathematics," Stevens notes. Because many view the existing mathematics curriculum as good and valuable, "experimentation is seen as far riskier."

Indeed, many—mathematicians included—have viewed this curriculum as somehow preordained, and have felt that substantial change is unnecessary and perhaps unwise. However, this perception is changing, as computers and calculators threaten to render obsolete much of the mathematics students learn at the precollege and even the college level. Stevens says that the intellectually challenging question of what students need to know about mathematics in the computer age is beginning to attract the attention of the mathematics research community.

The use of the computer is one of the most important influences in mathematics and science education, and mathematicians have lagged in this area as well. Anthony Ralston, professor of computer science and mathematics at the State University of New York at Buffalo, points to little use of technology in mathematics classrooms as evidence of too little concern about education on the part of mathematicians. "Mathematicians at universities have been less willing to use technology in teaching than those in other disciplines and less willing than precollege educators," he says. Ralston says that because mathematicians generally use computers less in their research than do scientific researchers, using computers in the mathematics classroom requires a dedication to teaching that too few mathematicians have.

Detachment from Societal Concerns

According to Blum, one reason that mathematicians are less involved in education than scientists is that mathematicians tend to be more detached from societal concerns in general. "Professionals in other sciences have been more astute in terms of where they fit into the political and social structure of our society," she says. But she notes that in the past five years or so,

the mathematical community has been reaching out in various ways to forge stronger connections with the larger scientific community and with the public. She cites declining research funds for mathematics and decreasing numbers of collegiate mathematics students as pressures that contributed to the change.

Blum also says that women research mathematicians have outpaced men both in innovation in educational activities and in level of involvement. The reason is that the lack of women in mathematics naturally led women mathematicians to consider ways of attracting more female students to become interested in the subject. "Women research mathematicians have known for a long time that there is a crisis in mathematics education because so many female students are filtered out of mathematics careers," says Blum. Now that the number of male mathematics students appears to be declining, she says, the problems of mathematics education are receiving more widespread attention in the mathematical community. In addition, Blum notes that many innovative programs to encourage girls in mathematics have developed methods that are effective with all students.

International View

U.S. mathematicians do not measure up well against their international counterparts when it comes to educational activities. The greatest European mathematical researchers have a history of writing elementary textbooks and lecturing to school children. Extensive reforms in school mathematics education in the Soviet Union were led by Kolmogorov, Pontryagin, and Vinogradov. Klein, Hilbert, Hadamard, Banach, and others were involved in mathematics teaching and education at the precollege level. In fact, in all areas of science, it has generally been true that researchers in other countries have been far more influential in educational matters than have their counterparts in the United States.

There are a number of reasons for this difference. In the case of the Soviet Union, the mandated national mathematics and science curriculum makes it much simpler to revise the curriculum if need be. In the U.S., changing what is taught in the schools means dealing with the nation's 16,000 school boards, whose ideas of what is important and worthwhile can and do differ.

Jack Wilson, executive director of the American Association of Physics Teachers, offers one explanation for the greater educational involvement on the part of European physicists. He says that because there is a much greater emphasis on physics and science in general in European schools, the students progress much more rapidly and can handle more sophisticated and substantive topics capable of capturing the researchers' interest. The researchers' involvement naturally promotes the continued emphasis on science in the schools.

This analysis may apply to mathematics education as well. "The Underachieving Curriculum," a 1987 national report on the Second International Mathematics Study, sent a tremor through the mathematical community and the nation with a host of alarming statistics about the low mathematics achievement of U.S. students as compared to their international counterparts. One of the main problems, the report says, is that U.S. students typically follow a "spiral curriculum" in mathematics, in which the same topics are revisited year after year, with little deepening of understanding and little progress. "The U.S. mathematics curriculum is characterized by a great deal of repetition and review," the report says. "The continued dominating role of arithmetic in the junior high school curriculum results in students entering high school with very limited mathematical backgrounds." A research mathematician hoping to contribute a more sophisticated understanding and broader perspective on the subject is likely to be disappointed by the students' weak backgrounds.

This lack of quality training in school mathematics is now being felt in the workplace. Many U.S. companies are finding that, because of advances in manufacturing and business procedures, employees' mathematical skills are inadequate to handle the new tasks. For example, Motorola Incorporated found its employees lacked the mathematical skills to understand a new statistics-based quality control system at one of its plants. The company responded by offering six hours of remedial training in grade school mathematics for all of its workers. And this is not an isolated situation: a recent survey found that 30% of American companies with 10,000 or more employees offered some sort of remedial training.

New Math

Many believe that one reason research mathematicians are not more involved in education is that the "new math" movement of the 1960s is widely perceived as a failed attempt by research mathematicians to improve the school mathematics curriculum. A product of the post-Sputnik emphasis on mathematics and science education, new math was a collection of innovative school mathematics curricula that stressed understanding of the underlying principles of mathematics over drill in mathematical computation. While many different curricula came under the collective heading of new math, the best known materials were produced by the School Mathematics Study Group (SMSG), funded primarily by the NSF. The SMSG began in the late 1950s and continued its activities in one form or another into the 1970s.

New math took a beating in the news media, which told stories of students who could not calculate because of new math and of frustrated parents who could not help their first-graders with the esoteric homework problems

they were assigned. Even the better new math curricula were denounced. For example, some believe the SMSG curriculum was one of the best of the new math lot, but, because SMSG was seen as the flagship of the new math movement, it was ridiculed with all the rest: SMSG was said to stand for "Some Mathematicians Sure Goofed" and "Some Mathematics, Some Garbage."

There were several main themes common to the new math curricula. Most of them emphasized the discovery method of learning, which is intended to enhance the students' conceptual understanding by leading them to discover on their own the internal logic and coherence of mathematics. In addition, new math was centered on the assumption that mathematics could be organized around a few basic ideas, such as the field axioms. This idea was tied to the discovery method by the belief that an understanding of the logical, deductive nature of mathematics would elucidate the subject's structural characteristics. A third theme, prompted by the ever-increasing pace of mathematical discovery, was the introduction of more sophisticated mathematics to younger students.

Many believe that one of the shortcomings of new math was that it ignored the psychological aspects of curricular development. Ed Dubinsky, professor of mathematics and education at Purdue University, says that one of the problems with new math was that all of the thinking was about the mathematics. "No one asked, what are kids capable of?" he says. "It made sense mathematically, but can kids learn it?" For example, some of the new math curricula stressed the use of nondecimal based number systems in the middle grades. The idea was to develop the abstract concept of a numeration system, but some have questioned whether students of that age are capable of grasping that level of abstraction.

In the early 1970s, many held the new math movement responsible for declining scores in standardized mathematics tests and called for a "back to basics" approach, stressing drill and computation. The connection between new math and declining test scores is questionable because comparable declines were observed in the verbal sections of the tests as well. This general pattern of decreasing academic achievement has been attributed to such factors as television viewing and the permissiveness of the schools in the 1960s. In addition, the proponents of new math argued at the time that the new math curricula had never been properly implemented in the first place, so the effectiveness of the approach was unknown.

Problems with Implementation

The implementation problem had several aspects. According to James T. Fey, professor of mathematics education at the University of Maryland, the formulators of the curricula "grossly underestimated" the difficulties of changing the mathematics curriculum. At the elementary school level, the task of training the teachers to use the new math curricula was never adequately addressed. While about half of the nation's 135,000 secondary mathematics teachers attended NSF-sponsored institutes on new math, only a small portion of the nation's 1.1 million elementary school teachers received such pedagogical instruction. In addition, elementary school teachers generally had rather weak mathematics backgrounds and were unable to properly utilize the curricula on their own. While secondary school teachers were better prepared to use the new math curricula, there was pressure not to change the traditional mathematics courses for college-bound students.

As a result, the new math movement was not as influential as is commonly thought. Fey was involved in a retrospective study in the mid-1970s that evaluated the success of the new math movement. "We found that, for the most part, new math had far less impact than it is credited with," he says. So why the perception that new math was a huge disaster? Fey claims that the truth about the impact of new math simply did not make a good story; far more interesting were the unflattering caricatures prevalent in the news media at that time. According to John Dossey, past president of NCTM and professor of mathematics at Illinois State University, new math was a "press event." The few curricula that were beyond the capabilities of the students and their teachers were the ones that got publicity, he says.

Many education experts agree that new math had an overall positive effect. "That the elementary mathematics curriculum is more than just arithmetic is a consequence of new math," says Fey. The inclusion of such topics as geometry and the beginnings of probability and statistics is a result of the new math thrust. In the secondary schools, new math was responsible for the introduction of inequalities, the expansion of the function concept, and the greater prominence of algebraic and logical structure.

New math had some positive effects beyond the schools as well. For example, a 1965 study by the Conference Board of Mathematical Sciences found that 75% of the departments surveyed said that it was new math that made it possible to introduce calculus as a freshman, rather than a sophomore course. Andrew Gleason, professor of mathematics at Harvard University, was involved in the new math movement, and he says that one piece of evidence for the positive effect of new math is that the number of students now entering college having already taken calculus is far larger than before new math. Gleason also attributes the surge of Ph.D.'s in the early 1970s in part to new math, saying that the more sophisticated material stimulated many mathematically talented students.

Some believe that the perception of failure of new math worsened the split between research mathematicians and mathematics educators. However, Dossey notes that the SMSG was composed of college and university mathematicians, mathematics educators, classroom teachers, and experts in the psychology of teaching and learning mathematics. Because SMSG's chairman, the late Edward G. Begle of Stanford University, was a research mathematician, the group became identified with the mathematics research community. In addition, Dossey says that research mathematicians and mathematics educators alike were dissatisfied with many of the poor new math curricula.

Research-education Split Persists

Whatever effect new math had on relations between the research and education communities, it is clear that the split persists. Research mathematicians sometimes claim that their ideas to improve education are not welcomed by education experts, who say that the mathematicians' ideas do not take into account current theories of teaching and learning. Mathematics educators say that the mathematicians do not recognize the validity of research in the psychological aspects of mathematics education. This cyclical pattern has prevented mutual respect and cooperation from developing.

Nevertheless, there are some signs that the situation is beginning to improve. For example, college and university mathematics departments are starting to strengthen ties to education departments. Clemens says that, five years ago, eyes would "roll heavenward" in his department if one of its members became involved with the education department. Now, he says, there is more serious interest and cooperation. Dubinsky says that Purdue University is making a serious effort to ensure that its two joint mathematics-education positions go to people with strong backgrounds in both research and education.

In addition, Dubinsky says, more mathematics departments are accepting the task of teacher training. A 1986 report by the Carnegie Forum on Education and the Economy, entitled "A Nation Prepared: Teachers for the Twenty-First Century," recommended that elementary and secondary school teachers earn degrees in their areas of specialty rather than in education; other reports have made similar recommendations. According to Dubinsky, "the movement within education to increase the content aspect and reduce the psychology-education component means an increased role for mathematics and mathematicians."

Mathematicians generally have not viewed mathematics education research as very helpful or profound. Dubinsky, who is known for his distinguished research in both areas, acknowledges that while a great deal of excellent research is published in mathematics education, "there are papers being written and research being done that is not as creative as one might hope." However, he stresses that the quality of the research is improving.

Dubinsky also emphasizes the importance of utilizing such research in rethinking education, for the typical mathematical point of view may be inappropriate for school mathematics. For example, the usual mathematical development treats metric space ideas before topologies without metrics. Dubinsky says that there is cognitive evidence that children grasp topological concepts, such as whether or not a planar region has holes, sooner than they grasp metric concepts, such as whether the region has corners. This particular piece of evidence is controversial, says Dubinsky, but it represents the kind of theoretical work that needs to be done to better understand the most effective ways of teaching sophisticated mathematical concepts.

Indeed, many mathematicians who have become involved in education have a high regard for mathematics educators. "Like many mathematicians, I thought mathematics education was not valuable, but I have developed a tremendous respect for those involved in it," says Blum, citing their creativity in rethinking educational issues. According to Ralston, "the problems of mathematics education are harder than mathematical research in some ways, because mathematics education deals with the human element." He also adds, "It would help if mathematicians looked on mathematics education with a less jaundiced eye than they tend to."

Young says that, until coming to the NSF, "I did not realize how far off our views of mathematics educators are." Noting that the mathematics educators are doing "important intellectual work," he says that the proposals he has been receiving for innovative school mathematics materials are "way ahead of anything being done at the university level." For example, he cites a high school level program that will create a course on chaos and fractals, using computers to allow the students to discover new facts on their own. "This [course] will be brilliant," he says, noting that almost all college courses on this material are taught outside mathematics departments. Young asks, "What will happen when the students who take courses like this get to college?", for their college mathematics classes may seem dated and boring in comparison.

The second part of this article will focus on these kinds of innovative programs, with an emphasis on those in which research mathematicians are involved. Many changes are taking place in mathematics education at the precollege level, and it is crucial that the mathematical community be aware of them, not only because of the contributions mathematicians can make, but also because of the effect these changes will have on collegiate mathematics education.

Computers and Mathematics

Edited by Jon Barwise

Editorial Notes

Think about the role that language plays in mathematics. Written as opposed to spoken language, that is. Even the most diehard Platonist mathematician has to admit the practical necessity of writing in mathematics, both in carrying out calculations and in keeping track of the details of all but the simplest proofs. And, of course, writing is crucial to being able to communicate our results to others, our contemporaries and future generations. It seems safe to say that without the invention of writing, mathematics as we know it would not exist. This is the kernel of truth in the formalist philosophy of mathematics.

Computers promise, or perhaps threaten, to have roughly the same magnitude of impact on mathematics. It seems likely that in a hundred years or so mathematics without the computer will be every bit as unimaginable as would current mathematics without writing. That's a strong prediction, not because it is surprising, but because, for better or worse, it has enormous implications for all aspects of the mathematical profession. This column is based on the assumption that the prediction is right, so that, as a profession, we need to start discussing its implications. The aim is to provide a forum where the mathematical community can discuss the impact that the computer is having and will have on our profession. We can also debate the prediction, if there are doubters.

There are two aspects to the computer/writing analogy. In the first place, computers greatly enhance the various powers that writing gives us in doing mathematics. This seems obvious in the cases of calculation and in the writing of mathematics. (The use of hand held calculators in calculus classes is discussed in a review of the HP-28S below.) So far the role of computers organizing, checking, or even generating proofs, has been small. But there are some striking exceptions, exceptions which suggest that this too will surely change in ways we do not yet imagine. (One of the articles below discusses the present and future role of computers in checking mathematical proofs.)

But computers will do more than extend the power of writing by opening up new vistas for the application of computers to mathematics, new areas of mathematics, new ways of doing and teaching mathematics, and entirely new ways of communicating about mathematics. One new area we can already see emerging is what has been called "experimental mathematics." At a recent meeting at the University of Wisconsin, Madison, I saw some exciting examples of this in the study of 2-dimensional cellular automata. The thrust of this work, by David Griffeath and collaborators, is to use the power, speed, and graphic abilities of today's computers to assemble and organize massive amounts of data about the probabilistic behavior of large collections of interacting cellular automata. Watching the demonstrations was very exciting, as one saw unsuspected hidden regularities emerge, regularities that currently have no explanation. Of course, one hopes that such discoveries will lead, in the long run, to definitions and theorems that explain the regularities discovered. Is this experimental work real mathematics? It is hard to know what else to call it, but the issue can be pursued in this column.

While my general opinion is that mathematics will become incredibly richer as a result of computers, there are some very serious problems on the horizon being brought about by computers. In particular, there is suddenly potential for many mathematical discoveries with algorithmic content to have enormous financial

consequences as they become implemented. And so it could happen that mathematics will become poorer as mathematicians become richer. This possibility seriously threatens the free flow of ideas which many of us take to be fundamental to mathematics. Mathematics is based on the idea that small, irrefutable steps, often by many people, taken in the large, lead eventually to a body of knowledge that belongs to all who contributed to it. We all know how impossible it is to assign credit for the solution of an old problem, which has gradually given away. How can we protect the free flow of ideas on which this accumulation of knowledge depends? How should we balance these concerns with rights of individuals to profit from their own labors?

Outside of mathematics, at least, these are the questions the U.S. patent law is intended to answer. The whole point of patents is to protect the rights of a discoverer while encouraging the discoverer to take his basic discovery out into the public realm. But do such laws apply to mathematics? It is usually assumed that they don't. But if not, should they? These are difficult issues addressed in an article below. This is clearly a matter where mathematicians need to be heard from, in this column, but also in congress, the patent office, and probably as expert witnesses in law cases. (Recently, methods of resource allocation using the Karmarkar algorithm were patented. See News and Announcements in this issue of *Notices*.)

For those of you who might have missed it, this column was born in the previous issue of these *Notices*. In the first number, we described the general plan for the column, and invited contributions. Here is a brief review of what we expect the column will come to contain.

- Reviews of mathematical software and hardware, both those used in research and in teaching.
- Expository articles about mathematical research topics inspired by computers.
- Articles telling how computers are now being used in traditional branches of mathematics.
- Opinion pieces used to air opinions about the computational needs and desires of the mathematical community.
- Other sorts of articles about computers and mathematics, on special topics.

The column can also serve as a clearinghouse for information about software that people develop and are willing to share with other mathematicians. Send articles and letters about computers and mathematics, or information about software you have developed, to the address below. In the latter case, your announcement should be fifty words or less, and should tell what system the program uses, and whether a disk should be sent to you for copying the program. Also, software (or hardware) that you think would be of interest to the mathematical community can be sent to me. I will try to find an appropriate reviewer.

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Are Algorithms Patentable?

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When a colleague of mine in the philosophy department told me that an electrical engineering professor at Stanford had patented an algorithm, I did not believe him. I figured that he had misread the campus reports and had gotten the facts wrong. I was teaching a course on computers and ethics, and everything I had read indicated that algorithms were not patentable subject matter. Indeed, Justice Rehnquist, writing the majority opinion in *Diamond v. Diehr*, said quite explicitly:

> We defined 'algorithm' as a 'procedure for solving a given type of mathematical problem,' and we concluded that such an algorithm, or mathematical formula, is like a law of nature, which cannot be the subject of a patent.

Clearly, then, my colleague had been misinformed.

However, as I made further inquiries, I soon found that other well-informed people on campus were saying the same thing. Ron Bracewell, an EE professor, had apparently been granted a patent for his new method of computing Fourier series. Overcome by curiosity (and quite possibly, by a measure of righteous indignation), I acquired a copy of the patent. It was entitled, "Computer and Method for the Discrete Bracewell Transform." One can infer a lot from a title to a patent, and I immediately acquired certain expectations. Before I describe the patent any further, let me back up a bit and tell you why I was led to these inferences and expectations.

A patent is a grant of a 17-year right to exclude others from making, using, or selling one's invention, and includes the right to license others to make, use, or sell it. To get patent protection, the object of the patent has to satisfy §101 and §102 of the patent law 35 U.S.C. §101 defines what is patentable subject matter:

> Whoever invents any new and useful process, machine manufacture, or composition of matter, or any new and useful improvements thereof, may obtain a patent, subject to the conditions and requirements of this title.

On the traditional reading of §101, the object of a patent has to be either a device or a process. In the case of a device, there has to be some hardware; in the case of a process, some substance has to be transformed. Indeed, the Supreme Court justices in *Cochran v. Deener* define:

> A process is a mode of treatment of certain materials to produce a given result. ... The process requires that certain things should be done with certain substances, and in a certain order.

§102 requires that the object of the patent satisfy three further tests. It must be useful, novel, and nonobvious.

Computer programs that satisfy §102 may be granted patents, as long as they do not claim protection for, or pre-empt, mathematical algorithms.* In *Gottschalk v. Benson*, for example, the Supreme Court found that an algorithm that converts binary code decimal numbers to equivalent pure binary numbers was *not* patentable. Moreover, in *Parker v. Flook*, the Court made it clear that an improved method of calculation *per se*, even when employed as part of a physical process, is not patentable. In that decision, however, the justices left room for patents that involved algorithms as long as they did not pre-empt the algorithm itself. They noted that "a process is not unpatentable simply because it contains a law of nature or a mathematical algorithm." And they backed this up in *Diamond v. Diehr*. In *Diehr*, the Court upheld (5 to 4) a patent on a process for curing rubber even though the process recited a mathematical formula. Unlike *Flook*, the justices did not view the claim as an attempt to patent the formula itself.

So with this background, let's return to "Computer and Method for the Discrete Bracewell Transform" (Patent #4,646,256).** The title made it clear that the patent attempts to satisfy §101 in two ways: the word 'computer' indicates that a device was being patented, and the word 'method' indicates that a process was also being patented. The patent included an abstract, drawings, introduction, summary, and a detailed description. Much to my surprise, the summary began as follows:

> The present invention is a special purpose computer and method of computation for performing a n-length real-number discrete transform. For a real-valued function $f(\tau)$, where τ has the values $0, 1, \ldots, n-1$, the Discrete Bracewell Transform [DBT] $H(\nu)$ in accordance with the present invention is as follows:
>
> $$H(\nu) = (n^{-1})\Sigma_{\tau=0}^{n-1} f(\tau)\, cas(2\pi\nu\tau/n),$$
>
> where,
>
> $$\nu = 0, 1, \ldots, n-1$$
> $$cas\,\theta = cos\,\theta + sin\,\theta.$$

In addition, a Fast Bracewell Transform [FBT] was associated with the DBT. The FBT is a new method for arriving at the DBT, and it does so by sequentially performing a series of operations (such as permutations, summations, etc.) on input that consists of an 'ordered data set of n real numbers.' Together, the DBT and FBT are claimed to be much more efficient than the Discrete Fourier Transform and its associated Fast Fourier Transform.

At this point, I began to be suspicious that the patent was seeking protection for both a formula and an algorithm. Maybe it was to undermine such suspicions that the author of the patent (attorney David Lovejoy) developed next a detailed description of the

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* Presumably, such programs satisfy §101 because they involve data (i.e., signal) processing, and hence, they meet the definition of a 'process.'

** For a copy, send $1.50 to: Patent and Trademark Office, Washington, D.C. 20231.

'invention' around three 'hardware' diagrams. Figure 1 of the patent shows 'a discrete transform computer.' It is a simple block diagram consisting of a 'control unit' that provides timing and other control signals to a 'generator' and two 'processors' (the latter perform the transform). Figure 2 shows an 'application system' that utilizes the discrete transform computer. It, too, is a simple block diagram in which a 'data collection device' feeds data to the 'computer,' which in turn feeds output to a 'utilization device,' all subject to a controlling device. Finally, Figure 3 is a layout of 'one specific embodiment of a computer for performing transforms.' It shows that an input data sequence would be processed in four stages, each stage being governed by a set of equations. The main body of the patent consists in detailed explanation of how these devices perform their tasks in accordance with the underlying mathematical equations.

As I proceeded through this description, I remained skeptical. For one thing, no particular piece of hardware was ever described. Rather, the patent described a series of possible 'embodiments,' some of which were 'preferred.' The patent seemed to be just an attempt to portray what was essentially a mathematical and computational discovery in the guise of the hardware (abstractly conceived) that would implement it. Secondly, the 'process' that was being protected did not essentially involve signal-processing but rather *numerical* transformations of one sequence of numbers into a another. So I failed to see a clear sense in which §101 was being satisfied. My skepticism became complete when I read the final section of the patent, where the author begins to say exactly what he is seeking protection for. He says:

> The present invention has been described employing several mathematical representations, but the invention is not limited to any particular representation. ... While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and detail may be made therein without departing from the spirit and scope of the invention.

To me, this suggests that it is really the mathematical equation and the underlying algorithm that are being protected, though of course, the author of the patent is extremely careful not to say this.

Before we can decide what the patent in fact protects, tough philosophical questions must be addressed. What are algorithms? Is there a canonical way to describe them? How can one determine whether a claim is really seeking protection for an algorithm, especially when it does not employ the canonical descriptions? Despite the fact that there are no generally accepted answers to these questions, the Patent Office saw fit to grant the patent. And if you were to discover an algorithm that was novel, useful, and nonobvious, you could probably get patent protection for it as well. As long as you couch your claims carefully, focus attention on the apparatus and processes required to implement your algorithm, and never specifically claim protection for the algorithm itself, it appears that you have a good chance of being successful.

Unfortunately, the fact that the Patent Office grants you a patent doesn't mean that if it were challenged in court, it would be upheld as valid. My analysis suggests that it would not. Indeed, in the symposium that I organized on this topic, the two law professors (who were specialists in patent law as it relates to computer programs) seemed to agree that if the Supreme Court remains consistent, then patents that preempt algorithms will be judged invalid. So everything turns on the question of whether the justices will view such patents as essentially just attempts to protect algorithms.*** Presumably, they will have to face, at least implicitly, the questions raised in the previous paragraph.

Let us assume that patents such as Bracewell's essentially claim protection for the underlying algorithms. Should the Court remain consistent and declare such patents legally invalid? Let me conclude with a few remarks on this question. It is usually said that the purpose of patent law is to promote the *public* exchange of useful practical knowledge. In exchange for bringing your invention before the public, the laws grant you certain protections you would not otherwise have were you to keep your invention to yourself (for example, if someone independently invents the object of your patent, he or she would not be able to profit from it). However, it is also said that the public has an interest in preventing anyone from owning the building blocks of science. That is why Newton's Laws and the Fundamental Theorem of Calculus are not patentable. So if algorithms are the building blocks of computer science, it

*** I should mention, however, that one of the law professors thought that the Court would overturn *Benson*.

would seem that they, too, should not be patentable.

Some would argue that even the building blocks of science should be patentable. Why shouldn't scientists be allowed to profit from their discoveries? Such a policy wouldn't prevent others from using the patented discoveries to make new discoveries (patents allow experimental use of the protected entity); it would only require that if patents are to be granted for discoveries based upon previously patented discoveries, some arrangement would have to be made to divide any profits made from the application of the new discovery. Presumably, the scientists involved will have an interest in the distribution of any profits, and though equitable arrangements could result from bargaining on these issues, those who are cynical about human nature will agree that the transactional costs will be very high.

Many of us, however, would be uneasy about such a situation. We might fear the corrupting effects of basic science no longer pursued primarily for the intrinsic value of finding answers to mysterious questions about nature, but instead for the extrinsic (monetary) value of finding such answers. In addition, many of us think that property rights should not extend to natural and mathematical laws. They are just not the right kind of thing to be counted as property, not even 'intellectual property.' Finally, it is certain that there would be an administrative and bureaucratic nightmare were we to allow pure scientists and mathematicians to patent their discoveries. Indeed, the individuals Gottschalk, Parker, and Diamond involved in the legal cases described above were not ordinary litigants—each was serving as the Commissioner of Patents and Trademarks, and each was justifiably concerned about the ability of the Patent Office to process effectively the flood of applications that would inevitably result should such a policy be undertaken.

The HP-28S Brings Computations and Theory Back Together in the Classroom*

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1. Introduction

While the capabilities of handheld supercalculators have delighted students for years, less-than-enthusiastic mathematics instructors have been left in the quandary described by Paul Zorn [Zo]. For example, solutions of linear systems in linear algebra courses, and such answers as $\int_{-1}^{1} dx/(1+x^2) = 1.570796327$ in calculus tests, have for some time now required from students nothing more than the touch of any key on their HP-15C. Recognizing the usefulness of such computing power, other academic units, such as business schools, have already incorporated fancy calculators (the HP-12C, for example) into their mathematics and statistics courses. Thus, there already exists a certain experience with computing devices within somewhat abstract mathematics courses. Based upon such experience, the present essay suggests specific answers to some of Zorn's questions about computing in the mathematics classroom.

2. An Historical Perspective on Mathematical Computing

Some appreciation of the historical relation between computing and mathematics will help in separating the novelty from the fad, for the evidence shows that many of the most elegant mathematical theories arose from concrete applied computations.

Example 1. In Plato's time (about 400 B.C.), according to van der Waerden's sources [W2, p. 13], the Delians requested the gods' assistance against a plague; Apollo asked that they construct an altar of the same shape as the existing one, but with twice the volume. Although the Greeks knew how to duplicate the cube by intersecting two parabolae [W3, p. 26], they could not construct the cube root of two with ruler and compass alone, an impossibility proved later by Galois' theory [W1, p. 199].

Incidentally, in the opinion of Charles H. Edwards [Ed, p. 11], the Greeks viewed ruler and compass as their *calculator* for solving algebraic equations in terms of geometric magnitudes. Apparently, then, the Greeks' "calculator" has corrupted neither mathematics nor students.

* Essay based on a talk presented by the author at the eighth Instructional Computing Conference, on 6 November, 1987 in Wenatchee, Washngton.

Example 2. Also according to van der Waerden's historical sources, the Renaissance Italians had material incentives for solving polynomial equations. In 1344, Dardi of Pisa used his solution of certain cubic equations to determine the internal rate of return on loans [W3, p. 49], while in 1535 the Venetian Tartaglia won thirty banquets by discovering the solution of a more general type of cubic equations [W3, p. 55]. Their results then inspired their successors' quest for the solution of the general polynomial equation, eventually leading to Galois' theory and Abel's proof of the impossibility of solving such equations with radicals only [W1, p. 190], [W3, p. 86–88].

Without implying that abstract algebra arose from the fear of Greek gods or from the greed of Italian financiers, these historical examples demonstrate the manner in which applied computations have incited mathematicians to develop "one of the most important and beautiful theories" [W3, p. 101]. These mathematicians used not only their minds, but also pen, ruler, and compass (but no calculator) as their computing devices. In the same spirit, had the HP-28S been available then, they might well have enjoyed experimenting with it. Similarly, modern mathematicians have already discovered new theorems suggested to them by their computers.

Example 3. In 1984, David Hoffman and William H. Meeks III found new examples of minimal surfaces properly embedded in Euclidean spaces, and they established some of the new properties of such surfaces, concerning ends, self-intersections, and symmetry groups [H2]. By their own account, Hoffman and Meeks do not believe that they could have made such discoveries without prior experiments with a computer [H1].

Example 4. Not only mathematicians, but other scientists, too, utilize computers to investigate new phenomena before formulating theories. For example, *The Wall Street Journal* reports that astrophysicist Michael L. Norman is currently gaining some understanding of intergalactic gas clouds by picturing their evolution with a supercomputer [Kn].

As the foregoing examples do not dismiss the merit of experimental computing in theoretical investigations, likewise they do not appear *a priori* to forbid calculators in the mathematics classroom. Before considering the teaching potential of the latest supercalculators, however, it may help to examine examples of such use.

3. Current Uses of Supercalculators in the Classroom

The following examples are instances of typical classroom uses of supercalculators during the past three years in the preparatory mathematics course for the Executive Master of Business Administration (EMBA) Program, at the University of Washington. Although, of course, senior executives in this program differ in many ways from college freshmen, the mathematics course for their program may serve as one model for future calculus courses. In that context, classroom experience shows that the planned utilization of a calculator may help reveal to students the tight connections between applications, computations, and theory.

Example 5. Imagine the beginning of a lecture on the quadratic formula. A brief allusion to a genuine application (for example, mentioning that the yield rate of a one-year Treasury bill is the [positive] solution of a quadratic equation) helps give students motivation for learning the formula. Then, after an algebraic derivation of the formula (a necessary step to qualify the material as mathematics), a numerical example may aid students in assimilating the concept. Beyond pedagogical examples with integer coefficients, real applications require substantial computations. Fortunately, the HP-28S "knows" the quadratic formula: it solves $A * X\text{^}2 + B * X + C = 0$ by returning (after cancelling redundancies) $(-B + s1 * \sqrt{(B\text{^}2 - 4 * A * C)})/(2 * A)$. Numerically, however, the quadratic formula reserves a few surprises, regardless of the model of calculator at hand. Consider the example $0.001X^2+1000X-0.001 = 0$. Substituting the values of the coefficients for A, B, and C, and selecting the respective values $+1$ and -1 for the sign $s1$ produces the answers 0 and -1000000. Yet, 0 does not solve the proposed equation. The class sits perplexed. Naturally, the error comes from the division by the "small" value of $2*A$, which magnifies the round-off error in the square root on the numerator. To improve the situation, multiplying top and bottom of the quadratic formula by the conjugate quantity $Q := -[B-\text{sgn}(B)\sqrt{(B^2-4AC)}]/2$ leads to the numerical analysts' alternate formula, with $X_1 := C/Q$ and $X_2 := Q/A$. Programming this version yields $X_1 = 0.000001$ instead of 0, an infinitely greater relative accuracy.

Observation 1. The surprise of an erroneous result from an apparently correctly programmed calculator arouses students' curiosity. Then they learn that an equation may admit several theoretical

methods of solution, which may perform with varying degrees of success in practice. This experience surpasses working rote problems, for students and instructor.

Example 6. Consider an introductory lecture on high-order polynomial equations (one of Zorn's "taboo" classroom topics [Zo, p. 920]), $f(v) := c_0 + c_1 v + c_2 v^2 + \cdots + c_n v^n = 0$.

A short overview of an application may catch students' attention. In finance, with $v := 1/(1 + r/2)$, such equations apply to long-term investments, each monomial corresponding to the present value, $c_k v^k = c_k/(1 + r/2)^k$, under some yet unknown rate of interest r, of each semi-annual transaction amount c_k. The positive root v of the polynomial, if unique, is the "yield rate", also called "internal rate of return," of the investment, as those computed by Dardi of Pisa in 1344. (For the case with multiple positive roots, consult [CP].) In practice, the concept of yield rate may serve to justify the use of taxpayers' money, as in *The Wall Street Journal*'s report of the remarkable 25% annual internal rate of return on Kentucky's twenty-year investment in a Toyota manufacturing plant [Ca]. Assessing in advance the performance of such a corporate investment may require solving for the yield rate and comparing it against other prevailing rates of interest, because the great uncertainty about future rates prevents the financier from estimating the net present value of the cash-flow.

An example may help in demystifying such equations. For instance, the thirty-year Treasury bond issued on 5 May 1987 gives the equation $f(v) := -9989.50 + 437.50v + 437.50v^2 + \cdots + 437.50v^{59} + 10437.50v^{60} = 0$. Calculus readily shows that f has exactly one positive root, v, and then such calculators as the HP-12C or the HP-28S find

$$r = 2/v - 2 = 0.0875995857108$$

in seconds, a result that students may verify in the *Treasury Bulletin* (September 1987, page 37): 8.76%. Furthermore, two students beginning with different initial approximations obtain two different sequences of iterations, which shows how a concrete yield rate may illustrate the abstract notion of two equivalent Cauchy sequences.

Observation 2. The genuine application to finance can sustain students' attention long enough to carry them through some theoretical considerations. Then, in the theoretical absence of any "formula," some abstract theory coupled with a supercalculator proves satisfactory. Moreover, the classroom discussion focuses on questions of existence, uniqueness, and nature of the solution, three subjects usually considered better mathematics than rote formulae.

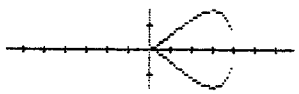
4. Potential Uses of Such Supercalculators as the HP-28S

Up until now, the most powerful calculators surpassed other hand-held devices mainly through their sophisticated numerical analysis routines, which could solve real non-linear equations and complex linear systems, or integrate real functions. Now, however, the state-of-the-art calculators combine all these numerical routines with graphic displays and symbolic manipulation programs that all share their data bases with one another. Rather than necessarily reducing courses to mere keypunching sessions, the availability of such supercalculators as the HP-28S may now bring some theoretical concepts closer to the not-so-mathematically minded student.

Example 7. Consider the typical exercise of sketching the level sets of functions of two variables, at any stage of the curriculum. For example, figures 1a and 1b display two zero-sets plotted by the HP-28S, in effect two exercises from Hartshorne's graduate text [Ha, 5.1c & 5.1a, p. 35]. Also plotted by the HP-28S, figures 1c and 1d show curves adapted from William Fulton's text [Fu, p. 65 & 68]. As a homework problem, students may try graphing the zero-set of $y^2+(x^2-4)(x^4-2x^2+1)$, a variant of exercise 3-2(d) in [Fu, p. 68]. Instead of plotting points by hand, students may devote their efforts to establishing the qualitative characteristics of the curve, while letting the calculator plot the graph shown in figure 1d. Noticing the regular singular point at $(1, 0)$, for instance, students may ask the HP-28S for the Taylor polynomial of degree two about that point, to which the calculator answers $12*(X - 1)\text{^}2$. Indeed, the curve has two tangent lines crossing at $(1, 0)$, with equations $y = \pm\sqrt{12}(x - 1)$. Similar calculations confirm the vertical tangent lines at $(2, 0)$ and $(-2, 0)$.

Observation 3. Students may discover the general properties of a curve faster with a supercalculator than with a pencil only, and then they may spend proportionally more time establishing those properties rigorously. Students may thus get to see the mathematics of curves from a point of view similar to that of Hoffman and Meeks in their investigations of properly embedded minimal surfaces.

(a)



$Y^2 + Y^4 = X^3 - X^4$

$-1.7<X<1.7\ ,\ -.5<Y<.5$

(b)

$Y^4 = X^2 - X^4$

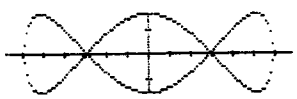
$-2.3<X<2.3\ ,\ -.7<Y<.7$

(c)

$Y^2 = X^2 + X^3$

$-1.7<X<1.7\ ,\ -.4<Y<.4$

(d)



$Y^2 = (4-X^2)(X^4-2X^2+1)$

$-2.3<X<2.3\ ,\ -2<Y<2$

Figure 1. Copies of the HP-28S display (reproduced by the HP 82240A printer), showing the portion of the plane corresponding to the stated inequalities.

Example 8. A lecture on the roots of complex polynomials might begin with Steve Smale's topologically algorithmic proof of the Fundamental Theorem of Algebra, followed by his proof of the convergence of Newton's method [Sm, p. 96 & 101]. Having assimilated statements and proofs, students may then examine how Newton's method converges in practice. A few keystrokes suffice to program Newton's formula

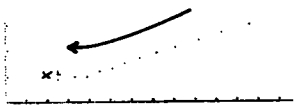
$$z_{k+1} := z_k - f(z_k)/f'(z_k)$$

into the HP-28S, which automatically runs it with complex numbers and identifies the complex plane with the display.

The execution, however, may reveal some unexpected phenomena. Consider the specific example $f(z) := z^9 - z + 9$. Starting with $z_0 := 2.9 + 3i$ leads rapidly to a first root, $r_1 := 0.649 + 1.088i$, along the path traced in figure 2a. Yet, beginning with the nearby $z_0 := 3.09 + 3i$ generates a sequence that seems to tend to the same root, but suddenly disappears from the screen, then comes back and converges to a second root, $r_2 := 1.184 + 0.423i$, as in figure 2b. Next, beginning with $z_0 := 3.1 + 3i$ leads back to r_1, but along the two-path trajectory plotted in figure 2c. Finally, starting with $z_0 := q3.3 + 3i$ produces a sequence converging to yet another root, $r_3 := 1.184 - 0.423i = \overline{r_2}$.

Students experimenting with the HP-28S in the manner just described may become interested in the following four questions. First, why does the sequence of iterations appear so erratic? Naturally, the abrupt changes occur where the sequence encounters a root of the derivative, f', which may send the next iteration anywhere on the Riemann sphere. Second, what set of initial values, z_0, will lead to one specific root rather than another? The question may interest students enough to send them to the library to read about Julia sets in [Pe]. Third, why does the sequence of iterations appear to spiral toward a root, rather than converging along a rectilinear trajectory? Students may try to explain this phenomenon by the absence of a Mean Value Theorem for complex functions. In the case of a root, r, this means that, in general, $f(r) - f(z_k) \neq (r - z_k)f'(z_k)$, and therefore $z_{k+1} - z_k = -f(z_k)/f'(z_k) \neq r - z_k$; thus, in general, $z_{k+1} - z_k$ differs from $r - z_k$ both in magnitude and in direction. Fourth, does f really have roots at r_1, r_2, and r_3, where Newton's method appears to stop?

(a)



$Z^9 - Z + 9 = 0$

$Z_0 = 2.9 + 3i$, Newton

root = 0.649 + 1.088i

(b)

$Z^9 - Z + 9 = 0$

$Z_0 = 3.09 + 3i$, Newton

root = 1.184 + 0.423i

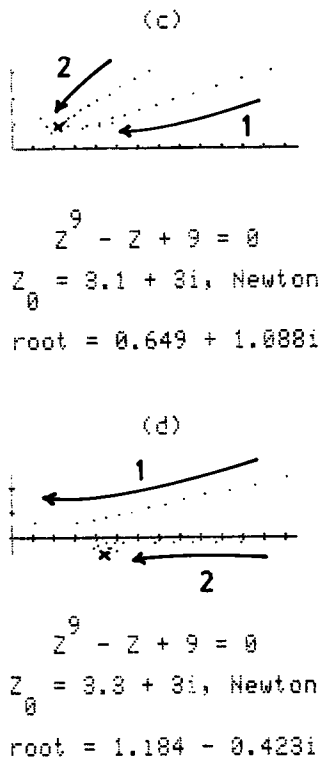


Figure 2. The hand-drawn arrows show how the successive iterations appear on the screen. The sequence jumps off the screen at the end of path 1 and reappears at the start of path 2. The hand-drawn crosses mark the indicated roots.

Observation 4. Even while performing routine tasks with a supercalculator, students may need to invoke theoretical results to validate their own findings. Moreover, students may stumble upon phenomena not described in their textbooks, and may hence become interested in additional independent reading, or perhaps in Smale's eleven open problems [Sm].

Counterexample 9. Not every sequence of iterations of a map need appear to converge or diverge in a straightforward manner. To illustrate how a sequence of iterations may behave, consider the map $f:\mathbf{R}^2 \to \mathbf{R}^2, \binom{x}{y} \mapsto \binom{y(1+\sin(0.7x))-1.2\sqrt{|x|}}{0.21-x}$.

Following Barry Martin's example [Ma], start with $(x_0, y_0) := (0, 0)$, and let the HP-28S compute and plot the first n iterations, $(x_n, y_n) := f^n(0, 0)$. Figure 3 shows the result.

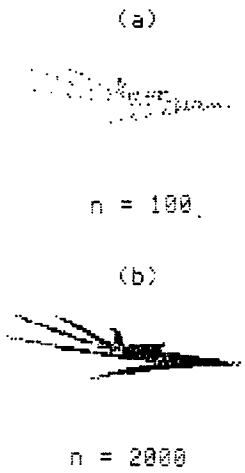


Figure 3. (a) The first hundred, and (b) the first two thousand iterations of Barry Martin's example (see counterexample 9).

5. Conclusions

The previous examples indicate that the availability of sophisticated computing devices may provide a larger number of not-so-mathematically inclined students with a greater opportunity to think about mathematics in the way many mathematicians do, while stretching further the potential of the already theoretically minded students. Supercalculators may thus inspire instructors and textbooks authors to steer away from too many routine manipulations: with today's technology, an author's new rote work pet peeve may show up as a mere symbol on next year's calculator. Instead, the discussion of the material may now focus upon the more creative and logical aspects of mathematics, which also happen to constitute that which employers want in graduates. Indeed, *The Wall Street Journal* [Du] reports Stuart Reeves, vice president in charge of recruiting and development at Electronic Data Systems Co., as saying that "being able to think critically is more important than [having] a computer-science degree."

The advent of such supercalculators as the HP-28S may thus have created a propitious situation for putting some mathematics back into the popular mathematics courses.

Acknowledgement. I thank Joyce d. Kehoe, Seattle writer, for her kind assistance in editing this essay.

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Observations on the Use of Computers in Proof Checking

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Of all the sciences, mathematics is the one that has relied least on technology. Generations of mathematicians have practiced their art and communicated their ideas with only the simplest writing implements. The traditional mathematician perhaps views computer proof checkers to be unnecessary diversions that are unlikely to have any significant, positive impact on the field. In this short piece, I would like to suggest that proof checkers can have a useful role to play, not just in theory, but in mathematical practice. The observations below arise mainly from my use of the Boyer-Moore theorem prover [BM] to check, in detail, a proof of Gödel's Incompleteness Theorem [SH].

Let me start with some pointed published objections [DM] to the use of proof checkers, and some responses to them.

The formal verification of serious mathematics is essentially infeasible.

It is true that little current research-level mathematics has been computer proof checked. However, a fair amount of college-level mathematics has been verified with a feasible amount of effort already, with the current unsophisticated level of technology. The entire proof of the Incompleteness Theorem was verified in about eighteen months. One of the earliest proof checking projects, de Bruijn's AUTOMATH [dB] succeeded in checking all the proofs in Landau's *Foundations of Analysis* [vB]. Proof checkers are continuing to grow in sophistication and there is as yet no conceivable premise for ruling the task infeasible.

Proof checkers subvert the social process by means of which mathematics is communicated and verified.

This is not a reasonable fear since mathematical methods and proofs are often more interesting than the results themselves. The true source of the objection, however, is the misconception that proof checkers merely validate a purported proof. In actual fact, much of the time and effort spent with a proof checker goes into locating and correcting mistakes, and in refining arguments. A proof checker thus plays the role of a tireless devil's advocate, isolating errors, hinting at counterexamples, clarifying intuitions, and highlighting inelegance. Through this process, the argument itself is polished, structured, and distilled to a point where it can be more thoroughly understood and more effectively communicated. Robinson [RO] has recently proposed that we design logics and proof checkers with the intent of clarifying proofs.

Why should we trust a computer over our intuitions?

We shouldn't. A proof checker cannot serve as a surrogate for mathematical judgment. However, this does not mean that computer generated proofs do not merit the mathematician's attention. The Boyer-Moore theorem prover, for example, can fill large gaps in an argument in surprising and illuminating ways. Re-

searchers at the Argonne National Laboratory have conjectured and solved a number of open problems in Algebra and Combinatory Logic by observing attempted mechanical proofs [LW].

It is worth listing some reasons why proof checking is such a surprisingly difficult activity, in case the above discussion conveys the opposite impression. If nothing else, these observations show the extent to which mathematical practice falls short of formal science it is often taken to be in the popular mind.

One of the most serious obstacles to a computer verification of a given textbook or journal proof is not the logical complexity of the proof itself, but the overwhelming amount of background knowledge that the reader is expected to have. A large part of the machine-checked proof of the Incompleteness Theorem involved facts that Gödel took as common knowledge, e.g., the unique prime factorization theorem.

Experience with computer proof checking shows that informal mathematical exposition makes subtle but pervasive use of informal concepts, concepts that have to be formalized prior to machine verification. For example, a formalization of a statement of the unique prime factorization theorem would involve definitions of collections of primes, equality between collections of primes, products of such collections, and so on. While it is obvious, it is worth noting that checking whether given informal notions have been accurately formalized cannot be checked by a machine. It is also worth pointing out that the choice of notations and representations, e.g., sets *vs.* lists, functions *vs.* relations, can have a drastic impact on any proof. Changes of representation or notation, while easily undertaken in an informal proof, can be tedious in the extreme in the case of a formal proof.

Machine checking of realistic, research-level proofs seems a daunting task at present, but there is a vast scope for improvement in the state of the technology. Proof checkers have the potential to become the mathematician's analogue of an electron microscope, especially in conjunction with the other uses of computers in mathematics such as computer algebra, graphics, etc. On the basis of the progress so far, it is reasonable to speculate that research in computer proof checking will eventually shed considerable light on the nature of mathematical explanation and notation, and provide fruitful sources of new conjectures and techniques. The pace of future progress will largely depend on the willingness of students, teachers, and researchers in mathematics to use and develop this technology.

This article benefited from the comments of a number of people to whom I am extremely grateful.

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Inside the AMS

A Profile of the AMS Offices

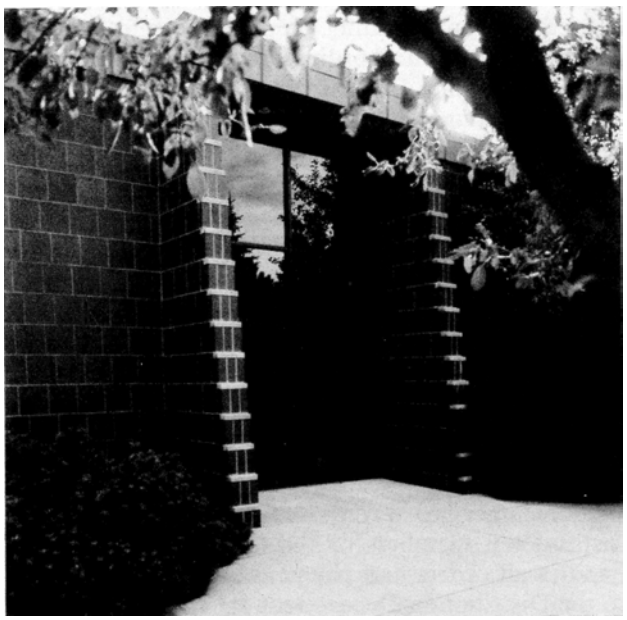
Since 1951, when the Society headquarters moved from its home at Columbia University to Providence, Rhode Island, the Society's membership has grown from about 4400 to over 21,000. One of the reasons for this growth is the rise of the American mathematical community to a position of leadership in the world mathematical scene. At the time of the move, the AMS had only about 20 employees, and *Mathematical Reviews* (*MR*) was only 11 years old. The Society now has a total of about 250 employees in its Providence headquarters office and the *MR* office in Ann Arbor, Michigan.

The Society's efficient organization, dedicated staff, and excellent facilities ensure that the AMS will continue to effectively serve its membership as the AMS enters its second century. Most members are familiar with the many services the AMS provides, but many are unaware of the magnitude of this enterprise. This article describes the way the two AMS offices work by highlighting the functions of each of their departments.

The Providence Headquarters Office

The AMS headquarters office is located near downtown Providence and near Brown University. The single-level, modern design office was built for the Society in 1973. The building contains facilities for almost all Society activities (except *MR*), including a major computer operation, a complete printshop, and a large warehouse. The Providence office employs about 150 people who work in various departments corresponding to different Society functions.

The Executive Director Department is headed by three Ph.D. mathematicians who engaged in teaching and research before becoming employees of the Society: the Executive Director and two Associate Executive Directors. The directors are responsible for implementing policies set by the Board of Trustees and the Council. This department also houses two other organizational units: the Personnel Office, which is responsible for staffing at the Providence office; and the Database Services Department, which manages MathSci, the online database providing an electronic index to the world's literature on mathematics, statistics, computer science, and their applications in a wide range of disciplines. Database Serivces now also offers MathDisc, the CD-ROM version of MathSci.



Providence

The Finance and Administration Division is grouped into three departments: Fiscal, Distribution, and Plant. As its name implies, the Fiscal Department is responsible for managing such functions as budget preparation and control, cash forecasting and investment, payroll, and maintenance of financial records. The Distribution Department handles all shipping and mailing for the AMS, maintains the warehouse, and manages inventory. All purchasing, building, operations, upkeep, and maintenance are provided by the Plant Department.

The Computer Services Division manages the computer needs of both the Providence headquarters and the *MR* office. The Programming and Analysis Department supplies system analysis, design, programming, documentation manuals, training, and troubleshooting. Computer Operations is responsible for operating and maintaining the Society's substantial computer facilties. The Society is now in the process of changing from its two DEC-20 computers to its two VAX 8600 computers. The computers are linked to the Ann Arbor office by a dedicated line. The computer facilities are an integral part of the both the AMS headquarters and *MR* offices, and almost every employee in both offices has a terminal on his or her desk.

The Publications Division is responsible for the Society's extensive mathematical publishing enterprise, one of the largest in the world. Five departments handle various aspects of book production. The Editorial Department oversees a number of functions, such as copyediting, proofreading, preparing front matter, and overall production coordination, among other tasks. The Translations Department is responsible for obtaining, editing, and translating various books and journals from other languages (primarily Russian) into English. Compostion Services comprises two sections: Keyboarding, which uses TEX, the computer typesetting system; and Publication Makeup, which is reponsible for finalizing pages in camera-ready form for printing. The Printing Department produces most of the Society's journals and all of its softcover books. The Marketing Department produces in-house catalogs, brochures, and other descriptive literature on AMS products and activities.

The Membership and Sales Department (M&S) has four major roles. First, the department maintains membership records for all the individual and institutional members of the Society. Second, M&S handles all orders and payments and transmits them to the Distribution Department for shipping and handling. Third, it is responsible for dues collection and customer inquiries. Finally, M&S helps to prepare camera copy for several directories for the mathematical sciences, such as the Combined Membership List.

The Meetings Department is responsible for organizing all meetings and conferences sponsored by the AMS, including the annual meeting in January, the summer meeting in August, eight sectional meetings each year, summer institutes, seminars, research conferences, short courses, and various symposia. The Meetings Department also coordinates the Employment Register during the annual meeting.

The Ann Arbor *MR* Office

The *MR* editorial offices are within walking distance of downtown Ann Arbor and the Central Campus of the University of Michigan. The nineteenth century, red brick *MR* building was originally constructed as a brewery. In 1984, the AMS purchased the building from the University of Michigan and renovated it to accomodate the 75 *MR* staff members in the departments described below. Both *MR* and *Current Mathematical Publications* (*CMP*) are prepared in this office.

Ann Arbor

The Administration Department is responsible for the management and support of the Ann Arbor operation. The Executive Editor, the Managing Editor, and the Associate Executive Editor represent *MR* at meetings of the Board of Trustees, Executive Committee, and Council and oversee all aspects of the production processes of *MR* products. Also included in this department are the Office Manager and the clerical support staff for *MR*.

The Editorial Department is staffed by professional mathematicians who are responsible for selecting items for review in *MR*, for assigning the items to thousands of *MR* reviewers worldwide, and for editing and classifying the reviews. Special language and mathematical expertise are provided by several editorial consultants, who work closely with *MR* editors.

The Library Department acquires and catalogs mathematical publications for review in *MR* and prepares the items in a form suitable for entry into the database. The Library also handles MathDoc, a

document delivery service that provides copies of original articles to users of *MR*, *CMP*, and MathSci. MathDoc specializes in providing papers that would otherwise be difficult to obtain.

The Slavic Languages Department translates, from Russian and other Slavic languages into English, titles, summaries, reviews of mathematical literature, and correspondence. The department also serves as a source of information on Slavic languages and Soviet publications.

The Reviewer Services Department handles comunication between *MR* and its thousands of reviewers. The department mails all material for reviews, processes returned reviews, and updates the reviewer and paper files in the *MR* database. Much of the initial preparation of monthly *MR* issues is done in this department.

The Author Records Department maintains the author file, which contains information about all authors of papers that *MR* has reviewed or is planning to review. The department's other responsibilities include work with the online database MathSci, supervising production of the *MR* and *CMP* indexes, and special projects.

The System Support Department offers technical assistance and advice on computer operations and hardware manintenance. Its main functions are developing and maintaining new database systems as necessary and working on programming projects and system design or improvements. The Department also supports MathSci and computer communication networks.

The Production Department oversees the computer operations necessary for producing *MR*, *CMP*, MathSci, various indexes, review volumes, and special projects. This department also keys corrections to the review text galleys, provides assistance to the Systems Department to run printers and manage queues, handles production scheduling, and coordinates deadlines.

The Copy Editors Department is responsible for copyediting and proofreading the contents of *MR* and *CMP*. The copyediting process includes marking mathematical notation, noting inconsistencies, checking for grammar and adherence to *MR* style, and verifying references, among other tasks.

Allyn Jackson
Staff Writer

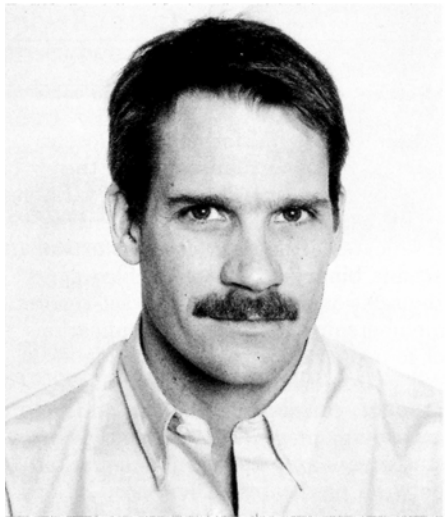
News and Announcements

AMS Centennial Research Fellowships Awarded

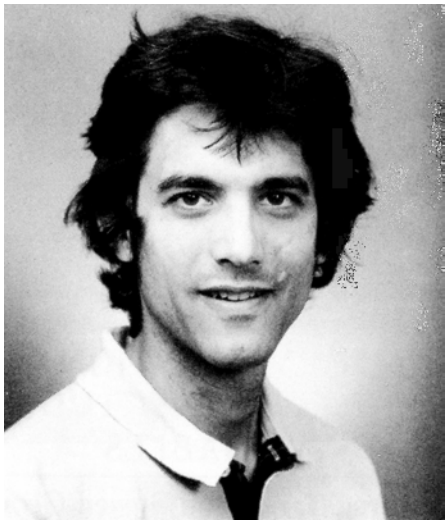
The Society has awarded three Centennial Research Fellowships for 1988-1989. The recipients are Steve Bell of Purdue University; Don Blasius of Bernard M. Baruch College, City University of New York; and David Gabai of California Institute of Technology.

STEVE BELL is a complex analyst who specializes in problems on holomorphic mappings between domains in complex euclidean space. He has used the theory of the inhomogeneous Cauchy-Riemann equations to study the boundary regularity of biholomorphic mappings between domains in n-dimensional complex space ($n > 1$).

Professor Bell received a B.S. in Applied Mathematics from the University of Michigan in 1976 and a Ph.D. from Massachusetts Institute of Technology in 1980 under the direction of Norberto L. M. Kerzman. He taught at Princeton University from 1980 to 1985 and at Purdue University from 1985 to the present. He was an NSF Postdoctoral Fellow in 1980 and a Sloan Fellow in 1984. He plans to use his AMS Fellowship over a period of two years to teach half-time.



DON BLASIUS received his Ph.D. in 1981 from Princeton University where he studied under G. Shimura. Since then he has taught at Columbia University (1981-1985), Yale University (1985-1986), and Baruch College (1987-1988), where he is currently an Associate Professor. He was at the Institute for Advanced Study in Fall 1981 and at the Mathematical Sciences Research Institute (1986-1987) on an MSRI Fellowship. He plans to use his AMS Fellowship over two years, spending the first at the University of California, Los Angeles. His primary research interests are number theory and automorphic forms.



DAVID GABAI received his Ph.D. with Bill Thurston at Princeton in 1980. He subsequently has worked at Harvard University, the Institute for Advanced Study, the University of Pennsylvania, the Mathematical Sciences Research Institute, the Institute des Hautes Etudes Scientifiques, and the California Institute of Technology, where he is currently a Professor of Mathematics. He was the recipient of NSF Postdoctoral and Sloan Foundation fellowships.

He plans to use this award at the California Institute of Technology during the 1988-1989 academic year to continue his investigations on the topology of 3-dimensional manifolds.

AMS Centennial Research Fellowships Invitation for Applications, 1989-1990 Deadline December 1, 1988

These fellowships are open to individuals five to ten years past the Ph.D. degree (or equivalent), regardless of age, but below the academic rank of professor. Applicants should have received the Ph.D. degree between January 1, 1979, and December 31, 1984. Moreover, the vita must include the equivalent of at least three full years postdoctoral teaching or industrial experience, i.e., non-fellowship years. The Selection Committee may give preference to applicants who have not had extensive postdoctoral research support.

The stipend has been set by the Trustees of the Society at $32,000 for nine months of full-time research or its equivalent. In addition, there will be an expense allowance of $1,000. Applicants must be citizens or permanent residents of a country in North America. Fellowships may be held at any institution the Fellow selects or at more than one in succession. There is flexibility in the choice of time interval(s) and manner in which the Fellow may draw funds. For instance, given the opportunity, a Fellow may elect to hold a half-time academic appointment with a teaching responsibility not exceeding one course per term while holding the fellowship at one-half stipend over a two-year period. The Fellow should consult with the Secretary of the Society to learn whether the arrangement proposed is acceptable to the Society.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Trustees have arranged a matching program from general funds in such fashion that funds for at least one fellowship are guaranteed. Because of the generosity of the AMS membership it was possible to award two fellowships for 1987-1988, and three fellowships for 1988-1989; however, in the several preceding years, it was not financially possible to award more than one fellowship.

The deadline for receipt of applications is December 1, 1988. Awards will be announced in February 1989, or earlier if possible.

For application forms, write to Executive Director, American Mathematical Society, P.O. Box 6248, Providence, RI 02940. (It should be noted that completed application and reference forms should NOT be sent to this address, but to the address given on the forms.)

The 1989-1990 Fulbright Scholar-in-Residence Award

Opportunities for American colleges and universities to host a visiting scholar from abroad for all or part of the 1989-1990 academic year are available through the Fulbright Scholar-in-Residence Program. Institutions are invited to submit proposals for visiting scholars in the humanities and social sciences, or in scientific or professional specializations with a strong international focus. Of particular interest for the 1989-1990 program year will be proposals to bring scholars in American literature, history, or politics; professionals from the media or government; or specialists in constitutional law or politics.

A Fulbright Scholar-in-Residence may teach regular courses from a foreign area perspective, serve as a resource person in interdisciplinary courses, assist in developing new courses, or participate in special seminars. An institution hosting a scholar-in-residence would be expected to share the scholar's expertise with a wide range of departments and with neighboring institutions, involve him/her in community activities and professional organizations, and provide opportunities for the visitor to pursue personal research interests.

The program provides round-trip travel for the grantee and, for full-year awards, one accompanying dependent; a monthly maintenance allowance; and incidental allowances for travel, books, and services essential to the assignment. The host institution is expected to share some costs in the form of supplementary funding, as well as support for housing.

The deadline for receipt of proposals is November 1, 1988. Detailed program guidelines and proposal forms may be obtained from the Council for International Exchange of Scholars, Eleven Dupont Circle N. W., Suite 300, Washington, D. C. 20036-1257. Telephone: 202-939-5401.

–Council for International Exchange of Scholars News Release

Crafoord Prize Recipients Announced

The Royal Swedish Academy of Sciences announced in April that it had conferred the prestigious Crafoord Prize on two mathematicians, Alexandre Grothendieck of the University of Montpellier in France, and Pierre Deligne of the Institute for Advanced Study in Princeton, New Jersey. Shortly after the announcement, Grothendieck turned down his half of the $210,000 prize.

Grothendieck explained his reasons in a letter to the Academy, published in the May 4 edition of the French newspaper *Le Monde*. He said that his salary was already "much more than sufficient for the material needs of myself and those I am responsible for." Asking, "is it not obvious that the excesses enjoyed by some can only come about at the expense of the needs of others?", Grothendieck stated that top researchers who receive such prizes generally possess a great deal of material wealth and scientific prestige already.

Grothendieck, who received the Fields medal in 1966, is best known for his fundamental advances in al-

gebraic geometry. He also introduced the idea of K-theory and revolutionized homological algebra. Deligne, a former student of Grothendieck, was honored with a Fields medal in 1978. Deligne provided the solution of the three Weil Conjectures concerning generalizations of the Riemann hypothesis to finite fields, and his work has done much to unify algebraic geometry and algebraic number theory.

The award cited their "fundamental research in algebraic geometry, especially for the introduction of étale cohomology [Grothendieck] and its application to various fields of mathematics [Grothendieck and Deligne] including the proof of the Weil Conjectures."

Holger Crafoord, a Swedish industrialist who made a fortune in pulp and paper products and in artificial kidneys, established the Holger and Anna-Greta Crafoord Prizes for basic research in several fields not covered by the Nobel Prizes: mathematics, astronomy, the geosciences, and the biosciences. Each year, the Academy designates an area within the field of science being honored that year and chooses individuals who have been influential in that area as prize winners. The entire award amount is $423,000, half of which goes to the prize winners, and half of which goes to support Swedish researchers in the chosen area of science.

The mathematics prize is given every 7 years. The first mathematics award was presented in 1982 to Louis Nirenberg of the Courant Institute of the Mathematical Sciences and V. I. Arnold of the University of Moscow. Deligne will receive his award in Stockholm on September 21. According to a representative of the Academy, Grothendieck's portion of the prize is expected to be returned to the general prize fund.

Grothendieck has been known for his exacting ethical standards. In 1970, he left his position at the Institut des Hautes Etudes Scientifiques at Bûres-sur-Yvette outside Paris, saying that his resignation was in protest of increasing military support for mathematical research. In his letter to the Academy, Grothendieck said he believes that "the only decisive proof of the fertility of ideas or of a new vision is that of time. Fertility is recognizable by offspring, not by honors." Grothendieck also stated that he did not wish to condone the declining ethical standards of the mathematical community by accepting the prize.

MSJ Announces Prizes

The Mathematical Society of Japan has announced the awarding of several prizes.

The first **Spring Prize of the Japan Mathematical Society 1988** was awarded to KAZUYA KATO, University of Tokyo, in recognition of his outstanding work on Class Field Theory for fields finitely generated over the prime fields.

The Mathematical Society of Japan's **Geometry Prize of 1988** was awarded to HIROTAKA FUJIMOTO of Kanazawa University, Japan, in recognition of his complete solution of a long standing conjecture on the Gauss maps of complete minimal surfaces.

The **1988 Japan Academy Prize** was awarded to MASAKI KASHIWARA, Research Institute for Mathematical Sciences, Kyoto, Japan, for his outstanding contributions to algebraic analysis. He, partly joined with M. Sato and T. Kawai, has originated microlocal analysis and developed the theory of linear differential equations, in particular, holonomic systems, using this new approach.

The ASAHI Prize 1988 was awarded to MASAKI KASHIWARA and TAKAHIRO KAWAI, Research Institute for Mathematical Sciences, Kyoto, Japan, for their outstanding contribution to algebraic analysis. The ASAHI Prize is given annually by the Asahi Shimbun, a major Japanese newspaper company, to a certain number of individuals and groups for distinction in arts, sciences, and other areas.

AMS Awards Prizes at the International Science and Engineering Fair

The 39th International Science and Engineering Fair (ISEF) was held on May 8–14, 1988 in Knoxville, Tennessee. For the first time, the AMS was represented, awarding seven prizes totalling $3,000. The AMS judges Peter Doyle, David Minda, and Carol Wood came to Knoxville on May 11 to meet the exhibitors and to select the prize winners. The AMS' participation was due largely to the initiative of Bill Thurston, who became interested through discussions with Westinghouse Science Talent Search contestants and with Dorothy Schriver of Science Service, the Program Director of ISEF.

Most of the 721 entrants in Knoxville were U.S. high school students who arrived via regional science fairs. The ISEF is subdivided by topic into 13 categories; the AMS judges focused on the 38 math exhibits. Peter Doyle scouted other categories for entries with mathematical content, and he eventually found one winner. Each entrant met with at least one of the judges; the winners met with at least two judges. The judges' role was two-fold: to select as winners those students showing the highest mathematical achievement, and to offer encouragement and advice to all mathematics students.

The following received cash awards and certificates from the AMS: First Place ($1000): CHRISTOPHER SKINNER, Little Rock, Arkansas, for "The Diophantine Equation $x^2 = 4q^n - 4q + 1$."

Two Second Places ($500): BRIAN CONRAD, Sleden, New York, for "Inverted Continued Fractions," and Laura Magde, San Diego, California, for the physics entry, "Viscous Fingers as Fractals."

Four Third Places ($250): YUN BEOM CHOI, The Bronx, New York,

for "Unitary Half Perfect Numbers"; ALLISON HUGHES, Polson, Montana, for "Fibonacci-Generalized"; WESLEY MCDERMOTT, Lake Worth, Florida, for "Mathematical optimization of school district boundaries"; VAMSI MOOTHA, Beaumont, Texas, for "Study of P_t-sets."

Winners Announced in Math Modeling Contest

Six student teams from across the country have been recognized for their outstanding solutions in the Mathematical Contest in Modeling. And this year there was a new twist: the contest has traditionally been for college students, but one of the winning teams was a group of high school students.

The contest allows students to put their mathematical acumen to work on real-world applications of mathematics. The teams, consisting of up to three students, have three days in which to produce an in-depth analysis of one of two modeling problems. Participation in the contest has increased by more than 30% per year since its inception in 1985, and this year's total of 204 participating teams represents a 37% increase over the number in 1987.

The contest gives the teams a choice of two problems, one "discrete" and one "continuous." This year, the discrete problem asked how to load a flatcar so as to minimize wasted floor space, given the dimensions and weights of each of seven types of crates and some other restrictions. The continuous problem sought an optimal search strategy for a helicopter trying to locate a drug smuggler in a power boat, given an approximate initial position of the boat relative to the helicopter and the speeds of each.

The three high school students, from the North Carolina School of Science and Mathematics, expressed "complete disbelief" at being chosen as one of the outstanding teams. Although the contest traditionally has been intended for college students, the contest application never specifically stated that a team must be from a college or university. When it was revealed that one of the winning papers was written by high school students, contest officials concluded that the students are technically undergraduates and let the ruling stand.

The high school team produced one of two outstanding solutions to the drug runner problem; the other was from a team from Drake University. Four teams presenting solutions to the railroad car problem received outstanding ratings: the Operations Research Department at the University of California, Berkeley; Harvard University; the University of Toronto; and the U.S. Military Academy at West Point.

Two teams selected from the winners for each problem received an all-expense paid trip to the national meeting of the Operational Research Society of America in April, where they presented their results. In addition, the Harvard University team received a new award from the Society for Industrial and Applied Mathematics (SIAM), in recognition of exceptional performance in the contest. The three team members will receive cash awards and a trip to the annual SIAM meeting in July.

The contest is administered by the Consortium for Mathematics and Its Applications (COMAP) and directed by Ben Fusaro of Salisbury State University. The problems are mailed to team advisers, who turn the problems over to the students on a specified Friday morning in February. The teams then choose one of the problems and are permitted to use any inanimate source they wish—books, journals, computers, etc. Solutions must be mailed to COMAP by the following Monday.

Newly Elected Members of the AAAS

The following mathematical scientists have been elected to the American Academy of Arts and Sciences: RUTHERFORD ARIS, University of Minnesota; JOHN W. PRATT, Harvard University; RICHARD SCHOEN, Stanford University; RICHARD P. STANLEY, Massachusetts Institute of Technology; and SRINIVASA VARADHAN, New York University.

National Academy of Engineering's New Foreign Secretary

Gerald P. Dinneen, Vice President for Science and Technology at Honeywell, Inc., Minneapolis, Minnesota, was recently elected the National Academy of Engineering's foreign secretary. During his three-year term, he will oversee international activities of the NAE and coordinate its contacts with engineering academies in other countries. He succeeds H. Guyford Stever, former president of Carnegie Mellon University.

Patents Issued to Mathematicians

Researchers at AT&T Bell Laboratories have been awarded three patents for methods of resource allocation utilizing the Karmarkar algorithm for linear programming.

Narendra K. Karmarkar, developer of the algorithm, received one of the patents for a method for allocating telecommunications and other resources. He was also named on another patent, together with Jeffrey C. Lagarias, also of Bell Labs, and David A. Bayer of Columbia University. The second patent covers an enhancement that accelerates the convergence of the Karmarkar algorithm by using power series approximation. The third patent went to Robert J. Vanderbei, also of Bell Labs, for methods of effectively stopping and starting the process of carrying out the algorithm.

It was not the Karmarkar algorithm itself, nor the computer code utilizing the algorithm that were patented. So what exactly was patent-

ed? Henry Brendzel, a patent attorney for Bell Labs, says that the patent covers "the method and apparatus of allocating resources in a physical environment." He explained that, like a law of nature, the algorithm is an abstract concept. "The carrying out of the concept to achieve a specific end result in a physical environment is what we have patented," he said. The environment might be a commercial enterprise, a military strategy, or a geological exploration scheme. For example, Bell Labs recently produced a system, consisting of both computer hardware and software, which uses the patented method to optimize allocation of a company's personnel.

The three patents were originally filed in 1985. According to Michael R. Garey, Director of the Mathematics Center at Bell Laboratories, the delay in obtaining the patent is standard.

The Karmarkar algorithm is based on interior methods for linear programming, in which the number of steps in the algorithm is reduced by passing through the interior of the regions in the linear programming scheme, rather than passing only along the edges. In the past forty or fifty years, many researchers have attempted to use this idea, but Karmarkar was the first to make it work.

Garey described one application for which AT&T uses the patented method. Every three months AT&T assembles a collection of predictions of the number of telephone calls for the coming three months over major calling routes. Usually the demand is growing, but there might be decreasing demand in some places. For example, if an industrial plant closes, telephone use may drop in that area. The task is to figure out how to route calls generally over the network to meet the demand with existing telephone trunks and to decide if new telephone trunks are needed.

The Karmarkar algorithm is used to figure out how best to route the projected telephone traffic in the network and where the optimal places are to install additional facilities for increased demand. Garey says that using the Karmarkar algorithm in applications like this will save AT&T millions of dollars each year.

For a more general discussion of patents and mathematics, see the article by Edward N. Zalta in the **Computers and Mathematics** column in this issue of *Notices*.

AWM Speakers' Bureau Directory

The Association for Women in Mathematics is preparing a new edition of the AWM Speakers' Bureau Directory, which lists women and men who are available to speak at high schools and/or colleges about a wide variety of subjects related to women and mathematics. Topics include pure and applied mathematics, careers in mathematics, and women's contributions to mathematics. AWM covers the speaker's travel expenses. Those interested in speaking for the Bureau can contact AWM at Box 178, Wellesley College, Wellesley, MA 02181. Telephone: 617-235-0320.

CSCPRC 1989-1990 China Programs

The Committee on Scholarly Communication with the People's Republic of China (CSCPRC) has announced its 1989-1990 National Program of Scholarly Exchanges with China. The program includes the following:

The Visiting Scholar Program supports one to three month visits for American and Chinese scholars in all disciplines between September 1989 and August 1990. For Americans in social sciences and humanities, the program supports scholars outside the China studies field to initiate and conduct research. For Americans in natural sciences and engineering, the program supports scholars to initiate and conduct research. Priority will be given to projects in disciplines to which research in China can make a unique contribution and to those which are of mutual benefit to American and Chinese scientists. The program also supports the nomination of Chinese scholars in all disciplines by American scholars. Priority will be given to Chinese who have not visited the U.S. recently and to those whose visits will contribute to future academic exchanges. For both American and Chinese components, women, minorities, scholars beginning their careers, and scholars based at or visiting provincial institutions in China, are especially encouraged. The deadline for applications to the Visiting Scholar Exchange Program is November 15, 1988.

The Graduate Program supports individuals enrolled in a graduate program in social sciences or humanities to do coursework or dissertation research at a Chinese university. The Research Program supports individuals in the social sciences and humanities who hold a Ph.D. or equivalent at the time of application to do in-depth research on China, the Chinese portion of a comparative study, or an exploratory survey of an aspect of contemporary China. Research grantees normally spend from two months to one year in the PRC, beginning no earlier than July 1989 and ending no later than December 1990. The deadline for application to the Graduate and Research Programs is October 15, 1988.

For application information on all the above programs, write to the Committee on Scholarly Communication with the People's Republic of China, National Academy of Sciences, 2101 Construction Avenue, Washington, D.C. 20418.

–CSCPRC News Release

National Science Foundation News & Reports

Mathematical Sciences Postdoctoral Research Fellowships

The NSF Mathematical Sciences Postdoctoral Research Fellowship program is designed to permit recipients to choose research environments that will have maximal impact on their future scientific development. Awards will be made for appropriate research in pure mathematics, applied mathematics and operations research, and statistics at an appropriate nonprofit United States institution.

The Fellowships will be offered only to persons who 1. are U.S. citizens or nationals as of January 1, 1989; 2. will have earned, by the beginning of their fellowship tenure, a doctoral degree in one of the mathematical sciences; 3. will have held the doctorate for no more than five years as of January 1, 1989; and 4. will not previously have held any other NSF postdoctoral fellowship. The evaluation of applicants will be based, in part, on ability as evidenced by past research work and letters of recommendation, likely impact on the future scientific development of the applicant, and scientific quality of the research likely to emerge. Applicants' qualifications will be evaluated by a panel of mathematical scientists.

For copies of the application brochure or further information, contact the Special Projects Program, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; tel. 202-357-3453; or the American Mathematical Society at 401-272-9500.

The deadline for applications is **November 15, 1988.**

NSF Seeks Proposals for the 1990 Regional Conference Series in Mathematical Sciences

The National Science Foundation is seeking proposals from host institutions in the U. S. for five-day regional research conferences. Each conference will feature a distinguished lecturer who will deliver 10 lectures on a subject of current interest in the mathematical sciences. The lecturer will give two lectures per day during the five days, with the remaining time available for study, informal discussion, and exchange of ideas.

Institutions having at least some research competence in the area of their proposals are eligible and encouraged to apply. The conference should be planned for a summer week in 1990 (not earlier than May 1), or held during a recess in the succeeding academic year.

The host institution is responsible for arranging conference details, hotels, and social events during the five-day conference. Participants in the conference will receive allowances for travel and subsistence under the host institution's grant from NSF.

The principal lecturer will receive $1,500 for delivering his or her lectures, and $2,500 for producing an expository monograph for the NSF/CBMS Series based on his or her lectures. The second stipend is dependent on approval of the manuscript by NSF. These monographs will be published in various series by one of three organizations: the American Mathematical Society, the Society for Industrial and Applied Mathematics, and, in conjunction, the American Statistical Association and the Institute of Advanced Studies.

Twenty copies of each proposal to be considered should be sent directly to the Data Support Service Station, National Science Foundation, 1800 G Street, NW, Washington, DC 20550. Proposals must follow the guidelines issued by CBMS. The deadline for proposals for 1990 conferences is April 1, 1989. For information sheet and guidelines write or call The Conference Board of the Mathematical Sciences, 1529 18th Street, NW, Washington, DC 20036; tel. 202-293-1170.

National Science Board Posts Announced

Mary L. Good and Thomas B. Day have been elected Chair and Vice Chair, respectively, of the National Science Board (NSB), the policymaking body of the NSF. Also, Warren J. Baker has been reappointed to the NSB. Good and Day will serve in their new positions until May 1990, and Baker will serve until May 1994.

In addition, President Reagan has announced his intention to nominate Charles L. Hosler, Jr., and Roland W. Schmitt as members of the NSB for

terms expiring May 10, 1994. These are reappointments.

Good is currently President-Engineered Materials Research, Allied Signal Corporation. She was Boyd Professor of Materials Science at Louisiana State University, Baton Rouge (1978-1980) and Boyd Professor of Chemistry at the University of New Orleans (1974-1978).

A physicist, Day has been President of San Diego State University since 1978. Before that, he was Vice Chancellor for Academic Planning and Policy and Special Assistant to the Chancellor at the University of Maryland, College Park.

Baker has been President of California Polytechnic State University since 1979. A civil engineer, he also served as Vice President of Academic Affairs at the University of Detroit (1976-1979).

Hosler has been Vice President for Research and Dean of the Graduate School at Pennsylvania State University since 1985. Prior to this, he was Dean of the College of Earth and Mineral Sciences at Pennsylvania State University (1966-1985).

Schmitt is currently President of Rensselaer Polytechnic Institute. Prior to this, he was with General Electric from 1951-1988 serving most recently as Senior Vice President for Science and Technology (1986-1988) and Senior Vice President for Corporate Research and Development (1980-1986).

One of the Board members, William F. Miller, a computer scientist and President and Chief Executive Officer of SRI International, is the only one who is a member of an active mathematical organization. However, since 1986, the 24-member board has had no representatives from the mathematical sciences.

William Wulf Named Head of CISE

William A. Wulf, an experimental computer scientist, is the new head of the Directorate for Computer and Information Science and Engineering. Wulf, who began the position in May, was AT&T Professor of Engineering and Applied Science at the University of Virginia.

Wulf's main areas of research are programming systems and computer architecture. He is particularly interested in the construction of systems—programming languages, compilers, operating systems—and the computer architecture that executes them efficiently.

Wulf received his Ph.D. in computer science in 1968 from the University of Virginia. He came to the faculty of Carnegie-Mellon University in 1968, and in 1981 founded Tartan Laboratories Incorporated, a Pittsburgh company. He joined the faculty of the University of Virginia in early 1988.

The directorate that Wulf heads is concerned with computer research, information science and technology, advanced scientific computing, and computer engineering and communications/signal processing. Wulf succeeds C. Gordon Bell who left the NSF in late 1987.

Fellowships for Japanese Language Study

A new program in the Division of International Programs will award fellowships to enable researchers in science and engineering to develop Japanese language skills. Forty to fifty awards will be made each year.

The program is part of a set of Japan initiatives developed to facilitate science and technology exchanges between the U.S. and Japan. The initiatives are designed to encourage U.S. researchers to make long-term visits to Japan, to promote the use of Japanese technical publications, and to expand collaborative research. The fellowships for Japanese language study are intended to help remove language and cultural barriers to U.S.-Japan science and technology exchanges.

The fellowships are aimed primarily at researchers at the graduate or postdoctoral level, but senior researchers, including researchers in industry, are also eligible. Applicants must be U.S. citizens or nationals.

There are two kinds of awards, and they may be combined in one application.

Academic program fellowships provide tuition and stipend for regular university Japanese language courses. The amount of the stipend will be based on the amount of NSF Graduate Fellowships (currently $12,300), and on the proportion that the courses represent in one's regular course load. The stipend for postdoctoral researchers is twice that for graduate students. Deadlines are May 15 for programs to start the following spring (January), and December 15 for those starting the following fall (September).

Intensive-study fellowships provide tuition and fees as required for a suitable intensive Japanese language course, a cost-of-living allowance of $1,025 to $2,050 per month, and a travel allowance, if necessary. The deadline is **October 15** for courses to begin six months or more after application.

For more information, contact: Japanese Language Fellowships, Division of International Programs, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; tel. 202-357-9558; ARPANET address cwallace@note.nsf.gov.

Grant Policy Information on Electronic Bulletin Board

The Division of Grants and Contracts (DGC) recently set up an electronic bulletin board to facilitate discussion on grants and general grants policy among grantees and the NSF. The bulletin board is being used to post notices of interest and serve as a forum for sponsored research administration. As of December 1987, more than forty institutions had signed up to participate in

the bulletin board. Recent postings on the bulletin board included an outline of the updated NSF F.L. 200, *Grant General Conditions*, which applies to all grant awards issued since late November 1987; a summary of the substantive changes in the revised F. L. 200; and a discussion of various topics raised by research administrators at participating institutions.

Users of BITNET who would like to be added to the electronic mailing list should address requests to: grants-r@NSF.

BITNET users will post notices to the bulletin board by sending to: grants@NSF.

INTERNET users (ARPANET, CSNET, MILNET) who would like to be added to the electronic mailing list should address requests to: grants-request@NOTE.NSF.GOV.

INTERNET users will post notices to the bulletin board by sending to: grants@NOTE.NSF.GOV.

For additional information, contact the NSF, Division of Grants and Contracts Policy Office, 1800 G Street, NW, Washington, DC 20550; tel. 202-357-7880.

–NSF News Release

News from Washington

James Gleick Awarded Math Communications Prize

The Joint Policy Board for Mathematics (JPBM) will present its first Communications Award to James Gleick on July 13, during the annual meeting of the Society for Industrial and Applied Mathematics (SIAM) in Minneapolis, Minnesota. Gleick, a science writer for the *New York Times*, is also the author of *Chaos*, which was published in 1987 and which traces the history and progress of mathematical work on chaos.

The JPBM Communications Award is being presented as part of the "100 Years of American Mathematics" festivities which are taking place throughout this year. The award recognizes Gleick's sustained and outstanding contributions in communicating mathematics to the general public. Gleick will receive $1,000 as part of the prize, and will also be honored by representatives of JPBM member societies at an awards luncheon.

The award is sponsored by the AMS, the Mathematical Association of America, and SIAM and is supported in part by a grant from Honeywell, Inc.

Winners of U.S. Math Olympiad

Eight top students have won Olympiad Medals in the seventeenth USA Mathematical Olympiad (USAMO), the final round of the high school segment of the American Mathematics Competitions. The national, three-stage competition involved more than 389,000 students.

The eight USAMO winners are:

First Place: Ravi D. Vakil, Toronto, Ontario, Martingrove Collegiate Institute

Second Place: Jordan S. Ellenberg, Potomac, Maryland, Winston Churchill High School

Third Place: Tal N. Kubo, Brookline, Massachusetts, Brookline High School

Fourth Place (tie takes up **Fifth** and **Sixth Places:**) Joshua B. Fischman, Bethesda, Maryland, Montgomery Blair HS; Hubert L. Bray, Houston, Texas, Westbury High School; Nhat Nguyen, Columbus, Ohio, Columbus Academy

Seventh Place (tie takes up **Eighth Place:**) Eric K. Wepsic, Boston, Massachusetts, Boston Latin School; David M. Patrick, Batavia, New York, Batavia High School

On June 7, the winners were honored in Washington, DC at the USAMO Awards Ceremony and Dinner, held at the National Academy of Sciences and the U.S. Department of State. In the next phase of the competition, these winners and 16 other students who did well in the USAMO will participate in an intensive four-week training session at the U.S. Naval Academy in Annapolis, Maryland. The training session will produce a U.S. team of 6 students for the 1988 International Mathematical Olympiad (IMO). The IMO, which consists of two 4 1/2-hour written examinations, will be held in Canberra, Australia on July 9-20.

The annual American Mathematics Competitions, administered by the Mathematical Association of America, comprise three events. The competitions begin with the American High School Mathematics Examination, a 1 1/2-hour, multiple-choice test of 30 questions based on non-calculus mathematics. More than 389,000 students participate in this first round. Three weeks later, 1,000-3,000 of the top scorers compete in the American Invitational Mathematics Examination, which presents 15 short-answer problems to be completed in 3 hours. The U.S. competition culminates with the USAMO, a 3 1/2-hour examination consisting of 5 essay questions.

Romania initiated the IMO in 1959, and the U.S. has participated in the contest since 1974. Typically, 30-35 nations send teams to the IMO. The U.S. team has usually placed among the top 3 nations in this prestigious competition, and, in 1977, 1981, and 1986, it earned first-place honors.

Putnam Examination Winners Announced

The forty-eighth annual William Lowell Putnam Mathematical Competition was held on December 5, 1987. Administered by the Mathematical Association of America (MAA), the prestigious competition drew 2170 contestants from 359 institutions

from across the United States and Canada.

The competition consists of an examination, given in two three-hour sessions. Designed to test originality as well as technical competence, the examination covers undergraduate mathematics through differential equations. The examination may include questions that cut across the bounds of various disciplines, as well as self-contained questions that do not fit into the usual categories.

An institution with at least three registered participants obtains a team rank based on the rank of three designated individual contestants. However, each contestant works independently on the examination, even if designated as a team member.

The five winning teams are listed below, in order of their ranking. (In all of the lists that follow, the contestants' names are in alphabetical order.) Harvard University: DAVID J. MOEWS, BJORN M. POONEN, MICHAEL REID; Princeton University: DANIEL J. BERNSTEIN, DAVID J. GRABINER, MATTHEW D. MULLIN; Carnegie Mellon University: PETROS I. HADJICOSTAS, JOSEPH G. KEANE, KARL M. WESTERBERG; University of California, Berkeley: DAVID P. MOULTON, JONATHAN E. SHAPIRO, CHRISTOPHER S. WELTY; Massachusetts Institute of Technology: DAVID T. BLACKSTON, JAMES P. FERRY, WALDEMAR P. HORWAT.

The six highest ranking individuals receive the Putnam Fellow distinction and $500 award. Their names and institutions are: DAVID J. GRABINER, Princeton University; DAVID J. MOEWS, Harvard University; BJORN M. POONEN, Harvard University; MICHAEL REID, Harvard University; CONSTANTIN S. TELEMAN, Harvard University; JOHN S. TILLINGHAST, University of California, Davis.

One of the Putnam Fellows will also receive the annual Putnam Prize Scholarship, to be used immediately or on completion of undergraduate study. The scholarship provides up to $12,000 plus tuition at Harvard University.

The next five top scorers, receiving a $250 prize, are: DANIEL J. BERNSTEIN, Princeton University; CONSTANTINE N. COSTES, Harvard University; JEREMY A. KAHN, Harvard University; RAV KUMAR RAMAKRISHNA, Cornell University; Japheth Wood, Washington University, St. Louis.

William Lowell Putnam, a member of the Harvard class of 1882, began the competition in 1938. The idea grew out of Putnam's profound belief in the value of organized team competition in college studies. In 1927, Putnam's wife created a trust fund to support such activities. The first competition supported by the fund was in the field of English and a few years later a second competition was held in mathematics. It was not until after Mrs. Putnam's death in 1935 that the examination assumed its present form and was administered by the MAA.

Annual Department Chairs' Colloquium

Each year, the Board on Mathematical Sciences of the National Research Council presents the Department Chairs' Colloquium, for the heads of mathematics, statistics and other mathematical sciences departments. This year's colloquium, to be held on October 14-15, 1988 at the Washington Marriott Hotel in Washington, DC, will offer a suite of sessions on *Computers in Mathematical Sciences Research and Training.* Planned are presentations and discussion sessions which examine the interplay between mathematical sciences research and computational methods, computer graphics and geometry, supercomputers, and issues involved in organizing and supporting computational facilities for mathematics and statistics research.

Also anticipated are updates on: plans for a second David Report dealing with infrastructure and opportunities in the mathematical sciences; collegiate and university mathematical sciences education and the Mathematical Sciences in the Year 2000 (MS2000) project; and developments and directions at the research funding agencies of ICEMAP (Interagency Commission for Extramural Programs in Mathematics).

Under development is a workshop on experiences with, and the development of proposals for, "extraordinary" methods of organizing and funding mathematical sciences research (e.g., science and technology centers, special years). Each year, the Chairs' Colloquium provides a unique opportunity for mathematical sciences department chairs and other interested parties to meet and discuss issues of mutual concern in a pleasant and stimulating setting.

The registration fee is $175 and covers the cost of handouts and meals (including a conference reception and banquet). Space is limited and advance registration is required. Registration and program information will be mailed in July. If you are considering first-time attendance and would like to be added to the mailing list, or if you require additional information, please contact: Board on Mathematical Sciences, National Research Council, 2101 Constitution Ave. NW, Room NAS 312, Washington, DC 20418; telephone 202-334-2421.

National Academy of Sciences Election

The National Academy of Sciences recently announced the election of 61 new members and 15 foreign associates from 8 countries in recognition of their distinguished and continuing achievements in original research.

The election was held on April 26, during the business session of the 125th annual meeting of the Academy. Election to membership in the Academy is considered one of the highest honors that can be accorded an American scientist or

engineer. Those recently elected bring the total number of current members to 1,540. Foreign associates are nonvoting members of the Academy with citizenship outisde the United States. The recent election brings the total number of foreign associates to 257.

The newly elected members and their affiliations at the time of the election are as follows: MITCHELL J. FEIGENBAUM, Professor of Physics, Rockefeller University; THEODORE E. HARRIS, Professor of Mathematics and Electrical Engineering, University of Southern California; HERBERT A. HAUPTMAN, Research Professor, State University of New York, Buffalo and President and Research Director, Medical Foundation of Buffalo; JOSEPH J. KOHN, Professor of Mathematics, Princeton University; JOHN N. MATHER, Professor of Mathematics, Princeton University; DANA S. SCOTT, University Professor of Computer Science and Mathematical Logic, Carnegie Mellon University; EDWARD WITTEN, Professor of Physics, Princeton University and Professor of Physics, The Institute for Advanced Study.

The newly elected foreign associate and his affiliation at the time of the election is as follows; country of citizenship is in parentheses: SIR DAVID R. COX, Professor of Statistics, Imperial College of Science and Technology (United Kingdom).

News from the Mathematical Sciences Education Board

In 1985, the National Research Council (NRC), at the request of the mathematical community, established the Mathematical Sciences Education Board (MSEB), to provide national leadership in mathematical sciences education from kindergarten through college. The MSEB is designed to provide sustained attention over many years to the major issues affecting the quality of instruction and learning in the mathematical sciences.

The 34-member Board is a unique coalition of teachers and supervisors, college and university mathematicians, educational administrators, and representatives of government, business, and industry. Shirley A. Hill, professor of mathematics and education at the University of Missouri at Kansas City, is chairman of the Board, and Marcia P. Sward is executive director.

The MSEB's coordinated program encompasses a wide range of activities. Some of the highlights include:

Study of employers' needs. MSEB has embarked upon an plan to study the kinds of mathematical skills employers will need in the workplace of the future and to engage these employers in the revitalization of mathematics education. A "kickoff" symposium, to be held November 17-18 1988 at the new NAS Beckman Center in Irvine, California, will focus on the connections between quality mathematics education and the ability of business and industry to compete internationally. John D. Macomber, former Chief Executive Officer of Celanese Corporation, has been selected as head of the steering committee for the symposium.

MS2000 project launched. MS2000 (Mathematical Sciences in the Year 2000: Assessment for Renewal in U.S. Colleges and Universities) is a joint project of the MSEB and the NRC's Board on Mathematical Sciences (BMS). Over a 3-year period, MS2000 will develop a national plan for enhancing the flow of mathematical talent, renewing faculty, reinvigorating teaching and scholarship, and making fundamental changes in the curriculum at the college and university level. The chairman of the MS2000 steering committee is J. Fred Bucy, former chief executive officer of Texas Instruments, Incorporated.

Steen commissioned to write report. Lynn Arthur Steen has been commissioned to write the NRC's first Report to the Nation on the state of U.S. mathematics education at all levels. The report, a joint effort by the MSEB and the BMS, will highlight weaknesses in U.S. educational practices and outline the national mobilization needed to ensure U.S. competitiveness. November 1988 is the target date for publication.

Curriculum report completed. At its meeting last January, the MSEB received the report of its Curriculum Framework Task Force, chaired by Anthony Ralston of the State University of New York at Buffalo. The report, prepared over an 18-month period, addresses the forces for change in school mathematics and points to specific directions of change in curriculum and instruction. The report is now being revised and prepared for publication in February 1989 as an MSEB curriculum framework.

Sponsors' meetings. The first semiannual Sponsors' Meeting was held last September at the National Academy of Sciences. These meetings are designed to inform the agencies that sponsor MSEB about the Board's activities, and to stimulate discussions of basic issues in mathematics education. The second meeting, held in May, focused on the new standards for school mathematics currently being developed by the National Council of Teachers of Mathematics (NCTM).

Outreach program. The success of the MSEB's overall effort depends on establishing and maintaining working relationships with a large number of groups and organizations representing academia, business and industry, and the public. Three professional consultants are working on development and implementation of a comprehensive plan for MSEB's outreach and public information activities.

Review of school mathematics standards. The MSEB has conducted a review of the standards for school mathematics being developed by the NCTM. Reactions were solicited from state officials, administrators, business and industry representatives, parents, and others. The findings are intended to identify possible

stumbling blocks in the acceptance of the standards and to assist NCTM and MSEB in planning ways to promote widespread adoption of the standards by school districts and states. A summary report has been presented to NCTM, and an analysis of the various reactions to the standards will be prepared this summer.

National advisory panel. The University of Wisconsin's National Center for Research in Mathematical Sciences Education is one of four discipline-based educational research centers established last fall by the Department of Education. At the university's invitation, the MSEB appointed an 8-member panel on the research agenda for the center. With Jeremy Kilpatrick of the University of Georgia as chairman, the panel held its first meeting on June 18.

The MSEB staff has now grown to ten members to handle the increased scope and diversity of the Board's projects. Last November, the MSEB moved to its permanent home at 818 Connecticut Avenue, NW, Suite 500, Washington, DC 20006; telephone 202-334-3294. Visitors are always welcome.

For Your Information

The Dilemma of the Golden Age

Frank Press

The remarks below are based on a presentation by Frank Press, President of the National Academy of Sciences, on the occasion of the 125th Annual Meeting of the National Academy of Sciences, April 26, 1988.

In recent years, I have used this occasion to discuss the Academy—its projects, its influence, and its relations with the government and our society. Today, however, I want to talk with you about the state of science and the scientific community in America. These are confused and troubling times for us. Limits on resources have made visible serious differences within our community, differences that may weaken the nation's scientific enterprise if they are not resolved without acrimony.

We face the dilemma of living in both the best and worst of times. In all fields of science, the journals and professional meetings are filled with exciting and challenging reports of new discoveries, new ideas, new applications. At the same time, president Reagan's proposed budget for 1989 is the strongest budget in support of science and technology in recent history. Yet, that budget is in difficulty with an essentially pro-science congress, and it has divided the scientific community. The United States supports more scientific research than Western Europe and Japan combined, and our system of universities, and national, and industrial laboratories is the envy of the world. Why then is our community in an unprecedented state of stress and internal dissension? That is the issue I want to confront. That is the dilemma that we as an Academy must confront.

The Dilemma of the Golden Age. We all believe that scientific exploration has intrinsic cultural and intellectual values of the deepest kind, and deserves widespread support on these grounds. However, we also know that the large resources allocated by governments to scientific research find their justification on more pragmatic grounds so well symbolized in the inscription in the dome of the Great Hall: "To science, pilot of industry, conqueror of disease, multiplier of the harvest..." Indeed, throughout history the patrons of science have understood the potential of new scientific knowledge as an instrument of public welfare, of power, of national security, and of national economic strength.

Science has been faithful to that compact—that the American people for their support of science could in time expect a better life and a stronger nation. And we continue to honor that compact, so much so that this can indeed be called the "Golden Age of Science"—a time of unprecedented progress in scientific discovery and its applications.

A confluence of circumstances accounts for the golden age: the large number of scientists at work all over the world; the high level of financial support by governments and industries; the availability of small and large instruments of extraordinary sensitivity that make possible experiments of a precision and scale previously unachievable; new mathematical and theoretical tools; and easy access to computers and electronic information transfer, facilitating the rapid acquisition and analysis of large amounts of data.

These tools and support drive an ever-changing science. New scientific fields are being created as traditional fields merge or are redefined. We've seen that with molecular biology, materials science, photochemistry, and microelectronics. We see that with emergent disciplines–in the mathematics of chaos, in optoelectronics, in the exploitation of quantum effects by surface scientists.

Whatever their professional origins, physicists, chemists, biologists, and engineers, and their ideas come together to pursue the new ideas. Boundaries between basic and applied research are eroding and in many fields the time between a discovery and its commercialization is now measured in years, rather than decades. It is a sign of our times and of the state of science that industrial scientists have won Nobel

Prizes in physics two years in a row, and university professors have become successful entrepreneurs.

The changing nature of science leads to experimentation with new institutions for conducting scientific and engineering research, such as interdisciplinary science centers and technology centers involving academic and industrial participants on university campuses. Shared facilities housing large and expensive equipment are becoming more common, attracting researchers from across the nation.

The dilemma lies in that very exuberance–in that golden age of discovery and advance. Our scientists are submitting, in record numbers, proposals of the highest quality, with enormous intellectual and material potential. We have also laid on the budget table very large and very expensive new ventures–in multiple fields from high-energy physics to molecular biology, whose time in the progress of science has arrived. The proposals–small and large–are superb in quality, but unprecedented in overall cost. And the reality is that these proposals come at a time of record budget deficits.

There is the heart of the dilemma. It is *not* the lack of political support for science. Political decision makers in the executive branch and Congress no longer need convincing that leadership of American science and technology is vital to our nation's future. The real political issue is what does science most urgently need to retain its strength and its excellence.

The issues are funding levels and priorities. Our political leadership has no way of gauging the amount of resources necessary to maintain the strength of American science and technology. What it does see is that the inevitable competition for funds leads to conflicting advice from within the scientific community. It learns of caustic debates among scientists in our journals and in the press. And it sees issues at times framed simplistically, as in the arguments of "big science," as embodied in the superconducting supercollider and the genome sequencing project, and "small science" as represented by scientists working alone or in small teams. ... We see confrontation and competition bordering on the unseemly between basic and applied work, between traditional and new fields, between modes of doing research, from the single investigator to centers. At a time when we should revel in dazzling progress in almost every field of science, this sniping and carping among scientists is disturbing and destructive.

The seemingly intractable problem of setting priorities in the allocation of R & D funds has dominated the discussions at our Academy's regional meetings and it consumes my correspondence and conversations with members. We scientists, who recommend the rationality and orderly process of our profession to government policy makers, are fast losing our credibility for being balanced, fair, and analytical. Our internal dissension and the mixed, conflicting, and self-serving advice emanating from our community are threatening our ability to inform wise policy making. I can think of no more important set of issues to address to the annual meeting this year.

The Reagan Budget Proposal. The concerns over the future of American science are joined in the preparation and approval of the federal budget. The issues of allocating resources and setting priorities cannot be understood without an appreciation of the federal budget process. So, let us look at the Reagan budget proposed for FY 1989. The President is to be commended for the statement of support for science implicit in his substantial budget initiatives for civil science and technology. He proposes a 29 percent increase over 1988 for budget function 250 which includes the National Science Foundation, NASA's Space Research and Technology programs, and the Department of Energy's general science program. He requests a 5.1 percent increase for the National Institutes of Health. The budget also signals approval and initial funding for the SSC, the genome sequencing project, and the space station. Whether or not one agrees with the specific details, the proposals carry the positive message that support of science and technology is essential to this nation's future.

The President's budget adheres to the bipartisan budget summit agreement reached after last year's stock market collapse. That agreement limits increases in total non-defense discretionary spending to $3.1 billion. That is a 2 percent increase, a virtually static budget. The President's budget hits this limit by allocating almost all of the allowable increase to science, space, and technology, rather than to social programs, such as housing and community development.

But that decision tests political reality. It leaves Congress in the unenviable position of deciding between a budget that enhances America's long-term competitiveness and one more responsive to near-term humanitarian needs and other domestic projects. ...

I believe that it is feckless and destructive for the scientific community to argue "for science at the expense of the homeless," as one congressman put it. It is also unrealistic to argue for generous funding of both science and social programs until the deficit is brought under control. Nevertheless, I believe that we have to make positive and responsible proposals that will strengthen American science and technology. ...

Here too, I will offer proposals that, I believe, are not politically stillborn, and that build on the good will of public officials towards science.

Criteria for Priorities. Our colleagues are divided on the issue of establishing priorities across fields. At regional meetings of the Academy we are told by some participants that no one in the scientific community is wise enough to set priorities among fields. Many urge us not to enter what they feel can only be a quagmire. Some believe that we should support all of the science initiatives on the table, that to propose a list of priorities will only serve to divide our community and to insure a reduced budget. Some argue that large science initiatives have historically been accompanied by increases in the entire science budget–small and large. Some propose that tradeoffs with other national needs, such as social programs and national security, should not enter into our considerations and our strategy. And, finally, there are protagonists for specific projects or categories–the SSC, space station, genome sequencing, superconductivity, small science projects etc.–who argue for their priority at the expense of others.

I say that we have to do better and I would like to propose criteria for the allocation of resources that are appropriate for the unprecedented federal deficit, and the state of science and technology. They are politically realistic and responsive to congressional requests for advice. My soundings of the scientific community lead me to believe that they are the least divisive. They are based on two premises. One is that we must seek to maintain American leadership in science and technology. The other is that we will steadily overcome the current national budget deficit crisis, as demanded by all thoughtful leaders in national government, industry, finance, education, and state government.

Category 1. To be funded now with highest priority–at a time of budgetary constraint when all agency budgets will be limited. I include in that:

1. Preserving the human resource base and the pipeline* for science and technology. This means absolute priority for training and research grants reaching the largest number of scientists, engineers, clinical researchers. This encompasses the funding of research universities and national laboratories in categories reaching the largest number of investigators and graduate students. Examples include NIH, NSF, DOE allocations that reach individuals and small groups, fellowships and assistantships, NASA space science grants, DOE basic energy sciences, mission agency research.

2. National crises, e.g., R & D for AIDS, renewing the nation's space launch capacity.

3. Extraordinary scientific breakthroughs, e.g., high temperature superconductivity.

Category 2. Large projects, with important national or scientific goals, to be authorized now. If full funding must be delayed beyond the present because of the budget deficit crisis, let it be so. However, sufficient funding should be made available to maintain the project until such time as large-scale commitments can be made. Examples:

1. SSC.

2. Mapping and sequencing the human genome.

Political Category. Prerogatives of the political system. Priority has traditionally been decided on the basis of value judgments by elected officials in the executive branch and Congress. Examples include:

1. The DOD R & D budget and national security.

2. The Space Station

3. Regional economic development, and employment.

4. Projects that enhance the U.S. image like manned space flight, or projects with significant contributions by foreign governments.

5. Initiatives to enhance U.S. "competitiveness" e.g., education, training, civil sector R & D.

It may be wise for huge multibillion-dollar projects like the space station to be left for major funding decisions by the next President, who will be in office in a scant eight months, and will have the responsibility for seeing them done.

The rationale for these categories is, I believe, straightforward. Above all, the science base must be maintained and even strengthened. And that means support for our ablest men and women with the best ideas. We must confront national crises such as AIDS and our sudden incapacity in space. And we must not be left behind when a major breakthrough occurs, such as with superconductivity.

Finally, although we may have to slow them down temporarily, we cannot shy away from major scientific opportunities simply because they cost a lot.

Basic to these criteria for establishing priorities is my belief that a great nation like the United States can and should undertake all of these initiatives–and can do so in the near term. I also believe, with others, that the next administration, with bipartisan support, must recommend a mix of budgetary cuts, reallocations, and revenue increases over a period

* It is especially important to attract more Americans now that a substantial fraction of our graduate students in science and engineering are no longer American.

of a few years. Those actions hopefully will remove the deficit crisis as a factor limiting the resources that can be committed to education, science, and technology. The argument in favor of such support is irresistible–the creation of wealth required to increase living standards and attend to other national needs can only flow from increased productivity, of the kind generated by new knowledge and a well-trained workforce. And if the trends initiated by President Reagan in the relationship between the superpowers continue, future Presidents may even be able to justify substantial reallocation of resources from the military to the civil sector.

Government Organization for Science and Technology Budgeting. Part of the difficulty with the budget and appropriation process can be attributed to the disarray of the federal government's system for developing the science and technology budget. It is astounding but true that nowhere in the federal budget-making process is there an evaluation of the complete federal budget for science and technology and its overall rationale in terms of national goals. Funds are requested by some fifteen federal departments and agencies without coordination. Requests appear in the budget process as fourteen separate budget functions, spread over at least six divisions of the Office of Management and Budget, and requiring approval by nine appropriations committees in Congress, with input from a number of budget and authorization committees.

I do not argue for a centralized Department of Science and Technology. That would be a disaster. Nor do I propose a politically unachievable change in the complex structure of congressional budget, authorization, and appropriation committees. However, I believe that with the growth and impact of R & D expenditures that now amount to $62 billion, there is now a need to assure a cross-cutting review of the budget proposal, in both the executive branch and the Congress. At present the process examines how each agency's science and technology budget meets the agency's mission. It is now necessary to review how the aggregate science and technology budget serves such national goals as competitiveness, health, security, and world position. It is also important to understand the impact of the overall budget on training and on equipment and facility needs.

It is feasible to do so within the existing governmental structure. I agree with those who propose that in the future the President's science advisor, working with the OMB director, should be given the coordinating role within the executive branch, and should assume the responsibility for providing the rationale for a coherent and adequate federal science and technology budget. This function would have to be carried out, as so many have said, as an instrument of presidential policy, as a resource to OMB, and not as special pleading for scientists.

It is preferable–in fact, it may be the only way to make the system work–for a President to direct his science advisor to assume this function as a part of the organization of the White House staff, rather than seeking to mandate this function by statute of Congress. To be effective in such a role, a science advisor must have authority and standing; elsewhere I have proposed that the science advisor be named a member of the Cabinet without portfolio or a full Assistant to the President to carry out these and other duties of like importance.

In recent weeks some members of the Congress, struggling with the President's budget, have proposed that the two budget committees in Congress provide an overview for the science and technology budget. By statute, the budget committees play a critical role in the budget process. They issue a joint resolution that specifies budget totals as well as allocations to each budget function. However, ultimate decisions are made by appropriations committees and disagreements typically occur. ... It is a reasonable extension of their mandate for the budget committees to provide Congress with a cross-cutting evaluation of the entire science and technology budget, with recommendations for allocations and priorities. It will be necessary, and is natural, for Congress to seek outside advice if it takes on this task; and it has been proposed by some that the National Academies, as congressionally chartered advisers, respond if called upon.

In a recent report the Congressional Research Service stated that "Without...advice [from the Academies or the Office of Technology Assessment] the Congress will have little choice but to make...decisions without formal guidance on priorities from experts in the scientific community, and the scientific community will have no choice but to accept the results."

That is the problem. And that is the challenge.

I believe that we cannot refuse such a call. In doing so, however, we must take care not to subsume a governmental role. However, we can analyze and comment on the impact of the overall budget for science and technology. And we must also be willing, for the first time, to propose priorities across scientific fields, if the times call for it. We can do so in a manner that is knowledgeable, responsible, and useful.

We should accept this new challenge in this, our 125th year of public service.

50 Year Anniversary

On the occasion of the Society's Centennial, we wish to recognize those individuals who have supported the AMS, through their membership, for 50 years or more.

V. W. Adkisson
L. V. Ahlfors
R. Lucile Anderson
Ralph G. Archibald
Bradford H. Arnold
Hubert A. Arnold
Leo A. Aroian
Harold M. Bacon
Lloyd C. Bagby
George A. Baker
N. Hansen Ball
Donald H. Ballou
S. F. Barber
Mabel S. Barnes
Robert C. F. Bartels
Ralph Beatley
Marjorie Heckel Beaty
Ross A. Beaumont
May M. Beenken
E. Maurice Beesley
Philip O. Bell
Peter G. Bergmann
Ebon E. Betz
Garrett Birkhoff
Z. William Birnbaum
Gertrude Blanch
Ralph P. Boas
Samuel Borofsky
Julia W. Bower
Oliver K. Bower
Evelyn Hull Boyle
G. V. Brady
Leo Branovan
Joel L. Brenner
H. W. Brinkmann
John C. Brixey
Foster Brooks
Arthur B. Brown
Mildred C. Brunschwig
Herbert Busemann
Jewell H. Bushey
Ethel B. Callahan
Edward A. Cameron
Robert H. Cameron
Howard H. Campaigne
Leonard Carlitz
Charles L. Carroll
Albert B. Carson
C. Ronald Cassity
Maria Castellani
Josephine H. Chanler
Alonzo Church
Helen E. Clarkson
Mary Dean Clement
Alfred H. Clifford
Leon W. Cohen
Teresa Cohen
Nancy Cole
Oliver C. Collins
Esther Comegys
Edwin H. Comfort
Nelson B. Conkwright
H. S. MacDonald Coxeter
Mahlon M. Day
John De Cicco
Luther J. Deck
Carl H. Denbow
Douglas Derry
Ainsley H. Diamond
R. P. Dilworth
Joseph L. Doob
Harold L. Dorwart
Francis G. Dressel
Daniel M. Dribin
Richard J. Duffin
Dewey C. Duncan
William L. Duren
Paul S. Dwyer
Leaman A. Dye
John Dyer
J. J. Eachus
Madeline L. Early
Edgar D. Eaves
Theodore M. Edison
Margaret C. Eide
Carolyn Eisele
George M. Ewing
A. D. Fialkow
F.A. Ficken
W. W. Flexner
Karl W. Folley
A. L. Foster
Ronald M. Foster
J. Sutherland Frame
Aline H. Frink
Thornton C. Fry
A. S. Galbraith
Henry L. Garabedian
K. S. Ghent
James Wallace Givens
Michael Goldberg
Herman H. Goldstine
Saul Gorn
Sallie P. Grant
John W. Green
Thomas N. E. Greville
Harriet M. Griffin
Margaret Gurney
Wayne W. Gutzman
Marshall Hall
Paul R. Halmos
Eugene H. Hanson
Walter J. Harrington
Orville G. Harrold
Philip Hartman
Bernard A. Hausmann
E. K. Haviland
Ernest Hawkins
Nola A. Haynes
Gustav A. Hedlund
Anna S. Henriques
Fritz Herzog
Magnus R. Hestenes
Arthur O. Hickson
Elizabeth S. Hirschfelder
Cecil T. Holmes
Alston S. Householder
Warren G. Hubert
W. N. Huff
M. Gweneth Humphreys
W. R. Hutcherson
Donald H. Hyers
Robert F. Jackson
Stanley B. Jackson
Nathan Jacobson
Emerson D. Jenkins
Borge Jessen
Fritz John
L. Wayne Johnson
Roberta F. Johnson
F. Burton Jones
Wilfred Kaplan
Edward S. Kennedy
Lawrence S. Kennison
Pierce W. Ketchum
Stephen C. Kleene
Morris Kline
E. C. Klipple
T. L. Koehler
F. W. Kokomoor
E. R. Kolchin
Carl F. Kossack
Harry L. Krall
Everett H. Larguier
Derrick H. Lehmer
Richard A. Leibler
Walter Leighton
Bela A. Lengyel
Howard Levi
Jack Levine
Daniel C. Lewis
Hans Lewy
Edgar R. Lorch
Lee Lorch
Clarence I. Lubin
C. F. Luther
Saunders Mac Lane
William G. Madow
Ralph Mansfield
R. J. Marcou
Morris Marden
May H. Maria
M. H. Martin
William T. Martin
W. J. Martyn
John R. Mayor
Edward D. McCarthy
A. J. McConnell
Dorothy McCoy
N. H. McCoy
Donald L. McDonough
W. H. McEwen
L. H. McFarlan
Ruth S. McKee
Audrey W. McMillan
Brockway McMillan
Edward J. McShane
Florence M. Mears
Albert E. Meder
Lyle E. Mehlenbacher
Russell J. Michel
Donald S. Miller
Harry L. Miller
W. I. Miller
Alfred K. Mitchell
Elmer B. Mode

Morris Monsky
Harriet F. Montague
Deane Montgomery
Marvin G. Moore
Charles W. Moran
David C. Morrow
David Moskovitz
Thirza A. Mossman
Thomas W. Mullikin
David C. Murdoch
Francis J. Murray
Cecil J. Nesbitt
Carroll V. Newsom
Abba V. Newton
Ivan Niven
Edward A. Nordhaus
C. O. Oakley
Edwin N. Oberg
E. J. Oglesby
Arthur Ollivier
P. S. Olmstead
John M. H. Olmsted
A. C. Olshen
Izaak Opatowski
Alexander Oppenheim
John C. Oxtoby
Theodore P. Palmer
R. Smith Park
Edson R. Peck
Sallie E. Pence
Paul M. Pepper
Sam Perlis
George W. Petrie
Ralph S. Phillips
Everett Pitcher
Emily C. Pixley
Theresa L. Podmele
Harry Polachek
Hillel Poritsky
Theodore H. Preiser
Walter Prenowitz
G. Baley Price
W. T. Puckett
Edwin J. Purcell
John W. Querry
Grace S. Quinn
John F. Randolph
Adrienne S. Rayl
Mina S. Rees
P. K. Rees
Francis Regan
Reingold Reingold
Karlem Riess
Fred D. Rigby
Robert F. Rinehart
John Riordan
Eugene K. Ritter
J. H. Roberts
Malcolm S. Robertson
G. B. de Robinson
Robin Robinson
Raphael M. Robinson
E. B. Roessler
Robert A. Rosenbaum
Arnold E. Ross
J. Barkley Rosser
Bryce T. Ruley
Edward A. Saibel
Rafael Sanchez
Sergei A. Schelkunoff
Edith R. Schneckenburger
Isaac J. Schoenberg
Charles H. W. Sedgewick
Irving E. Segal
Swarupchand M. Shah
Isador M. Sheffer
Darrell R. Shreve
Aubrey H. Smith
Frank Smithies
Robert H. Sorgenfrey
Emory P. Starke
David W. Starr
F. H. Steen
Rothwell Stephens
James J. Stoker
Marshall H. Stone
Dirk J. Struik
Eric A. Sturley
Alvin C. Sugar
Sister M. Helen Sullivan
Charles S. Sutton
J. L. Synge
Abraham H. Taub
Olga Taussky
Angus E. Taylor
George B. Thomas
Janet D. Thomas
William Rae Thompson
Robert M. Thrall
Jose Trevino
Albert W. Tucker
Annita Tuller
Atwell R. Turquette
Hugh L. Turrittin
Edmund H. Umberger
F. A. Valentine
Elbridge P. Vance
Herbert E. Vaughan
R. W. Wagner
Robert J. Walker
R. M. Walter
Lewis E. Ward
J. F. Wardwell
Stefan E. Warschawski
W. J. Webber
John V. Wehausen
Louis Weisner
Everett T. Welmers
Charles H. Wheeler
Albert L. Whiteman
Hassler Whitney
David V. Widder
E. P. Wigner
L. R. Wilcox
Margaret Y. Woodbridge
John W. Wrench
Clarence R. Wylie
Delbert E. Zilmer
M. A. Zorn

1988 AMS Elections

Council Nominations

Vice-President and Members-at-Large

One vice-president and five members-at-large of the Council will be elected by the Society in a contested election in the fall of 1988.

The vice-president will serve for a term of two years effective January 1, 1989. The Council has nominated one candidate for the position, namely:

Sun-Yung Alice Chang

The Council plans to name a second candidate.

The five members-at-large will serve for a term of three years. The Council nominated seven candidates. They are:

Jonathan L. Alperin	George R. Sell
Fan R. K. Chung	William Yslas Velez
Lawrence J. Corwin	Robert J. Zimmer
Hugo Rossi	

The Council plans to name additional candidates for member-at-large to bring their number to at least ten.

The deadline for petitions proposing additional nominations is July 6. Such proposals will not reach the Council for action by mail ballot until after that date.

President's Candidates

Nominating Committee 1989 and 1990

Four members of the Nominating Committee are to be elected in the fall of 1988. Continuing members are:

Roger C. Alperin	Jane P. Gilman
Ronald A. DeVore	Leonard L. Scott

President G. D. Mostow has named six of the eight candidates for the other four places. They are:

John B. Garnett	Andy Roy Magid
Victor Klee	James D. Stasheff
Ray A. Kunze	Alan D. Weinstein

If nominations by petition have not appeared bringing the total number of candidates to at least eight, it will be brought up to eight by the President.

Everett Pitcher, Secretary
Bethlehem, Pennsylvania

Meetings and Conferences of the AMS

FUTURE MEETINGS

FUTURE CONFERENCES

Coming Events

We are happy to report that preregistration for the **Centennial Celebration** is running ahead of what is normal for a summer meeting, and so it appears that attendance at this very special event will be exceptional. The scientific program which appears on the following pages promises to provide a rich and rewarding experience for everyone. The social program offers a variety of events, designed to appeal to all participants. So, if you have not yet made up your mind about attending, we hope you will decide to join us in this celebration, which happens only once in a lifetime!

The deadline for preregistration and housing requests for the **January 11-14, 1989 meeting in Phoenix, Arizona** is November 10. In order to be eligible for the drawing for free sleeping rooms, forms must be received in Providence no later than October 31. Since the form will appear for the first time in the October issue of the *Notices* (mailed from the printer on September 30), individuals interested in the room lottery should return their form as soon as they receive the October issue.

Mark your calendar now for the **August 7-10, 1989 meeting at the University of Colorado, Boulder**! Plans are now being made for a real Western Style Hoe Down, featuring local cuisine and entertainment. Also, early arrivals will have the opportunity to take a bus tour through the beautiful Rocky Mountain National Park and visit an authentic mining town.

Centennial Celebration
Providence, RI
August 8 – 12, 1988

Program

The Centennial Celebration of the American Mathematical Society will be held August 8 – 12, 1988 (Monday – Friday). Sessions will take place in the Providence Performing Arts Center (PPAC), the Omni Biltmore Hotel, the Holiday Inn – Providence Downtown, and at the Rhode Island School of Design.

The members of the Centennial Committee are FELIX E. BROWDER, Rutgers University; HAROLD M. EDWARDS, Courant Institute of Mathematical Sciences, New York University; ANDREW M. GLEASON, Harvard University, former President of the American Mathematical Society; GEORGE DANIEL MOSTOW, Yale University, President of the American Mathematical Society; and EVERETT PITCHER, Chairman, Lehigh University.

WHERE TO FIND IT	PAGE

The Centennial Committee was assisted by a number of subcommittees:

The members of the Centennial Program Committee are HYMAN BASS, Columbia University; FELIX E. BROWDER, Chairman; PHILLIP A. GRIFFITHS, Duke University; JOHN W. MILNOR, Institute for Advanced Study; CATHLEEN S. MORAWETZ, Courant Institute of Mathematical Sciences, New York University. FRANK T. BIRTEL of Tulane University is in charge of the AMS contributed paper sessions.

The members of the Centennial Public Information Committee are JOHN W. ADDISON, JR., University of California, Berkeley; YOUSEF ALAVI, Chairman, Western Michigan University; WILLIAM G. CHINN, San Francisco, California; RONALD R. COIFMAN, Yale University; RONALD L. GRAHAM, AT&T Bell Laboratories; PETER J. HILTON, SUNY at Binghamton; DON R. LICK, Eastern Michigan University; JEAN J. PEDERSEN, Santa Clara University; and CLIFFORD TAUBES, Harvard University. The members of the Committee on Travel Grants for the AMS Centennial are RICHARD W. BEALS, Chairman, Yale University; JOHN W. BUNCE, University of Kansas; ANTHONY W. HAGER, Wesleyan University; WILLIAM F. LUCAS, Claremont Graduate School; P. EMERY THOMAS, University of California, Berkeley; and FRANK UHLIG, Auburn University.

The Society wishes to thank the Mathematical Association of America for relinquishing its usual summer meeting program in deference to the expanded requirements of the Society on this special occasion. Sessions of the Association will be held August 6 and 7 (Saturday – Sunday), for the most part.

The Society is pleased to continue the tradition of joint invited addresses with the Association. The members of the Joint AMS-MAA Program Committee are HUGH L. MONT-

IMPORTANT DEADLINES

AMS Abstracts	
Of contributed papers	**Expired**
Centennial Preregistration and Housing	**Expired**
MAA Minicourse Preregistration	**Expired**
Motions for AMS Business Meeting	**July 12**
Clambake cancellations (50% refund)	**until July 25**
MAA and πME Banquets (50% refund)	**until July 25**
Preregistration cancellations (50% refund)	**until August 4**
Airport transfer cancellations (50% refund)	**after August 4**
Changes to residence hall packages	**after August 4**
Housing cancellations (90% refund)	**until August 4**
Housing cancellation penalty (10% plus one night)	**after August 4**
Tours (50% refund)	**until August 4**

GOMERY, Chairman, University of Michigan, Ann Arbor; M. SUSAN MONTGOMERY, University of Southern California; IVAN NIVEN, University of Oregon; and RICHARD S. PALAIS, Brandeis University.

On Monday, August 8, there will be a private ceremony at the Society's headquarters office at which the officers of the Association will formally present a gift of sculpture to the Society on the occasion of its Centennial. This 547 pound sculpture of Carrara marble titled *Torus with cross-cap and vector field* is by HELAMAN ROLFE PRATT FERGUSON, mathematician and sculptor, of Provo, Utah.

The sculpture resides in the lobby of the Society's headquarters building, and can be viewed during the hours set aside for Open House, described later in this announcement. Also, the sculpture is depicted on a commemorative poster available for purchase at the Souvenirs Section of the Centennial Registration Desk.

The Centennial Committee thanks the National Science Foundation for its support of the symposium on *Mathematics into the twenty-first century* (Grant #DMS8716887), and the Department of Energy (Grant #DE-FG02-88ER25056), the Office of Naval Research (Grant #N00014-88-J-1096), and the United States Army Research Office (Grant #DAAL03-88-G-0022) for its grant supporting travel and subsistence for young mathematicians attending the Centennial.

The Centennial Committee acknowledges with thanks the assistance of THOMAS F. BANCHOFF of Brown University in the design of the Centennial logo.

Some very special things have occurred in connection with the Centennial that participants may find of interest. First, the National Academy of Sciences Award in Mathematics, sponsored by the Society in commemoration of its Centennial, in the amount of $5,000, has been awarded for the first time in 1988 and will be awarded every four years hereafter. More information on this prize can be found on page 509 of the April issue of *Notices*.

The *Journal of the American Mathematical Society* began publication in January 1988 in conjunction with the Centennial year of the Society. This quarterly journal contains research articles of the highest quality in all areas of pure and applied mathematics. Editors of the journal are: Michael Artin, H. Blaine Lawson, Jr., Richard Melrose, Wilfried Schmid, and Robert E. Tarjan.

Edward E. David, Jr., Keynote Speaker

Also, in recognition of the Centennial Celebration of the Society, the Council has approved changing the name of the research fellowship program to the American Mathematical Society Centennial Research Fellowship.

Opening Ceremonies

The Opening Ceremonies will take place from 9:00 a.m. to 10:30 a.m. on Monday, August 8, in the PPAC. Representatives from the London Mathematical Society, the Mathematical Association of America, the Society for Industrial and Applied Mathematics, Brown University, city and state government, will address the assembly. A brief oral history of the Society will be presented by the Secretary. President Mostow will serve as Master of Ceremonies.

Keynote Address

EDWARD E. DAVID, JR., President of EED, Inc. and former Science Advisor to the President of the United States, will speak at 11:15 a.m. on Monday, August 8, on *Renewing U.S. mathematics: An agenda to begin the second century*. Dr. David will be introduced by GEORGE DANIEL MOSTOW.

Symposium on Mathematics into the Twenty-First Century

This symposium was organized by the Centennial Program Committee and is directed toward the future, not the past, of the American mathematical community, toward the creative innovation and new achievements foreseeable in terms of the ideas and the ongoing work of the generation of American mathematicians active today.

The speakers include four Fields Medalists, three winners of the Waterman Award, and several winners of other major mathematical prizes. The speakers have been asked to give talks of a nature that can be understood by a general mathematical audience, surveying the motives, paradigms, and prospects of major areas of contemporary mathematical research. It is hoped that this symposium will provide an active stimulus toward developing a broader consciousness among American mathematicians of the unifying trends of mathematical research uniting not only the classical central areas of pure mathematics, but uniting them as well with some of the most vital concerns of mathematical applications.

The names of the speakers, their affiliations, the titles, and the times and days of their talks follow:

MICHAEL ASCHBACHER
Professor of Mathematics
California Institute of Technology
Ph.D., University of Wisconsin, 1969

2:00 p.m.
Monday, August 8

Representations of finite groups as permutation groups

The classification of the finite simple groups in 1981 changed the landscape of finite group theory and led to an increased effort to describe the structure and representations of the simple groups. Together with the classification, this effort has made possible unexpected applications of finite group theory in other branches of mathematics.

Introduced by DANIEL GORENSTEIN.

LUIS A. CAFFARELLI
Professor of Mathematics
Institute for Advanced Study
Ph.D., University of Buenos Aires, 1972

3:15 p.m.
Monday, August 8

The geometry of solutions to nonlinear problems

This talk will discuss geometric techniques to study the shape and regularity of solutions to nonlinear elliptic equations and their level surfaces.

Introduced by LOUIS NIRENBERG.

PERSI DIACONIS
Professor of Mathematics
Harvard University
Ph.D., Harvard University, 1974

8:30 a.m.
Tuesday, August 9

Sufficiency as statistical symmetry

To judge what parts of a data set are worth saving, statisticians have developed a useful tool called *sufficiency*, which can be seen as an extension of the invariants of a group. Sufficiency allows a unified construction of statistical models, sheds light on the factorization of generating functions in combinatorics, and provides the underpinnings for recent work in statistical mechanics. This talk will explain the concept of sufficiency and survey these applications.

Introduced by GIAN CARLO ROTA.

CHARLES L. FEFFERMAN
Professor of Mathematics
Princeton University
Ph.D., Princeton University, 1969

9:45 a.m.
Tuesday, August 9

Problems from mathematical physics

This talk will cover two problems in mathematical physics. The first is from quantum mechanics and concerns the question of how large numbers of electrons combine with large numbers of protons to form large numbers of atoms. The second is from general relativity and concerns a proof that some small initial disturbance will not concentrate and become a black hole.

Introduced by FELIX E. BROWDER.

MICHAEL H. FREEDMAN
Charles Lee Powell Chair Professor
University of California, San Diego
Ph.D., Princeton University, 1973

2:00 p.m.
Tuesday, August 9

Working and playing with the two-dimensional disk

The conformal structure of the disk is useful in studying the topology of (real) surfaces. A more combinatorial-topological study of maps of a disk has illuminated the study of three-dimensional manifolds. This talk will briefly survey the role of the disk in the theory of high dimensional manifolds, and go on to address the special problems of a disk mapped into a four-dimensional manifold. This is the point at which the topological and smooth theories diverge, and some discussion of the disparities between them will be given.

Introduced by WILLIAM BROWDER, President-Elect of the AMS.

HARVEY M. FRIEDMAN
Professor of Mathematics
Ohio State University
Ph.D., Massachusetts Institute of Technology, 1967

3:15 p.m.
Tuesday, August 9

continued

The incompleteness phenomena

By 1922, the formalization of mathematics in terms of axiomatic set theory had emerged. The axioms and rules of inference of this formalism are collectively known as Zermelo Frankel set theory with the axiom of choice (ZFC). The incompleteness phenomena – assertions which cannot be proved or refuted with ZFC – have not yet necessitated a reassessment of ZFC, but the twenty-first century may see debate on which axioms and rules of inference should be allowed. This talk will provide a historical perspective on the incompleteness phenomena.

Introduced by SAUNDERS MAC LANE, former President of the AMS.

BENEDICT H. GROSS
Professor of Mathematics
Harvard University
Ph.D., Harvard University, 1978

8:30 a.m.
Wednesday, August 10

Modular forms and elliptic curves

This talk will survey some major developments in the theory of elliptic curves. The theory of elliptic functions and modular forms, created in the 19th century, concerns the real and complex solutions of cubic equations and their moduli. In the last fifty years, the original arithmetic viewpoint has once again emerged. The problem of counting the number of solutions (mod p) to equations with integral coefficients is related to certain Fourier expansions in the classical theory of modular forms. This relationship has led to some progress on the problem of constructing rational points.

Introduced by JOHN T. TATE.

JOSEPH HARRIS
Visiting Scholar in Mathematics
Harvard University
Ph.D., Harvard University, 1977

9:45 a.m.
Wednesday, August 10

Developments in algebraic geometry

One of the oldest branches of mathematics, algebraic geometry is concerned with the geometry of curves, surfaces and higher-dimensional objects defined by polynomial equations—conic sections, quadric surfaces, and so on. Over the last two centuries, algebraic geometry has undergone a series of transformations in which its basic objects of study were redefined, the most recent being the introduction of the concept of "schemes." This talk will describe these stages in the evolution of the subject and indicate how they arose as outgrowths of classical problems.

Introduced by PHILLIP A. GRIFFITHS.

ROGER E. HOWE
Professor of Mathematics
Yale University
Ph.D., University of California, Berkeley, 1969

2:00 p.m.
Wednesday, August 10

A century of Lie theory

The subject called Lie theory (the study of Lie groups, Lie algebras, algebraic groups, and their applications) is, like the AMS, just about one hundred years old. In that century, Lie theory has established itself as a central area of mathematics, using tools from many sources and having implications for many other fields. This talk will attempt to give a feeling for the diversity of applications of Lie theory and for the rich internal structure that supports the applications.

Introduced by GEORGE MACKEY.

VAUGHAN F. R. JONES
Professor of Mathematics
University of California, Berkeley
Ph.D., Université de Genève, Switzerland, 1979

3:15 p.m.
Wednesday, August 10

A von Neumann algebra excursion: From quantum theory to knot theory and back

A surprising result in von Neumann algebras suggested representations of the braid group into an abstract algebra discovered in statistical mechanics. The result allows one to associate to each braid a number which turns out to depend only on the knot obtained by closing the braid. The resulting new knot invariant stimulated the discovery of many more such invariants. These invariants are being used to study the way enzymes "untie" knotted strands of DNA in the process of replication.

Introduced by JOAN S. BIRMAN.

VICTOR G. KAC
Professor of Mathematics
Massachusetts Institute of Technology
Ph.D., Moscow State University, 1968

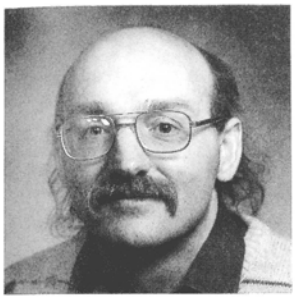
4:30 p.m.
Wednesday, August 10

continued

Modular invariance in mathematics and physics

This talk will focus on some beautiful, recently discovered connections between the representation theory of infinite dimensional Lie algebras and the theory of modular functions, and on related progress in theoretical physics. The basic examples covered will be: affine Kac-Moody algebra, the central extension of the loop group of a compact Lie group; and Virasoro algebra, the central extension of the Lie algebra of vector fields on the circle. The "modular invariant" representations of these algebras have been playing a fundamental role in recent developments of conformally invariant quantum field theories and in string theory.

Introduced by NATHAN JACOBSON, former President of the AMS.



ANDREW J. MAJDA
Professor of Mathematics
Princeton University
Ph.D., Stanford University, 1973

8:30 a.m.
Thursday, August 11

Mathematical fluid dynamics: The interaction of nonlinear analysis and modern applied mathematics

The rapid evolution of applied mathematics through large-scale computation reveals new fluid flow phenomena that are far beyond the capability of experimental measures. To explain and control these complex phenomena, new mathematical ideas from nonlinear analysis, differential equations, probability theory, and geometry must interact with computational methods and more traditional tools of applied mathematics. This talk will present a survey of several examples of this new mode of interdisciplinary research in mathematical fluid mechanics.

Introduced by PETER D. LAX, former President of the AMS.

CHARLES S. PESKIN
Professor of Mathematics
Courant Institute of Mathematical Sciences,
New York University,
Ph.D., Albert Einstein College of Medicine, 1972

9:45 a.m.
Thursday, August 11

Mathematics and computing in physiology and medicine: Examples from the past, present, and future

The examples considered are the Hodgkin-Huxley equations for the nerve impulse, computed tomography, a mathematical model for blood flow in the heart, and the robotics of large biological molecules. Computation is a key ingredient in all of these examples, and future success is tied to the development of large-scale computers and efficient numerical algorithms.

Introduced by CATHLEEN S. MORAWETZ.

DENNIS P. SULLIVAN
Professor of Mathematics
Graduate School and University Center,
City University of New York,
Ph.D., Princeton University, 1966

2:00 p.m.
Thursday, August 11

Progress on the renormalization conjectures in dynamical systems

Computation has led theoretical physicists to the discovery that, in certain dynamical systems, the geometrical structure at successively smaller scales is asymptotically constant. Moreover, the structure is universal in the sense that inequivalent systems have the same limiting structure. This talk will summarize the progress in the theoretical understanding of this numerical discovery.

Introduced by STEPHEN SMALE.

ROBERT E. TARJAN
James S. McDonnell Distinguished University Professor of Computer Science
Princeton University and Distinguished Member of Technical Staff
AT&T Bell Laboratories
Ph.D., Stanford University, 1972

8:30 a.m.
Friday, August 12

Mathematics in computer science

This talk will explore the interdependencies between mathematics and computer science as illustrated in the variety of mathematical ideas used to derive results in computer science theory and the use of computation in the proof of mathematical theorems.

Introduced by RONALD L. GRAHAM.

WILLIAM P. THURSTON
Professor of Mathematics
Princeton University
Ph.D., University of California, Berkeley, 1972

9:45 a.m.
Friday, August 12

continued

Three-dimensional geometry and topology

Three dimensions is the crossroad for geometry and topology. In dimensions higher than 3, topology becomes much more arbitrary, while geometry becomes much more restricted and rigid. In dimensions lower than 3, topology is more limited, while geometric constructions are more flexible. This talk will describe several instances of the close match between the geometry and topology of 3-dimensional objects, including the theory of polyhedra, the theory of knots, and the theory of 3-dimensional manifolds.

Introduced by LIPMAN BERS, former President of the AMS.

KAREN K. UHLENBECK
Professor of Mathematics
University of Texas
at Austin
Ph.D., Brandeis
University, 1968

11:00 a.m.
Friday, August 12

Instantons and their relatives

Instantons are geometric objects which were discovered by theoretical high energy physicists as a result of failed attempts to understand strong interactions. The instanton equation—of which instantons are solutions—derives from the nonlinear version Maxwell's equations formulated by Yang and Mills in 1954. The importance of the instanton equation in mathematics was recognized only in the past decade. Vortices and monopoles are only two of the many related geometric objects having elegant, interesting, and useful mathematical properties. This talk will attempt to describe some of the more colorful properties and uses of instantons and some conjectures for the future.

Introduced by SHIING S. CHERN.

EDWARD WITTEN
Professor of Physics
Institute for Advanced
Study
Ph.D., Princeton
University, 1976

2:00 p.m.
Friday, August 12

Quantum field theory and Donaldson polynomials

When Simon Donaldson initiated a program of using the self-dual Yang-Mills equations to study smooth four-manifolds, the relationship of his work to physical ideas was something of an enigma. Since then, it has become clear that relativistic quantum field theory provides a very natural setting for understanding Donaldson theory and its relationship to Floer theory, elliptic cohomology, conformal field theory, and possibly to other subjects, including string theory and the Jones polynomial. This talk will survey some of these developments.

Introduced by CLIFFORD TAUBES.

AMS-MAA Invited Addresses

By invitation of the AMS-MAA Joint Program Committee, the following speakers will speak on the history and development of mathematics.

RAOUL H. BOTT
William Caspar Graustein
Professor of Mathematics
Harvard University
D.Sc., Carnegie Institute
of Technology, 1949

11:00 a.m.
Tuesday, August 9

The topological constraints on analysis

This topic has been at the center of one of the two great American schools of topology. Some of its achievements during this century will be discussed.

Introduced by ANDREW M. GLEASON.

PETER D. LAX
Professor of Mathematics
Ph.D., New York
University, 1949

11:00 a.m.
Wednesday, August 10

Mathematics: Applied and pure

In this century, some have viewed mathematics as separated into pure and applied. Today more and more mathematicians realize that mathematics does not "trickle down" to application areas, but is an equal partner with other sciences. Modern computers have linked mathematics with other sciences.

Introduced by GEORGE DANIEL MOSTOW.

SAUNDERS MAC LANE
Professor Emeritus,
University of Chicago
Ph.D., University of
Göttingen, 1934

11:00 a.m.
Thursday, August 11

Some major research departments of mathematics

In the last century, the development of mathematics has been led by a number of outstanding research departments. The tradition was developed in the U.S. by Moore, Birkhoff, Veblen, Stone, and others. This talk will describe several mathematics research departments.

Introduced by LEONARD GILLMAN, President of the MAA.

91st Summer Meeting of the AMS August 8 – 12, 1988

Prizes

The 1988 Leroy P. Steele Prizes will be awarded at 3:15 p.m. on Friday, August 12.

Contributed Papers

There will be sessions for contributed papers on Monday, Tuesday, Wednesday, and Friday afternoons.

Council Meeting

The Council of the Society will meet at 5:00 p.m. on Sunday, August 7.

Business Meeting

The Business Meeting of the Society will take place immediately following the award of the Steele Prizes at 3:15 p.m. on Friday, August 12. 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, please refer to the box titled Committee on the Agenda for Business Meetings.

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 M. Salah Baouendi, Everett Pitcher (chairman), and Carol L. Walker.

In order that a motion for the Business Meeting of August 12, 1988, receive the service offered by the committee in the most effective manner, it should be in the hands of the Secretary by July 12, 1988.

Everett Pitcher, Secretary

Activities of Other Organizations

Association for Women in Mathematics (AWM)

The AWM Membership Meeting will take place at 7:30 p.m. on Tuesday, August 9. AWM will sponsor a panel discussion at 8:00 p.m. on Tuesday, on *Centennial reflections on women in American mathematics.* Panelists include MABEL S. BARNES, Professor Emeritus, Occidental College; JUDY GREEN, Rutgers University, Camden; JEANNE LADUKE, DePaul University; VIVIENNE MALONE-MAYES, Baylor University; and OLGA TAUSSKY-TODD, California Institute of Technology. An open reception is being planned by AWM to follow the panel.

Joint Policy Board for Mathematics (JPBM)

The JPBM Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 7:00 p.m. on Wednesday, August 10. This session will feature a panel being organized by SAMUEL M. RANKIN, III, Worcester Polytechnic Institute, on *MS2000 Panel on courses and curricula for mathematics master's degrees.* This will be followed at 8:00 p.m. by Birds-of-a-Feather sessions on *Academic employment of master's degree mathematicians in larger departments* moderated by DONALD F. REYNOLDS, Indiana State University. Panelists include ALPHONSE H. BAARTMANS, West Virginia University; ALBERTO R. GALMARINO, Northeastern University; and DONALD R. WHITAKER, Ball State University. The second concurrent session is on *Academic employment of master's degree mathematicians in smaller departments*, moderated by DAVID W. BALLEW, Western Illinois University. Panelists include RONALD M. DAVIS, Northern Virginia Community College and KAREN L. WHITEHEAD, South Dakota School of Mines. The third concurrent session is on *Industrial employment of master's degree mathematicians* moderated by TOM TROTTER, Arizona State University.

67th Summer Meeting of the Mathematical Association of America (MAA)

Minicourses

Seven Minicourses are being offered by the MAA, to be held on Saturday and Sunday, August 6 and 7. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: **EXP**, **EXP***Test, and the creation of testbanks* is being organized by PETER FRISK, Rock Valley College. Part A is scheduled from 8:00 a.m. to 10:00 a.m. and Part B from 2:00 p.m. to 4:00 p.m. on Saturday, August 6. Enrollment is limited to 30.

The scientific word processor, **EXP**, easily produces complex mathematical and scientific expressions, making it ideal for writing examinations in mathematics. A related program, **EXPTEST**, enables instructors to create, edit, and print examinations created by selecting questions from prepared testbanks. This workshop will discuss the basics of **EXP** itself, including its editing commands, special fonts and mathematical symbols, and keyboard macros. This is basic to the full discussion of **EXPTEST**, which will include the creation of testbanks, the writing of various types of questions those banks may contain, and the automatic generation of different, but equivalent, tests.

Minicourse #2: *Contributions of algebraic coding theory to finite geometry* is being organized by E. F. ASSMUS, JR., Lehigh University and J. D. KEY, who is Emmy Noether Lecturer at Bryn Mawr and on leave from the University of Birmingham. Part A is scheduled from 8:00 a.m. to 10:00 a.m. and Part B from 2:00 p.m. to 4:00 p.m. on Saturday, August 6. Enrollment is limited to 80.

After the appearance of Shannon's fundamental paper in 1948 engineers and mathematicians set to work to implement the ideas by constructing, via algebraic methods, so-called "error-correcting codes." Some of the very first attempts used certain geometries over finite fields to construct codes. During the next three decades an increasingly sophisticated body of results was fashioned and the theory became known as "algebraic coding theory." Late in the 1960s it became apparent that this theory could repay its debt to pure mathematics by making significant contributions to the field of finite geometry, which will be the subject of this Minicourse.

Although a most exciting aspect of this inter-relationship is the one deriving from the Goppa codes and their generalizations, that area requires a rather deep knowledge of algebraic geometry. The course will restrict itself to those aspects of the subject that can be comprehended with only minimal knowledge of group theory and finite geometry, but with a strong background in linear algebra, and a firm acquaintance with finite fields. After a brief historical introduction, the course will develop the necessary material from coding theory and finite geometry and conclude with a detailed description of some of the contributions of coding theory to finite geometry.

Minicourse: #3: *A survey of educational software* is being organized by DAVID P. KRAINES, Duke University and VIVIAN KRAINES, Meredith College. Part A is scheduled from 10:30 a.m. to 12:30 p.m. and Part B from 4:30 p.m. to 6:30 p.m. on Saturday, August 6. Enrollment is limited to 30.

The variety and the quality of software for IBM compatible computers has been increasing steadily. The objective of this Minicourse is to allow the participants to experiment with a representative collection of the better programs in calculus, linear algebra, differential equations, and other mathematical subjects. A variety of classroom applications will be demonstrated from a number of different computer packages. At the end of each two hour session, the participants will have the opportunity for "hands-on" use of some of these programs. Handouts will provide information on other educational software on the market or under development. No computer experience is required.

Minicourse #4: *Coloring and path following algorithms for approximating roots and fixed points* is being organized by WILLIAM F. LUCAS, Claremont Graduate School. Part A is scheduled from 10:30 a.m. to 12:30 p.m. and Part B from 4:30 p.m. to 6:30 p.m. on Saturday, August 6. Enrollment is limited to 80.

Cayley (1879) found that Newton's method for approximating *complex* roots of a polynomial equation could lead to complications. (See *Science News*, February 28, 1987, regarding regions with chaotic boundaries.) H. W. Kuhn (1974) has provided an elementary path following algorithm in the plane for finding such roots. The roots are triple points in a simple three coloring of the plane as was already evident in a geometric view provided in Gauss' thesis (1799).

The fundamental combinatorial lemmas by E. Sperner (1928) and A. W. Tucker (1946) for labeling (or coloring) the vertices of an n-simplex or n-octahedron are the discrete analogues of the Brouwer fixed point theorem and Borsuk-Ulam antipodal points theorems, respectively. These provide the basis for the path following algorithms of Scarf (1967) and others for finding approximate fixed points. Applications include the computing of equilibrium points or prices in game theory and economics.

These topics can be included at various levels in undergraduate courses on discrete mathematics, and do not assume any specialized prerequisites.

Minicourse #5: *Teaching calculus with an HP-28 symbol manipulating calculator* is being organized by JOHN W. KENELLY, Clemson University. Part A is scheduled for 8:00 a.m. to 10:00 a.m. and Part B from 2:00 p.m. to 4:00 p.m. on Sunday, August 7. Enrollment is limited to 40.

After briefly surveying the capabilities of currently available graphic calculators, the Minicourse will introduce participants, hands on, to the HP-28. Graphing, symbol manipulating, differentiation, equation solving, Taylor polynomials and (time permitting) matrix operations will be viewed.

There will be a discussion of the use of the HP-28 in calculus instruction, of how its use will change the treatment of current topics and how it will make possible the introduction of new topics in calculus.

Minicourse #6: *An introduction to MATLAB* is being organized by DAVID R. HILL, Temple University. Part A is scheduled from 10:30 a.m. to 12:30 p.m. and Part B from 4:30 p.m. to 6:30 p.m. on Sunday, August 7. Enrollment is limited to 30.

MATLAB is an interactive software package that has wide application for mathematics instruction and student use. Originally developed at a MATrix LABoratory, the software has evolved into a versatile environment for use in linear algebra, numerical analysis, calculus, discrete mathematics, and statistics. The availability of easily accessible graphics in two and three dimensions, a rich set of powerful commands, and the easy development of your own extensions provide a flexible tool for instruction and problem solving.

This course will provide: 1) An introduction to MATLAB's command set. 2) A "hands-on" opportunity to explore topics including solving linear systems, plotting, interpolation, least squares, and elementary statistics. 3) Examples of courseware for student self-practice. The format will be informal and self-paced with opportunities for discussion and an exchange of ideas. No formal prerequisites.

Minicourse #7: *Groups, graphs, and computing* is being organized by EUGENE M. LUKS, University of Oregon. Part A is scheduled from 10:30 a.m. to 12:30 p.m. and Part B from 4:30 p.m. to 6:30 p.m. on Sunday, August 7. Enrollment is limited to 80.

This Minicourse will explore exciting applications of group theory in theoretical computer science. Some central issues in computational complexity theory are illuminated in an exploration of problems that require manipulation of large permutation groups. Rubik's cube alone suggests both easy ("polynomial-time") and probably-hard ("NP-complete") problems. But it inspires, as well, problems that have defied such categorization. We shall discuss divide-and-conquer algorithms that underlie the best-known approach to such problems. These algorithms also provide the machinery behind the most efficient attacks on the important computational problem of testing isomorphism between graphs.

Participants interested in attending any of the MAA Minicourses should have completed the MAA Minicourse Preregistration Form **and sent it directly to the MAA office at the address given on the form so as to arrive prior to the June 1 deadline**. Please note that these MAA Minicourses are NOT the AMS Short Course.

Prize Session and Business Meeting

The MAA Prize Session and Business Meeting is scheduled from 4:30 p.m. to 5:30 p.m. on Tuesday, August 9. The 1988 Carl B. Allendoerfer, Lester R. Ford, and George Pólya Awards will be presented. Certificates of Meritorious Service will also be presented. Some by-law changes will be submitted to the membership. This meeting is open to all members of the Association.

Board of Governors

The MAA Board of Governors will meet at 8:30 a.m. on Sunday, August 7. This meeting is open to all members of the Association.

Section Officers

There will be a Section Officers' meeting at 4:30 p.m. on Monday, August 8.

MAA Banquet

The MAA is planning its thirteenth annual banquet for individuals who have been members of the Association for twenty-five years or more. The banquet will be held in the Bacchante Room of the Omni Biltmore on Wednesday, August 10. Dinner will be served at 7:00 p.m.

Tickets are $21 each; the price includes gratuity. The menu includes consomme royale, spinach salad, roast leg of veal dijon, potato and vegetable, warm Stanford rolls and butter, strawberries Romanoff, coffee, tea, and decaffeinated coffee. There will be a cash bar. Those who did not purchase tickets through preregistration should check at the Tickets/Tours desk to see if any are still available before the close of registration on Monday, August 8. If tickets were purchased through preregistration and must be cancelled, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence **by July 25**. After that date, no refund can be given.

Pi Mu Epsilon (ΠΜΕ)

ΠΜΕ will hold its annual meeting on Tuesday and Wednesday, August 9 and 10. The Council will meet at noon on Tuesday, August 9. On Wednesday, August 10, the Dutch Treat Breakfast will be at 6:30 a.m. There will also be sessions for contributed papers on Tuesday evening.

J. Sutherland Frame Lecture

The J. Sutherland Frame Lecture will be given at 8:30 p.m. on Wednesday, August 10, by DORIS W. SCHATTSCHNEIDER, Moravian College, on *You, too, can tile the Conway way.* Professor Schattschneider will be the first woman mathematician to deliver this distinguished lecture.

Banquet

The ΠΜΕ Banquet will take place on Wednesday, August 10, at 6:30 p.m. The banquet will be held in the Conference Room in the Chamber of Commerce Center in the Union Station Complex.

Tickets are $8 each; the price includes gratuity. The menu includes boneless breast of chicken with fresh tomato and basil, creamy baked pasta, summer green salad, crusty Italian bread, fresh fruit compote, brownies, coffee and punch. Those who did not purchase tickets through preregistration should check at the Tickets/Tours desk to see if any are still available before the close of registration on Monday, August 8. If tickets were purchased through preregistration and must be cancelled, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence **by July 25**. After that date, no refund can be given.

Other Events of Interest

Book Sales

Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. **These discounts will be available only to registered participants wearing the official meeting badge.** VISA and MASTERCARD credit cards will be accepted for book sale purchases at the meeting. The book sales will be open the same days and hours as the exhibits and are located in the Grand Ballroom in the Omni Biltmore.

AMS Members' Information Booth

Please visit the AMS Membership booth in the Grand Ballroom of the Omni Biltmore exhibit area during the Centennial Celebration. Complimentary coffee and tea will be served for Centennial participants. Carol-Ann Blackwood, the Head of the Membership & Sales Department of the Society, will be at the membership booth to meet members personally and distribute a special gift. Bring Mrs. Blackwood your comments and compliments about member services.

Special Exhibits

An exhibit of selected materials from the archives of the Society, featuring memorabilia from the Semicentennial Celebration held at Columbia University in 1938, will be on display in the lobby of the John D. Rockefeller, Jr. Library at Brown University on Sunday, August 7, noon to 5:00 p.m.; Monday through Thursday, August 8 – 11, 9:00 a.m. to 9:00 p.m.; Friday, August 12, 9:00 a.m. to 5:00 p.m.; and Saturday, August 13, 10:00 a.m. to 5:00 p.m.

An exhibit of selected mathematical drawings by Royal Vale Heath (author of *Mathemagic*, 1932) will be mounted in the Bell Gallery in the List Art Building at Brown University. The drawings, which make up the bulk of the collection donated to Brown by Miss Gloria Heath, include magic squares, polyhedrons, stars, and solids. This exhibit can be viewed Monday through Friday, August 8 – 12, from 9:00 a.m. to 5:00 p.m.

There will be a display of rare mathematical books in the John Hay Library at Brown University Monday through Friday, August 8 – 12, 9:00 a.m. to 5:00 p.m.

Commercial Exhibits

The book and educational media exhibits will be located in the Grand Ballroom in the Omni Biltmore, and will be open Monday through Friday, August 8 – 12. The hours they will be open are 1:00 p.m. to 5:00 p.m. on Monday, 9:00 a.m. to 5:00 p.m. Tuesday and Wednesday, 9:00 a.m. to 1:30 p.m. on Thursday, and 9:00 a.m. to noon on Friday. All participants are encouraged to visit the exhibits during the meeting.

How to Obtain Hotel Accommodations

Reservations at these hotels cannot be made by calling the hotel directly until after July 15, 1988. After July 15, 1988, the rates below may not apply.

In all cases "single" refers to one person in one bed; "double" refers to two persons in one bed; "twin" refers to two persons in two twin beds; and "twin double" refers to two persons in two double beds. A rollaway cot for an extra person can be added to a room; however, not all hotels are able to do so and for those that do, the number of cots available is limited and given on a first-come, first-served basis.

Participants should be aware that it is general hotel practice in most cities to hold a nonguaranteed reservation until 6:00 p.m. only. When one guarantees a reservation by paying a deposit or submitting a credit card number as guarantee in advance, however, the hotel usually will honor this reservation up until checkout time the following day. If the individual holding the reservation has not checked in by that time, the room is then released for sale, and the hotel retains the deposit or applies one night's room charge to the credit card number submitted.

If you hold a guaranteed reservation at a hotel, but are informed upon arrival that there is no room for you, there are certain things you can request the hotel do. First, they should provide for a room at another hotel in town for that evening, at no charge. (You have already paid for the first night when you made your deposit.) They should pay for taxi fares to the other hotel that evening, and back to the meetings the following morning. They should also pay for one telephone toll call so that you can let people know you are not at the hotel you expected. They should make every effort to find a room

for you in their hotel the following day, and if successful, pay your taxi fares to and from the second hotel so that you can pick up your baggage and bring it to the first hotel. Not all hotels in all cities follow this practice, so your request for these services may bring mixed results, or none at all.

Please make all changes to or cancellations of hotel reservations with the Mathematics Meetings Housing Bureau in Providence **before August 4, 1988.** The telephone number in Providence is 401-272-9500 (extension 290). After that date, changes should be made directly with the hotel. **Cancellations must be made directly with the hotel 48 hours prior to date of arrival in order to receive refunds of deposits.**

The hotels listed below accept American Express, MasterCard, Visa, Carte Blanche, and Diners' Club credit cards, personal checks with identification, and travelers' checks as payment for room charges. Rates are subject to a 10% state and room tax. Rates quoted are firm.

Omni Biltmore (Headquarters)
Kennedy Plaza
Providence, RI 02903
Telephone: 401-421-0700

Single occupancy	$ 70
Double occupancy	$ 80
Triple occupancy	$ 80
Triple occupancy w/cot*	$ 95
Quadruple occupancy	$ 80
Quadruple occupancy w/cot*	$ 95
Suites	$150

* Number of cots is limited.

Full service hotel. Restaurants and lounge. Parking is $6 per day for guests. Children 18 years and younger are free in same room as parents. All major credit cards accepted.

Holiday Inn
21 Atwells Avenue
Providence, RI 02903
Telephone: 401-831-3900

Single occupancy	$ 65
Double occupancy	$ 65
Triple occupancy	$ 65
Triple occupancy w/cot*	$ 71
Quadruple occupancy	$ 65
Quadruple occupancy w/cot*	$ 71
Suites	$135

* Number of cots is limited.

Full service hotel. Indoor swimming pool, jacuzzi, free parking, restaurant, and lounge. Children 18 years and younger are free in same room as parents. All major credit cards accepted.

How to Obtain Residence Hall Accommodations

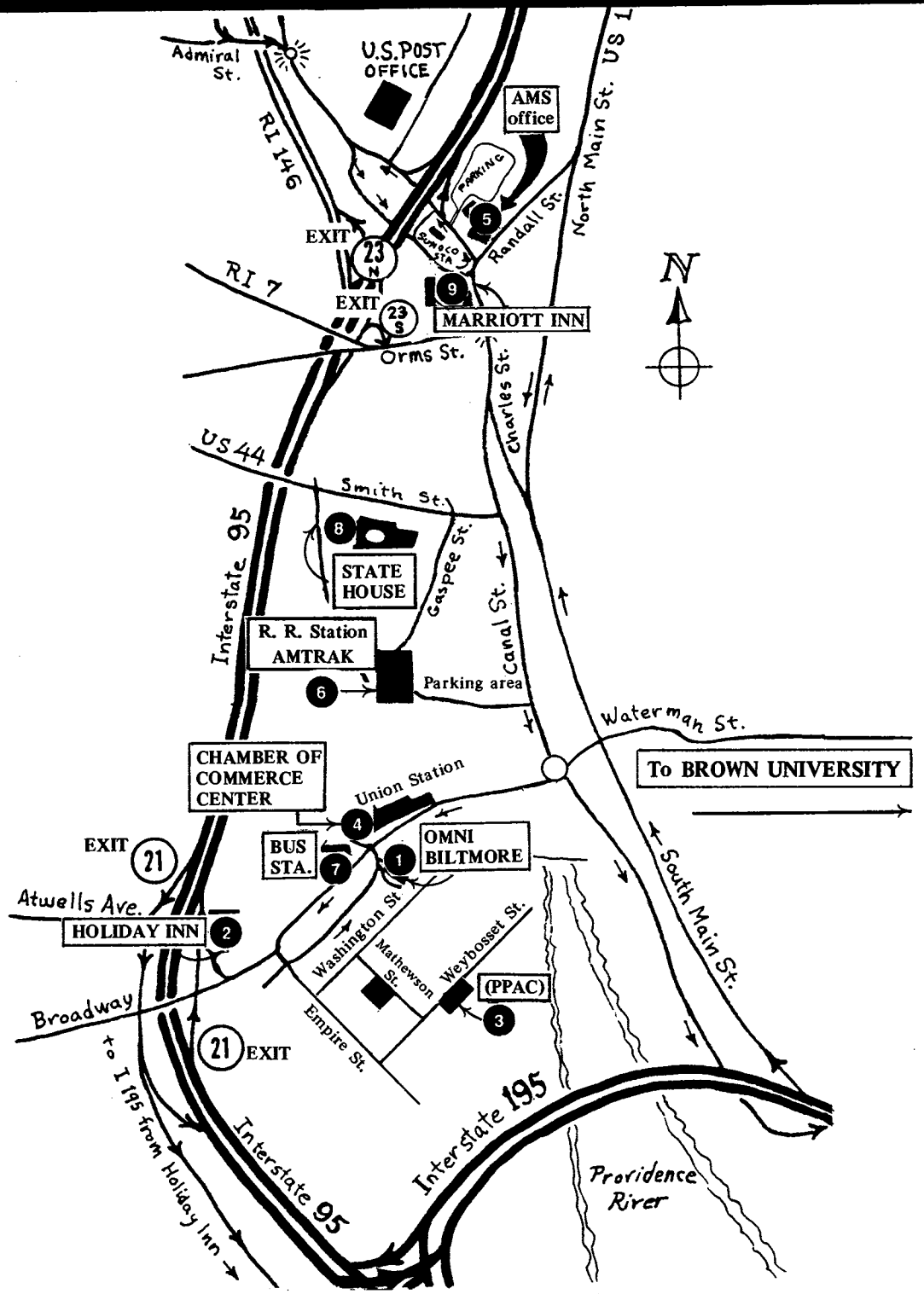
Centennial participants may occupy residence hall rooms at Brown University during the period August 5 to August 13 only. **All must check out by noon on August 13. All rooms on campus are offered through a room/board package only.** Only a very limited number of rooms on campus will be available for those participants who do not preregister but plan on attending the Centennial and registering on site. These rooms will be assigned at the Brown check-in desk where participants will be given a housing slip which should be taken to the Housing Section of the Centennial Registration Desk and payment made at the participant's earliest convenience. These payments can be made **only** during the hours the registration desk is open and can be made via personal checks, travelers' checks, or credit cards (Visa and MasterCard only).

Participants requesting housing on the Brown University campus will be assigned to one of six residence halls: Wayland Hall, Harkness Hall, Olney Hall, Diman Hall, Hegemann Hall, or the Graduate Center. (Please refer to the section below titled **Room and Board Rates.**)

Families with children will be allowed to stay in the dormitories; however, there is a maximum of one child per room. Sleeping bags for children staying with **both** parents will be permitted free of charge as long as the room is occupied to full bed capacity. Children occupying a bed will be charged the full room and board rate; however, children **under** seven years of age will be charged half-price for the meal portion of the package. (See section on **Hotels** above for alternate housing for families.)

Residence halls at Brown University have either three or four floors and no elevators or ramps. They are not accessible to the handicapped. All single rooms have a single bed, bureau, one closet, one chair, one desk, linen, a blanket and an overhead light. In addition to bed linen, pillow, and a blanket, participants will receive two towels, soap, and a disposal glass (exchangeable upon request at the check-in desk). **One** towel can be exchanged daily at a designated area. Participants are advised to bring their own washcloths and hangers. Rooms will be prepared for occupancy in advance; however, there is no daily maid service. There are no cots or cribs available. (See the section on Crib Rental.) In Wayland Hall, Harkness Hall, Olney Hall, Diman Hall, and the Graduate Center, there is one bathroom for each gender on each floor; all showers are open. Hegemann Hall is comprised of suites containing two or three bedrooms, a living room, and a bathroom with a private shower. Each hall is equipped with washers (50 cents) and dryers (50 cents). Vending machines are available in "Machine City," located in Keeney Quad, for candy, popcorn, soda, juice, coffee, and cigarettes.

DOWNTOWN PROVIDENCE



1 OMNI BILTMORE
2 HOLIDAY INN
3 PROVIDENCE PERFORMING ARTS CENTER (PPAC)
4 CHAMBER OF COMMERCE CENTER
5 AMERICAN MATHEMATICAL SOCIETY
6 R. R. STATION
7 BUS STATION
8 STATE HOUSE
9 MARRIOTT INN

Pets are not allowed in the residence halls.

There will be designated nonsmoking sleeping areas. The rooms are equipped with smoke alarms; the hallways are equipped with smoke alarms and heat detectors. Please note that none of the residence halls are air-conditioned.

Check-In Location and Times

There will be one main check-in desk for Brown residence halls located at a central location (to be determined at a later date) which will be staffed from 8:00 a.m. to 11:00 p.m.

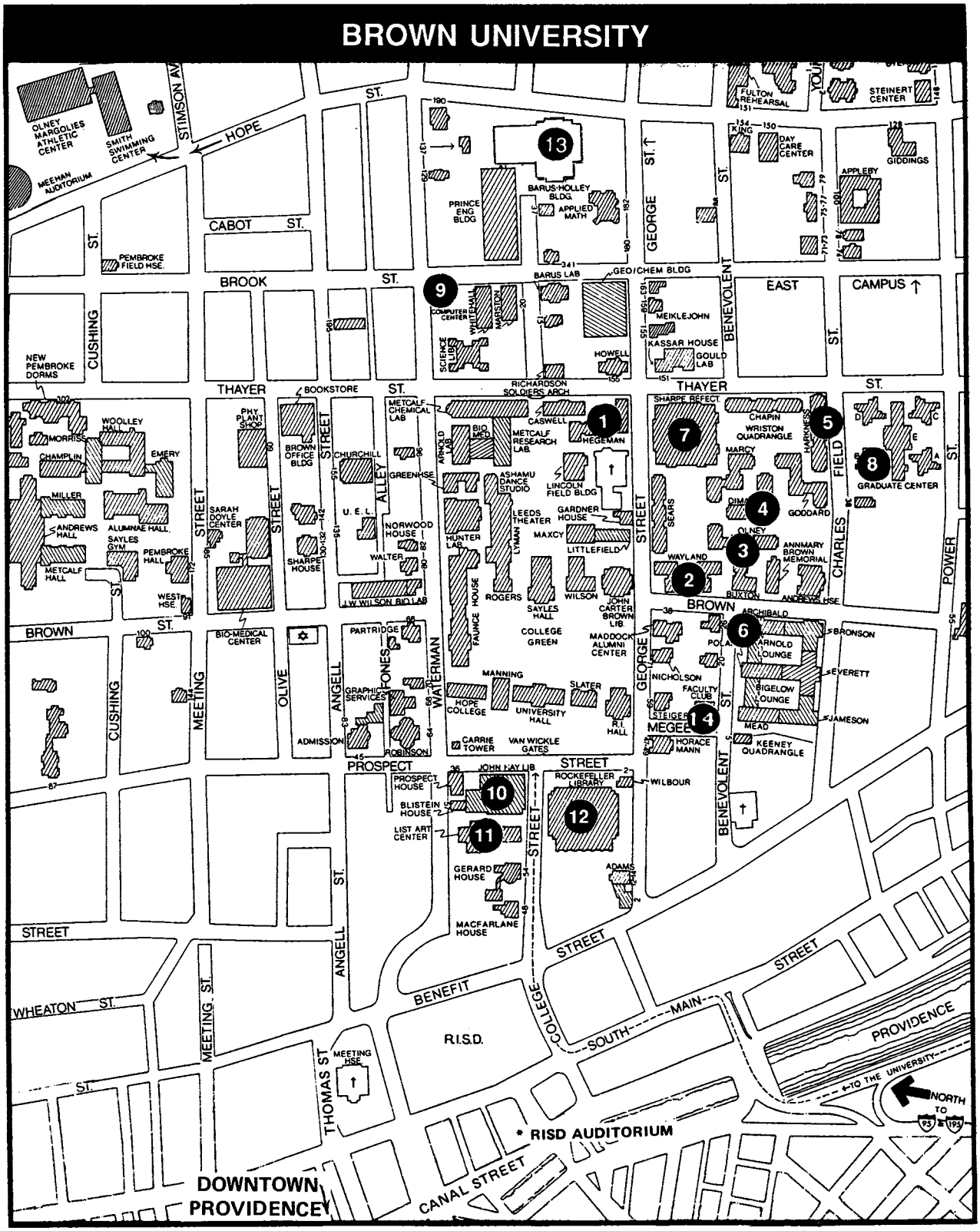
Telephone numbers to call for assistance will be posted for those participants arriving after 11:00 p.m. when the check-in desk is closed. Parking stickers for nearby university lots may be purchased at the Brown check-in desk at an estimated daily rate of $1.50.

At the time of check-in, participants assigned rooms through the Mathematics Meetings Housing Bureau will present their receipt which will enable them to receive two keys (one for the outside door and one for the room) and meal tickets at the Brown check-in desk. Those participants being assigned a room directly by the Brown check-in desk will be required to fill out a housing form, thus enabling them to receive keys. Spouses desiring a room key must follow this procedure also. **Please note that, although there is no deposit required for keys, a penalty of $2 will be imposed for each key lost or not returned.** It is the responsibility of the Mathematics Meetings Housing Bureau to collect this penalty. Therefore, it is requested that proper caution be exercised to avoid this charge. At checkout, all keys must be returned to the Brown check-in desk. Should the clerk not be present, please ensure that your name is left at the Brown check-in desk with the key.

Brown University
Room/Board Rates (per person)

	Adults	Children * under 7 years in bed	Child 7 years and older in sleeping bag	Child under 7 years in sleeping bag
8/5	$22.20 single $17.70 double	$22.20 single $17.70 double	No charge	No charge
8/6	$22.20 single $17.70 double	$22.20 single $17.70 double	No charge	No charge
8/7	$27.00 single $22.50 double	$24.60 single $20.10 double	$4.80 single $4.80 double	$2.40 single $2.40 double
8/8	$27.00 single $22.50 double	$24.60 single $20.10 double	$4.80 single $4.80 double	$2.40 single $2.40 double
8/9	$27.00 single $22.50 double	$24.60 single $20.10 double	$4.80 single $4.80 double	$2.40 single $2.40 double
8/10	$27.00 single $22.50 double	$24.60 single $20.10 double	$4.80 single $4.80 double	$2.40 single $2.40 double
8/11	$27.00 single $22.50 double	$24.60 single $20.10 double	$4.80 single $4.80 double	$2.40 single $2.40 double
8/12	$22.20 single $17.70 double	$22.20 single $17.70 double	No charge	No charge

* There is no charge for infants in arms.



1 HEGEMAN HALL
2 WAYLAND HALL
3 OLNEY HALL
4 DIMAN HALL
5 HARKNESS HALL
6 VENDING MACHINES
7 SHARPE REFECTORY
8 HALL B, GRADUATE CENTER
9 COMPUTER CENTER
10 JOHN HAY LIBRARY
11 LIST ART CENTER
12 ROCKEFELLER CENTER
13 BARUS & HOLLEY
14 FACULTY CENTER

.10
SCALE OF MILES 1.25 inch = .10 mile

* RISD AUDITORIUM

Room and Board Rates

Room and board rates for residence hall accommodations at Brown University can be found in a chart elsewhere in this announcement. Please note that there is no room tax applicable to these rates.

Should a family with two children request accommodations, two rooms would be required and the double rate (with appropriate adjustments for children under seven years of age) applies in each case. A family of three would require one double room at the double rate plus a second room for the third occupant at the single rate (with appropriate adjustments for children under seven years of age).

Please note that after August 4 no adjustment can be made to the room and board package price should the participant arrive later than the original date given when reservation was made, or leave earlier than the original departure date. Since no breakfast will be served on August 6, 7 and 13, there is no charge for breakfast included in the room rate for the previous nights. The cost of breakfast for children under seven years of age is half-price; there is no charge for babies in arms. **Meal tickets are nonrefundable.**

Food Services

The Sharpe Refectory located on the Brown University campus offers a variety of choices for breakfast. Breakfast is served cafeteria-style and **will not be available on a cash basis.** Breakfast will be served between 6:30 a.m. and 9:00 a.m. A typical breakfast menu is:

Mushroom or Mozzarella Cheese Omelette
Scrambled or Fried Eggs
Boiled Eggs
Grilled Ham
Pancakes or French Toast
Lyonnaise Potatoes
Grits
Danish Pastry
Choice of Beverage
Choice of Cereal

Servings are generous; unlimited seconds are offered on most.

As mentioned above, breakfast at Sharpe Refectory is included in the room and board package. Unfortunately, however, it will not be possible for participants to purchase either lunch or dinner at the Refectory on a cash basis.

There are several restaurants and specialty eating establishments within the immediate vicinity of Brown University. They range from Italian, French, and Japanese full course meals to pizza, homemade ice cream, and unusual sandwiches.

Changes, Cancellations and Refunds

If written notice of cancellation is received by the Housing Bureau **by August 4, 1988**, 50% of the preregistration fee and the cost of the tours, 90% of the residence hall package, 100% of the airport transfer and poster prices will be refunded. (100% refunds can be made for student, unemployed, and emeritus participants.) After August 4, 90% minus one night's stay will be refunded on residence hall packages, and 50% of the airport transfer and poster prices. It is regretted that no refunds of the preregistration fee or the cost of the tours can be made after August 4.

If written notice of cancellation is received by the Housing Bureau **by July 25**, 50% of the cost of the tickets for the MAA and ΠME banquets and clambake will be refunded. After July 25, no refunds will be possible.

Please make all changes to or cancellations of hotel reservations and residence halls with the Housing Bureau in Providence **before July 15, 1988**. The telephone number in Providence, Rhode Island, is 401-272-9500 (extension 290), the E-mail address is PONY%"MEET@SEED.AMS.COM", or Telex 797192. After that date, changes should be made directly with the hotel and residence halls. Most hotels will refund the $50 deposit **if notice of cancellation is received by them 48 hours prior to arrival.** All applicable refunds for residence housing will be issued by the Housing Bureau.

The Housing Bureau is unable to refund amounts less than $1.

Registration at the Meeting

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register. The fees for Centennial registration at the meeting listed below are 30% more than the preregistration fees.

Centennial Celebration	
Member of AMS, AWM, CMS, MAA, ΠME, SIAM	$ 89
Emeritus Member of AMS, MAA, SIAM	$ 30
Nonmember	$132
Student/Unemployed	$ 30
AMS Short Course	
Student/Unemployed	$ 15
All Other Participants	$ 45
MAA Minicourses	
(if openings available)	
Minicourses # 2, 4, 5, 7	$ 30
Minicourses # 1, 3, 6,	$ 50

Modes of payment which are acceptable, provided they are payable in U.S. dollars to the order of the

American Mathematical Society, are U.S. Postal Money Orders, certified U.S. bank checks, U.S. bank money orders, personal checks drawn on a U.S. bank, or credit card (Visa or MasterCard only).

An income tax deduction is allowed for education expenses, including registration fees, cost of travel, meals and lodging incurred to (i) maintain or improve skills in one's employment or trade or business or (ii) meet express requirements of an employer or a law imposed as a condition to retention of employment, job status, or rate of compensation. This is true even for education that leads to a degree. However, the Tax Reform Act of 1986 has introduced significant changes to this area. In general, the deduction for meals is limited to 80% of the cost. Unreimbursed employee educational expenses are subject to a 2% of adjusted gross income floor. However, there are exceptions to these rules. Therefore, one should contact one's tax advisor to determine the applicability of these provisions.

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

All **full-time** students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

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

Persons who qualify for emeritus membership in either the Society or the Association or SIAM may register at the emeritus member rate. The emeritus status refers to any person who has been a member of the AMS, MAA, or SIAM for twenty years or more, and is retired on account of age from his or her latest position.

Nonmembers who preregister or register at the meeting and pay the nonmember fee will receive mailings from AMS and MAA, after the meeting is over, containing information about a special membership offer.

Petition Table

At the request of the AMS Committee on Human Rights of Mathematicians, a table will be made available in the meeting registration area at which petitions on behalf of named individual mathematicians suffering from human rights violations may be displayed and signed by meeting participants acting in their individual capacities.

Signs of moderate size may be displayed at the table, but must not represent that the case of the individual in question is backed by the Committee on Human Rights unless it has, in fact, so voted. Volunteers may be present at the table to provide information on individual cases, but notice must be sent at least seven (7) days in advance of the meeting to the Director of Meetings in Providence (telephone 401-272-9500). Since space is limited, it may also be necessary to limit the number of volunteers present at the table at any one time. The Committee on Human Rights may delegate a person to be present at the table at any or all times, taking precedence over other volunteers.

Any material which is not a petition (e.g., advertisements, résumés) will be removed by the staff. **When registration closes, any material on the table will be discarded, so individuals placing petitions on the table should be sure to remove them prior to the close of registration.**

Registration Dates, Times, and Locations

AMS Short Course
Outside Auditorium, Rhode Island School of Design

Saturday, August 6	8:00 a.m. to 2:30 p.m.

Centennial Celebration
Garden Room, Omni Biltmore

Sunday, August 7	3:00 p.m. to 7:00 p.m.
Monday, August 8 through Wednesday, August 10	7:30 a.m. to 4:00 p.m.
Thursday, August 11	7:30 a.m. to 1:30 p.m.
Friday, August 12	7:30 a.m. to 1:00 p.m.

MAA Minicourses (until filled)
Outside Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University
Waterman Street (corner of Waterman and Brook)

Saturday, August 6	7:00 a.m. to 3:00 p.m.
Sunday, August 7	7:00 a.m. to 3:00 p.m.

Registration Desk Services

Assistance, Comments, and Complaints

A log for registering participants' comments or complaints about the meeting is kept at the Transparencies section of the registration desk. All participants are encouraged to use this method of helping to improve future meetings. Comments on all phases of the meeting are welcome. If a written reply is desired, participants should furnish their name and address.

Participants with problems of an immediate nature requiring action at the meeting should see the Director of Meetings, who will try to assist them.

Audio-Visual Assistance

A member of the AMS staff will be available to advise or consult with speakers on audio-visual usage.

Rooms where contributed paper sessions will be held are equipped with an overhead projector and screen. **Blackboards will not be available.**

Baggage and Coat Check

Baggage and coats may be left in the Centennial registration area in Garden Room of the Omni Biltmore **only** during the hours that registration is open. The staff cannot, however, take responsibility for lost or stolen articles.

Check Cashing

The Centennial cashier will cash personal or travelers' checks up to $50, upon presentation of the official meeting registration badge, provided there is enough cash on hand. Canadian checks must be marked for payment in U.S. funds. It is advisable that participants bring travelers' checks with them. When funds are low the meetings cashier will not be able to cash checks and travelers' checks can be easily cashed at local banks, restaurants, or hotels.

Daily Newsletter

A newsletter containing program changes and information of general interest to participants will be available each morning, August 8–12 at the registration desk. Participants should plan to pick up a copy every day.

Local Information

This section of the desk will provide information on local transportation, attractions, and events of interest.

Lost and Found

See the Centennial cashier.

Mail

All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, c/o Centennial Celebration, American Mathematical Society, P. O. Box 6887, Providence, Rhode Island 02940. Mail and telegrams so addressed may be picked up at the mailbox in the registration area during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.

Special Postal Cancellation

The U.S. Postal Service has agreed to set up an official substation in the Centennial registration area Monday through Friday, August 8 to 12, from 11:00 a.m. to 3:00 p.m., with the exception of Thursday, August 11, when it will close at 1:30 p.m. Stamps may be purchased and items mailed. A special cancellation will be used at this substation, offering participants an opportunity to obtain a pictorial cancellation for philatelic purposes which will identify the AMS Centennial. The Providence Postmaster has agreed to continue this special offer for 60 days after the Centennial. Interested parties should send their self-addressed material with proper postage to be cancelled to the Providence Post Office, 24 Corliss Street, Providence, Rhode Island 02904, Attention: Manager of Technical Sales and Service.

Personal and Telephone Messages

Participants wishing to exchange messages during the meeting should use the mailbox mentioned above. Message pads and pencils are provided. It is regretted that such messages left in the box cannot be forwarded to participants after the meeting is over.

A telephone message center is located in the registration area to receive incoming calls for participants. **The center is open from August 7 through 12, during the hours that the Centennial registration desk is open only.** Messages will be taken 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. Once the registration desk has closed for the day there is no mechanism for contacting participants other than calling them directly at their hotel or residence hall. The telephone number of the message center is 401-331-9358.

Information Table

The information table at Joint Meetings of the AMS and MAA is set up in the registration area for the dissemination of information of a nonmathematical nature of possible interest to the members. The administration of the information table is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for such joint meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8\frac{1}{2}'' \times 14''$.
2. A copy of any announcement proposed for the table is to be sent to the Director of Meetings, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.
3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case by case basis to establish precedents.
4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.
5. Copies of an accepted announcement for the table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meeting (for example, not by posting or personal distribution of handbills).
6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meeting.
7. At the close of registration, the table will be swept clean. A proponent who wishes the return of extra copies should remove them.

Transparencies

Speakers wishing to prepare transparencies in advance of their talk will find the necessary materials and copying machines at this section of the registration desk. A member of the staff will assist and advise speakers on the best procedures and methods for preparation of their material. There is a modest charge for these materials.

Visual Index

An alphabetical list of registered participants, including local addresses and arrival and departure dates, is maintained in the registration area.

Miscellaneous Information

Athletic Facilities

The facilities at the YMCA (available to current Y members; please check at membership window) at 160 Broad Street include an indoor pool; indoor track; basketball, handball and racquetball courts; universal weights; sauna; aerobics classes.

Tennis courts for public use are available at Nathan Bishop Junior High School on Sessions Street (off Elmgrove), and at Hope High School on Hope Street.

Any participant can use the Brown University athletic facilities at a cost of $2.75 per person per day or $7 per person per week. This includes the basketball court, outdoor tennis courts (indoor courts are an additional charge), weight room, jogging track, squash, swimming pool, sauna, and sun deck.

Book Stores

The Brown University Bookstore at 244 Thayer Street is open Monday–Saturday from 9:00 a.m. to 6:00 p.m.

The College Hill Bookstore at 252 Thayer Street is open Monday–Thursday from 9:00 a.m. to 11:00 p.m., on Friday & Saturday from 9:00 a.m. to midnight, and on Sunday from 10:00 a.m. to 11:00 p.m.

Camping

There are thirteen state or municipally owned campgrounds, offering a variety of facilities. Some accept reservations; others do not. There are many more private campgrounds, most of which encourage reservations. Because the Centennial takes place during a Rhode Island holiday weekend (V-J Day is Monday), space may be at a premium. The closest campground is a forty-minute drive from Providence. Overnight camping in rest/picnic areas, on public highways, in non-camping state/municipal parks, state/municipal beaches and their parking lots is prohibited. Please contact the Mathematics Meetings Housing Bureau at 401-272-9500, extension 290, or the RI Department of Economic Development, 401-277-2601, for more information.

Child Care

There are several registered day care facilities in Providence. Very few, however, have openings during the week of the Centennial, and many also require that the child be enrolled for a full week. The following have indicated that they are willing to accommodate Centennial participants:

Carter Day Nursery, 239 Public Street, Providence, RI, 401-751-9752. Contact Sister Mercain Hassett. Ages 3-5 years, certified kindergarten. Rates: $50/week, no daily or hourly rates available. Please call well in advance to make arrangements.

Brown Fox Point Day Care & Family Center, 150 Hope Street, Providence, RI, 401-521-5460. Contact Pam McGinn. Ages 3-5 years. Part-time five mornings or three afternoons per week, or full week. Rates: $35–$45/ part-time; full-time $45–$75. Please call two weeks in advance to make arrangements.

Mt. Hope Day Care Center, Inc., 421 Hope Street, Providence, RI, 401-521-7252. Contact Elizabeth Adam. Ages 3-6 years. Rates: $40 per week for half days, $55 per week for full days. Please make reservations by the end of June.

Child Care Center Inc., 345 Blackstone Boulevard, Providence, 401-272-3959. Ages: 2 months to 6 years.

YMCA Parent/Child Center, 438 Hope Street, Providence, 401-521-0155. Ages: 3 to 12 years.

JCC of RI Preschool, 401 Elmgrove Avenue, Providence, 401-861-8800. Ages: 3 months to 6 years.

Providence Central YMCA, 160 Broad Street, Providence, 401-456-0100. Ages: 1-1/2 to 6 years, approximately $60 per week

Federal Hill House Day Care Center, 9 Courtland Street, Providence, 401-421-4722. Ages: 3 to 12, sliding scale fees.

Smith Hill Day Care, 25 Danforth Street, Providence, 401-831-1720. Ages 2 to 6 years, approximately $2 per hour.

The following commercial babysitting services are available:

We Sit Better of RI, 1005 Fleet National Bank Building, Providence, RI. 401-421-1213. Referral service for babysitters. Members of the National Association of Referral Services.

Both the Biltmore and the Holiday Inn have babysitting referral services.

There will be a list of local babysitters available at the Local Information Section of the Centennial Registration Desk during the meeting.

In addition, a Parent-Child Lounge will be located adjacent to the Centennial registration area in the Grand

Ballroom of the Holiday Inn. It will be furnished with casual furniture, a crib, a television set, and VCR. Appropriate videotapes and cartoons will be available at the Telephone Message Center. Any child using this lounge **MUST** be accompanied by a parent (not simply an adult) who must be responsible for supervision of the child. This lounge will be unattended and parents assume all responsibility for their children. This lounge will be open only during the hours of registration and all persons must leave the lounge at the close of registration each day.

Crib Rental

A very limited number of portable cribs are available for rent from Rent It All, 738 N. Broadway, East Providence, RI 02914 (telephone 401-434-8479) for $4 per day or $20 per week (five days and over). There is a $18 charge each way for pickup and delivery. The cribs have mattresses, but linens are not provided. Participants renting these cribs for use in the university residence halls should notify the Brown check-in desk of the expected delivery. Payment may be made by VISA or MasterCard credit cards.

Participants not staying on campus will find portable cribs available on a first-come, first-served basis from the hotels.

Handicapped

The Brown University housing facilities are **not** accessible to the handicapped; however, most (not all) classrooms used for the MAA Minicourses are. Participants with special requests or questions regarding handicapped access at the university should contact Pat Henry, Conferences, 401-863-3500.

All hotels are accessible to the handicapped. Participants with special requirements should keep this in mind when requesting housing for the Centennial.

Participants with special questions regarding handicapped access in the city should contact The Governor's Commission on the Handicapped, 401-277-3731.

Libraries

The following libraries are within walking distance of the hotels and residence halls:

Brown University Sciences Library, Corner of Thayer & Waterman Streets, Monday – Thursday 9:00 a.m. – 9:00 p.m., Friday 9:00 a.m. – 5:00 p.m., Saturday 10:00 a.m. – 5:00 p.m.

Rockefeller Library, Brown University campus (same hours as Sciences Library)

John Hay Library (special collections), Brown University campus, Monday – Friday, 9:00 a.m. – 5:00 p.m.

John Carter Brown Library (early Americana collection), Monday – Friday, 9:00 a.m. – 5:00 p.m.

Providence Public Library, 150 Empire Street, Monday, Tuesday, and Thursday, 9:30 a.m. – 9:00 p.m.; Friday and Saturday, 9:30 a.m. – 5:00 p.m.

Providence Athenaeum (rare books), 251 Benefit Street, Monday – Friday, 8:30 a.m. – 5:00 p.m.

Local Information

In August, Providence is on Eastern Daylight Saving Time.

Participants should be aware that Monday, August 8, (Victory over Japan Day) is celebrated as a legal holiday in Rhode Island. There is no delivery of mail by the U.S. Post Office, and all banks and state offices are closed, as are many businesses.

All sessions during the period August 8 – 12 will be held in downtown facilities. Sessions scheduled to be held on Saturday and Sunday, August 6 – 7 will take place on College Hill (also known as the East Side), where Brown University is located. Both of these areas are very walkable, but the difficulty involved is in traveling between them. College Hill is not a misnomer, and, although picturesque, it is fairly steep. Fortunately several buses run regularly between Kennedy Plaza downtown and Thayer Street, the "main street" of College Hill. Taxis in Providence are not usually in evidence, except around hotels and bus and train stations, but it is easy to telephone for them. A trip from the Holiday Inn to the Brown campus would cost between $3 and $4. A small green trolley, called the Downtown Free Loop, circles around central Providence approximately every twelve minutes, and will stop just about anywhere on its route if the driver is given enough notice. Principal stops include the State House, First Baptist Church, Kennedy Plaza, and Davol Square. If this trolley is still in operation at the time of the Centennial, it is hoped that arrangements can be made for this trolley to drop participants off at the AMS headquarters office. In addition, the Society has arranged for a free shuttle service to and from Brown University that will run daily during the meeting. Although this free shuttle is primarily intended to provide transportation for participants staying in the Brown residence halls, participants staying in the downtown hotels may also utilize this shuttle to visit the Brown University area, including the special mathematical exhibits described in the section on Special Events.

Other than the steep climb, the walk through Providence to Brown University is very short, and many of Providence's more interesting sights happen to be along the way. The Art Deco Fleet National Bank, which faces Kennedy Plaza, is one such sight. It was once New England's most prominent skyscraper, and it is still an

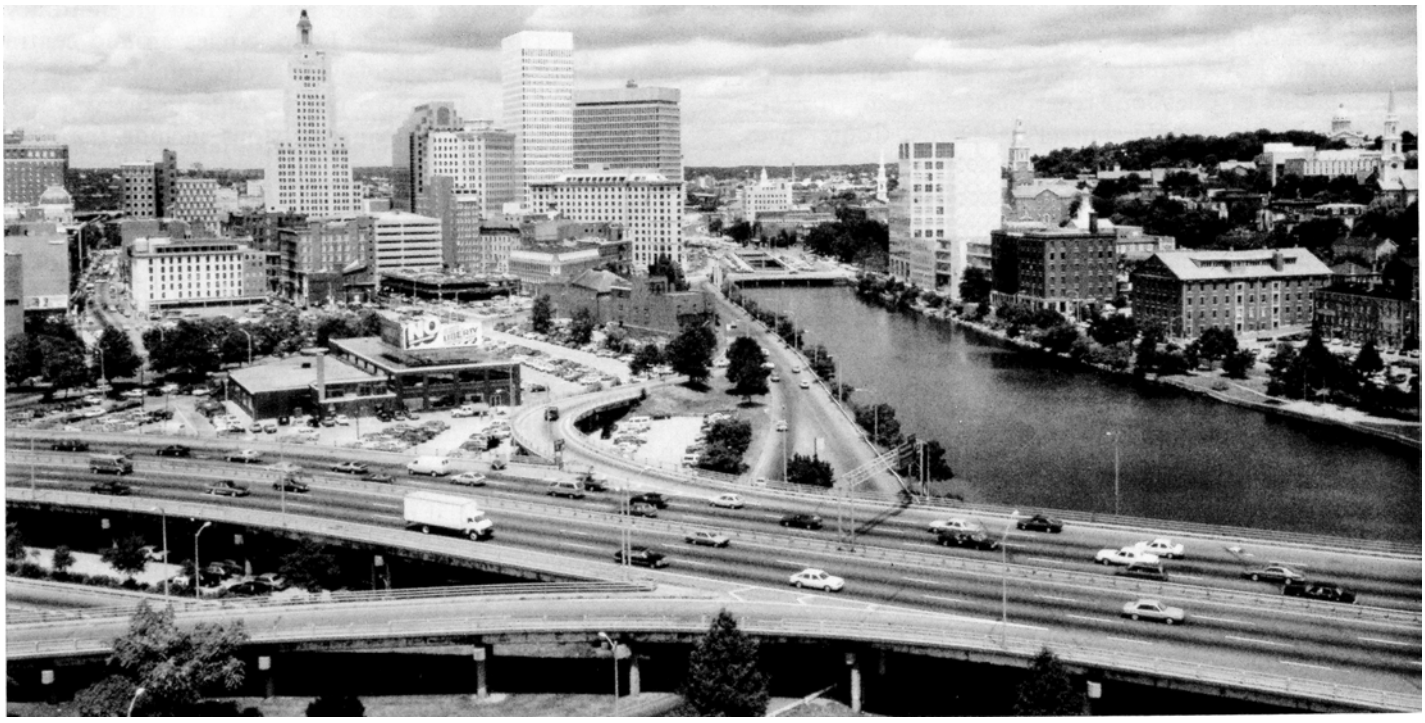
integral part of Providence's skyline. The myth persists that it is the original "Daily Planet" building of Superman fame. On the other side of the bank (which can be walked through) is the Arcade, America's first shopping mall, built in 1828. This exquisite, glass-roofed, Greek Revival building contains three floors of specialty shops, food shops, and small restaurants.

Providence possesses an extraordinary number of eighteenth and nineteenth century buildings, both public and private, and College Hill is a pleasant place to enjoy a remarkable collection of them. Benefit Street attracts national attention as the longest street of original colonial architecture in the country. Known as Providence's mile of history, it includes colonial, Federal, and Victorian residences, meticulously restored. Although most are private homes, there are two house museums on Benefit Street. One, the John Brown House, was referred to by John Quincy Adams as "the most magnificent and elegant mansion that I have ever seen on this continent." The more modest Stephen Hopkins House is a small, red, colonial once owned by Hopkins, a former Governor of Rhode Island and a signer of the Declaration of Independence. Another building of special interest is the Athenaeum, one of the oldest library companies in America; here Edgar Allan Poe courted Sarah Helen Whitman, a resident of Benefit Street. The First Baptist Church, with its back to Benefit Street, is the home of the first Baptist congregation in America, founded by Roger Williams and his followers in 1636. The church itself was built in 1775. The very fine Museum of Art of the Rhode Island School of Design is also located on Benefit Street. It contains over 60,000 holdings in sculpture, painting, graphics, textiles, and the decorative arts.

Theatregoers will enjoy the summer comedies and musicals presented by the Tony Award-winning Trinity Square Repertory Company in downtown Providence.

If one is in search of greenery, Providence's parks include tiny Prospect Terrace on the East Side, which features a statue of Rhode Island's founding father, Roger Williams, and an excellent, breezy view of Providence, including the beautiful dome of the State House. The visitor center of the Roger Williams National Memorial and a four-and-one-half acre park is located at Smith Street and North Main Street. This is the site of the founding of Providence by Roger Williams in 1636. Families may enjoy Roger Williams Park and Zoo, not far away on Elmwood Avenue. It is an elegant urban park of approximately 450 acres, with a lake, paddleboats, and a merry-go-round. The zoo is newly renovated. There is a small Museum of Natural History on the grounds.

Clusters of restaurants, most in close proximity to shopping areas, are located along Thayer Street, Wickenden Street, South and North Main Streets, in downtown Providence, and on Federal Hill. There is a great diversity of cuisines and cultures to be found in Providence's restaurants. One can find particularly good Italian food in the Federal Hill (Atwells Avenue) section of the



Downtown Providence

city. There are several French-inspired restaurants; Mexican restaurants exist, and the city's eastern offerings include Indian, Chinese, and Japanese cuisines. Usually one can find lunch for under $5; dinner prices range from inexpensive to moderately expensive.

An advantage of the state's small size is that there is no place in Rhode Island more than than an hour's drive from Providence. With its more than 400 miles of coastline, Rhode Island offers dozens of high quality public beaches on both sides of Narragansett Bay and along the Atlantic as far south as Watch Hill. Lists of beaches and information on boating, fishing, and other activities will be available at the Local Information Section of the Centennial Registration Desk.

One of the oldest and most famous seaside resorts in the country, Newport is barely an hour away from Providence. The beautiful and opulent city was the location of the America's Cup Races until recent years. During the summer the Tall Ships can frequently be seen in the harbor. Newport is also known for its sumptuous summer "cottages," built around the turn of the century by wealthy industrialists and social leaders, among them the Vanderbilts and the Astors.

Medical Services

Participants requiring medical assistance should refer to the following:

Rhode Island Hospital, large multi-service teaching facility, open 24 hours, 593 Eddy Street, Emergency telephone: 277-4000

Women & Infants, offering obstetric and neonatal care, at Rhode Island Hospital

Miriam Hospital, all services except psychiatric and obstetric, 164 Summit Avenue

Veterans Administration Hospital, Davis Park, Providence

Brown's Health Services, 13 Brown Street, open Monday-Friday, 8:00 a.m.–3:30 p.m. A physician is on duty during these hours. The University police and security people are Emergency Medical Technicians and may be called when health services are closed. They will transport to a nearby hospital if necessary.

Parking

Street parking is allowed in metered areas for 25 cents per hour. Meter time ranges from 30 minutes to 10 hours depending on location. Most meters have a two hour limit. There is no overnight street parking. Meter maids are frequent and plentiful.

There is no charge for parking in the hotel's facility for overnight guests staying at the Holiday Inn. There is a $6 per day charge for guests at the Omni Biltmore and $12 per day for those not staying.

There is a variety of parking garages and lots in the downtown area. Several have "early bird" rates of about $4.50 if you are in the lot by 9:00 a.m. and out by 6:00 p.m. Otherwise, you should expect to pay this much for a two-and-one-half hour period. Rates are fairly standard, with most charging a maximum of $7.50 per day. The Parkade (associated with the Biltmore) is the most expensive with a maximum of $12.50 per day, but it is the only one to allow overnight parking (free to overnight guests who have their ticket validated at the hotel front desk). There is a lot near the bus station that is more economical and allows overnight parking for $7.50, but it is unprotected. The following lots fall within the described rate structure:

Meyers Park, across from the Performing Arts Center

Outlet Parking Garage, on Pine Street behind the Performing Arts Center

Majestic Parking Garage, on Fountain Street, around the corner from the Holiday Inn (also near the Providence Public Library)

Parkade, behind the Omni Biltmore

Brown University has on-campus parking spaces available in overnight lots at an estimated cost of $1.50 per day. Parking permits will be sold at the check-in desk for the Brown residence halls.

Smoking

Please note that smoking is not allowed in any of the session rooms in the PPAC, Biltmore, Holiday Inn, or the Rhode Island School of Design.

There are designated nonsmoking sleeping rooms in the residence halls as well as hotels.

Special Events

AMS Open House

The Society invites all Centennial participants to visit its headquarters office at 201 Charles Street. Guided tours will be given daily from 1:00 p.m. to 3:00 p.m. Tuesday through Thursday, August 9–11. Reservations must be made by signing up at the Tickets/Tours Section of the Centennial Registration Desk. There is no charge for these tours which will be conducted by the various department and division heads of the AMS staff.

As previously mentioned, if the Downtown Free Loop trolley is still operating in August, plans are to have it drop off participants at the AMS office.

To get to the Society's headquarters from I95 North, take exit 23, State Offices. Turn left onto Orms Street at the end of the exit. Go left at the light at the bottom of the hill onto Charles Street. The Society is located in a one-story dark brown building about 200 yards on the right. From I95 South, take exit 23, Charles Street.

Bear right because traffic is one way at this point. Bear to the left and around V.F. Liquors to reverse direction. Continue about 300 yards and bear left around the Sunoco station. The Society's entrance is directly across from the Sunoco station on Charles Street.

Opening Reception

All Centennial participants are invited to attend the Opening Reception on Monday, August 8, at 7:00 p.m. at the Rhode Island State House. Free transportation will be provided. This predinner function features light hors d'oeuvres and beverages. Music will be provided by Musica Camera, a chamber music ensemble led by Ernest Nordman, recently retired from the Society's staff after 25 years of service.

The State House was built in 1900 of white Georgia marble. It has the third largest unsupported marble dome in the world, surpassed only by the Taj Mahal and St. Peter's Cathedral in Rome. Among the many historical artifacts housed in this building is a full length portrait of George Washington by Gilbert Stuart, a native Rhode Islander.

At the Semicentennial in 1938, all participants gathered on the steps of the Low Memorial Library at Columbia University for a group photograph. In an attempt to duplicate this feat, all participants are requested to gather on the front steps of the State House at 6:30 p.m., just prior to the Opening Reception. Copies of this photograph will be on sale later in the week at the Souvenirs Section of the Centennial Registration Desk.

Rhode Island State House

Clambake

On Thursday afternoon, August 11, a traditional New England clambake will take place at Francis Farm in Rehoboth, Massachusetts. Transportation will be provided. The clambake was originated by native Indians who cooked their clams on large, hot stones and covered the food with seaweed and hay. Francis Farm has replaced the stones with heated iron ingots, since, unlike rocks, they can be reheated. The same family has continued this tradition for 115 years. The "all-you-can-eat" menu includes chowder and crackers, clamcakes, clams hot from the bake with drawn butter, fresh fish, white and sweet potatoes, onions, sweet corn, sausage, brown bread, hard butter, pickles, watermelon, and coffee. Participants may substitute chicken for fish if advance notice is given.

Musical entertainment will be provided by the Old Fiddlers' Club of Rhode Island, whose repertoire includes all the old familiar songs.

The farm has facilities and equipment for volleyball, basketball, softball, and horseshoes. Entertainment will be provided for the children, including face-painting.

Tickets may be purchased at the Tickets/Tours section of the registration desk until the close of registration on Tuesday, August 9. Tickets are $23 for adults and $15 for children ages 6 through 12. There is no charge for children under 6 years of age. However, if bringing a child under 6 years of age, please inform the ticket vendor when purchasing the ticket. Please note that a 50% refund can be made on clambake tickets purchased through preregistration **until July 25**. After July 25, no refunds are possible.

RISD Museum

The Rhode Island Shool of Design Museum of Art at 224 Benefit Street is one of the nation's finest smaller art museums. In recognition of the Society's Centennial, the directors of the museum are extending free admission to Centennial participants wearing the official meeting badge during the period August 8 – 12. Brochures about the museum and containing its summer hours will be available at the Local Information section of the registration desk.

The RISD museum's collections include art treasures from all over the world, from ancient to avant-gard. The museum is especially renowned for its French masterpieces and contemporary American painting, and lists the gigantic Buddha from 10th Century Japan as a "must see". The Pendleton House wing, patterned after an early 19th Century Providence house, contains one of the foremost museum collections of American furniture and decorative arts.

Happy Hour

On Tuesday and Wednesday, August 9 – 10, from 5:30 p.m. to 7:30 p.m., a no-host cash bar will operate in the

Cafe on the Terrace of the Omni Biltmore Hotel. Free dry snacks will be provided. Participants are encouraged to use this occasion to spend some time with old and new friends.

Souvenirs

Photographs

A copy of the group portrait of Semicentennial participants will be on display in the registration area. Orders for reproductions of this photograph will be taken at the Souvenirs Section of the Centennial Registration Desk. The price for these reproductions has not yet been determined, but should be modest.

Copies of the group photograph taken on Monday, August 8, at the Opening Reception will also be on sale at the Souvenirs Section of the Centennial Registration Desk.

Commemorative Poster

The Society has prepared a poster commemorating its Centennial featuring a photographic reproduction of the sculpture Torus with Cross-Cap and Vector Field by Helaman Rolfe Pratt Ferguson of Brigham Young University. The sculpture is a gift from the Mathematical Association of America to the Society on the occasion of its Centennial. This striking poster is printed on museum quality glossy paper. The sculpture is white and photographed on a rich, blue background. These posters are on sale at the Souvenirs Section of the Centennial Registration Desk for $10 each. Those who purchased the poster through preregistration may pick up their copy at the Souvenirs Section. Please note that a 100% refund can be made on posters purchased through preregistration **until August 4**. After August 4, only 50% can be refunded.

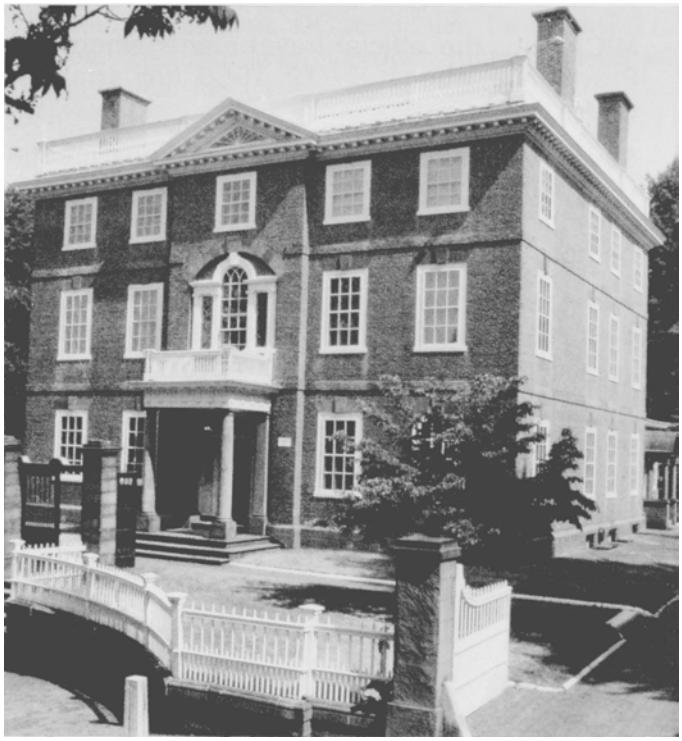
Tours

Tour of Historic Providence

Architectural historians regard the buildings of Providence's "East Side" as one of America's best examples of 18th century America. Homes from the colonial period to the contemporary cover every period of architectural importance in American Life. This area of Providence is not a recreated showplace; these homes have been lived in continuously since before the Revolutionary War. Benefit Street was created "for the common benefit of all" in the 1760s to relieve congestion on Providence's Main Street. Benefit Street followed a path along existing gardens, orchards, and family burial plots, and now has brick paved sidewalks lined with charmingly restored colonial, federal, Greek revival, and Victorian homes. Its rescue from blight was a triumph for historic preservation, turning it into one of New England's most beautiful residential areas. On this tour you will learn of Providence's rich history as a colonial capital, a bustling China Trade seaport, and an early center of industrial development as you view 18th century buildings on the city's waterfront. Included in this tour will be a visit to one of the private homes in this area that has undergone restoration to its original beauty. This tour is offered twice daily on Tuesday, August 9, and Thursday, August 11, departing from the front of the Omni Biltmore at 9:00 a.m. and 11:00 a.m. and returning at 11:00 a.m. and 1:00 p.m. Tickets are $12 for adults, $10 for children age 12 or under. There is no charge for infants not occupying a seat on the bus. Tickets may be purchased at the Tickets/Tours section of the registration desk as available. Please note that a 50% refund can be made on tour tickets purchased through preregistration **until August 4**. After August 4, no refunds are possible.

Living History Tour of Newport

A costumed character from Rhode Island history will serve as the guide for this bus tour of the colonial and Victorian city of Newport. Settled in the 18th century, Newport is home to the first synagogue and first Quaker meeting house in America. Newport is perhaps best known as the home of the "summer cottages" of the country's wealthiest families, such as the Vanderbilts and the Rockefellers. The highlight of the afternoon is a visit to Beechwood, the summer home of the Astor family.



John Brown House

Here, instead of roped-off displays and security guards, one finds a lively recreation of life in the 1890s. Mrs. Astor's guests and servants are portrayed in Newport's only living history tour. This tour is offered on Monday, August 8, Wednesday, August 10, and Friday, August 12, departing from the front of the Omni Biltmore at 1:00 p.m. and returning at 5:00 p.m. Tickets are $15 for adults, $12 for children age 12 or under. There is no charge for infants not occupying a seat on the bus. Tickets may be purchased at the Tickets/Tours section of the registration desk as available. Please note that a 50% refund can be made on tour tickets purchased through preregistration **until August 4**. After August 4, no refunds are possible.

Travel

By Air

For some years now, the AMS-MAA Joint Meetings Committee has engaged a travel agent for the January and August meetings in an effort to ensure that everyone attending these meetings is able to obtain the best possible airfare. This service is presently being performed by Meetings, Incentives, Conventions of America, Inc. (MICA); their advertisement can be found elsewhere in this meeting announcement. Although any travel agent can obtain Supersaver or other such published promotional fares, only MICA can obtain the special additional 5% discount over and above these fares, and the 35-40% off regular coach fare. The latter, of course, is financially beneficial only when one does not qualify for one of the promotional fares. Participants should pay particular attention to the cancellation policies stated in the ad.

Airport Transfers

Theodore Francis Greene Airport lies about nine miles south of Providence and is served by most major carriers. Cabs are metered, with a typical fare to the downtown area averaging $15.

The Society has made arrangements with the Airport Limousine to provide ground transfers to and from the Providence airport, the hotels, and the residence halls at Brown University. The cost one way is $5.75 per person (no charge for infants on parent's lap) or $11.50 round trip. Participants wishing to purchase these transfers through preregistration should have completed the

AIRLINE INFORMATION

appropriate section of the Preregistration/Housing Form and included payment with their preregistration fee. It is mandatory that participants purchasing these transfers provide accurate airline flight information. These transfers will be valid from Friday, August 5, through Monday, August 15. Transfers will be mailed to each participant with the acknowledgement of preregistration. A 100% refund can be made for airport transfers cancelled by August 4. After August 4 only 50% can be refunded.

Return transfers should be reconfirmed at the Tickets/Tours Section of the Centennial Registration Desk during the meeting. Return transfers can also be purchased at this desk.

There will be a desk in the lobby of the airport for the purpose of welcoming Centennial participants and dispensing information on transportation to and from the airport. A comfortable area has been set aside for those who must wait for the airport limousine or for outgoing flights.

Participants staying at the Holiday Inn-Providence Downtown should be aware that the Inn has a courtesy van that runs between the airport and the hotel between the hours of 6:00 a.m. and 11:00 p.m. When arriving in Providence, please use the green telephone in the baggage claim area to contact the van. Although the van runs until 11:00 p.m., the last time it can be called is 10:30 p.m.

There are several rental car companies located at the airport or directly across the street. Expect to pay $30 per day for a compact car and $35 per day for an intermediate size car, which includes free mileage for the first 75 miles each day. Hertz rates are $10–$15 higher. It may be less expensive to contract for a week if you intend to use the car for five days. Weekly rates start at about $133 for a compact car (Dollar Rent-a-Car). All accept most major credit cards. The following are at the airport or across the street (businesses with an asterisk have toll free numbers to make reservations; consult your local yellow pages):

*Avis, 738-5800

Budget Car & Truck Rental, 739-8900 (also has office at Omni Biltmore)

*Dollar Rent A Car, 739-8450

*Hertz, 738-7500 (also has office at Omni Biltmore)

*National Car Rental, 737-4800 (also has office at Omni Biltmore)

*Thrifty, 739-8660

By Auto

Interstate Route 95 (I95) goes through the center of Providence. If arriving from the South (as if from the airport) take I95 north to exit 21 (Broadway), at the second set of lights, take a right, and the Holiday Inn will be on the left side. To get to the Omni Biltmore, follow the previous directions but pass the Holiday Inn and take a left at the next light. Follow the road as it curves to the right, but bear left onto Fountain Street. Go through two sets of lights, and take a right at the third set onto Dorrance Street. The hotel will be on your right, across from Kennedy Plaza.

If arriving from the north on I95 South, take exit 21, Atwells Avenue, and go left at the light at the end of the exit. The Holiday Inn will be on your left. For the Omni Biltmore, go by the Holiday Inn and take a left at the traffic light. Follow the directions in the previous paragraph, bearing left onto Fountain Street.

Brown University is most easily accessible from I195 East (which merges with I95 North and South in the center of Providence). Take the Wickenden Street exit (#2). Cross Wickenden Street at the end of the exit but take an immediate left, following the signs to Benefit Street. Travel up Benefit Street about three-quarter miles to George Street. Take a right on to George Street, which leads to the residence halls. See campus map for exact location of these halls.

By Train

Amtrak provides regular train service from New York City and Washington, DC to the new Providence Train Station. This Northeast Corridor route connects with others nationwide.

By Bus

The Bonanza Bus terminal is also located downtown and has frequent service from New York City and Logan Airport in Boston.

Videotapes

The Society plans to videotape the eighteen lectures in the symposium *Mathematics into the Twenty-First Century* and the three AMS-MAA Joint Invited Addresses as a record of the Centennial Celebration. It is anticipated that the videotapes will be available for distribution later in 1988.

Weather

The normal daytime high in the city is 80 degrees F. The normal nighttime low is 61 degrees F. Average daytime humidity is 82%; nighttime is 54%. Record high temperature is 104 degrees F., while the low is 40 degrees F. Light sweaters or jackets are recommended for cool evenings, while natural fiber clothing such as cotton is advised for warm, humid days. Average rainfall for the month of August is 3.9 inches; however, August can bring frequent and heavy thunderstorms where several inches of rain can fall in a very short period of time. The highest rainfall for August on record is 7.92 inches.

Everett Pitcher, Chairman
Centennial Committee

Proposed Amendments to the Bylaws of the American Mathematical Society

for Presentation at the Business Meeting of 8 August 1988 in Providence

The Council of 23 April 1988 recommended a change in Article VIII, Section 4 of the bylaws. The change is indicated by ~~lining out~~ words to be deleted and **bold facing** words to be inserted. In applying the amended version, it is intended to define scholarly activity in terms of size of faculty, number of graduate students, and amount of published material reviewed in *Mathematical Reviews* and to calculate dues by formula as a weighted average of measures of these categories. The amendment is offered at the Business Meeting for the approval of the membership.

Article VIII

Dues and Privileges of Members

Section 4. The minimum dues of an institutional member shall depend on the ~~amount of published material credited to~~ **scholarly activity of** that member ~~in certain journals during a specific period~~. The formula for computing these dues shall be established from time to time by the Council, subject to approval by the Board of Trustees. Institutions may pay larger dues than the computed minimum.

Timetable

(Eastern Standard Time)

The final version of the timetable and program, including room assignments, will be distributed at the meeting.

Saturday, August 6	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:00 a.m. - 3:00 p.m.		MINICOURSE REGISTRATION Outside Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
8:00 a.m. - 10:00 a.m.		MINICOURSE #1 (Part A) **EXP, EXP***Test, and the creation of testbanks* **Peter Frisk** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
8:00 a.m. - 10:00 a.m.		MINICOURSE #2 (Part A) *Contributions of algebraic coding theory to finite geometry* **E. F. Assmus, Jr.** **J. D. Key** Room 168, Barus & Holley, Brown University	
	SHORT COURSE SERIES *CHAOS AND FRACTALS: THE MATHEMATICS BEHIND THE COMPUTER GRAPHICS*		
8:00 a.m. - 2:30 p.m.	SHORT COURSE REGISTRATION Outside Auditorium, Rhode Island School of Design		
10:30 a.m. - 11:45 a.m.	SHORT COURSE LECTURE #1 *Overview: Dynamics of simple maps* **Robert L. Devaney** Auditorium, Rhode Island School of Design		
10:30 a.m. - 12:30 p.m.		MINICOURSE #3 (Part A) *A survey of educational software* **David P. Kraines** **Vivian Kraines** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	

Saturday, August 6 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING (cont'd)			
10:30 a.m. - 12:30 p.m.		MINICOURSE #4 (Part A) *Coloring and path following algorithms for approximating roots and fixed points* **William F. Lucas** Room 168, Barus & Holley, Brown University	
AFTERNOON			
2:00 p.m. - 3:15 p.m.	SHORT COURSE LECTURE #2 **The horseshoe map** *Philip J. Holmes* Auditorium, Rhode Island School of Design		
2:00 p.m. - 4:00 p.m.		MINICOURSE #1 (Part B) **EXP, EXP*Test, and the creation of testbanks*** **Peter Frisk** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
2:00 p.m. - 4:00 p.m.		MINICOURSE #2 (Part B) *Contributions of algebraic coding theory to finite geometry* **E. F. Assmus, Jr.** **J. D. Key** Room 168, Barus & Holley, Brown University	
3:30 p.m. - 4:45 p.m.	SHORT COURSE LECTURE #3 *Chaotic attractors* **James A. Yorke** Auditorium, Rhode Island School of Design		
4:30 p.m. - 6:30 p.m.		MINICOURSE #3 (Part B) *A survey of educational software* **David P. Kraines** **Vivian Kraines** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
4:30 p.m. - 6:30 p.m.		MINICOURSE #4 (Part B) *Coloring and path following algorithms for approximating roots and fixed points* **William F. Lucas** Room 168, Barus & Holley, Brown University	

Sunday, August 7

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:00 a.m. - 3:00 p.m.		MINICOURSE REGISTRATION Outside Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
8:00 a.m. - 10:00 a.m.		MINICOURSE #5 (Part A) *Teaching calculus with an HP-28 symbol manipulating calculator* **John W. Kenelly** Room 168, Barus & Holley, Brown University	
8:30 a.m. - 3:30 p.m.		BOARD OF GOVERNORS' MEETING College & Sessions Rooms, Marriott	
9:30 a.m. - 10:45 a.m.	SHORT COURSE LECTURE #4 *Julia sets* **Linda Keen** Auditorium, Rhode Island School of Design		
10:30 a.m. - 12:30 p.m.		MINICOURSE #6 (Part A) An *introduction to MATLAB* **David R. Hill** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
10:30 a.m. - 12:30 p.m.		MINICOURSE #7 (Part A) *Groups, graphs, and computing* **Eugene M. Luks** Room 168, Barus & Holley, Brown University	
11:15 a.m. - 12:30 p.m.	SHORT COURSE LECTURE #5 *The Mandelbrot Set* **Bodil Branner** Auditorium, Rhode Island School of Design		
AFTERNOON			
2:00 p.m. - 3:15 p.m.	SHORT COURSE LECTURE #6 *Introduction to fractals* **Virginia Harrison** Auditorium, Rhode Island School of Design		
2:00 p.m. - 4:00 p.m.		MINICOURSE #5 (Part B) *Teaching calculus with an HP-28 symbol manipulating calculator* **John W. Kenelly** Room 168, Barus & Holley, Brown University	

Sunday, August 7 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
3:00 p.m. - 7:00 p.m.		REGISTRATION Garden Room, Omni Biltmore	
3:45 p.m. - 5:00 p.m.	SHORT COURSE LECTURE #7 *Iterated function systems* **Michael F. Barnsley** Auditorium, Rhode Island School of Design		
4:30 p.m. - 6:30 p.m.		MINICOURSE #6 (Part B) An introduction to MATLAB **David R. Hill** Room 167, Thomas J. Watson, Sr. Center for Information Technology, Brown University	
4:30 p.m. - 6:30 p.m.		MINICOURSE #7 (Part B) *Groups, graphs, and computing* **Eugene M. Luks** Room 168, Barus & Holley, Brown University	
5:00 p.m. - 10:00 p.m.	COUNCIL MEETING Bacchante Room, Omni Biltmore		
EVENING			
7:30 p.m.	SHORT COURSE FILMS *Computer graphics and computer generated films* Auditorium, Rhode Island School of Design		

Monday, August 8

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 4:00 p.m.		REGISTRATION Garden Room, Omni Biltmore	
9:00 a.m. -10:30 a.m.	OPENING CEREMONIES Providence Performing Arts Center		

Monday, August 8 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING (cont'd)			
11:15 a.m. - 12:15 p.m.	KEYNOTE ADDRESS *Renewing U.S. mathematics: An agenda to begin the second century* **Edward E. David, Jr.** Providence Performing Arts Center		
AFTERNOON			
1:00 p.m. - 5:00 p.m.	EXHIBIT AND BOOK SALE Grand Ballroom, Omni Biltmore	BOOK SALE Grand Ballroom, Omni Biltmore	
1:00 p.m. - 5:00 p.m.	EXHIBITS Grand Ballroom, Omni Biltmore		
2:00 p.m. - 3:00 p.m.	INVITED ADDRESS *Representations of finite groups as permutation groups* **Michael Aschbacher** Providence Performing Arts Center		
	SESSIONS FOR CONTRIBUTED PAPERS		
2:00 p.m. - 5:25 p.m.	*Differential equations* State Suite A, Omni Biltmore		
2:00 p.m. - 5:40 p.m.	*Number theory and algebra* State Suite B, Omni Biltmore		
2:00 p.m. - 5:25 p.m.	*Real and complex analysis* State Suite C, Omni Biltmore		
3:15 p.m. - 4:15 p.m.	INVITED ADDRESS *The geometry of solutions to nonlinear problems* **Luis A. Caffarelli** Providence Performing Arts Center		
4:30 p.m. - 6:30 p.m.		SECTION OFFICERS' MEETING College & Canal Rooms, Marriott	
	SESSION FOR CONTRIBUTED PAPERS		
5:30 p.m. - 5:55 p.m.	*History and biography* State Suite C, Omni Biltmore		
EVENING			
7:00 p.m. - 9:00 p.m.	OPENING RECEPTION Rhode Island State House		

Tuesday, August 9

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 4:00 p.m.	REGISTRATION Garden Room, Omni Biltmore		
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS *Sufficiency as statistical symmetry* **Persi Diaconis** Providence Performing Arts Center		
9:00 a.m. - 5:00 p.m.	EXHIBIT AND BOOK SALE Grand Ballroom, Omni Biltmore	BOOK SALE Grand Ballroom, Omni Biltmore	
9:00 a.m. - 5:00 p.m.	EXHIBITS Grand Ballroom, Omni Biltmore		
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS *Problems from mathematical physics* **Charles L. Fefferman** Providence Performing Arts Center		
11:00 a.m. - noon	AMS-MAA INVITED ADDRESS *The topological constraints on analysis* **Raoul H. Bott** Providence Performing Arts Center		
AFTERNOON			
noon - 2:00 p.m.			PI MU EPSILON COUNCIL LUNCHEON Conference Room, Chamber of Commerce Building
1:00 p.m. - 3:00 p.m.	OPEN HOUSE Headquarters Office		
2:00 p.m. - 3:00 p.m.	INVITED ADDRESS *Working and playing with the two-dimensional disk* **Michael H. Freedman** Providence Performing Arts Center		
	SESSIONS FOR CONTRIBUTED PAPERS		
2:00 p.m. - 5:40 p.m.	*Foundations and general algebraic structures* State Suite A, Omni Biltmore		
2:00 p.m. - 5:40 p.m.	*Functional and abstract analysis* State Suite C, Omni Biltmore		

Tuesday, August 9 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)			
3:15 p.m. - 4:15 p.m.	INVITED ADDRESS *The incompleteness phenomena* **Harvey M. Friedman** Providence Performing Arts Center		
4:30 p.m. - 5:30 p.m.		PRIZE SESSION AND BUSINESS MEETING Providence Performing Arts Center	
5:30 p.m. - 7:30 p.m.	HAPPY HOUR Cafe on the Terrace, Omni Biltmore		
EVENING			
6:00 p.m. - 7:00 p.m.			PME - RECEPTION Omni Biltmore
7:00 p.m. - 10:00 p.m.			PME - CONTRIBUTED PAPER SESSIONS State Suites A, B, & C, & Bacchante Room, Omni Biltmore
7:30 p.m. - 7:55 p.m.			ASSOCIATION FOR WOMEN IN MATHEMATICS MEMBERSHIP MEETING Providence Performing Arts Center
8:00 p.m. - 9:30 p.m.			AWM - PANEL DISCUSSION *Centennial reflections on women in American mathematics* **Mabel S. Barnes** **Judy Green** **Jeanne LaDuke** **Vivienne Malone-Mayes** **Olga Taussky-Todd** Providence Performing Arts Center
9:30 p.m. - 10:30 p.m.			AWM - OPEN RECEPTION Lobby, Providence Performing Arts Center

Wednesday, August 10

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
6:30 a.m. - 8:00 a.m.			PME - DUTCH TREAT BREAKFAST Refectory, Brown University
7:30 a.m. - 4:00 p.m.	REGISTRATION Garden Room, Omni Biltmore		
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS *Modular forms and elliptic curves* **Benedict H. Gross** Providence Performing Arts Center		
9:00 a.m. - 5:00 p.m.	EXHIBIT AND BOOK SALE Grand Ballroom, Omni Biltmore	BOOK SALE Grand Ballroom, Omni Biltmore	
9:00 a.m. - 5:00 p.m.	EXHIBITS Grand Ballroom, Omni Biltmore		
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS *Developments in algebraic geometry* **Joseph Harris** Providence Performing Arts Center		
11:00 a.m. - noon	AMS-MAA INVITED ADDRESS *Mathematics: Applied and pure* **Peter D. Lax** Providence Performing Arts Center		
AFTERNOON			
1:00 p.m. - 3:00 p.m.	OPEN HOUSE Headquarters Office		
2:00 p.m. - 3:00 p.m.	INVITED ADDRESS *A century of Lie theory* **Roger E. Howe** Providence Performing Arts Center		
	SESSIONS FOR CONTRIBUTED PAPERS		
2:00 p.m. - 4:25 p.m.	*Groups, rings, algebras and category theory* State Suite A, Omni Biltmore		
2:00 p.m. - 4:25 p.m.	*Applied mathematics* State Suite C, Omni Biltmore		

Wednesday, August 10 (cont'd)

American Mathematical Society | Mathematical Association of America | Other Organizations

AFTERNOON (cont'd)

3:15 p.m. - 4:15 p.m.

INVITED ADDRESS
A von Neumann algebra excursion: From quantum theory to knot theory and back
Vaughan F. R. Jones
Providence Performing Arts Center

4:30 p.m. - 5:30 p.m.

INVITED ADDRESS
Modular invariance in mathematics and physics
Victor G. Kac
Providence Performing Arts Center

5:30 p.m. - 7:30 p.m.

EVENING

6:30 p.m. - 8:15 p.m.

PME - BANQUET
Conference Room, Chamber of Commerce Building

7:00 p.m. - 8:00 p.m.

NATIONAL MEETING OF DEPARTMENT HEADS
MS2000 Panel on courses and curricula for mathematics master's degrees
Samuel M. Rankin III
State Suite B, Omni Biltmore

8:00 p.m. - 9:00 p.m.

Academic employment of master's degree mathematicians in larger departments
Alphonse H. Baartmans
Alberto R. Galmarino
Donald F. Reynolds (moderator)
Donald R. Whitaker
State Suite C, Omni Biltmore

8:00 p.m. - 9:00 p.m.

Academic employment of master's degree mathematicians in smaller departments
David W. Ballew (moderator)
Ronald M. Davis
Karen L. Whitehead
State Suite B, Omni Biltmore

8:00 p.m. - 9:00 p.m.

Industrial employment of master's degree mathematicians
Tom Trotter (moderator)
State Suite A, Omni Biltmore

7:00 p.m. - 10:00 p.m.

BANQUET FOR 25 YEAR MEMBERS
Bacchante Room, Omni Biltmore

Wednesday, August 10 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
EVENING (cont'd)			
8:30 p.m. - 9:30 p.m.			PME - J. Sutherland Frame Lecture *You, too, can tile the Conway way* **Doris W. Schattschneider** Providence Performing Arts Center

Thursday, August 11

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 1:30 p.m.	REGISTRATION Garden Room, Omni Biltmore		
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS *Mathematical fluid dynamics: The interaction of nonlinear analysis and modern applied mathematics* **Andrew J. Majda** Providence Performing Arts Center		
9:00 a.m. - 1:30 p.m.	EXHIBIT AND BOOK SALE Grand Ballroom, Omni Biltmore	BOOK SALE Grand Ballroom, Omni Biltmore	
9:00 a.m. - 1:30 p.m.	EXHIBITS Grand Ballroom, Omni Biltmore		
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS *Mathematics and computing in physiology and medicine: Examples from the past, present, and future* **Charles S. Peskin** Providence Performing Arts Center		
11:00 a.m. - noon	AMS-MAA INVITED ADDRESS *Some major research departments of mathematics* **Saunders Mac Lane** Providence Performing Arts Center		

Thursday, August 11 (cont'd)

	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON			
1:00 p.m. - 3:00 p.m.	OPEN HOUSE Headquarters Office		
2:00 p.m. - 3:00 p.m.	INVITED ADDRESS *Progress on the renormalization conjectures in dynamical systems* **Dennis P. Sullivan** Providence Performing Arts Center		
3:15 p.m. - 8:00 p.m.	CLAMBAKE Francis Farm		

Friday, August 12

	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 1:00 p.m.	REGISTRATION Garden Room, Omni Biltmore		
8:30 a.m. - 9:30 a.m.	INVITED ADDRESS *Mathematics in computer science* **Robert E. Tarjan** Providence Performing Arts Center		
9:00 a.m. - noon	EXHIBIT AND BOOK SALE Grand Ballroom, Omni Biltmore	BOOK SALE Grand Ballroom, Omni Biltmore	
9:00 a.m. - noon	EXHIBITS Grand Ballroom, Omni Biltmore		
9:45 a.m. - 10:45 a.m.	INVITED ADDRESS *Three-dimensional geometry and topology* **William P. Thurston** Providence Performing Arts Center		
11:00 a.m. - noon	INVITED ADDRESS *Instantons and their relatives* **Karen K. Uhlenbeck** Providence Performing Arts Center		

Friday, August 12 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON			
2:00 p.m. - 3:00 p.m.	INVITED ADDRESS *Quantum field theory and Donaldson polynomials* **Edward Witten** Providence Performing Arts Center		
	SESSIONS FOR CONTRIBUTED PAPERS		
2:00 p.m. - 5:40 p.m.	*Geometry and topology* State Suite C, Omni Biltmore		
2:00 p.m. - 5:25 p.m.	*Probability, statistics and numerical analysis* State Suite A, Omni Biltmore		
3:15 p.m. - 4:15 p.m.	STEELE PRIZE SESSION AND BUSINESS MEETING Providence Performing Arts Center		

Program of the Sessions

Abstracts of papers presented by speakers in the Symposium on Mathematics into the Twenty-First Century, AMS-MAA Invited Speakers, and AMS Sessions for Contributed Papers will be found in the August 1988 issue of *Abstracts of papers presented to the American Mathematical Society*, which will be provided to registrants at the meeting. Abstracts for other sessions are not available.

To maintain the schedule, beginning and ending times of presentations will be strictly enforced.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting. Where a presenter is visiting another institution, the permanent affiliation is given first, followed by the name of the institution being visited.

Saturday, August 6

MAA Minicourse #1: Part A

8:00 a.m.–10:00 a.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

8:00 a.m. **EXP, EXP***Test, and the creation of testbanks.*
Peter Frisk, Rock Valley College

MAA Minicourse #2: Part A

8:00 a.m.–10:00 a.m. Room 168, Barus & Holley, Brown University

8:00 a.m. *Contributions of algebraic coding theory to finite geometry.*
E. F. Assmus, Jr., Lehigh University and **J. D. Key**, Emmy Noether Lecturer at Bryn Mawr and on leave from the University of Birmingham

MAA Minicourse #3: Part A

10:30 a.m.–12:30 p.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

10:30 a.m. *A survey of educational software.*
David P. Kraines, Duke University and **Vivian Kraines**, Meredith College

MAA Minicourse #4: Part A

10:30 a.m.–12:30 p.m. Room 168, Barus & Holley, Brown University

10:30 a.m. *Coloring and path following algorithms for approximating roots and fixed points.*
William F. Lucas, Claremont Graduate School

MAA Minicourse #1: Part B

2:00 p.m.–4:00 p.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

2:00 p.m. **EXP, EXP***Test, and the creation of testbanks.*
Peter Frisk, Rock Valley College

MAA Minicourse #2: Part B

2:00 p.m.–4:00 p.m. Room 168, Barus & Holley, Brown University

2:00 p.m. *Contributions of algebraic coding theory to finite geometry.*
E. F. Assmus, Jr., Lehigh University and **J. D. Key**, Emmy Noether Lecturer at Bryn Mawr and on leave from the University of Birmingham

MAA Minicourse #3: Part B

4:30 p.m.–6:30 p.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

4:30 p.m. *A survey of educational software.*
David P. Kraines, Duke University and **Vivian Kraines**, Meredith College

MAA Minicourse #4: Part B

4:30 p.m.–6:30 p.m. Room 168, Barus & Holley, Brown University

4:30 p.m. *Coloring and path following algorithms for approximating roots and fixed points.*
William F. Lucas, Claremont Graduate School

Sunday, August 7

MAA Minicourse #5: Part A

8:00 a.m.–10:00 a.m. Room 168, Barus & Holley, Brown University

8:00 a.m. *Teaching calculus with an HP-28 symbol manipulating calculator.*
John W. Kenelly, Clemson University

MAA Board of Governors

8:30 a.m.–3:30 p.m. College & Sessions Rooms, Marriott

MAA Minicourse #6: Part A

10:30 a.m.–12:30 p.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

10:30 a.m. *An introduction to MATLAB.*
David R. Hill, Temple University

MAA Minicourse #7: Part A

10:30 a.m.–12:30 p.m. Room 168, Barus & Holley, Brown University

10:30 a.m. *Groups, graphs, and computing.*
Eugene M. Luks, University of Oregon

MAA Minicourse #5: Part B

2:00 p.m.–4:00 p.m. Room 168, Barus & Holley, Brown University

2:00 p.m. *Teaching calculus with an HP-28 symbol manipulating calculator.*
John W. Kenelly, Clemson University

MAA Minicourse #6: Part B

4:30 p.m.–6:30 p.m. Room 167, Thomas J. Watson Sr. Center for Information Technology, Brown University

4:30 p.m. *An introduction to MATLAB.*
David R. Hill, Temple University

MAA Minicourse #7: Part B

4:30 p.m.–6:30 p.m. Room 168, Barus & Holley, Brown University

4:30 p.m. *Groups, graphs, and computing.*
Eugene M. Luks, University of Oregon

AMS Council

5:00 p.m.–10:00 p.m. Bacchante Room, Omni Biltmore

Monday, August 8

Keynote Address

11:15 a.m.–12:15 p.m. Providence Performing Arts Center

11:15 a.m. (1) *Renewing U.S. mathematics: An agenda to begin the second century.*
Edward E. David, Jr., EED, Inc., Bedminster, New Jersey

AMS Invited Address

2:00 p.m.–3:00 p.m. Providence Performing Arts Center

2:00 p.m. (2) *Representations of finite groups as permutation groups.*
Michael Aschbacher, California Institute of Technology (844-20-51)

AMS Session on Differential Equations

2:00 p.m.–5:25 p.m. State Suite A, Omni Biltmore

2:00 p.m. (3) *Some non-existence results for the abstract Cauchy problem.*
S. Zaidman, Université de Montréal (844-34-15)

2:15 p.m. (4) *A delayed-advanced two-body problem.*
Jeffrey Hoag*, Providence College, and **R. D. Driver**, University of Rhode Island (844-34-68)

2:30 p.m. (5) *Oscillations of equations with piecewise constant arguments.*
Gerasimos Ladas, University of Rhode Island (844-34-118)

2:45 p.m. (6) *Asymptotic solutions of* $x\prime(t) = bx(t-1)$.
Bruce K. Driver, University of California at San Diego, La Jolla, and **R. D. Driver***, University of Rhode Island (844-34-119)

3:00 p.m. (7) *On the oscillations of the Goodwin oscillator.*
K. Gopalsamy, Flinders University, Australia, and **M. R. Kulenovic*** and **G. Ladas**, University of Rhode Island (844-34-120)

3:15 p.m. (8) *Stability conditions for delay differential equations.*
Istvan Gyori, University of Rhode Island (844-34-121) (Sponsored by Gerasimos Ladas)

3:30 p.m. (9) *On oscillations of neutral equations with mixed arguments.*
Gerasimos Ladas, University of Rhode Island, and **Stephen Schultz***, Providence College (844-34-125)

3:45 p.m. (10) *Semi-rigid partial differential operators and microlocal analytic hypoellipticity.*
A. Alexandrou Himonas, Princeton University (844-35-69)

4:00 p.m. (11) *Resonance and the 2nd BVP.* Preliminary report.
Victor L. Shapiro, University of California, Riverside (844-35-70)

4:15 p.m. (12) *Approximating solutions geometrically to a Monge-Ampere equation.*
Johanna Stenzel Schruben, University of Akron (844-35-107)

4:30 p.m. (13) *Wave propagation at computational domain boundaries.* Preliminary report.
Henry A. Warchall, University of North Texas (844-35-117)

4:45 p.m. (14) *A characterization of Cauchy kernels.*
Konrad J. Heuvers, Michigan Technological University (844-39-103)

5:00 p.m. (15) *Entropy of polynomial and rational maps.*
Shmuel Friedland, University of Illinois, Chicago (844-58-87)

5:15 p.m. (16) *Extinction of species in systems governed by difference equations of Lotka-Volterra type.* Preliminary report.
John E. Franke* and **Abdul-Aziz Yakubu**, North Carolina State University (844-58-92)

AMS Session on Number Theory and Algebra

2:00 p.m.–5:40 p.m. State Suite B, Omni Biltmore

2:00 p.m. (17) *Favorable conditions for amicability.* Preliminary report.
Mariano Garcia, Hostos Community College, City University of New York (844-11-30)

2:15 p.m. (18) *Distances of k-free integers in arithmetic progressions in real quadratic number fields.*
Werner G. H. Schaal, Fachbereich Mathematik der Universitat Marburg, Federal Republic of Germany (844-11-31)

2:30 p.m. (19) *On the non-vanishing of Poincaré series.*
C. J. Mozzochi, Institute for Advanced Study (844-11-32)

2:45 p.m. (20) *Class numbers and units of several kinds of quadratic fields.*
Xianke Zhang, University of Maryland, College Park (844-11-123)

3:00 p.m. (21) *Pisot numbers and binomial numbers.*
Kuoduo J. Huang, California State University, Los Angeles (844-11-128)

3:15 p.m. (22) *Samarth's conjecture in theory of numbers.*
Samarth Verma, Congdon Park School, Duluth (844-11-136) (Sponsored by Robert L. McFarland)

3:30 p.m. (23) *Kaninika's conjecture in theory of numbers.*
Kaninika Verma, Chester Park School, Duluth (844-11-135) (Sponsored by Robert L. McFarland)

3:45 p.m. (24) *Some aspects of theory of numbers.*
Krishnanand Verma, University of Minnesota, Duluth (844-11-134) (Sponsored by Robert L. McFarland)

4:00 p.m. (25) *Algorithmic derivation of some units in algebraic number fields.* Preliminary report.
Malvina Baica, University of Wisconsin, Whitewater (844-12-33)

4:15 p.m. (26) *A note on indecomposable projective modules.*
Adil G. Naoum, University of Baghdad, Iraq (844-13-16)

4:30 p.m. (27) *Algebraic integers in quadratic number field.*
Krishnanand Verma, University of Minnesota, Duluth, and **Ganesh Kumar***, University of Bihar, India (844-13-133) (Sponsored by Duane E. Anderson)

4:45 p.m. (28) *Reflexive state of a Markov chain.* Preliminary report.
James R. Weaver, University of West Florida (844-15-36)

5:00 p.m. (29) *Rational eigenvectors of singly stochastic matrices.*
Russell Jay Hendel, North Adams State College (844-15-79)

5:15 p.m. (30) *Greatest common divisor matrices.* Preliminary report.
Scott Beslin and **Steve Ligh***, University of Southwestern Louisiana (844-15-137)

5:30 p.m. (31) *Sasiada's example of simple radical rings.* Preliminary report.
Lung O. Chung, North Carolina State University (844-16-139)

AMS Session on Real and Complex Analysis

2:00 p.m.–5:25 p.m. State Suite C, Omni Biltmore

2:00 p.m. (32) *Fractal surfaces.*
Peter R. Massopust, LaGrange College (844-26-85)

2:15 p.m. (33) *On normal lattices and Wallman spaces.*
George M. Eid, John Jay College of Criminal Justice, City University of New York (844-28-35)

2:30 p.m. (34) *Analysis of a class of probability preserving measure algebras on compact intervals.*
W. C. Connett and **A. L. Schwartz***, University of Missouri, St. Louis (844-28-106)

2:45 p.m. (35) *Weighted subspaces of Hardy spaces.*
Hong Oh Kim*, Korea Advanced Institute of Science and Technology, Korea, and **Ern Geun Kwon**, Andong University, Korea (844-30-20)

3:00 p.m. (36) *Function classes related to Ruscheweyh derivatives.*
O. P. Ahuja*, University of Papua, New Guinea, and **H. Silverman**, College of Charleston (844-30-28)

Monday, August 8 (cont'd)

3:15 p.m. (37) *An inequality for real functions with applications to function theory.*
Walter Bergweiler, Cornell University (844-30-34)

3:30 p.m. (38) *The necessity of all of the Buchweitz tests.*
John Kasdan, Columbia University, School of Law (844-30-64) (Sponsored by Henre Jarquet)

3:45 p.m. (39) *Some extensions of Carlson's theorem.*
Antoinette Trembinska, John Jay College of Criminal Justice, City University of New York (844-30-65)

4:00 p.m. (40) *Mapping class groups of quadratic rational maps and* Aut_2.
Lisa R. Goldberg*, Institute for Advanced Study and Brooklyn College, City University of New York, and **Linda Keen**, Herbert H. Lehman College, City University of New York (844-30-86)

4:15 p.m. (41) *Interpolation sequences for Orlicz spaces.*
Maher M. H. Marzuq, Kuwait University (844-30-88)

4:30 p.m. (42) *Alternate forms of multidimensional complex variables.* Preliminary report.
E. Dale Martin, NASA Ames Research Center, Moffett Field, California (844-30-114)

4:45 p.m. (43) *On solutions of a cubic equation via hyperbolic functions of a complex variable.* Preliminary report.
Sadanand Verma, University of Nevada, Las Vegas (844-30-143) (Sponsored by L. J. Simonoff)

5:00 p.m. (44) *Higher order perturbations of the Chebyshev polynomials.* Preliminary report.
Attila Mate*, Brooklyn College, City University of New York, and **Paul Nevai**, Ohio State University, Columbus (844-42-105)

5:15 p.m. (45) *Characterization of inverse-closed Carleman classes.*
Jamil A. Siddiqi, Laval University (844-42-146)

AMS Invited Address

3:15 p.m.–4:15 p.m. Providence Performing Arts Center

3:15 p.m. (46) *The geometry of solutions to nonlinear problems.*
Luis A. Caffarelli, Institute for Advanced Study (844-35-47)

MAA Section Officers

4:30 p.m.–6:30 p.m. College & Canal Rooms, Marriott

AMS Session on History and Biography

5:30 p.m.–5:55 p.m. State Suite C, Omni Biltmore

5:30 p.m. (47) *A system more suitable to our meridian: Nicolas Pike's "Arithmetic", the bicentennial.*
Joe Albree, Auburn University at Montgomery (844-01-98) (Sponsored by Joe B. Hill)

5:45 p.m. (48) *Nikolai Luzin and "idealism".*
Charles E. Ford, Saint Louis University (844-01-108)

Tuesday, August 9

AMS Invited Address

8:30 a.m.–9:30 a.m. Providence Performing Arts Center

8:30 a.m. (49) *Sufficiency as statistical symmetry.* Preliminary report.
Persi Diaconis, Harvard University (844-62-41)

AMS Invited Address

9:45 a.m.–10:45 a.m. Providence Performing Arts Center

9:45 a.m. (50) *Problems from mathematical physics.*
Charles L. Fefferman, Princeton University (844-81-53)

AMS-MAA Invited Address

11:00 a.m.–12:00 noon Providence Performing Arts Center

11:00 a.m. (51) *The topological constraints on analysis.*
Raoul H. Bott, Harvard University

AMS Invited Address

2:00 p.m.–3:00 p.m. Providence Performing Arts Center

2:00 p.m. (52) *Working and playing with the two-dimensional disk.*
Michael H. Freedman, University of California at San Diego, La Jolla (844-57-42)

AMS Session on Foundations and General Algebraic Structures

2:00 p.m.–5:40 p.m. State Suite A, Omni Biltmore

2:00 p.m. (53) *Some evaluations of C. S. Peirce's contributions to algebraic logic.* Preliminary report. **Irving H. Anellis***, Iowa State University, and **Nathan Houser**, Indiana University-Purdue University, Indianapolis (844-03-11)

2:15 p.m. (54) *Some properties of recursively enumerable sets uniform for equivalence relations.* **Hong Ye**, University of Connecticut, Storrs (844-03-23)

2:30 p.m. (55) *Fuzzy regressivity and retraceability.* **Leon Harkleroad**, Cornell University and Bellarmine College (844-03-39)

2:45 p.m. (56) *Topological applications of the Ultrapower theorem.* **Paul Bankston**, Marquette University (844-03-110)

3:00 p.m. (57) *Towards a structure theory for ideals on P-kappa-lambda (continued).* **Donna M. Carr**, State University of New York, College at Plattsburgh, and **Donald H. Pelletier***, York University (844-04-74)

3:15 p.m. (58) *Unique Fibonacci formulas.* Preliminary report. **Joseph Arkin**, Spring Valley, New York, **David C. Arney**, United States Military Academy, **Gerald E. Bergum**, South Dakota State University, **Stefan A. Burr**, City University of New York, and **Bruce J. Porter***, United States Military Academy (844-05-05)

3:30 p.m. (59) *A perfect 4-dimensional hypercube of order 7.* **Joseph Arkin, David C. Arney***, and **Bruce J. Porter**, United States Military Academy (844-05-06)

3:45 p.m. (60) *Tiling the k^{th} power of a power series.* Preliminary report. **Joseph Arkin***, Spring Valley, New York, **David C. Arney**, United States Military Academy, **Gerald E. Bergum**, South Dakota State University, **Stefan A. Burr**, City University of New York, and **Bruce J. Porter**, United States Military Academy (844-05-07)

4:00 p.m. (61) *Generalized binomial coefficients and uses.* **Donald R. Snow**, Brigham Young University (844-05-25)

4:15 p.m. (62) *A conjecture on edge-cordial trees.* **Ho Kuen Ng*** and **Sin-Min Lee**, San Jose State University (844-05-61)

4:30 p.m. (63) *Birigidity in the plane.* **Brigitte Servatius**, Worcester Polytechnic Institute (844-05-76)

4:45 p.m. (64) *How to obtain an asymptotic expansion of a combinatorial sequence from an analytic identity satisfied by its generating function.* Preliminary report. **Jacob Plotkin**, Michigan State University, and **John Rosenthal***, Ithaca College (844-05-94)

5:00 p.m. (65) *Automorphism groups of unicyclic graphs.* **Donald McCarthy**, St. John's University (844-05-126)

5:15 p.m. (66) *A sum representation of meet-semilattice.* **S. M. Kim**, Yonsei University, Korea (844-06-08)

5:30 p.m. (67) *Tertiary decompositions of finite universal algebras omitting tame type 1.* Preliminary report. **William H. Rowan**, EMR, University of California, Berkeley (844-06-130)

AMS Session on Functional and Abstract Analysis

2:00 p.m.–5:40 p.m. State Suite C, Omni Biltmore

2:00 p.m. (68) *Multipliers of sequence spaces.* Preliminary report. **George Brauer**, University of Minnesota, Minneapolis (844-40-19)

2:15 p.m. (69) *Best approximation in $L(X, Y)$.* **W. Deeb** and **R. Khalil***, University of Kuwait, Kuwait (844-41-13)

2:30 p.m. (70) *Lipschitzian selections in approximation from nonconvex sets of bounded functions.* **Vasant A. Ubhaya**, North Dakota State University, Fargo (844-41-132) (Sponsored by Warren E. Shreve)

2:45 p.m. (71) *An extended Poisson type sum formula for general integral transforms and aliasing error bound for the generalized sampling theorem.* **A. J. Jerri**, The American University in Cairo, Egypt, and Clarkson University (844-42-03)

3:00 p.m. (72) *Some Fourier-Stieltjes coefficients revisited.* **Sylvester Reese**, Queensborough Community College, City University of New York (844-42-81)

3:15 p.m. (73) *A representation formula for the Dirichlet integral.* Preliminary report. **Kwang-Nan Chow*** and **David Protas**, California State University, Northridge (844-44-97)

3:30 p.m. (74) *Boundary value problems for abstract Volterra functional-differential equations.* **C. Corduneanu**, University of Texas at Arlington (844-45-122)

3:45 p.m. (75) *Best approximation in $L^p(I, X), 0 < p < 1$.* **W. Deeb*** and **R. Khalil**, University of Kuwait, Kuwait (844-46-10)

4:00 p.m. (76) *Zeros and fixed points of multifunctions with paracompact domains.* **Joseph C. Bellenger**, University of California, Riverside (844-46-75)

4:15 p.m. (77) *Some random best approximations and random fixed point theorems.* **V. M. Sehgal***, University of Wyoming, and **S. P. Singh**, Memorial University of Newfoundland (844-47-89)

4:30 p.m. (78) *Minimax inequalities, variational inequalities and fixed point theorems.* **Xie Ping Ding**, Sichuan Normal University, People's Republic of China (844-49-01)

4:45 p.m. (79) *Hyperbolic aproperness.* **Dan D. Pascali**, Forest Hills, New York (844-47-142)

5:00 p.m. (80) *Convergence of reduced gradient method.* **Abolghassem Alemzadeh**, State University of New York, College at Cortland (844-49-141)

Tuesday, August 9 (cont'd)

5:15 p.m. *Algebraic and topological selections of multivalued*
(81) *linear mappings.*
Sung J. Lee, University of South Florida, and **M. Zuhair Nashed***, University of Delaware (844-47-140)

5:30 p.m. *Modular functions in lattice statistical mechanics.*
(82) **Matthew P. Richey**, St. Olaf College (844-82-145)

AMS Invited Address

3:15 p.m.–4:15 p.m. Providence Performing Arts Center

3:15 p.m. *The incompleteness phenomena.*
(83) **Harvey M. Friedman**, Ohio State University, Columbus (844-03-49)

MAA Prize Session and Business Meeting

4:30 p.m.–5:30 p.m. Providence Performing Arts Center

PME Contributed Paper Sessions

7:00 p.m.–10:00 p.m. State Suites A, B, & C & Bacchante Room, Omni Biltmore

AWM Membership Meeting

7:30 p.m.–7:55 p.m. Providence Performing Arts Center

AWM Panel Discussion

8:00 p.m.–9:30 p.m. Providence Performing Arts Center

8:00 p.m. *Centennial reflections on women in American mathematics.*

Wednesday, August 10

AMS Invited Address

8:30 a.m.–9:30 a.m. Providence Performing Arts Center

8:30 a.m. *Modular forms and elliptic curves.*
(84) **Benedict H. Gross**, Harvard University (844-14-59)

AMS Invited Address

9:45 a.m.–10:45 a.m. Providence Performing Arts Center

9:45 a.m. *Developments in algebraic geometry.*
(85) **Joseph Harris**, Harvard University (844-14-52)

AMS-MAA Invited Address

11:00 a.m.–12:00 noon Providence Performing Arts Center

11:00 a.m. *Mathematics: Applied and pure.*
(86) **Peter D. Lax**, Courant Institute of Mathematical Sciences, New York University

AMS Invited Address

2:00 p.m.–3:00 p.m. Providence Performing Arts Center

2:00 p.m. *A century of Lie theory.*
(87) **Roger E. Howe**, Yale University (844-22-48)

AMS Session on Groups, Rings, Algebras and Category Theory

2:00 p.m.–4:25 p.m. State Suite A, Omni Biltmore

2:00 p.m. *Invariant forms on central simple structurable*
(88) *algebras.*
R. D. Schafer, Massachusetts Institute of Technology (844-17-27)

2:15 p.m. *A nonassociative powerassociative algebra of infinite*
(89) *matrices.*
Alexander Abian*, Iowa State University, and **Paula A. Kemp**, Southwest Missouri State University (844-17-77)

2:30 p.m. *On the monodromy group of everywhere tangent lines*
(90) *to the octic surface in* $\mathbf{P}^3$. Preliminary report.
Harry D'Souza, University of Michigan, Flint (844-17-78)

2:45 p.m. *Nonassociative rings with a special kind of*
(91) *endomorphism.* Preliminary report.
Tae-Il Suh, East Tennessee State University (844-17-82)

3:00 p.m. *Decomposition of quasi-injective objects over a*
(92) *Grothendieck category.*
Jinzhong Xu*, University of Toronto, and **Ho Kuen Ng**, San Jose State University (844-18-40)

3:15 p.m. *Gerstenhaber-Schack cohomology and Hattori's theory*
(93) *for mapping cones of squares.*
Klaus Werner Wiegmann, University of Duisburg, Federal Republic of Germany and University of Rochester (844-18-60)

3:30 p.m. (94) *Involutions in the general linear group $GL(n, F)$.*
Jo-Ann Cohen and **Kwangil Koh***, North Carolina State University (844-20-73)

3:45 p.m. (95) *Weight spaces of invariants of certain unipotent group actions.*
Jozsef Horvath, West Chester University of Pennsylvania (844-20-104)

4:00 p.m. (96) *Harmonic analysis, geometric quantization, and chaos.*
Mohamed W. I. Sesay, University of the District of Columbia (844-81-144)

4:15 p.m. (97) *Moufang loops with a unique nontrivial square are code loops.*
Orin Chein*, Temple University, and **Edgar G. Goodaire**, Memorial University of Newfoundland (844-20-67)

AMS Session on Applied Mathematics

2:00 p.m.–4:25 p.m. State Suite C, Omni Biltmore

2:00 p.m. (98) *On unsteady hydromagnetic flows of a dusty fluid between two oscillating plates.*
Lokenath Debnath, University of Central Florida (844-76-62)

2:15 p.m. (99) *The Thomas rotation formalism underlying the Lorentz group of the special theory of relativity.*
Abraham Ungar, North Dakota State University, Fargo (844-83-63)

2:30 p.m. (100) *Holors in accelerated coordinate transformations.*
Domina Eberle Spencer*, University of Connecticut, Storrs, and **Shama Y. Uma**, Bridgewater State College (844-83-100)

2:45 p.m. (101) *The Holor transformation of the Doppler shift in accelerated coordinate systems.*
Shama Y. Uma*, Bridgewater State College, and **Domina Eberle Spencer**, University of Connecticut, Storrs (844-83-101)

3:00 p.m. (102) *Conditions for the existence of tangential forces on current elements.*
Parry Moon, Massachusetts Institute of Technology, , and **Domina Eberle Spencer**, University of Connecticut, Storrs, **Shama Y. Uma**, Bridgewater State College, and **Philip Jay Mann***, University of Connecticut, Storrs (844-83-102)

3:15 p.m. (103) *Conditions on utility guaranteeing existence of optimal extraction paths in unbounded horizon problems.*
Jannett Highfill and **Michael McAsey***, Bradley University (844-90-93)

3:30 p.m. (104) *Three-dimensional controlled roundings do not always exist.* Preliminary report.
Lawrence R. Ernst, Bureau of the Census, Washington, D.C. (844-90-109)

3:45 p.m. (105) *Bounds for the coefficient of additivity of the characteristics function of a game.*
Miguel Paredes, Pan American University (844-90-112)

4:00 p.m. (106) *On a simple model for the spread of a sexually transmitted disease.* Preliminary report.
Alejandro Necochea, Pan American University (844-92-111)

4:15 p.m. (107) *Evaluating the hazard function using time dependent probabilities from pharamacokinetic models.* Preliminary report.
Dennis W. Quinn, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio (844-92-124)

AMS Invited Address

3:15 p.m.–4:15 p.m. Providence Performing Arts Center

3:15 p.m. (108) *A von Neumann algebra excursion: From quantum theory to knot theory and back.*
Vaughn F. R. Jones, University of California, Berkeley (844-57-54)

AMS Invited Address

4:30 p.m.–5:30 p.m. Providence Performing Arts Center

4:30 p.m. (109) *Modular invariance in mathematics and physics.*
Victor G. Kac, Massachusetts Institute of Technology (844-17-46)

Joint Policy Board for Mathematics: National Meeting of Department Heads

7:00 p.m.–9:00 p.m. State Suite B, Omni Biltmore

PME J. Sutherland Frame Lecture

8:30 p.m.–9:30 p.m. Providence Performing Arts Center

8:30 p.m. (110) *You, too, can file the Conway way.*
Doris W. Schattschneider, Moravian College

Thursday, August 11

AMS Invited Address

8:30 a.m.–9:30 a.m. Providence Performing Arts Center

8:30 a.m. (111) *Mathematical fluid dynamics: The interaction of nonlinear analysis and modern applied mathematics.*
Andrew J. Majda, Princeton University (844-76-44)

Thursday, August 11 (cont'd)

AMS Invited Address

9:45 a.m.–10:45 a.m. Providence Performing Arts Center

9:45 a.m. (112) *Mathematics and computing in physiology and medicine: Examples from the past, present, and future.* **Charles S. Peskin**, Courant Institute of Mathematical Sciences, New York University (844-92-55)

AMS-MAA Invited Address

11:00 a.m.–12:00 noon Providence Performing Arts Center

11:00 a.m. (113) *Some major research departments of mathematics.* **Saunders Mac Lane**, University of Chicago

AMS Invited Address

2:00 p.m.–3:00 p.m. Providence Performing Arts Center

2:00 p.m. (114) *Progress on the renormalization conjectures in dynamical systems.* **Dennis P. Sullivan**, Graduate School and University Center, City University of New York (844-58-45)

Friday, August 12

AMS Invited Address

8:30 a.m.–9:30 a.m. Providence Performing Arts Center

8:30 a.m. (115) *Mathematics in computer science.* **Robert E. Tarjan**, Princeton University (844-68-56)

AMS Invited Address

9:45 a.m.–10:45 a.m. Providence Performing Arts Center

9:45 a.m. (116) *Three-dimensional geometry and topology.* **William P. Thurston**, Princeton University (844-55-57)

AMS Invited Address

11:00 a.m.–12:00 noon Providence Performing Arts Center

11:00 a.m. (117) *Instantons and their relatives.* **Karen K. Uhlenbeck**, University of Texas at Austin (844-53-50)

AMS Invited Address

2:00 p.m.–3:00 p.m. Providence Performing Arts Center

2:00 p.m. (118) *Quantum field theory and Donaldson polynomials.* **Edward Witten**, Institute for Advanced Study (844-57-43)

AMS Session on Geometry and Topology

2:00 p.m.–5:40 p.m. State Suite C, Omni Biltmore

2:00 p.m. (119) *A geometric measure of the non-rectangularity of a hyperbola.* **Mangho Ahuja**, Southeast Missouri State University (844-51-24)

2:15 p.m. (120) *Lattice polygons in space.* **Stanley Rabinowitz**, Alliant Computer Systems Corporation, Littleton, Massachusetts (844-51-95)

2:30 p.m. (121) *Parallel plane curves: relations, properties, limits, and beyond.* **Rodney T. Hood**, Franklin College of Indiana (844-51-116)

2:45 p.m. (122) *Pasch's postulate and metrization.* Preliminary report. **James W. Petticrew**, Pan American University (844-51-129)

3:00 p.m. (123) *Covering curves with restricted curvature.* Preliminary report. **Mostafa Ghandehari**, Santa Clara University (844-52-09)

3:15 p.m. (124) *Automorphism groups of almost r-paracontact manifolds of P-Sasakian type.* **Andrzej Bucki**, Lycoming College (844-53-72)

3:30 p.m. (125) *Some results on the topological Markov chains.* **Zuo Ling Zhou**, Zhongshan University, People's Republic of China (844-54-04)

3:45 p.m. (126) *A conjecture concerning $X \times I$.* Preliminary report. **Ernest P. Lane**, Appalachian State University (844-54-29)

4:00 p.m. (127) *Semi-reasonable topologies.* Preliminary report. **Kathryn F. Porter**, Ball State University (844-54-71)

4:15 p.m. (128) *Construction of vector field on space models of Torus and Klein Bottle.* Preliminary report. **Margaret M. LaSalle**, University of Southwestern Louisiana (844-54-91)

4:30 p.m. (129) *Extending continuous functions to connected functions.* Preliminary report. **B. D. Garrett**, Tennessee State University (844-54-99)

4:45 p.m. (130) *Sufficient conditions for existence of counterexample to 3-dimensional Poincare conjecture.* Preliminary report.
Francis D. Lonergan, Webster, Massachusetts (844-55-14)

5:00 p.m. (131) *A spectral sequence for classifying rational homotopy type.*
Ronald N. Umble, Millersville University of Pennsylvania (844-55-66)

5:15 p.m. (132) *On the unitary bordism ring* $U_*(Z_p) \otimes Z_p$.
Ching-Mu Wu, Tamkang University, People's Republic of China (844-57-18)

5:30 p.m. (133) *Topological structures in computer and systems sciences.*
Efim Khalimsky, Borough of Manhattan Community College, City University of New York (844-99-147)

AMS Session on Probability, Statistics and Numerical Analysis

2:00 p.m.–5:25 p.m. State Suite A, Omni Biltmore

2:00 p.m. (134) *Open toss problem.* Preliminary report.
Prem N. Bajaj, Wichita State University (844-60-37)

2:15 p.m. (135) *Sufficient statistics for some pairwise independent stationary stochastic processes.* Preliminary report.
James B. Robertson, University of California, Santa Barbara (844-60-38)

2:30 p.m. (136) *Oriented percolation processes with interaction in population genetics.* Preliminary report.
R. B. Campbell, University of Northern Iowa (844-60-80)

2:45 p.m. (137) *Markov chains generated by endomorphisms,* III. Preliminary report.
John R. Durbin, University of Texas at Austin (844-60-84)

3:00 p.m. (138) *Simultaneous confidence bounds in multivariate analysis.*
Jack Tomsky, Lockheed Missiles and Space Company, Palo Alto, California (844-62-02)

3:15 p.m. (139) *Confounding and the Hadamard matrix problem.* Preliminary report.
Jay H. Beder, University of Wisconsin, Milwaukee (844-62-113)

3:30 p.m. (140) *Computation principles of mathematical physics.*
Chenggui Huang, Tianjin Normal University, People's Republic of China (844-65-17)

3:45 p.m. (141) *Interpolation by division.*
Herbert E. Salzer, Brooklyn, New York (844-65-22)

4:00 p.m. (142) *The solution of Poisson Boltzmann equation between two spheres—a modified iterative method.*
Abdul J. Jerri, Clarkson University and The American University in Cairo, Egypt, and **Russ L. Herman***, Clarkson University (844-65-26)

4:15 p.m. (143) *PFIS, a nonlinear system solver.*
S. K. Dey, Eastern Illinois University (844-65-83)

4:30 p.m. (144) *Improved error and* C^1 *derivative approximations for continuous Runge-Kutta formulas.*
Curtis Outlaw, **Leroy Derr** and **Diran Sarafyan***, University of New Orleans (844-65-96)

4:45 p.m. (145) *An algorithm for the inversion of generalized Vandermonde matrices.*
Luis Verde-Star, Universidad Autónoma Metropolitana, Mexico (844-65-115)

5:00 p.m. (146) *Computational electromagnetics.*
Brian McCartin, United Technologies Research Center, East Hartford, Connecticut (844-65-127)

5:15 p.m. (147) *The shape of clusters created from percolation of coalescing random walks.* Preliminary report.
Bao G. Nguyen, University of Mississippi and Illinois Institute of Technology (844-82-138)

AMS Steele Prize Session and Business Meeting

3:15 p.m.–4:15 p.m. Providence Performing Arts Center

Felix E. Browder
Chairman, Centennial Program Committee
New Brunswick, New Jersey

Frank T. Birtel
Associate Secretary
New Orleans, Louisiana

Presenters of Papers

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American Mathematical Society Short Course Series

Introductory Survey Lectures on *Chaos and Fractals: The Mathematics Behind the Computer Graphics*

Providence, Rhode Island, August 6 – 7, 1988

The American Mathematical Society, in conjunction with its Centennial Celebration, will present a two-day Short Course titled *Chaos and Fractals: The Mathematics Behind the Computer Graphics* on Saturday and Sunday, August 6-7, 1988, at the Rhode Island School of Design. The program is under the direction of ROBERT L. DEVANEY of Boston University and LINDA KEEN of Lehman College, CUNY.

The terms "chaos" and "fractal" have received widespread attention in the media in recent years. The alluring computer graphics images associated with these terms have heightened interest among scientists in these ideas. The purpose of this Short Course is to explain the rich mathematical concepts behind these terms. Basic ideas from dynamical systems theory, including chaos, strange attractors, Julia sets, and the Mandelbrot set, will be introduced and basic concepts from fractal geometry, especially fractal dimension and self-similarity, will be discussed. Applications in engineering, meteorology and data compression will be described.

Saturday, August 6:
Overview: Dynamics of Simple Maps, ROBERT L. DEVANEY, Boston University.
The Horseshoe Map and Applications in Engineering, PHILIP J. HOLMES, Cornell University.
Chaotic Attractors, JAMES A. YORKE, University of Maryland.
Sunday, August 7:
Julia Sets, LINDA KEEN, Lehman College, CUNY.
The Mandelbrot Set, BODIL BRANNER, The Technical University of Denmark, Copenhagen.
Introduction to Fractals, VIRGINIA HARRISON, University of California, Berkeley.
Iterated Function Systems, MICHAEL F. BARNSLEY, Georgia Institute of Technology.
Evening Session:
Computer graphics and computer generated films.

The lectures will assume no familiarity with chaotic dynamics or fractal geometry; however, those who wish to get the most benefit from the course should consult the first chapter of *Introduction to Chaotic Dynamical Systems*, R. L. Devaney, Addison-Wesley, 1985, or the introductory chapter of *Iterated Maps of the Interval as Dynamical Systems*, P. Collet and J.-P. Eckmann, Birkhauser, 1980.

Synopses of the talks and accompanying reading lists, which provide a variety of sources for study prior to the course, appeared in the April issue of *Notices*. Complete lecture notes will be mailed to those who preregister for the course, and will be available at the Short Course Registration Desk for those registering on site.

All who wish to participate in the Short Course may do so upon payment of a $35 advance registration fee ($45 on site). There are reduced fees for students and unemployed individuals. Please refer to the sections titled **Housing** and **Registration at the Meetings** in this issue of *Notices* for details.

The Short Course was recommended by the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members are Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Philip C. Curtis, Jr., Don O. Loftsgaarden, David J. Lutzer, and Audrey A. Terras. The Short Course series is under the direction of the CEEP Short Course Subcommittee, whose members are Stefan A. Burr (chair), Lisl Novak Gaal, Robert P. Kurshan, Barbara L. Osofsky, Marjorie L. Stein, and James J. Tattersall.

Lawrence, Kansas
University of Kansas
October 28–29

First Announcement

The eight-hundred-and-forty-fifth meeting of the American Mathematical Society will be held at the University of Kansas in Lawrence, Kansas on Friday, October 28, and Saturday, October 29, 1988.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Central Sectional Meetings, there will be four invited one-hour addresses. The speakers, their affiliations, and titles, when available, are:

BJORN DAHLBERG, Washington University, *Elliptic boundary value problems in non-smooth domains.*

STEVEN E. HURDER, University of Illinois at Chicago, *Geometry and the index theory of foliations.*

PETER SCOTT, University of Michigan, Ann Arbor, *Least area surfaces in 3-manifolds.*

SIDNEY M. WEBSTER, University of Minnesota, Minneapolis, title to be announced.

Special Sessions

By invitation of the same committee, there will be twelve special sessions of selected twenty-minute papers. Topics and the names and affiliations of the organizers follow.

Partial differential equations–Geometric equations, ANDREW ACKER, Wichita State University

Geometry and mathematical physics, JOHN K. BEEM, University of Missouri and PHILLIP E. PARKER, Wichita State University

Numerical linear algebra, RALPH BYERS, University of Kansas

Algebraic geometry, BRUCE CRAUDER and SHELDON KATZ, Oklahoma State University

Control theory, TYRONE DUNCAN, University of Kansas

Applications of set theory, WILLIAM FLEISSNER, University of Kansas

Real analysis, JAMES FORAN, University of Missouri at Kansas City

Flat bundles and geometric structures, WILLIAM MARK GOLDMAN, University of Maryland

Operator theory and applications to geometry, STEVEN E. HURDER, University of Illinois at Chicago and NOBERTO SALINAS, University of Kansas

Commutative algebra, DANIEL KATZ and JEFFERY LANG, University of Kansas

Potential theory and partial differential equations in nonsmooth domains, JILL PIPHER, University of Chicago and GREGORY VECHOTA, University of Illinois at Chicago

3-manifolds, PETER SCOTT, University of Michigan

Most of the papers to be presented at these special sessions will be by invitation. However, anyone submitting an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract form and submit it **by August 2, 1988**, three weeks before the deadline for contributed papers, in order that it may be considered for inclusion. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 24, 1988 abstract deadline**. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Registration

The registration desk will be open on Friday, October 28, and Saturday, October 29 at times and a location to be announced in the September issue of *Notices*. The registration fees are $30 for members of the AMS, $45

for nonmembers, and $10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Atlanta meeting announcement on page 68 of the January issue of *Notices*.

Local Information

Information on travel, accommodations, food service, and other pertinent local information will be available in the September issue of *Notices*.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

Claremont, California
Claremont McKenna College
November 12 – 13

First Announcement

The eight-hundred-and-forty-sixth meeting of the American Mathematical Society will be held at Claremont McKenna College, Claremont, California, on Saturday and Sunday, November 12 and 13, 1988.

Invited Addresses

By invitation of the Committee to Select Hour Speakers for Far Western Sectional Meetings, there will be three invited one-hour addresses. The speakers, their affiliations, and some of the titles follow:

WILLIAM JACOB, Oregon State University, *Galois cohomology and K-theory: Applications to division algebras and quadratic forms.*

ROBERT BROOKS, University of Southern California, title to be announced.

FRANCIS BONAHON, University of Southern California, *Riemann surfaces and measured laminations.*

Special Sessions

By invitation of the same committee, there will be five special sessions of selected twenty-minute papers. The topics, names and affiliations of the organizers and speakers are:

Low dimensional geometry, FRANCIS BONAHON and DAVID GABAI, California Institute of Technology.

Computers and software in mathematical research, ROBERT BORRELLI, Harvey Mudd College, and COURTNEY S. COLEMAN, Harvey Mudd College.

The spectrum of the Laplacian, ROBERT BROOKS and S.-Y. CHENG, University of California, Los Angeles.

Differential and difference equations, STAVROS N. BUSENBERG, Harvey Mudd College, and MARIO MARTELLI, California State University, Fullerton.

Division algebras, WILLIAM JACOB and ADRIAN WADSWORTH, University of California, San Diego.

Most of the papers to be presented at these special sessions will be by invitation. However, anyone submitting an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these special sessions should indicate this clearly on the abstract form and submit it **by August 2, 1988**, three weeks before the deadline for contributed papers, in order that it may be considered for inclusion. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in the Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 23, 1988 abstract deadline**. Participants are reminded that a charge of $16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Activities of Other Organizations

The Mathematical Association of America will meet on Saturday, November 12. LEONARD GILLMAN, University of Texas and President of MAA will give an AMS-MAA address. Information about other sessions of the MAA will be announced later.

Registration

The meeting registration desk will be located in the lobby of Bauer Center. The desk will be open from 8:30 a.m. to 2:00 p.m. on both Saturday and Sunday, November 12 and 13. The registration fees are $30 for both days for members of the AMS, $45 for nonmembers, and $10 for students and unemployed mathematicians. There is a special one-day fee for MAA members on Saturday only of $15.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Atlanta meeting announcement on page 68 of the January issue of *Notices*.

Accommodations

Rooms have been blocked at the following hotels and motels. Participants should make their own reservations directly with the hotel of their choice, identifying themselves as attending the American Mathematical Society's meeting at Claremont McKenna College. Rates quoted include applicable tax and are subject to change.

Shuttle service from and to Ontario International Airport is provided free of charge. The driving time is 15 to 20 minutes.

Griswold's Inn (walking distance)
555 West Foothill Boulevard
Claremont, CA 91711
(Corner of Indian Hill Boulevard)
Telephone: 800-854-5733 (except California), 800-821-0341 (in California) or 714-626-2411

Rooms (1-4 persons): $50 plus tax

Rooms must be reserved before October 21.

Ramada Inn (2.5 miles)
840 South Indian Hill Boulevard
Claremont, CA 91711
(Next to San Bernardino Freeway – Interstate 10)
Telephone: 800-228-2828 or 714-621-4831

Rooms (1-2 guests): $49 plus tax
Additional person: $6 per night

Food Service

The hotels listed above have their own restaurants. In addition, there are many good restaurants in Claremont and the surrounding area. A list will be provided at the meeting.

Luncheon

There will be a joint luncheon for MAA and AMS participants on Saturday, November 12 at noon in the Athenaeum on the college campus.

Travel

Claremont is located 35 miles east of Los Angeles.

Most major airlines serve Ontario International Airport (California). The drive from LAX is slow on Friday afternoons, but not as slow on Saturdays and Sundays.

Lance W. Small
Associate Secretary
La Jolla, California

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

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

Lawrence, October 1988

Bjørn Dahlberg
Steven E. Hurder
Peter Scott
Sidney M. Webster

Claremont, November 1988

William Jacob
Robert Brooks
Francis Bonahon

Phoenix, January 1989

John B. Conway
Percy Alec Deift
David Fried
R. L. Graham (AMS-MAA)
Peter Landweber
Cathleen S. Morawetz (AMS-MAA)
Steve Smale (AMS-MAA)
Luc Tartar

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

October 1988 Meeting in Lawrence
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: Expired
Deadline for consideration: August 2, 1988

Andrew Acker, *Partial differential equations–Geometric equations*
John K. Beem and Phillip E. Parker, *Geometry and mathematical physics*
Ralph Byers, *Numerical linear algebra*
Bruce Crauder and Sheldon Katz, *Algebraic geometry*
Tyrone Duncan, *Control theory*
William Fleissner, *Applications of set theory*
James Foran, *Real analysis*
William Mark Goldman, *Flat bundles and geometric structures*
Steven E. Hurder and Noberto Salinas, *Operatory theory and applications to geometry*
Daniel Katz and Jeffery Lang, *Commutative algebra*
Jill Pipher and Gregory Vechota, *Potential theory and partial differential equations in nonsmooth domains*
Peter Scott, *3-manifolds*

November 1988 Meeting in Claremont
Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: August 2, 1988

Francis Bonahon and David Gabai, *Low dimensional geometry*
Robert Borrelli and Courtney S. Coleman, *Computers and software in mathematical research*
Robert Brooks and S. -Y. Cheng, *The spectrum of the Laplacian*
Stavros N. Busenberg, *Differential and difference equations*
William Jacob and Adrian Wadsworth, *Division algebras*

January 1989 Meeting in Phoenix
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: September 21, 1988

Melvyn S. Berger, *Mathematics of nonlinear science*
John B. Conway, Harry Gonshor, and Martin Kruskal, *Surreal numbers*
Percy Deift, *Integrable systems*
David Eisenbud and Craig Huneke, *Commutative algebra and algebraic geometry*

Larry C. Grove and M. F. Newman, *Computational group theory*
William A. Harris, *Singular perturbation theory*
Victor C. Katz and Florence Fasanelli, *History of Mathematics*
Albert Mardin and Burton Rodin, *Computational aspects of complex analysis*
Sidney Port, *Stochastic processes*
Marc A. Rieffell, *Operator algebras and geometry*
Hal L. Smith, *Mathematics in population biology*

April 1989 Meeting in Worcester
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: July 15, 1988
Deadline for consideration: January 4, 1989

May 1989 Meeting in Chicago
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: August 15, 1988
Deadline for consideration: February 8, 1989
Jeffery Bergen, *Noncommutative ring theory*
Jonathan Cohen, *Numerical methods in harmonic analysis*
Stephen Doty, *Algebraic groups and related topics*
Christine Haught, *Recursion theory*
Cary Huffman and Neal Brand, *Codes and designs*

August 1989 Meeting in Boulder
Associate Secretary: Andy Roy Magid
Deadline for organizers: November 15, 1988
Deadline for consideration: April 25, 1989

October 1989 Meeting in Hoboken
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: January 15, 1989
Deadline for consideration: August 9, 1989

October 1989 Meeting in Muncie
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: January 15, 1989
Deadline for consideration: August 9, 1989

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings. They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the Program Committee from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but may be found in "Rules for Special Sessions" which can be found on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the Program Committee or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the Program Committee well in advance of the meeting and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to the *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noticed that Special Sessions must be announced in the *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three (3) weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Committee to Select Hour Speakers for the Section. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section, who then forwards the proposals to the Committee to Select which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
(Telephone 619-534-3590)

Central Section

Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
(Telephone 405-325-2052)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203-347-9411)

Southeastern Section

Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504-865-5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Call For Topics For 1990 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1990. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are outlined below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, or telephoning 401-272-9500.

Individuals willing to serve as organizers should be aware that the professional meeting staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and chairman of the Organizing Committee; (2) a two- or three-page detailed outline of the subject(s) to be covered, including the importance, timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; (5) a list of likely candidates who would be invited to participate and their current affiliations; and (6) any other observations which may affect the size of the conference and the amount of support required. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. By action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

1990 AMS Symposium in Pure Mathematics

This symposium in pure mathematics has traditionally been conducted in the spring of even numbered years in conjunction with a sectional meeting. The symposium can be held independently of a sectional meeting and serves to honor great accomplishments in mathematics. Proceedings are normally published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics.*

Topics in recent years have been:
1982 – *Several complex variables,* organized by YUM-TONG SIU of Stanford University
1984 – *Pseudodifferential operators and Fourier integral operators with applications to partial differential equations,* organized by FRANÇOIS TREVES of Rutgers University
1987 – *The mathematical heritage of Herman Weyl,* organized by R. O. WELLS, JR. of Rice University.

Deadline For Suggestions: September 1, 1988

1990 AMS Summer Institute

Summer institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a summer institute must not overlap those of the Society's summer meeting, which at the time of this printing have not yet been determined. There should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics.*

Topics in recent years have been:
1986 – *Representations of finite groups and related topics,* organized by JONATHAN L. ALPERIN of the University of Chicago.
1987 – *Theta functions,* organized by LEON EHRENPREIS of Temple University and ROBERT GUNNING of Princeton University.

1988 – *Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of University of California, Berkeley, and RONALD G. DOUGLAS of State University of New York at Stony Brook.
1989 – *Several complex variables and geometry*, organized by STEVEN G. KRANTZ of Washington University.

Deadline For Suggestions: September 1, 1988

1990 AMS-SIAM-SMB Symposium Some Mathematical Questions in Biology

This one-day symposium now under joint sponsorship with the Society for Mathematical Biology is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the Society as volumes in the series *Lectures on Mathematics in the Life Sciences.*

Topics in recent years have been:
1985 – *Plant biology*, organized by ROBERT M. MIURA of the University of British Columbia.
1986 – *Modeling circadian rhythms*, organized by GAIL A. CARPENTER of Northeastern University.
1987 – *Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.
1988 – *Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.
1989 – *Sex allocation and sex change: Experiments and models*, organized by MARC MANGEL of the University of California, Davis.

Deadline For Suggestions: September 1, 1988

1990 AMS-SIAM Summer Seminar

The goal of the summer seminar is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the Society as volumes in the series *Lectures in Applied Mathematics.*

Topics in recent years have been:
1985 – *Reacting flows: Combustion and chemical reactors*, organized by G.S.S. LUDFORD of Cornell University.
1987 – *Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.
1988 – *Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.
1989 – *The mathematics of random media*, organized by WERNER KOHLER of Virginia Polytechnic Institute and BENJAMIN WHITE of Exxon Research & Engineering Company.

Deadline For Suggestions: September 1, 1988

1990 AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences

These conferences are similar in structure to those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the sixth series of one-week conferences, being held in 1988, are *The mathematics and physics of order and disorder, Spatial statistics and imaging, Mathematical developments arising from linear programming, Geometric Problems in Fourier Analysis, Computational number theory, Current progress in hyperbolic systems: Riemann problems and computations, Mathematical problems posed by anisotropic materials, Geometric and topological invariants of elliptic operators, Elliptic genera and elliptic cohomology, Control theory & multibody systems.* If proceedings are published by the Society, they will appear as volumes in the series *Contemporary Mathematics.*

Deadline For Suggestions: February 1, 1989

1990 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions ordinarily extending over a period of one and one-half days starting immediately prior to the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business. Topics in recent years have been *Computation Complexity Theory* (January 1988), *Moments in Mathematics* (January 1987), *Approximation Theory* (January 1986), *Actuarial Mathematics* (August 1985), *Fair Allocation* (January 1985). Proceedings are published by the Society as volumes in the series *Proceedings of*

Symposia in Applied Mathematics, with the approval of the Editorial Committee. **Deadline for Suggestions:** Suggestions for the January 1990 course should have been submitted by July 1, 1988; suggestions for the August 1990 course should be submitted by December 1, 1988.	Submit suggestions to: Professor Stefan A. Burr, Chairman, Short Course Subcommittee, Department of Computer Science, CUNY, City College, New York, NY 10031.

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *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. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

1987–1988. **Academic Year Devoted to Differential Geometry**, University of North Carolina, Chapel Hill, North Carolina. (November 1987, p. 1137)

1987–1988. **Academic Year Devoted to Several Complex Variables**, Mittag-Leffler Institute, Djursholm, Sweden. (January 1987, p. 131)

1988-1989. **Academic Year Devoted to Operator Algebras**, Mittag-Leffler Institute, Djursholm, Sweden. (February 1988, p. 307)

March 6–December 24, 1988. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (March 1988, pp. 457-458)

April 17–December 24, 1988. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (October 1987, p. 995)

October 1988–August 1989. **Symposium on Singularity Theory and Its Applications**, University of Warwick, Coventry, United Kingdom. (May/June 1988, p. 724)

January 1–December 23, 1989. **Mathematisches Forschungsinstitut Oberwolfach** (Weekly Conferences), Federal Republic of Germany. (April 1988, p. 629)

July 1988

20–31. **Ninth Latin American School of Mathematics**, Santiago, Chile. (November 1987, p. 1140)

22–28. **Twelfth IMACS World Congress on Scientific Computation**, Paris, France. (April 1988, p. 635)

24–30. **International Conference on Radicals – Theory and Applications**, Sendai, Japan. (May/June 1988, p. 727)

24–August 5. **Constructive Methods in Computing Science**, Marktoberdorf, Germany. (May/June 1988, p. 727)

25–28. **First International Conference on Optimal Design and Analysis of Experiments**, Neuchatel, Switzerland. (February 1988, p. 311)

25–28. **Third KIT Mathematics Workshop**, Taejon, Korea. (May/June 1988, p. 727)

25–29. **Third International Conference on Fibonacci Numbers and Their Applications**, Pisa, Italy. (April 1988, p. 635)

25–30. **Third International Congress on Computational and Applied Mathematics**, University of Leuven, Belgium. (August 1987, p. 814)

25–30. **International Symposium on Engineering Mathematics**, Beijing, China. (April 1988, p. 635)

27–August 3. **Sixth International Congress on Mathematical Education**, Budapest, Hungary. (March 1988, p. 463)

* 28–30. **Algorithmic Aspects of Geometry and Algebra**, Cornell University, Ithaca, New York.

INFORMATION: Cornell University, Mathematical Sciences Institute, 294 Caldwell Hall, Ithaca, New York 14853-2602, 607-255-8005.

31–August 6. **Nonstandard Analysis**, University of Massachusetts, Amherst, Massachusetts, and Smith College, Northampton, Massachusetts. (January 1988, p. 159)

August 1988

1–5. **Fifteenth Annual Conference and Exhibition on Computer Graphics and Interactive Techniques (SIGGRAPH '88)**, Georgia World Congress Center, Atlanta, Georgia. (October 1987, p. 999)

1–5. **Thirty-eighth Gordon Research Conference on Statistics in Chemistry and Chemical Engineering**, New Hampton, New Hampshire. (April 1988, p. 636)

1–6. **Group Actions and Invariant Theory**, McGill University, Montreal, Quebec, Canada. (May/June 1988, p. 727)

1–7. **International Symposium on Number Theory and Analysis**, Tsing Hua University, Beijing, People's Republic of China. (February 1988, p. 311)

1–12. **Conference on Computational Tools of Numerical Approximation and Control**, Montana State University, Bozeman, Montana. (May/June 1988, p. 728)

*2–5. **Software Tools for Parallel Supercomputing**, Cornell University, Ithaca, New York.

INFORMATION: Cornell University, Mathematical Sciences Institute, 294 Caldwell Hall, Ithaca, New York 14853-2602, 607-255-8005.

4–11. **Algebraic Logic Conference**, Budapest, Hungary. (October 1987, p. 999)

5–8. **Second Boston Workshop for Mathematics Faculty**, Wellesley College, Wellesley, Massachusetts. (January 1988, p. 159)

6–7. **AMS Short Course on Chaos and Fractals: The Mathematics Behind the Computer Graphics**, Providence, Rhode Island. (April 1988, p. 597)

INFORMATION: M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

8–12. **AMS Centennial Celebration**, Providence, Rhode Island. (April 1987, p. 553)

INFORMATION: For further details, see the Meetings section of the April 1988 *Notices*.

8–12. **Fifth Marcel Grossman Meeting**, Perth, Western Australia. (April 1988, p. 636)

8–13. **Spaces of Self-Homotopy Equivalences**, Centre de recherches mathematiques, Université de Montréal, Montréal, Québec. (February 1988, p. 311)

8–14. **Conference on Algebraic Logic**, Budapest, Hungary. (May/June 1988, p. 728)

9–12. **International Symposium in Real Analysis**, University of Ulster, Coleraine, Northern Ireland. (February 1987, p. 364)

9–12. **Henstock Real Analysis Symposium**, University of Ulster, Coleraine, Northern Ireland. (March 1988, p. 463)

9–13. **First International Symposium on Algebraic Structures and Number Theory**, Hong Kong. (November 1987, p. 1140)

*11–13. **Mathematical Theory of Queueing Systems**, Cornell University, Ithaca, New York.

INFORMATION: Cornell University, Mathematical Sciences Institute, 294 Caldwell Hall, Ithaca, New York 14853-2602, 607-255-8005.

12–14. **International Conference on Mathematical Modelling in Sciences and Technology**, Madras, India. (Note date change, October 1987, p. 999)

13–17. **Kaehler Geometry and Several Complex Variables**, Eastern University, Charleston, Illinois. (April 1988, p. 636)

13–17. **NSF-CBMS Regional Conference: Rigidity in Several Complex Variables**, Eastern Illinois University, Charleston, Illinois. (May/June 1988, p. 728)

14–18. **Institute of Mathematical Statistics Annual Meeting**, Fort Collins, Colorado. (October 1987, p. 999)

14–27. **Harmonic Analysis on Reductive Groups**, Bowdoin College, Brunswick, Maine. (This conference has been postponed. For further details, see the announcement for July 30–August 12, 1989, in this section of Mathematical Sciences Meetings and Conferences)

15–19. **New Directions in Dynamical Systems**, Brown University, Providence, Rhode Island. (October 1987, p. 999)

15–19. **International Symposium on Approximation, Optimization and Computing**, University of Regina, Saskatchewan, Canada. (February 1988, p. 312)

15–19. **Advances in the Theory of Frechet Spaces**, Istanbul, Turkey. (May/June 1988, p. 728)

*15–19. **Joint Logic Programming Meeting**, University of Washington, Seattle, Washington.

INFORMATION: K. A. Bowen, 313 Link Hall, Syracuse University, Syracuse, New York 13210, 315-423-2466 or 2467.

15–20. **Universal Algebra**, Karlovy Vary, Czechoslovakia. (March 1988, p. 463)

16–19. **Institute of Mathematical Statistics Symposium on Probability and its Applications**, Colorado State University, Fort Collins, Colorado. (October 1987, p. 999)

16–September 9. **Summer School on Dynamical Systems**, International Centre for Theoretical Physics, Trieste (Italy). (April 1988, p. 636)

17–24. **Functional Analysis/Optimisation**, Australian National University, Canberra. (April 1988, p. 636)

19–24. **Georgia Topology Conference**, University of Georgia, Athens, Georgia. (February 1988, p. 312)

20–26. **Groups**, Pusan, Republic of Korea. (June 1987, p. 686)

21–25. **Crypto 88 Conference**, Santa Barbara, California. February 1988, p. 312)

21–27. **Seventeenth International Congress of Theoretical and Applied Mechanics**, Grenoble, France. (January 1987, p. 135)

21–27. **International Conference on General Algebra**, Krems/Donau, Austria. (November 1987, p. 1140)

21–September 7. **Eighteenth Ecole d'ete de Calcul des Probabilities**, Saint-Flour, Cantal. (March 1988, p. 463)

*22. **Third Annual AI and Simulation Workshop**, Minneapolis, Minnesota.

SPONSORS: AAAI/SCS/IMACS.
INFORMATION: P. Fishwick, Department of Computer and Information Science, University of Florida, Building CSE, Gainesville, Florida 32611.

22–25. **1988 Joint Statistical Meetings**, New Orleans, Louisiana. (June 1987, p. 686)

22–25. **Fifth International Conference on the New Quality Philosophy in Statistical Research and Statistical Education (Satellite Conference)**, New Orleans, Louisiana. (March 1988, p. 464)

22–26. **Conference on Categorical Topology and its Relations to Algebra, Analysis and Combinatorics**, Prague, Czechoslovakia. (October 1987, p. 1000)

22–26. **International Conference on Operator Theory: Advances and Applications**, University of Calgary, Alberta, Canada. (November 1987, p. 1140)

22–26. **20th Nordic Congress of Mathematicians**, Trondheim, Norway. (November 1987, p. 1140)

22–26. **Conference in Differential Geometry In Honor of M. Perdigão Do Carmo**,

Rio de Janeiro, Brazil. (March 1988, p. 464)

22–27. **Conference on Numerical Methods and Applications**, Sofia, Bulgaria. (March 1988, p. 464)

22–September 16. **Summer School: Jordan Algebras and Jordan Triples: Geometry and Analysis**, Poitiers, France. (March 1988, p. 464)

23–30. **1988 Association for Symbolic Logic European Summer Meeting**, Padova, Italy. (January 1988, p. 160)

27–31. **First Islamic Countries Conference on Statistical Sciences**, Lahore, Pakistan. (March 1988, p. 464)

28–31. **European Conference for Mathematics in Industry**, Glasgow, Scotland. (March 1988, p. 464)

*29–31. **IEEE Workshop on Languages for Automation**, University of Maryland, College Park, Maryland.

INFORMATION: P. A. Ligomenides, Cybernetics Research Laboratory, Electrical Engineering Department, University of Maryland, College Park, Maryland 20742, 301-454-6842.

29–September 1. **Fourteenth International Conference on Very Large Databases**, Hyatt Regency Hotel, Long Beach, California. (March 1988, p. 464)

29–September 2. **ICO Topical Meeting on Optical Computing**, Orsay, France. (October 1987, p. 1000)

29–September 2. **Orbit Method in Representation Theory**, Copenhagen, Denmark. (October 1987, p. 1000)

29–September 2. **Workshop on Symplectic Topology**, Mathematical Sciences Research Institute, Berkeley, California. (February 1988, p. 321)

29–September 2. **COMPSTAT '88 Eighth Symposium on Computational Statistics**, Copenhagen, Denmark. (March 1988, p. 464)

29–September 2. **Harmonic Analysis in Lie Groups**, Copenhagen, Denmark. (April 1988, p. 637)

29–September 2. **International Conference on Mathematical Statistics**, Olsztyn, Poland. (April 1988, p. 637)

29–September 2. **Thirteenth International Symposium on Mathematical Programming**, Tokyo, Japan. (April 1988, p. 637)

30–September 2. **Ninth Annual Meeting of the International Society of Clinical Biostatistics**, Innsbruck, Austria. (April 1988, p. 637)

September 1988

*5–23. **Workshop on Dynamical Systems**, Trieste, Italy.

INFORMATION: International Centre for Theoretical Physics, Trieste, Italy, P. O. B. 586, Miramare, Strada Costiera 11. Telephone: 2240-1.

6–10. **International Neural Network Society 1988 Annual Meeting**, Boston, Massachusetts. (February 1988, p. 312)

*10–11. **Fourth Seminar on Algebra**, Mashad University, Mashad-Iran.

PROGRAM: The seminar is devoted to group theory, ring theory, algebrated geometry and related areas.
INFORMATION: M. R. R. Moghaddam, Department of Mathematics, Statistics and Computer Science, Post Office Box 1159, Mashad University, Mashad-Iran.

12–16. **Theorie des Nombres**, Marseille, France. (March 1988, p. 464)

12–16. **Eurographics '88: Research, Practice and Experience**, Nice, France. (March 1988, p. 464)

*12–16. **Third International Symposium on Systems Analysis and Simulation**, Berlin, German Democratic Republic.

INFORMATION: A. Sydow, ZKI der ADW der DDR, Kurstrasse 33, DDR-1086 Berlin, German Democratic Republic.

13–16. **Workshop on Arboreal Group Theory**, Mathematical Sciences Research Institute, Berkeley, California. (January 1988, p. 160)

13–23. **Heyting Summer School and Conference on Mathematical Logic**, Chaika near Varna, Bulgaria. (February 1988, p. 312)

14–16. **Fifth IMA International Conference on Control Theory**, Strathclyde, Scotland. (April 1988, p. 637)

14–17. **Meeting of Topology**, Centro Congressi Cocumella, Sorrento (Naples), Italy. (March 1988, p. 464)

*18–21. **IMACS International Symposium on System Modelling and Simulation**, University of Calabria, Province de Cosenza, Italy.

INFORMATION: A. Eisinberg, Systems Department, University of Calabria, Province de Cosenza, Italy.

18–24. **DMV-Jahrestagung 1988**, Regensburg, Federal Republic of Germany. (March 1988, p. 464)

19–23. **Sixth International Colloquium on Differential Geometry**, Universidad de Santiago de Compostela, Santiago de Compostela, Spain. (February 1988, p. 312)

19–23. **Histoire de la Relativite Generale**, Marseille, France. (March 1988, p. 464)

23–25. **Fall Foliage Combinatorial Group Theory Conference**, Shaker Village, New Hampshire. (May/June 1988, p. 729)

24–25. **Last Fall Foliage Topology Seminar**, Shaker Village, New Hampshire. (May/June 1988, p. 729)

25–30. **International Symposium in Honor of René Thom**, Paris, France. (February 1988, p. 312)

26–30. **Computational Intelligence '88**, University of Milano, Milano, Italy. (March 1988, p. 465)

26–October 1. **Fifth International Conference on Complex Analysis**, Halle, German Democratic Republic. (October 1987, p. 1000)

*28–October 9. **Sixth International Summer School on Probability Theory and Mathematical Statistics**, Varna, Bulgaria.

INFORMATION : Department of Probability and Statistics, Post Office Box 373, 1090 Sofia, Bulgaria.

30–October 1. **Sixteenth Annual Mathematics and Statistics Conference**, Miami University, Oxford, Ohio. (April 1988, p. 637)

October 1988

*1. **Algebra Day**, Carleton University, Ottawa, Canada.

ORGANIZER: Ottawa-Carleton Institute for Graduate Studies and Research in Mathematics and Statistics, University of Ottawa-Carleton University.
INVITED SPEAKERS: M. Lorenz, Northern Illinois University; D. J. S. Robinson, University of Illinois at Urbana-Champaign; A. R. Wadsworth, University of California, San Diego; T. Wakamatsu, Jôbu, Japan.

INFORMATION: L. Ribes, Department of Mathematics and Statistics, Carleton University, Ottawa, Ontario K1S 5B6, Canada. Telephone: 613-564-7131.

3–5. **Knowledge-Based Robot Control**, Bonas, France. (May/June 1988, p. 729)

4–6. **Colloque Ergoia 88 Ergonomie et Intelligence Artificelle**, Biarritz, France. (April 1988, p. 637)

*5–7. **IFAC/IMACS/IFIP Symposium on Robot Control SYROCO '88**, Karlsruhe, Federal Republic of Germany.

INFORMATION: G. Hirzinger, DFVLR Oberpfaffenhofen, D-8031 Wessling, Oberbayern, Federal Republic of Germany.

9–13. **International Conference on Computer Languages**, Castle Premier, Miami Beach, Florida. (March 1988, p. 465)

10–12. **IEEE Workshop on Visual Languages**, University of Pennsylvania, Pittsburgh, Pennsylvania. (March 1988, p. 465)

*10–12. **Frontiers '88: Second Symposium on the Frontiers of Massively Parallel Computation**, George Mason University, Fairfax, Virginia.

INFORMATION: J. R. Fischer, Code 635, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, 301-286-3464.

10–14. **Workshop on Mathematical Programming**, Catholic University of Rio De Janeiro, Brazil. (May/June 1988, p. 729)

12–14. **Sensor-Based Robots: Algorithms and Architectures**, Bonas, France. (May/June 1988, p. 729)

*12–15. **Discrete Mathematics and Computer Science**, University of Montreal, Montreal, Quebec, Canada.

INVITED SPEAKERS: G. Brassard; M. Cosnard; J. Della Dora; J. Fonlupt; P. Frankl; P. L. Hammer; P. Hell; F. Jaeger; M. Nivat; F. Robert; N. Sauer; D. Therien; W. Tutte; M. Watkins.
ORGANIZERS: A. Achache; G. Hahn; M. Pouzet; I. G. Rosenberg.
INFORMATION: G. Hahn, Département d'I. R. O., Université de Montréal, C. P. 6128, Succ. A, Montréal, Québec H3C3J7 Canada. Telephone: 514-343-6806.

21–22. **Tenth Midwest Probability Colloquium**, Northwestern University, Evanston, Illinois. (May/June 1988, p. 730)

*24–26. **Twenty-ninth Foundations of Computer Science**, White Plains, New York.

INFORMATION: C. Papadimitrou, Department CSE, University of California/San Diego, La Jolla, California 92043, 619-534-2086.

28–29. **Seventeenth Midwest Differential Equations Conference**, Iowa State University, Ames, Iowa. (May/June 1988, p. 730)

28–30. **Central Sectional Meeting**, Lawrence, Kansas.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

*30–November 4. **Ninth International Conference on Computer Communications**, Tel Aviv, Israel.

SPONSORS: The International Council for Computer Communication; the Institute of Electrical and Electronic Engineers (Israeli Section); Information Processing Association (Israel).
INFORMATION: The Secretariat, Ninth International Conference on Computer Communications - ICCC 88, Post Office Box 50006, Tel Aviv 61500, Israel. Telephone: 972/3/654571.

31–November 18. **Workshop in Mathematical Ecology**, Trieste, Italy. (March 1988, p. 465)

November 1988

4–5. **Southeast Differential Equations Conference**, Athens, Georgia. (March 1988, p. 465)

12–13. **846th Meeting of the AMS**, Claremont, California.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

*12–13. **Twenty-fourth Midwest Partial Differntial Equations Seminar**, University of Notre Dame, Notre Dame, Indiana.

INFORMATION: N. K. Stanton, 219-239-7436; Mei-Chi Shaw, 219-239-6537; G. Roberts, 219-239-5402; or write to Department of Mathematics, University of Notre Dame, Notre Dame, Indiana 46556.

13–17. **French-Israeli Conference on Combinatorics and Algorithms**, Israel. (February 1988, p. 313)

18–19. **Quantitative Approaches to Diabetes**, Sydney, Australia. (April 1988, p. 638)

20–25. **Eighth Annual Conference: Towards a Whole Decade for Scientific and Technological Cooperation for International Development**, Jamaica, West Indies. (March 1988, p. 465)

21–December 16. **College on Global Geometric and Topological Methods in Analysis**, Trieste, Italy. (March 1988, p. 465)

December 1988

*5–8. **IMACS Conference on Expert Systems for Numerical Computing**, Purdue University, West Lafayette, Indiana.

PURPOSE: This international conference is designed to aid nonspecialists in the use of computers for scientific applications. It is intended to bring together active researchers, to allow for an exchange of ideas, viewpoints, and techniques.
PAPERS: The conference will include invited and contributed papers. Authors who wish to contribute papers should submit 3 copies of an extended abstract (2-3 pages, typed single-spaced on 8 by 11 inch paper) no later than July 31, 1988 to the address given below. All papers submitted will be reviewed. Authors will be notified regarding acceptance of their contribution no later than September 15, 1988.
INFORMATION: Abstracts and requests for information should be addressed to E. Houstis, Department of Computer Science, Purdue University, West Lafayette, Indiana 47907, 317-494-6003.

6–8. **First International Conference on Matter Elements Analysis**, Guangzhou, Guangdong, People's Republic of China. (October 1987, p. 1000)

12–15. **International Conference on Computer Vision**, Tarpon Springs, Florida. (May/June 1988, p. 730)

12–17. **International Course on Computational Geometry**, Dipartimento di Matematica, Università, Catania, Italy. (May/June 1988, p. 730)

13–15. **IMA/SIAM International Conference on Mathematics of Signal Processing**, Warwick, England. (April 1988, p. 638)

*13–17. **KAC-Moody Lie Algebras and Physics Conference**, North Carolina State University, Raleigh, North Carolina.

SPEAKERS: V. G. Kac; R. V. Moody; D. Olive.
INFORMATION: Conference Organizing Committee, Department of Mathematics, North Carolina State University, Raleigh, North Carolina 27695-8205, 919-737-3968 or 737-2370.

*14–16. **Raj Chandra Bose Memorial Conference on Combinatorial Mathematics and Applications**, Calcutta, India.

ORGANIZERS: Indian Statistical Institute in collaboration with the Calcutta Statistical Association.
INFORMATION: All correspondence and inquiries should be addressed to A. R. Rao, Secretary, Bose Conference, Division of Theoretical Statistics and Mathematics, Indian Statistical Institute, 203 B. T. Road, Calcutta 700 035, India.

27–31. **Holiday Symposium on Fermat's Last Theorem**, New Mexico State University, Las Cruces, New Mexico. (May/June 1988, p. 730)

January 1989

2–5. **International Colloquium in Ring Theory**, Bar-Ilan University, Ramat-Gan, Israel. (May/June 1988, p. 730)

4–6. **American Statistical Association Winter Conference: Statistics in Society**, San Diego, California. (March 1988, p. 465)

6–12. **Nonlinear Wave Equations**, George Mason University, Fairfax, Virginia. (April 1988, p. 638)

8–10. **Symposium in Honor of the Seventieth Birthday of Ted Harris**, Los Angeles, California. (May/June 1988, p. 730)

8–11. **First Caribbean Conference on Fluid Dynamics**, Saint Augustine, Trinidad, West Indies. (June 1987, p. 686)

9–13. **Sixth Texas International Symposium on Approximation Theory**, College Station, Texas. (April 1988, p. 638)

9–14. **K-Theory and Dynamics**, University of Florida, Gainesville, Florida. (April 1988, p. 638)

11–14. **Joint Mathematics Meetings**, Phoenix, Arizona. (April 1987, p. 553)

INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

15–20. **American Association for the Advancement of Science Annual Meeting**, San Francisco, California. (May/June 1988, p. 731)

23–27. **Workshop on Algorithms, Word Problems, and Classification in Combinatorial Group Theory**, Mathematical Sciences Research Institute, Berkeley, California. (February 1988, p. 313)

February 1989

21–23. **Seventeenth Annual Computer Science Conference**, Commonwealth Convention Center, Louisville, Kentucky. (May/June 1988, p. 731)

March 1989

19–22. **ENAR Spring Meeting**, Lexington, Kentucky. (March 1988, p. 465)

April 1989

3–6. **IEEE International Conference on Control and Applications**, Jerusalem, Israel. (April 1988, p. 638)

10–13. **IEEE Artificial Neural Networks Conference**, Sheraton International Conference Center, Reston, Virginia. (Note date change, March 1988, p. 465)

15–16. **Eastern Section Meeting**, College of the Holy Cross, Worcester, Massachusetts. (May/June 1988, p. 731)

May 1989

8–10. **Forty-Third Annual Quality Congress**, Toronto, Canada. (March 1988, p. 465)

8–12. **Workshop on Arithmetic Groups and Buildings**, Mathematical Sciences Research Institute, Berkeley, California. (March 1988, p. 465)

15–17. **1989 New Zealand Mathematics Colloquium**, Palmerston North, New Zealand. (May/June 1988, p. 731)

19–20. **Central Section Meeting**, Loyola University, Chicago, Illinois.

INFORMATION: J. Balletto, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

23–27. **International Conference on Computing and Information**, Toronto, Ontario, Canada. (April 1988, p. 638)

28–June 10. **AMS-SIAM Summer Seminar on the Mathematics of Random Media**, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. (May/June 1988, p. 731)

29–June 1. **Third International Conference in Mathematics: Fractional Calculus and Its Applications**, Nihon University, Tokyo, Japan. (May/June 1988, p. 731)

June 1989

5–16. **Workshop on the Geometry of Hamiltonian Systems**, Mathematical Sciences Research Institute, Berkeley, California. (April 1988, p. 638)

*12–16. **Computers and Mathematics**, Massachusetts Institute of Technology, Cambridge, Massachusetts.

CONFERENCE THEMES: This conference will focus on the use of the computer as a research tool in the mathematical sciences. Emphasis will be placed on the current and potential use of computer algebra and computer graphics as a research tool. The program consists of invited addresses, contributed papers and minicourses, mathematical software tutorials, and a special computer graphics event.
CONTRIBUTED PAPERS: Drafts are due by November 30, 1988, to E. Kaltofen, Department of Computer Science, RPI, Troy, New York 12180-3590.
CONTRIBUTED MINICOURSES: Proposals for 2- to 3-hour courses are due by October 10, 1988, to P. Gianni, IBM Research, Post Office Box 218, Yorktown Heights, New York 10598.
INFORMATION: H. Schmidt, Conference Secretary, 62 Eastview, Pleasantville, New York 10570, 914-769-2725.

July 1989

3–7. **Computational Ordinary Differential Equations**, London, England. (April 1988, p. 638)

10–12. **International Conference on Computational Techniques and Applications**, Griffith University, Brisbane. (April 1988, p. 639)

10–21. **Microprogram on Noncommutative Rings**, Mathematical Sciences Research Institute, Berkeley, California. (May/June 1988, p. 731)

30–August 4. **Sixteenth Annual Conference and Exhibition on Computer Graphics and Interactive Techniques (SIGGRAPH '89)**, Hynes Auditorium, Boston, Massachusetts. (March 1988, p. 466)

30–August 12. **Harmonic Analysis on Reductive Groups**, Bowdoin College, Brunswick, Maine. (January 1988, p. 160)

August 1989

1–9. **Eighteenth International Congress of the History of Science**, Hamburg, 1–5; Munich, 6–9, Federal Republic of Germany. (April 1988, p. 639)

6–10. **1989 Joint Statistical Meetings**, Washington, District of Columbia. (March 1988, p. 466)

13–19. **Fourth Conference on Differential Equations and Applications**, Rousse, Bulgaria. (May/June 1988, p. 731)

20–September 6. **Nineteenth Ecole d'ete de Calcul des Probabilities**, Saint-Flour, Cantal. (March 1988, p. 466)

28–September 1. **IFIP 89: Eleventh World Computer Conference**, San Francisco, California. (April 1988, p. 639)

29–September 6. **Forty-seventh Session of the International Statistical Institute**, Paris, France. (April 1988, p. 639)

September 1989

16–October 20. **Sixth World Congress on Medical Information**, Beijing, China. (April 1988, p. 639)

25–29. **Third International Conference on the Theory of Groups and Related Topics**, Australian National University, Canberra. (May/June 1988, p. 732)

October 1989

21–22. **Eastern Section Meeting**, Stevens Institute of Technology, Hoboken, New Jersey. (May/June 1988, p. 732)

27–28. **Central Section Meeting**, Ball State University, Muncie, Indiana. (May/June 1988, p. 732)

January 1990

17–20. **Joint Mathematics Meetings**, Louisville, Kentucky. (April 1987, p. 553)

INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

May 1990

25–31. **Tenth International Conference on Pattern Recognition**, Resorts Hotel, Atlantic City, New Jersey. (March 1988, p. 466)

August 1990

6–9. **1990 Joint Statistical Meetings**, Anaheim, California. (March 1988, p. 466)

January 1991

16–19. **97th Annual Meeting**, San Francisco, California.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

August 1991

17–21. **American Sociological Association Annual Meeting**, Cleveland, Ohio. (May/June 1988, p. 732)

19–22. **1991 Joint Statistical Meetings**, Atlanta, Georgia. (March 1988, p. 466)

New AMS Publications

THE COLLECTED PAPERS OF R. H. BING
Sukhjit Singh, Steve Armentrout, and Robert J. Daverman, Editors

A powerful mathematician and a great problem solver, R. H. Bing laid the foundation for a number of areas of topology. Many of his papers have continued to serve as a source of major theoretical developments and concrete applications in recent years. One outstanding example was Michael H. Freedman's use of Bing's Shrinking Criterion to solve the four-dimensional Poincaré Conjecture.

This two-volume set brings together over one hundred of Bing's research, expository, and miscellaneous papers. These works range over a great variety of topics in topology, including the topology of manifolds, decomposition spaces, continua, metrization, general topology, and geometric topology. In addition, there are a number of papers in the areas of convex functions, linearity, and conformal varieties. The introductory section in the first volume provides historical background on Bing's life and achievements.

This collection will appeal to mathematicians in all areas, and especially those in topology, as well as students, historians, and educators in the mathematical sciences, for it provides a complete historical summary of the mathematical events in the life of the man and the mathematician, R. H. Bing.

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1680 pages, 2 volumes (hardcover), July 1988
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THE MATHEMATICAL HERITAGE OF HERMANN WEYL
R. O. Wells, Jr., Editor
(Proceedings of Symposia in Pure Mathematics, Volume 48)

Hermann Weyl was one of the most influential mathematicians of the twentieth century. Viewing mathematics as an organic whole rather than a collection of separate subjects, Weyl made profound contributions to a wide range of areas, including analysis, geometry, number theory, Lie groups, and mathematical physics, as well as the philosophy of science and of mathematics. The topics he chose to study, the lines of thought he initiated, and his general perspective on mathematics have proved remarkably fruitful and have formed the basis for some of the best of modern mathematical research.

This volume contains the proceedings of the AMS Symposium on the Mathematical Heritage of Hermann Weyl, held in May 1987 at Duke University. In addition to honoring Weyl's great accomplishments in mathematics, the symposium also sought to stimulate the younger generation of mathematicians by highlighting the cohesive nature of modern mathematics as seen from Weyl's ideas. The symposium assembled a brilliant array of speakers and covered a wide range of topics. All of the papers are expository and will appeal to a broad audience of mathematicians, theoretical physicists, and other scientists.

Contents

James Arthur, *Characters, harmonic analysis, and an L^2-Lefschetz formula*
J. Lepowsky, *Perspectives on vertex operators and the Monster*
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Edward Witten, *Free fermions on an algebraic curve*

1980 *Mathematics Subject Classifications*: 00, 01
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REVIEWS IN GLOBAL ANALYSIS, 1980–86
Introduction by Anthony J. Tromba

The term "global analysis" refers to the general area of analysis on manifolds, in which the methods of modern algebra, analysis, geometry, and topology are blended. Although the beginnings of these ideas can be traced to the 17th century, major contributions in this direction were made by Lie, Riemann, and Poincaré toward the end of the last century, followed by the work of G. D. Birkhoff, E. Cartan, and Morse in the early part of this century. However, it is only in recent years that the subject has attained its present central position in mathematics. The subject has many rich applications to fields outside mathematics—such as mechanics, quantum physics, and general relativity—as well as within mathematics itself.

Today, this vital and active field is undergoing a virtual explosion of new and important results. *Reviews in Global Analysis* makes information about the most recent contributions to this rapidly growing field accessible both to specialists working in global analysis, and to those in other areas of pure and applied mathematics.

These five volumes contain the more than 18,000 reviews that appeared in *Mathematical Reviews* from 1980 through 1986 and have a primary or a secondary classification in Global Analysis (classification number 58). Relevant cross-references are provided with each review. The fifth volume of this set contains author and key indexes, making it very easy to locate items written by a specific author or to get information about collections or conference proceedings dealing with global analysis.

Contents

1980 *Mathematics Subject Classification*: 58
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A CENTURY OF MATHEMATICS IN AMERICA

Peter L. Duren, Editor
with the assistance of Richard A. Askey and Uta C. Merzbach

In the 100 years since the founding of the AMS, the American mathematical community has grown from a small group heavily dependent on European mathematicians to a large and influential group that in many areas sets the standard for the rest of the world. By the 1930s, there was a flourishing mathematical community to welcome the influx of mathematicians fleeing Europe. These refugees supplied additional strength and new vigor to a field that increased dramatically as a result of World War II and the postwar recognition of mathematics.

This volume, the first in the new History of Mathematics series, brings together a variety of perspectives on the political, social, and mathematical forces that have shaped the American mathematical community in the past century. Humorous, edifying, and poignant, this book presents the personal recollections of a number of mathematicians who have influenced the development of mathematics in this country.

One of the highlights of the volume is Lipman Bers's paper which was presented as an AMS-MAA Joint Invited Address in Atlanta in January 1988 and which gives a moving account of the reception that he and other European refugee mathematicians received in this country. Described here are some of the success stories of this century—such as classification of finite simple groups, delineated by Daniel Gorenstein—as well as some of the problems—such as the McCarthy period, chronicled by Chandler Davis. Paul R. Halmos, one of the most influential textbook writers, tells of the textbooks he used when he was a student and young professor and how they influenced him. Among the papers reprinted here are some that have appeared in journals not ordinarily read by mathematicians, such as the article by science historian Nathan Reingold, which appeared in *The Annals of Science*.

Mathematicians, historians of science, and students alike will find this book illuminating and rewarding. That the lessons of the past can guide the resolution of present problems makes this book important reading for all who are concerned with the development of mathematics. It will also make a fine addition to any library collection.

Contents

1980 *Mathematics Subject Classification*: 01
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AMS Centennial Publications

The following three books are being published in commemoration of the AMS's Centennial Celebration. The Semicentennial volumes are reprints of books originally produced in 1938 for the Semicentennial of the Society.

AMERICAN MATHEMATICAL SOCIETY CENTENNIAL PUBLICATIONS, Volume I: A History of the Second Fifty Years, American Mathematical Society 1939–1988 Everett Pitcher

This is volume one of a two-volume set which is being published to commemorate the AMS Centennial. (Volume 2 will contain the Proceedings of the AMS Centennial and will be published at a later date.) Professor Everett Pitcher served as an AMS Associate Secretary for 8 years and as the Society Secretary for the past 22 years. His long association with the Society, his detailed knowledge of its workings, and his historical perspective on the American mathematical community make him the ideal author for such a work.

Professor Pitcher chronicles the Society's activities over the past fifty years, as it grew in membership, in volume and diversity of its publications, in the number of meetings and conferences it organizes, and in the range of services it provides to the mathematical community. The book presents a picture of the AMS in 1938 and delineates the political and social influences that shaped its subsequent development. Some of the key personalities in the Society's history, notably the Presidents, are also described. This book is the crowning achievement in Professor Pitcher's years of dedication and service to the Society.

This book complements the history of the Society's first fifty years, written in 1938, the Society's semicentennial year, by Raymond Clare Archibald, who was the AMS librarian at that time. Archibald's history is volume one of American Mathematical Society Semicentennial Publications.

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1980 *Mathematics Subject Classification*: 01
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AMERICAN MATHEMATICAL SOCIETY SEMICENTENNIAL PUBLICATIONS, Volume I: A Semicentennial History of the American Mathematical Society 1888–1938 Raymond Clare Archibald

"The preparation of the manuscript for this History during the past two years has been the most enjoyable piece of literary work which I have ever undertaken. It has seemed as if contacts with past enthusiasms, visions, largeness of outlook, and charm of personality, could still be established."

So begins the preface of this delightful and fascinating work, in which R. C. Archibald, librarian of the Society from 1920 to 1941, outlines the history of the AMS in its first fifty years. Drawing upon his own and others' recollections and upon original Society records, Archibald has assembled a portrait of the early years of the AMS and of the development of mathematics in this country.

The story begins at Columbia University, where Thomas Scott Fiske founded the New York Mathematical Society, later to be called the American Mathematical Society. Among other subjects, Archibald touches on the development of the various AMS publications, the growth of the important

Chicago Section, the influence of the National Research Council (established just after World War I), and the meetings of the Society.

One of the most interesting features of the book is the section describing the past AMS Presidents up to 1938. Among them are such distinguished mathematicians as E. H. Moore, W. F. Osgood, Maxime Bôcher, E. B. Van Vleck, Frank Morley, Henry B. Fine, G. D. Birkhoff, Oswald Veblen, and Solomon Lefschetz. Instilled with profound respect, admiration, and affection, these short sketches contain many personal touches and anecdotes.

Contents

1980 *Mathematics Subject Classifications*: 00, 01
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AMERICAN MATHEMATICAL SOCIETY SEMICENTENNIAL PUBLICATIONS, Volume II: Semicentennial Addresses of the American Mathematical Society

The second Semicentennial volume contains brief treatises on eight mathematical areas and a historical summary of American contributions to mathematics during the Society's first fifty years. Some of the treatises are chronological or contain many references to early contributors; others are concerned chiefly with presenting a view of a particular subject as it stood at that time.

Contents

1980 *Mathematics Subject Classifications*: 00, 01
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OPERATOR THEORY AND ARITHMETIC IN H^∞
Hari Bercovici

(Mathematical Surveys and Monographs, Volume 26)

Jordan's classification theorem for linear transformations on a finite-dimensional vector space is a natural highlight of the deep relationship between linear algebra and the arithmetical properties of polynomial rings. Because the methods and results of finite-dimensional linear algebra seldom extend to or have analogs in infinite-dimensional operator theory, it is therefore remarkable to have a class of operators which has a classification theorem analogous to Jordan's classical result and has properties closely related to the arithmetic of the ring H^∞ of bounded analytic functions in the unit disk. C_0 is such a class and is the central object of study in this book.

A contraction operator belongs to C_0 if and only if the associated functional calculus on H^∞ has a nontrivial kernel. C_0 was discovered by Béla Sz.-Nagy and Ciprian Foiaş in their work on canonical models for contraction operators on Hilbert space. Besides their intrinsic interest and direct applications, operators of class C_0 are very helpful in constructing examples and counterexamples in other branches of operator theory. In addition, C_0 arises in certain problems of control and realization theory.

In this survey work, the author provides a unified and concise presentation of a subject that was covered in many articles. The book describes the classification theory of C_0 and relates this class to other subjects such as general dilation

theory, stochastic realization, representations of convolution algebras, and Fredholm theory.

This book should be of interest to operator theorists as well as theoretical engineers interested in the applications of operator theory. In an effort to make the book as self-contained as possible, the author gives an introduction to the theory of dilations and functional models for contraction operators. Prerequisites for this book are a course in functional analysis and an acquaintance with the theory of Hardy spaces in the unit disk. In addition, knowledge of the trace class of operators is necessary in the chapter on weak contractions.

Contents

1980 *Mathematics Subject Classifications*: 47; 46
ISBN 0-8218-1528-8, LC 88-10344
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280 pages (hardcover), July 1988
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BASIC HYPERGEOMETRIC SERIES AND APPLICATIONS

Nathan J. Fine

(Mathematical Surveys and Monographs, Volume 27)

The theory of partitions, founded by Euler, has led in a natural way to the idea of basic hypergeometric series, also known as Eulerian series. These series were first studied systematically by Heine, but many early results are attributed to Euler, Gauss, and Jacobi. Today, research in q-hypergeometric series is very active, and there are now major interactions with Lie algebras, combinatorics, special functions, and number theory.

However, the theory has been developed to such an extent and with such a profusion of powerful and general results that the subject can appear quite formidable to the uninitiated. By providing a simple approach to basic hypergeometric series, this book provides an excellent elementary introduction to the subject.

The starting point is a simple function of several variables satisfying a number of q-difference equations. The author presents an elementary method for using these equations to obtain transformations of the original function. A bilateral series, formed from this function, is summed as an infinite product, thereby providing an elegant and fruitful result which goes back to Ramanujan. By exploiting a special case, the author is able to evaluate the coefficients of several classes of infinite products in terms of divisor sums. He also touches on general transformation theory for basic series in many variables and the basic multinomial, which is a generalization of a finite sum.

These developments lead naturally to the arithmetic domains of partition theory, theorems of Liouville type, and sums of squares. Contact is also made with the mock theta-functions of Ramanujan, which are linked to the rank of partitions. The author gives a number of examples of modular functions with multiplicative coefficients, along with the beginnings of an elementary constructive approach to the field of modular equations.

Requiring only an undergraduate background in mathematics, this book provides a rapid entry into the field. Students of partitions, basic series, theta-functions, and modular equations, as well as research mathematicians interested in an elementary approach to these areas, will find this book useful and enlightening. Because of the simplicity of its approach and its accessibility, this work may prove useful as a textbook.

BIOGRAPHY

Nathan J. Fine received his PhD in 1946 from the University of Pennsylvania and taught there from 1947 to 1963. He was an NSF Postdoctoral Fellow (1953-1954), a Guggenheim Fellow (1958-1959), and E. S. Hedrick Memorial Lecturer (1966). In 1963, he moved to Pennsylvania State University, where he remained until his retirement in 1978. Author of *An Introduction to Modern Mathematics* and a co-author of *Rings of Quotients of Rings of Functions*, he has also written numerous papers in analysis, special functions, topology, number theory, combinatorics, and other topics.

Contents

1980 *Mathematics Subject Classifications*: 05, 11, 33
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DIRECT AND INVERSE SCATTERING ON THE LINE

Richard Beals, Percy Deift, and Carlos Tomei

(Mathematical Surveys and Monographs, Volume 28)

This book deals with the theory of linear ordinary differential operators of arbitrary order. Unlike treatments that focus on spectral theory, this work centers on the construction of special eigenfunctions (generalized Jost solutions) and on the inverse problem: the problem of reconstructing the operator from minimal data associated to the special eigenfunctions. In the second order case this program includes spectral theory and is equivalent to quantum mechanical scattering theory; the essential analysis involves only the bounded eigenfunctions. For higher order operators, bounded eigenfunctions are again sufficient for spectral theory and quantum scattering theory, but they are far from sufficient for a successful inverse theory.

The authors give a complete and self-contained theory of the inverse problem for an ordinary differential operator of any order. The theory provides a linearization for the associated nonlinear evolution equations, including KdV and Boussinesq. The authors also discuss Darboux-Bäcklund transformations, related first-order systems and their evolutions, and applications to spectral theory and quantum mechanical scattering theory.

Among the book's most significant contributions are a new construction of normalized eigenfunctions and the first complete treatment of the self-adjoint inverse problem in order greater than two. In addition, the authors present the first analytic treatment of the corresponding flows, including a detailed description of the phase space for Boussinesq and other equations.

The book is intended for mathematicians, physicists, and engineers in the area of soliton equations, as well as those interested in the analytical aspects of inverse scattering or in the general theory of linear ordinary differential operators. Because there is no other single work covering the analytical theory of inverse scattering for operators of degree greater than two, this book is likely to be a valuable resource to many.

Required background consists of a basic knowledge of complex variable theory, the theory of ordinary differential equations, linear algebra, and functional analysis. The authors have attempted to make the book sufficiently complete and self-contained to make it accessible to a graduate student having no prior knowlege of scattering or inverse scattering theory. The book may therefore be suitable for a graduate textbook or as background reading in a seminar.

Contents

1980 *Mathematics Subject Classifications*: 34, 35, 58
ISBN 0-8218-1530-X, LC 88-14487
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224 pages (hardcover), July 1988
Individual member $32, List price $53,
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AMENABILITY
Alan L. T. Paterson
(Mathematical Surveys and Monographs, Volume 29)

The subject of amenability has its roots in the work of Lebesgue at the turn of the century. In the 1940s, the subject began to shift from finitely additive measures to means. This shift is of fundamental importance, for it makes the substantial resources of functional analysis and abstract harmonic analysis available to the study of amenability. The ubiquity of amenability ideas and the depth of the mathematics involved points to the fundamental importance of the subject.

This book presents a comprehensive and coherent account of amenability as it has been developed in the large and varied literature during this century. The book has a broad appeal, for it presents an account of the subject based on harmonic and functional analysis. In addition, the analytic techniques should be of considerable interest to analysts in all areas. In addition, the book contains applications of amenability to a number of areas: combinatorial group theory, semigroup theory, statistics, differential geometry, Lie groups, ergodic theory, cohomology, and operator algebras.

The main objectives of the book are to provide an introduction to the subject as a whole and to go into many of its topics in some depth. The book begins with an informal, nontechnical account of amenability from its origins in the work of Lebesgue. The initial chapters establish the basic theory of amenability and provide a detailed treatment of invariant, finitely additive measures (i.e., invariant means) on locally compact groups. The author then discusses amenability for Lie groups, "almost invariant" properties of certain subsets of an amenable group, amenability and ergodic theorems, polynomial growth, and invariant mean cardinalities. Also included are detailed discussions of the two most important achievements in amenability in the 1980s: the solutions to von Neumann's conjecture and the Banach-Ruziewicz Problem.

The main prerequisites for this book are a sound understanding of undergraduate-level mathematics and a knowledge of abstract harmonic analysis and functional analysis. The book is suitable for use in graduate courses, and the lists of problems in each chapter may be useful as student exercises.

BIOGRAPHY

Alan L. T. Paterson obtained his PhD at the University of Edinburgh in 1969. His initial research interests lay in Banach algebra theory, but he later became interested in the phenomenon of amenability in its various forms. In 1984-1985, he was visiting professor at the University of Western Ontario and the University of British Columbia. He will be taking a position at the University of Mississippi, Oxford, MS in August 1988.

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1980 *Mathematics Subject Classifications*: 43, 47, 22, 03
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GEOMETRY OF RANDOM MOTION
Rick Durrett and Mark A. Pinsky, Editors
(Contemporary Mathematics, Volume 73)

In July 1987, an AMS-IMS-SIAM Joint Summer Research Conference on Geometry of Random Motion was held at Cornell University. The initial impetus for the meeting came from the desire to further explore the now-classical connection between diffusion processes and second-order (hypo)elliptic differential operators. To accomplish this goal, the conference brought together leading researchers with varied backgrounds and interests: probabilists who have proved results in geometry, geometers who have used probabilistic methods, and probabilists who have studied diffusion processes.

Focusing on the interplay between probability and differential geometry, this volume examines diffusion processes on various geometric structures, such as Riemannian manifolds, Lie groups, and symmetric spaces. Some of the articles specifically address analysis on manifolds, while others center on (nongeometric) stochastic analysis. The majority of the articles deal simultaneously with probabilistic and geometric techniques.

Requiring a knowledge of the modern theory of diffusion processes, this book will appeal to mathematicians, mathematical physicists, and other researchers interested in Brownian motion, diffusion processes, Laplace-Beltrami operators, and the geometric applications of these concepts. The book provides a detailed view of the leading edge of research in this rapidly moving field.

Contents

1980 *Mathematics Subject Classifications*: 58, 53, 60
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GEOMETRY OF GROUP REPRESENTATIONS
William M. Goldman and Andy R. Magid, Editors
(Contemporary Mathematics, Volume 74)

The representations of a finitely generated group in a topological group G form a topological space which is an analytic variety if G is a Lie group, or an algebraic variety if G is an algebraic group. The study of this area draws from and contributes to a wide range of mathematical subjects: algebra, analysis, topology, differential geometry, representation theory, and even mathematical physics. In some cases, the space of representations is the object of the study, in others it is a tool in a program of investigation, and, in many cases, it is both.

Most of the papers in this volume are based on talks delivered at the AMS-IMS-SIAM Summer Research Conference on the

Geometry of Group Representations, held at the University of Colorado in Boulder in July 1987. The conference was designed to bring together researchers from the diverse areas of mathematics involving spaces of group representations. In keeping with the spirit of the conference, the papers are directed at nonspecialists, but contain technical developments to bring the subject to the current research frontier. Some of the papers include entirely new results. Readers will gain an understanding of the present state of research in the geometry of group representations and their applications.

Contents

1980 *Mathematics Subject Classifications*: 20, 22, 30, 57
ISBN 0-8218-5082-2, LC 88-14490
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328 pages (softcover), July 1988
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THE FINITE CALCULUS ASSOCIATED WITH BESSEL FUNCTIONS

Frank M. Cholewinski

(Contemporary Mathematics, Volume 75)

Although Bessel functions are among the most widely used functions in applied mathematics, this book is essentially the first to present a calculus associated with this class of functions. The author obtains a generalized umbral calculus associated with the Euler operator and its associated Bessel eigenfunctions for each positive value of an index parameter. For one particular value of this parameter, the functions and operators can be associated with the radial parts of n-dimensional Euclidean space objects. Some of the results of this book are in part extensions of the work of Rota and his co-workers on the ordinary umbral calculus and binomial enumeration. The author also introduces a wide variety of new polynomial sequences together with their groups and semigroup compositional properties. Generalized Bernoulli, Euler, and Stirling numbers associated with Bessel functions and the corresponding classes of polynomials are also studied. The book is intended for mathematicians and physicists at the research level in special function theory.

BIOGRAPHY

Frank M. Cholewinski is Professor of Mathematics at Clemson University. He received a bachelor's degree in engineering physics and a master's degree in applied mathematics from Auburn University. He received his PhD in 1964 from Washington University under the supervision of I. I. Hirschman, Jr. Professor Cholewinski came to the University of North Carolina at Chapel Hill in 1964 before moving to Clemson in 1966.

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1980 *Mathematics Subject Classifications*: 33, 05, 12, 35, 39, 44
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ISSN 0271-4132
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THE STRUCTURE OF FINITE ALGEBRAS
David Hobby and Ralph N. McKenzie
(Contemporary Mathematics, Volume 76)

The utility of congruence lattices in revealing the structure of general algebras has been recognized since Garrett Birkhoff's pioneering work in the 1930s and 1940s. However, the results presented in this book are of very recent origin: most of them were developed in 1983. The main discovery presented here is that the lattice of congruences of a finite algebra is deeply connected to the structure of that algebra. The theory reveals a sharp division of locally finite varieties of algebras into six interesting new families, each of which is characterized by the behavior of congruences in the algebras. The authors use the theory to derive many new results that will be of interest not only to universal algebraists, but to other algebraists as well.

The authors begin with a straightforward and complete development of basic tame congruence theory, a topic that offers great promise for a wide variety of investigations. They then move beyond the consideration of individual algebras to a study of locally finite varieties. A list of open problems closes the work.

Contents

1980 *Mathematics Subject Classification*: 08
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212 pages (softcover), August 1988
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NUMBER THEORY AND ITS APPLICATIONS IN CHINA
Wang Yuan, Yang Chung-chun, and Pan Cheng-biao, Editors
(Contemporary Mathematics, Volume 77)

Of all modern mathematical forms, number theory is one of the earliest to be explored in China and is the one to which the Chinese have made their greatest contributions. Yan Wu-zhi first introduced number theory into China in the 1920s. Particularly influential in the field was Hua Loo-keng, who studied with G. H. Hardy and made significant contributions in the areas estimating complete exponential sums, Waring's problems, Tarry's problems, and Vinogradov's method. Interest in number theory continued to flourish following the founding of the People's Republic of China. The most noted accomplishments by Chinese mathematicians were

focused on the solution of Goldbach's Conjecture and on the sieve method. Although the Cultural Revolution interrupted research in number theory for more than 10 years, the field is now growing in China. A number of universities now have advanced programs in the subject and a wide variety of topics, including the applications of number theory.

This volume contains nine survey articles and three articles on current research. The collection emphasizes the accomplishments of Chinese number theorists during 1949-1979, a period when correspondence between China and other countries was discouraged. The collection is intended not only to survey the significant contributions of Chinese mathematicians, but also to reflect the latest developments and current state of research in number theory in China.

Contents

1980 *Mathematics Subject Classification*: 11
ISBN 0-8218-5084-9
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184 pages (softcover), August 1988
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REPRESENTATIONS OF RANK ONE LIE GROUPS II: n-COHOMOLOGY

David H. Collingwood

(Memoirs of the AMS, Number 387)

This paper is the second in a series aimed at a detailed understanding of the representation theory associated with a simple Lie group of real rank one. The author investigates in the regular integral setting the category of Harish-Chandra modules and the category of highest weight representations. One consequence of the main theorm is an algorithm to compute the "Iwasawa" nilpotent cohomology groups of the irreducible and induced representations in these two categories. Qualitatively, the author's results show that these cohomology groups are "as small as possible," a notion made precise through detailed spectral sequence analysis. These results are aimed toward an understanding of higher order extension groups. Although the final results concern rank one Lie groups, the ideas and approach are applicable to any semisimple matrix group. Directed at graduate students and researchers in the representation theory of Lie groups, this book requires a basic first course in Lie group representations and familiarity with the first paper in this series.

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1980 *Mathematics Subject Classifications*: 22; 20
ISBN 0-8218-2450-3, LC 88-10415
ISSN 0065-9266
108 pages (softcover), June 1988
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TOPOLOGICAL INVARIANTS OF QUASI-ORDINARY SINGULARITIES

Joseph Lipman

EMBEDDED TOPOLOGICAL CLASSIFICATION OF QUASI-ORDINARY SINGULARITIES

Yih-Nan Gau

(Memoirs of the AMS, Number 388)

This book contains two related papers of interest to algebraic geometers and geometric topologists interested in singularities. The first paper establishes the existence of a topological invariant of quasi-ordinary singularities on complex analytic hypersurfaces. This result is a main ingredient in the second paper, which presents an embedded topological classification of quasi-ordinary singularities using "characteristic monomials." The classification is a

higher-dimensional generalization of the classical topological treatment of plane curve singularities using characteristic pairs. Requiring a background in basic algebraic topology and commutative algebra, this book will give readers an enhanced appreciation of the interaction between algebra and topology.

Contents of Topological invariants of quasi-ordinary singularities

Contents of Embedded topological classification of quasi-ordinary singularities

1980 *Mathematics Subject Classifications*: 32, 14, 15
ISBN 0-8218-2451-1, LC 88-10559
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136 pages (softcover), June 1988
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TOPOLOGICAL TRIVIALITY AND VERSALITY FOR SUBGROUPS OF $\mathcal{A}$ AND $\mathcal{K}$

James N. Damon

(Memoirs of the AMS, Number 389)

Singularity theory plays an increasingly valuable role in the analysis of problems which can be modeled using nonlinear mappings. Much of the success of this approach results from the application of the infinitesimal methods originally suggested by Thom and developed by Mather. The appearance of moduli in such problems requires the solution of corresponding problems for topological equivalence of mappings.

This book presents two theorems which permit infinitesimal methods to be applied to such topological problems. The topological triviality theorem provides sufficient conditions for a deformation to be topologically constant; and the versality theorem ensures that a family of deformations of a germ of a mapping contains, up to topological equivalence, all possible perturbations of the germ. From these theorems follow versions of the basic theorems of singularity theory but for topological equivalence.

Requiring a familiarity with the basic ideas of singularity theory, this book will provide readers with a number of results which are useful in dealing with topological questions in virtually any area in which singularity theory can be applied.

Contents

1980 *Mathematics Subject Classifications*: 58, 14
ISBN 0-8218-2452-X, LC 88-15554
ISSN 0065-9266
106 pages (softcover), August 1988
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To order, please specify MEMO/389N

IRREDUCIBLE SUBGROUPS OF EXCEPTIONAL ALGEBRAIC GROUPS

Donna M. Testerman

(Memoirs of the AMS, Number 390)

This book is aimed at researchers in group theory and particularly those interested in the structure and representation theory of algebraic groups. The author focuses on certain subgroups of an exceptional algebraic group defined over an algebraically closed field of nonzero characteristic. The main result classifies those semisimple, closed, connected subgroups which act irreducibly on some nontrivial rational

module for the group. An extension of Dynkin's earlier work with groups of characteristic zero, this result is combined with the work of Seitz to provide a classification of the maximal, closed, connected subgroups of the classical algebraic groups in nonzero characteristic. In addition, the author develops techniques that are applicable to general questions in the study of embeddings of groups of Lie type.

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The one component theorem
Rank$(A) \geq 3$
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Special cases

1980 *Mathematics Subject Classification*: 20
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HILBERT'S PROJECTIVE METRIC AND ITERATED NONLINEAR MAPS

Roger D. Nussbaum

(Memoirs of the AMS, Number 391)

This book is concerned with nonlinear maps which take the interior of a cone in a Banach space into itself. The kinds of maps considered here are motivated by examples from mathematical biology, the theory of means and their iterates, and the so-called D-A-D theorems. Using Hilbert's projective metric, the author proves a variety of theorems concerning the asymptotic behavior of the iterates of these maps and the structure of their sets of eigenvectors. The author also provides applications to means and their iterates. To make the paper as self-contained as possible, the author summarizes relevant facts and definitions about cones, cone mappings, Hilbert's projective metric, and Thompson's variant on that metric.

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Uniqueness and global stability for eigenvectors
Iterates of unnormalized maps
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Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

V. I. Arnol'd, Richard Askey, S. G. Gindikin, N. K. Nikol'skii, and Allen Shields have been appointed to a *Subcommittee on Russian Mathematical History* by President G. D. Mostow. Professor Shields will serve as chairman.

Jane P. Gilman, Irwin Kra, William P. Thurston, William A. Veech, and James A. Voytuk have been appointed by President G. D. Mostow to the *Committee on Election Scheduling*. Professor Thurston will serve as chairman.

President G. D. Mostow has appointed Tosio Kato (1992) to the *Committee to Select the Winner of the Steele Prize*. Continuing members of the committee are Frederick J. Almgren, Jr. (1989), Luis A. Caffarelli (1990), William S. Massey (1989), Chairman, Frank A. Raymond (1989), Neil J. A. Sloane (1990), Louis Solomon (1989), Richard P. Stanley (1989), and Michael E. Taylor (1990). Terms expire on June 30.

Haynes R. Miller (1991) and Raghavan Narasimhan (1991) have been appointed by President G. D. Mostow to the *Committee on Summer Institutes and Special Symposia*. Other members of the committee are Steven L. Kleiman (1990), Paul H. Rabinowitz (1989), Thomas Crawford Spencer (1990), and Robert B. Warfield, Jr. (1989). Terms expire on February 28.

Roger E. Howe (AMS, 1992) has been appointed to the AMS-IMS-SIAM *Committee on Joint Summer Research Conferences in the Mathematical Sciences* by President G. D. Mostow. Other members of the committee are William B. Arveson (AMS, 1989), Daniel J. Kleitman (AMS, 1989), Mary Ellen Rudin (AMS, 1989), Lesley M. Sibner (AMS, 1990), and Stephen G. Simpson (AMS, 1990). Terms expire on June 30.

The name of the AMS-MAA-AAAS *Committee on Opportunities in Mathematics for Disadvantaged Groups* has been changed to the AMS-MAA-AAAS *Committee on Opportunities in Mathematics for Underrepresented Groups.*

The Society for Mathematical Biology has joined with the AMS and SIAM on the joint AMS-SIAM-SMB *Committee on Mathematics in the Life Sciences.* Members of the committee are Jack D. Cowan (1991), Michael C. Mackey (1989), Hans G. Othmer (1988), Richard E. Plant (1988), Chairman, and John M. Rinzel (1989).

Report of Past Meetings

The April Meeting in College Park

The Council

The Council met on 23 April 1988 at 7:00 PM in the Prince George Room of the Quality Inn in College Park, Maryland. President G. D. Mostow was in the chair.

The Council increased the size of the Editorial Committee of *Mathematical Reviews* from three to four. The additional position is to be filled in the next election.

The Council approved the change in name of the joint AMS-MAA-AAAS *Committee on Opportunities for Disadvantaged Groups* to *Committee on Opportunities in Mathematics for Underrepresented Minorities.*

The Council approved a proposal that the Society for Mathematical Biology (SMB) join with the Society and SIAM in the *Committee on Mathematics in the Life Sciences.* The SMB is the organization through which the AMS and SIAM arrange symposia at meetings of quantitative biologists.

The Council approved Society participation with the Mathematical Association of America in the possible launching of a newsletter on Collegiate Mathematics Education.

The Council recommended an amendment to the bylaws whereby institutional dues will be based on a broader definition of scholarly activity. See the program of the Centennial Meeting in August for the text.

The Council nominated some of the candidates for the election by the membership in the fall of 1988. They are as follows:

Vice President
(two for one position)
Sun-Yung Alice Chang

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William Yslas Velez
Robert J. Zimmer

Editorial Committees

American Journal
(two positions)
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Bulletin
Murray H. Protter

Colloquium Publications
Charles L. Fefferman

Mathematical Reviews
(two positions)
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Mathematical Surveys
David S. Kinderlehrer

Mathematics of Computation
Andrew M. Odlyzko

Proceedings
(six positions)
William W. Adams
J. Marshall Ash
Maurice Auslander
Andreas R. Blass
Clifford J. Earle

Transactions & Memoirs
Eugene F. Fabes

Committee to Monitor Problems in Communication
(two positions)
Arthur M. Jaffe

The Council agreed that the "negative checkoff" on the dues bill for the Centennial Fellowship in the amount of $10.00 should continue. The terms in which the fellowship will be offered are to be changed slightly by authorizing the selection committee to give preference to applicants who have not had extensive postdoctoral research support. The terms and conditions of the fellowship are to be studied by an ad hoc committee.

The Council empowered the President to increase Society representation in AAAS in such manner as is deemed suitable.

The Council empowered the President to appoint a committee to generate and review ideas for cosponsoring sessions involving applications of mathematics with other organizations.

The Council agreed to change the terms of the members of the Nominating Committee from two to three years, with problems of transition yet to be solved. It referred these problems to an ad hoc committee and further charged the committee to study a variety of problems about contested elections and lengths of terms for various offices.

The Council was made aware of a pending recommendation that the level of professional income separating the members paying lower dues from those paying higher dues be raised from $30,000 to $38,000. The Council had authorized the Executive Committee to act for it in this matter. The level was subsequently raised by the Executive Committee with the approval of the Board of Trustees.

Everett Pitcher
Secretary
Bethlehem, Pennsylvania

1988 Symposium on Some Mathematical Questions in Biology

The Dynamics of Excitable Media

The twenty-second annual Symposium on Some Mathematical Questions in Biology was held on Wednesday, May 4, in Room L2 of the Las Vegas Convention Center, during the annual meeting of the Federation of American Societies for Experimental Biology, May 1 – 6, 1988. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics, and the Society for Mathematical Biology. The AMS-SIAM Committee on Mathematics in the Life Sciences served as the Organizing Committee for the symposium. The committee consisted of Gail A. Carpenter (Northeastern University); Kenneth L. Lange (Massachusetts Institute of Technology); Hans G. Othmer (University of Utah); Alan S. Perelson (Los Alamos National Laboratory); Richard E. Plant, Chairman (University of California, Davis); and John Rinzel (National Institutes of Health). Professor Othmer was the organizer of the symposium.

The theme of the symposium was The Dynamics of Excitable Media. There were two half-day sessions, each including three one-hour lectures. Forty-two people registered for the symposium. Support was provided by a grant from the National Science Foundation.

Miscellaneous

Personal Items

George Berzsenyi, Professor of Mathematics at Lamar University, has accepted the chairmanship of the Mathematics Department at Rose-Hulman Institute of Technology in Terre Haute, Indiana, beginning August 15, 1988.

Gustave Choquet, of the University of Paris IV, was elected an Honorary Member of the London Mathematical Society, in recognition of his contributions to analysis, potential theory, functional analysis, measure theory, and infinite-dimensional convexity theory.

James Paul Fulton, of Hampton University, has received a 1988 NASA/ASEF Summer Faculty Fellowship Award.

Judy Green, Associate Professor of Mathematics at Rutgers University, has been elected First Vice-President of the American Association of University Professors for 1988-1990.

Sung J. Lee has returned to the University of Florida after a one-year leave at the University of Delaware.

Paul Nevai has returned to Ohio State University from the University of South Carolina.

Walter M. Patterson III, of Lander College, South Carolina, has been promoted to Professor at that institution, effective August 1988.

Philip Saffman, Professor of Applied Mathematics and Executive Officer for Applied Mathematics at the California Institute of Technology, has been elected a Fellow of the Royal Society of London.

Teo Sturm has been promoted to full Professor of Mathematics at the University of Natal, Durban, South Africa.

Michael J. Tierney, of the Virginia Military Institute, has been promoted to Professor of Mathematics and Computer Science at that institution.

Deaths

Sholom Arzt, of Cooper Union, New York, died on January 2, 1988, at the age of 58. He was a member of the Society for 37 years.

Norman H. Blaufox, of Montrose, New York, died on March 12, 1988, at the age of 62. He was a member of the Society for 7 years.

Richard C. Courter, of Constantine, Michigan, died on June 15, 1987, at the age of 70. He was a member of the Society for 30 years.

Henry A. Dye, of the University of California, Los Angeles, died on November 26, 1986, at the age of 60. He was a member of the Society for 37 years.

Ben Goldbeck, Professor Emeritus of Texas Christian University, died on October 1, 1987, at the age of 71. He was a member of the Society for 35 years.

George G. Harvey, Professor Emeritus of the Massachusetts Institute of Technology, died on April 9, 1988, at the age of 80. He was a member of the Society for 53 years.

I. N. Kagno, of Bronx, New York, died on April 4, 1988, at the age of 80. He was a member of the Society for 56 years.

Julia P. Kennedy, of Georgia State University, died on April 16, 1988, at the age of 49. She was a member of the Society for 14 years.

Horst Leipholz, Professor Emeritus of the University of Waterloo, died on March 22, 1988, at the age of 68. He was a member of the Society for 7 years.

Emmanuel O. Okoronkwo, of Loyola University, died on April 9, 1988, at the age of 41. He was a member of the Society for 3 years.

Owen G. Owens, Professor Emeritus of Wayne State University, died on December 21, 1986, at the age of 71. He was a member of the Society for 43 years.

Myra Reed, of St. Bonaventure University, died on October 20, 1987, at the age of 51. He was a member of the Society for 22 years.

Hugo B. Ribeiro, of Pennsylvania State University, died on February 26, 1988, at the age 77. He was a member of the Society for 40 years.

Morris Schreiber, of Rockefeller University, died on April 30, 1988, at the age of 61. He was a member of the Society for 35 years.

Gordon L. Tindle, of London, England, died on March 24, 1988, at the age of 46. He was a member of the Society for 6 years.

William Wooton, of Lake San Marcos, California, died on January 5, 1988, at the age of 68. He was a member of the Society for 29 years.

Visiting Mathematicians

(Supplementary List)

This list of visiting mathematicians includes only foreign mathematicians visiting in the United States and Canada.

Visiting Foreign Mathematicians

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Al-Amrani, Abdellah (Morocco)	Queen's University	Algebra	3/89 - 4/89
Brümmer, G. L. C. (South Africa)	University of Toledo	Topology, Category Theory	9/88 - 12/88
Byczkowski, Tom (Poland)	Case Western Reserve University	Probability	8/88 - 12/88
Emery, Michel (France)	University of British Columbia	Stochastic Differential Equations	7/88 - 6/89
Frigon, Marlene (Italy)	University of British Columbia	Differential Equations	9/88 - 8/89
Giordano, Thierry (Switzerland)	Queen's University	Operator Algebras	9/88 - 3/89
Györfi, Zoltán (Hungary)	University of Toledo	Information Theory	9/88 - 9/89
Hermann, Manfred (West Germany)	Queen's University	Commutative Algebra	9/88 - 10/88
Jin, Gyo T. (Korea)	University of British Columbia	Knot Theory	7/88 - 12/88
Kashiwara, Masaki (Japan)	Johns Hopkins University	Algebraic Analysis	9/88 - 12/88
Katsura, Toshiyuki (Japan)	Queen's University	Arithmetical Algebraic Geometry	8/88
Krajicek, Jan (Czechoslovakia)	University of Illinois at Urbana-Champaign	Mathematical Logic	8/88 - 5/89
Kwapien, Stan (Poland)	Case Western Reserve University	Probability, Functional Analysis	6/88 - 9/88
Lin, Shao-Shiung (Taiwan)	University of Minnesota	Combustion, Mathematical Physics, Differential Equations	6/88 - 9/89
Matsuki, Toshihiko (Japan)	Johns Hopkins University	Algebraic Analysis	9/88 - 5/89
Olagunju, David (Nigeria)	Argonne National Laboratory	Bifiguration Phenomena in Combustion	9/88 - 8/89
Oshima, Toshio (Japan)	Johns Hopkins University	Algebraic Analysis	2/89 - 4/89
Peletier, L. A. (Netherlands)	Argonne National Laboratory	Non-Linear Differential Equations	7/88 - 8/88
Power, John (Australia)	Case Western Reserve University	Category Theory	8/88 - 6/89
Rao, S. E. (India)	University of Saskatchewan	Lie Theory	9/88 - 8/89
Sekiguchi, Jiro (Japan)	Johns Hopkins University	Algebraic Analysis	9/88 - 5/89
Shimizu, Yuji (Japan)	Johns Hopkins University	Algebraic Analysis	9/88 - 5/89
Sieverking, Malte (West Germany) (J. W. G. University Hamburg)	University of British Columbia	Differential Equations	9/88 - 1/89
Suwa, Noriyuki (Japan)	Queen's University	Arithmetic Algebraic Geometry	7/88 - 8/88
Szymanski, Jerzy (Poland)	Case Western Reserve University	Random Graphs	8/88 - 12/88
Tutek, Z. (Yugoslavia)	University of Saskatchewan	Hyperbolic Systems	3/88 - 8/89
Ueno, Kenji (Japan)	Queen's University	Algebraic Geometry, Superstring Theory	8/88
Womersley, Robert (Australia)	Argonne National Laboratory	Numerical Optimization	9/88 - 11/88 1/89 - 2/89
Wu, Jianhong (People's Republic of China)	Memphis State University	Functional Differential Equations	8/88 - 12/88

Name and Home Country	Host Institution	Field of Special Interest	Period of Visit
Xiao, Changcheng (China)	University of British Columbia	Finite Group Theory	10/88 - 9/89
Ycart, Bernard (France)	Case Western Reserve University	Probability	6/88 - 8/88
Yokonuma, T. (Japan)	University of Saskatchewan	Lie Theory	9/88 - 8/89

Reciprocity Agreements

The American Mathematical Society has "reciprocity agreements" with a number of mathematical organizations around the world. A current list appears below.

These Reciprocity Agreements provide for reduced dues for members of these organizations who choose to join the AMS and who reside outside of the U.S. and Canada. Reciprocally, members of the AMS who reside in the U.S. or Canada may join these organizations at a reduced rate. Summaries of the privileges available to AMS members who join under the terms of reciprocity agreements are given on the following pages. Members of these organizations who join the AMS as reciprocity members enjoy all the privileges available to ordinary members of the Society. AMS dues for reciprocity members are $44 for 1988 and $44 for 1989. Each organization was asked to review and update its listing in the Spring. An asterisk (*) after the name of an organization indicates that no response to this request had been received when the August *Notices* went to press. A disc (•) before the name of an organization indicates that application forms for that organization may be obtained by writing the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

Africa

•Nigerian Mathematical Society*

Apply to: Christopher O. Imoru (Secretary), Nigerian Mathematical Society, Department of Mathematics, University of Ife, Ile-Ife, Nigeria.

Dues: $10; payable to the Treasurer, Nigerian Mathematical Society, Department of Mathematics, University of Benin, Benin City, Nigeria.

Privileges: *Journal of the Nigerian Mathematical Society* at the price normally charged to individual members.

Officers: A. Olubummo (President), J. O. C. Ezeilo (Vice-President), C. O. Nwachuku (Treasurer), C. O. M. Imoru (Secretary), S. A. Ilori (Assistant Secretary), H. O. Tejumola (Editor-in-Chief).

Asia

•Allahabad Mathematical Society*

Apply to: P. Srivastava, Secretary, Allahabad Mathematical Society, 10, C.S.P. Singh Marg, Allahabad-211001, India.

Dues: US $25 (annual), US $250 (life), US $125 (life for members of American Mathematical Society); payable to Allahabad Mathematical Society.

Privileges: The Journal of the Society is sent to members regularly.

Officers: U. N. Singh (President), Vachaspati (Vice-President), K. K. Azad (Treasurer), P. Srivastava (Secretary).

Calcutta Mathematical Society*

Apply to: U. Basu, Secretary, Calcutta Mathematical Society, 92, Acharya Prafulla Chandra Road, Calcutta 700 009, India.

Dues: $2; payable to U. Basu, Secretary.

Privileges: *News Bulletin* (free of cost).

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Indian Mathematical Society

Apply to: S. P. Arya, General Secretary, Indian Mathematical Society, Department of Mathematics, Maitreyi College, Bapu Dham Complex, Chanakyapuri, New Delhi 110 021, India.

Dues: $20; payable to V. M. Shah, Hon. Treasurer, IMS, Department of Mathematics, M. S. University, Baroda, India.

Privileges: *Journal of the Indian Mathematical Society* or *Mathematics Student.*

Officers: M. K. Singal (President), V. Singh (Immediate Past President), V. M. Shah (Treasurer), S. P. Arya (General Secretary), J. N. Kapur (Academic Secretary), I. B. S. Passi (Editor of *Journal of Indian Mathematical Society*), A. M. Vaidya (Editor of *Mathematics Student*).

Korean Mathematical Society

Apply to: Kun Soo Chang, 538 Dowha Dong, Mapo Ku, Sung Ji Building, Room 706, Seoul 121, Korea.

Dues: $15; payable to the Korean Mathematical Society.

Privileges: Free receipt of *Bulletin* (two issues per year) and *Journal of the Korean Mathematical Society* (two issues per year).

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•Malaysian Mathematical Society*

Apply to: The Secretary, Malaysian Mathematical Society, c/o Department of Mathematics, University of Malaya, Kuala Lumpur, Malaysia.

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•Mathematical Society of Japan

Apply to: Setsuko Izawa, Secretary, Mathematical Society of Japan, 25-9-203, Hongo 4-chome, Bunkyo-ku, Tokyo 113, Japan.

Dues: US $40; payable to Mathematical Society of Japan.

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Southeast Asian Mathematical Society*

Apply to: Boon-Yian Ng, Southeast Asian Mathematical Society, c/o Department of Mathematics, University of Malaya, Kuala Lumpur, Malaysia.

Dues: US $5; payable to Boon-Yiang Ng, Southeast Asian Mathematical Society.

Privileges: *SEAMS Newsletter, Southeast Asian Bulletin of Mathematics.*

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Apply to: H. M. Srivastava, Foreign Secretary, VPI, Department of Mathematics, University of Victoria, Victoria, British Columbia, Canada, V8W 2Y2 or R. C. Singh Chandel, Secretary, VPI, Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Dues: US $7.50 (annual), US $75 (life); payable to Vijnana Parishad, c/o Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Privileges: *Jñānābha* (an interdisciplinary mathematical journal currently published once a year); back volumes available at 25% discount.

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Europe

Asociación Matemática Española*

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Dues: DM 12; payable to G. Preuss, Institut für Mathematik I, FU Berlin, Arnimallee 3, D-1000 Berlin 33, Federal Republic of Germany.

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Apply to: Deutsche Mathematiker-Vereinigung e.V., Albertstraße 24, 7800 Freiburg, Federal Republic of Germany.

Dues: DM 30.- (for reciprocity members); payable to Kreissparkasse Tübingen 16269 (BLZ 641 500 20), Federal Republic of Germany or Postscheckamt Stuttgart 18517-706 (BLZ 600 100 70), Federal Republic of Germany.

Privileges: *Mitteilungen der Deutschen Mathematiker-Vereinigung* (four issues a year), *Jahresbericht der Deutschen Mathematiker-Vereinigung* (four issues a year).

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•Edinburgh Mathematical Society

Apply to: The Honorary Secretary, Edinburgh Mathematical Society, James Clerk Maxwell Building, King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, Scotland.

Dues: $6 (preferably £3 sterling); payable to the Honorary Treasurer.

Privileges: *Proceedings* at reduced rate of $12 (preferably £6 sterling) per annum.

Officers: R.M.F.Moss (President), B. D. Sleeman (Vice-President), A. C. McBride (Treasurer), J. Martin, C. J. Shaddock (Secretaries).

•Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)

Address for mail: Reinhard Mennicken, University of Regensburg, D-8400 Regensburg, Federal Republic of Germany.

Apply to: R. Ansorge, Institut für Angewandte Mathematik, Universität, Hamburg, Bundesstr. 55, D-200 Hamburg 13, Federal Republic of Germany.

Dues: 25.-DM; payable to J. Siekmann, FB 12 - Maschinentechnik, Universität - GHS Essen, Schützenbahn 70, D-4300 Essen, Federal Republic of Germany.

Privileges: Regular publications of GAMM and participation in scientific meetings at a reduced rate.

Officers: W. Walter (President), J. Zierep (Vice-President), J. Siekmann (Treasurer), R. Mennicken (Secretary).

Glasgow Mathematical Association

Apply to: R. J. Steiner, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, University Gardens, Glasgow G12 8QW, Scotland.

Dues: £22; payable to Glasgow Mathematical Association.

Privileges: *Glasgow Mathematical Journal.*

Officers: K. A. Lindsay (President), R. J. Cole, R. Bailey (Vice-Presidents), R. J. Steiner (Treasurer), P. A. Boyle (Secretary).

•Irish Mathematical Society

Address for mail: A. G. O'Farrell, Secretary, Maynooth College, County Kildare, Ireland.

Apply to: G. M. Enright, IMS Treasurer, Department of Mathematics, Mary Immaculate College, Limerick, Ireland.

Dues: US $4 (1989), $6 (1990); payable to G. M. Enright.

Privileges: Right to receive the *Bulletin of the Irish Mathematical Society*; right to subscribe to the *Proceedings of the Royal Irish Academy* (Section A) at a reduced rate.

Officers: S. Dineen (President), F. Gaines (Vice-President), G. M. Enright (Treasurer), A. G. O'Farrell (Secretary).

Íslenzka Stærdfrædafélagid*

Apply to: President, Raunvísindastofnun Háskólans, Dunhaga 3, 107 Reykjavik, Iceland.

Dues: $10; payable to Íslenzka Stærdfrædafélagid.

Privileges: Newsletter (yearly).

Officers: Halldór I. Eliasson (President), Kristian Jónasson (Treasurer), Ragnar Sigurdsson (Secretary).

London Mathematical Society

Apply to: The Administrator, London Mathematical Society, Burlington House, Piccadilly, London W1V 0NL, United Kingdom.

Dues: £5; payable to London Mathematical Society. (New members should not send payment until elected.)

Privileges: *LMS Newsletter.* Reduced rates for the *Bulletin, Journal,* and *Proceedings of the LMS*; *Nonlinearity*; *Journal of Applied Probability*; *Mathematika*; *Mathematical Proceedings of the Cambridge Philosophical Society*; *Quarterly Journal of Mathematics*; LMS Lecture Notes; LMS Student Texts; LMS Monographs. (Please write to the LMS for complete details.)

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Apply to: Gerd Salter, Norsk Matematisk Forening, Matematisk Institutt, Postboks 1053 Blindern, N-0316 Oslo 3, Norway.

Dues: N.kr. 20 or N.kr. 200 for permanent membership; payable to Gerd Salter, Norsk Matematisk Forening.

Privileges: Reduced subscription rate on *Mathematica Scandinavica* and *NORMAT* (*Nordisk Matematisk Tidskrift*), free monthly information bulletin "infomat" about the activites of the Society.

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Apply to: Werner Kuich, President, Österreichische Mathematische Gesellschaft, Technische Universität Wien, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria.

Dues: öS 150; payable to Inge Troch, Treasurer.

Privileges: *Internationale Mathematische Nachrichten* (IMN).

Officers: Werner Kuich (President), Ludwig Reich (Vice-President), Inge Troch (Treasurer), Hans Reichel (Secretary).

Polskie Towarzystwo Matematyczne*

Apply to: Polskie Towarzystwo Matematyczne, Śniadeckich 8, 00-950 Warszawa, Poland.

Dues: $8; payable to Polskie Towarzystwo Matematyczne.

Privileges: Participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions; in addition, members receive one of the following five series of the publication *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, *Dydaktyka Matematyki* (Didactics of Mathematics) in Polish.

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Real Sociedad Matemática Española

Apply to: J. Llovet, Secretario General de la Real Sociedad Matemática Española, Serrano 123, Madrid 28006, Spain.

Dues: $30; payable to Secretario, R. S. M. E.

Privileges: *Boletin Real Sociedad Matemática Española* and *Revista Matemática Ibero Americana.*

Officers: P. L. Garcia Perez (President), Juan Llovet Verdugo (Secretary).

•Sociedade Portuguesa de Matemática

Apply to: J. E. Valença, Sociedade Portuguesa de Matemática, Av. da República 37 4°, 1000 Lisboa, Portugal.

Dues: 600 Portuguesa Escudos; payable to Sociedade Portuguesa de Matemática.

Privileges: *Boletim da Sociedade Portuguesa de Matemática*, free; discount of 70% in the subscription fees for *Portugaliae Matemática.*

Officers: A. Ribeiro Gomes (President), J. E. Valença, J. C. Silva, J. F. Queiró (Vice-Presidents), A. M. Cadete (Treasurer).

Societat Catalana de Matemàtiques

Apply to: Secretari de la Societat Catalana de Matemàtiques, Carrer del Carme 47, 08001 Barcelona, Spain.

Dues: 1000 pessetes for members of the AMS, payable to the Societat Catalana de Matemàtiques.

Privileges: *Butlettí de la Societat Catalana de Matemàtiques*, (2 numbers a year).

Officers: J. Girbau (President), Carles Perelló (Secretary), Rubi Corberó (Associated Secretary).

Société Mathématique de Belgique*

Apply to: Guy Hirsch, Secretary, Société Mathématique de Belgique, 317, Avenue Charles Woeste, 1090 Brussels, Belgium.

Dues: $16; payable to Société Mathématique de Belgique, preferably by International Money Order, VISA, MasterCard, or American Express.

Privileges: *Bulletin de la Société Mathématique de Belgique, Series A* (two numbers per year) and *Series B* (two numbers per year), about 450 pages a year.

Officers: P. Van Praag (President), F. Van Oystæyen (Vice-President), G. Hirsch (Secretary-Treasurer).

Société Mathématique de France

Address for mail: Société Mathématique de France, B.P. 126-05, F 75226 Paris, Cedex 05, France.

Apply to: Madame Janine Le Peintre, S.M.F., B.P. 126-05, F 75226 Paris, Cedex 05, France.

Dues: $40 or $58; payable to American Mathematical Society or S.M.F.

Privileges: Individuals who pay dues of $40 are entitled to receive *Officiel* and *Gazette.* Individuals who pay dues of $58 are entitled to *Officiel, Gazette,* and *Bulletin. Astérisque* may be purchased at a discount price. (Members in the U. S., Canada, or Mexico should order their copies from the AMS. See the AMS *Catalogue of Publications.*)

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•Société Mathématique Suisse

Apply to: H. Holmann, Secretary SMS, Institut de Mathématiques, Université de Fribourg, CH-1700 Fribourg, Pérolles, Switzerland.

Dues: SFr. 15.- for members of the AMS residing outside Switzerland; payable to H. Holmann.

Privileges: *Commentarii Mathematici Helvetici* (reduced price); information concerning activities of SMS.

Officers: N. A'Campo (President); U. Stammbach (Vice-President); H. Holmann (Treasurer-Secretary).

Société de Mathématiques Appliquées et Industrielles

Apply to: Société de Mathématiques Appliquées et Industrielles, Centre de Mathématiques Appliquées, École Polytechnique, 91128 Palaiseau, France.

Dues: US $25; Société de Mathématiques Appliquées et Industrielles.

Privileges: Free subscription to the *News Bulletin,* reduced rates at conferences organized by SMAI.

Officers: J. C. Nedelec (President), P. Lascaux, J. Periaux (Vice-Presidents), M. Lenoir (Treasurer), G. Meurant (Secretary).

•Suomen Matemaattinen Yhdistys

Apply to: Ilkka Holopainen, Secretary, Department of Mathematics, University of Helsinki, Hallituskatu 15, SF-00100 Helsinki, Finland.

Dues: 60 FIM; payable to Aatos Lahtinen, Treasurer, Department of Mathematics, University of Helsinki, Hallituskatu 15, SF-00100 Helsinki, Finland.

Privileges: *Arkhimedes.*

Officers: Seppo Rickman (President), Olli Martio (Vice-President), Aatos Lahtinen (Treasurer), Ilkka Holopainen (Secretary).

Svenska Matematikersamfundet

Apply to: Svenska Matematikersamfundet, Matematiska Institutionen, Umeå Universitet, S-901 87 Umeå, Sweden.

Dues: 75 Skr. or 100 Skr. for permanent membership; payable to Svenska Matematikersamfundet, Ingegerd Palmér, Såningsvägen 54, S-175 45 Järfälla, Sweden.

Privileges: *Mathematica Scandinavica* and *Nordisk Matematisk Tidskrift* at reduced rate. Information about the meetings of the Society.

Officers: Urban Cegrell (President), Gert Almkvist (Vice-President), Ingegerd Palmér (Treasurer), Tord Sjödin (Secretary).

•Unione Matematica Italiana

Apply to: Segreteria della Unione Matematica Italiana, Dipartimento di Matematica, Piazza Porta S. Donato, 5, 40127 Bologna, Italy.

Dues: 40,000 lire; payable to Unione Matematica Italiana.

Privileges: Free *Notiziario dell'UMI* (monthly), *Bollettino dell'UMI, ser. A* (3 issues a year), and membership list. Reduced fees for subscriptions to *Bollettino dell'UMI, Ser. B.* and discounts for other UMI publications.

Officers: Alessandro Figà-Talamanca (President), Benedetto Scimemi (Vice-President), Enrico Obrecht (Treasurer), Giuseppe Anichini (Secretary).

Wiskundig Genootschap

Address for mail: Wiskundig Genootschap, Delft University of Technology, Department of Mathematics and Informatics, P.O. Box 356, 2600 AJ Delft, The Netherlands.

Apply to: Membership Department, Wiskundig Genootschap, University of Utrecht, Postbus 80010, 3508 TA Utrecht, The Netherlands.

Dues: Hfl 40.-; payable to Amro Bank, Utrecht, The Netherlands, Account 45.65.88.167, Penningmeester Wiskundig Genootschap.

Privileges: *Nieuw Archief Voor Wiskunde* (three issues a year containing articles and a problem section), *Medelingen* (nine issues a year containing announcements and book reviews), *Proceedings of the Royal Academy of Sciences* – "Indagationes Mathematicae" (can be obtained at a reduced subscription rate of Hfl 120.-).

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Latin America

•Sociedad Colombiana de Matemáticas

Apply to: Sociedad Colombiana de Matemáticas, Apartado Aéreo 2521, Bogotá, D.E., Colombia.

Dues: $16; payable to Sociedad Colombiana de Matemáticas.

Privileges: Either *Revista Colombiana de Matemáticas* (four issues a year) or *Lecturas Matemáticas* (three issues a year).

Officers: Myriam Muñoz de Özak (President), Jairo Charris (Vice-President), Luis Giraldo (Treasurer), Myriam Leonor Campos (Secretary).

Sociedad de Matemática de Chile

Apply to: Secretario, Sociedad de Matemática de Chile, Casilla 110-V, Válparaíso, Chile.

Dues: US $10; payable to Sociedad de Matemática de Chile.

Privileges: Receive: *Gaceta de la Sociedad* (three issues per year), *Circular de Informaciones* (ten issues per year); *Notas de la Sociedad de Matemática de Chile.*

Officers: Rubí Rodríguez (President), Rolando Rebolledo (Vice-President), Jaime Figueroa (Treasurer), Victor González (Secretary).

Sociedad Matemática de la Republica Dominicana

Apply to: Eduardo Luna, Sociedad Matemática de la Republica Dominicana, Apartado 797-2, Santo Domingo, Dominican Republic.

Dues: US $6; payable to Isidro Rodríguez, Sociedad Matemática de la Republica Dominicana.

Privileges: Right to receive *Notimat* (bimonthly newsletter) and *Revista Matemática Dominicana* (twice a year).

Officers: Eduardo Luna (President), Pedro Suárez (Vice-President), Isidro Rodríguez (Treasurer), David Castillo (Secretary).

•Sociedad Matemática Mexicana*

Apply to: Sra. Hilda C. de Villa, Apartado Postal 70-450, Mexico 20, D.F. Mexico 04510.

Dues: US $10; payable to Sociedad Matemática Mexicana.

Privileges: To be a regular member paying half of the regular fee for persons living outside of Mexico.

Officers: Alejandro Lopez-Yanez (President), Diego B. Hernandez (Vice-President), Juan Morales (Treasurer), Luis Rivera-Gutierrez (Secretary).

•Sociedade Brasileira de Matemática

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Dues: US $6; payable to Sociedade Brasileira de Matemática.

Privileges: 50% reduced membership rate; *Boletim da SBM*; and up to a 25% discount of Society publications.

Officers: César Camacho (President), Paulo Roberto G. Sad (Vice President), Carlos F. B. Palmeira (Treasurer), Mario Jorge D. Carneiro (Secretary).

Sociedade Brasileira de Matemática Aplicada e Computacional

Apply to: Comissão de Admissão da SBMAC, Rua Lauro Müller, 455, 22.290, Botafogo, Rio de Janeiro, RJ, Brasil.

Dues: $16; payable to Sociedade Brasileira de Matemática Aplicada e Computacional.

Privileges: Vote in election for officers of the Society, present papers at meetings of the SBMAC, receive the *Boletim* and *Matemática Aplicada e Computacional*, and reduced registration fees at SBMAC Congress.

Officers: Carlos A. de Moura (President), Leon R. Sinay (Vice-President), Joaquim Pereira Neto (Treasurer), Hilton V. Machado (Secretary).

•Sociedade Paranaense de Matemática

Apply to: C. Pereira da Silva, Sociedade Paranaense de Matemática, Caixa Postal 1261, 80001, Curitiba-PR, Brasil.

Dues: US $12; payable to Sociedade Paranaense de Matemática.

Privileges: *Boletim da Sociedade Paranaense de Matemática* (two issues per year), *Monografias da Sociedade Paranaense de Matemática* (one issue per year).

Officers: C. Pereira da Silva (President), R. Petronzelli (Vice-President), E. Andretta (Treasurer), M. G. Borges (Secretary).

Unión Matemática Argentina

Apply to: Secretary of the Unión Matemática Argentina, Casilla de Correo 3588, 1000-Correo Central, Buenos Aires, Argentina.

Dues: US $6; payable to Unión Matemática Argentina.

Privileges: *Revista de la Unión Matemática Argentina* (two issues per year).

Officers: Roberto L. Cignoli (President), Juan A. Tirao, Roberto A. Macías (Vice-Presidents), Graciela Ana Canziani (Treasurer), Susana Elena Trione (Secretary).

Middle East

•Iranian Mathematical Society

Apply to: Secretary, Iranian Mathematical Society, P. O. Box 13145-418, Tehran, Iran.

Dues: $10; payable to Iranian Mathematical Society, M. Radjabalipour.

Privileges: *Bulletin of the Iranian Mathematical Society* and reduced rate for participation in the annual Iranian Mathematics conferences.

Officers: M. Toomanian (President-Secretary), M. Radjabalipour (Treasurer).

Israel Mathematical Union

Apply to: Israel Mathematical Union, c/o Abraham Berman, Secretary, Department of Mathematics, Technion-Israel Institute of Technology, Haifa 32000, Israel.

Dues: $10; payable to Israel Mathematical Union.

Privileges: *Newsletter*; may attend and present papers at meetings.

Officers: Zvi Ziegler (President), Moshe Goldberg (Treasurer), Abraham Berman (Secretary).

South Pacific

Australian Mathematical Society

Address for mail: W. R. Bloom, Murdoch University, Murdoch, WA 6150 Australia.

Apply to: B. D. Jones, Department of Mathematics, University of Queensland, St. Lucia, Queensland 4067, Australia.

Dues: $A25; payable to B. D. Jones.

Privileges: Free copies of *The Gazette* and copies of *Journal Series A and B, The Bulletin* and the *Lecture Series* at members' rates.

Officers: N. S. Trudinger (President), R. S. Anderssen, G. I. Gaudry, J. R. Blake (Vice-Presidents), B. D. Jones (Treasurer), W. R. Bloom (Secretary).

Mathematical Society of the Philippines*

Apply to: Membership Committee, Mathematical Society of the Philippines, Department of Mathematics, Ateneo de Manila University, P.O. Box 154, Masophman, Philippines.

Dues: $5; payable to Mathematical Society of the Philippines.

Privileges: Publications and newsletter of the Mathematical Society of the Philippines.

Officers: Jose Marasigan (President), Rene P. Felix (Vice-President), Leticia Castillo (Treasurer), Norman Quimpo (Secretary).

•New Zealand Mathematical Society

Address for mail: Department of Mathematics, University of Canterbury, Christchurch, New Zealand.

Apply to: J. A. Shanks, Treasurer, Department of Mathematics, University of Otago, Dunedin, New Zealand.

Dues: $NZ 13.50; payable to J. A. Shanks, Treasurer, Department of Mathematics, University of Otago, Dunedin, New Zealand.

Privileges: *Newsletter of the NZMS* (3 per year); subscription to *Mathematical Chronicle* at reduced rate.

Officers: B. A. Woods (President), I. L. Reilly (Vice-President), J. A. Shanks (Treasurer), D. R. Breach (Secretary).

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Employment at _____
(Name of Institution) (City) (Country)

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Please return this form to: Advertising Department
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No listing for a position will be printed if it expresses or implies any preference, limitation, specification, or discrimination based on age, color, race, religion, sex, or national origin in contravention of any federal or state statute prohibiting discrimination in employment on the basis of these criteria. The publisher reserves the right to edit any listing prior to publication which does not conform with federal or state law on discrimination in employment.

All employers in the United States are required to abide by the requirements of Title VII of the Civil Rights Act of 1964, announcing a national policy of equal employment opportunity in private employment, without discrimination because of color, race, religion, sex, or national origin. All U.S. listings are accepted with the understanding that the employer complies with federal requirements. Advertisers not subject to U.S. laws may be required to sign a statement that they do not discriminate in employment on grounds of age, color, race, religion, sex, or national origin. *Applicants should be aware that institutions outside the U.S. may not be legally bound to conform to these or similar requirements and the AMS cannot assume responsibility for enforcing compliance. Applicants are advised to inform themselves of conditions that may exist at the institutions to which they apply.*

In particular, readers should note that the Equal Employment Opportunity Act (42 U.S.C., §§2000e et seq.), which prohibits discrimination in employment on the basis of race, religion, sex, or national origin, contains (in §2000e-1) an exception from the provisions of the Act for any religious corporation, association, educational institution, or society with respect to employment of individuals of a particular religion to perform work connected with the carrying on by such corporation, association, educational institution, or society of its activities.

The Age Discrimination Act of 1967 (29 U.S.C., §§621 et seq., as amended), makes it unlawful for an employer to discriminate against any individual between the ages of 40 and 70 because of age. Thus it is legal to seek as an employee someone who is "over 30," but not one "over 50"; neither is it legal to express a preference for someone who is "young," or is a "recent graduate," since the latter tend (on statistical grounds) to be young.

Classified Advertisements

SUGGESTED USES for classified advertising are books or lecture notes for sale, books being sought, positions available, exchange or rental of houses, and typing services.

THE 1988 RATE IS $.85 per word with a minimum of $42.50. The same ad in 6 consecutive issues is $4.00 per word. The same ad in 10 consecutive issues is $7.00 per word. Type will be set solid unless centering and spacing are requested. A centered line of any length or the equivalent in white space is $10.00 (one-time charge). A word is defined as a group of characters with space at each end. Prepayment is required of individuals but not of institutions. For an additional $10.00 charge, announcements can be placed anonymously. Correspondence will be forwarded.

DEADLINES are listed on the inside front cover.

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SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-556-7774 and speak to Paula Montella for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940. Individuals are requested to pay in advance, institutions are not required to do so.

POSITIONS AVAILABLE

Department of Mathematics
University of Alberta

Applications are invited for tenure-track positions, subject to budgetary approval, in Approximation Theory (File AP-1), Numerical Optimization or Partial Differential Equations (File NP-1), in Number Theory (File NT-1), or closely related areas and Algebraic or Differential Topology (File AT-1) at the Assistant Professor level, beginning July 1, 1989. Requirements are a Ph.D. and proven ability or demonstrated potential for research and teaching. Current salary range is from $33,144 (Canadian) per annum depending upon qualifications. Send vitae and arrange for three letters of reference to be sent to: Professor L. H. Erbe, Chairman, Department of Mathematics, University of Alberta, Edmonton, Canada, T6G 2G1. In accordance with Canadian Immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Closing date for applications is October 31, 1988. Please quote file numbers when responding to this advertisement. The University of Alberta is committed to the principal of equity in employment.

University of Victoria

The Department of Mathematics at the University of Victoria is seeking strong candidates for the 1988-89 NSERC University Research Fellowship competition. These research fellowships have an initial term of up to five years and are awarded on a competitive basis by the Natural Sciences and Engineering Research Council of Canada. The duties of a University Research Fellow will include teaching one course per term in Mathematics and participation in the graduate program. Areas of research strength in the Department include discrete mathematics, non-linear PDE's in mathematical physics, and operator theory.

Applicants should submit, not later than August 30, 1988, a curriculum vitae and the name of at least 3 referees to:

Dr. C. R. Miers, Chairman
Department of Mathematics
University of Victoria
Victoria, B.C.
V8W 2Y2

The University of Victoria offers equal employment opportunities to qualified male and female applicants. NSERC regulations require that University Research Fellowship nominees be Canadian citizens or landed immigrants at the time of nomination.

University of Toronto
Department of Mathematics

The Department of Mathematics, University of Toronto is looking for strong applicants in pure or applied mathematics to nominate as candidates for NSERC Research Fellowships for 1989-90. These are five year research positions (subject to a review in the third year) with a teaching load of at most one course per year. One of the five years may usually be taken as a sabbatical. Successful candidates may, in special circumstances, be considered directly for a tenure-stream position.

Applicants should have a relatively recent doctorate and have demonstrated their ability with some substantive post-thesis research. They must be Canadian citizens or landed immigrants by November 1, 1988. The University of Toronto encourages both men and women to apply.

Applicants should send an up-to-date curriculum vitae, a short description of their research program, and arrange to have three letters of reference sent directly to Professor D. Masson, Associate Chairman, Department of Mathematics, University of Toronto, Toronto, Ontario, Canada M5S 1A1. This material should arrive before October 1, 1988. The Department's choice of candidates will be made in October and the final decision will be announced by NSERC in the spring.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY–DEPARTMENT OF MATHEMATICS. We anticipate making one or more tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Very strong research potential required for junior-level appointments and demonstrated outstanding record for senior-level appointments. Applications will be accepted until March 15, 1989, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

The Department of Mathematics is actively seeking applications in the area of discrete mathematics and combinatorics. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be accepted until March 15, 1989 or until a successful candidate is found. A formal letter of application expressing interest, a resume, and names, addresses, and telephone numbers of three references should be sent to Chairman, Discrete Mathematics Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

The University of Michigan, Ann Arbor, seeks a Director for its Residential College, an innovative unit of its College of Literature, Science and the Arts distinguished by its concern for undergraduate teaching in the arts, hunanities, social and natural sciences. The Director is expected to have a genuine interest in the opportunities to develop imaginative programs in a residential college environment, as well as a distinguished record of research. Appointment as Director is for five years, effective July 1, 1989. Appointment carries tenure, and will be made jointly with the university department appropriate to the Director's research specialization. Please send letter of application or nomination by September 30 to Associate Dean, Jack W. Meiland, 2522 LSA Bldg., University of Michigan, Ann Arbor, MI 48109. The University of Michigan is an Equal Opportunity/Affirmative Action Employer.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY-DEPARTMENT OF MATHEMATICS. One position for a senior visitor (Associate or Full Professor) in Analysis is anticipated for the academic year 1989–1990. The position can be split into two one-semester appointments. Areas of expertise of potential interest to current faculty members are preferred. Duties are expected to include teaching of a topics course and interaction with graduate students. Salary is negotiable. Applications received by September 1, 1988 will be considered. To apply, send curriculum vitae to Joseph A. Ball, Chairman, Analysis Visitor Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061. Virginia Tech is an Equal Opportunity/Affirmative Action employer.

UNIVERSITY OF COLORADO AT COLORADO SPRINGS, DEPARTMENT OF MATHEMATICS, COLORADO SPRINGS, CO 80933-7150

Applications are invited for several tenure-track positions starting Fall 1989. Preferred areas: Algebra, Differential Equations, Harmonic Analysis, Probability and Statistics. However, candidates with research interests outside of these areas are also encouraged to apply. Applicants should have significant research accomplishments or exceptional research promise and evidence of good teaching ability. Ph.D. is required. Salary and rank are negotiable. The average weekly teaching load is 7 1/2 hours. There is generous support for faculty development like conference travel, teaching off-loads and summer research. Please arrange to send a resume and 3 letters of reference to Dr. K. M. Rangaswamy, Chairman. Initial screening will begin on December 1, 1988 and continue through March 1989 or until all positions are filled. UCCS is an Equal Opportunity/Affirmative Action Employer.

The Department of Mathematics is actively seeking applications in the area of computational mathematics and numerical analysis. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be reviewed as they are received and will be accepted until the positions are filled. A formal letter of application expressing interest, a resume, and the names, addresses, and telephone numbers of three references should be sent to Chairman, Numerical Analysis Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

McGill University
Department of Mathematics and Statistics

The Department of Mathematics and Statistics at McGill University is seeking to fill a tenure-track Assistant or Associate Professorship in Mathematical Statistics in September 1989.

The applications should be sent to:

Professor K. P. Russell, Chairman
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
Montreal, Quebec, Canada
H3A 2K6

Please include a statement of research accomplishments and plans along with your letter of application, and arrange for 3 letters of recommendation to be forwarded. McGill University is an equal opportunity employer, but in accordance with the Canadian Immigration requirements priority will be given to Canadian citizens and permanent residents. The deadline for the receipt of completed applications is October 28, 1988.

POSITIONS AVAILABLE

UNIVERSITY OF CAPE TOWN POSTS IN THE DEPARTMENT OF APPLIED MATHEMATICS

Applications are invited for the following posts (starting dates negotiable):

PROFESSOR

Priority will be given to applications from scholars whose major interests and activities are in mechanics (solid and/or fluid), but consideration will also be given to applicants of standing in mathematical modelling of complex systems, such as biological, technological or socio-economic systems. Applied mathematicians whose major interests are in areas (for example, numerical analysis or differential equations) which are complementary to mechanics and mathematical modelling, are also invited to apply.

ASSOCIATE PROFESSOR, SENIOR LECTURER AND LECTURER

Applicants should be well-qualified, with teaching and research interests in any branch of Applied Mathematics, including mathematical modelling, general relativity and cosmology, and mechanics.

The salary packages include attractive staff benefits such as medical aid, a housing subsidy in certain circumstances and a good pension scheme. Further details concerning remuneration will be supplied on request.

The ranks of the successful applicants will be decided upon the basis of qualifications and experience; candidates should indicate in their letters of application for which post/s they wish to be considered.

Please submit a full curriculum vitae and the names and addresses of three referees (who should be supplied with a copy of the curriculum vitae and list of publications) to the Registrar (Attention: Appointments Office, Ref: DP), University of Cape Town, Rondebosch 7700, Republic of South Africa (telex: 5-22208 UCTADSA; telefax: 27-21-6502138). The closing date for applications is 15 August 1988, but late applications will be considered.

Further information may be obtained from the above, or from the Counsellor, Science and Technology, South African Embassy, Suite 350, 4801 Massachusetts Avenue, NW, Washington DC 20016.

The University's stand against apartheid and all racially discriminatory legislation is on record. Information on this as well as on the University's policy not to discriminate in the appointment of staff or the selection of students on grounds of sex, race or religion is obtainable on request.

SYDNEY/AUSTRALIA
THE UNIVERSITY OF NEW SOUTH WALES
SCHOOL OF MATHEMATICS
LECTURER IN PURE MATHEMATICS
(Tenured or tenurable appointment)
(REF 1039)

Applicants should have a PhD or equivalent qualification, and active research interests in an area of pure mathematics. Preference will be given to candidates whose research reinforces and extends existing strengths in the School. The successful applicant will be expected to participate in the general teaching activities of the School as well as in the teaching of pure mathematics at all levels and in the supervision of graduate students. The School is currently committed to developing its strengths in mathematical computer science.

The position will be available from February 1989, and appointment will be either with tenure, or on the basis of a contract with provision for conversion to tenure.

Further information from Professor I H Sloan, Head of School [(02) 697 2957].

Applications close on 16 September 1988.

Salary: $A28,694 range $A37,435

Commencing salary according to qualification and experience.

Applicants should forward two copies of their application, including curriculum vitae, telephone number during business hours, transcripts of academic record and the names and addresses of two referees to the Academic Staff Office, PO Box 1, Kensington, NSW, 2033, Australia.

Equality of employment opportunity is University policy.

Head, School of Civil Engineering
Purdue University

The Schools of Engineering at Purdue University invite nominations and applications for the position of Head, School of Civil Engineering. The successful candidate will possess outstanding leadership qualities and administrative abilities. The candidate shall be eligible for appointment as full professor with immediate tenure based on a distinguished record of scholarly activity to include teaching, research and service in the engineering profession.

Purdue is a land grant institution. The Schools of Engineering constitute one of the largest and highest quality engineering instructional and research organizations in the United States. The School of Civil Engineering currently has 58 faculty members and over 600 graduate and undergraduate students excluding freshmen. Research activities cover a broad range of topics and account for an annual expenditure of approximately $3 million. The curriculum spans a wide spectrum of Civil Engineering disciplines, with emerging technologies being continuously integrated into both instruction and research. The candidate selected shall be an innovative individual with a firm grasp and understanding of the current and future needs of the Civil Engineering profession.

The position will be available as early as 1 July 1989. Applications will be considered until the position is filled. Screening of applications will begin 1 August 1988. Nominations and applications should be sent to:

Dr. Henry T. Yang
Dean, Schools of Engineering
Purdue University
West Layfayette, IN 47907

Purdue is an Equal Opportunity/Affirmative Action employer.

POSITIONS AVAILABLE

NEW FACULTY
in
COGNITIVE AND NEURAL SYSTEMS
at
BOSTON UNIVERSITY

Boston University seeks a tenure track assistant professor starting in Fall, 1989 for its M.A. and Ph.D. Program in Cognitive and Neural Systems. This program offers an intergrated curriculum offering the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. Each faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic or computational research experience modelling a broad range of real-time nonlinear neural networks, especially in one or more of the areas: adaptive pattern recognition, speech and language, cognitive information processing, self-organization, and conditioning and attention. Send a complete curriculum vitae and three letters of recommendation to Professor Stephen Grossberg, Chairman, CNS Program, Center for Adaptive Systems, 111 Cummington Street, Boston University, Boston, MA 02215 by January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

McGill University
Department of Mathematics and Statistics

The Department of Mathematics and Statistics at McGill University wishes to sponsor a strong candidate for the Natural Sciences and Engineering Research Council of Canada (NSERC) 1988-89 University Research Fellowship Competition. These Fellowships are five year research positions (with a review in the third year), in the nature of Research Assistant Professorships, and carry a teaching load of at most one course throughout the academic year. Applicants should have shown some substantial research ability beyond their doctoral thesis. They should be Canadian Citizens or landed immigrants by November 1, 1988.

Interested candidates should send their curricula vitae to:-

Professor K. P. Russell, Chairman
Department of Mathematics and Statistics
McGill University
805 Sherbrooke Street West
Montreal, Quebec, Canada
H3A 2K6

They should arrange for at least two letters of reference from competent referees to be sent directly to the same address. All documentation should reach the department by September 9, 1988. The department will make its recommendations to NSERC early in October 1988. NSERC will announce its decision in March 1989.

NEW SENIOR FACULTY
in
COGNITIVE AND NEURAL SYSTEMS
at
BOSTON UNIVERSITY

Boston University seeks a full professor or associate professor starting in Fall, 1989 to act as Co-Director for its M.A. and Ph.D. Program in Cognitive and Neural Systems. The Co-Director will play a major role in curriculum development, administration, and training of mathematically advanced graduate students. The program curriculum offers the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. The faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic and computational research experience modelling a broad range of real-time nonlinear neural networks, enabling them to teach graduate courses including the areas of adaptive pattern recognition and self-organization. Send a complete curriculum vitae and at least three letters of recommendation to Professor Stephen Grossberg, Director, CNS Program, Center for Adaptive Systems, 111 Cummington Street, Boston University, Boston, MA 02215 by January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

POSITIONS AVAILABLE

FOR SALE

PASCAL-SC: Compilers for personal computers, documentation, software. FBSoftware, 5101 Odana Road, Madison, Wisconsin 53711. (608) 273-3702.

Journals from 1961, American Mathematical Monthly, Bulletin AMS.
For detailed information write
Professor Bert Ross
Mathematics Dept.
University of New Haven
West Haven, Conn. 06516

PUBLICATIONS

MATH SCI PRESS, 53 Jordan Rd., Brookline, MA 02146, (617)738-0307. SPECIAL SALE: INTERDISCIPLINARY MATHEMATICS, Vols. 1-9, 11-16, 18, 19. LIE GROUPS: 1-3, 6-8, 10, 11. SYSTEMS AND CONTROL: 1, 2. $10 plus postage for each volume.

Just appeared:

Z. Frolik (ed): General Topology and its Relations..., Proc. of the Sixth Prague Topol. Symp. 1986, 736 pp., DM 108.- or $66.-

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Order directly from: Heldermann Verlag, Nassauische Str. 26, D-1000 Berlin-West 31.

ANNOUNCEMENTS

CALL FOR PAPERS

PRIZE ($1,000) for **PHILOSOPHIA MATHEMATICA** (circulating in some 50 nations since 1964) on such topics as: 1. Ethics and Mathematics (in particular, Morals of Knowledge in general); 2. Sociology or Social Theory of Mathematics; 3. The Topological vs the Algebraic; 4. Others, related to the study on the Nature of Mathematics (definitely not via Logic alone). For details, write to: [Prof.] J. Fang, ODU (Phil), Norfolk, VA 23529-0083.

POSITIONS WANTED

Position in mathematics required for fall 1988. UK citizen. Ian D. Macdonald. Please call 011-44-259-61601.

UNIVERSITY OF WARWICK – ENGLAND

Professorship in Mathematics

Applications are invited for a Professorship in Mathematics, including possibly the Directorship of the Mathematics Research Centre, to succeed Professor E.C. Zeeman, FRS, the founding Professor of the Department, following his appointment as Principal of Hertford College, Oxford. The Department has strengths and research interests in both pure and applied Mathematics and it is expected that the successful candidate will be able to stimulate the work of the Department across the broad spectrum of the subject.

Salary will be on the Professorial scale: current minimum £23,380.

Applications (3 copies) should be sent to the Registrar, University of Warwick, Coventry CV4 7AL, United Kingdom, telephone: England (011 44) 203 523627 from whom further particulars may be obtained, quoting reference number 43/A/87/106 (please mark clearly on envelope). The closing date for applications is 1st October 1988.

UNIVERSITY OF WARWICK

New Mathematics WYSIWYG Typesetting Package for Macintosh Users

The Formulator™ word processor provides an interactive environment for preparing mathematical documents. It provides a front-end for the TEX program. Typesetting using the Formulator™ can be encoded, if so desired, in plain TEX markings language.

Formulator™ is a multi-window, full featured, equation processor that lets you create and edit equations effortless with a minimum of keystrokes. The rules of mathematical typesetting are understood by the program. Formulae appear on the screen just as they will be printed ('WYSIWYG'). Integrals, fraction bars, roots, etc. grow as you type.

'... It is highly automatic about making correct choices and can translate into TEX. What's more it came with one of the better HyperCard stacks I've seen. The stack is an introduction to Formulator, and is so well done that I could easily learn the features of the program in ten minutes.' R. Palais in these Notices.

For more detailed information, contact: IOS, P.O. Box 2848, Springfield, VA 22152-2848, USA. Telex: 499 49 67 info ctr; Fax: (703) 250 47 05.

SIAM Conference on

Domain Decomposition Methods

Intercontinental Hotel, Houston, Texas

March 20–22, 1989

Cosponsored by Société de Mathématiques Appliquées et Industrielles

The conference will present state of the art numerical solution methods for partial differential equations using domain decomposition. By breaking the original problem into smaller subdomains of the original problem, if correctly implemented, such an approach will require fewer computer resources and will lead to better utilization.

Who Will Attend

The conference will bring together specialists in areas such as partial differential equations, numerical analysis, computer science, geophysics, and engineers from the aerospace, oil, and chemical industry, and more generally, anyone who is involved in the numerical solution of large systems of partial differential equations.

For additional information, contact SIAM Conference Coordinator: 117 South 17th Street, 14th Floor, Philadelphia, PA 19103-5052. Telephone (215) 564-2929. E-Mail to SIAM@Wharton.Upenn.edu FAX Number: 215-564-4174

Conference Themes

- Mathematical Foundations of Domain Decomposition Methods
- Coupling Domain Decomposition Methods of Multigrid or Finite Element Methods
- Numerical Analysis of Domain Decomposition Methods
- Implementation on Parallel Computers
- Hyperbolic Problems and Computational Fluid Dynamics
- Finite Element Methods
- Spectral Methods
- Engineering Applications

Invited Presentations

(Tentative)

Software for Parallel Computers
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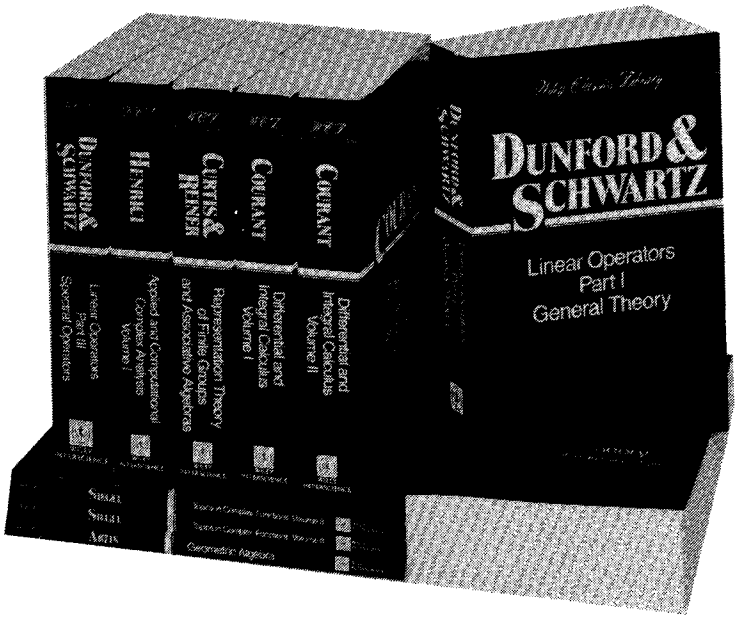

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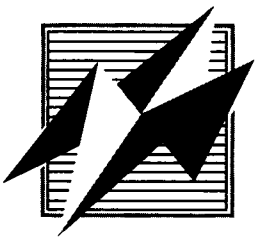

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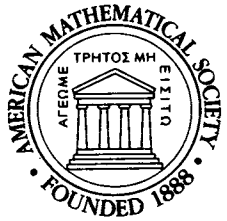

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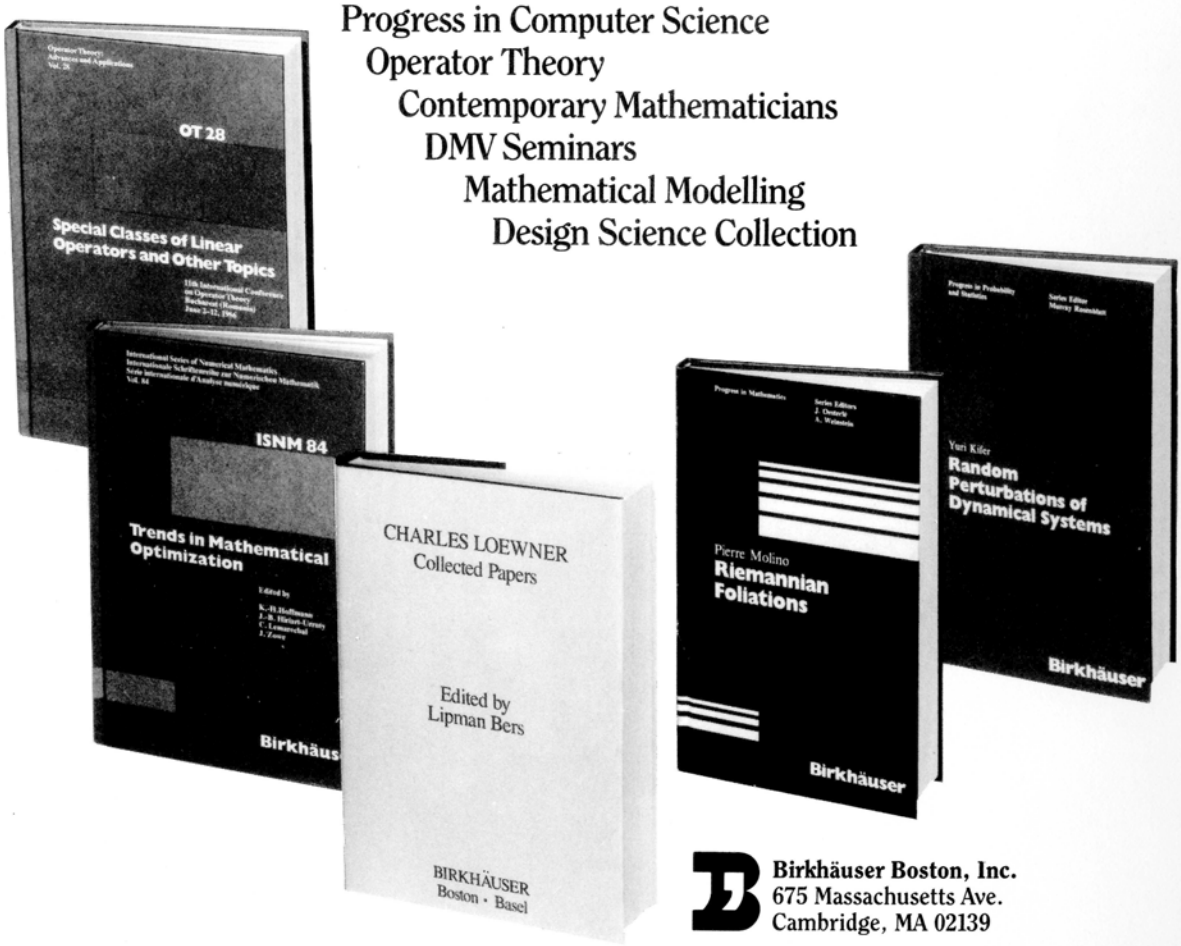

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